CHAPTER 3 LINE 11 "CORRIDOR-2" OR LINE 3 EXTENSION (TECHNICAL PART)

This chapter compiles the study and examination results to date for Corridor-2 (Line 3 Extension).

As of September 2025, it was formally agreed between JICA and MMRCL that Corridor-2 would be excluded from the scope of the Line 11 Project financed by ODA loan, due to the additional time required for the Government of India's project approval process. Accordingly, the present chapter is positioned as a reference document. The study results obtained thus far remain valid as technical findings; however, further examinations and some unfinished items are left as future tasks to be pursued once the approval process progresses.

3.1 Traffic Demand Forecast

3.1.1 Review of the Traffic Demand Forecast in DPR

The demand forecast model for Corridor-2 is as same as that of Corridor-1, which is based on the demand forecast model developed in CTS and maintained by IIT Bombay. On the other hand, the demand forecast for Corridor-1 and Corridor-2 was conducted in different studies by different consultants. Although the demand forecast model for both studies is the same, the model is calibrated based on the traffic survey of each study. The demand forecast of Corridor-2 was updated in July 2024 although it does not consider the change in the alignment of Corridor-1 from the DPR in 2023. The network of other metro lines is included in the demand forecast for Corridor-2. Table 3.1.1 shows the transfer between Line-3 and other lines in the demand forecast.

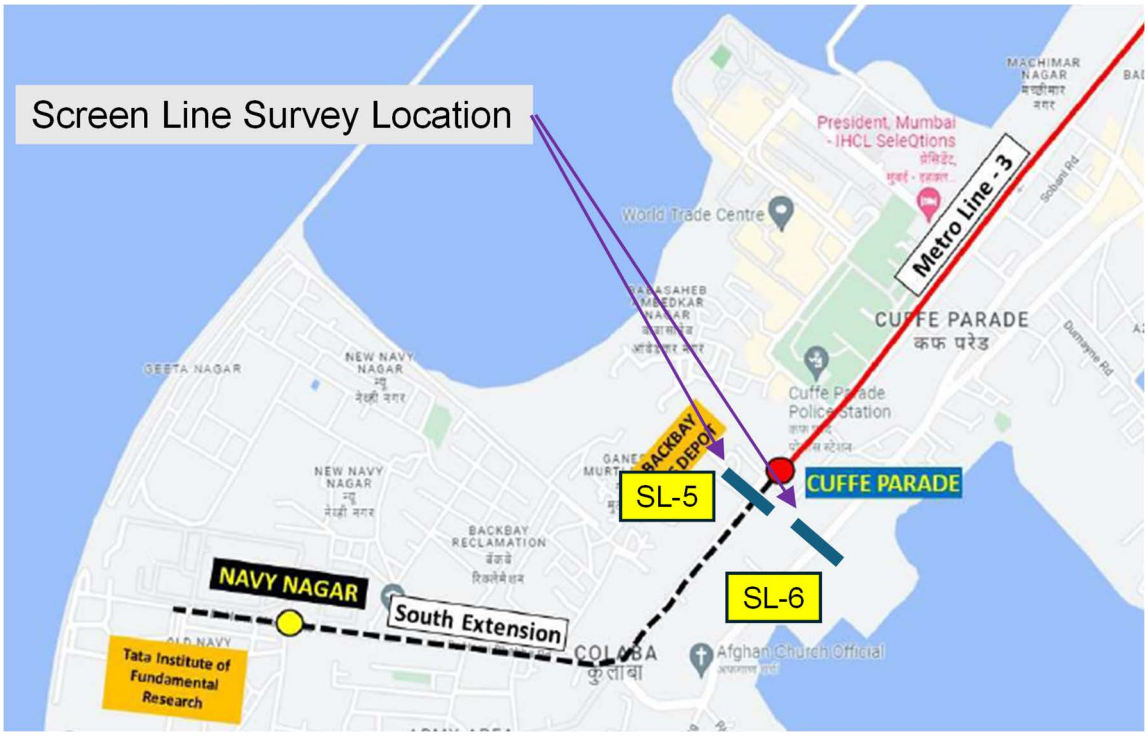
Table 3.1.1 Transfer Between Line-3 and Other Metro Lines

Metro Lines		Transfer		
From	To	2026	2031	2041
3	1	7,135	7,357	7,367
	2	11,597	12,109	13,326
	6	6,166	6,473	7,776
	8	2,870	3,655	4,762
	7A	3,245	3,346	3,971
	11	3,808	3,857	4,300
1	3	9,257	9,726	10,491
2		15,154	16,778	18,017
6		10,410	11,220	12,734
8		4,857	5,549	8,026
7A		5,961	6,506	8,373
11		7,589	7,609	8,204

Source: Consultant of the DPR for Corridor-2

For Corridor-2, traffic surveys around Corridor-2 were conducted in 2023, in which the locations of the screen line surveys are shown in Figure 3.1.1. The traffic volume between Cuffe Parade and Navy Nagar

for both directions was 40,569 vehicles per day and the peak hour traffic volume was 4,240 vehicles per hour (sum of SL-5 and SL-6). The traffic volume of bus along Corridor-2 was 455 vehicles per day including private buses and school buses. Along Corridor-2, motorcycle is the dominant mode accounting for 49.2% of the vehicle, followed by passenger car for 24.7% and taxi for 15.1% in terms of the number of vehicles.

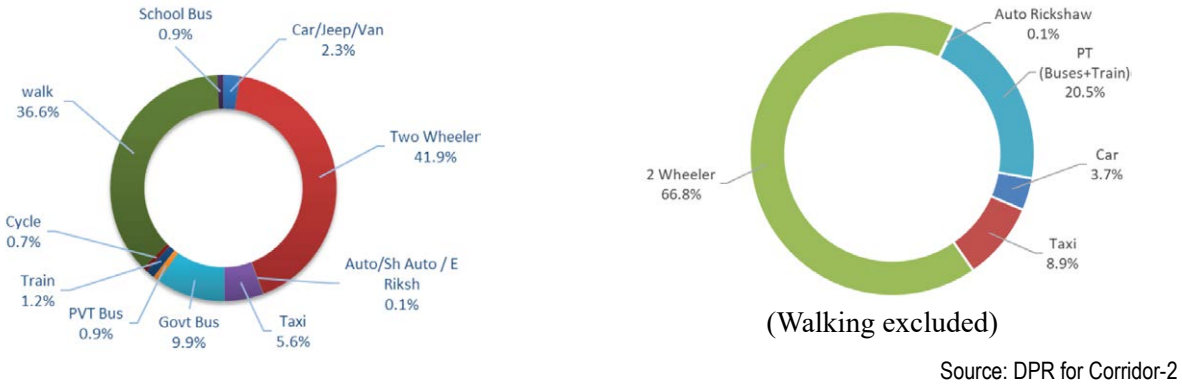


Source: DPR for Corridor-2

Figure 3.1.1 Screen Line Survey Locations

In 2023, a household interview survey for 400 households was conducted within the influence area between Cuffe Parade and Navy Nagar. Figure 3.1.2 shows the modal share around Corridor-2 based on the household interview survey. Motorcycle (two-wheeler) accounts for 41.9% in case that non-motorized modes are included, and 66.8% in case that non-motorized modes are excluded.

There is a difference in the conversion factor of peak hour traffic to the daily traffic. The study for Corridor-2 estimates the peak hour rate at 9% while that of Corridor-1 is 10%.



Source: DPR for Corridor-2

Figure 3.1.2 Modal Share around Corridor-2

3.1.2 Update of the Traffic Demand Forecast

In the previous plan of Corridor-1, CSMT Metro station was proposed adjoining to the underground station of Line 3, while the CSMT station of the final plan of Corridor-1 locates 100m far from the Line-3 station. In addition, while the alignment of the previous plan of Corridor-1 was far from that of Line-3 except for the south end (CSMT), the new alignment of Corridor-1 runs in parallel with Line-3 between Byculla and CSMT Stations. Although the distance between stations of both lines is as long as approximately 1km, the new alignment of Corridor-1 will affect the number of passengers of Line-3 because passengers using feeder modes from the east of Line-3 stations will shift to Corridor-1 stations.

Table 3.1.2 shows the transfer demand between Line-3 and Line-11 (original) at CSMT Station in the peak hour based on a hearing to the consultant of the DPR for Corridor-2. CMST Stations of Line-3 and the original plan of Line-11 are very close to each other while the CMST Station of Corridor-1 (revised) is located a little far away from the Line-3 station.

Table 3.1.2 Transfer Between Line-3 and Line-11 at CSMT Station in the Peak Hour

From	To	2031	2041
Line-3	Transfer + alighting	5,812	6,349
	Line-11	3,857	4,300
	Transfer rate (%)	66.4%	67.3%
Line-11	Transfer + alighting	11,493	11,851
	Line-3	7,609	8,204
	Transfer rate (%)	66.2%	69.2%

Source: Consultant of the DPR for Corridor-2

Considering the difference in the alignment of Corridor-1, it is assumed that the number of transfer passengers estimated in DPR for Corridor-2 will reduce 30%.

Table 3.1.3 shows the result of the adjustment of the projection of boarding and alighting of Line-3 and Corridor-2 in the peak hour. Since the horizontal years for the projections in the DPR for Corridor-2 were 2031, 2041, and 2051, the passenger demand for the year from 2034 to 2044 was estimated by the linear interpolation.

Table 3.1.3 Projection of Boarding and Alighting of Line-3 and Corridor-2

Station	2032		2034		2037		2042	
	Board	Alight	Board	Alight	Board	Alight	Board	Alight
Aarey Milk Colony	11,040	6,789	13,426	6,911	17,006	7,094	12,048	7,410
SEEPZ	1,647	1,223	2,003	1,245	2,536	1,277	1,797	1,334
MIDC	2,170	2,510	2,638	2,555	3,342	2,623	2,368	2,740
Marol Naka	12,140	9,193	14,764	9,358	18,701	9,605	13,249	10,033
CSIA (International)	16,414	9,497	19,962	9,668	25,284	9,923	17,913	10,364
Sahar Road	2,476	2,820	3,012	2,870	3,815	2,946	2,703	3,077
CSIA (Domestic)	2,349	6,862	2,857	6,985	3,618	7,170	2,563	7,489
Santacruz	2,620	2,274	3,186	2,314	4,035	2,375	2,859	2,481
Vidyanagari	4,773	4,989	5,805	5,079	7,353	5,213	5,209	5,445
Bandra Kurla Complex	19,034	14,500	23,148	14,760	29,319	15,150	20,772	15,824
Dharavi	4,490	4,794	5,460	4,880	6,916	5,009	4,900	5,232
Shitla Devi Temple	4,409	5,289	5,362	5,383	6,792	5,526	4,812	5,771
Dadar	3,569	3,028	4,340	3,082	5,498	3,164	3,895	3,304
Siddhivinayak	2,081	2,713	2,531	2,762	3,206	2,835	2,271	2,961
Worli	2,547	5,008	3,097	5,097	3,923	5,232	2,779	5,464
Acharya Atre Chowk	3,020	4,456	3,673	4,536	4,652	4,656	3,296	4,862
Science Museum	2,435	4,919	2,961	5,007	3,750	5,139	2,657	5,367
Mahalaxmi Metro	2,981	1,133	3,625	1,153	4,592	1,184	3,253	1,236
Mumbai Central	3,377	3,115	4,106	3,170	5,201	3,253	3,685	3,397
Grant Road	2,856	4,638	3,473	4,720	4,398	4,844	3,116	5,058
Girgaon	2,286	2,958	2,780	3,009	3,520	3,087	2,493	3,221
Kalbadevi	2,584	4,578	3,141	4,657	3,978	4,775	2,816	4,982
CST	8,146	4,289	9,889	4,362	12,504	4,470	8,801	4,660
Hutatma Chowk	890	4,467	1,082	4,544	1,370	4,661	970	4,863
Churchgate	619	2,393	753	2,433	953	2,492	675	2,595
Vidhan Bhawan	1,315	3,031	1,598	3,082	2,024	3,159	1,432	3,294
Colaba/Cufee Parade	1,223	2,009	1,487	2,043	1,882	2,094	1,332	2,183
Navy Nagar	1,085	1,101	1,319	1,119	1,670	1,147	1,182	1,196
Total	124,576	124,576	151,480	126,786	191,838	130,102	135,843	135,843

Source: Estimation by JST based on the DPR for Corridor-2

Table 3.1.4 shows the projection of daily passenger boarding and passenger-km of Line-3 and Corridor-2 after the adjustment.

Table 3.1.4 Passenger-km of Metro Line-3 and Corridor-2 (Daily)

Year	2031	2041	2051
Boarding	1,371,891	1,494,710	1,641,298
Passenger-km	11,833,292	12,899,987	14,165,106
Average trip length (km)	8.63	8.64	8.65

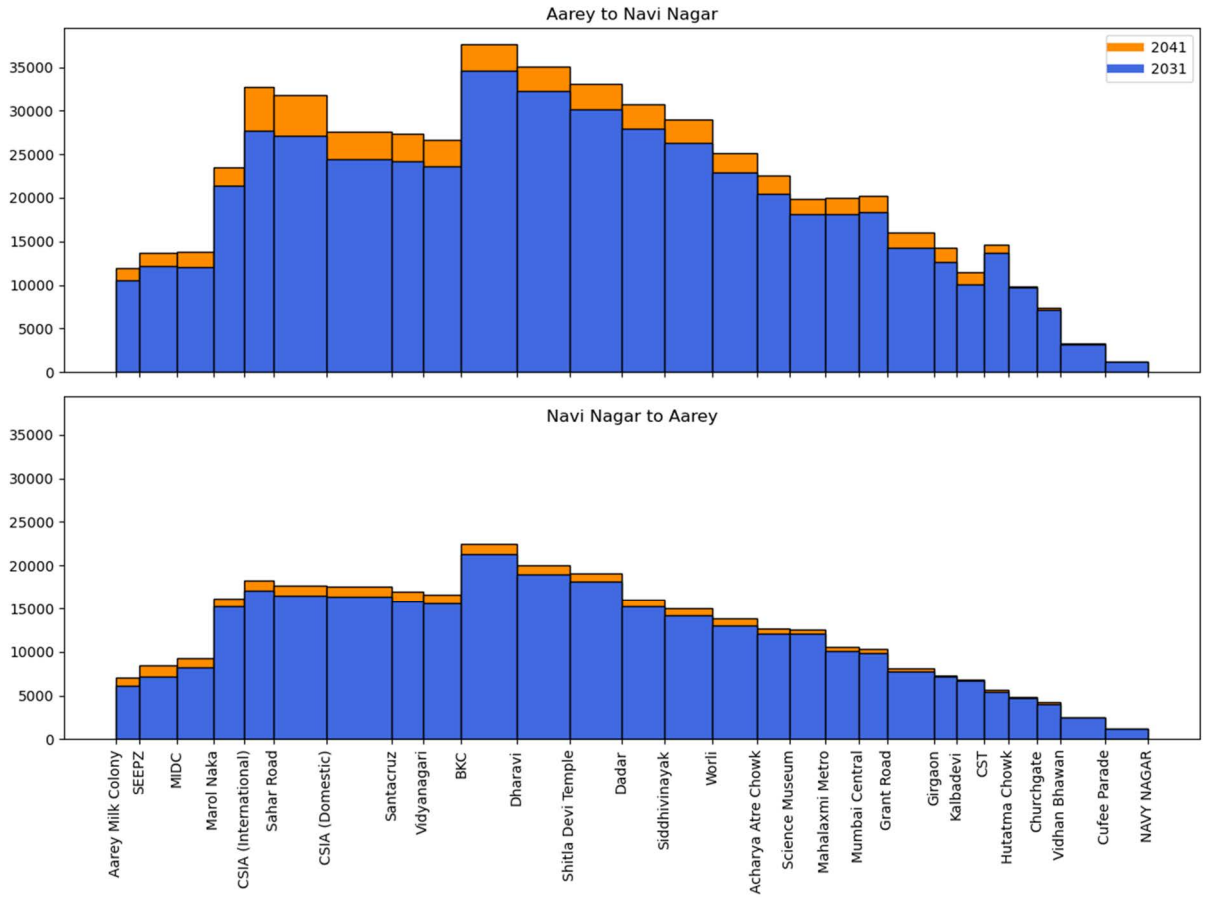
Source: Estimation by JST based on the DPR for Corridor-2

Table 3.1.5 shows the section-wise ridership of Line-3 and Corridor-2 by direction in the peak hour.

Table 3.1.5 Section-wise Ridership of Line-3 and Corridor-2 (Peak Hour)

Station		2032		2034		2037		2042	
A	B	A to B	B to A	A to B	B to A	A to B	B to A	A to B	B to A
Aarey Milk Colony	SEEPZ	11,040	6,789	11,238	6,911	11,535	7,094	12,048	7,410
SEEPZ	MIDC	12,687	8,012	12,914	8,156	13,256	8,371	13,845	8,744
MIDC	Marol Naka	12,710	8,376	12,938	8,527	13,280	8,752	13,871	9,141
Marol Naka	CSIA (International)	22,067	14,786	22,463	15,051	23,057	15,449	24,082	16,136
CSIA (International)	Sahar Road	30,613	16,414	31,162	16,709	31,985	17,150	33,408	17,913
Sahar Road	CSIA (Domestic)	29,746	15,892	30,280	16,177	31,080	16,604	32,462	17,342
CSIA (Domestic)	Santacruz	25,527	16,185	25,985	16,476	26,671	16,911	27,857	17,663
Santacruz	Vidyanagari	25,298	15,611	25,752	15,890	26,432	16,310	27,607	17,035
Vidyanagari	BKC	24,635	15,163	25,076	15,435	25,739	15,843	26,883	16,547
BKC	Dharavi	34,798	20,792	35,422	21,165	36,358	21,724	37,974	22,690
Dharavi	Shitla Devi Temple	32,265	18,563	32,843	18,896	33,710	19,395	35,209	20,257
Shitla Devi Temple	Dadar	30,340	17,517	30,883	17,831	31,699	18,302	33,108	19,115
Dadar	Siddhivinayak	28,108	14,744	28,611	15,008	29,367	15,404	30,672	16,089
Siddhivinayak	Worli	26,482	13,751	26,956	13,997	27,668	14,366	28,897	15,004
Worli	Acharya Atre Chowk	22,915	12,645	23,326	12,871	23,941	13,211	25,005	13,797
Acharya Atre Chowk	Science Museum	20,408	11,573	20,773	11,780	21,321	12,090	22,268	12,626
Science Museum	Mahalaxmi Metro	17,887	11,537	18,207	11,743	18,687	12,052	19,516	12,586
Mahalaxmi Metro	Mumbai Central	17,825	9,626	18,144	9,798	18,622	10,055	19,448	10,500
Mumbai Central	Grant Road	17,846	9,385	18,165	9,552	18,643	9,802	19,471	10,235
Grant Road	Girgaon	13,886	7,207	14,134	7,335	14,506	7,525	15,148	7,856
Girgaon	Kalbadevi	12,306	6,299	12,525	6,408	12,853	6,572	13,422	6,857
Kalbadevi	CST	9,914	5,902	10,090	6,001	10,353	6,149	10,808	6,409
CST	Hutatma Chowk	12,793	4,923	13,009	5,010	13,335	5,139	13,903	5,364
Hutatma Chowk	Churchgate	8,443	4,151	8,584	4,223	8,796	4,332	9,168	4,521
Churchgate	Vidhan Bhawan	6,088	3,571	6,191	3,633	6,346	3,727	6,615	3,889
Vidhan Bhawan	Cufee Parade	3,096	2,295	3,149	2,335	3,227	2,395	3,364	2,500
Cufee Parade	Navy Nagar	1,101	1,085	1,119	1,104	1,147	1,133	1,196	1,182

Source: Estimation by JST based on the DPR for Corridor-2



Source: Estimation by JST based on the DPR for Corridor-2

Figure 3.1.3 Peak Hour Section Traffic by Direction of Metro Line-3

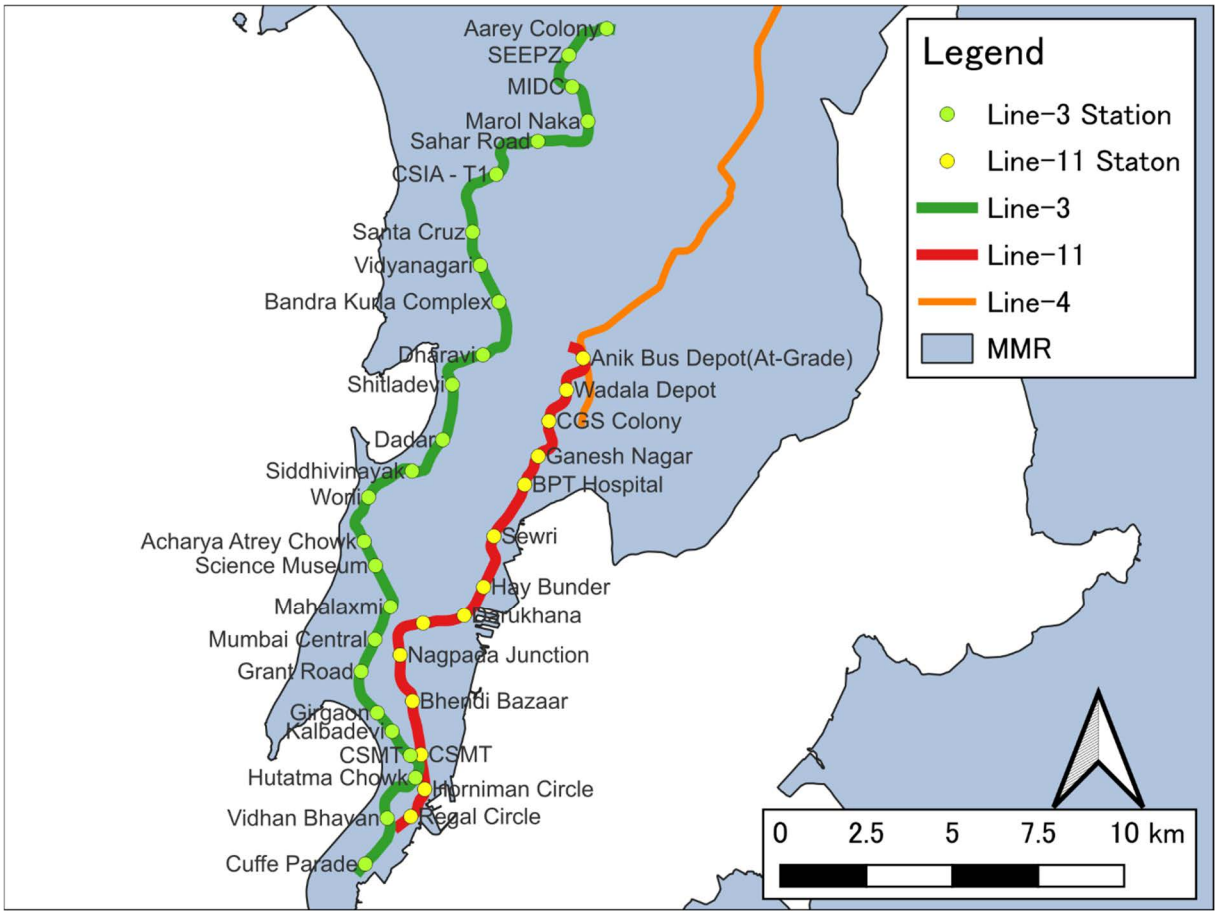
3.1.3 Demand Forecast for Scenario Analysis

3.1.3.1 Demand Forecast for Corridor-1 without Line-3 and Corridor-2

Although the Metro Line-3 is under construction, it is necessary to evaluate the project of Metro Line-3 and its extension (Corridor-2) as a project (See the detail in the economic analysis chapter). In this case, demand forecast of Corridor-1 without Line-3 is required for the without case of Line-3 and Corridor-2 in the economic analysis.

Since both Line-3 and Corridor-1 run north and south in parallel, passengers of Line-3 will shift to Corridor-1 in the demand forecast if Line-3 is removed from the network of the model. Therefore, the demand forecast without Line-3 requires another study by removing Line-3 from the present demand forecast model.

Figure 3.1.4 shows the alignment of Line-3 and Corridor-1. It is expected that a part of passengers of Line-3 between Mahalaxmi and Vidhan Bhavan will shift to Corridor-1 in case that Line-3 is removed from the demand forecast model.

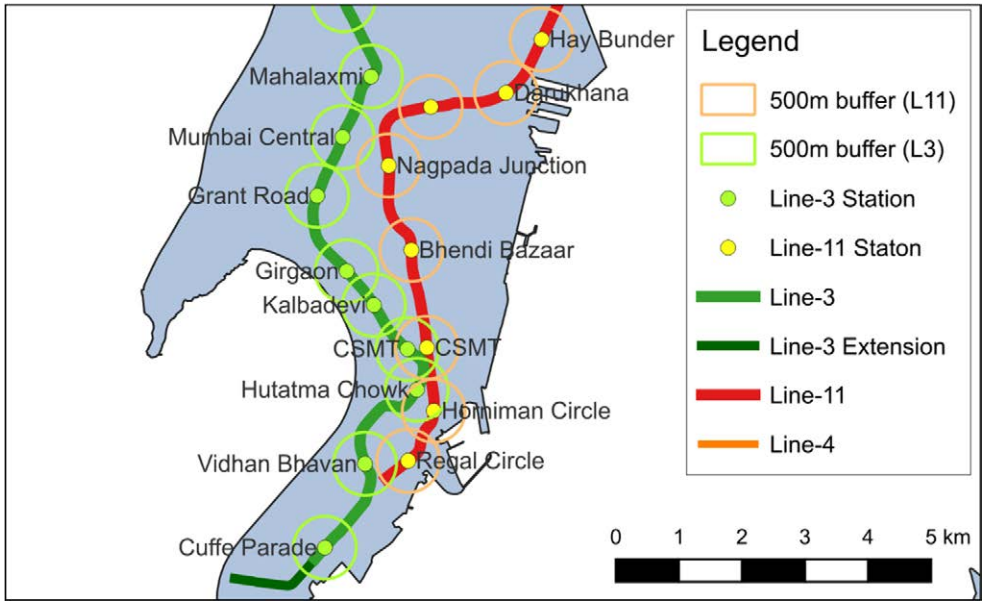


Source: Illustration by the JST

Figure 3.1.4 Location of Line-3 and Line-11

Passenger volume between Mahalaxmi and Vidhan Bhavan of Line-3 in the peak hour is 18,300 in 2031 and 19,960 in 2041, respectively, according to the hearing to the DPR consultant. Figure 3.1.5 shows the locations of stations and 500m radius circle from stations. In without Line-3, passengers for long distance trips will shift to Line-11 by changing the feeder mode. On the other hand, it is assumed that

passengers who travel only one or two sections will not shift to Line-11 without Line-3 considering the distance between stations and the distance between Line-3 and Line-11.



Source: Illustration by the JST

Figure 3.1.5 Station and 500m Radius Buffer Circle

Table 3.1.6 shows the estimation of passenger boarding and passenger-km of Corridor-1 in case that Line-3 is not implemented.

Table 3.1.6 Passenger Forecast of Corridor-1 without Line-3 and Corridor-2

Passenger boarding per day				Passenger-km per day			
2031	2032	2041	2051	2031	2032	2041	2051
598,625	627,698	889,347	1,001,791	4,717,953	4,849,072	6,029,137	6,793,786

Source: DPR and the estimation by JST

3.1.3.2 Demand Forecast of Corridor-1 and Line-3 without Corridor-2

For the economic analysis of Corridor-2, passenger demand of Line-3 without Corridor-2 is necessary. The number of passengers boarding and alighting in the peak hour for Corridor-2 in 2031 is estimated at approximately 1,200 each as shown in Table 3.1.5, which accounts for only 1% of the passenger boarding and alighting of Line-3. If Corridor-2 is not implemented, some of these trips would use a feeder mode to Cuffe Parade Station to ride Line-3 or transfer a feeder mode from Line3 at the station. However, such demand would be small because the fare of the feeder system and the metro network is not integrated. Here, it is assumed that 25% of passengers between Cuffe Parade and Navi Nagar Stations will use a feeder mode to transfer at Cuffe Parade Station. In addition, if Corridor-2 is not implemented, the number of passengers of Corridor-1 will reduce because a part of passengers from/to Navi Nagar Station transfers to/from Corridor-1 at CSMT Station, although such demand is very small. Table 3.1.7 shows the result of the calculation of passenger boarding and passenger-km of Corridor-1 and Line-3 without Corridor-2 considering the assumptions above.

Table 3.1.7 Passenger Forecast of Corridor-1 and Line-3 without Corridor-2

Passenger boarding per day				Passenger-km per day			
2031	2032	2041	2051	2031	2032	2041	2051
1,931,527	1,972,549	2,341,749	2,596,631	16,289,403	16,524,897	18,644,350	20,646,189

Source: DPR and the estimation by JST

3.1.4 Estimation of Traffic Impact during the Construction Period

The same method as Corridor-1 was applied to estimate the traffic impact during the construction period of Line-3 and Corridor-2. Line-3 stations are underground stations except for Aarey Colony Station, and stations under road constructed by cut and cover method have caused traffic congestion. The following 13 stations are considered to calculate the delay by road closure: SEEPZ, Sitaladevi, Dadar, Worli, Archarya Atre Chowk, Mahalxmi, Central, Grant Road, Girgaon, Kalbadevi, Hutatama Chowk, Cuffe Parade, and Navi Nagar.

Table 3.1.8 and Table 3.1.9 show the results of the calculation of the delay by construction in passenger-hours for Line-3 and Corridor-2, respectively.

Table 3.1.8 Calculation of Delay in Passenger-hours (Line-3)

Car	Taxi	Rickshaw	2-Wheeler	Bus	Truck	Total
1,854,458	1,145,400	3,654,372	4,063,444	4,472,515	320,760	15,510,950

Source: Estimated by JST

Table 3.1.9 Calculation of Delay in Passenger-hours (Corridor-2)

Car	Taxi	Rickshaw	2-Wheeler	Bus	Truck	Total
154,538	95,450	304,531	338,620	372,710	26,730	1,292,579

Source: Estimated by JST

3.2 Civil Engineering and Alignment

3.2.1 Route Plan and Alignment

3.2.1.1 Chainage

For this study, a survey centre line has been established. The survey centre line has a chainage, while the track centre line has not chainage. The 0 km chainage set at the centre of the Cuffe Parade. From the 0 km point towards the Navy Nagar station, the chainage counts minus number to the beginning point of the alignment for this project. The beginning point of the alignment is -1k900m that is located the end of stabling lines at Navy Nagar station. The chainage of the Navy Nagar station is -1k409m163.

3.2.1.2 Design criteria

The design criteria for track alignment is the same as for Line-11 Corridor-1.

3.2.1.3 Track centre distance

(1) Minimum track centre distance

The minimum track centre distance, cant value, and maximum speed for each curve radius are the same as for Line-11.

(2) Track centre distance

In principle, the track centre distance is following the original plan provided from MMRCL. However, front, rear, at the Navy Nagar station, scissors crossover will be installed on the JST's revised plan for the train operation purpose. The track centre distance should be changed from 4.2 m to 4.5m. The track centre distance for the stabling tracks at the Cuffe Parade station will be 4.5 m and 5.58 m on the plan by JST.

3.2.1.4 Planned alignment

For realising the original alignment plan, the side part of existing tunnel that is used for the shunting neck of Line-3 should be excavated. The joint section between existing section and the newly constructed section has straight alignment section. However the distance of the straight line is 12 m only that is not satisfied design criteria that is mentioning 25m for the minimum straight length between curves. Also, the curve radius is 140 m only on a curved section from -1k052m to -0k865m. The design criteria has mentioned the minimum curve radius is 200 m for main lines. Current alignment plan for Line-11 Corridor-2 can be changed. However the changes are not to be significant like as changing the destination of the alignment plan. Therefore, JST is following the intension form MMRCL, and those section should be studied on the basic design phase.

3.2.1.5 Station locations

Station locations has not been changed.

3.2.1.6 Control points

The alignment between Cuffe Parade and Navy Nagar passes near the high-raise building called Aadarsh building. Therefore, it is necessary to note the building location and the foundations of the building when the basic design gas been conducted.



Source: JST

Figure 3.2.1 Aadarsh Building



Source: JST

Figure 3.2.2 Location of the Cuffe Parade Station

3.2.2 Track Structure

Track structure for Line 11 Corridor-2 is the same as Line-11 corridor-1.

3.2.3 Engineering Survey

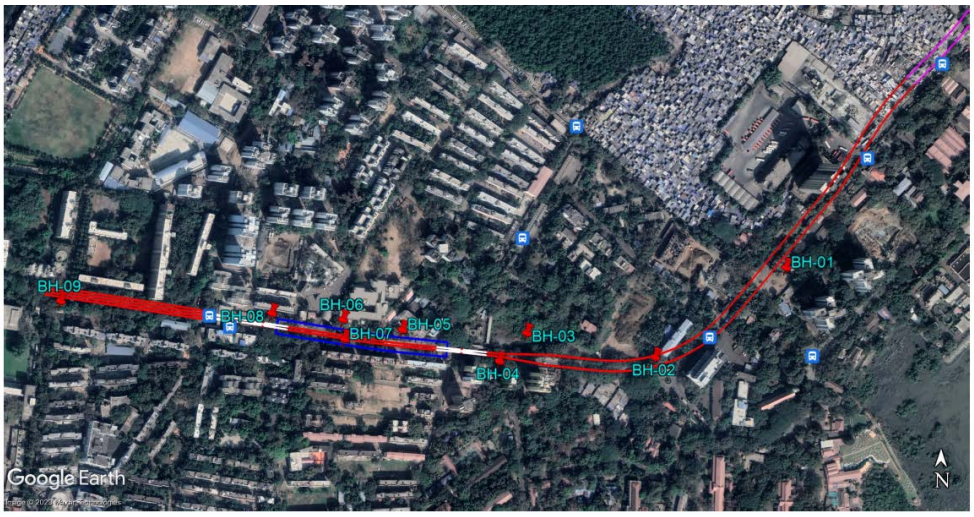
3.2.3.1 Geotechnical Survey

(1) Geotechnical conditions

The geological condition of corridor-2 is similar to corridor-1, with basalt bedrock layer formed by volcanic activities, and covered with alluvium in some areas.

(2) Survey location and specifications

MMRCL carried out a geotechnical survey at 9 sites between Cuffe Parade station which is the current terminal station of Line 3 and Navy Nagar station including stabling lines which are an extension of Line 3. As shown in Figure 3.2.3, geotehnical survey were carried out 4 sites (BH-05 ~ BH08) around the planned station location, 4 sites (BH-01 ~ BH04) in accordance with planned alignment and 1 site (BH-09) at the planned stabling line. The specifications of the boring survey are shown in Table 3.2.1. In addition to the geotechnical survey, laboratory survey for the soil and rock to confirm the physical and mechanical characteristics were carried out. Items of the laboratory survey shown in Table 3.2.2.



Source: DPR Line 3 Extension

Figure 3.2.3 Survey Sites

Table 3.2.1 Specifications of Boring Survey

Items	Contents
Survey interval	Every 1 km （Survey locations are considered in accordance with geological condition）
Number of sites	9
Borehole diameter	150 mm
Depth of drilling	30 m
Original position test （Soil）	Standard penetration test （Every 3 m）
Core Observation	Soil and Rock: Color, Weathering level, Characteristic Rock: Core Recovery, RQD

Source: Prepared by JST based on DPR

Table 3.2.2 Laboratory Survey for Soil and Rock

No.	Category	Items	IS Code
1	Soil	Sieve Analysis	IS2720 (Part 4)
2	Soil	Atterberg Limits	IS 2720 (Part 5)
3	Soil	Bulk/Dry Density	IS 2720 (Part 2)
4	Soil	Specific Gravity	IS 2720 (Part 3)
5	Soil	Natural Moisture Content	IS 2720 (Part 2)
6	Soil	Direct Shear Test	IS 2720 (Part 11)
7	Soil	Triaxial Shear Test	IS 2720 (Part 13)
8	Rock	Water Absorption	IS 13030 IS 1124
9	Rock	Specific Gravity	IS 1122
10	Rock	Unconfined Compressive Strength (UCS)	IS 9143
11	Rock	Point Load Index (PLI)	IS 8764
12	Rock	Rock Mass Rating (RMR)	IS 13365 (Part 1)

Source: Prepared by JST based on DPR

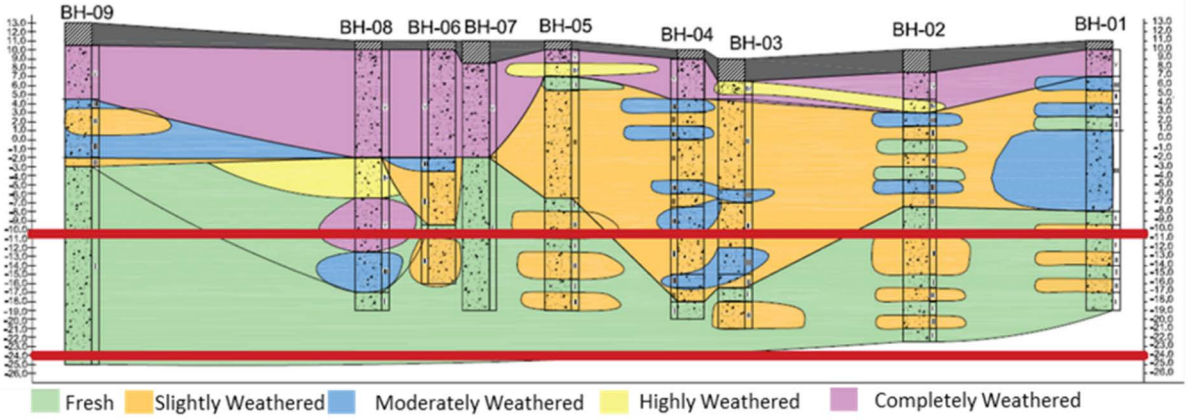
(3) Consideration and evaluation of geological survey results

- Number of the survey and locations

  As mentioned above, the survey was conducted at 9 sites along the route of approximately 2 km. This is considered sufficient to understand the geological conditions for the alignment of Corridor-2. During the design stage, it is necessary to confirm the elevation data for each borehole in order to accurately determine the construction depth of the MRT tunnel, as this information is not included in the DPR. This survey reviewed results with expected depth for tunnel construction (GL -10.5 to -24 m).

- Geotechnical conditions

  The geological conditions along the route indicate that the ground consists of alluvium and basalt bedrock layers, as shown in the geological cross section in Figure 3.2.4. The depth of the alluvium is relatively shallow, ranging from GL -1.5 m to GL -3 m from the ground surface, with bedrock located beneath the alluvium. As the depth of the bedrock increases from the ground surface, the effects of weathering decrease, and the rock becomes a harder layer. RQD results from each boring survey and unconfined compressive results of rocks from laboratory survey are shown in Figure 3.2.5.

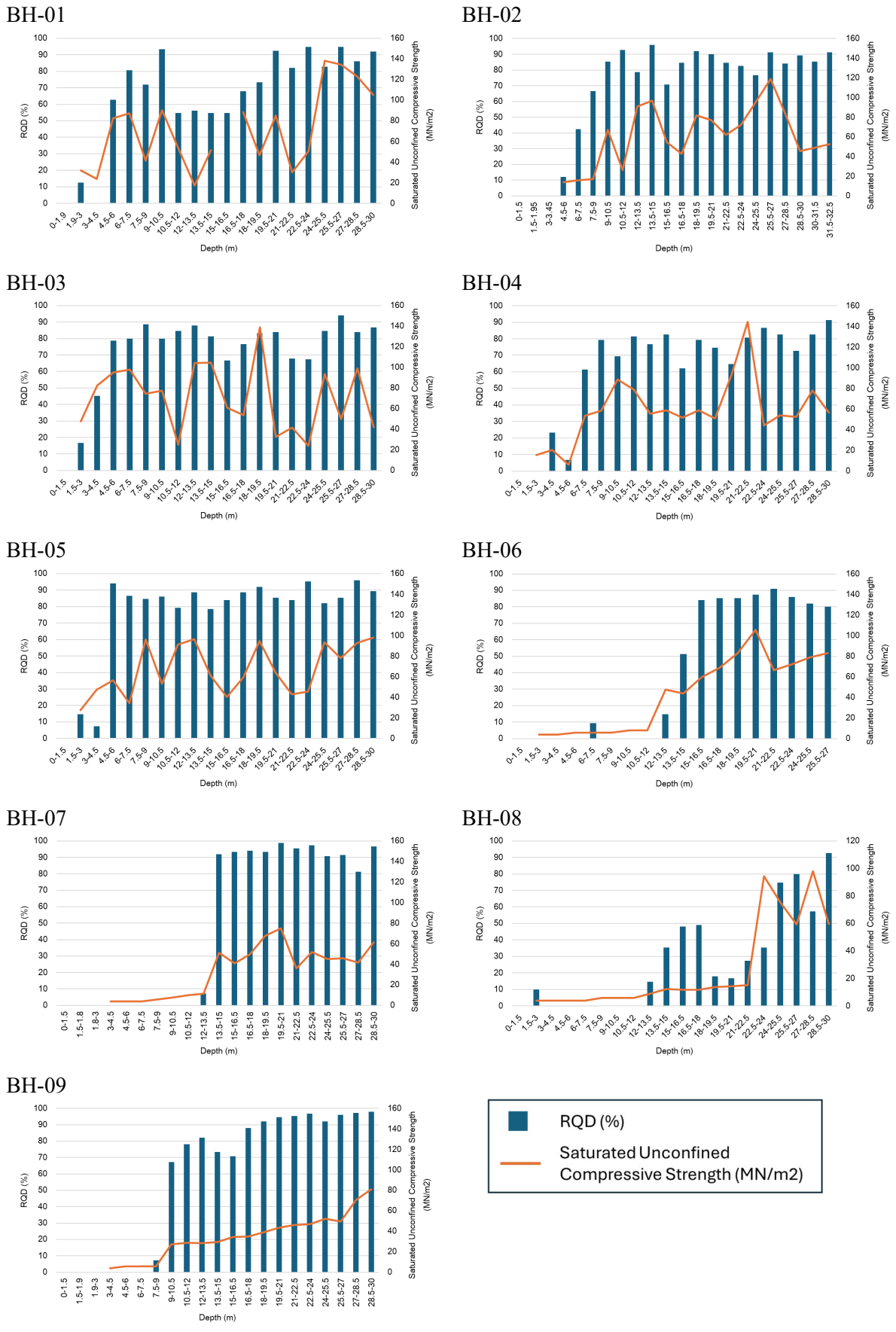


No.	Longitude	Latitude	Elevation (m)
BH-01	72.816313	18.908079	11
BH-02	72.814517	18.906895	10
BH-03	72.812739	18.907199	9
BH-04	72.812363	18.90683	10
BH-05	72.811023	18.90723	11
BH-06	72.810196	18.907355	11
BH-07	72.810219	18.907101	11
BH-08	72.809218	18.907437	8
BH-09	72.806228	18.907734	13

*India DEM Map

Source: Prepared by JST based of the DPR

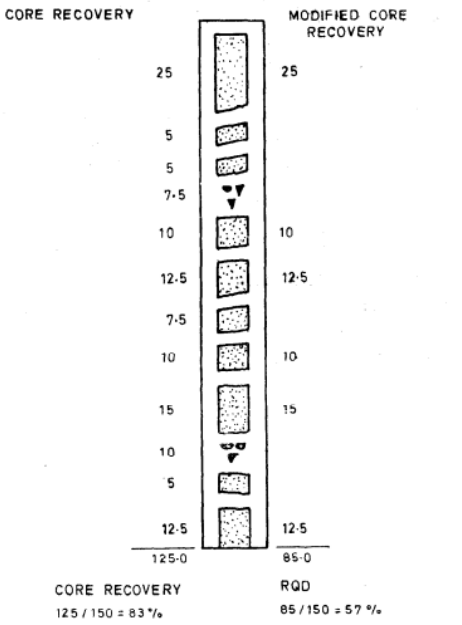
Figure 3.2.4 Geological Cross Section



Source: JST

Figure 3.2.5 RQD and Unconfined Compressive Results at Each Survey Site

RQD is an index used to assess the condition of rock fractures. As shown in Figure 3.2.6, it is expressed as the percentage of the total length of core samples longer than 10 cm relative to the drilling length (typically 1.5 m). A lower RQD indicates more fractured rock, which generally means the rock is more fragmented and brittle. The interpretation of RQD is shown in Table 3.2.3 according to IS11315 (Part 11). According to the RQD values for the depth expected for MRT underground tunnel construction (GL -10.5 m to -24 m), it tends to range from Excellent (90-100%) to Fair (50-75%), indicating high-quality rock with fewer fractures. However, there are sections categorized as Poor (25-50%) and Very Poor (below 25%), indicating densely fractured and brittle layers.



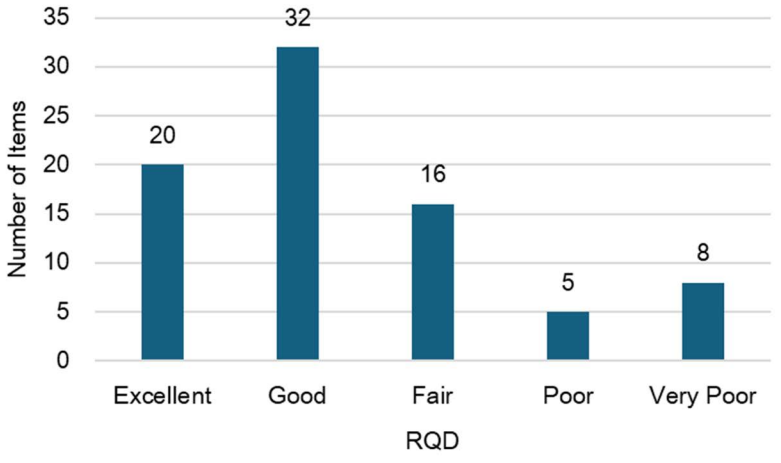
Source: IS1135 (Part 11)

Figure 3.2.6 RQD Calculation Method

Table 3.2.3 RQD Index

RQD (%)	Core Quality
90 - 100	Excellent
75 - 90	Good
50 – 75	Fair
25 – 50	Poor
< 25	Very Poor

Source: Prepared by JST based on IS1135(Part 11)

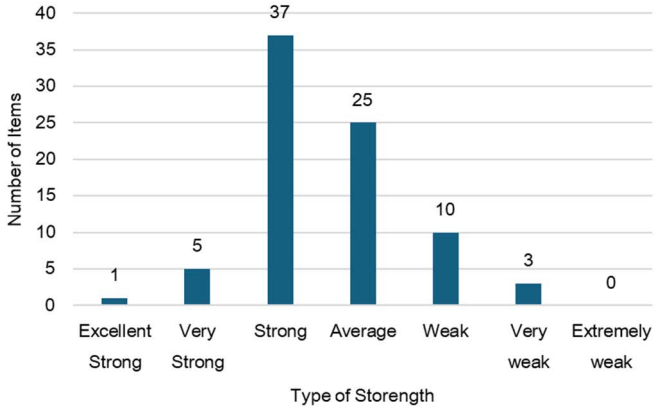


Source: JST

Figure 3.2.7 RQD trends (GL-10.5 to - 24 m)

The strength of the rock mass can be assessed from the results of the unconfined compressive strength test, and IS1336 (Part 1) classifies rock strength into seven categories as shown in Table 3.2.4. Looking

at the unconfined compressive strength of the rock at the depth assumed for MRT underground tunnel construction (GL -10.5 m to -24 m), it is able to see that the rock layers range from Exceptionally Strong (>250 MN/m²) to Extremely Weak (2 MN/m²). Based on the frequency of these categories shown in Figure 3.2.8, the rock is mainly classified as Strong (50-100 MN/m²) to Average (25-50 MN/m²), indicating that the rock layer at this depth has sufficient strength. On the other hand, considering the results classified as Weak or below, the unconfined compressive strength decreases at relatively shallow depths from GL-10.5 m to GL-13.5 m, where strong weathering is observed. Additionally, as shown in the geological cross-section Figure 3.2.4, a strongly weathered zone is observed down to a depth of GL -22.5 m at BH-08, where the unconfined compressive strength is also low.



Source: JST

Figure 3.2.8 Tend of Unconfined Compressive Level from GL-10.5 to -24 m

Table 3.2.4 Rock strength classifications

Type of strength	Compressive Strength (MN/m²)
Exceptionally Strong	> 250
Very Strong	100 - 250
Strong	50 - 100
Average	25 - 50
Weak	10 - 25
Very weak	2 - 10
Extremely weak	< 2

Source: IS 13365 (Part1)

In general, the geological conditions in Corridor-2 are stable, with few fractures in the bedrock, and the geology is sufficiently strong. However, the results of some boring surveys revealed strongly weathered zones with low rock strength at the depth assumed for MRT underground tunnel construction. In addition, mass fractures were observed in these areas. Since relatively deeply weathered zones have been identified along the MRT construction alignment, it will be important to verify the extent of weathering and its potential impact on construction during the detailed design stage.

(4) Necessity of additional survey and proposal

The geological conditions of the site are generally good conditions. There is the basalt bedrock layer under the several meters below the surface alluvium. The bedrock layer is generally stable, and it has

sufficient strength for MRT construction. The geological conditions are unlikely to pose a significant obstacle to construction. Therefore, no additional geotechnical investigations were conducted during this study, only an evaluation of the geotechnical conditions based on a review of the DPR and other relevant literature. It is suggested that a new geotechnical investigation be conducted during the design phase. Considerations for doing so are listed below.

I. Determining the necessity of soil boring survey: In the DPR, the soil boring survey was conducted on only the surface soil (approximately 1.5 to 3 m), and all depths under the level that were conducted as rock boring. For areas with low core recovery or where strong weathering is observed near the surface, it is advisable to switch to soil boring as needed and conduct standard penetration tests to confirm soil strength (N-value).

II. Survey around BH-06 to BH-08: At the survey site, it was confirmed that the strongly weathered zone extends to the depth assumed for MRT tunnel construction, and the rock strength is low. Therefore, in addition to the geological survey conducted in the DPR, it is advisable to conduct several additional boring surveys near BH-06 to BH-08 to confirm the geological conditions.

3.2.3.2 Topographic Survey

(1) Overview of topographic survey

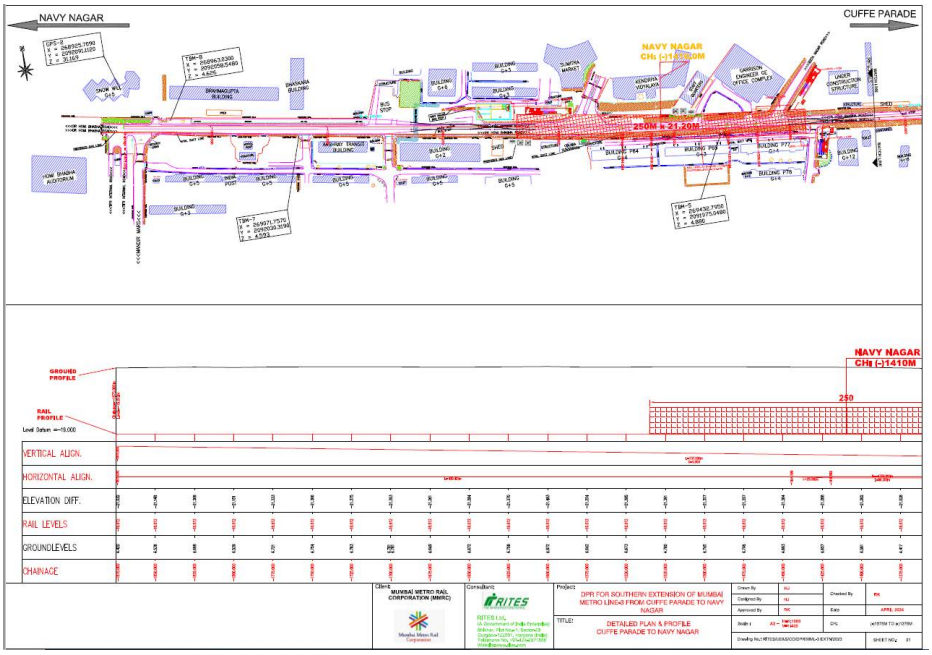
To conduct the survey, MMRCL prepared a draft alignment on free map software and then carried out the topographic survey within 50 m on each side from the centreline of the draft drawings (total 100 m both sides). The condition of the topographic survey is shown in Table 3.2.5.

Table 3.2.5 Condition of Topographic Survey

Items	Contents
Target area	100 m (50 m per side from track center)
Topographic Survey	• GPS survey • Traverse survey • Levelling survey

Source: JST

Based on the above conditions, JST collected floor plan, alignment and alignment profile as shown in Figure 3.2.9



Source: MMRCL

Figure 3.2.9 Floor Plan and Planned Alignment (Sample)

(2) Necessity of additional survey and proposal

The survey results received from MMRCL include the elevation, buildings, and road boundaries. It is considered sufficient to confirm the necessary land acquisition area and the number of obstacle buildings for the cut and cover method at the survey stage. Therefore, JST did not carry out an additional topographic survey. The following items are proposals for the design stage.

- Elevation data
  For corridor 2, elevation information was obtained by level surveying, which is insufficient data compared to the drone-based data for corridor 1. If the alignment proposed by MMRCL is subject to change, elevation data with a resolution of approximately 10 meters (mesh) will be required for alignment consideration.

- Updating information
  The development situation in Mumbai is remarkable, and numerous projects, including road viaduct and building construction, are still underway in parallel. Depending on the development status along the line, it is necessary to prepare new topographic survey. In this survey, an obstacle investigation was conducted to confirm future development plans along the route and underground obstructions. However, since the route passes through a naval area, it was not possible to obtain information regarding such plans. Therefore, during the detailed design stage, it will be conduct to update the drawings as appropriate based on the situation.

3.2.3.3 Obstacle survey

Mumbai has been developing rapidly in recent years, and with the construction of high-rise buildings, transportation infrastructures, and underground developments are being carried out. It is considered that there are many obstacles along the planned alignment of Corridor-1. Therefore, identifying underground

utilities which might be obstacles in MRT construction is important.

The DPR for Corridor 2 is organized with underground lifeline utility information such as overlapping locations with Corridor-2 (Table 3.2.6), agencies of each lifeline. On the other hand, other obstacles have not been investigated.

Table 3.2.6 Location of underground lifeline utilities in Corridor-2

TABLE 5.30: WATER PIPELINES

S. No	From Chainage (m)	To Chainage (m)	Affected Length (M)	Position LHS/RHS	Dia/Size (mm)	Depth (BGL in m)	Type	Position from Alignment	Diversion required	Utility Department
1	500	800	300.00	LHS	300	1.3	CI	Perpendicular	Yes	BMC
2	500	1644	1144.00	RHS	600	1.7	MS	Parallel	No	TIFR
3	500	1643	1143.00	RHS	300	1.6	MS	Parallel	No	TIFR
4	800	800	39.25	Crossing from RHS to LHS	300	1.2	CI	Perpendicular	Yes	BMC
5	802	802	42.16	Crossing from RHS to LHS	300	1.3	CI	Perpendicular	Yes	BMC
6	815	1287	472.00	RHS	300	1.4	CI	Parallel	No	BMC
7	920	1869	949.00	Center	600	1.5	MS	Parallel	No	TIFR
8	1682	1682	18.58	Crossing to LHS	600	1.8	MS	Perpendicular	Yes	TIFR
9	1865	1865	63.61	Crossing to LHS	600	1.5	MS	Perpendicular	Yes	TIFR
10	1869	1869	79.48	Crossing to RHS	600	1.5	MS	Perpendicular	Yes	TIFR

TABLE 5.31: SEWER PIPE LINES

S. No	From Chainage (m)	To Chainage (m)	Affected Length (M)	Position LHS/RHS	Dia/Size (mm)	Depth (BGL in m)	Position from Alignment	Diversion required	Utility Department
1	500	540	40.000	LHS	350	3.5	Parallel	No	BMC
2	509	532	23.000	LHS	350	3.6	Parallel	No	BMC
3	1471	1471	62.560	Crossing From LHS to RHS	450	4.00	Perpendicular	Yes	TIFR
4	1481	1826	345.000	RHS	450	4.00	On The Alignment	No	TIFR
5	1862	1875	13.000	CENTER	450	4.00	Parallel	No	TIFR

Source: MMRCL

(1) Characteristics of the Corridor-2

Corridor 2 is planned to construct tunnels and stations under the roads. High-rise buildings are being constructed along the corridor, and there is a possibility of interference between foundation piles and the MRT tunnel. Other public lifelines such as water, gas, electricity, and sewage are installed under the road. In addition, since the corridor passes through a naval area, there are concerns about underground use and interference with naval facilities. Therefore, obstacle survey was conducted.



Source: JST

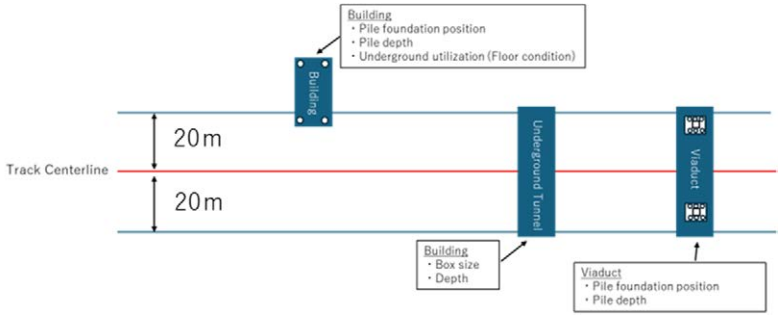
Figure 3.2.10 Example of Obstruction on Corridor-2

(2) Obstacle survey by sub consultant

There are several structures along the route of Corridor-2 that could potentially become obstacles to MRT construction. In the DPR, there is no specification about obstacles, and MMRCL only conducted an underground survey. Therefore, an obstacle survey by a subconsultant has been carried out to identify obstacles in corridor-2..

- Survey methodology

  The survey was conducted to identify obstacles that could potentially affect the MRT construction. The survey followed the alignment of Corridor-2 proposed by MMRCL and was carried out within a range of 20 m on either side (a total of 40 m) from the track center, as shown in Figure 3.2.11. The survey targeted underground utilities and structures, such as foundation piles, underground utilizations, and underground tunnels as well as any other underground structures that affect MRT construction. The specifications of the survey are shown in Table 3.2.7.



Source: JST

Figure 3.2.11 Survey range (total 40m)

Table 3.2.7 Survey Specifications

Item	Content
Objects	Identification of structures that could potentially affect underground tunnel construction
Survey Range	20 m on either side (a total of 40 m) from the track center of the planned route by MMRCL *The concept of the range is shown in Figure 3.2.11
Information Collected	• Location of structures • Owner/ Manager • Types • Length of foundation piles • Underground utilization
Target Structures	• Foundations pile of public and private buildings • Underground lifeline utilities (electricity, water, gas, sewage, etc.) • Others

Source: JST

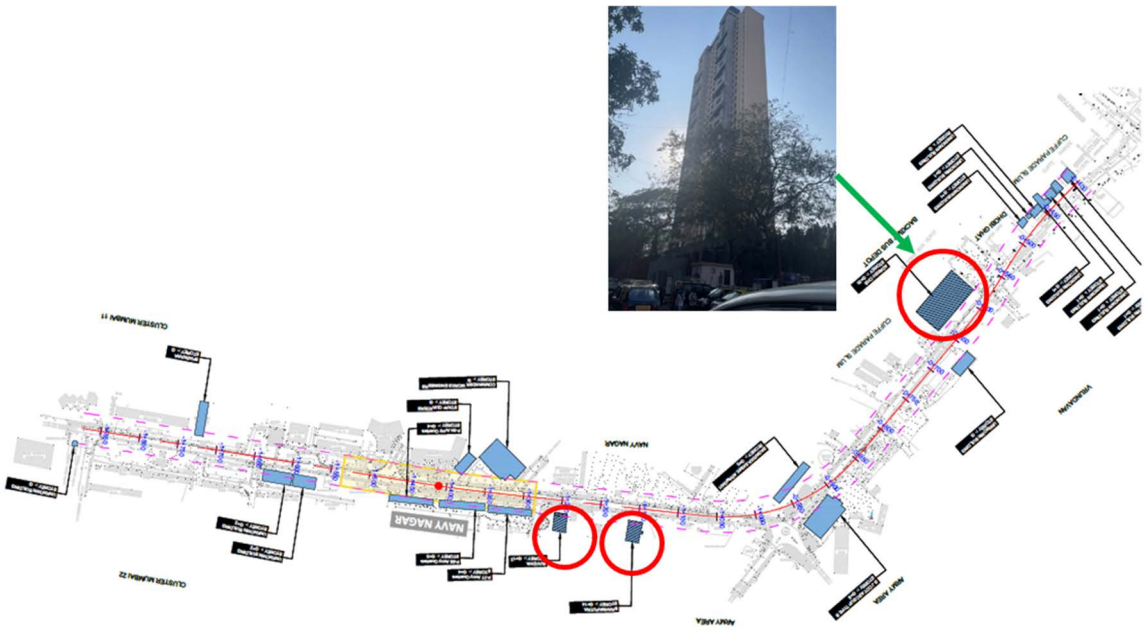
Due to the large number of buildings, it was challenging to verify the presence of foundation piles in detail. Therefore, the survey focused on high-rise buildings with 10 or more floors.

(3) Survey Results

1) Foundation piles for buildings

As shown in Figure 3.2.12, three buildings with more than 10 floors were identified within the survey area. These buildings fall under the jurisdiction of the Military Engineering Service. Although a request was made for information regarding their foundations, the data could not be obtained due to military-related restrictions. Since the ground in Mumbai typically consists of high-quality bedrock below GL -15 meters, it is assumed that, similar to the buildings along Corridor-1, these buildings are supported by raft foundations and retaining walls extending to around GL -20 meters.

In this survey, it was not possible to obtain information on the building foundations due to military restrictions. Accordingly, during the detailed design stage, it is expected that the General Consultant, in coordination with the Navy, will conduct further investigations and confirm the depths of foundation piles and sheet piles.



Source: JST

Figure 3.2.12 High-rise building in the survey area

2) Underground lifeline utilities

According to the survey conducted by MMRCL, utilities are installed at a relatively shallow depth from the surface. Considering the cross-sectional diameter of each utility, it is considered that they are within a range of about 5 meters from the surface. At station sites and other locations where cut-and-cover construction is planned, detailed countermeasures including utility diversions shall be examined in coordination with the agencies responsible for each utility. Based on a survey conducted by MMRCL, it is considered that underground lifelines are located at a shallow depth, approximately within a depth of GL -5 meters. In stations and other locations where construction using the open-cut method is planned, it is necessary to take precautions during construction, such as rerouting these lifelines.

In this survey, confirmation regarding underground lifelines was sought from the Ministry Engineer Service. However, due to military reasons, it was not possible to obtain detailed data. Since the results of the DPR survey also did not include detailed drawings of the underground lifelines, it can be said that additional investigations will be necessary when formulating construction plans. During the detailed design stage, it is expected that the General Consultant, in coordination with the Navy, will conduct further investigations and verify the relevant utilities as part of the proposed solution. Agencies of each lifeline are shown in Table 3.2.8

Table 3.2.8 Agency of underground lifeline utility agency

S. No.	Agency Name	Utility Services
1	Garrison Engineer (West), Colaba	Water Pipelines & Electrical HT/LT Lines
2	Garrison Engineer (NW), Navy Nagar	Water Pipelines & Electrical HT/LT Lines
3	Commander Works Engineer (NW)	Water Pipelines & Electrical HT/LT Lines
4	Commander Works Engineer (Army)	Electrical HT/LT Lines
5	Tata Institute of Fundamental Research (TIFR)	Water Pipelines & Optical Fiber Cables (OFC)/ Telecommunication Cables
6	New Navy Nagar, CANAC	Water and Sewer Pipelines & Optical Fiber Cables (OFC)/ Telecommunication Cables
7	BEST Undertaking, Colaba	Electrical HT/LT Lines & Optical Fiber Cables (OFC)/ Telecommunication Cables
8	BEST Bhawan, Colaba	Water and Sewer Pipelines
9	Mahanagar Gas Limited (MGL)	Gas Pipelines
10	Brihanmumbai Municipal Corporation (BMC)	Water and Sewer Pipelines
11	RELIANCE JIO Communication (OFC)	Optical Fiber Cables (OFC)/ Telecommunication Cables
12	MTNL (Cables)	Optical Fiber Cables (OFC)/ Telecommunication Cables

Source: MMRCL

(4) Necessity of additional survey and proposal

As stated in the above findings, due to Corridor-2 being a naval area, sufficient information regarding obstructions could not be obtained. During the detailed design stage, these datasets will be updated as necessary and incorporated into the design accordingly.

3.2.4 Civil Engineering

3.2.4.1 Overview of Civil structure plan and design concept

The civil design for Line 11 Corridor-2 follows the design criteria of the Line 3 project, ensuring consistency in technical specifications, structural integrity, and operational efficiency.

The Line 3 extension from Cuffe Parade to Navy Nagar is a critical expansion of the Mumbai Metro network, designed to enhance connectivity in the southern part of the city. This extension builds upon

the currently under-construction Line 3 and aims to facilitate seamless urban transit through an underground alignment.

(1) Civil Construction Plan

1) Recommended Option for Corridor Selection

According to the DPR, it has been observed during the site visit that Dr. Homi Bhabha Road may provide the optimum road width for the project. The General Consultant of Mumbai Metro Line-3, in consultation with MMRCL, has developed the following recommended option:

"A double side platform metro station in front of the Navy Residential Area, including a crossover before and after Navy Nagar Metro Station with an additional turnout and fan for the stabling yard."

2) Alignment Option for Stabling Lines

According to the DPR, after reviewing the Pre-feasibility Report prepared by M/s Maple, the General Consultant of Mumbai Metro Line-3, the recommended option for corridor selection was further developed, and additional alternatives were explored. Efforts were made to identify a suitable location for stabling lines beyond the proposed Navy Nagar Station. The options presented in Table 3.2.9 were analyzed and evaluated.

Table 3.2.9 Alignment Options Considered for Stabling Lines

Option	Tunnel Type	Station Platform	Stabling Lines	Total Length
A	Single Tunnel (10m)	Two side platforms	5 lines (1 rake on each)	1.60 km
B	Single Tunnel (10m)	Two side platforms	4 lines (2 rakes each)	1.90 km
C	Twin Tunnels	One island platform	4 lines (1 rake on each)	1.60 km

Source: JST based on DPR

A meeting was held between officials from TIFR, MMRCL, and RITES (23rd March 2023), where all three proposed options (A, B, and C) were presented and discussed in detail.

TIFR expressed concerns regarding the extension of the metro tunnel inside its premises, citing that highly precise scientific work conducted at microscopic and atomic scales using specialized, highly sensitive equipment would be severely disrupted. Additionally, TIFR stated that the alignment inside its premises was not acceptable and suggested that the extension should terminate near the TIFR entry gate.

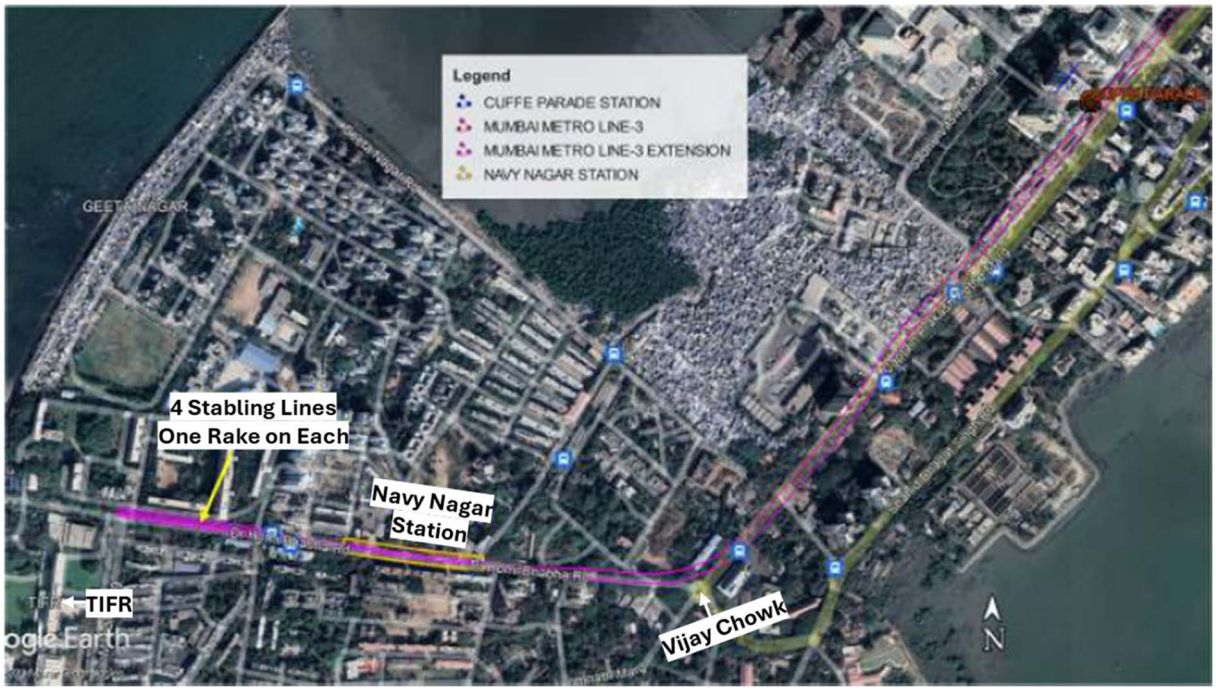
3) Revised Alignment Proposal by MMRCL

Following TIFR's concerns, MMRCL advised RITES to modify the alignment proposal as follows:

Twin tunnels up to Vijay Chowk, reducing the track center distance from 15m to 4.2m before Navy Nagar Station with two side platforms. In the revised DPR, it was changed from 4.2 m to 4.5 m.

Four underground stabling lines beyond Navy Nagar, terminating at the TIFR entry gate.

The final location and alignment of the proposed extension is shown in Figure 3.2.13



Note: Tata Institute of Fundamental Research (TIFR)

Source: DPR

Figure 3.2.13 Recommended Final Location and Alignment of Stabling Lines

Finalized Key Features of the Alignment:

- Total Length: 1.45 km
- Underground Station: Navy Nagar Station
- Stabling Lines: 4 underground stabling lines beyond Navy Nagar Station, ensuring efficient train operations, particularly for overnight stabling.
- Track Infrastructure: 2 scissors crossovers—one before and one after Navy Nagar Station—to optimize train movement and operations.

(2) Design Specification

The civil design specifications for Line 11 Corridor-2 refer to those of the Line 3 project.

(3) Underground Section

The underground section is divided into three parts: the underground tunnel section, the underground station section and underground stabling lines area. This section explains the construction methods for each of these underground sections.

1) Tunnel Section

Three construction method alternatives, based on the tunnel construction methodology, as outlined in as outlined in Table 3.2.10 and Figure 3.2.14 to Figure 3.2.19, have been evaluated in the DPR to determine the most feasible approach for implementation.

Table 3.2.10 Construction Methodology Alternatives for Line-11 Corridor-2

Construction Method	Alternative-1 Mix of C&C, NATM, TBM [m]	Alternative-2 Full C&C [m]	Alternative-3 Mix of C&C, NATM [m]
Cut-and-Cover	750	1,400	590
NATM	650	50	860
TBM	50	0	0
Total	**1,450**	**1,450**	**1,450**

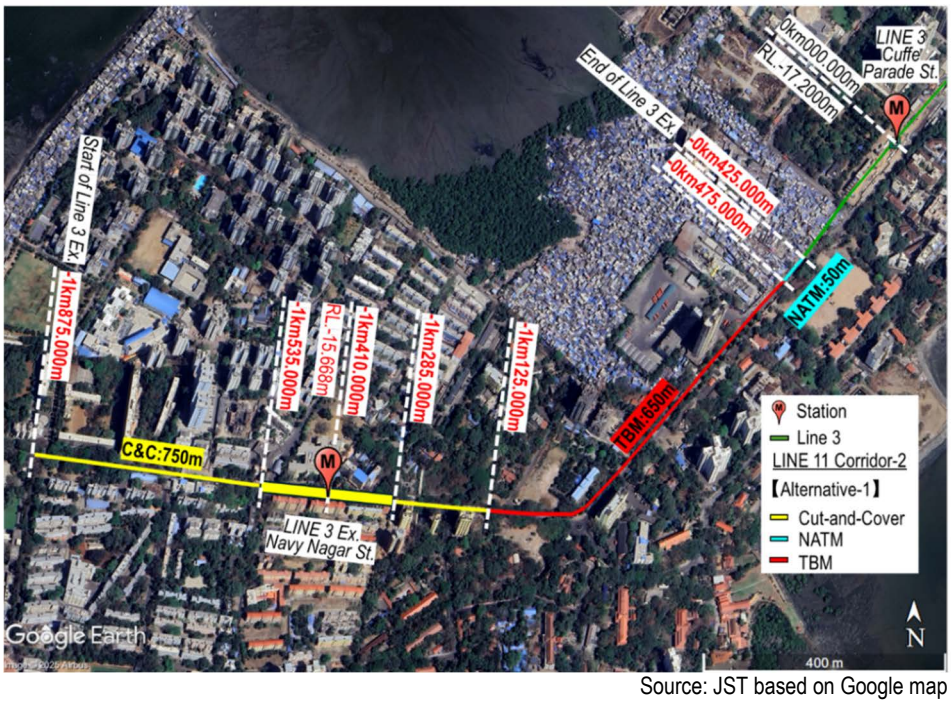
Source: JST based on DPR

The Table 3.2.11 compares these three tunnel construction alternatives—TBM (Alternative-1), Cut-and-Cover (Alternative-2), and NATM (Alternative-3)—based on key parameters such as construction period, land requirement, affected structures, and capital cost.

Table 3.2.11 Comparison of Three Alternatives for Line 11 Corridor-2

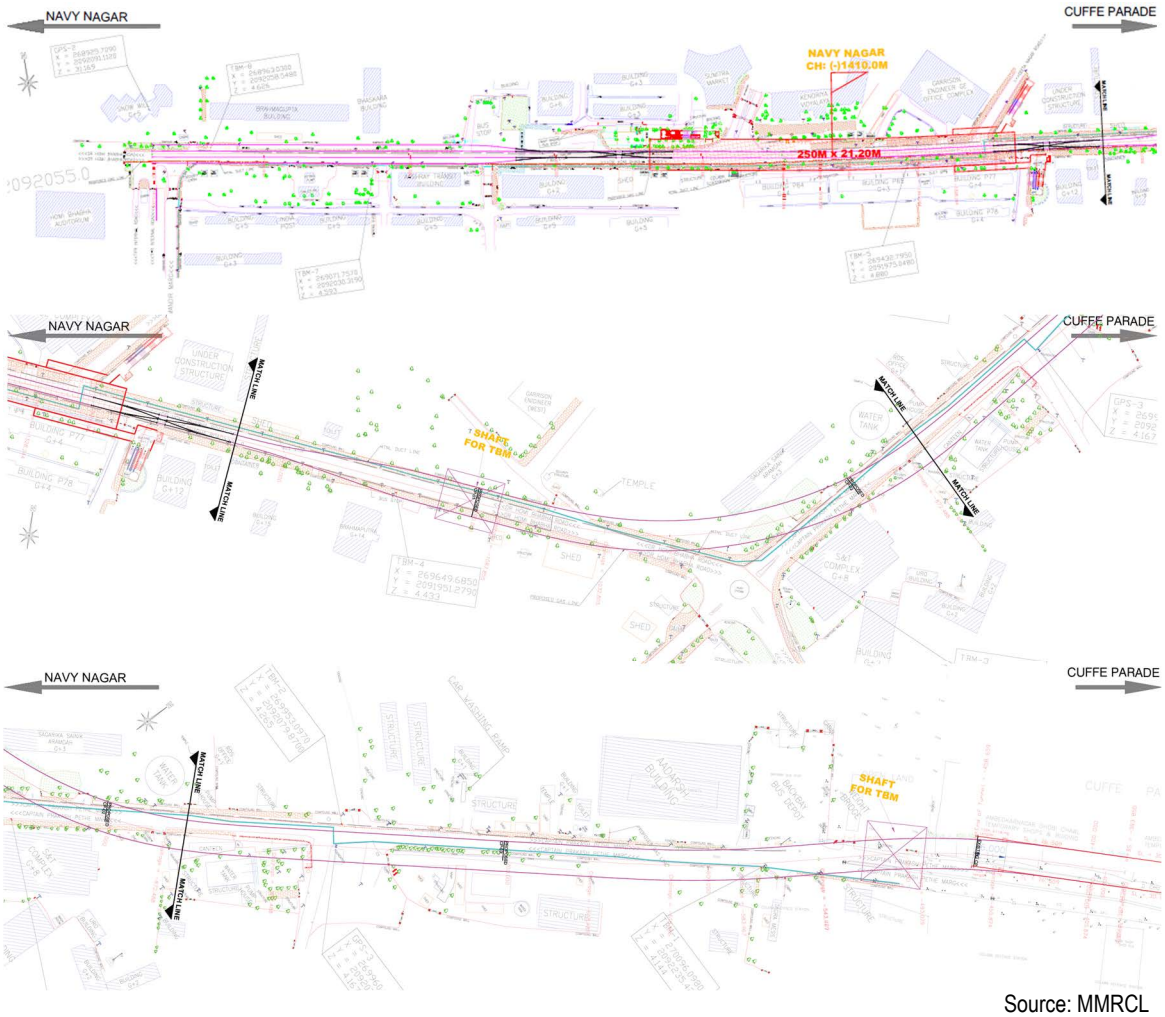
Description (Construction method of tunnel)		Alternative-1 (TBM)	Alternative-2 (Cut-and-Cover)	Alternative-3 (NATM)
Construction Period	Years for Civil Works	2	2.5	3.5
		◎	○	△
Land Required	Permanent [m²]	1,913	1,913	1,913
	Temporary [m²]	64,087	77,450	70,584
		◎	△	○
Affected Structures	Area [m²]	1,853	3,338	1,843
		○	△	◎
Capital Cost	[Rs. in Crore]	1,412.03	1,324.38	2,096.40
		○	◎	△

Source: JST based on DPR



Source: JST based on Google map

Figure 3.2.14 Construction Method of Alternative-1: Mix of C&C, NATM, TBM



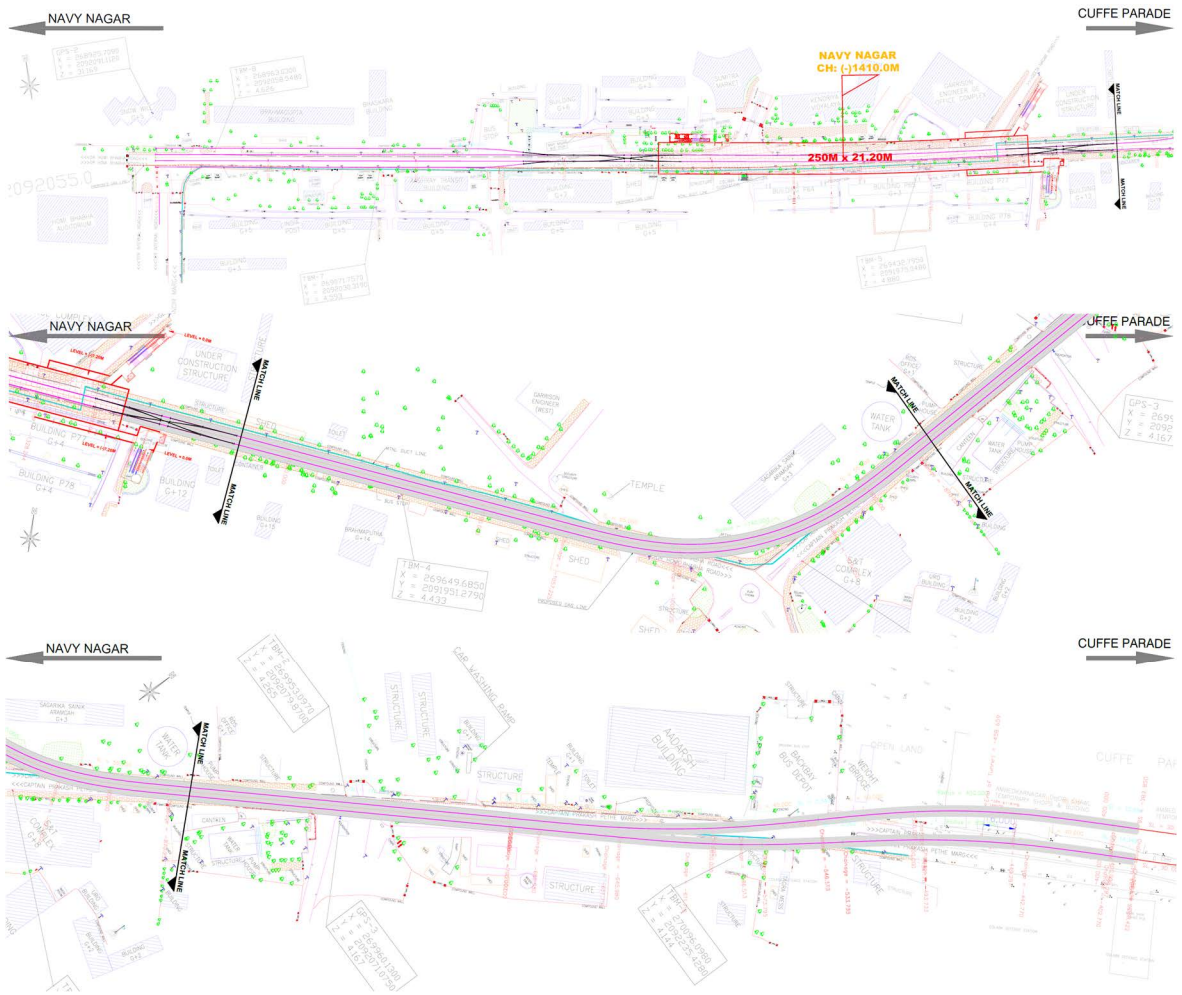
Source: MMRCL

Figure 3.2.15 Alignment Plan for Alternative-1: Mix of TBM, NATM & Cut & Cover



Source: JST based on Google map

Figure 3.2.16 Construction Method of Alternative-2: Full Cut & Cover



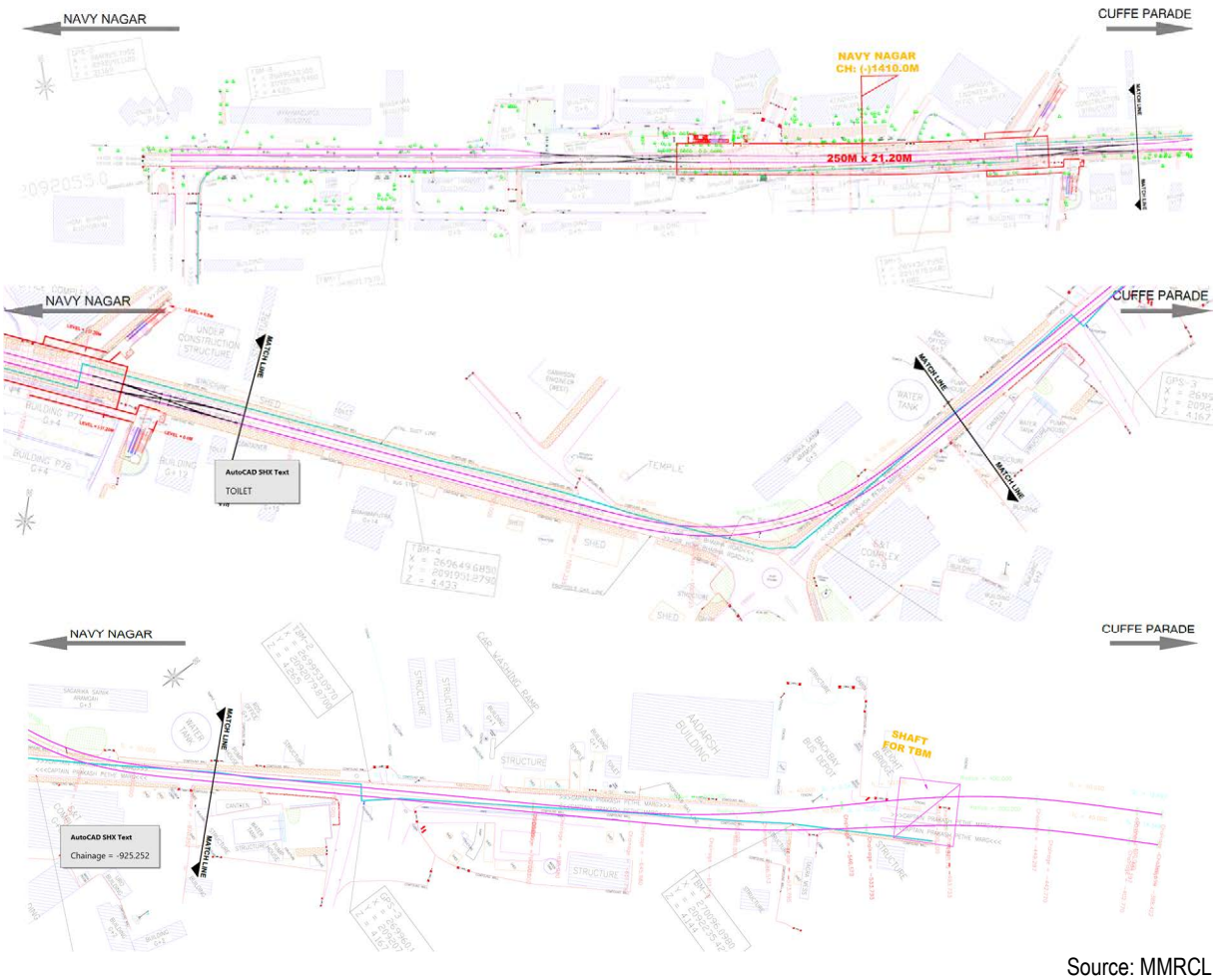
Source: MMRCL

Figure 3.2.17 Alignment Plan for Alternative-2: Full Cut & Cover



Source: JST based on Google map

Figure 3.2.18 Construction Method of Alternative-3: Mix of Cut & Cover and NATM



Source: MMRCL

Figure 3.2.19 Alignment Plan for Alternative-3: Mix of Cut & Cover and NATM

As a result, the DPR concludes that:

- In terms of Construction Period and Land Required: Alternative-1 (Mix of TBM, NATM & Cut & Cover) is the most favorable.
- In terms of Affected Structures: Alternative-3 (Mix of NATM and Cut & Cover) is the most favorable.
- In terms of Capital Cost: Alternative-2 (Full Cut-and-Cover) is the most favorable.

However, the proposed tunnel section is 650m in length with a 220m radius curve and it is surrounded by numerous trees (124 trees over a 750m section, as per the DPR). Given these site conditions, the feasibility and constructability of constructing the tunnel using Cut-and-Cover, TBM, or NATM must be carefully examined to determine the most appropriate method.

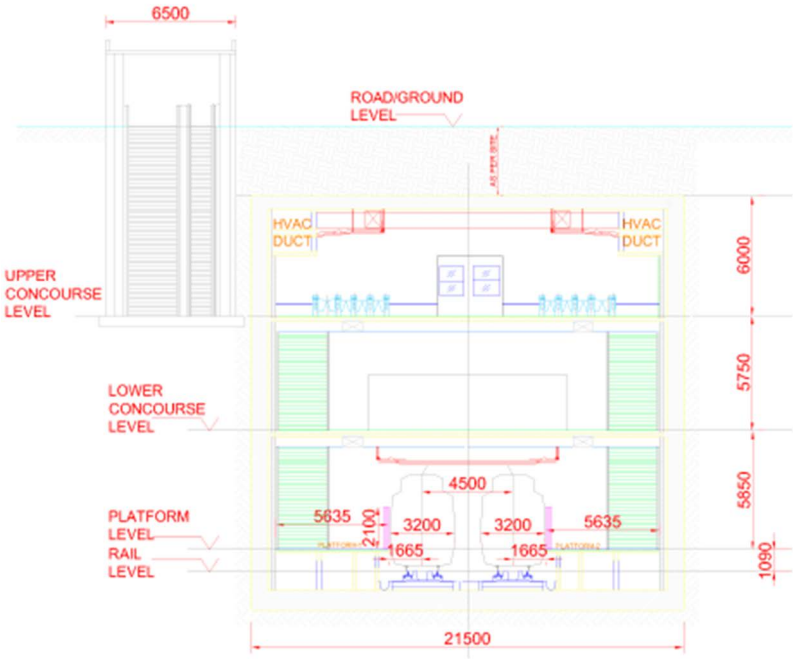
Therefore, the next section: Review of Existing Structure and Recommendations for Future Design. presents the JST proposal, considering these factors.

2) Navy Nagar Station

As mentioned in the DPR, the terminal underground Navy Nagar Station (Chainage (-)1410m) is proposed on Dr. Homi Bhabha Road in the Army Area, Navy Nagar, Colaba, Mumbai. The station is designed on a curve with a radius of (-)1750m and features two side platforms connected by a

common concourse. It will provide connectivity to the Navy Nagar Army Area and nearby residential and commercial zones.

The cross-section of Navy Nagar Station is shown in Figure 3.2.20.



Source: DPR

Figure 3.2.20 Cross Section of Navy Nagar Station

Table 3.2.12 summarizes the key design characteristics of Navy Nagar Station. The station is designed with a cut-and-cover construction method, and considering the constructability of the two scissors crossovers to be built before and after the station, a side platform configuration has been proposed in the DPR.

Table 3.2.12 Station Design Parameters and Construction Methods for Line 11 Corridor-2

Station	Chainage [m]	Ground Level [m]	Rail Level [m]	Platform depth from GL [m]	Track Center Spacing [m]	Station Level	Construction method	Type pf Platform
Navy Nagar	-1410	4.332	-15.668	18.910	4.5	3	Cut-and-Cover	Two Side

Source: JST based on DPR

Considering the construction of scissor crossings before and after the station, the proposal of station design in the DPR is appropriate.

3) Stabling Lines

a) Number of Stabling Lines

Four stabling lines (each accommodating one rake) are proposed beyond Navy Nagar Station. Additionally, two rakes can be stabled at Navy Nagar Station platform, bringing the total stabling capacity at the terminal station (Navy Nagar) to six rakes.

Apart from this, a stabling facility for 29 rakes has been planned at Aarey Depot of Mumbai Metro Line 3.

b) Design of Stabling Lines

As mentioned in the DPR, the length of an 8-car rolling stock is approximately 179 m. To accommodate friction buffer stops, signaling, and interlocking requirements, the stabling lines are designed for a total length of 200 m, assuming a rolling stock speed of 15 km/h within the depot. The breakdown is as follows:

- 179 m – Length of an 8-car rolling stock
- 10 m – Length of the buffer for rolling stock & signaling/interlocking requirements
- 1 m – Clear distance between the rolling stock and the buffer
- 10 m – Safety clearance

  Total: 200 m

Accordingly, stabling lines with covered sheds are designed for 200 m lengths. The track center distance for stabling lines ranges from 4.4 m to 5.6 m, while for inspection lines, it ranges from 6.25 m to 7.00 m.

This provides sufficient space for constructing pathways in the stabling area and within the inspection shed, ensuring easy access for internal train cleaning and equipment maintenance.

To facilitate this extension, stabling lines at the southern end of the line are necessary for train launching and retrieval.

3.2.4.2 Review of Existing Structure and Recommendations for Future Design

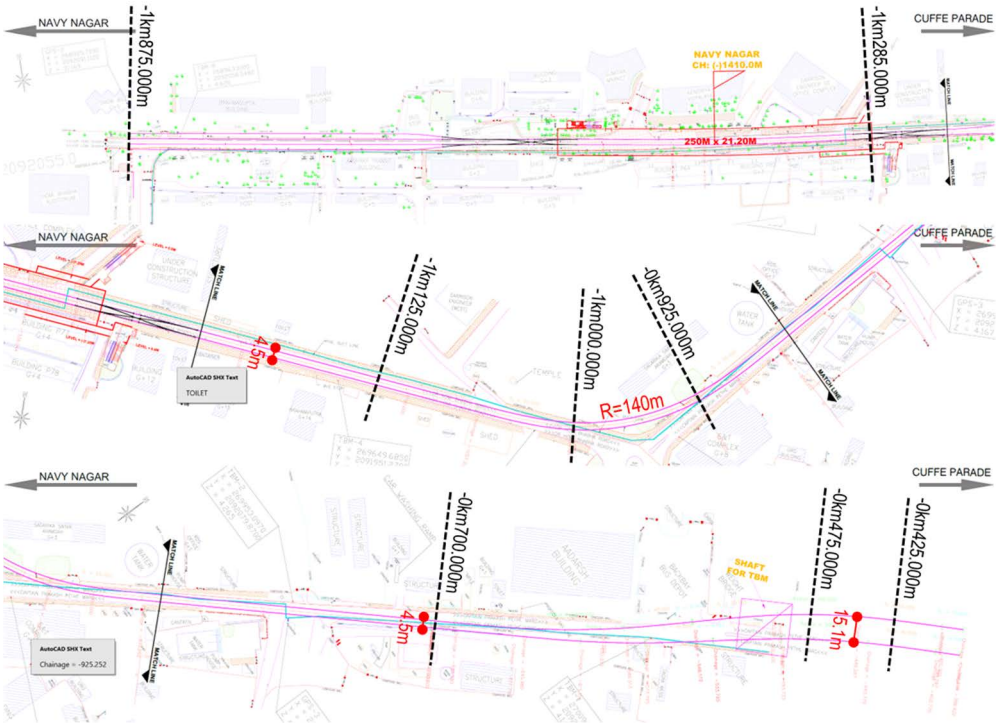
(1) Review of Existing Structure

As explained in the previous section, the DPR presented three alternative proposals based on the tunnel construction methodology for the Line 11 Corridor-2. Following a review by the JST on the suitability for the short curved alignment and constructability, NATM was determined to be the most suitable method. This is due to its flexibility in accommodating the curved and short alignment of the 860 m tunnel section, as well as its minimal impact on affected structures, trees, the surface environment, and residents.

Regarding Alternative-3, according to the revised DPR, the section from chainage -1km875m to the end of Navy Nagar station chainage -1km285m will be constructed using the cut & cover method.

The track center distance between the two tracks will be 4.5m from chainage -1km285m to chainage -0km700m. Beyond chainage -0km700m, the track center gradually increases to 15.1m, which is the same as the connection point of Cuffe Parade station. Additionally, a sharp curve with a radius of 140 m is planned in this section.

The details of the alignment are shown in Figure 3.2.21.



Source: MMRCL

Figure 3.2.21 Alignment Plan of Alternative-3: Mix of Cut & Cover and NATM

(2) Recommendations for Future Design

Considering the distance, alignment, and site conditions, Alternative-3 is considered to have the best constructability and minimal impact on the surface environment. Additionally, NATM offers a high degree of flexibility for expanding from a single-track to a double-track tunnel, making it well-suited for such modifications.

The conceptual design for tunnel construction in this alternative includes key sections labeled A-A, B-B, C-C, D-D, and E-E, as shown in Figure 3.2.22

To minimize the impact on the surface environment, the JST proposes reducing the track center distance from 4.5 m to 4.2 m before chainage -0km700m.

Additionally, for the 140 m radius curve around chainage -0km975m, there is a risk of interference between the up-line and down-line. Therefore, the JST proposes modifying the curve to a 200 m radius, which aligns with the absolute minimum radius specified in the DPR design criteria.



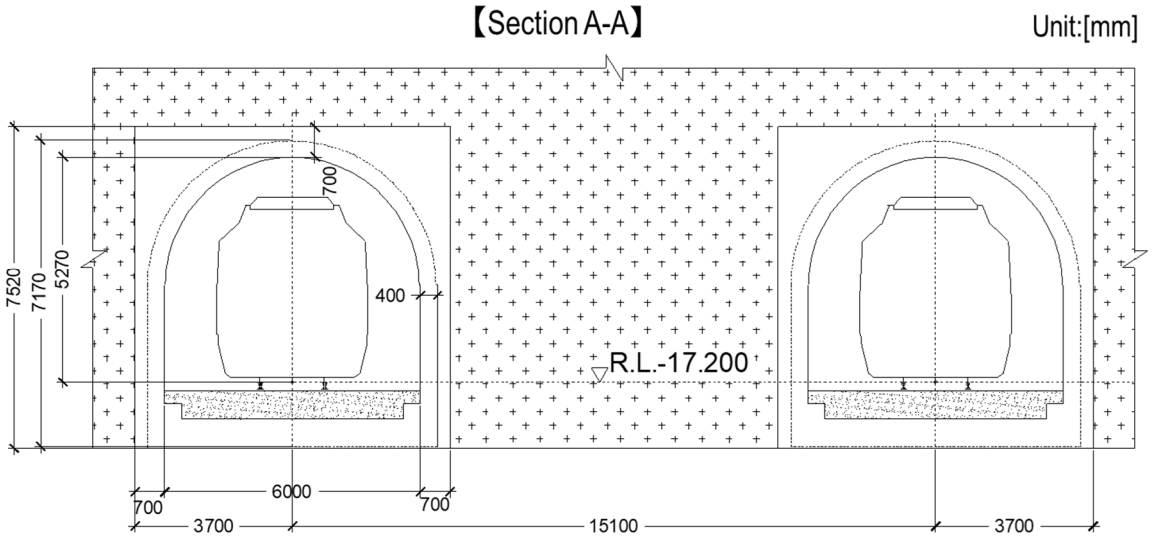
Source: JST based on Google map

Figure 3.2.22 Key Sections of Alternative-3: Mix of Cut & Cover and NATM

Below is an explanation of the conceptual design proposed by JST for Line 11 corridor-2.

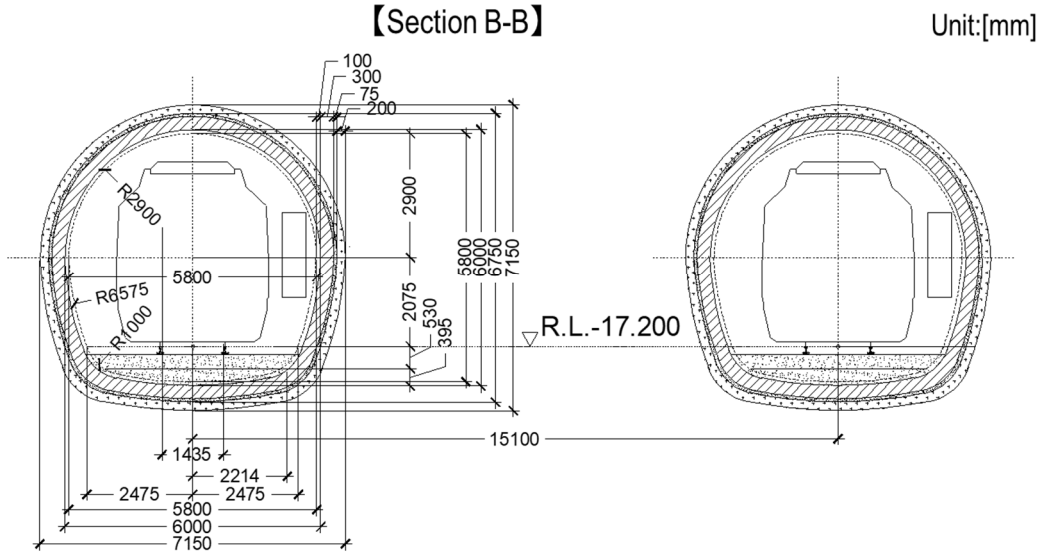
Figure 3.2.23 (Section A-A) shows the south end of Cuffe Parade station, where Line 11 corridor-2 connects with Line 3. Special attention must be given to waterproofing works at the connection point to ensure structural integrity and durability. (see Figure 3.2.25)

Figure 3.2.24 (Section B-B) shows the conceptual cross section of the single track twin NATM tunnels. From Section B-B to Section C-C, the track center distance gradually decreases from 15.1 m to 4.2 m. Beyond chainage -0km700, the tunnel transitions from twin single-track NATM tunnels to a double-track single NATM tunnel. Particular care must be taken in the design stage regarding structural design and material selection for this transition zone.



Source: JST based on CAD file provided by MMRCL

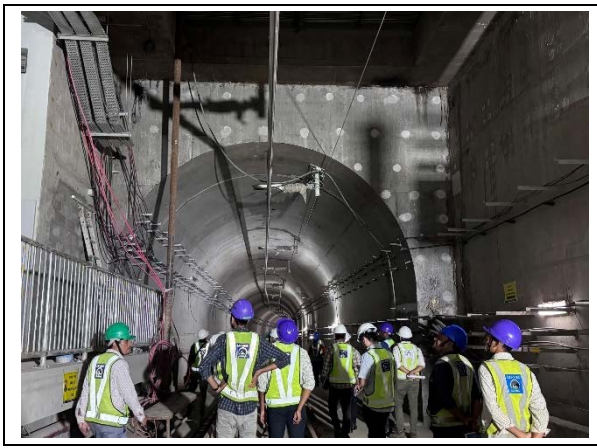
Figure 3.2.23 South end of Cuffe Parade Station



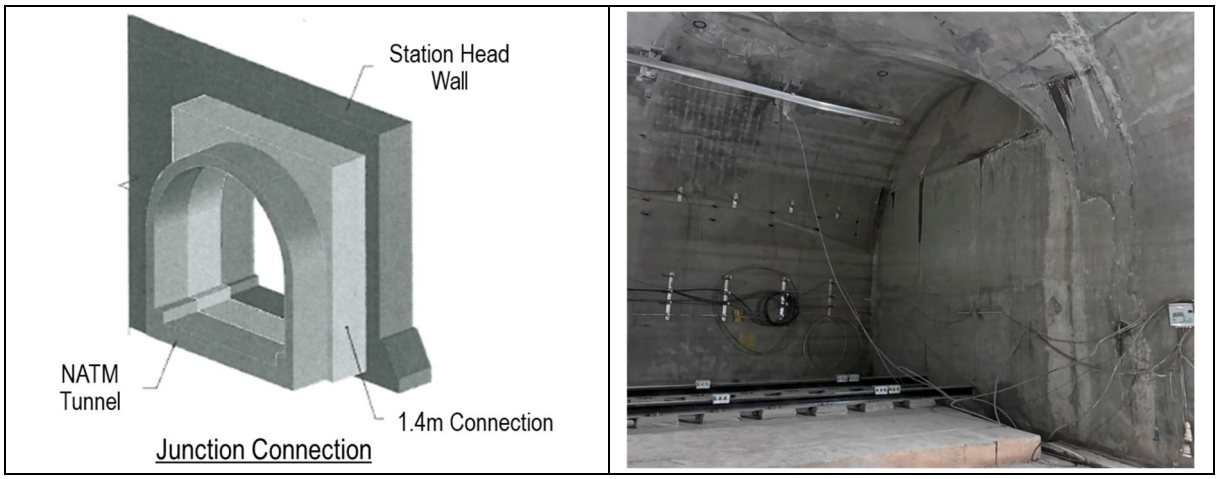
Note: The dimensions shown in this figure are subject to change. The R.L is based on shared CAD alignment data.

Source: JST

Figure 3.2.24 Conceptual Cross Section of the Single Track Twin NATM Tunnels

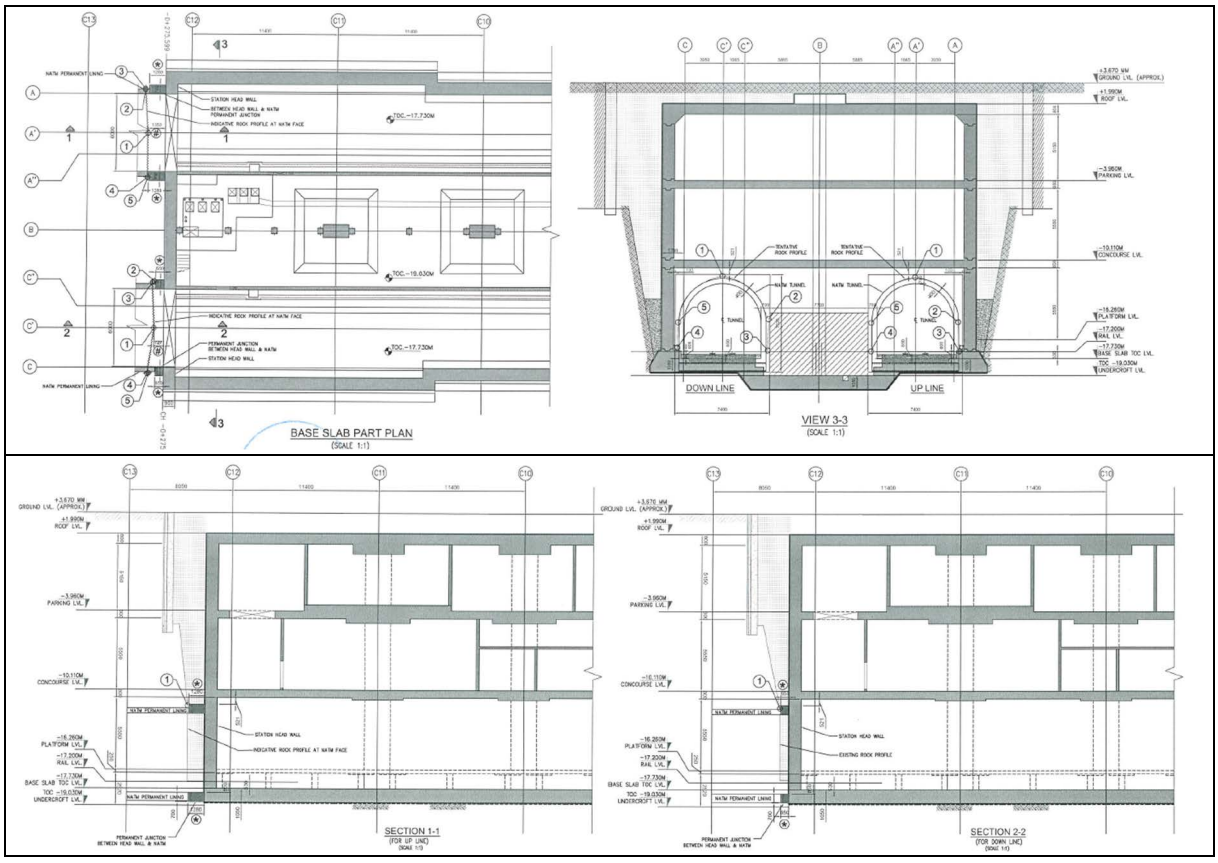






Note: Photos taken by JST during the site visit of Line-3 Cuffe Parade Station on August 28,2024.

Source:JST



Source: MMRCL

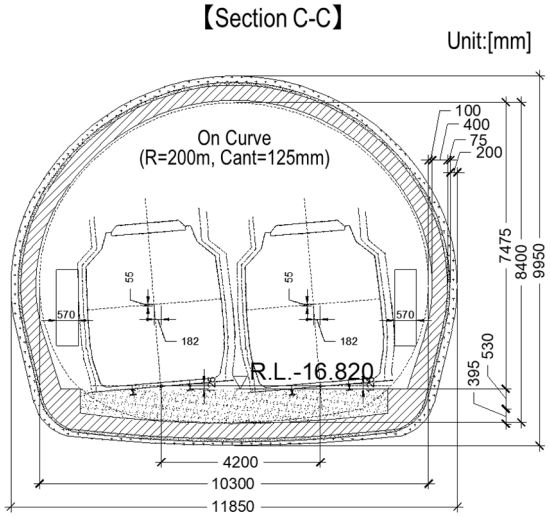
Figure 3.2.25 Junction Between Head Wall and NATM at Line 3 Cuffe Parade Station

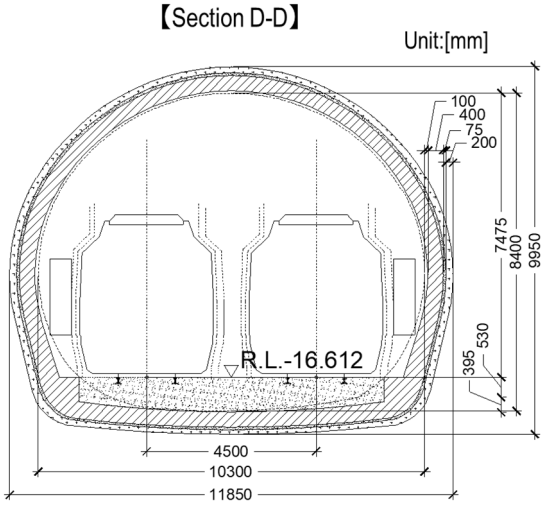
Figure 3.2.26 (Section C-C) shows the conceptual cross section of the double track single NATM tunnel on a curve. For this curved section, the JST proposes modifying the curve to a 200 m radius, which aligns with the absolute minimum radius specified in the design criteria to prevent potential interference between the up-line and down-line.

Figure 3.2.27 (Section D-D) shows the conceptual cross section of the double track single NATM tunnel before Navy Nagar station. As the curve ends and the tunnel enters the straight section leading toward the scissors crossing, the track center distance gradually increases from 4.2 m to 4.5 m, aligning with

the track center distance at Navy Nagar Station.

Figure 3.2.28 (Section E-E) shows the conceptual cross section of the stabling lines area beyond Navy Nagar station, where four stabling lines are planned. Considerations for fire protection and ventilation planning will be addressed during the design stage.



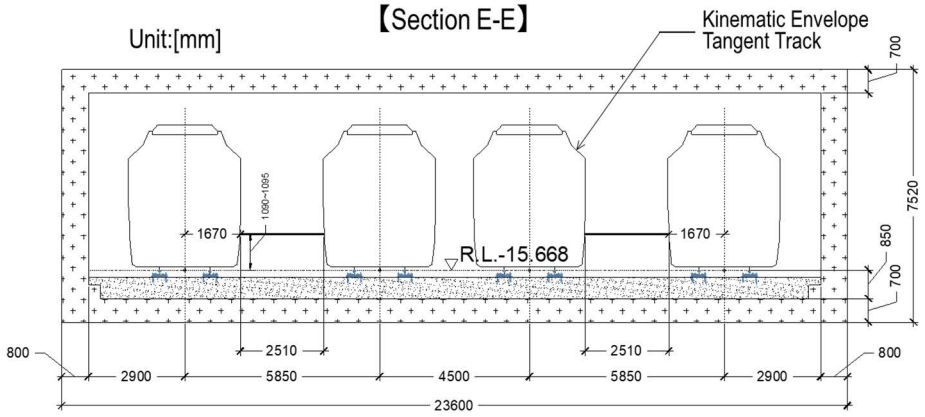


Note: The dimensions shown in this figure are subject to change. The R.L is based on shared CAD alignment data.

Source: JST

Figure 3.2.26 Conceptual Cross Section of the Double Track Single NATM Tunnel on Curve

Figure 3.2.27 Conceptual Cross Section of the Double Track Single NATM Tunnel before Navy Nagar Station



Note: The dimensions shown in this figure are subject to change. The R.L is based on revised DPR.

Source: JST

Figure 3.2.28 Conceptual Cross Section of the Stabling Lines Area

The above content was proposed to MMRCL during the 2nd Kick-off Meeting on January 20 and the DFR presentation held on June 5. JST indicated that, given the area's strict security measures, the difficulty of land acquisition, and the presence of numerous trees and residential buildings, the NATM method would be a reasonable and viable option.

On the other hand, MMRCL stated that they are considering the C&C method, taking into account cost considerations, provided that land acquisition can be carried out smoothly. MMRCL also explained that the Navy area has high transportation demand but currently lacks access to railway or metro services. A

request was made by the area's management for improved access through the extension of Line 3. Based on this, MMRCL believes that cooperation regarding land acquisition and temporary transplantation of trees can be expected to some extent.

However, since the feasibility of the C&C method depends on the smooth implementation of such measures, the NATM method continues to be retained as an alternative. It was noted that both NATM and C&C methods remain under consideration.

As for the TBM option, during the 2nd Kick-off Meeting held on January 20, 2025, JST explained that the TBM method is not an optimal choice due to the section length and curve conditions of the Line 3 extension area. MMRCL agreed with this assessment. Furthermore, during the DFR presentation on June 5, 2025, MMRCL reiterated its position that the TBM method is not appropriate for this section. Based on the above, MMRCL emphasized that the final decision on whether to adopt the NATM or C&C method will be made during the Basic design stage by the IC.

3.3 Station Planning

3.3.1 Overview of Existing Studies and Review (Corridor-2)

3.3.1.1 Outline of Station Planning (Corridor-2)

There is only one station in Corridor-2 Section, which is Navy Nagar Station. This is the terminal underground station (Chainage (-)1410m) of Line 3 proposed on Dr. Homi Bhabha Road, Army Area, Navy Nagar Colaba, Mumbai. The station has planned on curve having radius (-)1750m. The station has been planned with two side platforms connecting with common concourse. The station has two unpaid & one paid area at concourse level & three entry/exit at ground level, two at one side & one at another side of the station.

It provides connectivity to Navy Nagar Army Area & nearby residential and commercial area.

Issues and Concerns:

- The station is planning in highly sensitive & tight security army area.
- The station has not enough ROW to accommodate proper entry/exit on ground.
- The road profile also exhibited station on curvature.



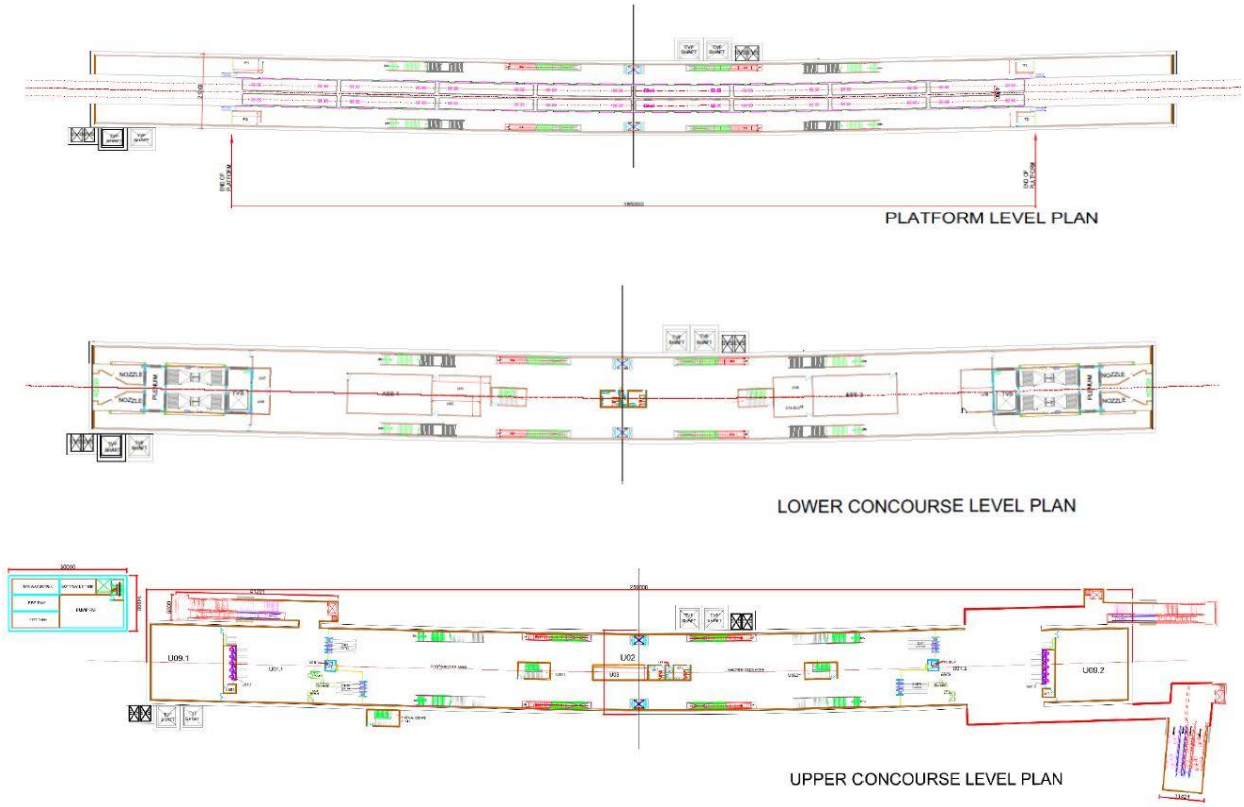
Source: DPR 2025

Figure 3.3.1 Mumbai Metro Line-3 from Cuffe Parade to Navy Nagar

Proposed Navy Nagar Station description in DPR as follows.

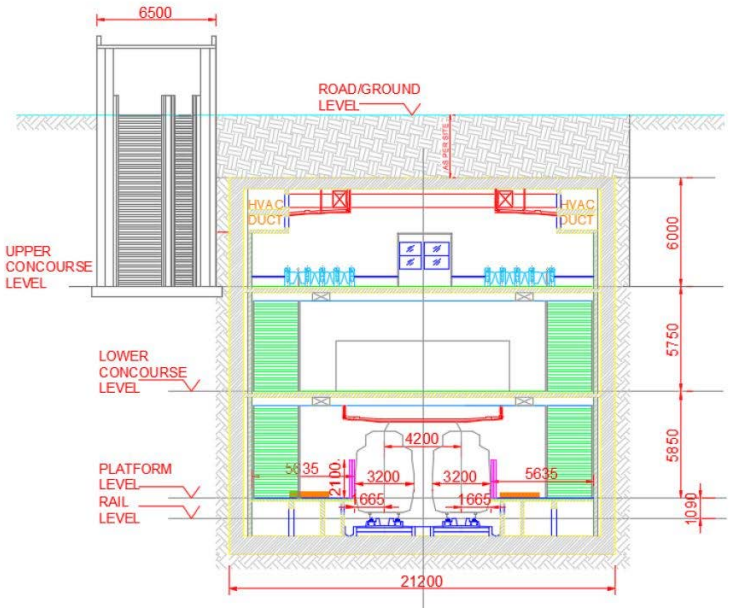
- The station box has 250 m length and three levels. Due to two side platforms, an additional level (i.e., Lower Concourse Level) has been developed for TVF, ASS area & other system rooms in this station.
- The upper concourse level comprises of unpaid concourse, TOMs, AFC in and out Gates, public toilets (located in paid area), all the passenger amenities, Station Control Room (SCR), ECS Plant Room and EFO and few retail spaces. The lower concourse level has, in addition to the concourse, Signaling & Telecom equipment rooms, TVS panel rooms, UPS rooms, ASS, Refuse & Cleaner Room etc. Platform level has platforms, tracks, Lift, Escalators, Staircases etc.
- Two banks of 2.4 m width of staircases, 2 escalators & 1 lift on each side of platform have been provided to meet the traffic demands. 2 fire-exit of 1.7m have been designed from upper concourse to lower concourse. In addition, provision of lift has been done to bring passengers from upper concourse to platform level and vice versa.
- Three entrances have been provided to the station, two at one side & one at another side. Entrances could be increased to 4 nos. as requirements based on traffic projections and better connectivity. Structure of the underground station is essentially a concrete box about 21.20m wide, about 20.70m depth and 250m long with two intermediate slabs. Sides of the box are made of 0.8-1.2-m thick RCC walls.
- An ancillary building comprising of pump room & water tanks, Chiller Room, DG and Cooling Towers have been placed on top of the box is placed near station.

The section and plans are presented in following figures.



Source: DPR 2025

Figure 3.3.2 Navy Nagar Station Plans in DPR



Source: DPR 2025

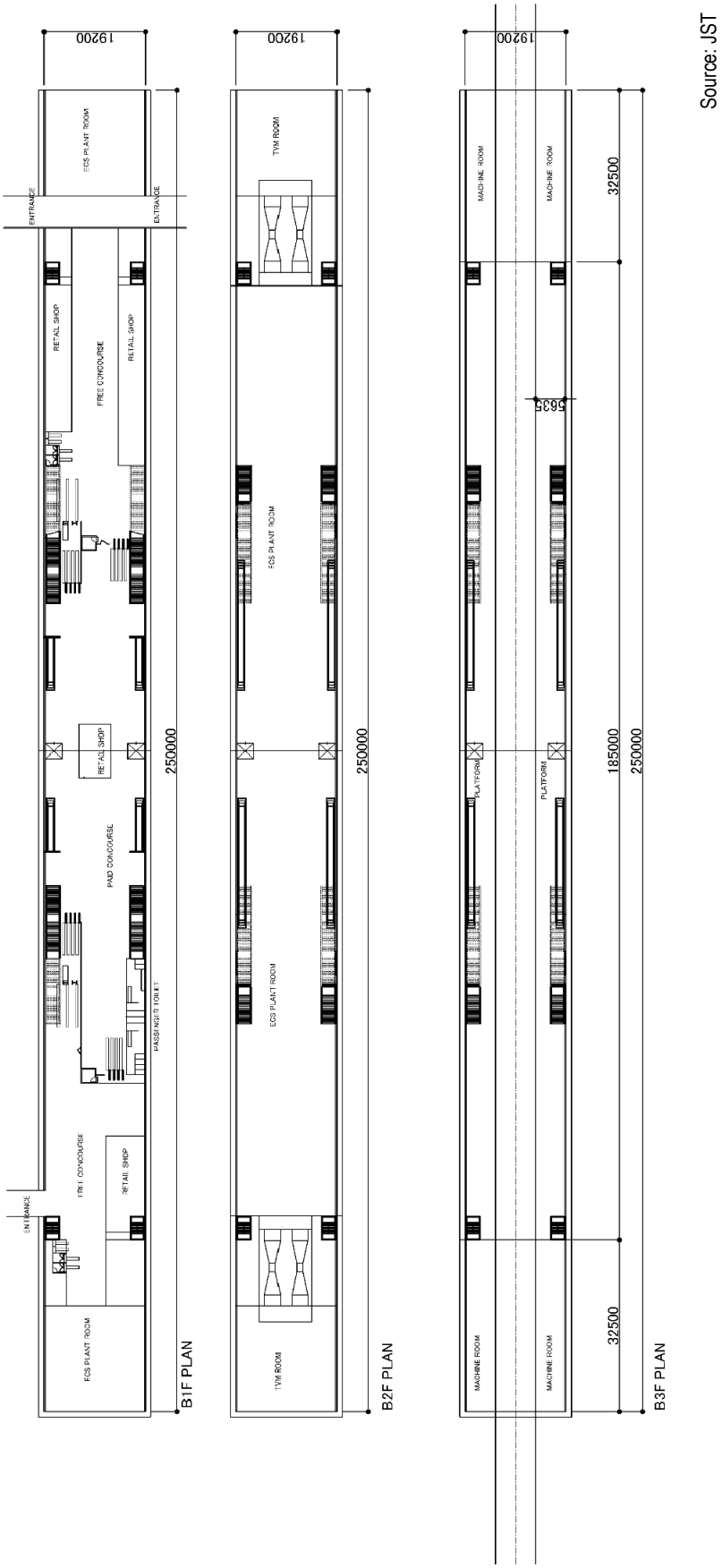
Figure 3.3.3 Navy Nagar Station Cross Section in DPR

3.3.2 Reviews of Existing Studies and Proposals for Improvement (Corridor-2)

A review was conducted for the station planning described in the received DPR, drawings and design reports. Comments and recommendations for the future development of basic design and detail design phase are mentioned for improvement.

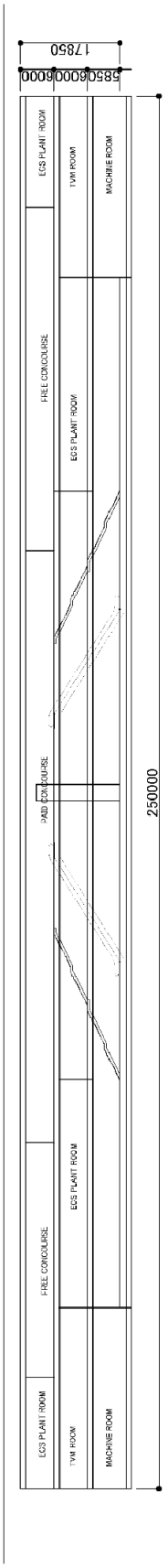
- Station has been planned on curve section. Further study should be conducted to avoid curved platforms.
- In DPR drawing, lower concourse level (B2F) is not well utilized. This level should be fully utilized for ECS and ventilation. Station length could be shorter by utilizing this floor.
- Stairs and escalator locations on platform could be optimized and paid concourse could be more compact.
- Retail shops could have more spaces in free concourse area.
- Passenger toilet can be located at corner, not center of the concourse.
- Emergency stairs should be located at both ends of platform.

After reviewing station plan in DPR, JST developed alternative station schematic drawings for reference. The drawings are presented in following pages.



Source: JST

Figure 3.3.4 Navy Nagar Station Alternative Plan



Source: JST

Figure 3.3.5 Navy Nagar Station Long Section

3.4 Train Operation Plan

3.4.1 Salient Features

The length of Line 11 corridor-2 has been planned at 1.875km, from south end station of Metro Line 3. One station has been planned for this extension, and train operation has been considered same as Line 3 and coordinated with current Line 3 operation. Based on the GoA level in Line 3 in opening year of this extension, the Automatic Train Operation System (ATO) (GoA-2) or Unattended Train Operation System (UTO) (GoA-4) will be implemented.

3.4.1.1 Planned Station

For Line 11 Corridor-1, stations have been planned as per the following;

Table 3.4.1 List of Stations from Cuffe Parade to Navy Nagar

Number	Station Name	Chainage(m)	Remarks
1	Cuffe Parade	0.00	Island Platform, Current Final Station
2	Navy Nagar	(-)1410	Side Platform

Source: DPR

3.4.1.2 Train Operation Philosophy

(1) Current Line 3 Condition/Plan

Peak hour operation headway should be considered based on max PHPDT as well as traffic demand in each section. Off peak hours should be according to attractive frequency operation service and traffic demand. Some assumptions for train operation have been considered based on Line 3 extension DPR, September 2024, as per the following;

- Scheduled Speed has been considered for 35km/h
- Services of running for 19 hours of the day (5 am until 12 am)
- Minimum dwell time at intermediate stations has been 30 second
- Normal operation loop has been 2 loop; One loop is end to end between Aarey JVLR and Navy Nagar, the other loop is between Bandra-Kurla Complex and Navy Nagar
- Turn-back time at the terminal station is taken as 3 minutes

After opening of Navy Nagar station, all train operation will extend until Navy Nagar for south terminal station. Train operation for Line 3 Corridor-2 should be coordinated with current Line 3 project; in this chapter, Line 3 Corridor-2 as well as current Line 3 has been considered as necessary.

(2) Travel Time Simulation

Prior to consideration of the train operation plan, the assumption for scheduled speed should be verified since this condition is a fundamental factor in the planning stage. Verification of scheduled speed – 35k/h will be described based on specifications for rolling stock and track alignment.

1) Rolling Stock Specifications

Trainset of 8 cars for Line 11 Corridor-2 has been considered according to DPR as per the following;

8 car train: DMC + TC + MC + MC + MC + MC + TC + DMC

DMC: Driving Motor Car
TC: Trailer Car
MC: Motor Car

For the simulation, most severe condition should be adopted, hereafter case of AW4 (fully seating plus standee zone@ 8 persons/sqm) has been considered. The weight of the car and with passengers is estimated as below.

Table 3.4.2 Details of Car Weight and Passenger Weight

	DMC	TC	MC	8 Car Train
Tare Weight	42	42	42	336
Passenger				
Congestion(8p@sqm)	23.4	24.7	24.7	195
Gross Weight				
Congestion(8p@sqm)	65.4	66.7	66.7	531

Source: DPR

Rolling Stock performance parameters for train operation have been considered according to DPR as per the following;

Table 3.4.3 Details of Rolling Stock Performance Parameters

Item	Value
Maximum Operating Speed	85 km/h
Minimum Design Average Acceleration rate for fully loaded(AW4) train on level tangent track	
0 to 40 km/h	3.6 km/h/s
0 to 60 km/h	3.06 km/h/s
0 to 80 km/h	2.34 km/h/s
Service braking rate from 80 km/h to standstill for fully loaded (AW4) train on level tangent track	3.6 km/h/s

Source: DPR

2) Line 11 Corridor-2 Track Alignment Specifications

Track alignment, especially horizontal curves, affects speed restraint in train operation. Horizontal curves have been designed according to DPR as per the following;

Table 3.4.4 Details of Horizontal Curves

Number	Curve	Radius(m)	Chainage(m)	
			Start Curve	End Curve
1	Left	-1750	-1444.60	-1328.24
2	Left	-220	-1087.85	-817.49
3	Left	-550	-658.49	-543.47
4	Right	400	-543.03	-405.87

Source: DPR

Speed restraint against horizontal curves which applied proper cant has been designed according to DPR as per the following;

Table 3.4.5 Details of Speed Restraint from Horizontal Curve

Radius (m)	Maximum Permissible Speed (km/h)
400 or over	80
350	75
300	70
200	55
150	45

Source: DPR

Vertical alignment, i.e., gradient of rail track, has been designed according to DPR as per the following;

Table 3.4.6 Details of Rail Track Gradient

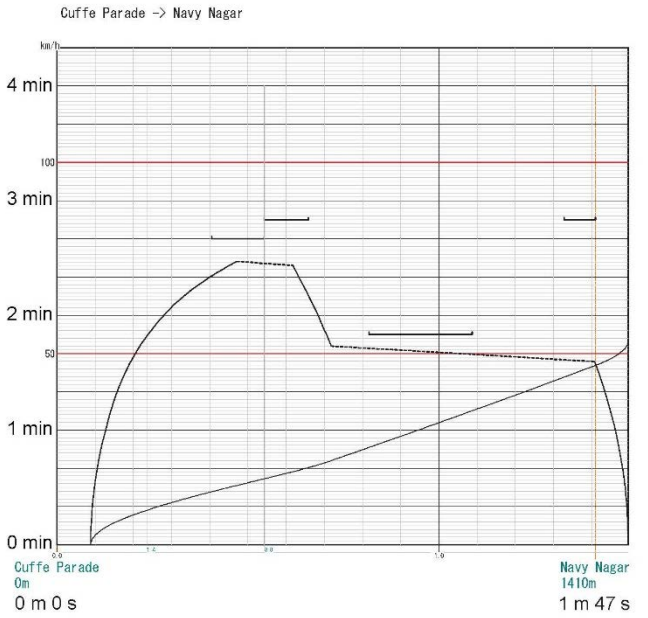
Number	Chainage		Rail Level		Gradient (‰)	Remarks
	From	To	From	To		
1	-1875	-1125	-16.612	-16.612	0.00	LEVEL
2	-1125	-700	-16.612	-17.20	-1.4	FALL
3	-700	-400	-17.20	-17.20	0.00	LEVEL

Source: DPR

(3) Simulation Outcome

1) Run Curve

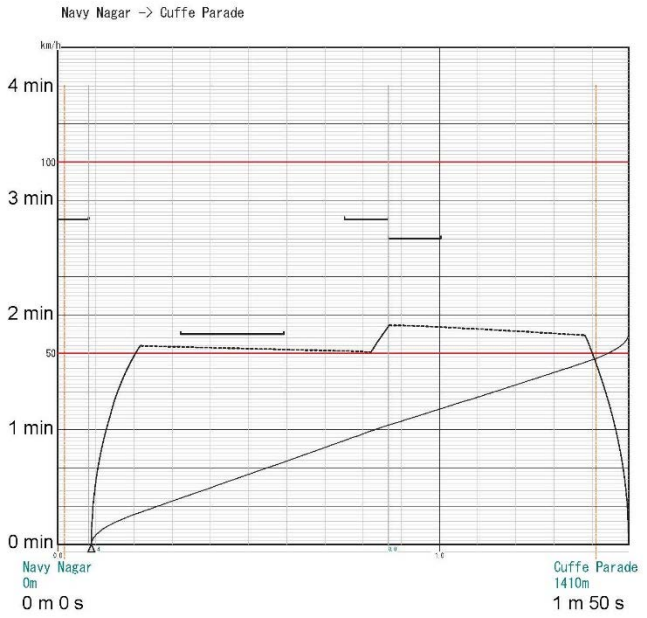
Operation simulation for southbound, from Cuffe Parade to Navy Nagar, has come out as follows;



Source: JST

Figure 3.4.1 Run Curve from Cuffe Parade to Navy Nagar

Similarly, simulation for northbound, from Navy Nagar to Cuffe Parade, has come out as follows;



Source: JST

Figure 3.4.2 Run Curve from Navy Nagar to Cuffe Parade

2) Travel Time

Simulation for southbound, from Cuffe Parade to Navy Nagar, has come out as follows;

Table 3.4.7 Travel Time between Each Station (Southbound)

Number	Station Between		Travel Time
1	Cuffe Parade	Navy Nagar	1 min 47 sec

Source: JST

Similarly simulation for northbound, from Gateway of India to Anik Depot, has come out as follows;

Table 3.4.8 Travel Time between Each Station (Northbound)

Number	Station Between		Travel Time
1	Navy Nagar	Cuffe Parade	1 min 50 sec

Source: JST

Assuming that scheduled speed of current Line 3, from JVLR to Cuffe Parade, is 35km/h for both direction. Hereafter calculation for extension section has been carried out as follows;

Southbound: Dwell time at Cuffe Parade station + travel time until arrival at Navy Nagar
Northbound: Travel time until arrival at Cuffe Parade + Dwell time at Cuffe Parade station

Northbound operation time will be 2 min 17 sec. Furthermore, southbound operation time will be 2 min 20 sec. Travel kilometers utilized in this simulation is 1.41 km for Line 11 Corridor-2, therefore computed scheduled speed is as follows;

Southbound: 37.05 km/h
Northbound: 36.26 km/h

Based on outcome of the simulation, it is appropriate to establish scheduled speed for Line 11 Corridor-2, at 35km/h.

3.4.2 Train Operation Plan

3.4.2.1 Max PHPDT

PHPDT for Line 3 and Line 11 Corridor-2 for the years 2034, 2041, and 2051 for the purpose of train operation planning are indicated as follows;

Table 3.4.9 PHPDT for Line 3 + Line 11 Corridor-2

Year		2034		2041		2051	
Station Between		To Navy Nagar	To Aarey JVLR	To Navy Nagar	To Aarey JVLR	To Navy Nagar	To Aarey JVLR
Aarey JVLR	SPEEZ	11,238	6,911	11,931	7,338	13,101	8,057
SPEEZ	MIDC – Andheri	12,914	8,156	13,711	8,659	15,055	9,508
MIDC – Andheri	Marol Naka	12,938	8,527	13,736	9,053	15,083	9,940
Marol Naka	CSMI Airport T2	22,463	15,051	23,848	15,980	26,187	17,547
CSMI Airport T2	Sahar Road	31,162	16,709	33,083	17,739	36,328	19,479
Sahar Road	CSMI Airport T1	30,280	16,177	32,147	17,174	35,299	18,858
CSMI Airport T1	Santacruz Metro	25,985	16,476	27,587	17,491	30,292	19,207
Santacruz Metro	Bandra Colony	25,752	15,890	27,339	16,870	30,020	18,524
Bandra Colony	Bandra-Kurla Complex	25,076	15,435	26,622	16,386	29,233	17,993
Bandra-Kurla Complex	Dharavi	**35,422**	21,165	37,605	22,469	41,293	24,673
Dharavi	Sitaladevi Temple	32,843	18,896	34,867	20,060	38,286	22,027
Sitaladevi Temple	Dadar	30,883	17,831	32,786	18,929	36,002	20,786
Dadar	Siddhivinayak	28,611	15,008	30,374	15,932	33,353	17,495
Siddhivinayak	Worli	26,956	13,997	28,617	14,858	31,423	16,315
Worli	Acharya Atre Chowk	23,326	12,871	24,762	13,663	27,191	15,003
Acharya Atre Chowk	Science Museum	20,773	11,780	22,052	12,504	24,214	13,730
Science Museum	Mahalaxmi	18,207	11,743	19,327	12,464	21,222	13,686
Mahalaxmi	Mumbai Central Metro	18,144	9,798	19,259	10,398	21,148	11,418
Mumbai Central Metro	Grant Road	18,165	9,552	19,282	10,136	21,173	11,130
Grant Road	Girgaon	14,134	7,335	15,001	7,779	16,472	8,542
Girgaon	Kalabadevi	12,525	6,408	13,291	6,790	14,595	7,456
Kalabadevi	CST Metro	10,090	6,001	10,703	6,347	11,753	6,969
CST Metro	Hutatma chowk	13,009	5,010	13,768	5,312	15,118	5,833
Hutatma chowk	Churchgate	8,584	4,223	9,079	4,477	9,970	4,917
Churchgate	Vidhan Bhavan	6,191	3,633	6,551	3,852	7,194	4,229
Vidhan Bhavan	Cuffe Parade	3,149	2,335	3,331	2,476	3,658	2,718
Cuffe Parade	Navy Nagar	1,119	1,104	1,184	1,171	1,300	1,285

Note: Each year's max PHPDT is marked in bold

Source: JST

3.4.2.2 Train Capacity

Composition of train has been considered based on DPR as per the following;

Basic unit of trains: DMC1 + TC1 + MC1 + MC2 + MC3 + MC4 + TC2 + DMC2
DMC: Driving Motor Car
TC: Trailer Car
MC: Motor Car

Train Capacity
For the train considered in Line 11 Corridor-2, it has 3200mm width car body. Train capacity has been as per the followings;

Train Capacity (@ 6 passengers per square meter of standee area)

DMC	282 (44 seated + 238 standing)
MC2/MC3	298 (52 seated + 246 standing)
MC1/MC2/TC1/TC2	295 (54 seated + 241 standing)
8-Car Train(DMC1+TC1+MC1+MC2 +MC3+MC4+TC2+DMC2)	2340 Passengers

Train Capacity (@ 8 passengers per square meter of standee area)

DMC	361 (44 seated + 317 standing)
MC2/MC3	380 (52 seated + 328 standing)
MC1/MC2/TC1/TC2	376 (54 seated + 322 standing)
8-Car Train(DMC1+TC1+MC1+MC2 +MC3+MC4+TC2+DMC2)	2986 Passengers

DPR mentioned two types of train capacity based on GoA 2 and GoA 4 condition. However here, one train capacity with GoA 2 has been considered.

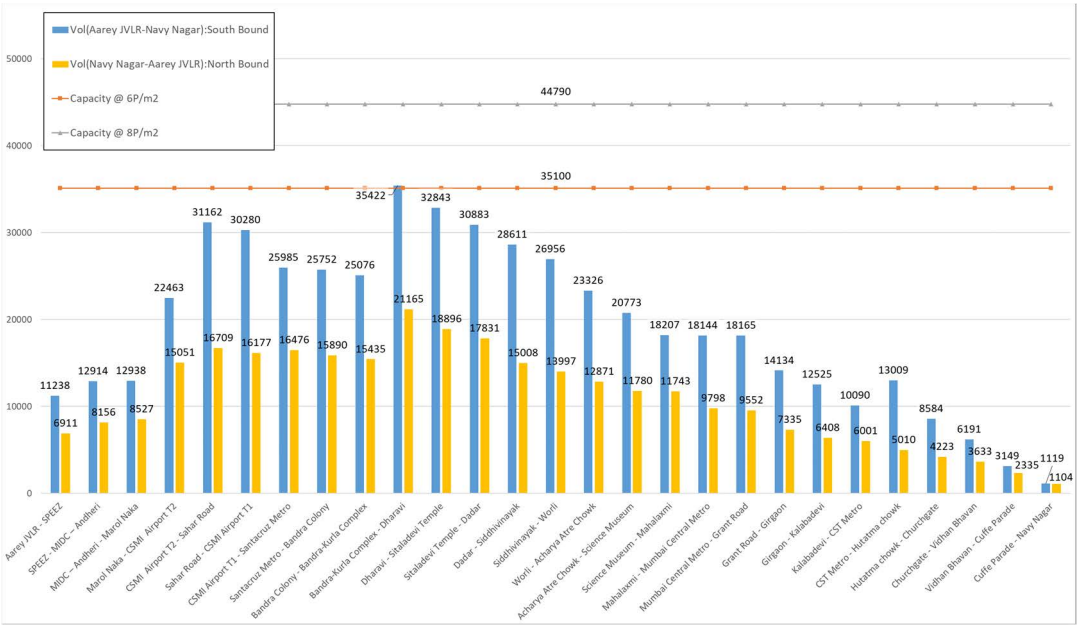
3.4.2.3 Yearly Train Operation Plan

Based on the estimated PHPDT, train operation has been planned with train carrying capacity @ 6 persons per square meter of standee area for Line 3 + Line 11 Corridor-2, Aarey JVLR to Navy Nagar for the years 2034, 2041, and 2051, respectively. Details are as follows;

(1) Year 2034

Max PHPDT in Line 3 and Line 11 Corridor-2 has been estimated at 35,422 between Bandra Kurla Complex and Dharavi for southbound.

- Operation headway has been 4 min during peak hour
- Train Capacity with 6 p/sqm of standee area for 4 min headway has been 35,100
- Train Capacity with 8 p/sqm of standee area for 4 min headway has been 44,790



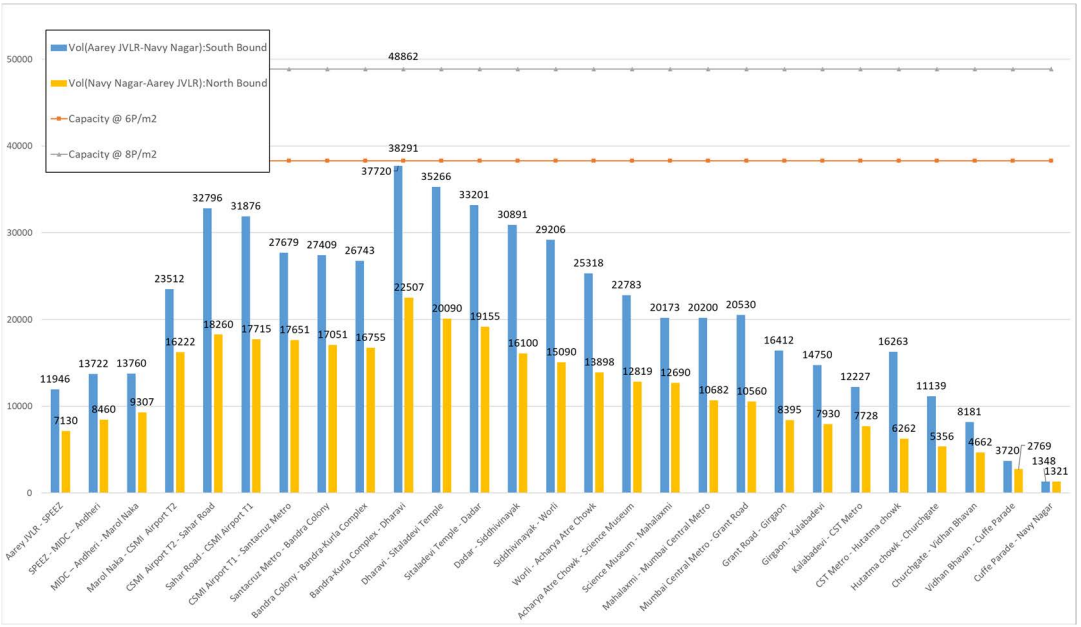
Source: JST

Figure 3.4.3 PHPDT and Train Capacity in 2034

(2) Year 2041

Max PHPDT in Line 3 and Line 11 Corridor-2 has been estimated at 37,605 between Bandra Kurla Complex and Dharavi for southbound.

- Operation headway has been 3.67 min during peak hour
- Train Capacity with 6 p/sqm of standee area for 3.67 min headway has been 38,291
- Train Capacity with 8 p/sqm of standee area for 3.67 min headway has been 48,862



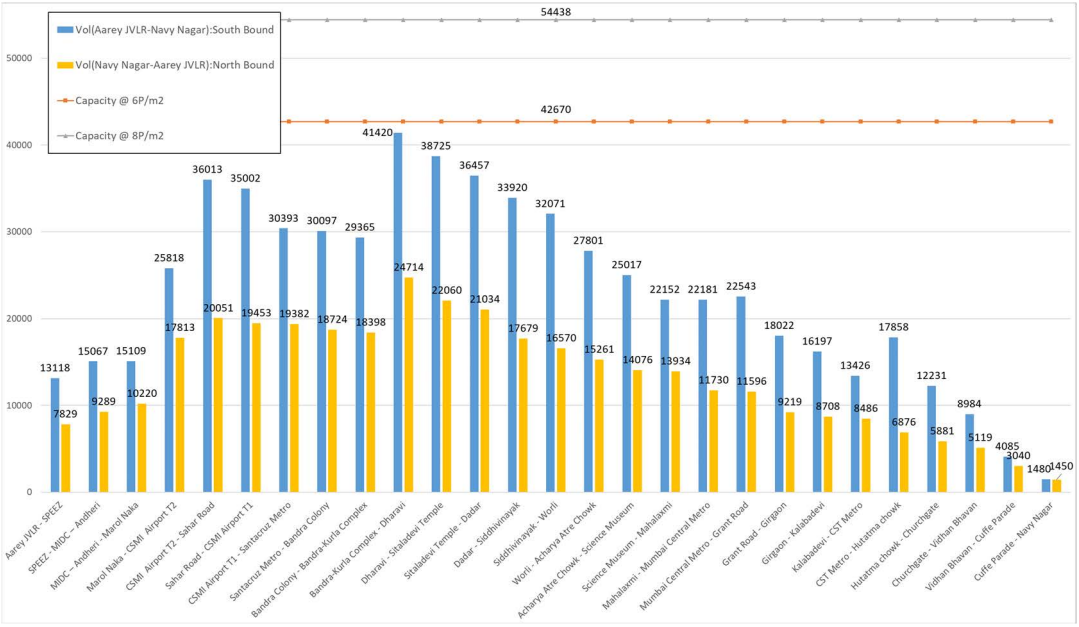
Source: JST

Figure 3.4.4 PHPDT and Train Capacity in 2041

(3) Year 2051

Max PHPDT in Line 3 and Line 11 Corridor-2 has been estimated at 41,293 between Bandra Kurla Complex and Dharavi for southbound.

- Operation headway has been 3.33 min during peak hour
- Train Capacity with 6 p/sqm of standee area for 3.33 min headway has been 42,670
- Train Capacity with 8 p/sqm of standee area for 3.33 min headway has been 54,438



Source: JST

Figure 3.4.5 PHPDT and Train Capacity in 2031

Table 3.4.10 shows a brief summary of this section.

Table 3.4.10 Yearly Train Operation Plan in Peak Hour

Year	Headway(min)	Max PHPDT Demand	Train Capacity
2034	4	35,422	35100* 44790**
2041	3.67	37605	38291* 48862**
2051	3.33	41293	42670* 54438**

Note: * Capacity with 6 p/sqm in standee area
** Capacity with 8 p/sqm in standee area

Source: JST

3.4.2.4 Hourly Train Operation Plan

Train operation during off peak hours should be based on ridership demand and considered for highly convenient service of metro system. Hourly train operation plans for 2031, 2041, and 2051 are presented in tables as follows;

Table 3.4.11 Hourly Train Operation Plan in 2034

Time	No. of Loops	Section: Navy Nagar to Bandra Kurla Complex		Section: Bandra Kurla Complex to Aarey JVLR	
		Headway (min)	No. of Operation per Direction per Hour	Headway (min)	No. of Operation per Direction per Hour
5 - 6	1	12	5	12	5
6 - 7	2	5.5	10.91	11	5.45
7 - 8	2	4.33	13.85	8.67	6.92
8 - 10	1	4	15	4	15
10 - 11	2	4.33	13.85	8.67	6.92
11 - 12	2	5.33	11.25	10.67	5.63
12 - 13	2	5.33	11.25	10.67	5.63
13 - 15	2	5.33	11.25	10.67	5.63
15 - 16	2	5.33	11.25	10.67	5.63
16 - 17	2	4.33	13.85	8.67	6.92
17 - 19	1	4	15	4	15
19 - 20	2	4.33	13.85	8.67	6.92
20 - 21	2	5.33	11.25	10.67	5.63
21 - 22	2	5.33	11.25	10.67	5.63
22 - 23	2	6	10	12	5
23 - 24	1	12	5	12	5
Total No. of train trips per direction per day			225.04		147.52

Source: JST

Table 3.4.12 Hourly Train Operation Plan in 2041

Time	No. of Loop s	Section: Navy Nagar to Bandra Kurla Complex		Section: Bandra Kurla Complex to Aarey JVLR	
		Headway (min)	No. of Operation per Direction per Hour	Headway (min)	No. of Operation per Direction per Hour
5 - 6	1	12	5	12	5
6 - 7	2	5.5	10.91	11	5.45
7 - 8	2	4	15	8	7.5
8 - 10	1	3.67	16.36	3.67	16.36
10 - 11	2	4	15	8	7.5
11 - 12	2	5	12	10	6
12 - 13	2	5	12	10	6
13 - 15	2	5	12	10	6
15 - 16	2	5	12	10	6
16 - 17	2	4	15	8	7.5
17 - 19	1	3.67	16.36	3.67	16.36
19 - 20	2	4	15	8	7.5
20 - 21	2	5	12	10	6
21 - 22	2	5	12	10	6
22 - 23	2	6	12	12	5
23 - 24	1	12	5	12	5
Total No. of train trips per direction per day			240.36		157.91

Source: JST

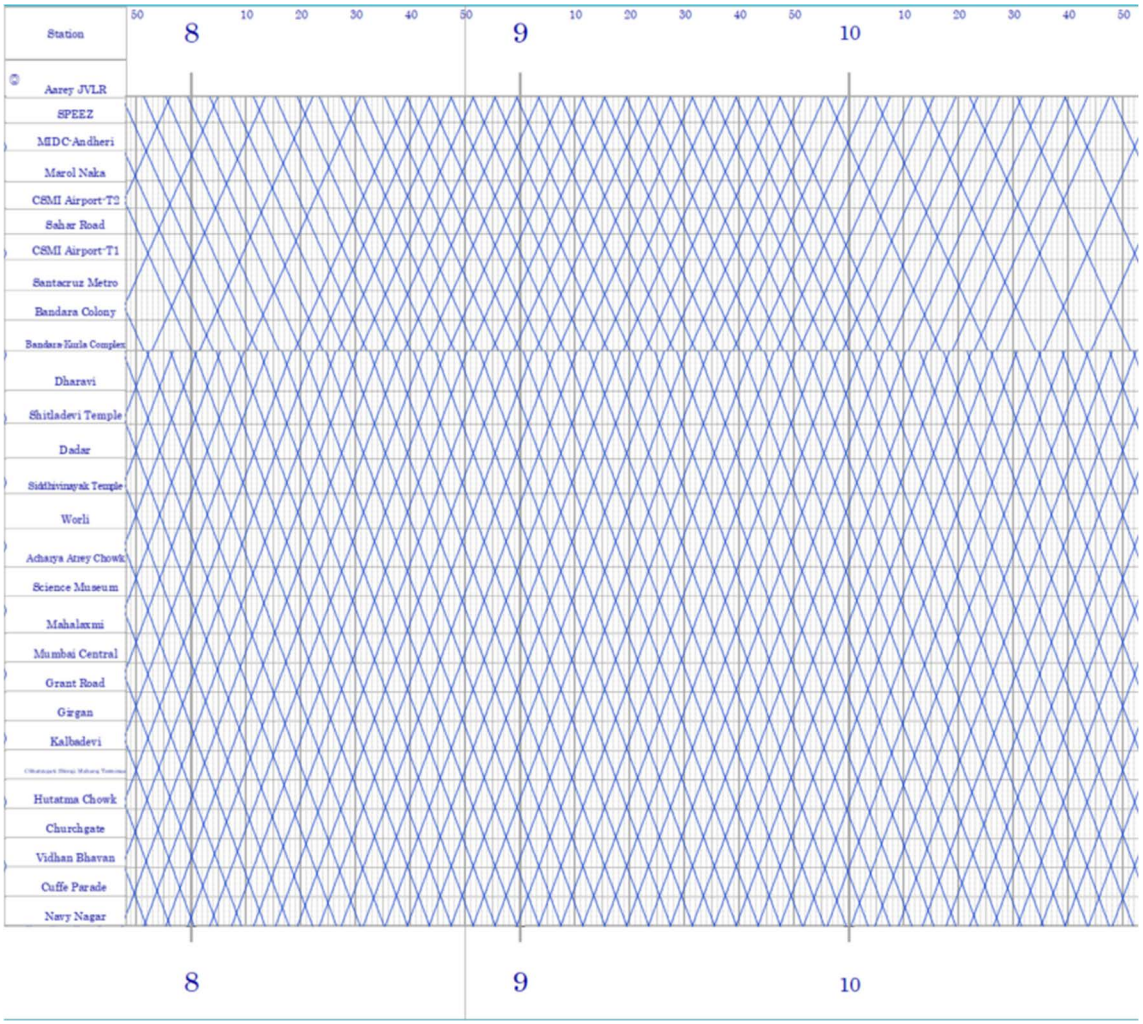
Table 3.4.13 Hourly Train Operation Plan in 2051

Time	No. of Loop s	Section: Navy Nagar to Bandra Kurla Complex		Section: Bandra Kurla Complex to Aarey JVLR	
		Headway (min)	No. of Operation per Direction per Hour	Headway (min)	No. of Operation per Direction per Hour
5 - 6	1	12	5	12	5
6 - 7	2	5.5	10.91	11	5.45
7 - 8	2	3.67	16.36	7.33	8.18
8 - 10	1	3.33	18	3.33	18
10 - 11	2	3.67	16.36	7.33	8.18
11 - 12	2	4.5	13.33	9	6.67
12 - 13	2	4.5	13.33	9	6.67
13 - 15	2	4.5	13.33	9	6.67
15 - 16	2	4.5	13.33	9	6.67
16 - 17	2	3.67	16.36	7.33	8.18
17 - 19	1	3.33	18	3.33	18
19 - 20	2	3.67	16.36	7.33	8.18
20 - 21	2	4.5	13.33	9	6.67
21 - 22	2	5	12	10	6
22 - 23	2	6	10	12	5
23 - 24	1	12	5	12	5
Total No. of train trips per direction per day			260.36		171.18

Source: JST

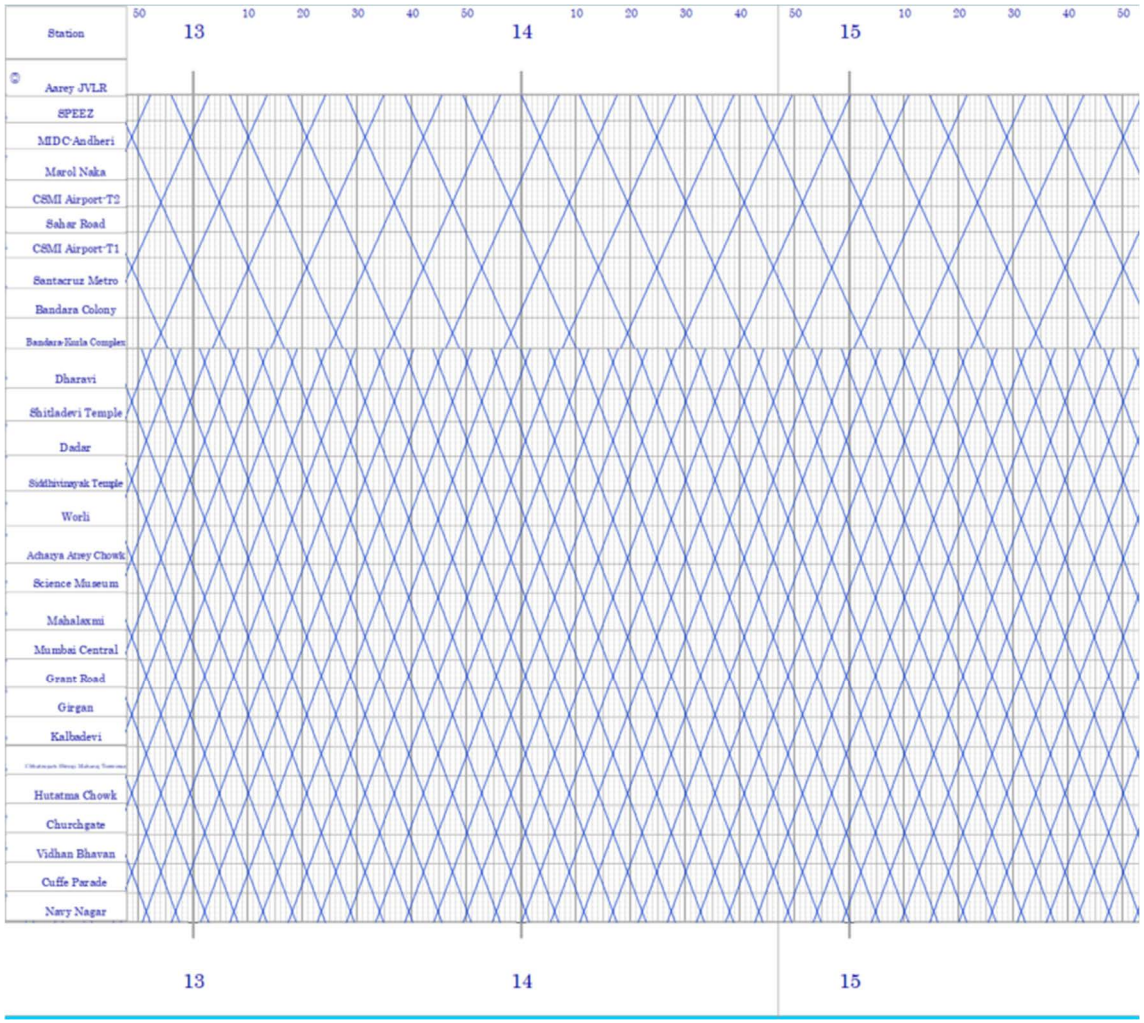
3.4.2.5 Example of Timetable

Based on calculated train headway in peak hour and off peak hour in previous section, timetable for planned opening year, 2034, and future year, 2051, has been shown as follows:



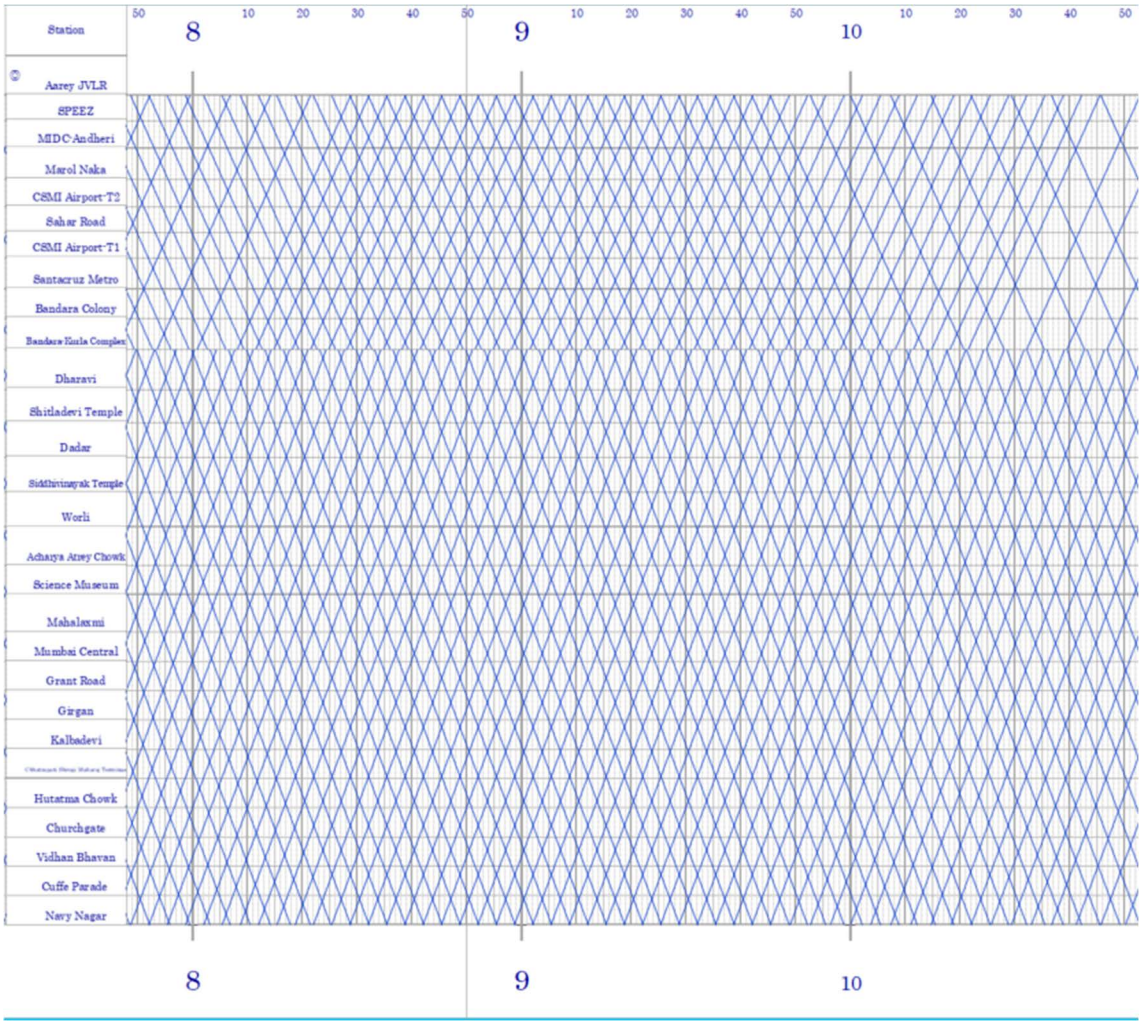
Source: JST

Figure 3.4.6 Peak Hour Timetable in 2034



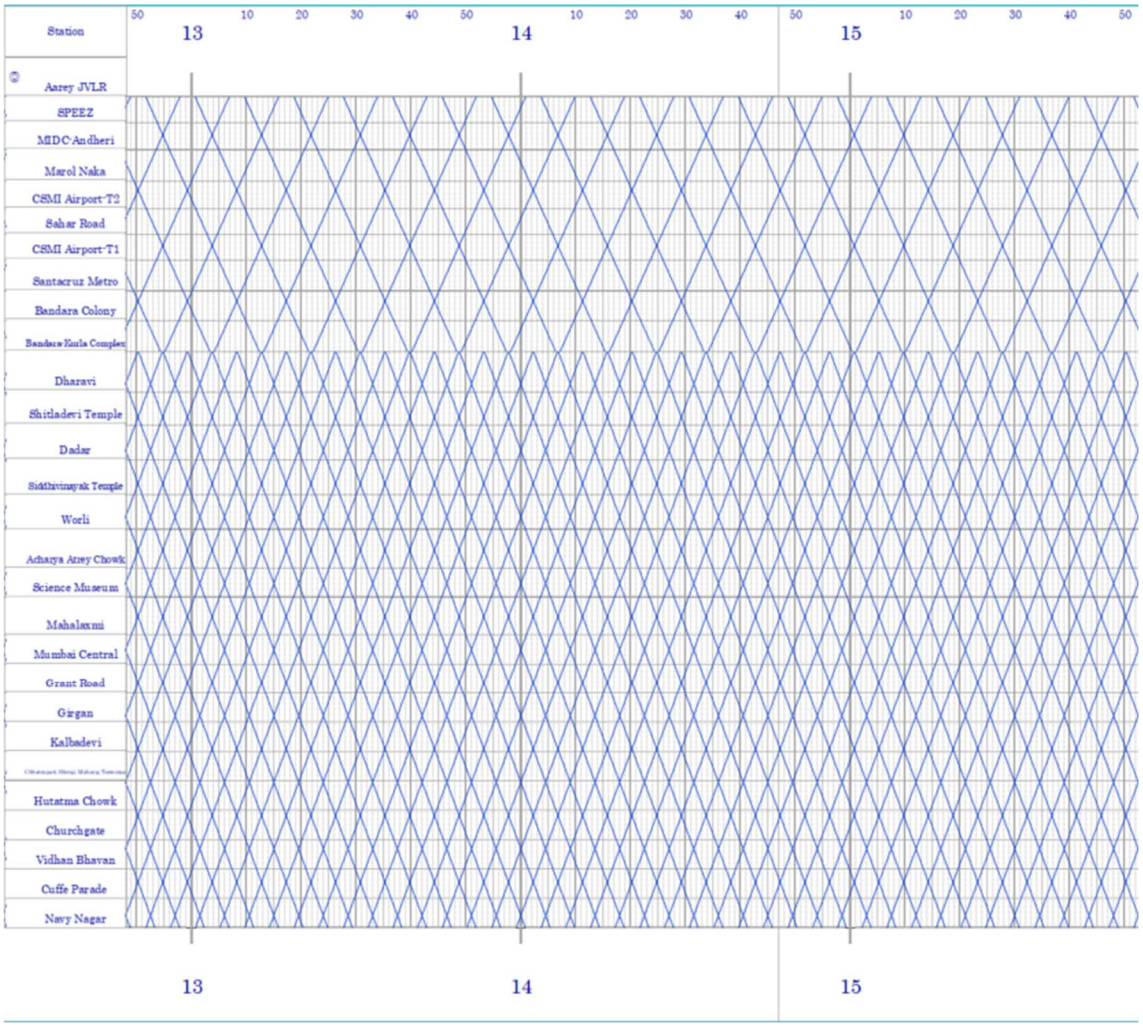
Source: JST

Figure 3.4.7 Off Peak Hour Timetable in 2034



Source: JST

Figure 3.4.8 Peak Hour Timetable in 2051



Source: JST

Figure 3.4.9 Off Peak Hour Timetable in 2051

3.4.3 Required Number of Rolling Stock for Line 11 Corridor-2

Requirement of trains for the Line 11 Corridor-2 is calculated based on following assumptions:

- Schedule speed is taken as 35 km/h for the round trip
- Total turn round time is taken as 6 min at terminal stations
- Car requirement has been calculated based on the headway during peak hours
- The calculated number of rakes in fraction is rounded off to next higher number
- Traffic reserve is taken 5% to failure of train on line and to make up for operational time lost
- Repair and maintenance has been estimated as 10% of the train requirement

Required number of Rolling Stock has been calculated in Table 3.4.14.

Table 3.4.14 Required Number of Rolling Stock for Line 11 Corridor-2

Year	Length	Scheduled Speed	Run Time (min)	Total Round Trip Time	Headway	Minimum Trainset	Traffic Spare@5%	Maint. Spare@10%	Total Trainset
2034	35.01	35 km/h	60.02	5	4	32	2	3	37
2041	35.01	35 km/h	60.02	5	3.67	35	2	3	40
2051	35.01	35 km/h	60.02	5	3.33	38	2	3	43

Source: JST

3.4.4 Vehicle Kilometer

Based on train operation planning, after considering maintenance period, Vehicle Kilometers for Line 3 and Line 11 Corridor-2 are as follows:

Table 3.4.15 Vehicle Kilometers for Loop 1 (Aarey JVLR to Navy Nagar)

Year	Section Length	No. of Cars per Train	No. of Trains per day per Direction	Daily Train -KM	Annual Train –KM (Million)
2034	35.01	8	147.52	10329.48	3.770
2041	35.01	8	157.91	11056.79	4.036
2051	35.01	8	171.18	11986.15	4.375

Source: JST

Table 3.4.16 Vehicle Kilometers for Loop 2 (Bandra Kurla Complex to Navy Nagar)

Year	Section Length	No. of Cars per Train	No. of Trains per day per Direction	Daily Train -KM	Annual Train –KM (Million)
2034	22.71	8	77.52	3521.04	1.285
2041	22.71	8	82.45	3745.09	1.367
2051	22.71	8	89.18	4050.64	1.478

Source: JST

3.5 Intermodal Integration

3.5.1 Intermodal Integration

(1) Introduction

Ridership Dependency: The success of a Mass Rapid Transit System is closely linked to the accessibility of areas generating and attracting trips within the catchment zone.

Last Mile Connectivity: Crucial for enhancing metro ridership, involving a network of footpaths, cycle lanes, and bus feeder systems.

(2) Steps for Efficient Multimodal Integration

Define Requirements: Identify the needs for last mile connectivity at metro stations.

Land Use Assessment: Evaluate existing and proposed land use to pinpoint major trip demand and attraction points.

Station Location Correlation: Assess how station placement can facilitate multimodal integration.

Road Network Understanding: Analyze the road network for potential area-level integration.

Infrastructure Assessment: Check for the presence of pedestrian networks, NMT lanes, IPT connectivity, and bus stops within the catchment area.

(3) Need for Multimodal Integration

Smooth Movement: Ensures efficient commuter movement across various modes (buses, IPT, private vehicles, NMT) in terms of time, cost, comfort, safety, and accessibility.

Increased Demand: Successful integration can boost public transportation demand by optimizing travel cost and time, allowing seamless mode interchange.

(4) Approach

Last Mile Connectivity: Focus on ensuring seamless door-to-door travel.

Complementary Services: Last mile services complement rapid transit by enabling easy transfers to the main metro line, influencing transit ridership and user choices.

(5) Multimodal Integration at Corridor Level

Feeder Services: Target users beyond 1 km from the metro catchment zone with buses, mini buses, and shared autos.

Frequency: Align feeder bus frequency with metro timings (ideally 5-10 minutes).

Connectivity: Connect residential, commercial, and activity centers to metro stations using a Hub and Spokes model.

Catchment Area: Assess a 3-4 km radius around metro stations to identify major trip generation points.

Bus Types: Use shuttle buses, mini vans, and battery-operated vehicles.

Pedestrian Network: Enhance efficiency by considering land use distribution, important landmarks, and missing pedestrian infrastructure links.

(6) NMT and Public Bicycle Sharing

Public Bicycle Sharing (PBS): Provide last mile connectivity through a dense network of cycles.

Cycle Lanes and Docking Stations: Necessary at metro stations and major areas to promote sustainable and non-motorized modes.

Multimodal Integration at Station Area Level

Integration of Modes: Ensure seamless travel by integrating various modes at metro stations.

Infrastructure: Include bus stops, IPT stops, pedestrian networks, information boards, adequate lighting, and interactive public spaces.

Design Principles: Follow standard practices and guidelines (IRC and UTTIPEC) for station area design, ensuring universal accessibility and barrier-free designs.

(7) Way Forward

Integrated Transportation System: Provide a system seamlessly integrated across all modes with first and last mile connectivity.

Detailed Studies: Conduct studies to assess existing facilities, identify gaps, and propose enhancements for feeder buses, cycle tracks, and pedestrian paths.

Implementation: Ensure these provisions are in place before the commercial operation of metro services to benefit users and improve ridership and financial viability.

3.5.2 System and Technology Selection

This corridor, extending from Cuffe Parade to Navy Nagar, covers a length of 1.45 km and includes one underground stations and four (4) stabling lines.

The Mumbai Metro Line 3 Extension is a grade-separated system with the exclusive right-of-way, featuring modern, state-of-the-art rolling stock capable of high acceleration and deceleration, with a maximum speed of 95 kmph and an operating speed of 85 kmph. The system adheres to metro rail geometric design standards, permitting a minimum curve radius of 120m. Depending on infrastructure elements such as rolling stock, signaling systems, and station platform lengths, the metro system can be designed to handle PHPDT capacities ranging from 10,000 to 80,000.

Considering the specific characteristics of Mumbai, its traffic demand, and available right-of-way, an 8-car train composition has been adopted for Mumbai Metro Line 3 Extension to ensure high-capacity transit operations for the corridor.

The system will be operated by MMRCL, which is currently operating Mumbai Metro Line 3. Therefore, it is essential to adopt similar technical specifications to the existing Mumbai Metro Line 3 to ensure seamless operations and maintenance compatibility. The following table outlines the key system specification parameters for Mumbai Metro Line 3 Extension.

Table 3.5.1 System Specification Parameters for Corridor-2 (Mumbai Metro Line 3 extension)

Parameter	System Specification
Corridor	Cuffe Parade to Navy Nagar
Traffic Handling Capacity (PHPDT)	70,920 with a headway of 2 minutes
Gauge	Standard gauge (1435 mm)
Traction System	25 kV AC Overhead Catenary
Rolling Stock	8-Car (DMC + TC + MC + MC + MC + MC + TC + DMC)
Axle Load	≤17 T
Maximum Design Speed	95 kmph
Maximum Operating Speed	85 kmph
Maximum Acceleration	1.0 m/s²
Maximum Deceleration	1.0 m/s² (Normal Brake)
Emergency Braking	More than 1.3 m/s²

Source: JST based on DPR

3.6 Signalling and Telecommunication

3.6.1 Signaling System

3.6.1.1 Existing Survey Results

(1) Train Control System

Mumbai Metro Line 11 Corridor-2 adopts CBTC (Communication-Based Train Control), which offers more advantages compared to the conventional DTG (Distance to Go) Signaling System, and it is considered beneficial to introduce CATC (Continuous Automatic Train Control) for continuous automatic control of trains. Additionally, since CBTC has already been implemented in Mumbai Metro Line 3, it is planned to be extended to Mumbai Metro Line 11 Corridor-2 as well.

Mumbai Metro Line 11 Corridor-2 comprises the subsystems outlined in Table 3.6.1: ATP (Automatic Train Protection), ATO (Automatic Train Operation), UTO (Unattended Train Operation), and ATS (Automatic Train Supervision).

Table 3.6.1 Main Technical Specifications of CATC

Main Systems/ Equipment	Key Technical Specifications
Automatic Train Protection (ATP)	ATP is a key subsystem of CBTC, and it achieves its functions using fail-safe methods. The main technical specifications of ATP are planned as follows: • Accurate train position detection methods for CBTC-equipped trains. • Wireless transmission of train position information, detected by onboard equipment, to ground equipment. • Wireless transmission of signals and route information (from ground equipment to onboard equipment). • Continuous generation of speed profiles (ATP speed patterns) appropriate for the route conditions, based on track data and train data. • Monitoring of the maximum allowable speed for the track section. • Monitoring of the maximum speed set by the train itself. • Maintenance of safe distances between trains. • Continuous monitoring of braking curves in relation to defined targets (such as stopping points and speed restriction zones). • Monitoring of travel direction and rollback. • In-cab signalling. • Detection of overspeed, with application of audio/visual warnings and brakes as necessary. • Safety protection functions during door opening and closing. • Compliance with Safety Integrity Level 4 (SIL 4) standards (as per CENELEC standards EN 50126, EN 50128, and EN 50129).
Automatic Train Operation (ATO)	ATO enables automatic train operation from station to station under the safety functions of ATP. The train control and signalling systems in ATO perform the following functions: • Control of train speed through acceleration, coasting, and appropriate deceleration by applying and releasing brakes. • Automatic control of speed and acceleration to prevent unnecessary braking and stops. • Control of train stopping at stations. • Providing indications necessary for train operation. • Continuous determination of Maximum Safe Speed (MSS) and Limit of Movement Authority (LOMA) using ATP functions. • Automatic door opening (after the train stops at a station). • Automatic train operation (executed after departure preparation, initiated by the driver pressing the door-closing and departure buttons).

Main Systems/ Equipment	Key Technical Specifications
	• Train operation management according to headway or timetable. • Automatic turnaround control at terminal stations. • Compliance with Safety Integrity Level 2 (SIL 2) standards as per CENELEC standards EN50126, EN50128, and EN50129.
Unattended Train Operation (UTO)	UTO is an autonomous driving method that does not require a driver. It includes GoA3, where an attendant is on board, and GoA4, which is fully unmanned and managed automatically. • Door operation control can be automatic/manual. • Constant communication is maintained with the Operation Control Center (OCC), where controllers can contact passengers and provide support in emergencies. • Functions implemented are realized through ATO (Automatic Train Operation).
Automatic Train Supervision (ATS) system	The ATS system enables train operation control and remote station equipment control in OCC, BCC, DCC, and SCR. • Train presence indication, monitoring, and continuous control of train movement • Automatic and manual route setting • Automatic and manual train control (adjustment of train intervals) • Continuous tracking and recording of train positions • Degraded mode management • Train timetable management • Display and print output of train timetables • Information transmission for display on PIDS and announcements via PA systems • Monitoring and control of CBTC equipment (ATS, ATP, ATO, and CBI) • Operational support (alarm output, system operation data storage, etc.) • Dual-system equipment configuration • Safety integrity level conforms to SIL 2 of the CENELEC standards EN 50126, EN 50128, and EN 50129.

Source: DPR, JST

(2) Computer Based Interlocking System (CBI) and Other Signaling Equipment

The technical specifications for electronic interlocking devices and other signalling equipment for Mumbai Metro Line 11 Corridor-2 are shown in Table 3.6.2.

Table 3.6.2 Main Technical Specifications of CBI and Other Signaling Equipment

Main Systems/ Equipment	Main Technical Specifications
Computer Based Interlocking System (CBI)	A CBI system will be installed at each station with facilities such as turn-back tracks, depot tracks, sidings, and depots to operate point switching, crossing, and route setting. The main technical specifications of CBI are planned as follows: • Route setting and cancellation are carried out remotely from the OCC via this system. • If operations are handed over from the OCC to the station, route setting and cancellation can also be performed at the station. • Continuous monitoring and control of train presence indication, train movement, and station equipment in the SCR (Station Control Room). • Manual route setting in SCR and remote route setting from OCC. • Control and display of ground signals within the station premises. • Control and display of electric point machines within the station premises. • Block functions. • Safety integrity level conforms to SIL 4 of CENELEC standards (EN 50126, EN 50128, EN 50129).
Train Detection Device (Digital Axle Counter)	The main technical specifications of the digital axle counter are planned as follows: • Serves as a secondary train detection method for CBTC-equipped vehicles (backup system in case of ATP failure).

Main Systems/ Equipment	Main Technical Specifications
	• Provides a train detection method for non-CBTC-equipped trains/vehicles. • Installed within the same range as the CBTC control area. • Composed of axle sensors and indoor units (evaluation devices).
Ground Signal	The main technical specifications for the ground signal are planned as follows: • A secondary train operation method for CBTC-equipped vehicles (backup system in case of ATP failure) • A train operation method for non-CBTC-equipped vehicles • Installation at stations with electronic interlocking devices for turnout protection (to support bidirectional operations) • Use of LED signals to ensure high reliability and reduce maintenance costs
Electric Point Machine	The main technical specifications of the electric point machine are planned as follows: • Mainline point machines are of the non-trailable type, powered by 3-phase AC, 50Hz, 380V, and comply with international standards. • Depot point machines are of the non-trailable type, powered by DC 110V, and comply with Indian domestic standard IRS.

Source: DPR, JST

(3) Others

- Establish an OCC (Operation Control Center) at the Aarey Colony Depot, with a BCC (Backup Control Center) at Bandra Kurla Complex Station as a backup in case of OCC failure.
- Install new CBI at Navy Nagar Station.
- The safety of the mainline section is planned to be ensured by ATP.
- The level of automation for train operation on Mumbai Metro Line 3 is initially planned to operate at GoA2 (requiring crew), with a proposed upgrade to GoA4 (driverless automated train operation). This plan is designed to support both on Mumbai Metro Line 11 Corridor-2.
- UPS (Uninterruptible Power Supply) will be shared among signalling equipment such as the CBTC system, communication equipment, AFC system, PSG, etc., with a two-hour backup planned in case of power outages.
- All equipment rooms are planned to be equipped with air conditioning.
- Materials used for wiring, installation, grounding connections, cable routing, power supply, track circuits, axle counters, relays, electric point machines, power supply, etc., are planned to comply with appropriate IS (Indian Standards), IRS (Indian Railway Standards), BS (British Standards), or equivalent international standards.

3.6.1.2 Review and Proposal of Existing Surveys

(1) Conformity Assessment with International and Regional Standards, Validity of Equipment Planning

The survey team conducted an assessment to confirm whether the signalling equipment for Mumbai Metro Line 11 Corridor-2 adopts appropriate international and regional standards.

Table 3.6.3 Application of Main Technical Standards for Signalling Equipment

Applicable Standards				Remark
	International Standards	Regional Standards		
		International	Domestic	
◆ Train Control System (CBTC) • Automatic Train Protection (ATP, SIL4) • Automatic Train Operation (ATO, SIL2) • Automatic Train Supervision (ATS, SIL2)	IEEE1474.1			
	IEC62267			UTO
	IEC62290			UTO
		EN50126		RAMS・SIL
		EN50128		RAMS・SIL
		EN50129		RAMS・SIL
◆ On-site Equipment (Materials used for wiring, grounding, cable routing, power supply, track circuits, axle counters, relays, electric point machines, power supply, etc.)			IS	
			IRS	Point machines, etc.
		BS		
◆ The Principle of Fail-Safe (Regulations regarding the operation of CBTC devices, electronic interlocking systems, relays, and electric point machines, etc.)		EN50126		Equivalent to IEC62278
		EN50128		Equivalent to IEC62279
		EN50129		Equivalent to IEC62425
◆ Immunity to External Interface	IEC			IEC60502,IEC62236,IEC 61000 Series
		EN		EN50575,EN50121 Series
◆ Signaling and Train Control Systems in General	IEC IEEE ITU-T	CENELIC BS	IS	

Source: DPR, JST

1) Conformity with International and Regional Standards

a) Potential Restrictions on Entry Due to International and Regional Standards

The JST reviewed whether the signalling equipment for Mumbai Metro Line 11 Corridor-2 imposes restrictions on the entry of many companies due to international standards, regional standards, or Indian domestic standards.

- The signalling equipment for Mumbai Metro Line 11 Corridor-2 is equivalent to or similar to signalling equipment with a proven track record of use within India.
- The signalling equipment for Mumbai Metro Line 11 Corridor-2 considers the application of international standards, widely applied regional standards, and regional standards established by organizations such as the Bureau of Indian Standards and the Ministry of Railways.

Based on the above, the JST confirmed that the signalling equipment for Mumbai Metro Line 11 Corridor-2 does not impose restrictions on entry due to international or regional standards.

b) Regarding the Concept of Safety Certification

For Mumbai Metro Line 11 Corridor-2, safety certifications such as CBTC and electronic

interlocking systems (based on the fail-safe principle) are planned to be implemented using CENELEC, a regional standard. Concerns were raised that the application of CENELEC, as a regional standard, could increase barriers to entry and costs.

However, subsequent investigations and interviews with MMRCL confirmed the following:

- The majority of CBTC manufacturers have already entered the Indian market, and each company complies with CENELEC standards.
- While IEC develops standards covering a broad range of electrical and electronic technologies, CENELEC specifies detailed guidelines regarding "railway safety and reliability". It was referenced as it more appropriately aligns with the current objectives.
- Overall, the signalling equipment allows compatibility with international standards, and the concept of safety certification does not impose constraints.

Based on these findings, the current description does not pose barriers to entry, allows general companies to participate, and does not impact costs.

From points i) and ii), the JST confirmed that the signalling equipment for Mumbai Metro Line 11 Corridor-2 complies with appropriate international and regional standards.

2) Validity of Equipment Planning

For "resistance to external interfaces," EN standards are used for two types of matters.

Regarding the safety and performance of cables, EN50575, compared to IEC60502, specifically ensures the safety of electrical cables used within buildings. In this case, as most of the equipment is located inside tunnels, the adoption of standards designed for use within buildings does not impose particular restrictions on equipment selection.

Additionally, in terms of EMC (Electromagnetic Compatibility) / EMI (Electromagnetic Interference) performance, which indicates electromagnetic wave emissions and noise resistance, either IEC or EN standards are required. Therefore, this does not impose any specific restrictions.

(2) Review of the Validity of Equipment Planning Based on Future Demand Forecast

Mumbai Metro Line 11 Corridor-2 is planned as a 1.45 km extension on the southern side of the 33.5 km Mumbai Metro Line 3. With this, the daily number of passengers on the route from Navy Nagar Station to Aaray Station is expected to reach 41,420 PHPDT (Passengers Per Hour Per Direction) by 2051. Additionally, the peak operation interval in 2051 is planned to be 3.3 minutes, with the minimum design interval set at 2-minute headways.

The CBTC signalling system employs a moving block method that continuously transmits the position of the train, making it suitable for reducing train intervals. As a result, it has been confirmed that the system accommodates the transportation capacity based on future demand, demonstrating that the plan is valid.

(3) Validity Assessment of Equipment Modification Flexibility

The CBTC system planned this time does not use physical ground-based equipment such as track circuits for train position detection but instead adopts train-mounted equipment for position detection. Therefore, even if changes to ground equipment occur, most cases can be addressed with modifications primarily focused on the data and software of the onboard equipment. This enables flexible responses to equipment and operational changes.

The JST confirmed that Mumbai Metro Line 11 Corridor-2 takes into account the flexibility for modifications to signalling equipment and other systems.

(4) Proposal

a) Introduced Equipment

Mumbai Metro Line 11 Corridor-2 is planned as a 1.45 km/1 station extension to the 33.5 km/27 station route of Mumbai Metro Line 3. Operations will be conducted as part of the same railway section using the same vehicles, and equipment monitoring and maintenance will also follow the same operational framework. In terms of equipment maintenance, securing spare parts, training for fault response, and operations, it is considered appropriate to adopt new train control systems and signalling equipment that are identical or equivalent to those of Mumbai Metro Line 3.

b) Points of Consideration

When introducing equipment for Mumbai Metro Line 11 Corridor-2, there is a tendency for the equipment to differ due to the time difference from Mumbai Metro Line 3, even if the manufacturer remains the same. Therefore, the following considerations are deemed necessary during design and procurement:

- Ensuring the functionality of Mumbai Metro Line 3 is achieved.
- Compatibility with the OCC (Operations Control Center) equipment of the preceding Mumbai Metro Line 3.
- Securing interfaces with other communication infrastructures.
- Ensuring equipment handling is equivalent to Mumbai Metro Line 3 to simplify maintenance.
- If possible, ensuring interchangeability for replacement purposes.

It is recommended to proceed with the introduction of equipment while verifying the functionality of not only the ground-based equipment but also the compatibility with both old and new onboard equipment.

3.6.2 Telecommunication System

3.6.2.1 Existing Survey Results

(1) Telecommunication Equipment

The main technical specifications of the communication equipment for Mumbai Metro Line 11 Corridor-2 are shown in Table 3.6.4.

Table 3.6.4 Main Technical Specifications of Telecommunication Equipment

Main Systems/ Equipment	Main Technical Specifications
Fiber Optic Transmission System (FOTS)	The main technical specifications of the optical information transport system are planned as follows: • Construction of an IP-based gigabit Ethernet network using optical transmission equipment. • The Fiber Optical System (FOS) will use outdoor single-mode fiber (96 cores), laid on both sides of the tracks and configured in a ring structure for redundancy. • The system will meet the requirements of other communication systems (e.g., CCTV, ticketing system, maintenance management system, PAS, PIDS, clocks, telephone system, signalling system, SCADA, etc.) and provide a communication backbone connecting the OCC (Operations Control Center), BCC (Backup Control Center), depot, and all stations.
Private Branch Exchange (PBX)	The proposed PBX (Private Branch Exchange) is a centrally integrated, IP (Initiation Protocol)-based telephone exchange system, and its main technical specifications are planned as follows: • A centrally integrated IP telephone exchange eliminates the need to install small exchanges at each station. • Enables communication with wireless users within Mumbai Metro Line 3, as well as calls to external telephone systems. • The telephone system includes a PSTN (Public Switched Telephone Network) connection function for hotline telephone services with Mumbai Police, Mumbai Fire Department, and Mumbai Disaster Management.
Electric Clock System (GPS Synchronization)	The main technical specifications of the electric clock system are planned as follows: • The master clock is synchronized with GPS standard synchronization signals. • Slave clocks are installed on platforms, concourses, station master's rooms, depots, and other service facilities, and are synchronized with the master clock. • Accurate time information from the master clock is provided to all subsystems, including FOTS (Fiber Optical Transmission System), PBX (Private Branch Exchange), wireless systems, signalling systems, PSD (Platform Screen Doors), AFC (Automatic Fare Collection), SCADA, and onboard equipment.
Mobile Radio System (TETRA)	The main technical specifications of TETRA are planned as follows: • Communication of voice and data between the ground and trains is possible. • At least 8 simplex voice calls can be made simultaneously at each station. • In addition to the radios in the front or rear cabs of the vehicles, 1,200 portable radios will be used. • The radio system enables bidirectional low-speed data transmission for signalling and vehicle systems. • The coverage area of the radio system allows duplex communication within trains, tunnels, exit stairs, firefighter escape routes, central shafts of tunnels, TVS rooms, TVS shafts, tunnel cross passages, station rooms, auxiliary buildings, and surface areas near stations.
Passenger Announcement System (PAS)	The main technical specifications of the PA system are planned as follows: • Broadcast voice messages to passengers and staff at stations from OCC, BCC, and stations. • The station PAS allows operators at OCC, BCC, and SCR to pre-record voice announcements. • The station PAS automatically plays pre-recorded announcements triggered by the signalling system, such as the arrival of the next train or delayed trains. • Announcements to passengers at stations are played in the order of Marathi, Hindi, and English. • The station PAS automatically plays pre-recorded evacuation announcements triggered by the fire protection system. • The station PAS integrates with the passenger information display system to show the same visual messages to passengers.
Passenger Information Display System (PIDS)	The main technical specifications of the PIDS are planned as follows: • Display devices will be installed in the concourses and platforms of all stations. • Operators at OCC and BCC can send visual information, either live or pre-recorded, to public areas of the stations. • Displays will show destinations, arrival/departure times, and special messages during emergencies. • Information for passengers will be displayed in three languages: Marathi, Hindi, and English. • The system can automatically play pre-recorded evacuation signs triggered by the fire protection system. • LED boards are preferred for passenger display boards on platforms.

Main Systems/ Equipment	Main Technical Specifications
CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM	The main technical specifications of the CCTV system are planned as follows: • The CCTV system will use IP cameras with a resolution of 2 megapixels, which can be remotely operated and monitored from security rooms such as OCC, BCC, and SCR. • Data will be recorded in full-time, full-frame, and full-resolution for 31 days. • CCTV cameras will be used for multiple purposes, including monitoring train operations, security, and checking work progress at depots. • For security purposes, they will also be used to monitor individuals entering or crossing tunnels.
Centralized Voice Recording System (CVRS) Centralized Data Recording System (CDRS)	The main technical specifications of the VRS are planned as follows: • Recording of voice, radio, public address announcements, and emergency voice communications (OCC/BCC/DCC). • Voice recordings will be stored for future evaluation. The main technical specifications of the FRS are planned as follows: • Collecting alarms and maintenance data from the communication system to share information about faults and enable early response by dispatchers and maintenance personnel. • Sending text messages to mobile phones selected by MMRCL.
Access Control and Intrusion Detection System (ACIDS)	Staff of Mumbai Metro Line 11 Corridor-2 will be issued the same contactless smart cards as AFC to manage entry and exit. • Entry permissions to security areas are managed by the system. • Alarms are triggered for the opening of designated doors in restricted control rooms, equipment rooms, stations, emergency exits, etc. • Entry and exit are recorded with details such as date, time, and location.
Network Monitoring and Management System (NMS)	The main technical specifications of the NMS are planned as follows: • Diagnosing faults in individual communication equipment connected to the network from the central system and responding as quickly as possible to improve operational efficiency and reduce maintenance personnel. • Planning to install M&E SCADA to monitor and control systems such as elevators and escalators at stations from OCC/BCC.

Source: DPR, JST

(2) Others

- The uninterruptible power supply (UPS) is planned to provide power for approximately 2 hours during a power outage to the train control system (CBTC), signalling equipment, communication equipment, AFC system, and PSD control devices.
- All communication equipment rooms will be equipped with air conditioning to maintain a room temperature of 25°C.

3.6.2.2 Review of Existing Surveys and Improvement Proposals

(1) Conformity Assessment with International and Regional Standards

The JST confirmed whether the signalling equipment of Mumbai Metro Line 11 Corridor-2 adopts appropriate international and regional standards.

Table 3.6.5 International and Regional Standards Adopted in Communication Equipment

Applicable Standards				Remark
	International Standards	Regional Standards		
		Foreign	Domestic	
Fiber Optic Transmission System (FOTS)	ITU-T Related Standards			
	IEC Related Standards			
	IEEE Related Standards			
	IETF Related Standards			
Passenger Announcement System (PAS)	IEC Related Standards			
Mobile Radio Communication System (TETRA)	ITU-R Related Standards			
		ETSI Related Standards		EN300394
Access Control and Intrusion Detection System (ACIDS)	ISO/IEC			
Structured Cabling	ISO/IEC			
	ANSI/TIA			
	IEC			

Source: DPR, JST

1) Conformity with International and Regional Standards

a) Potential Restrictions on Entry Due to International and Regional Standards

The JST examined whether the signalling equipment of Mumbai Metro Line 11 Corridor-2 restricts the entry of many companies due to international, regional, or Indian domestic standards.

- The communication equipment of Mumbai Metro Line 11 Corridor-2 is equivalent to or similar to the communication equipment with a proven track record in India.
- The communication equipment of Mumbai Metro Line 11 Corridor-2 considers the application of international standards for each piece of equipment.

Based on the above, the JST confirmed that the communication equipment of Mumbai Metro Line 11 Corridor-2 is not restricted by international or regional standards.

b) Conformity with Regional Standards

Some of the communication equipment of Mumbai Metro Line 11 Corridor-2 is planned to comply with EN standards. Since EN standards are European standards, the survey team considered that some suppliers might find it difficult to bid. The survey team examined whether this could lead to an increase in construction costs.

TETRA, the mobile radio system that complies with EN standards, is a professional digital radio widely used for public safety and is standardized in Japan and widely used worldwide. Since it has been standardized since 1995, many companies provide products with this technology, and the survey

team confirmed that it would not lead to an increase in construction costs.

2) Appropriateness of Equipment Characteristics

The JST confirmed that the communication equipment of Mumbai Metro Line 11 Corridor-2 is equivalent to or similar to equipment with a proven track record in India. Therefore, the survey team confirmed that the communication equipment of Mumbai Metro Line 11 Corridor-2 is appropriate.

(2) Assessment of the Appropriateness of Equipment Plans Based on Future Transportation Demand

The Fiber Optic Transmission System (FOTS) for Mumbai Metro Line 11 Corridor-2 is planned to be configured with a gigabit Ethernet network. The plan includes laying two 96-core optical fibers, with some cores leased out, providing ample capacity. Additionally, other communication equipment is at the same level as that used in the current Mumbai Metro Line 3, confirming that the communication equipment plan is appropriate for future use.

(3) Review of the Appropriateness of Integration with the Preceding Mumbai Metro Line 3 Communication Equipment

The communication equipment plan for Mumbai Metro Line 11 Corridor-2 is designed to be equivalent to the communication equipment of Mumbai Metro Line 3, which has already partially commenced operations, and the standards are similarly expressed. The connection of equipment between the two lines is possible, and in the future, the standardization of equipment is also feasible. Therefore, the survey team confirmed that the communication equipment of Mumbai Metro Line 11 Corridor-2 does not hinder the connection with Mumbai Metro Line 3.

(4) Proposals

1) Introduction of Equipment

Mumbai Metro Line 11 Corridor-2 is planned to extend the 33.5 km/27 station route of Mumbai Metro Line 3 by 1.45 km/1 station. The same trains will operate on the same line, and the monitoring and maintenance of equipment will be carried out in the same manner. Additionally, for equipment maintenance, securing spare parts, training for fault response, and operations, it is considered appropriate to use the same or equivalent communication equipment as Mumbai Metro Line 3.

2) Points of Attention

Communication equipment often uses many general-purpose products. Even if the manufacturer is the same, the introduction of communication equipment for Mumbai Metro Line 11 Corridor-2 may differ from that of Mumbai Metro Line 3 due to different introduction times. Therefore, the following considerations are necessary during design and procurement:

- Ensure connectivity with the communication equipment of the preceding Mumbai Metro Line 3.
- Ensure interfaces with subsystems such as the train control system.
- Confirm specifications carefully, as issues may become apparent with higher communication speeds.

- Simplify maintenance by ensuring that the handling of equipment is the same as that of Mumbai Metro Line 3.
- If possible, ensure parts are interchangeable.

It is recommended to proceed with the introduction while confirming interfaces with other systems.

3.6.3 Fare Collection System

3.6.3.1 Overview of Existing Studies

Mass Rapid Transit Systems handle large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the system. To achieve this objective, ticketing system shall be simple, easy to use/operate, easy on accounting facilities, capable of issuing single/multiple journey tickets, amenable for quick fare changes and require overall lesser manpower. Mumbai Metro Line 3 has adopted Contactless card technology for Automatic Fare Collection. In addition to the contactless cards, QR ticketing and Common Mobility Card is also proposed for adoption in line-3. Therefore, similar system of fare collection is proposed for extension of Mumbai Metro Line 3 from Cuffe Parade to Navy Nagar.

Account Based ticketing system shall be implemented for line-3. The system shall be used across all proposed transportation modes. Common Mobility card shall be linked to a prepaid account and the fare deduction will be as per the fare calculation logic for all transit operators.

The main technical specifications of AFC System Facilities are shown in the below Table 3.6.6.

Table 3.6.6 The Main Technical Specifications of AFC System Facilities

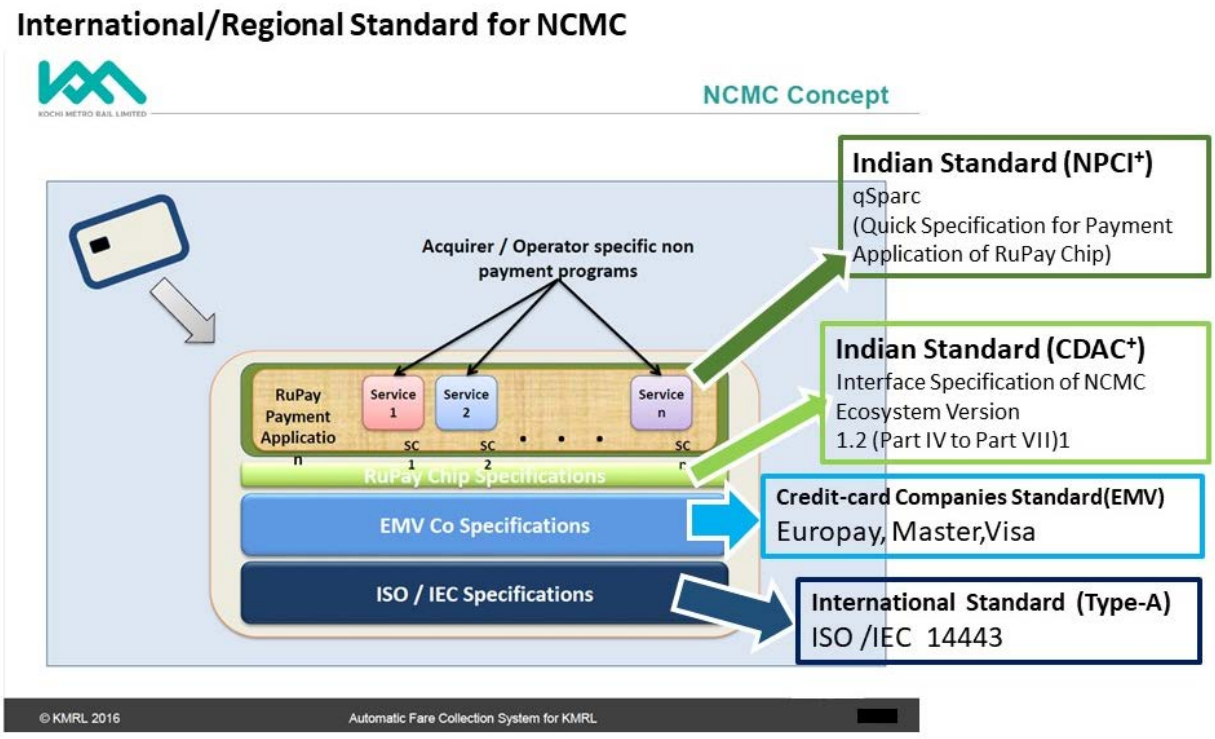
Main System/Device/Equipment	The Main technical specifications
Central Computer Station Computer Automatic Fare Gate (AFG) Ticket Office Machine (TOM) Excess Fare Office (EFO) Ticket Vending Machine (TVM) Passenger Operated Machine (POM) Ticket Reader (TR) Portable Ticket Decorder	The main technical specifications of AFC System Facilities are planned as follows: • Fare media ▪ NCMC (National Common Mobility Card) - Contactless smart card Interface Specification of NCMC Ecosystem Version 1.2 (Part IV to Part VII), CDAC, the Indian standard - qSparc (quick Specification for Payment Application of RuPay Chip, NPCI, the Indian standard) - NCMC recharge using cash, debit/credit card, and Netbanking/web portal ▪ Quick Response (QR) ticket - Paper or mobile (QR Ticketing System for Transit Operators -Specifications (v1.1)-, CDAC, the Indian standard) ▪ NFC IP-1 (ISO/IEC 18092) • AFC System Facilities ▪ All devices at the station (AFG, TOM/EOF, TVM/POM, etc.) are connected to the Station Computer with the local station network. ▪ All station computers are connected to the Central Computer with backbone optical fiber cables. ▪ Up to 256 Station Computers can be connected to the Central Computer. ▪ Retractable flap gate - Entry gate - Exit gate - Swing barrier (for disabled people) ▪ 25 passengers per minute per gate as AFG capacity

Source: DPR, JST

3.6.3.2 Reviews of Existing Studies and Proposals for Improvement

JST confirmed with MMRCL that same type of AFC as used in Line-3 should be used in MMRCL Corridor-2.

JST confirmed with MMRCL that National Common Mobility Card (NCMC) trials were under process and it would be implemented in Line 3 and extended to Corridor-2.



+CDAC: Centre for Development of Advanced Computing
+NPCI: Nation Payment Corporation of India

Source: UNBUNDLING FOR PPP, Automatic Fare Collection System for KMRL, PRAVEEN GOYAL (Kochi metro Director (System)), JST (Add comment)

Figure 3.6.1 International/Regional Standard for NCMC

Table 3.6.7 International/Regional Standards adopted for PMRCL's AFC system facilities

The main International/Regional Standards					Remark
		International Standards+	Regional Standards		
			Overseas	Domestic	
Automatic Fare Collection (AFC) System	Interface Specification of NCMC Ecosystem Version 1.2 (Part Ⅳ to Part Ⅶ) 1	(✓)		✓	• The Rupay Chip is mounted on the fare media based on Type-A (ISO/IEC 14443) and EMV (Europay, Master, VISA: The credit-card companies standard)
	qSparc (quick Specification for Payment Application of Rupay Chip)			✓	
	ISO/IEC 18092 (IP-1)	✓			• NFC (Near Field Communication)

+ "International Standards" in the table also include standards established by international parties and companies.

Source: JST

JST confirmed with MMRCL that state govt. had implemented mobile app system and passenger could buy one ticket for different line with separate QR Code for different line.

JST understood that passenger could use same card for different lines after implementation of NCMC card.

JST confirmed with MMRCL that credit card system is not under consideration at this point but if any proposal comes on PPP modal, they will explore in future.

JST believes that the adaption to NCMC due to the interoperability will be better solution in India.

JST assumes that Indian-related metro corporations will modify their AFC systems to adapt to NCMC (Type-A and EMV, qSparc) in the Figure 3.6.1 and Table 3.6.7 because they are strongly requested by the Indian-related authority (MoHUA) to achieve full interoperability by NCMC.

3.7 Rolling Stock

3.7.1 Overview

The rolling stock for the Mumbai Metro Line 3 Extension (Cuffe Parade to Navy Nagar) follows the same specifications as the main Line 3 corridor. These trains are designed to ensure operational efficiency, passenger comfort, and future scalability.



Source: JST

Figure 3.7.1 Rolling Stock for Mumbai Metro Line 3 (Source: JST)

3.7.2 Rolling Stock Features

The rolling stock for the extension has been selected based on several key factors:

- Passenger Comfort & Safety: Ergonomic seating, ventilation, and safety systems.
- High Reliability: Proven design with robust components.

- Energy Efficiency: Lightweight materials, regenerative braking.
- Operational Flexibility: Scalable to meet future demand.
- Modern Aesthetics: Contemporary design with stainless steel

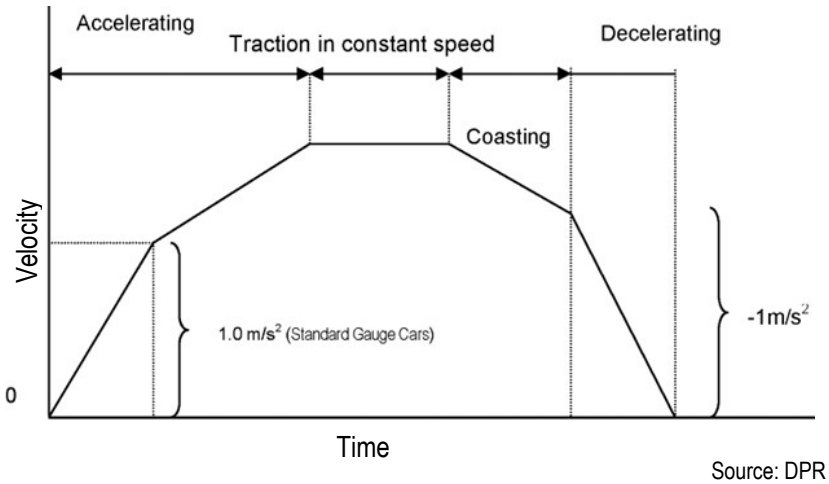
3.7.2.1 Performance

Table 3.7.1 shows the performance parameters and Figure 3.7.2 shows the rolling stock performance curve.

Table 3.7.1 Performance Parameters

Item	Value
Maximum Design Speed	95 kmph
Maximum Operating Speed	85 kmph
Minimum Design Average Acceleration rate for fully loaded (AW4) for 8 car train on level tangent track shall be as under:	
0 to 40 kmph	1.0 m/s^2
0 to 60 kmph	0.85 m/s^2
0 to 80 kmph	0.65 m/s^2
Minimum Design Average Acceleration rate for crush loaded (AW3) for 8 car train on level tangent track shall be as under:	
0 to 35 kmph	1.20 m/s^2
0 to 60 kmph	0.85 m/s^2
0 to 80 kmph	0.65 m/s^2
Maximum service braking rate from 85km/h to standstill including delay time by egeneration/pneumatic braking for fully loaded (AW4) train on level tangent track	1.0 m/s^2
Maximum service braking rate from 85km/h to standstill including delay time by egeneration/pneumatic braking for fully loaded (AW3) train on level tangent track	1.1m/s^2
Emergency braking rate	1.3 m/s^2

Source: JST based on DPR



Source: DPR

Figure 3.7.2 Rolling Stock Performance Curve

3.7.2.2 Specification

The table below shows the main specifications of rolling stock for Mumbai Metro Line 3.

Table 3.7.2 Rolling Stock Specification Sheet

Item	Details	
Gauge	1,435mm	
Electrification	AC 25kV 50Hz Overhead Catenary System	
Train Configuration	8-car formation: DMC + TC + MC + MC+ MC + MC + TC + DMC DMC: Driving Motor Car TC: Trailer Car MC: Motor Car	
Carbody Material	Stainless Steel Stainless steel provides superior corrosion resistance, facilitating cost reduction through ease of maintenance.	
Carbody Dimensions	Maximum Carbody Width	3.2m
	Carbody Length	DMC approx. 22.6 m TC, MC approx. 22.64 m
	Maximum Length	23m (Coupler to coupler)
	Carbody Height	4.048m
Passenger load	65 kg/person	
Passenger Capacity	DTC	282 (seated: 44, standing: 238 at 6 persons/m²) 361 (seated: 44, standing: 317 at 8 persons/m²)
	MC	298 (seated: 52, standing: 246 at 6 persons/m²) 380 (seated: 52, standing: 328 at 8 persons/m²)
	8-car	2,352 (seated: 400, standing: 1,952 at 6 persons/m²) 3,002 (seated: 400, standing: 2,602 at 8 persons/m²)
Weight	Empty Train Weight (Maximum)	8-car formation: Not exceed 336.0 t
Maximum Axle Load	17 t	
Operation Speed	Design max. speed	95 km/h
	Operation max. speed	85 km/h
Bogie	Air-spring bolster-less bogies	
Brake System	Electrically commanded pneumatic brakes Fail-safe emergency brakes Spring-actuated parking brakes Regenerative braking Electro-pneumatic blending brakes Anti-skid functionality Disc brakes or tread brakes	
Emergency Door	Front evacuation door	
Passenger Doors	Electrically controlled double-leaf sliding doors (4 per side)	
Seat	Long seat	
Propulsion System	VVVF Inverter Control (Switching element: IGBT) (Over current protection, short circuit protection, over temperature protection and low power supply detection) Induction Motor (24 units in 6M2T 8-car formation)	
HVAC System	Air conditioning, heating, humidity control, set at 25°C with 60% RH	
Communication system	Communication with base Operational Control Center and station control Public Address Passenger Information Display System Talk Back Units, which permit conversation between passengers and the drivers	

Item	Details
Safety Features	Automatic Train Protection (Singal system) Fire Safety (low fire load, low heat release rate, low smoke and toxicity) Two fire extinguishers per car, One fire extinguisher per cab (as per MoHUA* guidelines) Crashworthiness features (EN15227 and EN 12663) Interior security camera *MoHUA: Ministry of Housing and Urban Affairs

Source: JST based on DPR

3.7.2.3 The Required Number of Rolling Stocks

The projected rolling stock needs for Line 3, including the extension are total 43 trainsets (344 cars) according to the DPR. An additional 1 trainset is required for the Navy Nagar extension.

Table 3.7.3 Required Number of Rolling Stocks

Phase	Required No. of Rolling Stock
Aarey Milk Colony station - Colaba/Cufee Parade station	42 trainsets
Aarey Milk Colony station - Navy Nagar (1 station and 4 stabling line extension)	43 trainsets

Source: JST based on DPR

3.7.2.4 Cost (N/A)

3.7.3 Rolling Stock Maintenance

The rolling stocks are cleaned and maintained on the cycles described in the table below to ensure the safety of the vehicles, maintain their functionality, cabin comfort and cleanliness, and the provision of transportation services.

Table 3.7.4 Rolling Stock Inspection Schedule

Type of Schedule	Interval	Work content	Location	Time Taken
Daily	Daily	Check of train condition, internal cleaning/mopping of floor and walls with vacuum cleaner.	Stabling Line	2 hours
'A' Check	5,000km. (15 days)	Check on safety and reliability of critical equipment, visual inspection, testing of systems, replacements of oils, lubricants.	Inspection Line	4 hours
'B' Check	15, 000 km. (45 days)	'A' Check plus items of 'B' Check	Inspection Line	8 hours
'C' Check	60,000 km. (6 months)	'B' Check plus items of 'C' Check	Inspection Line	1 day
'D' Check	120,000 km. (1 year)	'C' check plus items of "D" check	Inspection Line	2 days
Intermediate Overhaul (IOH)	500,000 km. (4 years)	Check and testing of all subassemblies (Electrical + Mechanical). Overhaul of pneumatic valves, Compressor. Condition based maintenance of sub-systems to bring them to original condition. Replacement of parts and rectification, trial run.	Workshop	9 days
Periodical Overhaul (POH)	1,000,000 km. (8 years)	Dismantling of all sub-assemblies, bogies suspension system, traction motor, gear, control equipment, airconditioning units etc. Overhauling to bring them to	Workshop	18 days

Type of Schedule	Interval	Work content	Location	Time Taken
		original condition. Checking repair and replacement as necessary. Inspection and trial.		

Source: JST based on DPR

The rolling stock maintenance facilities are described in Chapter 3.9

3.8 Power Supply and Traction

3.8.1 Overview of Existing Studies

3.8.1.1 Power Supply Facilities

(1) Power Receiving Facilities

Mumbai Metro Line 3 has been planned with three Receiving substations. Power Supply at 110kV will be stepped down to 33 kV and 25 kV voltage level for auxiliary and traction services. The proposed corridor (From Cuffe Parade to Navy Nagar) is the extension of existing/already planned Mumbai Metro Line 3. Therefore, the power supply for Cuffe Parade to Navy Nagar will be extended from the sources proposed for Mumbai Metro Line 3. Receiving substations planned for Mumbai Metro Line 3 are given in the Table 3.8.1

Table 3.8.1 Proposed Receiving Substations

SN.	Grid Substation	Location of RSS of Metro Authority	Transformers Ratings	
			Traction	Power
1	Saki Receiving Substaion of Tata Power (110kV)	Sariput Nagar RSS near Aarey metro station	110/27.5 kV, 30/42MVA (2Nos)	110/33 kV, 32/45MVA (2Nos)
2	Dharavi Receiving Substaion of Tata Power (110kV)	Dharavi RSS near Dharavi metro station	110/27.5 kV, 30/42MVA (2Nos)	110/33 kV, 32/45MVA (2Nos)
3	Mahalaxmi Receiving Substaion of Tata Power (110kV)	Science Musemum RSS near Science Museum metro station	110/27.5 kV, 30/42MVA (2Nos)	110/33 kV, 32/45MVA (2Nos)

Source: DPR and JST

In order to ensure high reliability of power supply, feed from more than one Receiving Sub Station (RSS) is planned for every section. Under normal circumstances, each RSS will feed specific section of the corridor. In case of emergency condition i.e. when one RSS fails, the other RSS will feed the section of the RSS under outage. Therefore, it is essential that all the sources of supply as Table 3.8.2 and connected transmission & distribution networks are reliable and have adequate built in redundancies.

Table 3.8.2 Feeding Zones for Different Receiving Substations

SN.	Receiving Substation	Feeding Zone	Feeding Zone Including south extension till Navy Nagar
1	Seicence Museum RSS	Chainage 0 to 13400	Chainage (-) 1450 to 13400 (Navy Nagar-Worli)
2	Dharavi RSS	Chainage 13400 to 25800	Chainage 13400 to 25800 (Worli-CSIA Domestic)
3	Aarey RSS	Chainage 25800 to 33613 (end of line beyond Aarey Station and Depot)	25800 to end of line beyond Aarey Station and Depot (CSIA Domestic- Aarey)

Source: DPR and JST

(2) Traction System:

25kV Rigid OHE system in the Figure 3.8.1 comprises a hollow Aluminum Conductor Rail of adequate cross section with 150 sq.mm copper contact wire held with elastic pinch. The Al conductor rail is supported by an insulator and single cantilever arrangement attached to drop-down supports fixed to tunnel roof. The supports are located at maximum of 10 metre and there is no tension in the conductors and hence, no tensioning equipment is required in tunnel. The design of 25kv rigid OHE system shall be in accordance to electrical clearances and contact wire height as per IEC 60913 and EN50122, which is summarized below:

- Contact wire height = 4318mm (with Panto locked down height of 4048mm)
- Structure to Live parts clearances = 270/170/150mm (Static/Dynamic/Abs. min dynamic)
- Vehicle to Live parts clearances = 290/190/150mm (Static/Dynamic/Absolute/ min dynamic)

Navy Nagar station is the last station of the proposed alignment of Mumbai Metro Line 3. Therefore, in view of ease of operation and in order to reduce the voltage drop in OCS, Sub sectioning and paralleling post has been proposed at Navy Nagar.



Source: DPR and JST

Figure 3.8.1 25kV Rigid Overhead Contact system

(3) Auxiliary Supply Arrangements for Station

The auxiliary power will be required for:

- Lights & fans for station
- Service Buildings
- Foot over Bridges/Subways.
- Maintenance Depots
- Air-conditioning
- Lifts
- Escalators
- Water Supply Pumping Stations – for washing, toilets as well as fire protection measures.
- Equipment – Signalling, Telecom, Automatic Fare Collection etc.

The power for the auxiliary loads will be distributed along the alignment through 33 kV Ring main network. Auxiliary sub‐stations (ASS) are envisaged to be provided at each station for stepping down

33 kV supply to 415 V for auxiliary applications. The ASS will be located at concourse or platform level inside a room. The auxiliary load requirements have been assessed at 2500 kVA for Navy Nagar station.

The above capacities of transformers have been worked out based on conceptual design. Therefore, these may be required to be revised for better accuracy during design stage of project.

3.8.1.2 Mechanical Facilities (Platform Screen Door)

Platform Screen Doors (PSDs) will be installed at all stations (full height doors for underground station). They will be used to separate the passengers' platform area from the tracks in the underground stations. The underground PSDs will be of the full-height type, fitted between the platform floor and the ceiling. This means that when the doors are closed, air cannot circulate between the stations and the outside environment (including the station exterior and within the tunnels). This can result in up to substantial energy savings for environmental control systems.

The full height platform screen doors as Figure 3.8.2 have following advantages:

i) It prevents accidental falls off the platform onto the lower track area, suicide attempts and homicides by pushing.

ii) It prevents or reduces wind felt by the passengers caused by the piston effect which could in some circumstances make people fall over.

iii) It reduces the risk of accidents, especially from service trains passing through the station at high speeds.

iv) It improves climate control within the station especially underground stations (heating, ventilation, and air conditioning are more effective when the station is physically isolated from the tunnel).

v) It improves security - access to the tracks and tunnels is restricted.

vi) It lowers operating costs- eliminate the need for motormen or conductors when used in conjunction with Unattended Train Operation (UTO).

vii) It prevents litter build up on the track, which can be a fire risk.

viii) It improves the sound quality of platform announcements, as background noise from the tunnels and trains that are entering or exiting is reduced.



Source: DPR and JST

Figure 3.8.2 The Full Height Platform Screen Door (PSD)

3.8.2 Reviews of Existing Studies and Proposals for Improvement

3.8.2.1 Power Supply Facilities

(1) Power Receiving Facilities

- JST confirmed with MMRCL that they had finalized TATA extension power supply, from Saki, Dharavi, and Mahalaxmi Grid SS in Line-3 to Corridor-2. Power to Corridor-2 will be received from TATA power Grid Substation in the current line 3. Therefore, there is no need to install RSS, power transmission lines, TSS for Corridor-2.
- It is necessary for the stable operation and passenger security to deliver the stable electric supply. Therefore, to ensure redundancy is important for the system design. Dharavi RSS and Science Museum RSS are fed from GSS at 110 kV through 2 circuit, 3-phase cable lines respectively. Furthermore, Each RSS has backup facilities and loads can receive parallel supply from two RSSs. In normal conditions, Science Museum RSS will feed power to Corridor-2. In case of the Science Museum RSS fails, then the Dharavi RSS will extend power to Corridor-2 through line 3. For the above reason, JST evaluates that the measures of stable electric supply are sufficient.
- JST confirmed with MMRCL that Power supply system for Corridor-2 should be monitored and controlled from a centralized Operation Control Centre (OCC) through SCADA system as Figure 3.8.3. The system will be extended from line 3. In addition, the fault locator at the existing Line 3 TSS will be reconfigured so that it can locate faults up to the extension line, Corridor-2.



Source: JST

Figure 3.8.3 Centralized Operation Control Centre (OCC) Through SCADA System

(2) Traction System

- According to DPR, the high density traffic is supposed to be a peak period headway of 3.3 minutes in the upcoming future, 2051. Considering economic advantages offered by 25kV AC system in line 3 for connection to corridor-2, JST understood that it was proposed to adopt 25kV AC system for Corridor-2. JST confirmed with MMRCL that 25 kV AC Rigid OHE system shall be adopted as Traction System for underground. JST believes that it's reasonable due to narrow tunnel space as same as line 3.
- When adopting AC feeding system, there is a concern about the emerging of the Electro Magnetic Interference (EMI). Because Booster Transformer is proposed for EMI mitigation, JST asked at the MMRCL meeting of the 5th of June 2025 whether Booster Transformer would be installed or not. MMRCL made a reply, "The department of telecommunication has given clearance to charge the system without using Booster Transformer." Therefore,, it is possible to use the simple feeding system in Corridor-2.
- Regarding grounding method, return conductor will be connected to main earth terminal at every 500 m in elevated and underground section, similar to the practice being followed in DMRC. JST think that the earthed system is appropriate.

(3) Auxiliary Supply Arrangements for Station/Depots

- According to the DPR, JST correctly understood that ASSs were envisaged to be provided at each station as same as line 3 for stepping down 33 kV supply to 415 V for the auxiliary applications below.
  - Lights & fans for station
  - Service Buildings
  - Foot over Bridges/ Subways
  - Maintenance Depots
  - Air-conditioning
  - Lifts
  - Escalators

- Water Supply Pumping Stations – for washing, toilets as well as fire protection measures.
- Equipment – Signaling, Telecom, Automatic Fare Collection, etc

➢ The ASS is expected to be located on the mezzanine or platform level of the station, similar to ASS on other subway lines.

3.8.2.2 Mechanical Facilities (Platform Screen Door)

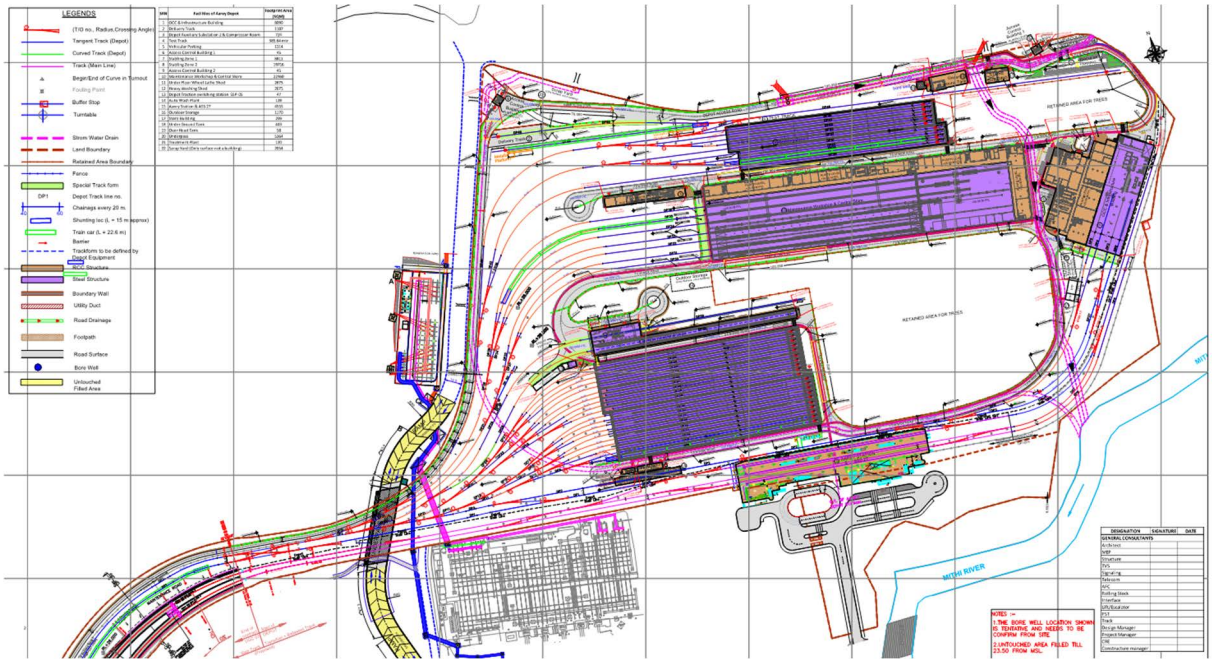
JST confirmed with MMRCL that full high PSG would be provided in two underground stations JST thinks that it's appropriate because of underground section.

3.9 Depot

The maintenance and stabling activities for the extended corridor will continue to be supported by the Aarey Depot, which is already in use for Mumbai Metro Line 3.

3.9.1 Aarey Depot

The Aarey depot serves as a maintenance and stabling facility for Mumbai Metro Line 3. It is located in Aarey Milk Colony, covering an area of 30 hectares. The depot is responsible for major and minor rolling stock maintenance, trainset stabling, and operational control. Figure 3.9.1 shows the Aarey Depot Layout



Source: JST

Figure 3.9.1 Aarey Depot Layout Provided by MMRCL

3.9.2 Additional Stabling Line

The Mumbai Metro Line 3 extension from Cuffe Parade to Navy Nagar incorporates four new underground stabling lines beyond Navy Nagar station.



Source: JST

Figure 3.9.2 Additional 4 Stabling Line beyond Navy Nagar Station

As indicated in chapter 3.8, the final number of trainsets held is 43 trainsets, so the locations where trainsets are stabled at night are shown in Table 3.9.1. Aarey depot has 29 stabling lines, two inspection lines with overhead catenary and one (1) heavy wash line. Therefore the number of stabling trains at Aarey depot should be 31.

Table 3.9.1 Rolling Stock Stabling Location

Stabling location	The number of trainsets
Aarey depot	31
The additional stabling line beyond Navy Nagar Station	4
Navy Nagar Station	2
Cuffe Parade Station	1
Bandra – Kurla Complex (BKC) Station	3
Aarey Station	2
Total	**43**

Source: JST based on DPR

3.10 Cost Estimation (N/A)

3.11 Operation and Maintenance (O&M)

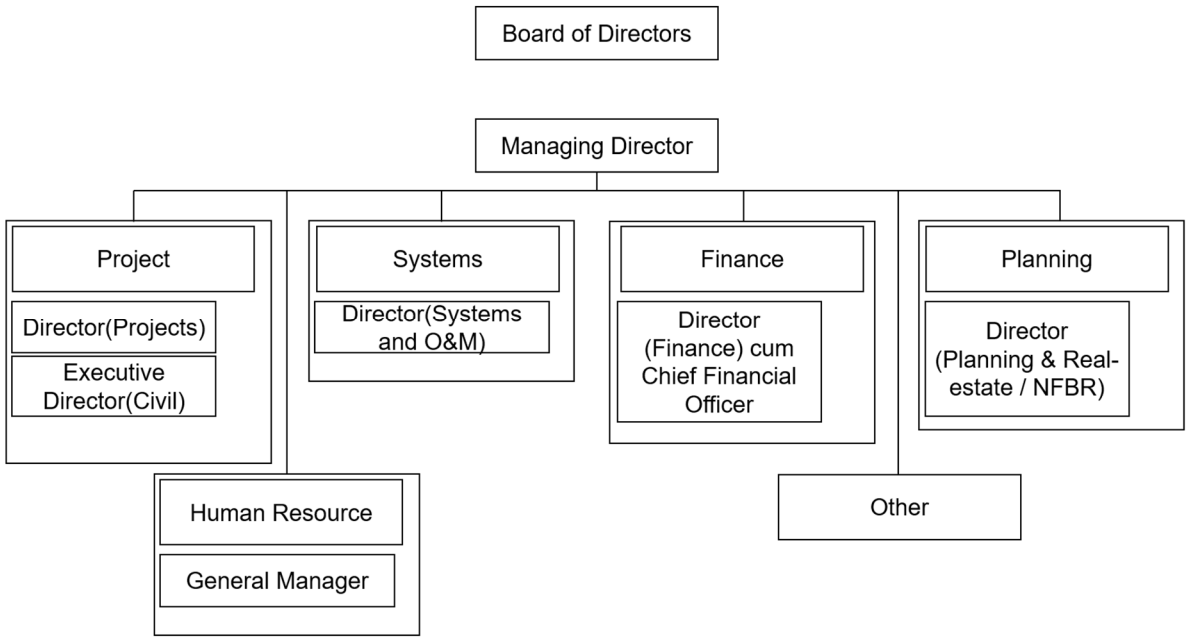
3.11.1 Operation and Maintenance (O&M)

3.11.1.1 O&M Philosophy

O&M department should be one of the most significant elements for metro system since metro is public transportation and make advantages to community residents. Operation department should have technical capability for effective train operation, station service, and etc., as local community partner. Maintenance department should have high level technical capability to utilize metro system more long term to make system efficient operation and high quality for more safety system. For those reason, training or technical transfer before the implementation of the metro and continuous training for enhancing skill should be considered for MMRCL.

3.11.1.2 Organization Chart for O&M

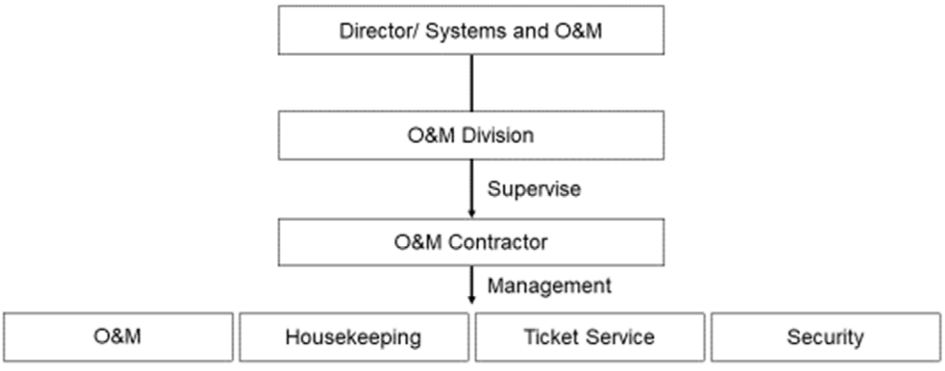
Current organization chart of MMRCL is as follows:



Source: JST

Figure 3.11.1 Organization Chart of MMRCL

Managing Directormanages all related departments such as Project department, Systems and O&M department, and etc. in MMRCL. Other in Organization Structure include Human Resource, Role & Responsibility, Land, and PR. O&M for Line 11 Corridor-2 has to be considered current O&M scheme in Line 3, since Line 11 Corridor-2 is extension of Line 3 and it should not be separated for efficiency. Figure below describes current scheme and organization chart for O&M of Line 3.



Source: JST

Figure 3.11.2 O&M Scheme in Metro Line 3

3.11.1.3 Implementation of Operation and Maintenance

In Line 3, Operation and Maintenance is outsourced to O&M contractor, DMRC. MMRCL will supervise DMRC's activities, and set KPIs for evaluation of the performance. Based on KPIs, DMRC will receive remuneration for their activities. Furthermore, other activities for train operation such as

housekeeping work, ticket service, and security, will be operated by other contractors. O&M contractor, DMRC, also manage these companies for their responsibility. In the event that the extension requires the recruitment of additional O&M personnel or the implementation of new training programs, such activities will be carried out in accordance with DMRC's planning and management. At present, there are no identified issues or challenges with outsourcing O&M. However, in the future, when re-tendering for O&M contractors after the expiration of the current O&M contract, there are concerns such as differences in performance between the current O&M contractor and potential new O&M contractor, and the difficulty of accumulating railway operation knowledge in MMRCL.

3.11.1.4 O&M Cost (N/A)

3.11.1.5 Replacement Cost (N/A)

3.11.2 Disaster Management and Security Measures

(1) Introduction

Disasters are crises that cause extensive damage to life and property, disrupt the physical and psychological foundations of communities, and exceed local coping capacities. They are broadly categorized into natural and man-made disasters. Once a disaster occurs, it brings severe distress and requires extraordinary responses. In recent years, signs of abnormal weather due to global warming have become increasingly evident, making it essential for railway operators to implement appropriate disaster management measures.

(2) Necessity of Disaster Management Measures

The World Health Organization (WHO) defines a disaster as an event that causes damage, economic disruption, and loss of life, justifying extraordinary responses from outside the affected area. Globally, awareness of disaster management has been rising, with international frameworks such as the Hyogo Framework for Action (2005) and the Sendai Framework for Disaster Risk Reduction 2015–2030 being established. In India, the Disaster Management Act, 2005, was enacted to promote disaster awareness and preparedness. The DPR proposes a disaster management plan in accordance with this Act. In the event of a disaster occurring within the operational area of the Mumbai Metro, there is a potential for significant human casualties and infrastructure damage. Therefore, an efficient disaster management plan is essential to mitigate these impacts.

(3) Types of Disasters and Objectives of Disaster Management

The types of disasters and the main objectives of disaster management measures as described in the DPR are as follows:

Natural Disasters:

- Earthquakes

- Floods

Man-made Disasters:

- Terrorist attacks
- Bomb threats
- Hostage situations
- Chemical or biological gas releases
- Fires
- Train accidents
- Sabotage
- Stampedes

Objectives of Disaster Management

- Save lives and alleviate suffering
- Provide assistance to stranded passengers and arrange prompt evacuation
- Instill a sense of security by providing accurate information
- Protect metro rail property
- Expedite the restoration of train operations
- Ensure coordinated handling of crisis situations
- Train officials and workers to handle emergencies effectively

Railway operators must take preventive, restorative, and responsive actions against various types of disasters. These objectives align with the seven global targets of the Sendai Framework, and the DPR is considered appropriate in this regard.

(4) Preparedness for Disaster Management

Following the enactment of the Disaster Management Act, 2005, India established the National and State Disaster Management Authorities, command and control mechanisms at national, state, and district levels, and mandated the preparation and implementation of disaster management plans by various authorities. The DPR outlines the effective and flexible installation of the following systems at metro stations and facilities:

(5) Implementation in Metro System

Since each personnel in the metro operating company must carry out appropriate measures, disaster management protocols should be incorporated into the metro system's operational rules or standard procedures. Periodic risk assessments should be conducted, and disaster management measures should be updated and reviewed for continuous improvement. In the case of large-scale disasters, some measures may require cooperation from passengers, local communities, and other public authorities.

(6) Comments and Suggestion on DPR

As mentioned above, the DPR outlines legal frameworks and objectives that meet international standards. The systems and response policies described are comparable to those of Japanese railway operators. JST recommends that, following the extension, MMRCL should continue to establish foundational regulations not only for field operations but also within its headquarters and management

divisions. This is because MMRCL's headquarters and management divisions must lead all relevant departments and organizations in disaster management and conduct inspections to ensure that the regulations are functioning properly and are updated as needed. Furthermore, in post-disaster response, MMRCL should address not only physical countermeasures but also soft measures, such as support for stranded commuters and recovery efforts

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS/ LAND ACQUISITION AND RESETTLEMENT (CORRIDOR 1)

A. [Environmental and Social Considerations]

4.1 Overview of Project Components

The components of the project are outlined below.

Table 4.1.1 Project Components

Category	Description
Civil Engineering	Construction of tracks Construction of underground stations Construction of depot
Buildings	Construction of depot facilities
Power Supply System	Receiving and transforming substation facilities
Other Related Facilities	Quarry sites, soil collection sites, disposal sites Construction yards

Source: JST

4.2 Related Projects

A project with a high degree of relevance to the present undertaking is the Mumbai Metro Line 3 Construction Project (financed by ODA loan). Commenced in 2016, the project covers a total length of 33.5 km. Of this, the 12.69 km section from the northern terminus at Aarey Colony Station to the Bandra-Kurla Complex (BKC), the central business district, was opened to service in October 2024 as Phase 1. The section between BKC Station and Worli commenced operation in May 2025. Furthermore, the Phase 3 section, which runs along the western side of Bombay Island from Worli Station to the southern terminus at Cuffe Parade Station—the portion most closely related to Line 11—commenced operation on October 9, 2025, As operation has already commenced and no further construction impacts are anticipated, no cumulative or secondary impacts with Mumbai Metro Line 3 are expected. Moreover, the Mumbai Metro Line 3 Construction Project and Line 11 Construction Project are independent undertakings; therefore, they do not constitute an indivisible and integrated project.

In addition, the Mumbai Metro Line 4 Project (financed by KfW – Kreditanstalt für Wiederaufbau, Germany), which is planned to connect with Corridor 1 of Line 11 at Anik Depot Station, is being implemented by the Mumbai Metropolitan Region Development Authority (MMRDA), with approximately 75% of construction works completed. The acquisition of land for the depot planned at Mogharpada in Thane District had been delayed, and the transfer to MMRDA had not been completed. However, following a government resolution in June 2025, the land has been formally transferred to MMRDA, and construction of the depot is expected to commence immediately. The depot is planned to be equipped with 64 stabling lines, 20 maintenance lines, a control center, an automatic train washing

system, and other heavy maintenance facilities[30]. While Line 4 and Corridor 1 of Line 11 will be connected at Anik Depot Station, Line 11's Corridor 1 will be underground and Line 4 will be elevated; therefore, no through-operation between the two lines will be implemented. The construction status of Line 4 in the vicinity of Anik Depot Station is as shown in the attached photographs, with the commencement of operations currently anticipated in November 2027[31]. In contrast, the commencement of this Project is scheduled for June 2028. Accordingly, as the construction periods of the two projects do not overlap, no cumulative or secondary impacts are anticipated. Furthermore, as they are implemented independently, the Mumbai Metro Line 4 Construction Project and the Line 11 Construction Project do not constitute an indivisible and integrated project.

Table 4.2.1 Construction Status of Other Mumbai Metro Lines Related to the Project



Mumbai Metro Line 4 Construction Status near Anik Depot

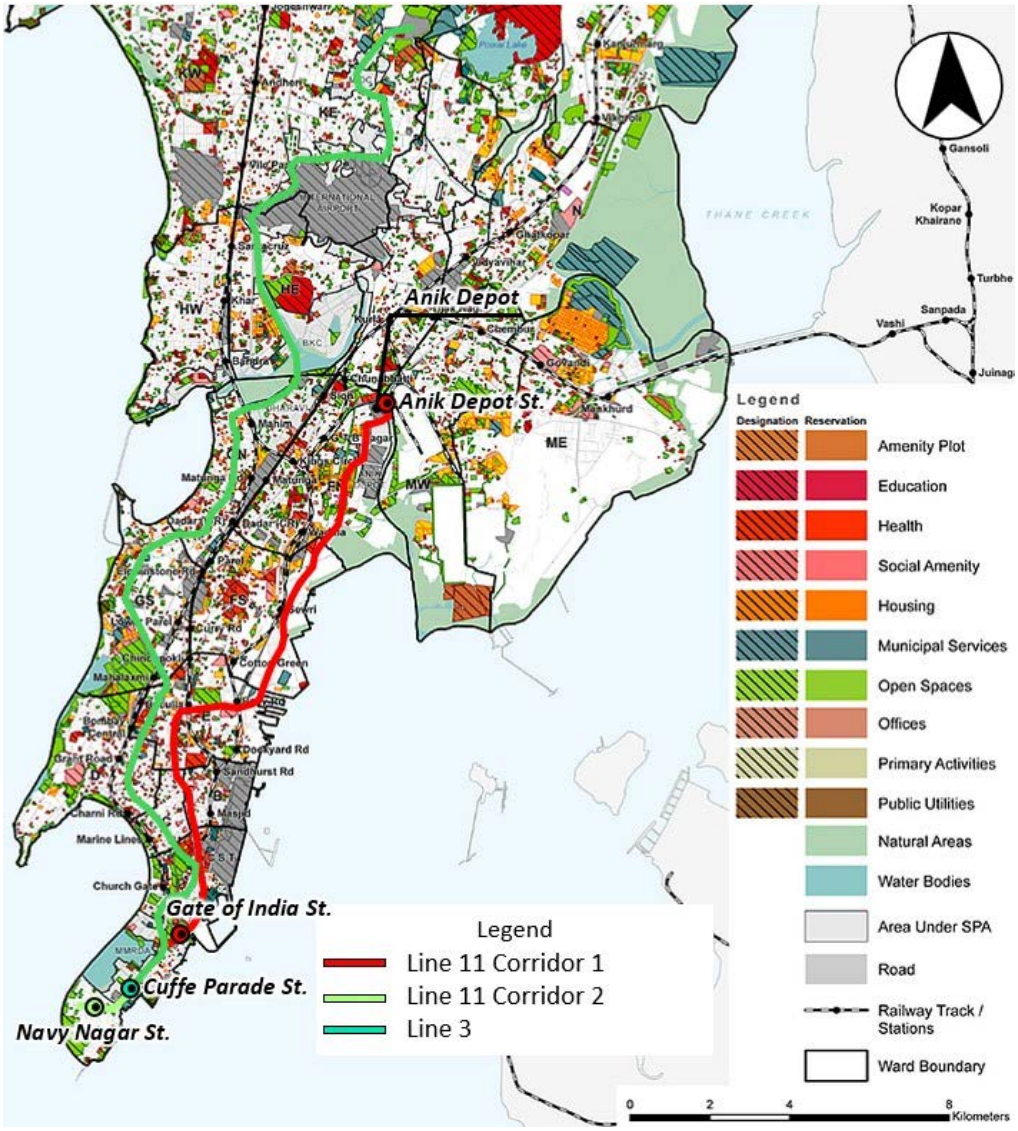
Source: JST

4.3 Environmental Conditions

4.3.1 Land Use

Corridor 1 of Line 11 begins at Anik Depot Station, which includes a depot, and passes through commercial, residential, industrial, and public zones, ultimately reaching Gateway of India Station.

[30] https://indianexpress.com/article/cities/mumbai/thane-mogharpada-mumbai-metro-largest-depot-10068327/
[31] https://devgatha.in/en/mumbai-metro/?utm_source=chatgpt.com



Source: Prepared by the JST based on the Draft Mumbai Development Plan 2014–34

Figure 4.3.1 Land Use Along Mumbai Metro Lines 3 and 11

Table 4.3.1 Environmental Conditions along Corridors 1 of Mumbai Metro Line 11

Corridor 1 of line 11	
	
1. Anik Depot (proposed depot site at bus terminal entrance)	2. Wadala

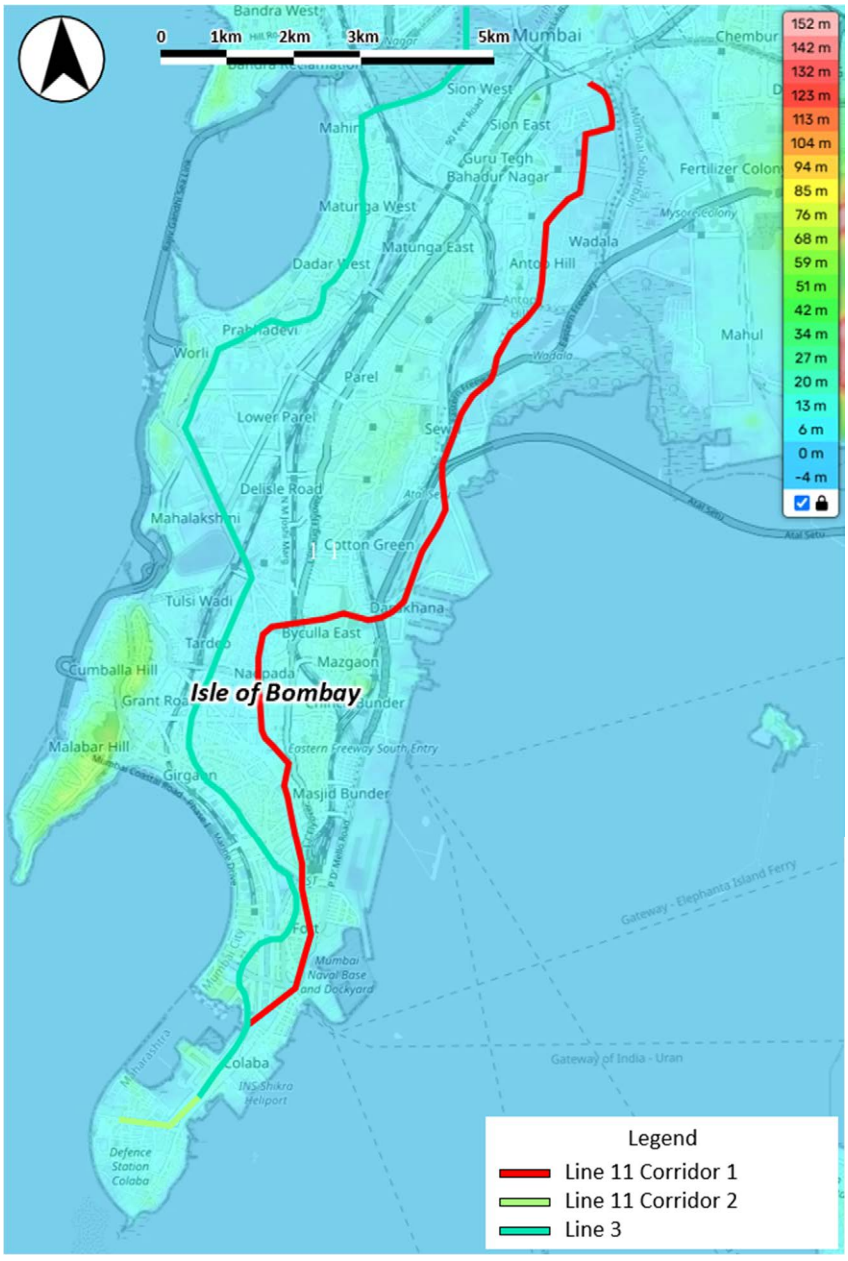
Corridor 1 of line 11	
	
3. CGS colony	4. Ganesh Nagar
	
5. BPT hospital	6. Sewri Metro
	
7. Hay Bunder	8. Darukhana

Corridor 1 of line 11	
	
9. Byculla	10. Nagpada Junction
	
11. Bhendi Bazaar	12. CSMT Metro
	
13. Horniman Circle	14. Gateway of India

Source: JST

4.3.2 Topography and Geology

The proposed Line 11 and associated depot are located between latitudes 18°54’24"N and 19°02’54"N, and longitudes 72°48’20"E and 72°52’44"E. The route traverses Mumbai City, which is situated on Bombay Island, running parallel to the existing Line 3. The average elevation of Mumbai City is 14 meters above sea level. While the northern suburban areas are characterized by numerous hills, the elevation along Line 11 is relatively low, with most segments—except a few in the southernmost part—being under 10 meters in elevation.

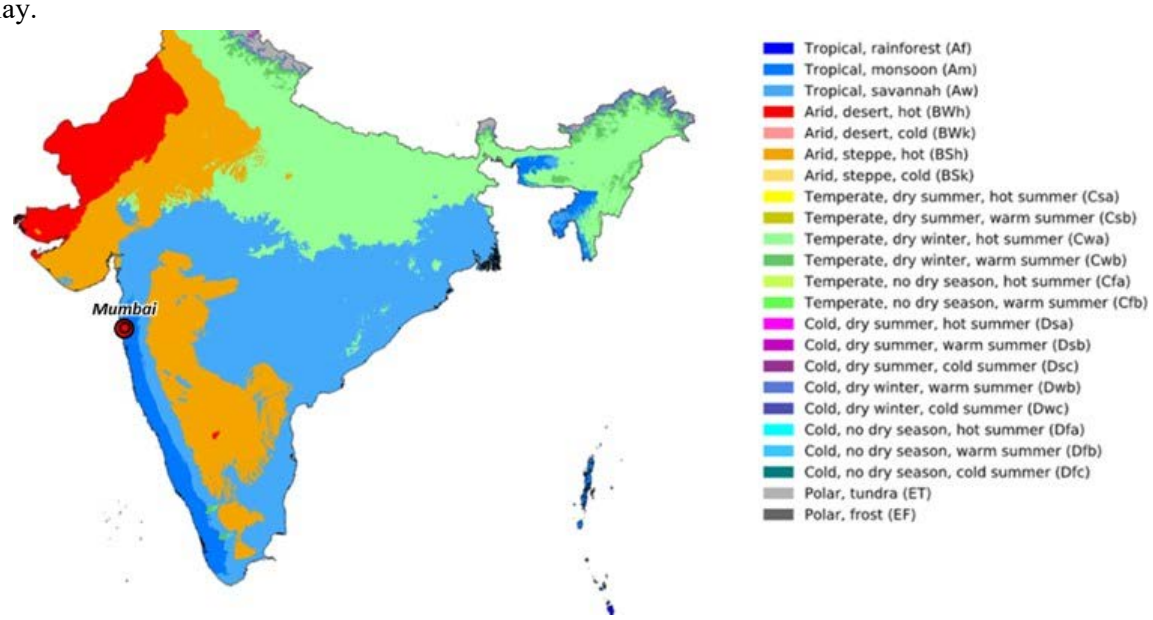


Source: Prepared by JST based on topographic-map.com

Figure 4.3.2 Topography Along the Mumbai Metro Route

4.3.3 Meteorology

India spans a vast territory and is classified into 23 Köppen climate zones. The climate of Mumbai City, where this project is located, falls under the tropical savanna climate (Aw). The monsoon season lasts from June to September, during which more than 90% of the annual precipitation of approximately 2,500 mm occurs. The dry season extends from November to May and is generally warm with minimal rainfall. Although the humidity slightly decreases during the dry season, it does not become extremely dry. The average daily temperature difference between the monsoon and dry seasons in Mumbai is only 5.8°C. The monthly average maximum temperature ranges narrowly from 29.7°C in July to 34.1°C in May.



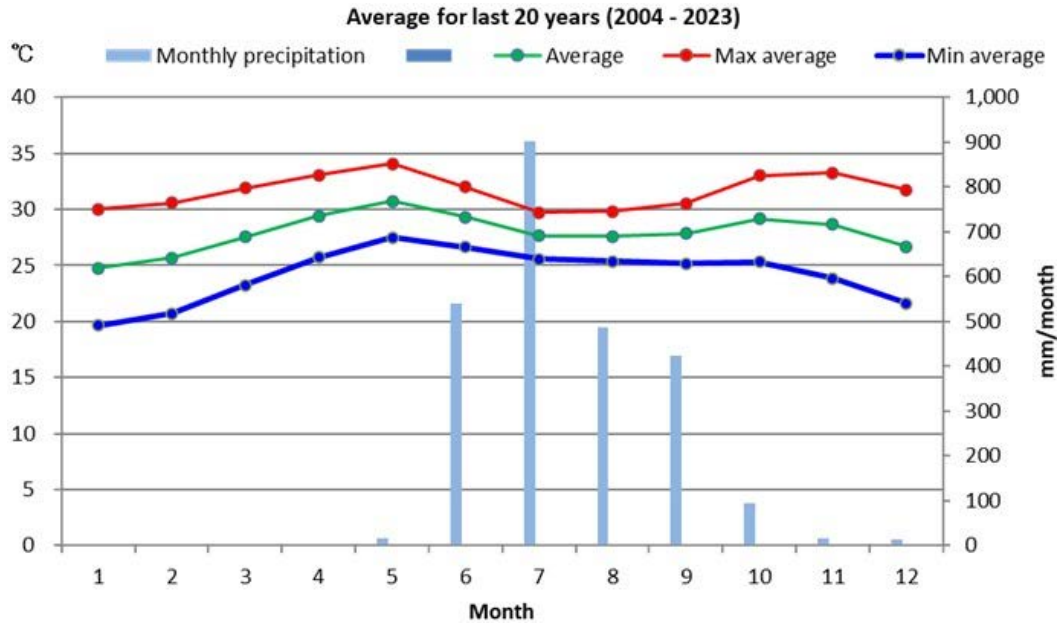
Source: Peel, M. C., Finlayson, B. L., and McMahon, T. A. (2007) (University of Melbourne)

Figure 4.3.3 Köppen Climate Classification in India

Table 4.3.2 Monthly Rainfall and Average Temperature in Mumbai

Place	Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mumbai	Rainfall (mm)	0.2	1.3	2.5	1.0	16.8	539.6	901.0	486.8	423.4	93.8	14.8	14.3	2495.4
	Avg Temp (°C)	24.8	25.7	27.6	29.4	30.7	29.3	27.6	27.6	27.9	29.2	28.7	26.7	27.9
	Avg Max Temp (°C)	30.0	30.6	31.9	33.1	34.1	32.0	29.7	29.8	30.5	33.0	33.3	31.7	-
	Avg Min Temp (°C)	19.6	20.7	23.3	25.7	27.5	26.6	25.6	25.4	25.2	25.3	23.8	21.6	-

Source: Prepared by JST based on data from Japan Meteorological Agency (ClimatView: Monthly Climate Statistics Tool)



Source: Prepared by JST based on data from Japan Meteorological Agency (ClimatView: Monthly Climate Statistics Tool)

Figure 4.3.4 Monthly Rainfall and Average Temperature in Mumbai

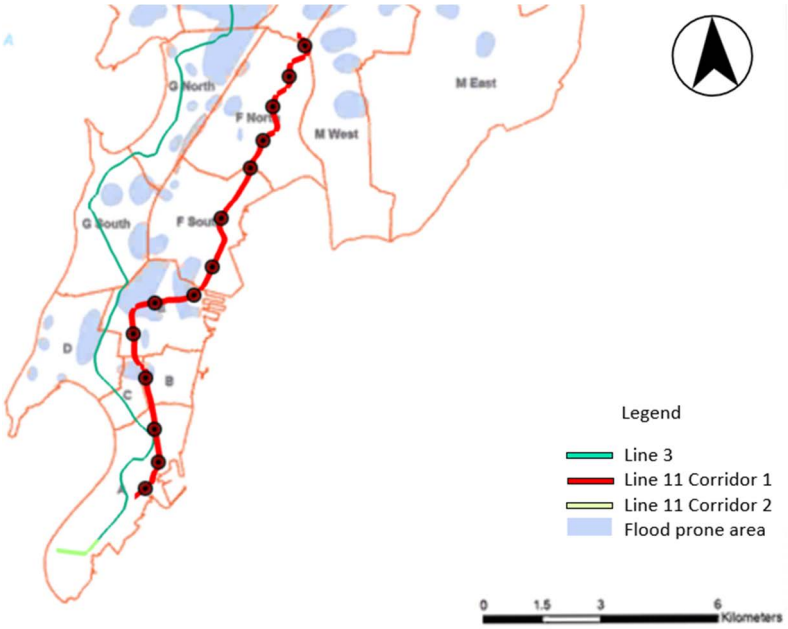
4.3.4 Natural Disasters

According to the "District Disaster Management Plan 2022" issued by the Municipal Corporation of Greater Mumbai, the city has not suffered major disasters such as earthquakes or monsoon-induced floods in the past and is considered to have a relatively stable climate. However, in recent years, intense rainfall has increased due to climate change, causing frequent incidents of inundation and waterlogging.

4.3.4.1 Flooding (Including Inundation and Waterlogging)

Due to the low elevation below 10 meters except for some parts of the southern end, Mumbai is susceptible to flooding during the monsoon season. In July 2005, rainfall of 900 mm was recorded within a few hours, equivalent to 45% of the annual total. The areas inundated during this event are shown below. In recent years, flooding and waterlogging caused by heavy rainfall have become a nearly annual occurrence, and urgent drainage measures are needed[32]. Although no cyclone-related disasters have occurred since 1882, in June 2020, Cyclone Nisarga brought heavy rainfall to Alibag, located about 100 km south of Mumbai[33]. In May 2025, rainfall of 90 mm/hour was recorded in Mumbai, causing flooding at Acharya Atre Chowk Station of Metro Line 3, which had just opened that month. Approximately 1.1 million liters of rainwater accumulated at a construction-closed station entrance, leading to retaining wall collapse and flooding of station premises and tracks, resulting in a suspension of operations for several days[34].

[32] DISTRICT DISASTER MANAGEMENT PLAN, MUMBAI CITY DISTRICT, 2022
[33] https://www.afpbb.com/articles/-/3286457
[34] https://www.hindustantimes.com/cities/mumbai-news/11-million-litres-of-water-in-an-under-construction-pit-at-aac-ed-to-its-collapse-101748373858448.html?utm_source=chatgpt.com

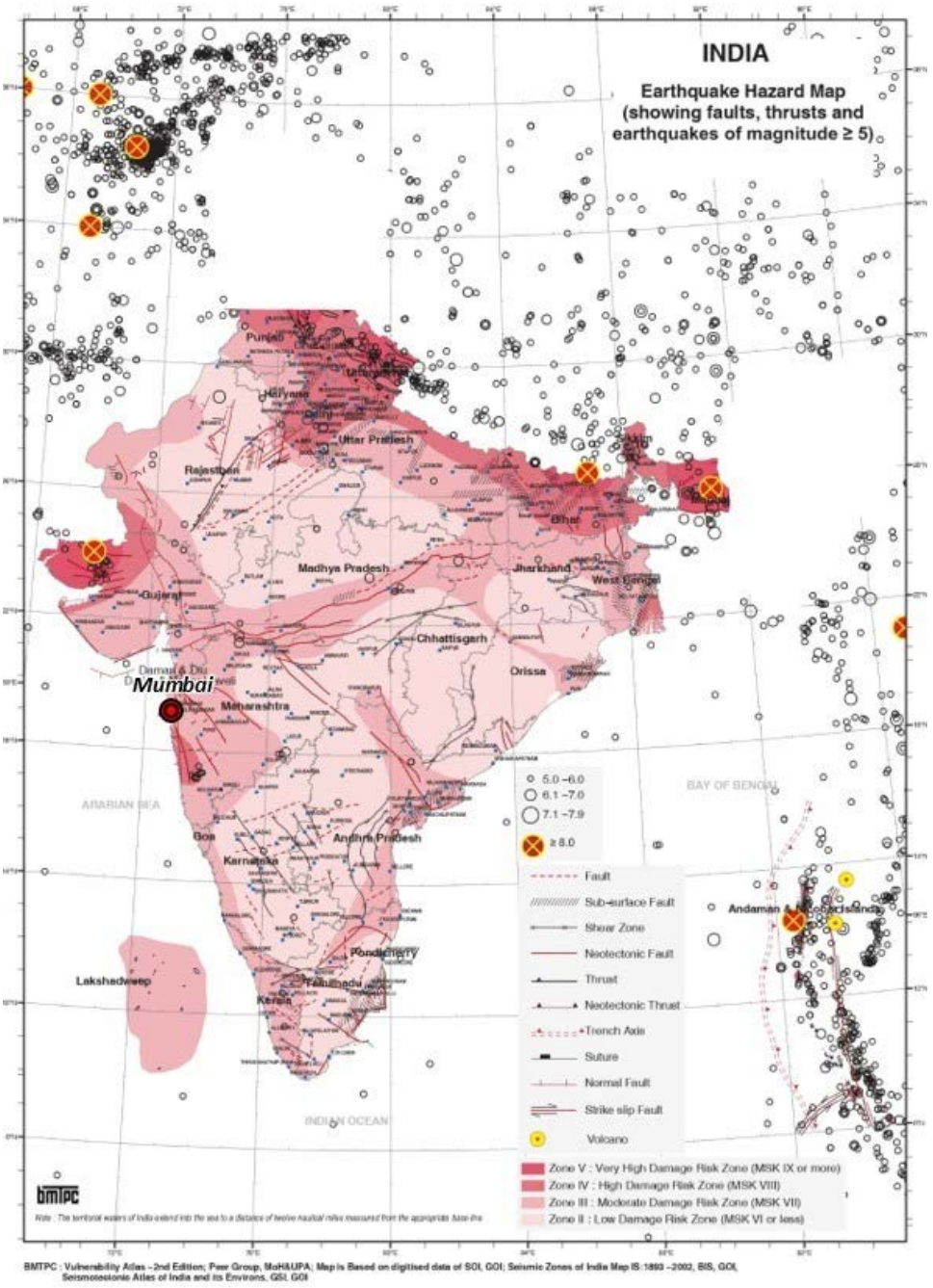


Source: Prepared by JST based on data from "Mapping the Unmeasurable Spatial Analysis of Vulnerability to Climate Change and Climate Variability," 2014, Alex de Sherbinin

Figure 4.3.5 Inundation Area from the July 2005 Flood

4.3.4.2 Earthquakes

According to the seismic zoning map published by the Bureau of Indian Standards, the project site falls within Zone III, indicating a moderate-risk area. The map below shows the epicenters of earthquakes with a magnitude of 5.0 or greater that occurred in India and surrounding regions between 1893 and 2002. No earthquakes of magnitude 5 or greater have been observed near Mumbai City. The closest epicenter was located approximately 100 km north of Mumbai, where a magnitude 6 earthquake was recorded in the past.



Source: Building Materials and Technology Promotion Council

Figure 4.3.6 Epicenters of Earthquakes (Magnitude ≥ 5.0) in India and Surrounding Areas

4.4 Local Legal Frameworks for Environmental and Social Considerations

4.4.1 Environmental Laws and Regulations

4.4.1.1 Environmental Policy, Strategy, and Legal Framework

India has enacted various environmental laws, including the foundational Environment (Protection) Act, 1986, which came into force in May 1986. In addition, the National Environment Policy was introduced in May 2006, followed by the Environment Impact Assessment Notification, 2006 in September of the same year, which stipulates project categories, screening and scoping procedures, and public

consultations required for environmental permitting. These procedures fall under the supervision of the Impact Assessment Division of the Ministry of Environment, Forest and Climate Change (MoEFCC).

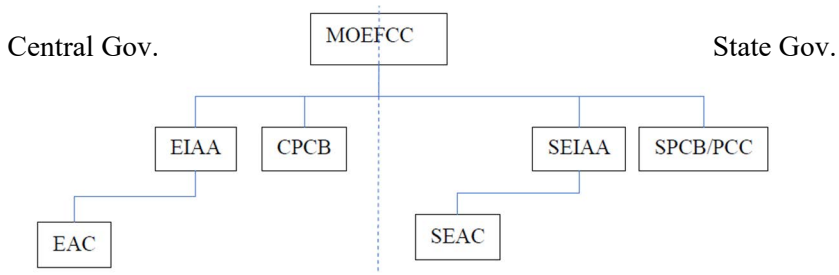
4.4.1.2 EIA-Related Institutions

Key organizations involved in Environmental Impact Assessment (EIA) in India include the MoEFCC, which is responsible for establishing EIA-related legislation; the Environmental Impact Assessment Authority (EIAA), which acts as the supervisory body for Category A projects; and the Expert Appraisal Committee (EAC), which is responsible for reviewing Category A projects.

Table 4.4.1 EIA-Related Organizations and Their Roles

Organization name	Role
Ministry of Environment Forest and Climate Change (MoEFCC)	The national organization responsible for overseeing environmental matters. It is the parent organization of both the EIAA and SEIAA.
Environment Impact Assessment Authority at Centre level (EIAA)	The central organization overseeing EIA procedures. It operates under MoEFCC and serves as the supervisory authority for Category A projects, with the authority to issue Terms of Reference (TOR), EIA approvals, and Environmental Clearance (EC). After issuing EC, it is responsible for compliance monitoring. Additionally, it has the authority to appoint the EAC, receive applications from project proponents, issue TOR/EIA to proponents, receive draft EIA reports, publish EIA summaries online, convey collected comments to the proponents, forward revised EIA reports to the EAC, and decide whether or not to accept the EAC's recommendations and approve the projects.
Expert Appraisal Committee (EAC)	A central expert committee that conducts EIA reviews. Its members are appointed by MoEFCC. For Category A projects, the headquarters of MoEFCC issues EC based on the EAC's recommendations.
State level environment Impact assessment authority (SEIAA)	The state-level authority overseeing EIA procedures. It acts as the supervisory authority for Category B1 and B2 projects and has the authority to issue Environmental Clearance (EC) for Category B projects.
Central Pollution control board (CPCB)	The national organization is overseeing pollution control. It announces and organizes public hearings for Category A projects and submits the No Objection Certificate (NOC) and public hearing minutes to the EIAA. It is also responsible for post-EC pollution monitoring.
State Expert Appraisal Committee (SEAC)	The state-level expert committee responsible for EIA reviews. Its members are appointed by the state government and notified by the central government.
State Pollution control board/ Pollution Control Committee (SPCB/PCC)	State government organizations are responsible for pollution control. They announce and organize public hearings for Category B projects and submit the NOC and public hearing minutes to the SEIAA. They are also responsible for post-EC pollution monitoring.
National Environment Appellate Authority (NEAA)	An independent body separated from ministries and state governments, responsible for handling appeals on environmental matters. It allows appeals against EC decisions in response to requests raised during public hearings.
Cabinet Committee on Investment (CCI)	Established in January 2013, this committee participates in the EC process. Headed by the Prime Minister, the CCI sets deadlines for identifying and approving investment projects over INR 10 billion in sectors such as infrastructure and manufacturing. It reviews the approval or rejection processes by relevant ministries and agencies and holds the authority to make EC decisions.
National Green Tribunal (NGT)	A special court dedicated to environmental matters. It handles lawsuits concerning environmental conservation, forest protection, and compensation for damage resulting from violations of environmental laws or project approval conditions.
Regional center of the Ministry of Environment and Forest	Supports the activities of EACs in each state. Specific roles include preparing materials for public consultations, developing training materials, and providing education and training to local organizations and governments.
Public/ NGO	Citizens or NGOs directly or indirectly affected by projects may access EIA summaries. During public hearings, they may raise concerns about projects or submit written comments.

Source: Environment Impact Assessment Guidebook for Japanese Companies' Overseas Project development- India-, IGES



Source: Environment Impact Assessment Guidebook for Japanese Companies' Overseas Project development- India-, IGES

Figure 4.4.1 Organizational Structure of MoEFCC and EIA-Related Divisions

4.4.1.3 Environmental Management Laws

(1) Environment (Protection) Act, 1986

Enforced in May 1986, the Act is positioned as a so-called Basic Environmental Law, forming the basic framework for environmental protection, and consists of a total of 4 chapters and 26 sections. The Environment (Protection) Act stipulates the responsibilities of the central government for the prevention, management, and reduction of environmental pollution. The central government is granted the authority to formulate appropriate rules and regulations in order to achieve the objectives stipulated under the Environment (Protection) Act. The term "environment" as defined in the Environment (Protection) Act is: "Environment includes water, air, and land, and the inter-relationship which exists among and between water, air, and land, and human beings, other living creatures, plants, micro-organisms, and property." The authority to prevent, regulate, and reduce factors that pollute or cause damage to this defined "environment" is stipulated under the Environment (Protection) Act. In areas where prevention and regulation of environmental impact are necessary, the central government is authorized to establish relevant rules.

(2) Environment Impact Assessment Notification, 2006

Environmental Impact Assessment (EIA) in India is positioned, under the Environment (Protection) Act, as one of the principal procedures for the review and approval of new or modified projects, based on the National Environment Policy (2006). The EIA procedures are stipulated in the Environment Impact Assessment Notification, 2006. This Notification (2006) prescribes the Environmental Clearance (EC), reviewing organizations, project category classifications, procedures for screening and scoping, methods for applying for EC, validity period of EC, post-EC monitoring, transfer of EC, and various prescribed forms. In India's EIA system, there is no system of EIA ordinances established by local governments. As shown in the following table, India's environmental categories are divided into three groups: A, B1, and B2. While the distinction between Category A and the other categories is relatively clear, the distinction within Category B1 and lower is partially ambiguous and is determined during the screening process. Moreover, depending on the category, the supervisory authority for issuing EC, the reviewing organization, and other required documents differ.

Table 4.4.2 Overview of Supervisory and Reviewing Authorities by Category in India

Category	EIA Supervisory Authority	Reviewing Organization	EIA	Environmental Clearance (EC)	Monitoring
A	MoEFCC	EAC	Required	Need approval	Required
B1	SEIAA	SEAC	Required	Need approval	Required
B2 (Excluding Mineral Mining)	SEIAA	SEAC	N/A	Need approval from SEIAA	Required
B2 (Mineral Mining)	DEIAA	DEAC	N/A	Need approval from SEIAA	Required
Non-EC project	N/A	N/A	N/A	N/A	Required

Note: MoEFCC: Ministry of Environment, Forest and Climate Change, SEIAA: State Environment Impact Assessment Authority, SEAC: State Expert Appraisal Committee, DEIAA: District Environment Impact Assessment Authority, DEAC: District Expert Appraisal Committee

Source: Environment Impact Assessment Notification 2006

(3) Coastal Regulation Zone (CRZ) Notification, 2019

This notification, established under the Environmental Protection Act, aims to conserve India's coastal environment and promote sustainable development. It is a revised version of the 2011 notification. Its primary objectives are to protect coastal ecosystems, give priority to sustaining the livelihoods of local communities such as those engaged in fisheries, and to promote sustainable development while taking into account risks from sea-level rise due to climate change and from natural disasters. The scope of application covers the coastal area extending 500 m landward from the High Tide Line (HTL), land within 50 m along water bodies subject to tidal influence, and marine areas including their seabed up to 12 nautical miles within the territorial waters. With the exception of the Andaman & Nicobar Islands and the Lakshadweep Islands, the notification applies to the entire mainland coast of India and all its coastal water bodies. The CRZ is classified into the four categories shown in the table below, with Category I being the most significant, followed in order by II and III. While Categories I–III cover terrestrial and brackish water areas, Category IV pertains to coastal marine areas and tidal water bodies. Project proponents are required to obtain CRZ clearance prior to commencement of any construction or development activities. Depending on the category and the scale of the project, the MoEFCC or the relevant State Government/Coastal Zone Management Authority will conduct the review.

Table 4.4.3 Overview of Supervisory and Review Authorities by CRZ Category

Category	Target Area	Reviewing Authority	Main Submission Documents
I	Environmentally most critical areas (mangroves, coral reefs, sand dunes, national parks, etc.)	MoEFCC	- Application Form - CRZ Map (HTL/LTL demarcation map, scale 1:4000) - Project Layout Plan and Technical Specifications - Environmental Impact Assessment (EIA) and - Environmental Management Plan (EMP) - Risk Assessment and Disaster Management Plan - Public Hearing Records (as applicable) - Consent Letters/NOC from Relevant Authorities
II	Already developed urban areas	State Government or Union Territory Coastal Zone Management Authority	- Application Form - CRZ Map (HTL/LTL Demarcation Map) - Project Layout Plan - Simplified Environmental Management Plan (EMP) - Consent Letters/NOC from Relevant Authorities
III	Relatively undeveloped areas (further divided into III-A and III-B based on population density)		

Category	Target Area	Reviewing Authority	Main Submission Documents
IV	Coastal marine areas and tidal water bodies	MoEFCC	Same as Category I
Prohibited Activities	Establishment or expansion of new industrial facilities; manufacture or storage of hazardous materials; reclamation or alteration of natural waterways; discharge of untreated wastewater; extraction of sandstone; alteration of sand dunes; disposal of plastic waste; extraction of groundwater; etc.		
Permitted Activities	Port facilities, disaster management facilities, tourism (eco-tourism), traditional fishing, pipelines, desalination plants, and other activities permitted subject to the implementation of environmental mitigation measures.		

Source: CRZ Notification, 2019

4.4.1.4 Environmental Screening of the Project

(1) Screening under Environmental Impact Assessment Notification 2006

EIA is not required to be conducted as all railway projects are exempted from Environmental Clearance procedures in India.

(2) Screening based on JICA Guidelines

The project is classified as "Category A" in the JICA Guidelines promulgated in January 2022, because it corresponds with the condition that it is likely to have significant adverse impacts on the environment and society as a railway sector.

4.4.1.5 Study Policy of the Project

Although the project is exempt from environmental clearance procedures in India, the JICA Guidelines define "Environmental assessment includes an assessment of potential environmental and social impacts that may be caused by the project, an analysis of alternative plans, as well as adequate mitigation measures and monitoring plans, in accordance with laws or regulations of the host countries." Accordingly, the Environment assessment procedures for Mumbai metro line 11 project carried out as per MoEFCC guidelines (EIA Notification, 2006) along with JICA guidelines. The following table presents the results of the gap analysis between the JICA Guidelines and the relevant domestic laws and regulations of India.

Table 4.4.4 Discrepancies between the JICA Guidelines and Indian Domestic Regulations

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Basic Principles	• Environmental and social impacts caused by projects must be assessed and examined at the earliest possible planning stage. Alternatives or mitigation measures must be examined, in order to avoid such impacts as much as possible, and to minimize, reduce or mitigate them when such avoidance is impossible. The result of the examinations must be reflected into the project plan. • Such examinations must be endeavored to include an analysis of environmental and social costs and benefits in the most quantitative terms possible, as well as a qualitative analysis, and to be in a close harmony with the economic, financial, institutional, social, and technical analyses of projects. • The findings of the examination of environmental and social considerations, including alternatives and mitigation measures, must be documented as an independent document or as a part of other documents. Environmental assessment reports must be prepared for projects with potential significant impacts. • For projects which may have significant impacts in particular, or for controversial projects, a committee of experts may be formed so that projects may seek their opinions, in order to increase accountability.	**Early-stage identification, avoidance/minimization of impacts, examination of alternatives and mitigation measures, and reflection in the project plan** EIA Notification, 2006: The procedural stages of Environmental Clearance (Screening / Scoping / Public Consultation / Appraisal) require consideration from the initial planning stage (Para 7(i)). Annex III prescribes the mandatory components of the EIA report, explicitly including: "4. Impacts and Mitigation Measures," "5. Analysis of Alternatives (technology/site)," and "10. Environmental Management Plan (EMP)." **Quantitative cost-benefit evaluation (supplemented by qualitative assessment) and consistency with economic, financial, institutional, social, and technical analyses** EIA Notification, 2006: Annex III stipulates "9. Environmental Cost-Benefit Analysis (where recommended during the scoping stage)." Impact assessment (both quantitative and qualitative) is integrated with "4. Impacts and Mitigation Measures," "6. Environmental Monitoring Programme," and "10. EMP" for alignment with technical and operational analyses of the project. **Documentation of results (including alternatives and mitigation measures) as a standalone report or as part of other documents; preparation of an Environmental Impact Assessment report for projects with significant impacts** *IA Notification, 2006*: The obligation to submit an EIA report and its structure is stipulated in Annex III and Annex III-A (summary). Following the public consultation procedure (Annex IV), the final EIA, public hearing recordings, and related materials are submitted in accordance with Annex V for appraisal. For new, expansion, or modification projects, an EIA/Environmental Clearance is required pursuant to Para 2 and Para 7. **For projects with significant impacts or subject to considerable objections, establishment of a committee composed of experts to enhance accountability and obtain opinions** EIA Notification, 2006: The composition and authority of the Central/State Expert Appraisal Committee (EAC/SEAC) are stipulated (Para 4, Para 5, and Annex VI). Based on Annex V, the EAC/SEAC conducts appraisal and provides recommendations, with conditions or grounds for rejection explicitly recorded in the minutes.	Although no significant divergence is observed with the EIA Notification, 2006, this project falls outside its scope of application; therefore, the JICA Guidelines shall be followed.
Examination of Measures	• Multiple alternatives must be examined in order to avoid or minimize adverse impacts by the project and to choose better project options in terms of environmental and social • considerations. In the examination of measures, priority is to be given to avoidance of environmental impacts. When this is not possible, minimization, reduction, and then mitigation of the impacts must be considered, in accordance with the mitigation hierarchy. Compensation measures must be examined only when significant impacts are still remain even with the aforementioned measures. • Appropriate plans and systems for measures, such as monitoring plans and environmental management plans, must be prepared. The costs of implementing such plans and systems, and the financial methods to fund such costs, must be determined. For projects with particularly significant impacts, detailed environmental management plans must be prepared.	**Examination of Alternatives / Mitigation Hierarchy (Avoidance → Minimization → Reduction → Mitigation → [Compensation only when unavoidable])** EIA Notification, 2006: Para 7 (Scoping requires the Terms of Reference to mandate the examination of alternatives and mitigation measures). Annex III "Analysis of Alternatives"; Annex III "Anticipated Impacts & Mitigation Measures" (including avoidance, minimization, and offsetting of impacts); Annex III "Environmental Management Plan (EMP)." **Environmental Management Plan (EMP), Monitoring Plan, Institutional Arrangements / Cost and Financing, and Detailed EMP for Projects with Significant Impacts** EIA Notification, 2006: Annex III "Environmental Monitoring Programme" (parameters, methods, frequency, reporting schedule, and budget); Annex III "EMP" (description of organizational arrangements and implementation responsibilities). Para 10: Biannual compliance reporting is mandatory with respect to Environmental Clearance conditions. CRZ Notification, 2019 (applicable to projects in Coastal Regulation Zones): Requires States/Union Territories to prepare detailed EMPs and integrate them into the Coastal Zone Management Plan (CZMP).	Although no significant divergence is observed with the EIA Notification, 2006, this project falls outside its scope of application; therefore, the JICA Guidelines shall be followed. In addition, as the CRZ Notification, 2019 constitutes India's specific coastal regulation, the procedures stipulated therein shall be observed.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Scope of Impacts to Be Assessed	• The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water use, climate change, biodiversity, and Ecosystem services, including trans-boundary or global scale impacts. These also include social considerations such as: Migration of population including involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor peoples and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. • In addition to the direct and immediate impacts of projects, derivative, secondary, and cumulative impacts as well as impacts associated with indivisible projects are also to be examined and assessed to a reasonable extent. It is also desirable to consider the impacts through a project life cycle.	**Wide-ranging Environmental and Social Impacts (air, water, soil, waste, accidents, water use, climate change, biodiversity, ecosystem services, human health and safety, natural environment [including transboundary and global impacts], and social aspects: resettlement, livelihoods, land use, community structures, vulnerable groups, equity, gender, cultural heritage, communicable diseases, labour conditions, etc.)** Environment (Protection) Act, 1986: Comprehensive objective to protect the "human environment" (Sec.3, Sec.6). EIA Notification, 2006: Annex III "Anticipated Environmental Impacts and Mitigation Measures" covers impacts on air quality, water quality, soil, waste, accident prevention, human health and safety; Annex III "Impact on Biodiversity & Socio-Economic Environment" includes flora and fauna, forests, ecosystems, agriculture, cultural heritage, socio-economic aspects (employment, livelihoods, resettlement, etc.); Annex III "Environmental Monitoring Programme" requires monitoring plans for air, water, soil, and noise. Wildlife (Protection) Act, 1972: Impact assessment for protected areas and endangered species (as applicable). Biological Diversity Act, 2002: Regulation of access to and conservation of biodiversity and genetic resources. Factories Act, 1948 / Occupational Safety, Health and Working Conditions Code, 2020: Ensures occupational safety and working conditions. **Consideration not only of direct impacts but also indirect, secondary, and cumulative impacts, as well as impacts of associated/integrated projects and over the entire project life cycle** EIA Notification, 2006: Annex III "Cumulative Environmental Impact Assessment" requires inclusion of impacts from related projects; Annex III "Project Description" requires description of all project life cycle stages (construction, operation, decommissioning); Para 7(i) stipulates that the scope of assessment must define the range of direct, indirect, and cumulative impacts during the scoping stage.	Although no significant divergence is observed with the EIA Notification, 2006, this project is outside its scope of application; therefore, the JICA Guidelines shall be followed.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Compliance with Laws, Standards, and Plans	• Projects must comply with the laws, ordinances, and standards related to environmental and social considerations established by host country governments, including local governments. Projects must also conform to the environmental and social consideration policies and plans of the host country governments. • In principle, Projects must be undertaken outside of areas that are specifically designated for conservation of nature or cultural heritages by the host county governments, unless the main purpose of the Projects is to promote or restore the protection of such areas. Also, projects shall not cause significant adverse impacts on such designated conservation areas.	**Compliance with National and Local Government Laws, Standards, and Policies on Environmental and Social Considerations** Environment (Protection) Act, 1986 (Sec.3, Sec.6): The Central Government sets standards necessary for environmental protection. Air (Prevention and Control of Pollution) Act, 1981; Water (Prevention and Control of Pollution) Act, 1974: Establishes emission standards and permitting requirements. EIA Notification, 2006 (MoEFCC): Environmental Clearance (EC) is mandatory for projects. Maharashtra Pollution Control Board (MPCB) Regulations: State-level issuance of "Consent to Establish" and "Consent to Operate." Maharashtra State Environment Policy (2010): Sets objectives for sustainable development, climate change mitigation, and water resource protection. Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975 (amended 2023): Requires permits for tree felling in urban areas and mandates compensatory plantation. Solid Waste Management Rules, 2016 (under EPA 1986): Implemented by MPCB within the state. **Implementation of Projects Outside Designated Areas (must not cause significant impacts on legally protected natural or cultural heritage sites)** Wildlife (Protection) Act, 1972: Development activities in national parks, wildlife sanctuaries, and reserved forests are prohibited in principle and subject to strict permitting. Forest (Conservation) Act, 1980: Diversion of forest land requires prior approval from the Central Government and entails compensatory afforestation obligations. Ancient Monuments and Archaeological Sites and Remains (AMASR) Act, 1958: Prohibits development within 200 m of protected monuments; the 200–500 m zone is a regulated area. CRZ Notification, 2019 (under EPA 1986): Development within Coastal Regulation Zones (CRZ-I to CRZ-IV) is prohibited in principle, with limited regulated exceptions. Maharashtra Regional and Town Planning Act, 1966: Imposes restrictions on construction in designated protected areas (green belts, conservation zones) under state-level urban planning. Heritage Regulations for Greater Mumbai (1995, revised 2012): Restricts development within heritage buildings and precincts in Mumbai designated as cultural heritage at the state level.	Compliance with the relevant laws and regulations of India shall be ensured.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Social Acceptability	• Projects must be adequately coordinated so that they are accepted in a socially appropriate manner for the countries and areas where the projects are planned. For Projects with potentially significant environmental and social impacts, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans are examined. The outcome of such consultations must be incorporated into the project plans. • Appropriate considerations must be given to vulnerable social groups, such as women, children, elderly peoples, people in poverty, indigenous peoples, persons with disabilities, refugees, internally displaced persons, and minorities. Such vulnerable social groups are susceptible to environmental and social impacts and may have little access to decision-making processes within society.	**Stakeholder consultation, information disclosure, and incorporation of alternative options from an early stage** EIA Notification, 2006: Para 7(i) & Annex IV: Public Consultation is mandatory (required for Category A and B1 projects). Public Hearings are hosted by the State Pollution Control Board (SPCB) / Maharashtra Pollution Control Board (MPCB), and opinions from local residents are recorded. The Draft EIA Report, including information on alternatives and mitigation measures, must be disclosed in advance and its outcomes reflected in the final EIA. Right to Information (RTI) Act, 2005: Provides a legal framework for residents to request disclosure of environmental documents and permitting information. Maharashtra PCB Regulations: Specify detailed state-level procedures for conducting public hearings (notice, comment period, and verbatim recording). **Consideration for socially vulnerable groups (women, children, the elderly, the poor, indigenous peoples, persons with disabilities, minorities, etc.)** Constitution of India: Arts. 15, 21, and 46 provide constitutional bases for non-discrimination and protection of vulnerable groups (including women, children, and SC/ST). EIA Notification, 2006: Annex III ("Impact on Socio-Economic Environment") requires assessment of livelihoods, employment, health, safety, and resettlement impacts. Annex IV (Public Consultation) specifies that arrangements should enable vulnerable groups to express views. Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA): Requires consent of indigenous/forest-dwelling communities (Gram Sabha approval) at the time of forest diversion. Maharashtra State Women's Policy (revised 2013): Sets state-level commitments to protect the rights of women and children and requires due consideration in development planning.	Although no significant divergence is observed with the EIA Notification, 2006, this project does not fall under its applicability; therefore, the JICA Guidelines shall be followed.
Climate Change	• For projects that are expected to generate more than a certain amount of greenhouse gas emissions, the total amount of greenhouse gas emissions will be estimated and disclosed before the project implementation.	EIA Notification, 2006: Annex III "Anticipated Environmental Impacts and Mitigation Measures" requires assessment of air pollutants, including greenhouse gas (GHG) emissions, under the Air Environment section. Where an Environmental Cost-Benefit Analysis is mandated, climate change impacts are also included within the scope of assessment. However, there is no explicit provision that directly obliges the numerical estimation and disclosure of GHG emissions.	The JICA Guidelines shall be followed.
Biodiversity	• Projects must not involve significant conversion or significant degradation of critical habitats or critical forests. • Illegal logging of forests must be avoided. Project proponents need to obtain logging permits from regulatory agencies, and are encouraged to obtain forest certifications for forestry projects, in order to ensure the prevention of illegal logging.	**No significant conversion or degradation of critical habitats or critical forests** Environment (Protection) Act, 1986: Sec.3 and Sec.6 empower the Government to designate "Ecologically Sensitive Areas (ESA)" and restrict development activities. Various notifications (e.g., Western Ghats ESA Notification) regulate conversion of protected forests and habitats. Forest (Conservation) Act, 1980: Sec.2 requires prior approval of the Central Government for the diversion of forest land to non-forest purposes. Large-scale deforestation or conversion of forests for development projects is in principle restricted. Wildlife (Protection) Act, 1972: Sec.29 and Sec.35 prohibit land conversion and tree felling within national parks and wildlife sanctuaries.	This project does not involve significant conversion or degradation of critical habitats or critical forests, nor does it entail illegal logging; therefore, it is not applicable.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Involuntary Resettlement and Loss of Livelihood	• Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. If avoidance is not possible even after such examination, effective measures to minimize impacts and to compensate for losses must be taken upon agreement with the affected people. • Project affected people, such as people to be resettled involuntarily and/or people who may lose their livelihoods by the project, must be provided sufficient compensations and supports by the project proponents in a timely manner. Compensations must be calculated at full replacement cost as much as possible, and provided in advance. Project proponents must make efforts for the affected people to improve or at least restore their standards of living, income opportunities and production levels to the pre-project levels. Measures to achieve this may include: Providing land or monetary compensations for losses of land or assets, supporting for alternative sustainable livelihood, supporting for expenses necessary for relocation, and supporting for re-establishment of communities at resettlement sites. • Compensation standards are disclosed and consistently applied. The project affected persons need to be aware of the compensation standards. In principle, the contents of the • individual compensation to be agreed are explained to the project affected persons in writing, and the project affected persons can confirm the contents at any time. • Appropriate participation of the project affected people and their communities must be promoted in the planning, implementation and monitoring of measures against involuntary resettlement and loss of livelihood. • For projects that result in large-scale involuntary resettlement, a Resettlement Action Plans (RAP) must be prepared and made available to the public prior to the resettlement and provision of compensation and support. In preparing the RAP, consultations must be held with the project affected people and communities, based on sufficient information made available to them in advance. When consultations are held, explanations must be given in languages and forms that are understandable to the project affected people. It is desirable that the RAP includes elements laid out in the Environmental and Social Standard (ESS) 5 of the World Bank's environmental and social policies.	**Land Acquisition and Minimization of Its Impacts** The Right To Fair Compensation And Transparency In Land Acquisition, Rehabilitation And Resettlement Act, 2013 （LARR2013） Article 4 and Article 8(1)(c): Only the minimum land necessary for project implementation shall be acquired. Article 8(2): The administrative authority overseeing land acquisition and environmental impacts shall verify and supervise that resident displacement due to the project is minimized, that impacts on infrastructure and the natural environment are kept to a minimum, and that the adverse effects on affected individuals are avoided or mitigated to the greatest extent possible. Chapter II: Conduct social impact assessments on affected persons during land acquisition, publish draft compensation and support policies, and formulate final compensation and support policies that incorporate the opinions and suggestions of affected persons. Resettlement & Rehabilitation Policy, Mumbai Urban Transport Project, 2000 (R&R MUTP 2000) 3(a): By examining feasible alternatives, minimize resettlement and prioritize various elements of the project. **Compensation Policy** LARR2013 Article 3(c): The scope of compensation and support covers land and asset owners as well as those whose primary livelihood depends on the land to be acquired. Article 3(p), Article 27, and Article 29: The scope of assets and losses eligible for compensation includes land, buildings attached to the land, and structures attached to the buildings. Article 26: Land price shall be the higher of the average registered sale price of nearby land or the notified market price. Article 28(5): Compensation includes expenses necessary for relocating residences and business premises. R&R MUTP 2000 3(b): Just prior to actual relocation, affected persons shall be compensated for their losses at replacement cost. To be discussed according to each law, standard, and restriction.	Follow JICA guidelines

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Indigenous Peoples	• Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. If avoidance is not possible even after such examination, effective measures for indigenous peoples must be taken to minimize the impacts and to compensate for the losses. • When projects may have adverse impacts on indigenous peoples, all of their rights in relation to land and resources must be respected in accordance with the spirit of the relevant international declarations and treaties, including the United Nations Declaration on the Rights of Indigenous Peoples. Efforts must be made to obtain the Free, Prior, and Informed Consent (FPIC) of the affected indigenous peoples. • Measures for the affected indigenous peoples must be prepared as an Indigenous Peoples Plan (IPP), which may constitute as a part of other documents for environmental and social considerations, and must be made public in compliance with the relevant laws and ordinances of the host country. In preparing the IPP, efforts must be made to obtain the FPIC of the affected indigenous peoples based on sufficient information made available to them in advance. When consultations are held, explanations are given in languages and forms that are understandable to the indigenous peoples concerned. It is desirable that the IPP includes the elements laid out in the ESS 7 of the World Bank's environmental and social policies.	LARR 2013 Article 41: Land acquisition in the settlements of designated castes and tribes shall be avoided as far as possible, and additional support shall be provided to those affected when necessary. LARR MH 2014 Article 17 (4): In cases involving involuntary relocation of designated castes and tribes, the state government shall prepare a development plan.	Corridor 1 identified no indigenous people within the project area; therefore, no Indigenous Peoples Plan will be prepared.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Monitoring	• During the project implementation, project proponents monitor whether any unforeseeable situations occur, and the performance and effectiveness of the planned mitigation measures. Project proponents take appropriate measures based on the results of such monitoring. • In cases where sufficient monitoring is deemed essential for appropriate environmental and social considerations, such as projects for which mitigation measures should be implemented while monitoring their effectiveness, Project proponents must ensure that the project plans include feasible monitoring plans. • Project proponents should make efforts to make the monitoring results available to local stakeholders involved in the project. • When third parties point out specifically that environmental and social considerations are not being fully undertaken, project proponents should make efforts to reach an agreement on the procedures to resolve the problems, through forums for discussions and examinations of the countermeasures with participation of stakeholders involved in the projects, based on sufficient information disclosure.	**Additional measures based on unforeseen circumstances, the status of mitigation implementation, and assessment of effectiveness** EIA Notification, 2006: Annex III "Environmental Monitoring Programme" specifies the methods, frequency, and reporting procedures for monitoring environmental parameters (air, water, soil, noise). Para 10 requires project proponents to submit compliance reports on Environmental Clearance (EC) conditions on a half-yearly basis to MoEFCC and the State Pollution Control Board (SPCB). **Formulation of monitoring plans and ensuring feasibility of implementation** EIA Notification, 2006: Annex III "Environmental Management Plan (EMP)" requires a detailed plan including responsible institutions, organizational arrangements, financing, and monitoring schedules. Annex III "Monitoring Programme" mandates specification of monitoring methods, frequency, and sampling locations. **Disclosure of monitoring results (to local stakeholders)** EIA Notification, 2006: Annex IV (Public Consultation) requires disclosure of information during public hearings and incorporation of stakeholder inputs. Para 10 also provides that compliance reports submitted must be made available for public inspection, as specified in MoEFCC guidelines. Right to Information Act, 2005: Enables residents to formally request disclosure of monitoring reports. Maharashtra Pollution Control Board (MPCB) Regulations: Require, for certain projects, the publication of EC compliance reports on the MPCB website. **Response to third-party observations and establishment of forums for consultation** EIA Notification, 2006: Public Hearing (Annex IV) provides a formal mechanism for local residents and NGOs to submit opinions. The Expert Appraisal Committee (EAC) / State Expert Appraisal Committee (SEAC) consider such third-party observations and public comments when making recommendations (Para 4, 5). National Green Tribunal (NGT) Act, 2010: Provides a legal forum for third parties (citizens, NGOs, etc.) to challenge inadequate environmental and social considerations, and enables adjudication, mediation, and remedial orders.	Although no significant divergence is observed with the EIA Notification, 2006, this project is outside its applicability; therefore, the JICA Guidelines shall be followed.
Grievance Redress Mechanism	• A mechanism for handling concerns and grievances from people and communities affected by the project's environmental and social impacts must be in place. • The grievance redress mechanism needs to be easily accessible for the project affected people and communities. Project proponents disseminate the information about the grievance redress mechanism through consultations with local stakeholders. The project affected people and communities must not be disadvantaged by filing a grievance. • Project proponents should make efforts to respond promptly to the grievances they receive, taking into account the concerns and needs of the project affected people and communities.	**Establishment of a grievance redress mechanism** EIA Notification, 2006: Public Hearing (Annexure IV) provides an official forum for affected residents to raise opinions and grievances. The Expert Appraisal Committee (EAC) / State Expert Appraisal Committee (SEAC) make recommendations taking into account the concerns expressed by residents. National Green Tribunal (NGT) Act, 2010: Provides a judicial grievance redress mechanism for environmental disputes, enabling residents and NGOs to file petitions directly. **Mechanisms that are easily accessible, widely known, and without adverse consequences for complainants** Right to Information (RTI) Act, 2005: Enables residents to easily obtain information on environmental permits, monitoring results, and project-related data. Maharashtra Pollution Control Board (MPCB) Regulations: Provide complaint reception desks and online portals to allow residents to file complaints directly. Companies Act, 2013 (CSR Policy): Encourages large enterprises to establish systems for receiving grievances and feedback from communities as part of Corporate Social Responsibility activities. **Prompt response and due consideration of concerns** EIA Notification, 2006: Opinions expressed at public hearings must be recorded verbatim and are required to be reflected in the final EIA report. NGT Act, 2010: Requires that grievances, once admitted, be heard expeditiously and remedial orders be issued. MPCB Regulations: Empower the Board to conduct site inspections and issue corrective orders promptly upon receiving environmental complaints.	Although no significant divergence is observed with the EIA Notification, 2006 and other relevant laws, this project falls outside the applicability of the EIA Notification, 2006; therefore, the JICA Guidelines shall be followed.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Information Disclosure	• In principle, project proponents disclose information about environmental and social considerations of their projects. JICA assists the project proponents through implementing cooperation projects as needed. • JICA discloses important information about environmental and social considerations at the key stages of cooperation projects, in an appropriate manner in accordance with the JICA Guidelines. • JICA discusses and agrees with project proponents on the frameworks that ensure information disclosure at the early stage of cooperation projects. • The information to be disclosed has to include environmental and social considerations, as well as the project information. • In addition to the information to be disclosed, JICA provides information about environmental and social considerations to third parties to the extent possible in response to their requests. • JICA actively encourages project proponents to disclose and present information about environmental and social considerations of their projects to local stakeholders. • Project proponents disclose information well in advance when they have consultations with local stakeholders in cooperation with JICA. On such occasions, JICA supports project proponents in preparation of documents in an official or widely used language(s) and in a form understandable by local peoples. • JICA discloses information on its website in Japanese, English, official language(s) and/or language(s) widely used in the host countries. It also provides the relevant reports for public reading at the JICA library and at related overseas offices. • JICA pays due consideration to the confidentiality of the commercial and other matters of project proponents, taking into account their competitive relationships. JICA encourages project proponents to exclude confidential information from any documents on environmental considerations that they submit which may later be subject to public disclosure. JICA takes into account the management of information of project proponents, and discloses their documents subject to their approval. Any information that is prohibited from public disclosure in the agreement documents between JICA and project proponents may be disclosed only upon obtaining the approval of the project proponents or in accordance with legal requirements.	**Proactive disclosure of environmental and social information (disclosure at key project stages)** EIA Notification, 2006: Para 7(i): At the Scoping/ToR stage, disclosure of EIA contents (alternatives, mitigation measures, etc.) is required. Annexure IV (Public Consultation): Draft EIA Report must be disclosed in advance, with a mandatory summary in the local language, and stakeholder opinions must be recorded. Annexure V: At the time of final EIA submission, the public hearing proceedings and video recording must be attached and disclosed. **Ensuring a framework for early-stage disclosure** EIA Notification, 2006: Specifies the scope and method of disclosure when issuing the Terms of Reference (ToR). Right to Information (RTI) Act, 2005: Sec.2(j), Sec.4(1)(c),(d) ensure early disclosure of administrative documents and permit-related information. **Disclosure of environmental and social information together with project-related information** Environment (Protection) Act, 1986: Rules under Sec.3 and Sec.6 mandate disclosure of Environmental Clearance (EC) applications and conditions. Maharashtra Pollution Control Board (MPCB) Regulations: Conditions for Consent to Establish/Operate are disclosed on the MPCB website. **Response to information requests from third parties** RTI Act, 2005: Sec.6 enables residents to request environmental documents. **Disclosure to local stakeholders (official/local languages)** EIA Notification, 2006: Annexure IV requires that the summary of the Draft EIA Report be provided in the local language (e.g., Marathi). MPCB Regulations: Notices of public hearings must be published in Marathi-language newspapers. **Web-based disclosure (multi-language disclosure)** MoEFCC Circulars (2009 onwards): EIA reports and EC conditions must be uploaded on the MoEFCC website. MPCB website: Publishes Consent and EC compliance reports (in English and Marathi). **Protection of commercial confidentiality and sensitive information** RTI Act, 2005: Sec.8(1)(d) exempts trade secrets and intellectual property from disclosure. EIA Notification, 2006: Draft/Final EIA reports must not contain confidential information. Companies Act, 2013: Corporate information disclosure under CSR reporting is limited to the extent that it does not cause competitive disadvantage.	Although no significant divergence is observed with the EIA Notification, 2006 and other relevant laws, this project falls outside the applicability of the EIA Notification, 2006; therefore, the JICA Guidelines shall be followed.

Source: JST

4.4.1.6 Other Environment-Related Permissions and Licenses Required for This Project

As previously stated, this project is not subject to the environmental clearance procedures under the Indian national system. However, the project proponent is required to undertake various procedures with the State of Maharashtra and the Municipal Corporation of Greater Mumbai, as shown below. The

application timing for these various permissions and licenses is primarily before construction, during construction, and during operation. Under the Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975 (as amended in 2023), provisions are stipulated regarding the number of compensatory trees to be planted in relation to the number of trees felled, cut, or transplanted due to a project. During the construction of the Mumbai Metro Line 3, the Tree Authority guidelines of the Municipal Corporation of Greater Mumbai required compensatory planting at a ratio of three times the number of trees felled or cut, and twice the number of trees transplanted (non-survived). In contrast, the revised version of the Act in 2023 stipulates that "a number of trees equivalent to the age of the transplanted tree, of the same species or of other locally endemic/indigenous species, shall be planted, and transplantation shall only be carried out under the supervision of qualified horticultural experts". Similarly, Compensatory plantation in lieu of trees felled (cut) in accordance with revised version of tree act in 2023.

Table 4.4.5 Main Permissions and Licenses Required

Item	Acts/ Rules	Concerned Agency	Stage
Consent to Establish and Consent to Operate for Batching plant, maintenance depot and workshop activities	The Water (Prevention and Control of Pollution) Act, 1974, amended 1988, The Air (Prevention and Control of Pollution) Act 1981, amended 1987, and The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (Combined consent regime)	Maharashtra State Pollution Control Board	Pre-Construction (Consent to Establish), and Before operation (Consent to Operate)
CRZ Clearance	CRZ Notification 2019	Maharashtra Coastal Zone Management Authority / State Environment Impact Assessment Authority	Pre-Construction
Tree conservation and management	Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975, amended in 2023	Tree Authority, Brihanmumbai Municipal Corporation (BMC), Garden Department	Pre-construction
C&D Waste Management Plan	C&D Waste Management Rules, 2025 (Effective from 1st April 2026)	Brihanmumbai Municipal Corporation	Pre-construction
Permission for extraction of ground water	Environment (Protection) Act, 1986	CGWA (Local Unit)	Pre-construction as well as for operation
Generation, handling, storage and transportation of hazardous waste	Hazardous and Other wastes (Management & Transboundary Movement) Rules, 2016	Maharashtra State Pollution Control Board	Construction and Operation
Development permission near World Heritage Structures	Brihanmumbai Municipal Corporation (BMC) (BMC Act, 1888)	Mumbai Heritage committee, Brihanmumbai Municipal Corporation	Pre-construction

Source: EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC

4.4.1.7 Other Environment-Related Laws and Regulations

Other environment-related laws and regulations are shown as below.

Table 4.4.6 Other Environment-Related Laws and Regulations

Classification	Laws / Systems / Guidelines etc.
Air	Air (Prevention and Control of Pollution) Act, 1981 Air (Prevention and Control of Pollution) Rules, 1982 Revised National Ambient Air Quality Standards, Notification, 2009
Water	Water (Prevention and Control of Pollution) Act, 1974 Water (Prevention and Control of Pollution) Rules, 1975 IS 10500 : 2012 Indian Standard DRINKING WATER — SPECIFICATION
Waste	Bio medical waste Management Rules, 2016 The Batteries (Management and Handling) Rules, 2011 Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 C&D Waste Management Rules, 2025 (Effective from 1st April 2026) Solid Waste Management Rules, 2016 (as amended by the Solid Waste Management (Amendment) Rules,2020) Fly Ash Utilization Notification 2021 E-Waste Management Rules, 2022 Battery Waste Management (Amendment) Rules, 2023
Soil	Environment Protection (Management of Contaminated Sites) Rules, 2025
Noise	Noise Pollution (Regulation and Control) Rules, 2000 (Amendment 2002, 2006) EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition.
Biodiversity	Wildlife Protection Act, 1972 The Maharashtra (Urban area) protection and preservation of Trees Act 1975 and its amendments The Wild Life (Protection) Amendment Act, 2002 The wild life (Protection) Rules, 1995 Biological Diversity Act, 2002 Indian forest Act,1927 Forest conservation act, 1980, 1988, etc. National forest policy, 1988 Forest rights act, 2006 Forest conservation amendment rules, 2003
Cultural and Historical Heritage	Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010
Labor environment including labor safety	Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996, (BOCW Act-Central) Contract Labor (Regulation & Abolition) Act, 1970 Inter-State Migrant Workmen Act, 1979 Minimum Wages Act 1948 The payment Wages Act 1936, ESIC 1948, WC 1923 Payment of Bonus Act 1965 Equal Remuneration Act 1976 Payment of Gratuity Act 1972, EPFO
Others	Coastal Regulation Zone notification, 2019

Source: JST

4.5 Comparative study of alternatives (Including No project)

4.5.1 Current Situation and Related Projects

As described below, alternative alignment studies for the urban railway connecting the densely populated areas of Dharavi / Anik / Wadala in the north and the CSMT area in the south of Bombay Island are being conducted. Regarding the area in question, as previously mentioned in Chapter 1, the construction projects for Mumbai Metro Line 3 and Line 11—which connect the city center to the southern tip of Mumbai and provide interchange with CSMT Station (636,000 passengers/day) and Churchgate Station (505,000 passengers/day)[35], the busiest Indian Railways stations located on Bombay Island—are positioned as priority projects within the Mumbai Metropolitan Region, based on the revised Mumbai Metro Master Plan of 2017. These lines are expected to serve as alternative routes to alleviate congestion on Indian Railways, where the peak-hour maximum passenger load factor reaches 250%. This project corresponds to the eastern corridor (Line 11), following the western corridor (Line 3).

The railway systems currently operating in this area include the Indian Railways' Western Line, Central Line, and Harbor Line, as well as the Mumbai Monorail and Mumbai Metro Line 3. While Indian Railways experiences severe congestion during morning and evening peak hours, the Mumbai Monorail suffers from poor connectivity with Indian Railways and infrequent services (15 to 20-minute intervals on weekdays, 30 to 40-minute intervals on holidays), leading to a decline in the number of users—from a peak of 6.166 million in FY2015–2016 to 3.636 million in FY2022–2023[36]—with current daily ridership at only 18,000 passengers[37]. Furthermore, since Mumbai Metro Line 3 has been in operation for less than one-year, public recognition among Mumbai residents is still in progress. As such, it has not yet fulfilled its role in serving as an alternative transportation option or promoting modal shift from Indian Railways.

Table 4.5.1 Utilization Status of Indian Railways and Mumbai Monorail

		
Indian Railways Morning Rush Hour Conditions	Mumbai Monorail Utilization Status	Mumbai Metro Line 3 Utilization Status

Source: JST

The Mumbai Metro Line 3, which is highly related to the present project, was initiated in 2016 under a Japanese ODA loan. With the commencement of operations on October 9, 2025, for the section between

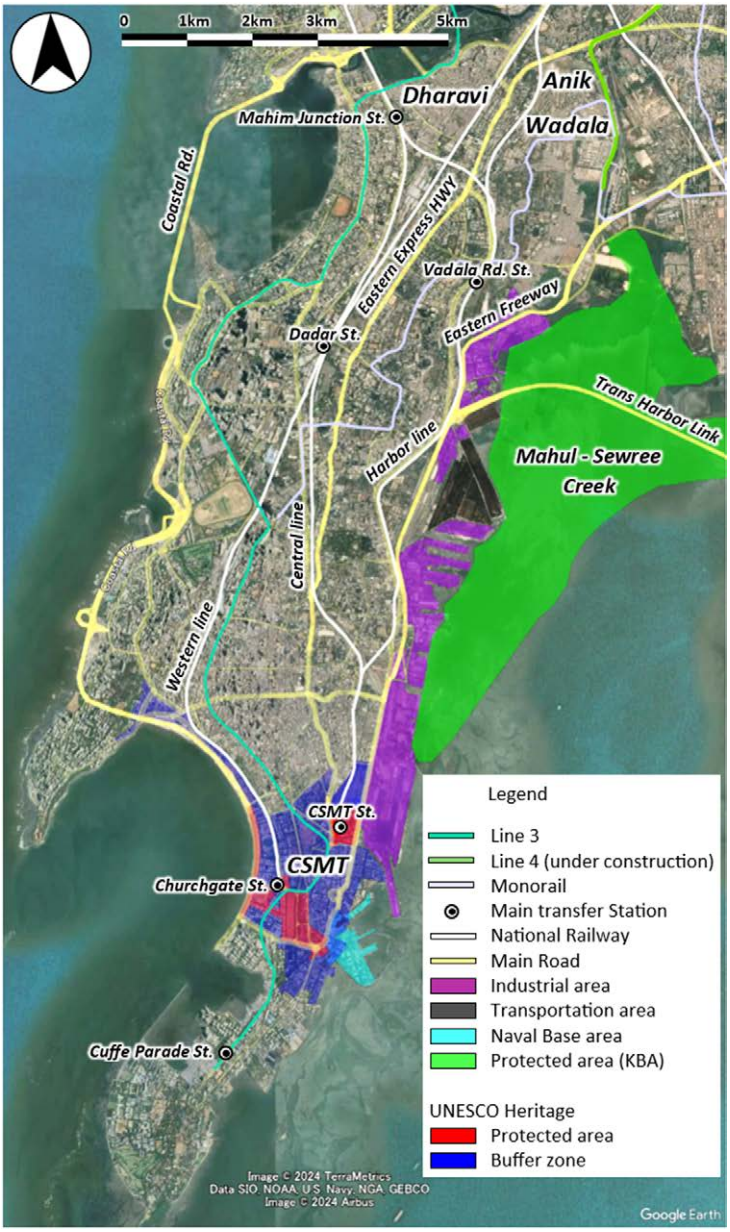
[35] https://timesofindia.indiatimes.com/city/mumbai/thane-is-busiest-railway-station-in-mumbai/articleshow/20129363.cms
[36] https://www.financialexpress.com/business/railways-mumbais-monorail-sees-uptick-in-ridership-but-commuters-still-prefer-taking-metro-heres-why-3024112/
[37] https://timesofindia.indiatimes.com/10-years-of-mumbai-monorail-the-joyride-that-never-took-off/articleshow/113566872.cms

Worli Station and Cuffe Parade Station, the entire Line 3 has now been fully opened to service[38].

In addition, Mumbai Metro Line 4 (a project financed by KfW – Kreditanstalt für Wiederaufbau, the German Development Bank) is being implemented by the Mumbai Metropolitan Region Development Authority (MMRDA), with approximately 75% of construction works completed. Although the handover of the land planned for the depot at Mogharpada in Thane District to MMRDA was delayed due to difficulties in securing the land, following a government resolution in June 2025, the land has been formally transferred to MMRDA, and construction of the depot is expected to commence immediately. The depot is planned to be equipped with 64 stabling tracks, 20 maintenance tracks, a control center, an automatic train washing system, and other heavy maintenance facilities[39]. At Anik Depot Station, Mumbai Metro Line 4 and Line 11 Corridor 1 will be connected; however, since Corridor 1 of Line 11 is underground and Line 4 is elevated, through-service operation between the lines will not be implemented.

[38] https://timesofindia.indiatimes.com/business/infrastructure/mumbai-metro-line-3-pm-modi-metro-inauguration-phase-2-aqua-line-top-things-to-know-route-timing-fare-stations-connectivity-passenger-capacity/articleshow/124382537.cms

[39] https://indianexpress.com/article/cities/mumbai/thane-mogharpada-mumbai-metro-largest-depot-10068327/



Source: Prepared by the JST based on Google Earth

Figure 4.5.1 Road and Railway Network and Land Use Conditions, etc. on Bombay Island

4.5.2 Evaluation Methods in Alternatives Study

4.5.2.1 Depot

The selection of a depot site is based on the following key criteria:

i. **Land area**: A depot requires a vast area to accommodate and maintain rolling stocks, as well as to set up facilities for rolling stock replacement and cleaning.

ii. **Efficiency of railway operations**: To ensure smooth train entry and exit (between the mainline and the depot), the facility should be located near major railway network routes, as well as starting and terminal stations.

iii. Traffic accessibility: Easy access to public roads is essential for workers' commuting and material transportation. Consequently, locations within residential areas, protected zones, or

green spaces, which may be affected by noise, vibration, or ecological impact, should be avoided.

iv. Impact on the surrounding environment due to project implementation: Considerations include **Land acquisition, Resettlement**, and ecological impacts (e.g., tree logging).

Among the above criteria, Land area and Efficiency of railway operations are crucial factors when evaluating the depot's functions and facilities. Additionally, from an environmental and social perspective, Land acquisition and Resettlement are also of high importance. Therefore, these three factors will be given 1.5 times the weight compared to the other criteria.

4.5.2.2 Preliminary and Detailed Alignment

When considering alternative proposals for preliminary and detailed alignment, the evaluation will be conducted based on the goals of the high-level plan (HLP), the current situation, and chronic road traffic congestion, with a focus on the following factors:

- **Consistency with the high-level plan (HLP)**
- Contribution to **alleviating road traffic congestion**, improving air quality, and reducing greenhouse gas emissions through modal shift
- **Promotion of modal shift by eliminating areas lacking railway service**
- Contribution to **improving public transportation convenience** through connectivity with other railway lines and avoidance of competing other railway routes
- Impact on the surrounding environment due to project implementation (e.g., **cultural and historical heritage structures**, **land acquisition/resettlement**, and protected areas)
- Reduction of construction costs and **shortening of the construction period**

Among these factors, the following will be given double weighting compared to other factors: Consistency with the high-level plan (HLP), which determines the future direction of public transportation in Mumbai metropolitan area; Construction period, which significantly affects the total project cost; Passenger demand (= modal shift) and Public transportation convenience, which reflect project benefits and sustainability; and Land acquisition/resettlement, from an environmental and social consideration perspective. Furthermore, the impact on cultural and historical heritage will be given triple weighting compared to other factors. This is based on JICA's Environmental and Social Considerations Guidelines (2022), which state: "In principle, Projects must be undertaken outside of areas that are specifically designated for conservation of nature or cultural heritages by the host county governments, unless the main purpose of the Projects is to promote or restore the protection of such areas. Also, projects shall not cause significant adverse impacts on such designated conservation areas." On the other hand, alignment length, which also affects total project cost, will be given standard weighting. This is because the difference between alternatives is less than 1–2 km over a total length of approximately 20 km. Similarly, impact on protected natural areas will receive standard weighting, as alternatives that would directly affect such areas are not considered. The following table presents the scoring distribution for each category, considering the applied weightings. As a result, the "Social and Economic (S&E)" category is given the highest weighting in preliminary alignment evaluation, while the "Environmental and Social Considerations (ESC)" category is prioritized in detailed alignment evaluation. This reflects

the fact that the project area is densely populated with severe road congestion, making traffic alleviation and improvement a primary focus in the preliminary alignment evaluation. In contrast, the detailed alignment evaluation considers social and economic factors while also placing greater emphasis on environmental and social considerations through a more granular evaluation approach.

Table 4.5.2 Point allocation by category in alternative analysis of preliminary and detailed alignments

		Preliminary Alignment Study			Detailed Alignment Study			Remarks
No.	Cat.	Item	Weighting		Item	Weighting		
1	HLP	Consistency with Maste plan	**10**	**10**	-	-	-	Due to the significant difference in alignment scale between MP and detailed study, comparison is difficult; therefore, it is excluded from detailed study items.
2	Const.	alignment length	5	**25**	alignment length	5	**20**	In detailed study, Construction period is excluded due to difficulty of quantitatively estimating it for each alternative. Instead, No. of station is added. Total score is reduced by 5 pts.
		Method	5		Method	5		
		Workability and safety	5		Workability and safety	5		
		Construction period	**10**		No. of station	5		
3	S&E	Impact on traffic during construction	5	**35**	Impact on traffic during construction	5	**35**	In preliminary study, 10pts allocation for 'Convenience for Passenger' was further subdivided in the detailed study while maintaining total score. There is no change to the overall point allocation.
		Passenger demand & modal shift	**10**		Passenger No. (2041)	**10**		
		Convenience for passenger	**10**		No. of connecting lines	5		
					Number of transfer stations	5		
		Elimination of areas lacking railway service	**10**		Elimination of areas lacking railway service	**10**		
4	ESC	Land acquisition/ Resettlement	**10**	**30**	Land acquisition	**10**	**55**	In preliminary study, 10 pts allocation for Land acquisition/ resettlement was further subdivided in detailed study. In detailed study, Land acquisition and No. of affected households remain at 10 pts, as they pertain to impact on residents. Furthermore, 'No. of logged tree and Reduction of GHG emissions' were added as environmental impact items. Total score increased by 25 pts.
					No. of affected structures	5		
					No. of affected households	**10**		
		Impact on world heritage areas	**15**		Impact on world heritage areas	**15**		
		Impact on protected natural areas	5		Impact on protected natural areas	5		
		-	**-**		No. of logged tree	5		
					Reduction of GHG emissions	5		
Total			**100**			**110**		

* HLP: High-level plan, Const.: Construction, S&E: Social and Economic, ESC: Environmental and Social Considerations

Source: JST

4.5.2.3 Common items

As an evaluation method, regardless of whether the criteria are quantitative or qualitative, the best alternative among all options (e.g., the alternative that ensures constructability and safety throughout the entire alignment, minimizes land acquisition area, or maximizes passenger demand) will receive the full score. For other alternatives, a proportional (or inversely proportional) allocation method will be applied, where the score is calculated by multiplying the allocated points by the ratio of the given alternative to the best alternative (see example below). However, this does not apply to qualitative evaluation items. Additionally, the minimum score for each item is set at 1 point.

Table 4.5.3 Evaluation method for each alternative (e.g., Depot)

No.	Evaluation item	Weighting	Alt. 1		Alt. 2		Alt. 3	
1	Site area (For accommodation evaluation of rolling stock, the alternative with the largest site area receives full score.	15	15 ha (Largest area receives full score)	15	12 ha 15 × (12 / 15) = 12	12	10 ha 15 × (10 /15) = 10	10
2	Land acquisition (For impact assessment, the alternative with the minimum land acquisition area receives full score.)	15	15 ha 15×(3/15) = 3	3	10 ha 15×(3/10)=4.5	4.5	3 ha (Minimum area receives full score)	15

Source: JST

4.5.3 Alternative Analysis for Corridor 1 of Line 11

4.5.3.1 Depot

As a first step, an examination was conducted to identify available land in the Dharavi / Anik / Wadala area and the CSMT area, where the northern and southern terminal stations are planned. Due to its location at the southern tip of Isle of Bombay, CSMT area has limited available land, making site selection unfeasible. Meanwhile, as previously mentioned, Dharavi area is home to India's largest slum cluster and has been undergoing redevelopment since 2004, making it unsuitable for a depot. Accordingly, three candidate sites were identified based on their proximity to the planned terminal stations: (i) the Anik Bus Depot (Alternative 1), adjacent to Anik Depot Station, which is expected to offer a sizable contiguous area; (ii) the Wadala Depot (Alternative 2), adjacent to Wadala Station; and (iii) the current construction yard of Mumbai Metro Line 3 (Alternative 3). The locations of these candidate sites are shown in the figure below. An alternative without a dedicated depot (i.e., "without project") was not included in the analysis, as it would require overnight rolling stock storage at each station, preventing proper rolling stock maintenance and significantly impacting railway operations. Given these considerations, "Proceeding with the project" was deemed necessary.

As a result of the alternative analysis, Alternative 1, which is currently used as a bus depot, received the highest evaluation in terms of facilities, functionality, and environmental and social considerations, making it the recommended option.

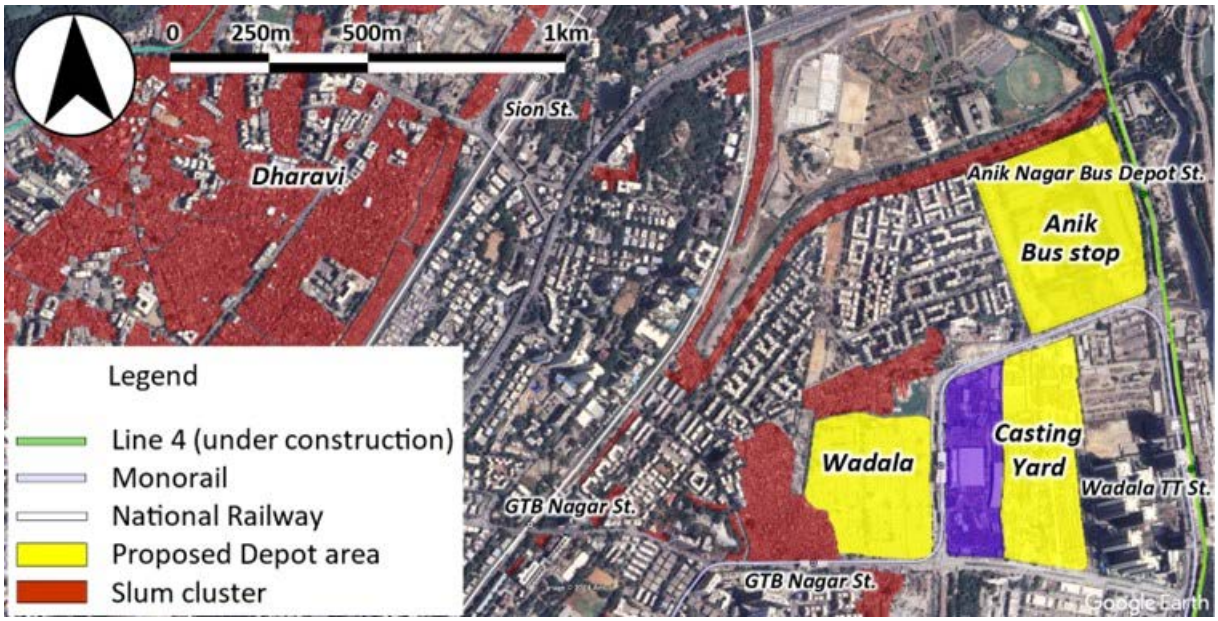
Table 4.5.4 Evaluation results of depot alternatives

No.	Evaluation item	Weighting	Alt. 1 (Anik Bus Depot)		Alt. 2 (Residencial area)		Alt. 3 (Construction yard)	
Facilities and Functions								
1	**Site area**	**15**	Approx.15.9 ha	**15**	Approx. 10.3 ha	**9.7**	Approx. 10 ha	**9.4**
2	No. of rakes accommodated	10	21 rakes	10	18 rakes	8.6	19rakes	9
3	Test track line	10	Max. 340 m	10	Max. 300 m	8.8	Max. 320 m	9.4
4	**Connectivity to main line**	**15**	Since, east and south sides are adjacent to overpass of line 4 and monorail, respectively, connection to main line from those two	**15**	Since east and south sides are adjacent to monorail overpass, they must be crossed either underground or on an elevated platform	**15**	East-west and north sides are adjacent to monorail viaducts; therefore, when connecting to main line in these three directions, necessary to	**10**

No.	Evaluation item	Weighting	Alt. 1 (Anik Bus Depot)		Alt. 2 (Residencial area)		Alt. 3 (Construction yard)	
			directions must be made underground or over the overpass.		when connecting to main line in those two directions.		cross over viaducts either underground or on an elevated railway line.	
Environmental and Social considerations								
5	**Land acquisition**	**15**	15.9 ha (public)	**9.4**	10.3 ha (private)	**1.5**	0 ha	**15**
6	No. of affected structure	10	Approx. 30 Bldgs.	10	Approx. 1,900 Bldgs.	1	Approx. 30 Bldgs.	10
7	**No. of affected household**	**15**	0	**15**	Approx. 1,900 HHs	**1**	0	**15**
8	No. of logged tree	10	Approx. 190 trees	5.3	Approx. 120 trees	8.3	Approx. 100 trees	10
Total		**100**	**Recommended**	**89.7**		53.9		87.9

*Bolded study items are recorded at 1.5 times normal distribution of points. In addition, evaluation of land acquisition for Alt. 1 is assigned 10 times more points than for private land because it is public land.

Source: JST



Source: Village wise slum cluster map of greater Mumbai with satellite imagery (2015), Slum Rehabilitation Authority, Greater Mumbai, JST based on Google Earth

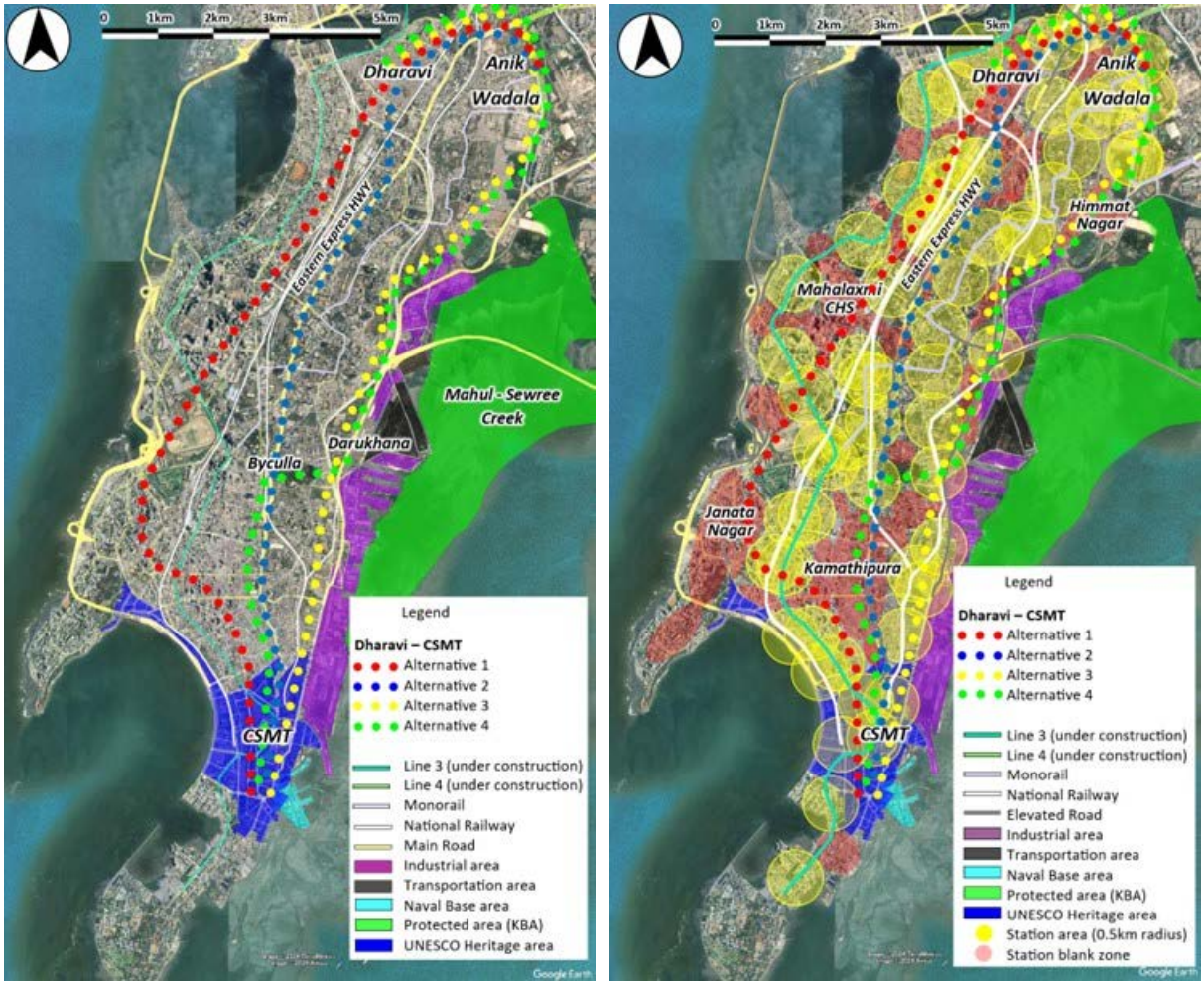
Figure 4.5.2 Candidate site for Depot

4.5.3.2 Preliminary Alignment Study

(1) From Dharavi / Anik / Wadala to CSMT

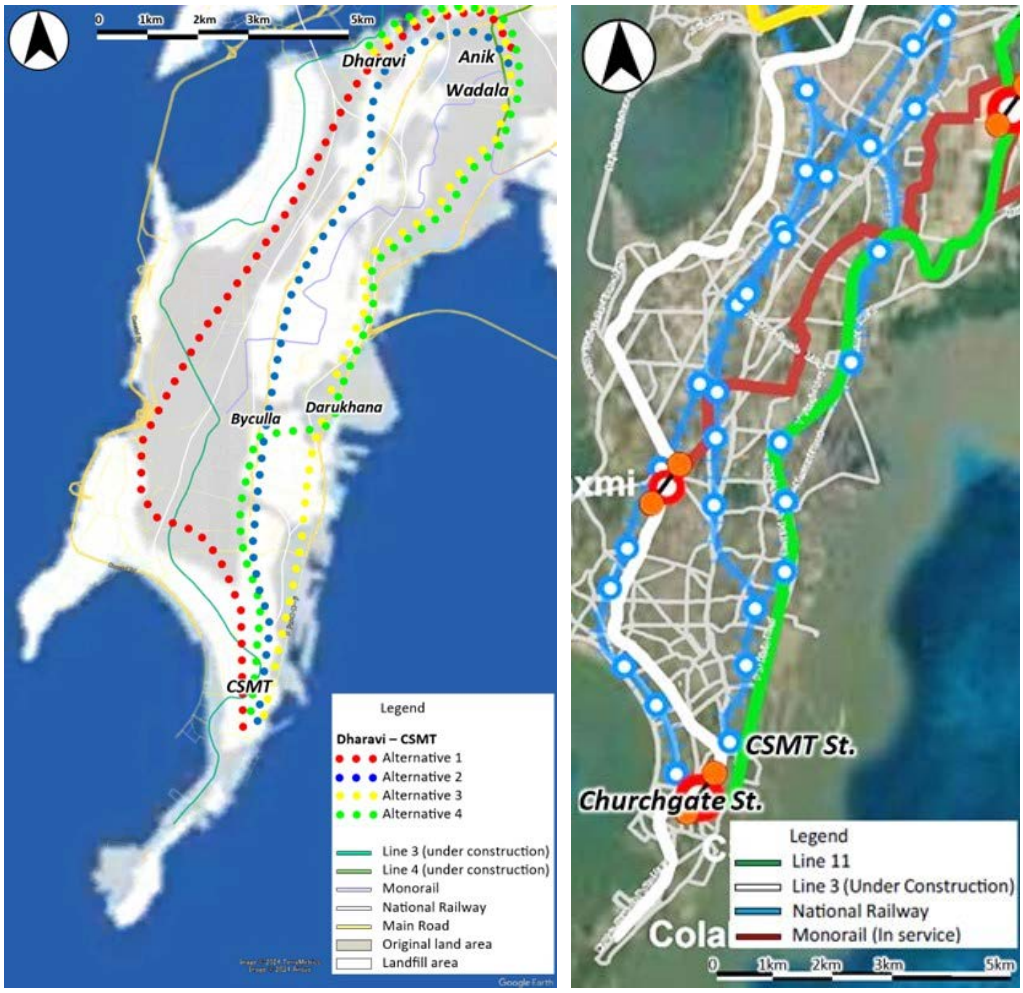
An examination of alternative alignments was conducted for the urban railway connecting the densely populated areas of Dharavi / Anik / Wadala in the north and the CSMT area in the south of Bombay Island. The analysis considered alternative routes starting from or passing through potential depot sites, such as Anik Bus Terminal and Wadala, and extending to the CSMT area, where government offices and tourist attractions are concentrated. Three main route options—eastern, central, and western—were initially considered. However, based on key evaluation criteria, including consistency with high-level plans (Master Plan), cost reduction and shorter construction periods, elimination of areas lacking railway

service, passenger demand, land acquisition and resettlement, and minimization of impacts on World Heritage areas and protected zones, four alternatives were selected: the eastern route, the central route, a hybrid of the two, and a "without project" option. As a fundamental assumption, vertical alignment alternatives (elevated, ground, underground) were also assessed. Elevated or ground alignments were deemed impractical due to further aggravation of existing severe traffic congestion caused by lane reductions, the prevalence of elevated structures along major roads, and difficulties in securing transition zones between ground and underground sections. Therefore, a fully underground alignment was adopted as the baseline plan to minimize impact.



Source: JST based on Google Earth

Figure 4.5.3 Preliminary alignment alternatives and Land use, Station catchment areas, and Areas lacking railway service



Source: (Left) Courtesy of Nikhil Anand /Sara Anand, JST based on Google Earth,
(Right) Mumbai Metro Master Plan, 2017

Figure 4.5.4 Classification of Land and Reclaimed Areas on Isle of Bombay and Mumbai Metro Master Plan

1) Without Project

If the project is not implemented, there will be no need for new land acquisition, resettlement, or tree logging. However, chronic traffic congestion and air pollution issues will continue to worsen. Furthermore, from socio-economic and climate change mitigation perspectives, proceeding with the project is deemed desirable. The positive and negative impacts of not implementing the project are outlined below.

i. Positive Impacts

If the project is not implemented, the following negative impacts will not occur:

- No adverse effects on local flora and fauna due to construction activities.
- No traffic restrictions during the construction period, preventing social and economic disruptions to commercial areas along the corridor.
- No land acquisition or resettlement along the corridor, allowing residents and business owners to continue their economic activities at the same location.

ii. Negative impact

If the project is not implemented, the following negative impacts will occur:

- The alternative railway line planned for the eastern coast of Isle of Bombay under Mumbai Metro Master Plan (MMMP) will not be constructed, causing significant delays or modifications in the advancement of Mumbai Metropolitan Region's public transportation plans.
- Traffic congestion will worsen, severely impacting passenger transport by road vehicles, further delaying the achievement of punctuality and rapid transit, leading to escalating socio-economic losses.
- The increase in slow-moving vehicles will likely worsen air pollution and greenhouse gas emissions, contradicting India's National Clean Air Programme (NCAP) and the climate change mitigation measures outlined in India's Nationally Determined Contributions (NDCs).
- The lack of passenger redistribution will result in further overcrowding of the national railway network, increasing the risk of falling accidents and passenger disputes.
- The loss of access to a safe and reliable public transport system may deter women from participating in the workforce, delaying progress toward gender mainstreaming.

2) Alternative 1: Western route (RED)

This proposed route begins in the Anik and Wadala areas, passing through Dharavi before heading southward in parallel with the national railway and the ongoing construction of Mumbai Metro Line 3. After crossing the Janata Nagar area, the route then turns southeast and reaches the CSMT area. The proposed alignment poses challenges in that it runs through station catchment areas already covered by the national railway or Mumbai Metro Line 3, making it incompatible with the alternative railway corridor specified in the MMMP. Additionally, because the route passes beneath major arterial roads where Metro Line 3 is already under construction, it would necessarily traverse through narrow urban streets. This is likely to result in extensive land acquisition and resettlement, with the anticipated negotiations expected to prolong the construction period. Another significant consideration is the construction cost. The depot sites at Anik and Wadala are located on the eastern side, meaning the route would need to cross multiple national railway lines before heading westward. As a result, the total length of the route would be longer compared to other alternatives, and the number of underground crossings would be higher. This requires more careful and complex construction methods, leading to higher costs. On the positive side, the route passes through land with solid geological conditions, ensuring favorable conditions for construction and safety. Moreover, as the route would terminate near UNESCO heritage areas in CSMT and VADEM, the construction method would need to be specifically designed to fully avoid any impact on these designated heritage structures.

3) Alternative 2: Central route (BLUE)

Similar to Alt. 1, this proposed route begins in the Anik and Wadala areas, passing through Dharavi

before heading south along the Eastern Express Highway, ultimately reaching the CSMT area. This route could serve as an alternative railway corridor as outlined in MMMP, but it is more skewed to the west compared to the Master plan. Since most of the highway is elevated, this alternative involves relatively minimal land acquisition and fewer resettlements. However, the presence of underground structures such as bridge piers along the highway imposes constraints on both the design and construction processes. In particular, the planned station sites will face difficulties due to excavation constraints, and the increased depth of the underground station platforms will impose further restrictions on the construction method. This, in turn, is expected to increase construction costs. Additionally, because the highway runs through reclaimed land, the surface soil is relatively soft, which raises concerns about the construction feasibility and safety. During construction, there is a high likelihood that reducing the number of traffic lanes on the main roads could exacerbate existing traffic congestion. On the positive side, while the station catchment areas overlap with those of the national railway and monorail, this route has the potential to fill gaps in areas such as Dharavi and Kamathipura, which are underserved. As with other alternatives, this route also terminates near the UNESCO World Heritage areas in CSMT and VADEM and therefore requires careful construction methods to avoid any impact on designated heritage structures.

4) Alternative 3: Eastern route (YELLOW)

This route starts from the Dharavi area, proceeds eastward, and after passing through candidate depot sites in Anik and Wadala, heads south along the port area, ultimately reaching the CSMT area. Since it largely follows the planned alignment outlined in the MMMP, it can contribute to easing congestion as an alternative route to the National railways. However, two-thirds of the southern section of the route passes through industrial or port areas, and due to overlapping station catchment areas with the National railways, additional demand is not expected. On the other hand, this route can help eliminate the areas lacking railway service in the Himmat Nagar area. Furthermore, the entire route passes through solid ground areas, ensuring good construction conditions and safety. However, since it is the closest route to the KBA (Key Biodiversity Area) of Mahul-Sewree Creek, potential impacts should be carefully considered. Additionally, similar to other alternative routes, as the final station is located near the World Heritage Area around the CSMT and VADEM areas, construction methods that completely avoid impacting the designated structures will be required.

5) Alternative 4: Compromise route between alternatives 2 and 3 (YELLOW-GREEN)

The plan follows Alt. 3 from the starting point at the Dharavi area to near the Darukhana area, and then changes direction westward in the vicinity of Darukhana, heading inland. At the Byculla area, the route changes direction southward and then follows Alt. 2. As more than half of the planned route outlined in the MMMP is adhered to, this route functions effectively as an alternative to the National railway. However, by heading west near Darukhana, the route passes through areas with relatively soft surface soils, making construction and safety slightly less assured compared to Alt. 1 and 3. On the positive side, by this westward deviation, a greater separation from the KBA is achieved, thereby minimizing ecological impact. Despite this, the inland section of the route also crosses through areas

with softer surface soils, which slightly compromises construction and safety compared to Alt. 1 and 3. In addition, the route passes through industrial zones or port areas with low demand, accounting for about one-third of the total route length. However, by passing through the more densely populated Byculla area and the areas lacking railway service in Kamathipura, an increase in demand can be expected, compared to Alt. 3. Like other alternatives, the route terminates near the World Heritage area of the CSMT area and VADEM, so construction methods that completely avoid impacting designated structures are required.

As a result of the alternative evaluation, Alt. 4 received the highest score in terms of the high-level plan, construction, social/economic aspects, and environmental and social consideration. However, Alt. 3 is the next best option, and it was selected as the comparison for subsequent alternative evaluations.

Table 4.5.5 Evaluation results of preliminary alignment alternatives (Corridor 1)

No.	Evaluation item		Weighting	Alt. 1 (Western route)		Alt. 2 (Central route)		Alt. 3 (Eastern route)		Alt. 4 Compromise route between Alt. 3 and 4	
Higher level plan											
1	**Consistency with MMMP**		**10**	Doesn't follow MMMP route and overlaps with Line 3, thus not functioning as alternative route to NR.	**2.5**	Likely to function as an alternative route to NR, but does not follow MMMP planned route.	**5**	Follows MMMP route and functions as an alternative route to NR.	**10**	Follows more than half of the MMMP route and functions as an alternative route to NR.	**7.5**
Construction											
2	Construction cost	Alignment length	5	Anik or Wadala to Dharavi, then continuing west, making the total length the longest (about 19 km)	4.5	Anik or Wadala to Dharavi, then only moving south, making the distance the shortest (about 17 km)	5	Dharavi to Anik or Wadala, then only moving south, making the distance the shortest (about 17 km)	5	Dharavi to Anik or Wadala, then west at Darukhana, making the total length relatively longer (about 18 km)	4.7
3		Method	5	Passing under the railway tracks of NR and Line 3 increases tunnel depth, but the sections with significant depth are shorter compared to other alternatives.	5	Entire route passes under highway, which increases tunnel depth, and excavation methods at station areas become difficult	1	South section passes under highway, increasing tunnel depth, and excavation methods at station areas become difficult	3	south section passes under highway, increasing tunnel depth, and excavation methods at station areas become difficult	3

No.	Evaluation item	Weighting	Alt. 1 (Western route)		Alt. 2 (Central route)		Alt. 3 (Eastern route)		Alt. 4 Compromise route between Alt. 3 and 4	
4	Workability and safety	5	Except for the south section, the route passes through areas with a bearing layer, ensuring constructability and safety.	4	Entire route passes through reclaimed surface ground, which does not ensure constructability and safety.	1	Except for some sections, the route passes through areas with a bearing layer, ensuring constructability and safety.	4	While there are many areas with a bearing layer, the southern section passes through reclaimed surface ground, constructability and safety are somewhat less guaranteed compared to alt. 1 and 3.	3
5	**Construction period**	**10**	Construction between stations is relatively easy. Land acquisition and resettlement occur in station installation areas, requiring additional time.	**2**	In both sections between stations and station installation areas, project passes through relatively soft surface ground. Additionally, in station installation areas under highways, open-cut method is difficult to apply, causing delays.	**6**	While construction between stations is relatively easy, in station installation areas under highways, open-cut method is difficult to implement, leading to longer construction times.	**8**	In south section, project passes through relatively soft surface ground in both the sections between stations and station installation areas. Furthermore, in station installation areas under highways, open-cut method is difficult to apply, resulting in delays.	**6**
Social and Economic										
6	Impact on traffic during construction	5	Since route passes through an urban area, traffic congestion occurs at numerous points, though on a small scale.	2.5	As route runs almost entirely under highway, large-scale congestion occurs throughout entire line.	1.7	Since approx. 1/3 of route passes under highway, relatively large-scale congestion occurs.	5	Since about half of route passes under highway, relatively large-scale congestion occurs.	3.3

No.	Evaluation item	Weighting	Alt. 1 (Western route)		Alt. 2 (Central route)		Alt. 3 (Eastern route)		Alt. 4 Compromise route between Alt. 3 and 4	
7	**Passenger demand and modal shift**	**10**	Since many sections overlap with NR alignment and Line 3, a significant modal shift is unlikely to occur.	**5**	As route runs along highway, passenger demand is high, contributing to a modal shift. But, since NR runs parallel, passengers will be dispersed.	**10**	Since route passes through port area and overlaps with NR alignment, passenger demand is low, and a significant modal shift is unlikely to occur.	**2.5**	In north section, route passes through port area and overlaps with NR alignment. But, in south section, it passes through densely populated residential areas, leading to a modal shift.	**7.5**
8	**Convenience for passengers**	**10**	Except at intersections with NR and Line 3, tunnel depth is generally standard, ensuring good accessibility to passenger platforms.	**10**	Since route runs almost entirely under highway, tunnel depth is significantly deep, making passenger access to platforms the most inconvenient.	3.3	Although approx. 1/3 of route passes under highway, accessibility to passenger platforms at stations in other sections is good.	**10**	Although about half of route passes under highway, accessibility to passenger platforms at stations in other sections remains good.	**6.7**
9	**Elimination of areas lacking railway service[40]**	**10**	Passing through Mahalaxmi CHS and Janata Nagar areas (total: approx. 2.5 km).	**5**	Passing through Kamathipura area (approx. 3 km).	**6**	Passing through Himmat Nagar area (approx. 2 km).	**4**	Passing through Himmat Nagar and Kamathipura areas (total: approx. 5 km).	**10**
Environmental and Social considerations										
10	**Land acquisition/ Resettlement**	**10**	Since route passes through urban areas, it occurs in most station installation areas.	**2.5**	As route runs along highway, occurrences in station installation areas are minimal, but securing station entrances is challenging due to commercial area.	**10**	It occurs in parts of the north section.	**7.5**	It occurs in parts of the north section.	**7.5**
11	**Impact on world heritage areas**	**15**	alignment passes through the area.	**1**	alignment passes through the area.	**1**	alignment passes through the area.	**1**	alignment passes through the area.	**1**
12	Impact on protected natural areas	5	Adequate separation can be secured.	5	Relatively adequate separation can be secured.	3.8	In all sections except north section, route is in close proximity.	1.7	Intermediate section is in close proximity.	2.5
Total		100		49		53.8	**Comparative proposal**	**61.7**	**Recommended**	**62.7**

* For the items in bold, the scores are calculated at twice or three times the usual weighting.

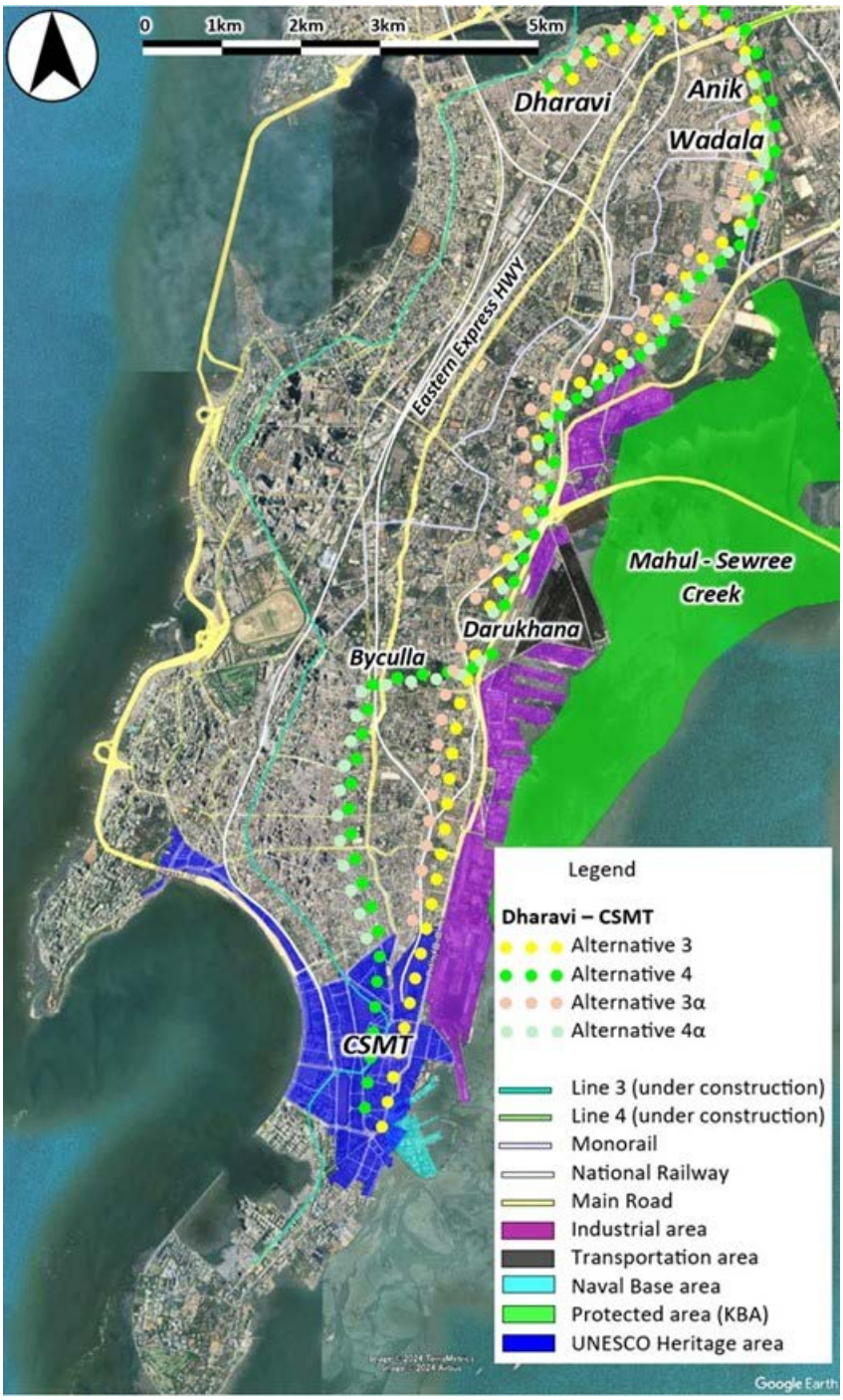
Source: JST based on Google Earth

[40] Dharavi area is also an area lacking railway service but is excluded as it is common to all four alternatives.

(2) World Heritage area

According to JICA Guidelines (2022), " In principle, Projects must be undertaken outside of areas that are specifically designated for conservation of nature or cultural heritages by the host county governments, unless the main purpose of the Projects is to promote or restore the protection of such areas. Also, projects shall not cause significant adverse impacts on such designated conservation areas." (for details, refer to 4.3.7.10 Cultural Heritage). However, one of the exceptions is clearly stated in the FAQ of the guidelines as " No feasible alternative plans shall be available in areas other than the area designated as such by the country and/or local governments by laws and/or ordinances to protect nature and cultural heritage" and therefore, in this section, to confirm this fact, an alternative proposal review was conducted for a total of four alternatives: the two alternatives (Alt. 3 and 4) that were selected as the recommended and the comparative proposal in the previous section, along with two additional alternatives (3α and 4α) that terminate just before the World Heritage Area, as shown in the table below. The alternative proposals were examined as shown in the table below. In the analysis, the four alternatives were reevaluated, and regardless of whether they were quantitative or qualitative evaluation items, the best alternative among all alternatives was given full marks. The scores for other alternatives were calculated using a proportional (or inverse proportional) allocation method by multiplying the score by the ratio of the best proposal (see Table 4.5.3). However, qualitative evaluation items were not subject to this method. The minimum score for each item was set to 1 point.

As a result of the alternative evaluation, Alt. 4, which was the original alternative, received the highest evaluation in terms of high-level plan, construction, and social and economic aspects, as well as environmental and social consideration, just like in the previous section. Similarly, Alt. 3 was the second one and was selected as the comparative proposal for the detailed alignment study for each section.



Source: JST based on Google Earth

Figure 4.5.5 Preliminary alignment alternatives (World Heritage area)

Table 4.5.6 Evaluation results of preliminary alignment alternatives regarding appropriateness of entering World Heritage area.

No.	Evaluation item		Weighting	Alt. 3 (Eastern route)		Alt. 4 (Compromise route		Alt. 3α		Alt. 4α	
High level plan											
1	**Consistency with MMMP**		**10**	Follows MMMP alignment and connects to NR CSMT station, functioning as an alternative route to NR.	**10**	Deviates slightly from MMMP alignment in south section but connects to NR CSMT station, allowing it to function as an alternative route to NR.	**7.5**	Follows MMMP alignment but doesn't extend to NR CSMT station area, making transfers impossible and preventing it from functioning as alternative to NR.	**2**	Deviates slightly from MMMP alignment in south section and doesn't extend to NR CSMT, making transfers impossible and preventing it from functioning as alternative to NR.	**1.5**
Construction											
2	Construction cost	Alignment length	5	Dharavi to Anik or Wadala, then only moving south, making the distance the shortest (about 17 km)	4.7	Dharavi to Anik or Wadala, then west at Darukhana, making the total length relatively longer (about 18 km)	4.5	It is approx. 1-2 km shorter than Alt 3.	5	It is approx. 1-2 km shorter than Alt 4.	4.7
3		Method	5	South section passes under highway, increasing tunnel depth, and excavation methods at station areas become difficult	4.2	South section passes under highway, increasing tunnel depth, and excavation methods at station areas become difficult t	4.2	Compared to Alt 3, section under highway where open-cut methods are difficult in the station areas is reduced.	5	Compared to Alt 4, section under highway where open-cut methods are difficult in the station areas is reduced.	5
4	Workability and safety		5	Except for some sections, the route passes through areas with a bearing layer, ensuring constructability and safety.	5	While there are many areas with a bearing layer, the southern section passes through reclaimed surface ground, constructability and safety are somewhat less guaranteed compared to alt. 1 and 3.	4	Except for some sections, the route passes through areas with a bearing layer, ensuring constructability and safety.	5	Compared to Alt. 4, south section, which passes through surface ground due to reclamation, is shortened, ensuring better constructability and safety.	4.5

No.	Evaluation item	Weighting	Alt. 3 (Eastern route)		Alt. 4 (Compromise route		Alt. 3α		Alt. 4α	
5	**Construction period**	**10**	While construction between stations is relatively easy, in station installation areas under highways, open-cut method is difficult to implement, leading to longer construction times.	**8.5**	In south section, project passes through relatively soft surface ground in both the sections between stations and station installation areas. Furthermore, in station installation areas under highways, open-cut method is difficult to apply, resulting in delays.	**6.5**	Compared to Alt. 3, reduction in section under highway where open-cut methods are difficult in station areas results in a shorter construction period.	**10**	Compared to Alt. 4, reduction in sections where soil improvement is needed between stations and in station installation areas, as well as reduction in section under highway where open-cut methods are difficult, leads to a shorter construction period.	**7.6**
Social and Economic										
6	Impact on traffic during construction	5	Since approx. 1/3 of route passes under highway, relatively large-scale congestion occurs.	4.2	Since about half of route passes under highway, relatively large-scale congestion occurs.	2.7	Compared to Alt 3, reduction in section under highway leads to a slight alleviation of large-scale traffic congestion.	5	Compared to Alt 4, reduction in section under highway leads to a slight alleviation of large-scale traffic congestion.	3.2
7	**Passenger demand and modal shift**	**10**	Since route passes through port area and overlaps with NR alignment, passenger demand is low, and a significant modal shift is unlikely to occur.	**3.3**	In north section, route passes through port area and overlaps with NR alignment. But, in south section, it passes through densely populated residential areas, leading to a modal shift.	**10**	Since it doesn't connect to NR CSMT station, with highest passenger volume on Isle of Bombay, passenger demand is significantly lower than Alt. 3.	**1**	Since it doesn't connect to NR CSMT station, with highest passenger volume on Isle of Bombay, passenger demand is significantly lower than Alt. 4.	**2**
8	**Convenience for passengers**	**10**	Although approx. 1/3 of route passes under highway, accessibility to passenger platforms at stations in other sections is good.	**10**	Although about half of route passes under highway, accessibility to passenger platforms at stations in other sections remains good.	**6.7**	Compared to Alt. 3, access to CSMT area will be by foot, rickshaw, or taxi, and due to the impact of traffic congestion, travel time will be longer compared to Alt.3.	**1.5**	Compared to Alt. 3, access to CSMT area will be by foot, rickshaw, or taxi, and due to the impact of traffic congestion, travel time will be longer compared to Alt.4.	**1**
9	**Elimination of areas lacking railway service**[41]	**10**	Passing through Himmat Nagar area (approx. 2 km).	**4**	Passing through Himmat Nagar and Kamathipura areas (total: approx. 5 km).	**10**	Passing through Himmat Nagar area (approx. 2 km).	**4**	Passing through Himmat Nagar and Kamathipura areas (total: approx. 4 km).	**8**

[41] Dharavi area is also an area lacking railway service but is excluded as it is common to all four alternatives.

No.	Evaluation item	Weighting	Alt. 3 (Eastern route)		Alt. 4 (Compromise route		Alt. 3α		Alt. 4α	
Environmental and Social considerations										
10	**Land acquisition/ Resettlement**	**10**	It occurs in parts of the north section.	**10**	It occurs in parts of the north section.	**10**	It occurs in parts of the north section.	**10**	It occurs in parts of the north section.	**10**
11	**Impact on world heritage areas**	**15**	alignment passes through the area.	**1**	alignment passes through the area.	**1**	Alignment doesn't pass through the area	**15**	Alignment doesn't pass through the area	**15**
12	Impact on protected natural areas	5	In all sections except north section, route is in close proximity.	3.3	Intermediate section is in close proximity.	5	In all sections except north section, route is in close proximity.	3.3	Intermediate section is in close proximity.	5
Total		100	**Comparative proposal**	**68.3**	**Recommended**	**72.0**		**66.5**		**67.6**

* For the items in bold, the scores are calculated at twice or three times the usual weighting.

Source: JST based on Google Earth

4.5.3.3 Detailed Alignment Study

In the evaluation of preliminary alignment study, the "Eastern route" and the "Compromise route" were selected as the comparative and recommended routes. Based on this, detailed alignment study for each alignment section of these two s were conducted as outlined below. However, with regard to the section from the Dharavi area to the Anik area, since the progress of the previously mentioned Dharavi Redevelopment Project remains uncertain and falls outside the jurisdiction of MMRC, MMRC has decided to exclude it from the scope of this project due to concerns over potential delays. Therefore, in this section, the alternative alignment study will be conducted starting from Anik Depot, which has been selected as the depot site. On the other hand, with regard to the "no project" alternative, it is not considered in this section, as it has been determined during the overall alignment study that the implementation of the project is desirable.

(1) From Anik Depot St. to BPT Hospital St.

In the section concerned, since the alignment of the comparative option and the recommended option in the preliminary alignment study overlaps, a comparison of the following two alternatives is conducted in the detailed alternative study.

1) Alternative 1 (RED)

After Anik Depot Station, the alignment proceeds westward while transitioning underground, and connects with the Mumbai Monorail at Wadala Station. It then moves southward, passing through CGS Colony station, Ganesh Nagar station, and BPT Hospital station. Since the distance between CGS Colony station and the Mumbai Monorail's Antop Hill station is approx. 200 meters, transfers are possible. Although the route passes through a slum cluster, it runs entirely underground between stations, minimizing any impact. However, land acquisition and resettlement will be required at Wadala station.

2) Alternative 2 (GREEN and YELLOW-GREEN)

Since Mumbai Metro Line 4 (currently under elevated construction) has been extended up to Bhakti Park Station, Corridor 1 of Line 11 will begin at this station and continue westward on an elevated structure, passing through Ganesh Nagar Station and reaching BPT Hospital Station. If this alternative is adopted, passengers will be required to transfer at Anik Depot Station, and a transfer to the Mumbai Monorail will also be possible at Bhakti Park Station.

As a result of the alternative evaluation, Alt. 1 received the highest rating in terms of construction, socio-economic impact, and environmental and social considerations. Therefore, it has been selected as the recommended option.

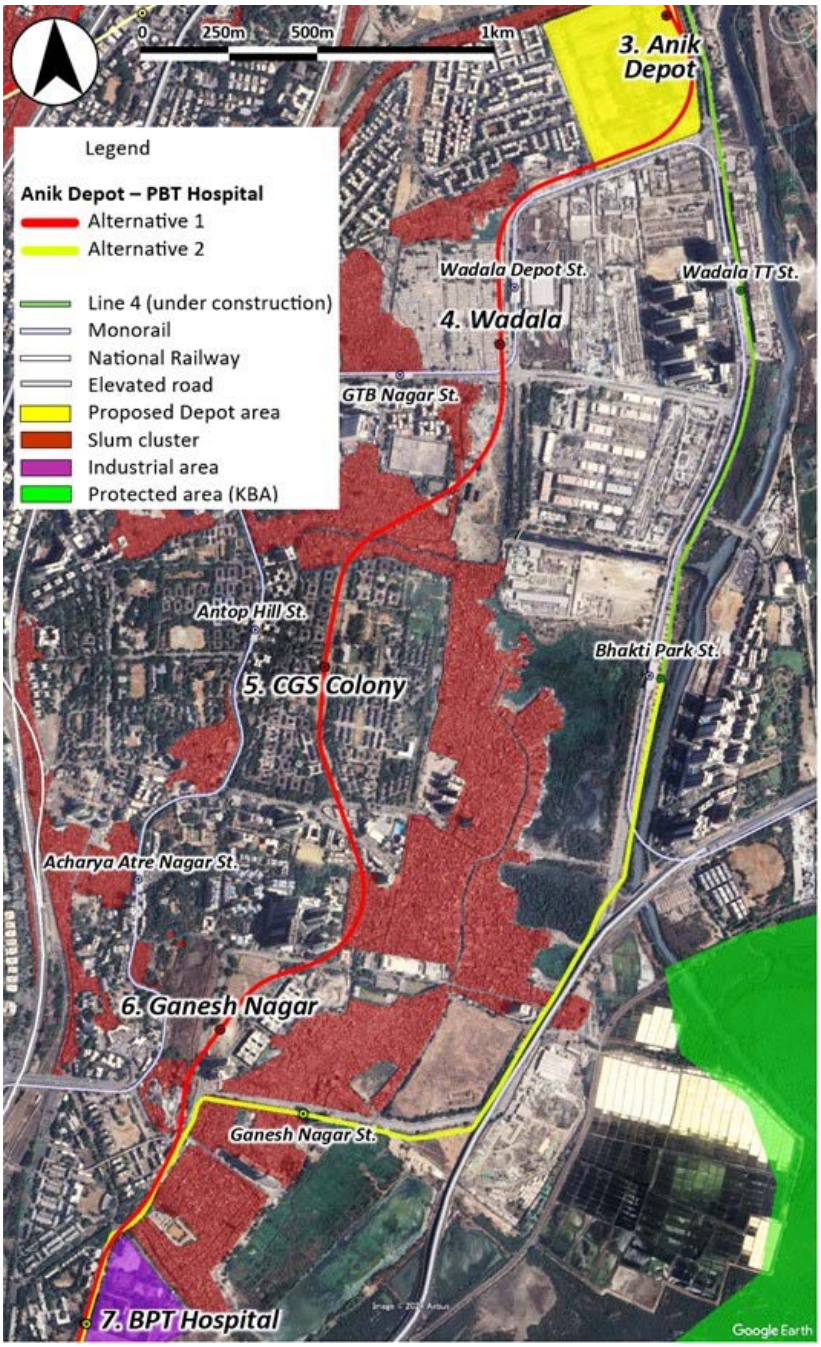
Table 4.5.7 Evaluation results of detailed alignment study from Anik Depot to BPT Hospital

No.	Evaluation item	Weighting	Alt. 1 (RED)		Alt. 2 (GREEN and YELLOW-GRREN)	
Construction						
1	Alignment length	5	Although route is relatively short at approx. 4.6 km, it is entirely underground (which costs 3-5 times more than an elevated section), making it more expensive compared to the other.	1.2	Route is approx. 4.9 km long, slightly longer than the other, but since it includes elevated sections, it is more cost-effective in comparison.	5
2	Method	5	At intersection with the Mumbai Monorail, tunnel depth increases.	2	Since entire section is elevated, construction can be carried out using standard methods.	5
3	Workability and safety	5	Throughout entire section, route passes through a stable bearing layer, ensuring both constructability and safety.	5	Throughout entire section, route passes through a stable bearing layer, ensuring both constructability and safety.	5
4	No. of station	5	5 stations（underground）	1.3	5 stations（elevated）	5
Social and Economic						
5	Impact on traffic during construction	5	Except for BPT Hospital station, all other stations are within designated premises, resulting in no significant impact.	5	All stations are located above roads, which is expected to reduce traffic lanes.	2
6	Passenger No. (2041)	**10**	420,263 persons/day	**10**	364,126 persons/day	**8.7**
7	No. of connecting lines	5	Mumbai monorail	5	Mumbai monorail	5
8	Number of transfer stations	5	2 stations	5	2 stations	5
9	Elimination of areas lacking railway service	**10**	Himmat Nagar area	**10**	Himmat Nagar area	**10**
Environmental and Social considerations						
10	**Land acquisition**	**10**	0.2 ha	10	0.2 ha	10
11	No. of affected structures	5	Approx. 60 Bldgs.	5	Approx. 70 Bldgs.	4.3
12	**No. of affected households**	**10**	Approx. 130 HHs	**10**	Approx. 150 HHs	**8.7**
13	Impact on world heritage areas	**-**	-	-	-	-

No.	Evaluation item	Weighting	Alt. 1 (RED)		Alt. 2 (GREEN and YELLOW-GRREN)	
14	Impact on protected natural areas	5	Although it is an underground section, it comes within 0.7 km of the area.	5	elevated section comes as close as 0.25 km to the area.	1
15	No. of logged tree	5	Approx. 10 trees	5	Approx. 30 trees	1.7
16	Reduction of GHG emissions	5	306 t-CO_2/day	5	200 t-CO_2/day	3.3
Total		**95**	**Recommended**	**84.5**		**79.7**

* For the items in bold, the scores are calculated at twice the usual weighting. Additionally, for comparisons between elevated and underground sections, the underground section is evaluated at a quarter of the elevated section based on the cost ratio.

Source: JST



Source: Village wise slum cluster map of greater Mumbai with satellite imagery (2015), Slum Rehabilitation Authority, Greater Mumbai, JST based on Google Earth

Figure 4.5.6 Detailed alignment alternatives from Anik Depot to BPT Hospital

(2) From BPT Hospital St. to Darukhana St.

In this section, the comparative and recommended alternatives of the preliminary alignment study are overlapped. Therefore, a comparison will be made between the two alternatives in the detailed alternative study. The eastern side of this section consists of an industrial area and port zone, with the national railway passing on the west, limiting the options for alignment. As a result, there are no significant differences between the alternatives. However, the connection to Sewri national railway station is on the west side in Alt. 1 and on the east side in Alternative 2. Additionally, Alt. 2, which progresses southward from BPT Hospital on an elevated section, transitions immediately underground as it heads west toward Sewri station, making this section a transition section from elevated to underground.

As a result of the alternative evaluation, Alt. 1 received the highest rating in terms of construction, socio-economic factors, and environmental and social considerations. Therefore, it has been selected as the recommended option.

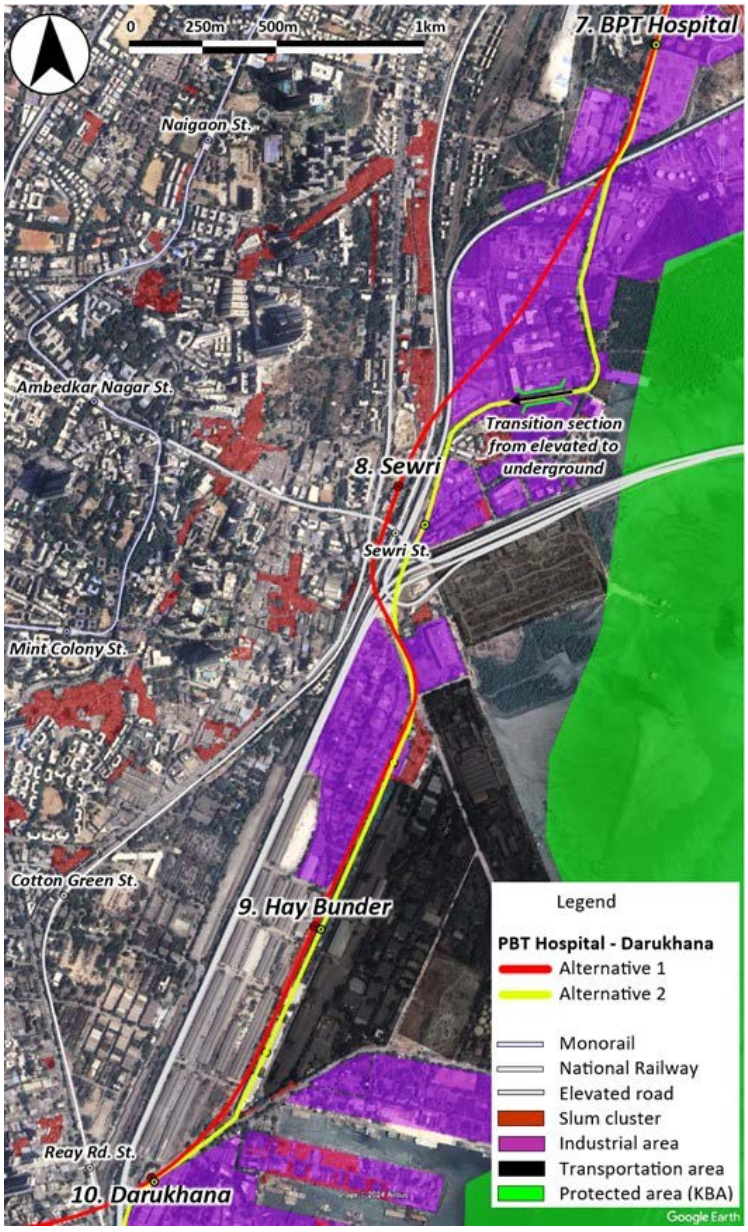
Table 4.5.8 Evaluation results of detailed alignment study from BPT Hospital to Darukhana

No.	Evaluation item	Weighting	Alt. 1 (RED)		Alt. 2 (GREEN and YELLOW-GRREN)	
Construction						
1	Alignment length	5	Approx. 4.4 km	2.8	Approx. 4.6 km, of which, 1.4 km is an elevated section.	5
2	Construction method	5	Entire section is underground, but tunnel depth increases as it passes under highway.	1	1.4 km elevated section allows for relatively easier construction methods, but after transitioning to the underground section, tunnel depth increases as it passes under highway.	2
3	Workability and safety	5	Except near Sewri Station, area passes through good bearing layer, ensuring the feasibility and safety of construction.	5	Except near Sewri Station, area passes through good bearing layer, ensuring the feasibility and safety of construction.	5
4	No. of Station	5	4 stations（underground）	5	4 stations（underground）	5
Social and Economic						
5	Impact on traffic during construction	5	Since Hay Bunder St. and Darukhana St. will be located under roads, a reduction in traffic lanes is expected.	5	Since Hay Bunder St. and Darukhana St. will be located under roads, a reduction in traffic lanes is expected.	5
6	Passenger No. (2041)	**10**	380,758 person/day	**10**	268,630 person/day	**7.1**
7	No. of connecting lines	5	National railway	5	National railway	5
8	Number of transfer stations	5	2 stations (Sewri St., Reay Rd. St.)	5	1 station (Sewri St.)	2.5
9	Elimination of areas lacking railway service	**-**	-	**-**	-	**-**
Environmental and Social considerations						
10	**Land acquisition**	**10**	0.7 ha	10	1 ha	7
11	No. of affected structures	5	Approx. 90 Bldgs.	2.8	Approx. 50 Bldgs.	5

No.	Evaluation item	Weighting	Alt. 1 (RED)		Alt. 2 (GREEN and YELLOW-GRREN)	
12	**No. of affected households**	**10**	Approx. 480 HHs	**1.8**	Approx. 86 HHs	**10**
13	Impact on world heritage areas	**-**	-	-	-	-
14	Impact on protected natural areas	5	Although it is an underground section, it comes within 0.35 km of the area.	5	elevated section comes as close as 0.15 km to the area.	1
15	No. of logged tree	5	Approx. 80 trees	5	Approx. 190 trees	2.1
16	Reduction of GHG emissions	5	306 t-CO_2/day	5	200 t-CO_2/day	3.3
Total		**85**	**Recommended**	**68.3**		**64.9**

* For the items in bold, the scores are calculated at twice the usual weighting. Additionally, for comparisons between elevated and underground sections, the underground section is evaluated at a quarter of the elevated section based on the cost ratio.

Source: JST



Source: Village wise slum cluster map of greater Mumbai with satellite imagery (2015), Slum Rehabilitation Authority, Greater Mumbai, JST based on Google Earth

Figure 4.5.7 Detailed alignment alternatives from BPT Hospital to Darukhana

(3) From Darukhana St. to before CSMT World Heritage Area

In this section, in addition to the recommended and comparison options selected in the preliminary alignment study, a total of three alternatives were examined, including an option that avoids the highway and passes through areas lacking railway service. The detailed alternative study was conducted as follows.

1) Alternative 1 (RED)

The route progresses westward from Darukhana St., passing Byculla St. and the highway, then turns southward, passing through Nagpada Junction St. and Bhendi Bazaar St. before reaching the World Heritage area. Transfers with the national railway are possible at both Darukhana and Byculla stations. Additionally, this route passes through the areas lacking railway service of Kamathipura.

2) Alternative 2 (YELLOW-GREEN)

This route progresses southward from Darukhana St., passing through Wadi Bandar St. and Clock Tower St. before reaching the World Heritage area. A transfer with the national railway is possible at Darukhana St. Throughout the entire line, the route passes through an industrial area, meaning the expected number of passengers is low. Additionally, this route comes closest to Key Biodiversity Area.

3) Alternative 3 (ORANGE)

This route follows the same path as Alternative 1 until Byculla St., after which it heads south, passing through JJ Junction St. and Bhendi Bazaar St., while traversing under the highway. As with Alt. 1, transfers with the national railway are possible at both Darukhana St. and Byculla St., and the route also passes through the Kamathipura area, which is an area lacking railway service.

After considering aspects such as construction, socio-economic impacts, and environmental and social considerations, Alt. 1 received the highest evaluation and was selected as the recommended option.

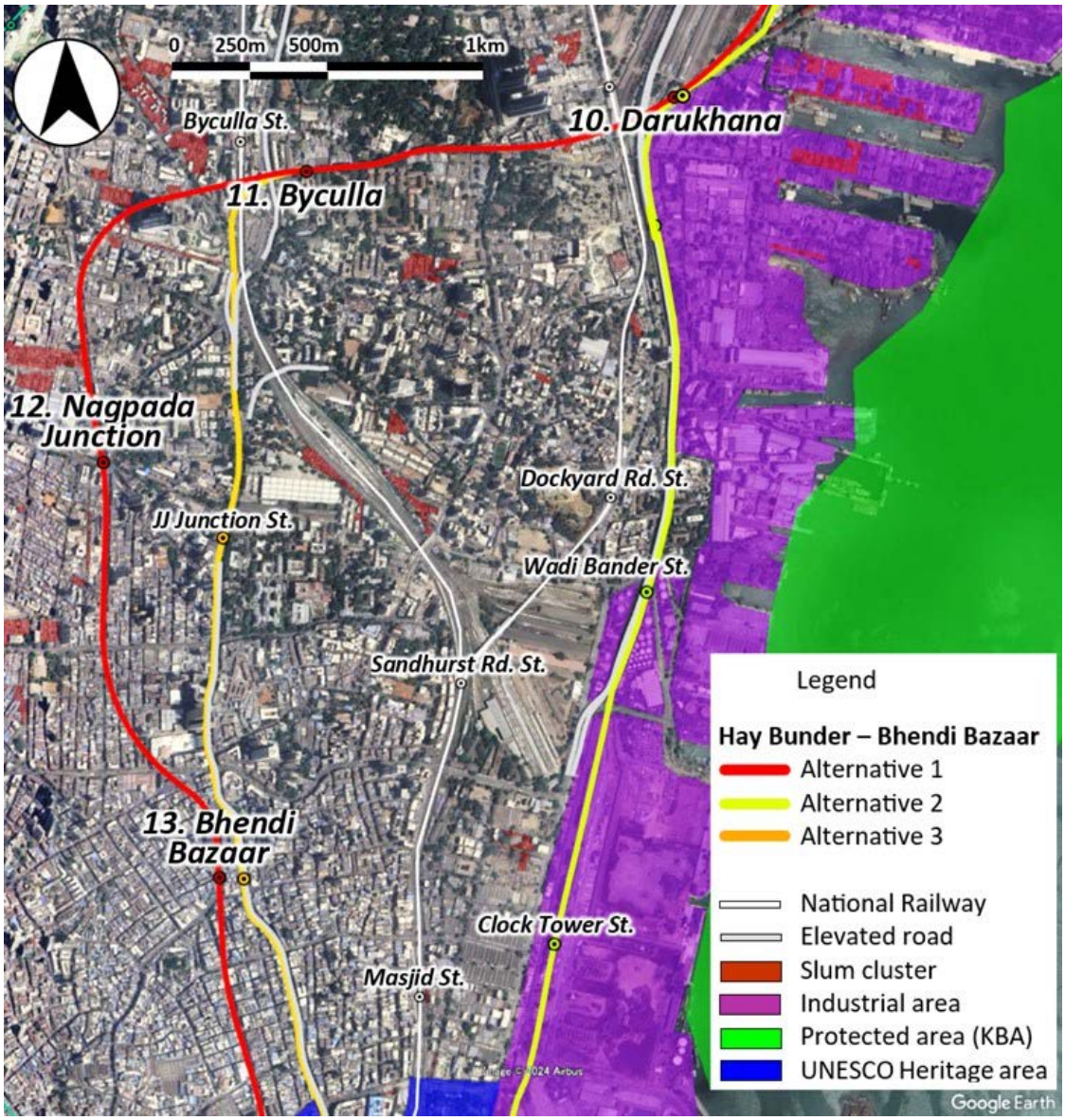
Table 4.5.9 Evaluation results of detailed alignment study from Darukhana to before CSMT World Heritage area

No.	Evaluation item	Weighting	Alt. 1 (RED)		Alt. 2 (YELLO-GREEN)		Alt. 3 (ORANGE)	
Construction								
1	Alignment length	5	Approx. 5 km	3.3	Approx. 3.25 km	5	Approx. 4.5 km	3.6
2	Construction method	5	Tunnel depth increases by passing under railway tracks, but section is shorter compared to the others.	5	North section (about 2 km) passes under highway, increasing tunnel depth, making excavation methods at station area difficult.	2.5	South section from Byculla (about 2 km) passes under highway, increasing tunnel depth, making excavation methods at station area difficult.	2.5
3	Workability and safety	5	South section from Bhedi Bazaar St. (about 0.8 km), section passes through reclaimed surface ground, so construction feasibility	5	Section between Darukhana and Wadi Bandar St. (about 1.6 km) passes through reclaimed surface ground, so	2.5	South section from Byculla St. (about 3.2 km), section passes through reclaimed surface ground, so construction feasibility	1.3

No.	Evaluation item	Weighting	Alt. 1 (RED)		Alt. 2 (YELLO-GREEN)		Alt. 3 (ORANGE)	
			and safety are not guaranteed.		construction feasibility and safety are not guaranteed.		and safety are not guaranteed.	
4	No. of station	5	4 stations	3.8	3 stations	5	4 stations	3.8
Social and Economic								
5	Impact on traffic during construction	5	Due to passing through urban area, small-scale but numerous traffic jams occur.	5	Due to passing under highway (about 2 km), large-scale traffic jams occur.	2.5	Due to passing under highway (about 2 km), large-scale traffic jams occur.	2.5
6	**Passenger No. (2041)**	**10**	279,792 person/day	**10**	187,405 person/day	**6.7**	279,478 person/day	**10**
7	No. of connecting lines	5	NR	5	NR	5	NR	5
8	Number of transfer stations	5	2 (Reay Rd. St., Byculla St.)	5	1(Reay Rd. St	2.5	2 (Reay Rd. St., Byculla St.)	5
9	**Elimination of areas lacking railway service**	**10**	Passing through Kamathipura area (approx. 3 km)	**10**	Nothing	**1**	Passing through Kamathipura area (approx. 3 km)	**10**
Environmental and Social considerations								
10	**Land acquisition**	**10**	0.5 ha	**2.0**	0.1 ha	**10**	0.3 ha	**3.3**
11	No. of affected structures	5	Approx. 40 Bldgs.	2.5	Approx. 20 Bldgs.	5	Approx. 40 Bldgs.	2.5
12	**No. of affected households**	**10**	Approx. 260 HHs	**1**	0	**10**	Approx. 220 HHs	**1**
13	Impact on world heritage areas	**-**	-	-	-	-	-	-
14	Impact on protected natural areas	5	Adequate separation can be ensured	5	Closely spaced throughout entire section	1	Relatively adequate separation can be ensured	3
15	No. of logged tree	5	Approx. 50 trees	5	Approx. 80 trees	3.1	Approx. 70 trees	3.6
16	Reduction of GHG emissions	5	306 t-CO_2/day	4.9	200 t-CO_2/day	3.2	312 t-CO_2/day	5
	Total	**95**	**Recommended**	**72.4**		**63.8**		**62**

***** For the items in bold, the scores are calculated at twice the usual weighting.

Source: JST



Source: Village wise slum cluster map of greater Mumbai with satellite imagery (2015), Slum Rehabilitation Authority, Greater Mumbai, JST based on Google Earth

Figure 4.5.8 Detailed alignment alternatives from Darukhana to before CSMT World Heritage area

(4) From CSMT World Heritage area to Horniman Circle

In Corridor 1 of Line 11, there are sections that pass through the UNESCO World Heritage protection area and buffer zone, so it is necessary to consider alignments and construction methods that avoid impacts on designated structures. Based on this, a comparison of four alternatives for the section from CSMT area to Horniman Circle Station was conducted. The alignment alternatives are as follows:

- Alt. 1 (RED): Route passing through the urban area, connecting CSMT Metro St. to Horniman Circle St.
- Alt. 2 (ORANGE): Route passing under the highway, merging with Alt. 1 from CSMT Metro St.
- Alt. 3 (YELLO-GREEN): Route starting from the coastal area, curving west from Carnac Bunder St, passing through World Heritage area, and connecting to Line 3 CSMT Metro St. (not pass

through CSMT East St.).

- Alt. 4 (LIGHT BLUE): Route passing through the coastal area, passing through CSMT East St. from Carnac Bunder St., and connecting to Horniman Circle St.

As shown in the table below, the alternatives were compared and examined in terms of construction, socio-economic impact, and environmental/social considerations. As a result, Alt. 1, which had the highest positive socio-economic impact, the least negative environmental/social impact, and the lowest construction cost, was selected as the recommended option.

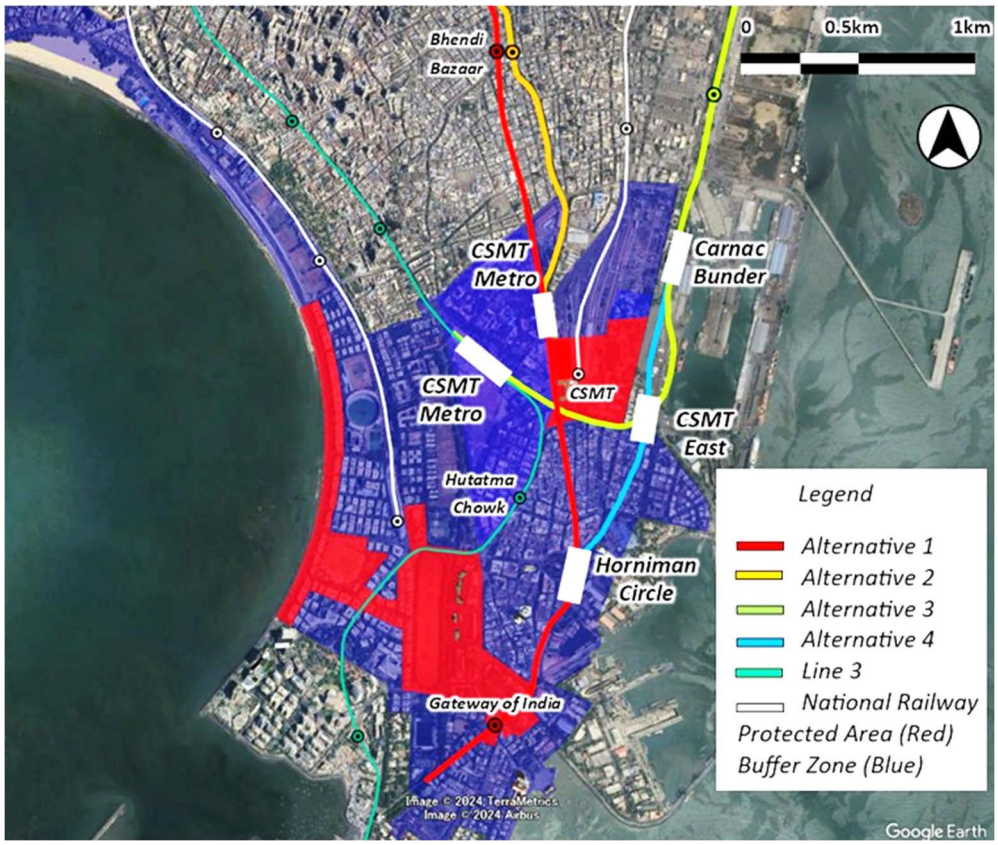
Table 4.5.10 Evaluation results of detailed alignment study from CSMT World Heritage area to Horniman Circle St.

No.	Evaluation item	Weighting	Alt. 1 (RED)		Alt. 2 (ORANGE)		Alt. 3 (YELLOW-GREEN)		Alt. 4 (LIGHT BLUE)	
Construction										
1	Alignment length	5	1.7 km	2.2	1.8 km	2.1	0.75 km	5	0.75 km	5
2	Method	5	Since it only passes through general roads, the depth is shallower compared to Alt. 2 and 4.	5	It passes under some national roads, so the depth of the underground section increases.	3	Since it only passes through general roads, the depth is shallower compared to Alt. 2 and 4.	5	It passes under some national roads, so the depth of the underground section increases.	3
3	Workability and safety	5	Due to passing through surface soil created by reclamation, the construction feasibility and safety are somewhat not guaranteed.	3	Due to passing through surface soil created by reclamation, the construction feasibility and safety are somewhat not guaranteed.	3	Due to passing through surface soil created by reclamation, the construction feasibility and safety are somewhat not guaranteed.	3	Due to passing through some good supporting ground, the construction feasibility and safety are more guaranteed compared to other options.	5
4	No. of Station	5	2 stations	5	2 stations	5	3 stations	3.3	2 stations	5
Social and economic										
5	Impact on traffic during construction	5	Since two stations pass through the city area, traffic congestion will occur at two locations.	2.5	Since two stations pass through the city area, traffic congestion will occur at two locations.	2.5	Since 1 station passes through the city area, traffic congestion will occur at a location.	5	Since 1 station passes through the city area, traffic congestion will occur at a location.	5
6	Passenger No. (2041)	**10**	606,100 persons/day	**10**	606,100 persons/day	**10**	374,900 persons/day	**6.2**	329,510 persons/day	**5.4**
7	No. of connecting lines	5	2 (Line 3, NR)	5	2 (Line 3, NR)	5	2 (Line 3, NR)	5	0 (CSMT NR St. doesn't have an east exit, so it will not serve as an interchange station.)	1
8	Number of Transfer Stations	5	2 stations	5	2 stations	5	2 stations	5	0	1

No.	Evaluation item	Weighting	Alt. 1 (RED)		Alt. 2 (ORANGE)		Alt. 3 (YELLOW-GREEN)		Alt. 4 (LIGHT BLUE)	
9	Elimination of areas lacking railway service	**-**	-		-		-		-	
Environmental and Social considerations										
10	Land acquisition	**10**	0.15 ha	**10**	0.15 ha	**10**	0.24 ha	**6.3**	0.65 ha	**2.3**
11	No. of affected structures	5	4 Bldgs.	5	4 Bldgs.	5	6 Bldgs.	3.3	10 Bldgs.	3.0
12	No. of affected households	**10**	0	**10**	0	**10**	24 HHs	**1**	24 HHs	**1**
13	Impact on World Heritage Areas	**15**	Alg.: Passing through protected area and buffer zone. Station: CSMT Metro and Horniman Circle are located within protected area.	**5.6**	Alg.: Passing through protected area and buffer zone. Station: CSMT Metro St. and Horniman Circle St. are located within protected area.	**5.6**	Alg.: Passing through protected area and buffer zone. Station: CSMT Metro St. is located within buffer zone.	**11.3**	Alg.: Passing through buffer zone. Station: CSMT East St. and Horniman Circle St. are located within buffer zone.	**11.3**
14	Impact on Protected Natural Areas	-	-	-	-	-	-	-	-	-
15	No. of logged tree	5	25 trees	5	25 trees	5	65 trees	1.9	52 trees	2.4
16	Reduction of GHG Emissions	5	306 t-CO_2/day	5	306 t-CO_2/day	5	200 t-CO_2/day	3.3	165 t-CO_2/day	2.7
Total		**95**	**Recommended**	**78.3**		76.2		64.5		53.1

***** For the items in bold, the scores are calculated at twice or triple the usual weighting.

Source: JST



Source: JST based on Google Earth

Figure 4.5.9 Detailed alignment alternatives from CSMT World Heritage area to Horniman Circle

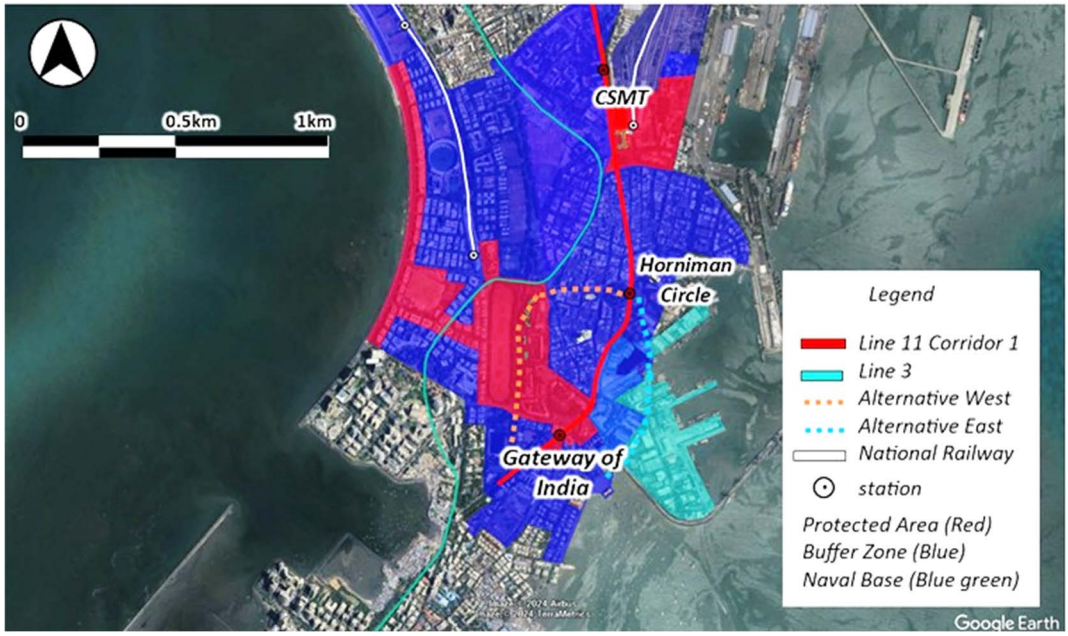
(5) Gateway of India St.

Gateway of India Station serves as the terminus located within the UNESCO World Heritage area. Regarding the alignment from Horniman Circle St. to Gateway of India St., three alternatives were considered, as shown in the figure below: the recommended alignment from preliminary alignment study (RED), a western passing route (ORANGE), and an eastern passing route (LIGHT-BLUE).

As a result, the eastern route, which avoids the VADEM protected area of the World Heritage site, was found to be practically unfeasible for construction. Therefore, selecting the recommended alignment, which has an advantage in terms of demand, was deemed appropriate.

- Recommended alignment (RED): This route passes through both the VADEM protected area and the buffer zone of the World Heritage site, requiring mitigation measures and construction methods to avoid impacts on designated structures.
- Western Route (ORANGE): Similar to RED route, this route also passes through the VADEM protected area and buffer zone of the World Heritage site. Additionally, it overlaps with the alignment of Line 3, which may lead to passenger dispersion, making it unlikely to generate significant ridership.
- Eastern Route (LIGHT-BLUE): While this route only passes through the VADEM buffer zone and avoids impacts on designated structures, it extends towards the coastal area, which is

designated as a Naval Base. Therefore, construction is considered infeasible. (For Corridor 2 of Line 11, Navy Nagar Station was deemed feasible for construction, as it serves a military residential area where the metro demand is high.)



Source: JST based on Google Earth

Figure 4.5.10 Detailed alignment alternatives from Horniman Circle to Gateway of India

Based on the recommended alignment mentioned above, a comparative study was conducted on three alternatives regarding the location of Gateway of India Station, as shown in the figure below: one within the protected area and two outside it.

- Alt. 1 (ORANGE): Positioned crossing the World Heritage protected area.
- Alt. 2 (LIGHT-BLUE): Located further south than Alt. 1, within the buffer zone.
- Alt. 3 (YELLOW-GREEN): Located further north than Alt. 1, also within the buffer zone.



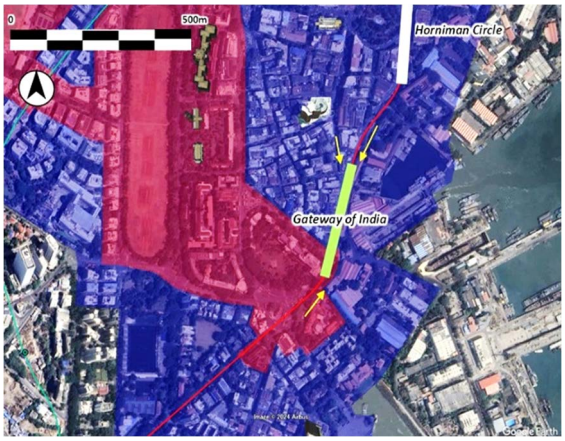
Source: JST based on Google Earth

Figure 4.5.11 Gateway of India St. Location – Alt. 1 (ORANGE)



Source: JST based on Google Earth

Figure 4.5.12 Gateway of India St. Location – Alt. 2 (LIGHT-BLUE)



Source: JST based on Google Earth

Figure 4.5.13 Gateway of India St. Location – Alt. 3 (YELLOW-GREEN)

The results of the comparison of the three alternatives based on convenience, construction impact, and environmental & social considerations are summarized in the table below. Alt. 1 is located within the World Heritage protected area; however, it has the least impact on affected structures and households. Additionally, it received the highest evaluation for convenience, making it the recommended option.

Table 4.5.11 Alternative Analysis for the Location of Gateway of India St.

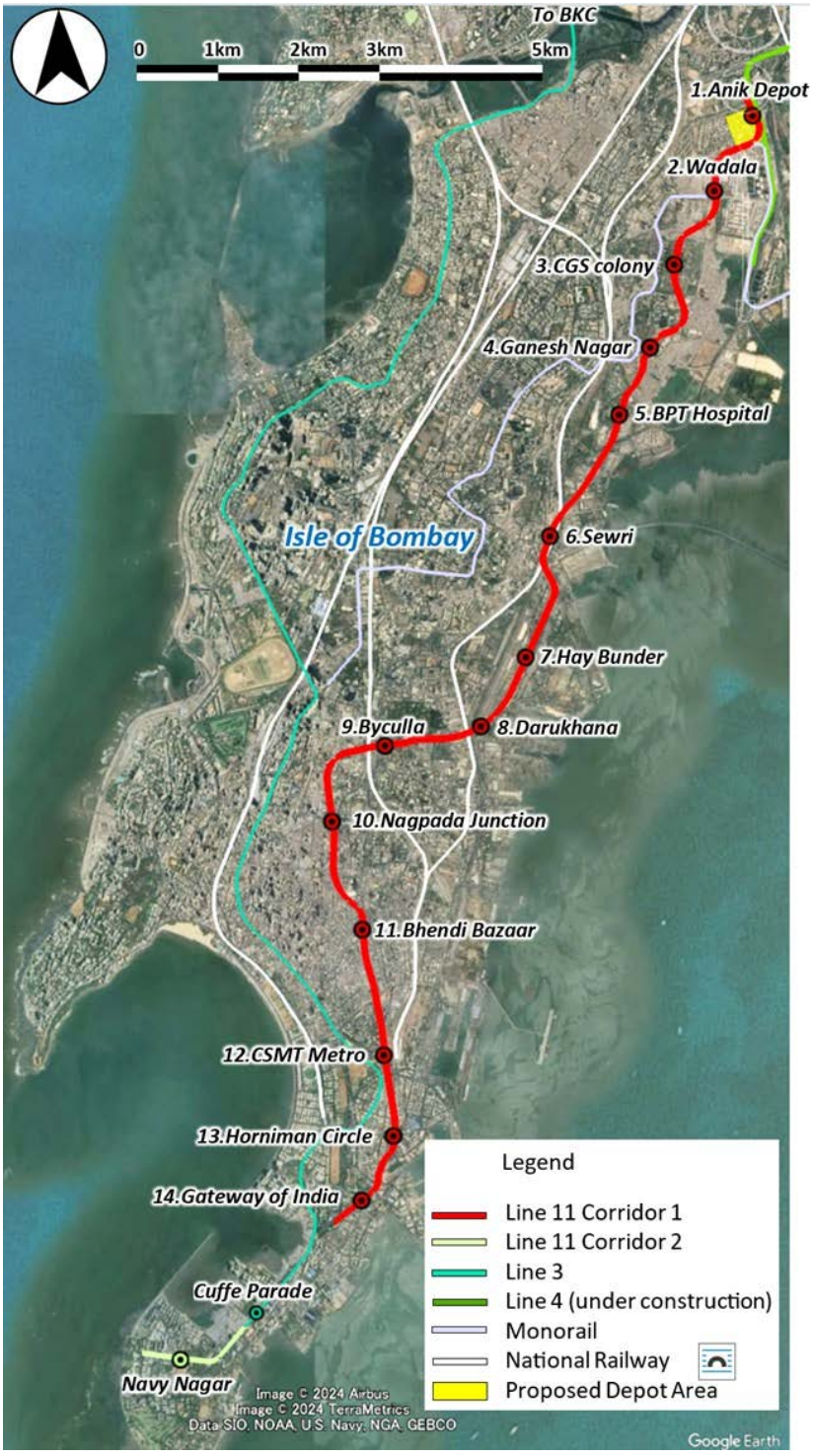
No.	Evaluation item	Weighting	Alt. 1 (ORANGE)		Alt. 2 (LIGHT-BLUE)		Alt. 3 (YELLOW-GREEN)	
Social and economic								
1	Impact on traffic during construction	5	Construction at high-traffic intersection, leading to significant congestion impact	2.5	Relatively low traffic, so the impact on congestion is relatively minor	5	Relatively low traffic, so the impact on congestion is relatively minor	5
2	**Convenience for passenger**	**10**	Improved convenience by creating an entrance in the block north of the station where tourist attractions are concentrated (about 50m). Relatively good access to Gateway of India (about 420m), leading to expected tourist demand.	10	Far from the blocks in the north and northeast where tourist attractions are concentrated (about 200m), making it less convenient compared to alt. 1 and 3. Access to Gate of India (about 430m), is slightly farther than alt. 1.	6.1	Improved convenience by creating an entrance in the block north of the station where tourist attractions are concentrated (about 50m). Access to Gateway of India (about 530m), is farther compared to alt. 1.	9

No.	Evaluation item	Weighting	Alt. 1 (ORANGE)		Alt. 2 (LIGHT-BLUE)		Alt. 3 (YELLOW-GREEN)	
3	**Passenger demand**	**10**	Located in the central city area, ensuring demand can be secured.	**10**	Located in a residential area, ensuring relatively secured demand.	**9**	Since it is only about 550 meters away from Horniman Circle St., there is an overlap in station's catchment area.	**7.5**
Environmental and Social Considerations								
4	No. of affected structures	5	0	5	10 Bldgs.	1	11 Bldgs.	1
5	**No. of affected households**	**10**	0	**10**	75 HHs	**1**	50 HHs	**1**
6	**Impact on World Heritage Areas**	**15**	Construction within World Heritage protection area	**3**	Partially within World Heritage protection area, mainly within the buffer zone	**15**	Partially within World Heritage protection area, mainly within the buffer zone	**15**
7	No. of logged tree	5	5 trees	5	30 trees	1	5 trees	5
Total		**55**	**Recommended**	**46**		**38.1**		**43.5**

* For the items in bold, the scores are calculated at twice or triple the usual weighting.

Source: JST

Based on the above, the overall alignment and depot location selected as the recommended option are as shown in the figure below.



Source: JST based on Google Earth

Figure 4.5.14 Selected recommendeda altenative for Corridor 1 & depot of Line 11

4.6 Screening and Scoping Plan for Environmental and Social Considerations

This section outlines the screening and scoping plan and survey TOR based on the environmental and social positive and negative impacts expected from the prioritized alternatives, using information obtained from field surveys and existing literature.

4.6.1 Scoping

The primary environmental and social considerations for this project are the construction of the underground tracks, station buildings, and the depot for Corridor 1 of Line 11. The impact factors, affected items, and the extent of the impacts, which are the results of scoping, are shown in the table below. Additionally, scoping results for related facilities, such as quarries, borrow pits, disposal sites, and casting yards needed during the construction phase, are also presented. The evaluation is based on the pre-construction and construction phases. For quarries and borrow areas, the responsibility for developing environmental management and monitoring plans lies with the project proponent, MMRC and their construction contractor. Subsequently, based on the detailed design by the project proponent, the construction contractor will develop the construction plan, including details of the related facilities, and once approved by Government of India, the contractor will begin using the related facilities. Meanwhile, as candidate locations for disposal sites and casting yards have already been narrowed down, as described below, the environmental and social impact assessment has been carried out on the assumption that these identified candidate sites will be utilized.

Table 4.6.1 Scoping for the Facilities Construction including depot of Corridor 1, Line 11

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
Pollution				
1	Air pollution	✓		**CS:** Emission gas (NOx, SOx) and dust ($PM_{2.5}$, PM_{10}) are caused temporarily by some heavy machines and dump trucks. **OS:** Positive impact will be offered by the decrease of traffic along the Corridors.
2	Water Quality	✓	✓	**CS:** - Turbid water will be generated in surface water and ground water along the Corridors due to civil and excavation works. - There is a possibility of being discharged with organic wastewater at an installed base campsite. **OS:** There is a possibility of organic wastewater discharged from the toilet installed at every station and the depot.
3	Waste	✓	✓	**CS:** - It is predicted that construction waste such as soil and logged trees is generated. - General waste and excreta will be generated from the base campsite. **OS:** General waste and excreta will be generated from every station and a depot, etc.
4	Soil contamination	✓	✓	**CS:** -Excavated soil at the construction site may be contaminated. - Oil leaks from constriction equipment may cause soil contamination. **OS:** Soil contamination may be generated at the proposed depot due to oil leaks of heavy machine and rolling stock coating.
5	Noise and vibration	✓	✓	**CS:** Noise and vibration will be generated by heavy construction machines, dump trucks, concrete placing work, and traffic congestion due to traffic control. **OS:** Mumbai Metro can contribute to reducing traffic noise and vibration through traffic volume reduction, but Mumbai Metro may emit additional noise and vibration from its operation.
6	Ground subsidence	✓	✓	**CS/OS:** Construction activities that have a negative impact on underground water such as large-scale digging and water pumping are not scheduled in this project. But there is still a possibility of ground subsidence in case the foundation under the elevated section is soft.
7	Offensive odor	✓	✓	**CS:** Offensive odor may be emitted depending on the volume of general waste from basecamp sites. **OS:** Offensive odor may be emitted depending on the volume of general waste from every station and depot.
8	Bottom Sediment			**CS/OS:** The section does not involve crossing a river, so no impact on the sediment is expected.
Natural Environment				
	Protected area			**CS:** Although the Mahul - Sewree Creek area is a protected zone, there is an industrial

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
9		✓		area and port zone between Corridor 1 of Line 11 and the protected area. Due to the existing activities in that area, the impact of the project is considered minimal. **OS:** Since the entire section is underground, the metro operation is not expected to have any impact on the protected area.
10	Biodiversity	✓	✓	**CS:** Construction of underground stations and the depot may impact the ecosystem through tree logging. **OS:** Insufficient maintenance of planted trees may lead to a reduced survival rate.
11	Hydrology	✓		**CS:** Construction activities that have a negative impact on underground water such as large-scale digging and water pumping are not scheduled in this project. However, some impact on hydrology around the project site will occur in case of high groundwater level. **OS:** Construction activities which have a negative impact to underground water, such as large- scale digging and water pumping, are not scheduled.
12	Geology and Topography	✓	✓	**CS/OS:** No significant geomorphological or geological features are present in the project area; however, the assessment is carried out on the basis of the natural condition survey results.
Social Environment				
13	Land acquisition/ Resettlement	✓		**Pre-CS:** It is predicted that there are land acquisition and resettlement along the Corridors and in Depot area. **OS:** Since there is no land acquisition during operation, there is no expected impact.
14	Poverty	✓		**Pre-CS:** Impact will be evaluated based on the characteristics of the local community around the project area. In the case of displacement of residents from slum areas, there is a potential risk of negative effects on their livelihood at the relocation sites. **OS:** Since no land acquisition is required during operation, activities that could negatively affect the impoverished population are not anticipated.
15	Indigenous and ethnic people	✓		**Pre-CS:** The impact on indigenous and ethnic people is evaluated based on characteristics of local society around the project area. **OS:** Since land acquisition and resettlement will be completed before construction, operation activities that have a negative impact on indigenous and ethnic people are not expected.
16	Local economy such as employment and livelihood, etc.	✓		**Pre-CS/CS:** - A negative impact on the livelihood of PAPs may be generated depending on land acquisition and resettlement. - With opening of Mumbai Metro, drivers of route buses and three wheelers, which are overlapping their operation area of transportation, may suffer negative impacts on their livelihoods. **OS:**- New employment may be created with opening of Mumbai Metro. - A positive impact for the local economy will be generated such as timesaving for traveling within Mumbai city and alleviation of traffic congestion.
17	Land use and utilization of local resources	✓	✓	**CS:** Land acquisition within Mumbai Metro stations and a depot may occur, potentially leading to negative impacts. **OS:** Although land acquisition or similar issues will not arise during operation, there is a potential risk of negative impacts due to haphazard development along the railway line, particularly around the stations, as well as the use of local resources.
18	Water use and its rights	✓		**CS:** Land acquisition and construction work may affect drinking water sources such as wells. **OS:** Since land acquisition and similar activities will not occur during operation, there will be no impact on water usage. However, irrigation facilities and drinking water infrastructure (such as water supply systems and wells) located within the project area (underground, track, station buildings, and a depot) may be affected during the construction period. If they are not repaired or properly maintained, there is a possibility that these impacts will persist into the operational phase.
19	Existing social infrastructure and services	✓		**CS:**- A negative impact on sensitive facilities such as schools, hospitals, and community centers may occur depending on land acquisition and traffic issues such as congestion and accidents. - The impact of the relocation of underground facilities is expected due to the construction work. **OS:** Improvement of accessibility by installing Mumbai Metro stations is expected, by which there is a possibility of a positive impact on the use of social infrastructure such as school, hospital, etc.

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
20	Social institutions such as social infrastructure and local decision - making institutions			**CS:** Since the construction is mainly conducted in the central part of the existing road and underground, there is no possibility of local community severance. **OS:** There is no community severance because Mumbai metro will be constructed by underground structures for most of all sections.
21	Maldistribution of benefit and damage	✓	✓	**CS:** Due to the project area, there is a possibility that there may be uneven distribution of benefits and damages, such as road closures, detour routes, and other restrictions, depending on the location. **OS:** Opening of Mumbai Metro may impact the operating profits of bus companies and rickshaw unions that operate along the same routes.
22	Local conflict of interest	✓		**CS:** Residents and municipalities may demand that construction contractor should supply employment opportunities equally as construction workers. **OS:** It is predicted that there is no local conflict of interest because Mumbai Metro services are evenly accessible for local communities.
23	Cultural Heritage	✓	✓	**Pre-CS/CS:** At the current alignment, there is a possibility that it may pass near some historical buildings. However, the final alignment will be confirmed, and any potential impacts will be reassessed at that stage. **OS:** There is no impact on religious and historical buildings because of no-additional land acquisition at the operation stage. However, the impact of vibration from Mumbai Metro operation should be reviewed.
24	Landscape			**CS/OS:** This project is an underground development, so there is little to no expected impact on the landscape.
25	Gender	✓	✓	**CS:** There may be a gender gap regarding wage, salary, and treatment as construction workers. **OS:** Employment opportunities for women may be limited concerning Mumbai Metro operation because the opportunities may not be the same for females despite having the same qualifications and abilities as males. Additionally, female passengers may give up getting on trains for fear of congestion on the train during commuting time.
26	Children's right	✓		**CS:** Negative impact on children's rights is not estimated by the project, but the impact possibility should be evaluated based on the information collected by the field survey. **OS:** There is no impact on children's rights by Mumbai Metro operation.
27	Health (Infectious diseases such as HIV/AIDS, etc.)	✓	✓	**CS:** Infectious diseases such as STD, COVID-19, etc. may be spread by the inflow of construction workers. Additionally, Land use changes by soil cutting and soil filling may create new habitats for mosquitoes that can mediate dengue fever. **OS:** There is a possibility that STD and other infectious diseases spread by increasing the number of settlers and travellers after Mumbai Metro operation.
28	Labor environment including labor safety	✓	✓	**CS:** It is necessary to improve the labor environment for construction workers following related laws and regulations. **OS:**- There is no big change in the labor environment for residents by Mumbai Metro operation. - Appropriate labor environment for working staff needs to be secured following related laws and regulations.
Others				
29	Accidents	✓	✓	**CS:** There is a possibility of increased traffic accidents due to construction-related vehicles using the main roads along the alignment. **OS:** Risk of passenger falls from the platform
30	Cross-border impact and climate change	✓	✓	**CS:** Greenhouse gas emissions will increase slightly by cutting street trees along the Corridors, operation of construction heavy machinery, and construction of structures. **OS:** Since the traffic volume along the Corridors will reduce due to Mumbai Metro operation, the reduction of greenhouse gases can be expected. On the other hand, it is also conceivable that greenhouse gases will be generated due to the electric consumption by Mumbai Metro operation.

Note: ✓: Items to be assessed, Pre-CS: Pre-Construction Stage, CS: Construction Stage, OS: Operation Stage

Source: JST

Table 4.6.2 Scoping for the Use of Project-Associated Facilities (Borrow Areas, Disposal Sites, Quarries, and Casting Yards)

No.	Impact item	Evaluation	Reason for evaluation
		CS	
Pollution			
1	Air pollution	✓	Nitrogen oxides (NOx), sulfur oxides (SOx), and particulate matter (PM_{10} and $PM_{2.5}$) are generated temporarily due to the operation of certain construction machinery and dump trucks.
2	Water Quality	✓	If the drainage is undeveloped, it may affect the surrounding water sources during rainfall.
3	Waste	✓	Surplus materials will be generated.
4	Soil contamination	✓	Temporary soil contamination due to oil leakage may be caused by using fuel for heavy machines and vehicles.
5	Noise and vibration	✓	Noise and vibration are caused by construction heavy machinery and dump trucks.
6	Ground subsidence		No activity that will cause land subsidence is expected.
7	Offensive odor	✓	Potential generation of offensive odors affecting the surrounding area, depending on the type of waste and the storage method and duration.
8	Bottom Sediment		No activity that will deteriorate bottom sediment is expected.
Natural Environment			
9	Protected area	✓	If there are protected areas in the vicinity of the related facilities, it may affect the conservation area.
10	Biodiversity	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and the ecosystem may be affected. There is also a possibility of logging trees.
11	Hydrology		No activity that will cause changes to hydrology is expected.
12	Geography and topography	✓	If the valuable geography and topography exist in the vicinity of the related facilities, it may affect geography and topography.
Social Environment			
13	Land acquisition/ Resettlement		As a basic policy, the registered site by the local government should be utilized, so there will be no land acquisition, resettlement or economic displacement.
14	Poverty	✓	If there are impoverished communities living in the vicinity, potential impacts could be anticipated.
15	Indigenous and ethnic people	✓	If there are ethnic minorities or indigenous communities living in the vicinity, potential impacts could be anticipated.
16	Local economy such as employment and livelihood, etc.		No activity that will impact on local economy and livelihood is expected.
17	Land use and utilization of local resources	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and Land use and utilization of local resources may be affected.
18	Water use and its rights	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and water use and its rights may be affected.
19	Existing social infrastructure and services	✓	Existing roads, schools, hospitals, and community centers may be temporarily affected due to frequent dump truck traffic.
20	Social institutions such as social infrastructure and local decision - making institutions		No activity that will impact social institutions is expected.
21	Maldistribution of benefit and damage		No activity that will impact distribution of benefit and damage is expected.
22	Local conflict of interest	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and local conflict may occur between the owner and residents.
23	Cultural Heritage	✓	Some negative impacts may occur if there is a cultural heritage near the project area.
24	Landscape	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and the landscape may be affected.
25	Gender		No activity that will impact on gender is expected.

No.	Impact item	Evaluation	Reason for evaluation
		CS	
26	Children's right		No activity that will impact on children's rights is expected.
27	Health (Infectious diseases such as HIV/AIDS, etc.)		No activity that will impact on health is expected.
28	Labor environment including labor safety	✓	It is necessary to secure an appropriate working environment following relevant laws.
Others			
29	Accidents	✓	The use of surrounding roads by delivery and construction vehicles for Mumbai Metro project may increase the likelihood of traffic accidents.
30	Cross border impact and climate change		Cross-border impacts and impact on climate change are not expected.

Note: ✓: Items to be assessed, CS: Construction Stage

Source: JST

4.6.2 Methodology of Environmental Baseline Survey and Analysis

The contents and analysis methods of the surveys conducted by MMRC and the JICA Survey Team, as well as the survey locations and coverage areas, are presented below. In addition, in order to understand the socio-economic conditions along Corridors 1, an interview survey was conducted with 10 respondents per station, totalling 150 individuals.

Table 4.6.3 Environermental Baseline Survey and Analysis

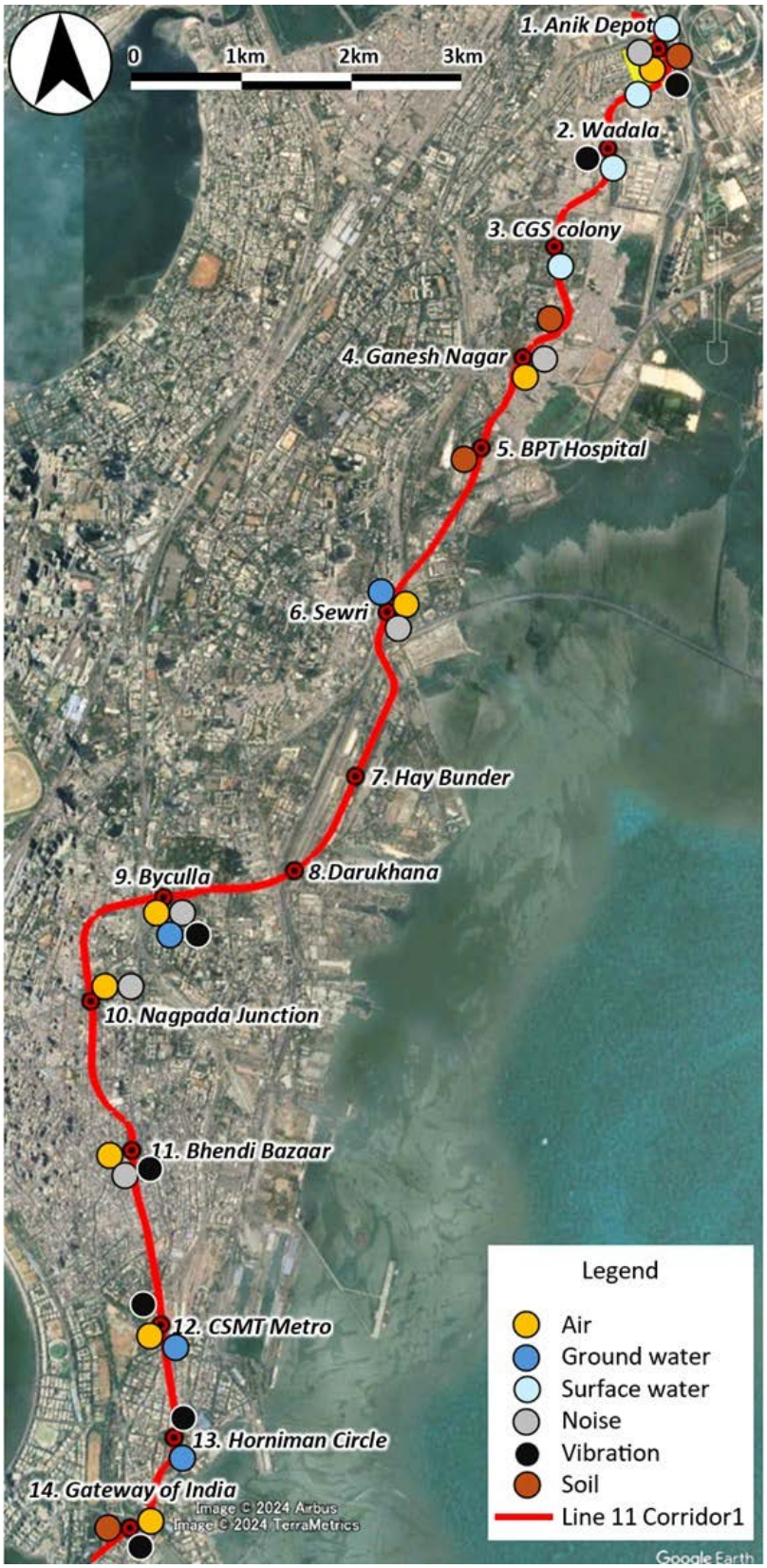
No.	Impact Item	Survey Item	Survey Analysis
Pollution Control			
1	Air Pollution	① Field survey (1) Survey Locations: Eight locations along Mumbai Metro Line 11 Corridor 1 (Anik Depot, Ganesh Nagar, Sewri, Byculla, Nagpada Junction, Bhendi Bazaar, CSMT Metro, Gateway of India) (2) Survey Items: SO_2, CO, NO_2, O_3, PM_{10}, $PM_{2.5}$ (3) Frequency: At least once each during the monsoon and dry seasons (excluding rainy days), with 24-hour measurements ② Impact During Construction	① A comparison will be made between the survey results and the existing survey results as well as the standard values. ② The contents, method, duration, and scope of the construction works, the types of construction machinery, the operation locations, the operation period, the number of construction vehicle movements, the duration, and the traffic routes will be confirmed to the extent possible.
2	Water Quality	① Field survey **Surface water** (1) Survey locations: A total of four locations such as drainage channels and rivers along Corridor 1 of Mumbai Metro Line 11 (2) Items: Colour, odour, turbidity, pH, electrical conductivity, total hardness, chloride compounds, iron, total dissolved solids, sulphate, nitrate, lead, copper, manganese, mercury, cadmium, zinc, hexavalent chromium, total alkalinity, calcium, magnesium, sodium, potassium, dissolved oxygen, BOD, COD (3) Frequency: Once each during rainy and dry seasons **Groundwater** (1) Survey locations: Eight locations along Corridor 1 of Mumbai Metro Line 11 (Anik Depot, Ganesh Nagar, Sewri, Byculla, Nagpada Junction, Bhendi Bazaar, CSMT Metro, Gateway of India) (2) tems: Colour, odour, taste, turbidity, pH, chloride compounds, iron, total dissolved solids, sulphate, nitrate, fluoride, lead, copper, manganese, phenolic compounds, mercury, cadmium, arsenic, cyanide, zinc, detergents, hexavalent chromium, total	① A comparison will be made between the survey results and the existing survey results as well as the standard values. ② The contents, method, duration, and scope of the construction works, the types of construction machinery, the operation locations, the operation period, the number of construction vehicle movements, the duration, and the traffic routes will be confirmed to the extent possible.

No.	Impact Item	Survey Item	Survey Analysis
		alkalinity, aluminium, boron, coliform group, coliform bacteria (3) Frequency: Once each during rainy and dry seasons ② Impacts during construction and operation phases	
3	Waste	Construction waste disposal method Note: The construction waste disposal site currently in use has been identified.	Information collection on registered construction waste disposal sites along the Line 3 corridor or, if necessary, site investigation will be conducted. In addition, interviews with relevant ministries regarding records of construction waste disposal and quantitative forecasts will be conducted.
4	Soil Contamination	① Field survey (1) Survey locations: 8 locations along Corridor 1 of Mumbai Metro Line 11 (Anik Depot, Ganesh Nagar, Sewri, Byculla, Nagpada Junction, Bhendi Bazaar, CSMT Metro, Gateway of India) (2) Items: pH, electrical conductivity, lead, mercury, cadmium, arsenic, cyanide, hexavalent chromium (3) Frequency: Once each during rainy and dry seasons ② Impacts during operation phase	① Comparison between survey results, existing survey results, and standard values ② Hearing with MMRC
5	Noise and Vibration	① Field survey (1) Survey locations: 8 locations along Corridor 1 of Mumbai Metro Line 11 (Anik Depot, Ganesh Nagar, Sewri, Byculla, Nagpada Junction, Bhendi Bazaar, CSMT Metro, Gateway of India) (2) Items: Environmental noise (LAeq, 24 hours continuous / weekdays), Environmental vibration (24 hours / weekdays) Note: In addition, surveys will be conducted in front of 1 to 5 structures that are particularly susceptible to impacts (villages, schools, hospitals, etc.) (3) Frequency: Once (dry season) ② Noise and vibration levels during construction and operation phases in representative sections ③ Impacts during construction phase	① Comparison between survey results, existing survey results, and standard values ② Noise: Quantitative prediction (At the road boundary of representative elevated sections and at locations requiring consideration – Traffic noise / LAeq dB(A)) Vibration: Quantitative prediction (At the road boundary of representative underground sections and at locations requiring consideration – Traffic vibration / Lv dB) ③ As much as possible, confirmation of construction details, methods, duration, scope, types of construction machinery, operating positions, operating durations, number of construction vehicles in operation, duration, and travel routes
6	Land Subsidence	Impacts during construction phase	Utilization of results from previously conducted topographic surveys and subsurface ground investigations, as well as hearing with MMRC.
7	Offensive Odors	Impacts during construction and operation phases	Information collection regarding offensive odors expected to be generated from base camps, stations, and depots.
Natural Environment			
8	Protected Areas	Impacts during construction and operation phases	Information collection on protected areas (Sewri Creek)
9	Biodiversity	① Field survey (1) Survey area: Within 100 meters on both sides from the alignment of Corridor 1 of Metro Line 11 (2) Survey items: Terrestrial flora and fauna affected by the construction project, species names, scientific names, IUCN, Red List, distribution maps, identification photos, nesting, spawning status. Especially, Sisav (Dalbergia latifolia), Sita Ashok (Saraca asoca) are to be surveyed. (3) Frequency: Once each in rainy and dry seasons Note: Interviews with experts or professors shall be conducted as necessary. ② Confirmation of land use patterns	①② Information collection through existing data review and field survey

No.	Impact Item	Survey Item	Survey Analysis
10	Tree counting	① Field survey (1) Survey area: Review of species and number of trees to be relocated or felled due to station and depot construction of Corridor 1 of Metro Line 11 (2) Survey items: Number of each tree species and IUCN Red List (3) Frequency: Once Note: For species categorized as VU or higher (including CR, EN) on the IUCN list, location information shall also be included (e.g., Dalbergia latifolia and Saraca asoca). Interviews with experts or professors shall also be conducted as necessary.	Utilization of existing survey data and hearing with MMRC
11	Hydrology	① Survey on past flood and inundation history ② Impacts during construction phase	① Information collection ② Utilization of results from previously conducted topographic surveys and subsurface ground investigations, as well as hearing with MMRC
12	Topography and Geology	Impacts during construction phase	Utilization of results from previously conducted topographic surveys and subsurface ground investigations, as well as hearing with MMRC
Social Environment			
13	Land acquisition/ Resettlement	Refer to "B.[Land Acquisition and Resettlement]"	
14	Poverty	Impact on Poverty	Utilization of interview survey results and social impact survey results
15	Indigenous and ethnic people	Refer to "B.[Land Acquisition and Resettlement]"	
16	Local economy such as employment and livelihood, etc.	Impact on employment and livelihoods in the local economy	Utilization of existing data and interview survey results
17	Land use and utilization of local resources	Confirmation of land use and local resource use	Utilization of existing data and interview survey results
18	Water use and its rights	Confirmation of water use conditions by residents along the alignment	Utilization of existing data and interview survey results
19	Existing social infrastructure and services	① Field Survey (1) Survey Area: Within approximately a 200-meter radius along the Corridors 1 of Mumbai Metro Line 11 (2) Survey Items: Distribution of hospitals, schools, religious sites, community centers, etc. (including interview surveys) (3) Frequency: Once ② Distribution of Underground Utilities	① Utilization of existing data, on-site inspections, and results from interview surveys ② Utilization of existing CAD data
20	Social institutions such as social infrastructure and local decision - making institutions	① Restrictions on Road Crossings and Setting of Detour Routes ② Collection of Opinions from Bus Companies and Rickshaw Unions Regarding This Project	Utilization of existing data, interview survey results, and social impact survey results
21	Local conflict of interest	Impact on Conflicts of Interest within the Community	Utilization of existing data and interview survey results
22	Cultural Heritage	Cultural and Historical Heritage in the Vicinity of the Project Area	Utilization of existing data and interview survey results
23	Gender	Refer to "B.[Land Acquisition and Resettlement]"	
24	Children's right	Impact on Children's Rights	Confirmation of Relevant Domestic Laws and the Existence of Child Labor
25	Health (Infectious diseases such as HIV/AIDS, etc.)	① Incidence Rate of Infectious Diseases in the Project Area Vicinity ② Relevant Implementing Organizations	Utilization of existing data and interview survey results

No.	Impact Item	Survey Item	Survey Analysis
26	Labor environment including labor safety	① Confirmation of Relevant Indian Laws and International Standards ② Verification of Occupational Safety Measures at Construction Sites	① Information collection ② On-site inspection and interviews
Others			
27	Accidents	Number of traffic accidents and reasons for accidents along the corridor	Review of existing documents and on-site surveys. Where possible, interviews will be conducted with local police stations or municipal authorities within the jurisdiction.
28	Cross border impact and climate change	Estimation of greenhouse gas emissions and reduction amounts resulting from this project	Utilization of collected data and interviews with MMRC, as well as application of JICA Climate FIT.
29	Soil Borrow Pits, Disposal Sites, and Construction Yards	Basic information including total capacity, remaining capacity, year of registration, owner, photographic documentation, name of permits, responsible agencies, and details of administrative procedures Note: Hearings with relevant ministries regarding the actual performance of waste disposal will also be conducted.	Information will be collected, or site surveys will be conducted as necessary, for registered borrow pits, disposal sites, and construction yards along Mumbai Metro Line 11 Corridors 1 and 2.
30	Stakeholder Meeting	Public consultations will be conducted jointly with the social environment survey.	

Source: JST



Source: Prepared by the JST based on Google Earth

Figure 4.6.1 EIA Survey Locations and Survey Area of Metro Line 11 Corridor 1

4.7 EIA Survey Results

The MMRC conducted studies on various environmental and social impact considerations, and the EIA/SIA reports for Corridor 1 of Line 11 were shared with the JICA Survey Team in January 2025. The Survey Team thoroughly reviewed these EIA/SIA reports and conducted supplementary investigations from March to July 2025. Subsequently, an updated version was also shared by MMRC in July 2025. The consolidated are presented below.

4.7.1 Pollution Control

4.7.1.1 Air Pollution

(1) Survey

In Mumbai, ambient air quality measurements were conducted most recently by the World Health Organization (WHO) in 2018 and 2019. In particular, with respect to PM_{10}, Mumbai was ranked 41st and 81st from the bottom among approximately 5,000 cities worldwide, recording concentrations of 165 µg/m³ in 2018 and 125 µg/m³ in 2019, respectively[42]. However, under the National Clean Air Programme (NCAP), launched across India in 2019, the Government set a target of reducing PM_{10} levels by 40% from 2017 values by 2026. In Mumbai, the PM_{10} concentration in 2017 was 161 µg/m³, whereas the preliminary figure for 2024 is 94 µg/m³, reflecting a reduction of approximately 42%, which indicates that the NCAP target has already been achieved. Nevertheless, the National Ambient Air Quality Standards (NAAQ) annual average target of 60 µg/m³ has not yet been met, and efforts to further improve air quality are ongoing.

With respect to the surveys, for Corridor 1 of Line 11, the dry season survey was conducted in May and November 2024 and the monsoon season survey in June 2025. Regarding PM_{10} and $PM_{2.5}$, concentrations at all locations along Corridor 1 exceeded the environmental standards during the dry season, with some locations recording more than 1.5 times the standard value. However, for all other parameters, concentrations at all monitoring locations were below the standard values, indicating an improving trend in air quality. The main sources of air pollution include the rapid population growth and the consequent increase in vehicular emissions, traditional cooking practices, operations of thermal power plants, and smoke emissions from brick production. However, apart from vehicular traffic along the project corridor, there are no major pollution-emitting facilities located within the project area. In India, the standards for ambient air quality are stipulated under the notification issued by the Central Pollution Control Board (CPCB) dated 18 November 2009.

[42] WHO Air Quality Database (Update 2022), WHO

Table 4.7.1 Survey results and applicable ambient air quality standards in India (Unit: µg/m³)

Measurement location/Period			Parameter	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO	O_3
Unit				µg/m³	µg/m³	µg/m³	µg/m³	mg/m³	µg/m³
A-1	1. Anik Depot	2nd – 24th, May, 2024 (Dry season)	Min	98.00	59.00	11.00	16.00	0.62	-
			Max	**138.00**	**84.00**	17.00	21.00	0.78	-
			Average	**118.25**	**70.63**	13.75	18.38	0.71	-
			98%	**137.02**	**83.16**	16.86	20.86	0.78	-
A-2	2. Ganesh Nagar		Min	**101.00**	58.00	16.00	14.00	0.63	-
			Max	**144.00**	**88.00**	22.00	23.00	0.81	-
			Average	**123.13**	**72.25**	19.13	18.50	0.73	-
			98%	**143.02**	**87.16**	21.86	22.72	0.81	-
A-3	3. Sewri		Min	**136.00**	**86.00**	12.00	17.00	0.73	-
			Max	**177.00**	**111.00**	18.00	24.00	0.87	-
			Average	**153.38**	**97.38**	14.75	20.50	0.79	-
			98%	**175.74**	**110.16**	17.86	23.86	0.87	-
A-4	4. Byculla		Min	92.00	54.00	9.00	14.00	0.72	-
			Max	**122.00**	**78.00**	14.00	21.00	0.82	-
			Average	**105.38**	**66.88**	11.25	17.50	0.77	-
			98%	**121.44**	**77.58**	13.86	20.86	0.81	-
A-5	5. Nagpada Junction		Min	**101.00**	54.00	14.00	12.00	0.66	-
			Max	**136.00**	**81.00**	21.00	22.00	0.80	-
			Average	**117.50**	**65.63**	17.50	16.88	0.73	-
			98%	**134.88**	**79.74**	20.86	21.72	0.80	-
A-6	6. Bhendi Bazaar		Min	80.00	41.00	18.00	20.00	0.49	-
			Max	**172.00**	**112.00**	24.00	28.00	0.68	-
			Average	**121.00**	**77.38**	21.00	23.63	0.56	-
			98%	**167.94**	**110.46**	23.86	27.72	0.67	-
A-7	7. CSMT Metro		Min	**102.00**	**62.00**	11.00	16.00	0.69	-
			Max	**142.00**	**89.00**	18.00	26.00	0.82	-
			Average	**119.25**	**75.75**	14.50	20.88	0.74	-
			98%	**140.32**	**88.44**	17.86	25.72	0.82	-
A-8	8. Gateway of India		Min	76.00	43.00	6.00	9.00	0.51	-
			Max	**108.00**	**61.00**	11.00	14.00	0.63	-
			Average	90.88	53.00	8.38	11.50	0.58	-
			98%	**107.02**	**60.72**	10.86	13.86	0.63	-
A-1	1. Anik Depot	2nd Oct– 29th, Nov, 2024 (Dry season)	Min	**109.00**	53.00	13.00	19.00	0.62	35.48
			Max	**145.00**	**94.00**	22.00	31.00	0.99	54.47
			Average	**126.38**	**76.06**	17.25	24.25	0.81	45.74
			98%	92.80	21.70	30.70	0.99	92.80	54.37
A-2	2. Ganesh Nagar		Min	**116.00**	53.00	14.00	19.00	0.63	33.62
			Max	**152.00**	**96.00**	23.00	32.00	0.90	53.76
			Average	**131.31**	**79.88**	19.13	25.88	0.78	42.19
			98%	**149.90**	**94.50**	23.00	31.70	0.90	53.17
A-3	3. Sewri		Min	**135.00**	**77.00**	12.00	21.00	0.66	30.74
			Max	**177.00**	**110.00**	21.00	29.00	0.98	52.63

Measurement location/Period			Parameter	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO	O_3
Unit				µg/m³	µg/m³	µg/m³	µg/m³	mg/m³	µg/m³
			Average	**156.44**	**91.31**	17.75	25.50	0.85	39.67
			98%	**175.80**	**109.40**	20.70	29.00	0.97	52.40
A-4	4. Byculla		Min	95.00	52.00	11.00	18.00	0.69	30.23
			Max	**135.00**	**88.00**	20.00	30.00	0.96	49.41
			Average	**116.50**	**72.31**	15.63	24.56	0.84	39.67
			98%	**134.10**	**86.80**	19.70	29.70	0.95	48.64
A-5	5. Nagpada Junction		Min	91.00	51.00	11.00	17.00	0.67	35.99
			Max	**130.00**	**85.00**	21.00	32.00	0.96	57.16
			Average	**108.06**	**70.44**	15.56	24.31	0.84	45.10
			98%	**127.90**	**83.80**	20.70	31.40	0.96	56.10
A-6	6. Bhendi Bazaar		Min	**101.00**	45.00	14.00	20.00	0.63	29.78
			Max	**160.00**	**99.00**	25.00	33.00	0.92	47.74
			Average	**132.06**	**74.94**	18.25	27.31	0.74	38.25
			98%	**158.50**	**97.80**	24.10	32.40	0.91	47.11
A-7	7. CSMT Metro		Min	**112.00**	57.00	11.00	19.00	0.60	31.48
			Max	**140.00**	**97.00**	20.00	32.00	0.86	45.85
			Average	**123.75**	**80.44**	16.31	25.56	0.74	36.58
			98%	**139.70**	**96.40**	19.70	32.00	0.86	44.65
A-8	8. Gateway of India		Min	85.00	45.00	10.00	16.00	0.41	30.26
			Max	**131.00**	**88.00**	21.00	33.00	0.81	41.28
			Average	**109.44**	**64.56**	15.88	22.56	0.63	34.27
			98%	**129.80**	**86.20**	20.70	32.40	0.79	41.12
A-1	1. Anik Depot	June, July, 2025 (Rainy season)	24hours	60.29	20.3	16.14	18.54	0.68	8.7
A-2	2. Ganesh Nagar			40.1	10.4	12.3	19.8	0.65	12.2
A-3	3. Sewri			69.2	28.5	15.8	22.4	0.7	9.3
A-4	4. Byculla			46.3	15.14	10.21	14.36	0.5	14.5
A-5	5. Nagpada Junction			63.42	20.46	15.22	25.78	0.62	11.87
A-6	6. Bhendi Bazaar			60.28	21.34	16.35	23.93	0.52	15.3
A-7	7. CSMT Metro			68.1	22.5	13.3	22.8	0.68	10.1
A-8	8. Gateway of India			48.7	16.2	10.2	15.4	0.36	14.31
CPCB 2009				100 (24hrs)	60 (24hrs)	80 (24hrs)	80 (24hrs)	2 (8hr)	100 (8hrs)
WHO				150 (24hrs)	75 (24hrs)	125 (24hrs)	120 (1hr)	-	60 (8hrs)

Note: Exceedances of the standard values are indicated in bold.

Source: Draft EIA report for Mumbai Metro Line-11, Aug, 2024, MMRC, EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC, Central Pollution Control Board Notification dated 18th Nov. 2009/ WHO global air quality guidelines (AQG), WHO

1) Particulate Matter (PM_{10} and $PM_{2.5}$)

PM_{10} refers to particulate matter with a diameter of 10 µm or less, and $PM_{2.5}$ refers to particulate matter with a diameter of 2.5 µm or less. $PM_{2.5}$ is generally defined as fine particulate matter. The main components of particulate matter are sulfates, nitrates, ammonia, sodium chloride, black carbon, mineral dust, water, etc., and it consists of a complex mixture of organic and inorganic solid and liquid particles suspended in the air. Dust was monitored through continuous 24-hour measurement

of PM_{10} and $PM_{2.5}$. As a result of the dry season survey, it was confirmed that PM_{10} and $PM_{2.5}$ exceeded the national standards at most sites in Corridor 1.

2) Carbon Monoxide (CO)

Carbon monoxide is a tasteless, odourless toxic gas that is mainly generated from incomplete combustion of carbon. That is, when there is insufficient oxygen to produce carbon dioxide (CO_2), only half the oxygen binds with carbon, resulting in the formation of carbon monoxide. It is also generated from the combustion of fossil fuels, automobile exhaust, and industrial smoke. Inhalation of carbon monoxide impedes the transport of oxygen in the bloodstream, resulting in cellular and tissue dysfunction due to oxygen deficiency. Excessive inhalation can lead to death. The 8-hour concentration of carbon monoxide was below the national standard of 2 mg/m³ at all sites in both seasons.

3) Nitrogen Dioxide (NO_2)

Nitric oxide (NO) and nitrogen dioxide (NO_2) are the major nitrogen oxides. They are generated by vehicle operation and maintenance, as well as from private power generation equipment. Human effects depend on nitrogen and oxygen concentration, reaction time, temperature, etc., and excessive intake of nitrogen oxides may cause bronchitis and edema. According to the MMRC's survey, 24-hour continuous monitoring of NO_2 concentrations in the environment was conducted, and all sites recorded levels below the national standard of 80 μg/m³.

4) Sulphur Dioxide (SO_2)

The main sources of sulfur dioxide include combustion of fuels such as oil, production of chemical products, and automobile exhaust. In severe cases, respiratory diseases and inflammation of the throat and eyes may occur. Sulphur dioxide concentrations were measured continuously over 24 hours at each site, and when comparing the average concentrations with the national standards, all sites recorded levels below the standard of 80 μg/m³.

(2) Prediction

Quantitative predictions were considered, but due to the lack of general environmental data in India—such as wind direction and speed, solar radiation, atmospheric radiation, cloud cover, and atmospheric stability—it was not possible to evaluate the reliability of the predictive results. Therefore, qualitative predictions were carried out.

1) Construction phase

Given the current air environment in Mumbai, heavy machinery and trucks may cause further traffic congestion and deterioration of air quality; however, the impact is not expected to be severe for the following reasons:

- All underground stations will be constructed either on private or public land, or beneath arterial roads and narrow streets. In order to avoid worsening traffic congestion caused by the operation of heavy machinery, measures such as nighttime operations and the provision of

detour routes will be implemented, thereby limiting the overall impact.

- Work procedures will be arranged so that the operation of construction machinery does not concentrate for long periods at fixed locations.
- In cases where road closures are unavoidable, detours will be planned in advance through detailed review.

In addition to the above, mitigation measures will be taken to avoid deterioration of air quality, such as the adoption of low-emission heavy machinery and trucks, avoiding unnecessary engine idling, regular sprinkling of water, and installation of fences.

2) Operation phase

With the increasing population of Mumbai, the number of registered vehicles is expected to continue to rise, and traffic volume along the Mumbai Metro Line 11 corridor is also expected to increase. However, after the metro becomes operational in 2031, a modal shift from private cars and buses to the metro is expected, leading to a temporary decrease in traffic volume along the corridor. Furthermore, in order to alleviate current traffic congestion, the construction of high-standard roads and road improvement projects such as overpasses are planned along the corridor, suggesting that Mumbai's air quality will improve. Also, since no air pollutants will be emitted from the metro during operation, and because the replacement of private vehicles is expected to reduce NOx and SOx emissions, Mumbai's air environment is anticipated to improve as a result.

4.7.1.2 Water Quality

(1) Survey

With respect to the groundwater survey, the dry season survey for Corridor 1 was conducted in November 2024 and the monsoon season survey in June 2025. The results are as follows. For Corridor 1, all monitoring locations during the dry season exceeded the standards for Total Dissolved Solids (TDS), Total Hardness (as $CaCO_3$), Chloride (as Cl^-), Calcium (as Ca^{2+}), Magnesium (as Mg^{2+}), and Manganese (as Mn). Even during the monsoon season, when constituents tend to be relatively diluted, exceedances of the standards were observed for Total Dissolved Solids, Total Hardness, Chloride, and Total Alkalinity. These findings suggest possible impacts from anthropogenic pollution such as industrial effluents and domestic sewage; however, geological factors such as the presence of rocks and minerals rich in metals, as well as seawater intrusion and salt damage, are also considered potential causes. At GW-1 and GW-3 during the monsoon season, sampling could not be conducted due to the failure of well pumps, and these locations are therefore recorded as blanks. With respect to this matter, it is observed that, due to rainfall conditions, lower values tend to be detected in the rainy season as compared to the dry season. Therefore, from the perspective of establishing threshold levels, the baseline survey is considered appropriate and acceptable. However, during the survey, considerable time was required to identify wells. The primary reason for this was that the majority of facilities and households do not utilize well water, indicating that opportunities for citizens to consume well water are almost negligible. In India, the drinking water quality standards are stipulated under IS 10500: 2018, Indian

Standard, Drinking Water — Specification.

With respect to surface water/ domestic effluent (river, sewage etc.) quality, comparison with domestic standards indicated that all parameters were below the standard values in both seasons. In India, effluent quality standards are stipulated under the General Standards for Discharge of Environmental Pollutants– PART A: Effluents in Environment (Protection) Rules, 1986.

(2) Prediction

With regard to domestic and industrial wastewater in Mumbai, observations of water quality in surrounding rivers indicate that, particularly in areas adjacent to slums, untreated effluents are discharged together with stormwater into drainage channels, which subsequently flow into rivers and lakes within the city. During the rainy season, rainwater mixed with sewage overflows within the city, leading to the deterioration of sanitary conditions. Additionally, during the excavation work for underground metro stations, turbid water may be generated if the groundwater level is high, which may lead to further water quality degradation. However, in the construction of underground stations, diaphragm walls are installed in various locations to prevent fluctuations in the groundwater level and degradation of groundwater quality, and therefore this impact is not considered to be serious.

On the other hand, at construction sites, mitigation measures to prevent deterioration of water quality, such as the installation of sedimentation tanks and drainage treatment facilities should be implemented. During operation, since organic wastewater may be discharged from toilets installed at each station and depot, drainage treatment systems will be installed at each station and depot to maintain water quality.

Table 4.7.2 Groundwater Survey Results (Dry Season) and Applicable Water Quality Standards in India

Item	Unit	Line 11 Corridor 1				Acceptable Limits (Permissible Limit) (IS 10500:2018)	WHO (drinking water)
		GW-1 Horniman Circle	GW-2 CSMT	GW-3 Byculla	GW-4 Sewri		
Turbidity,	N.T.U	< 1	< 1	< 1	**7**	1 (5)	Less than 5 N.T.U
pH at 25°C		7.5	7.4	7.6	7.2	6.5-8.5	-
Colour	Pt/Co	< 5	< 5	< 5	22	5 (15)	-
Odour	-	Agreeable	Agreeable	Agreeable	**Non-Agreeable**	Agreeable	-
Taste	-	Agreeable	Agreeable	Agreeable	**Non-Agreeable**	Agreeable	-
Total Dissolved Solid	mg/l	**1100**	**1066**	**1210**	**1442**	500 (2000)	
Total Hardness as $CaCO_3$,	mg/l	**412**	**396**	**390**	**418**	200 (600)	-
Chloride as Cl	mg/l	**254**	246	240	**266**	250 (1000)	-
Total Iron as Fe	mg/l	0.292	0.271	0.254	**0.392**	0.3	0.3
Calcium as Ca	mg/l	**84**	74	**76**	**81**	75 (200)	-
Magnesium as Mg	mg/l	**54**	**51.5**	**49**	**53**	30 (100)	-
Sulphates as SO_4	mg/l	156	152	170	184	200 (400)	250
Nitrates as NO_3	mg/l	11	9	8	22	45	50
Fluorides as F	mg/l	0.48	0.39	0.45	0.76	1.0 (1.5)	1.5
Lead as Pb	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.01
Copper as Cu	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	0.05 (1.5)	1.0
Manganese as Mn	mg/l	**0.24**	**0.22**	**0.22**	**0.28**	0.1 (0.3)	0.1
Phenolic Compound as C_6H_5OH	mg/l	NIL	NIL	NIL	NIL	0.001 (0.002)	-
Mercury as Hg	mg/l	NIL	NIL	NIL	NIL	0.001	0.001
Cadmium as Cd	mg/l	**< 0.05**	**< 0.05**	**< 0.05**	**< 0.05**	0.003	0.003
Arsenic as As	mg/l	**< 0.05**	**< 0.05**	**< 0.05**	**< 0.05**	0.01 (0.05)	0.01
Cyanide as Cn	mg/l	NIL	NIL	NIL	NIL	0.05	0.07
Zinc as Zn	mg/l	0.20	0.18	0.16	0.21	5 (15)	-
Hexavalent Chromium as Cr^{+6}	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	0.1	0.05
Sodium as Na	mg/l	164	154	158	170	-	-
Potassium as K	mg/l	11	19	12	44	-	-
Electrical Conductivity @ 25°C	µS/cm	1589	1510	1464	1638	-	-
Total Alkalinity as $CaCO_3$	mg/l	170	144	142	120	200 (600)	-
Aluminum as Al	mg/l	NIL	NIL	NIL	NIL	0.03 (0.2)	-

Item	Unit	Line 11 Corridor 1				Acceptable Limits (Permissible Limit) (IS 10500:2018)	WHO (drinking water)
		GW-1 Horniman Circle	GW-2 CSMT	GW-3 Byculla	GW-4 Sewri		
Boron as B	mg/l	NIL	NIL	NIL	NIL	0.5 (1.0)	0.5
Anionic detergents (as MBAS)	mg/l	NIL	NIL	NIL	NIL	0.2 (1)	
Coliform	MPN/100ml	NIL	NIL	NIL	**24**	-	-
Fecal Coliform	Org/ 100ml	Absent	Absent	Absent	**Present**	-	-

Source EIA report for Metro Line-11, (Anik Depot to Gateway of India), Dec, 2024, MMRC, IS 10500 : 2018 Indian Standard DRINKING WATER — SPECIFICATION / Guidelines for Drinking-water Quality, (WHO)

Table 4.7.3 Groundwater Survey Results (Rainy Season) and Applicable Water Quality Standards in India

Item	Unit	Line 11 Corridor 1				Acceptable Limits (Permissible Limit) (IS 10500:2018)	WHO (drinking water)
		GW-1 Horniman Circle	GW-2 CSMT	GW-3 Byculla	GW-4 Sewri		
Turbidity,	N.T.U	-	< 1.0	-	< 1.0	1 (5)	Less than 5 N.T.U
pH at 25°C		-	6.68	-	6.65	6.5-8.5	-
Colour	Pt/Co	-	< 5.0	-	< 5.0	5 (15)	-
Odour	-	-	Agreeable	-	Agreeable	Agreeable	-
Total Dissolved Solid	mg/l	-	**880**	-	**1600**	500 (2000)	
Total Hardness as $CaCO_3$,	mg/l	-	**352**	-	**1090**	200 (600)	-
Chloride as Cl	mg/l	-	52	-	**685**	250 (1000)	-
Total Iron as Fe	mg/l	-	0.036	-	0.046	0.3	0.3
Sulphates as SO_4	mg/l	-	65	-	84	200 (400)	250
Nitrates as NO_3	mg/l	-	< 0.5	-	< 0.5	45	50
Fluorides as F	mg/l	-	0.32	-	0.38	1.0 (1.5)	1.5
Silver as Ag	mg/l	-	< 0.01	-	< 0.01	0.1	0.1
Lead as Pb	mg/l	-	< 0.005	-	< 0.005	0.01	0.01
Copper as Cu	mg/l	-	< 0.01	-	< 0.01	0.05 (1.5)	1.0
Total Chromium as Cr	mg/l	-	< 0.01	-	< 0.01	-	0.05
Manganese as Mn	mg/l	-	< 0.01	-	< 0.01	0.1 (0.3)	0.1
Nickel as Ni	mg/l	-	< 0.01	-	< 0.01	0.02	0.07
Phenolic Compound as C_6H_5OH	mg/l	-	< 0.001	-	< 0.001	0.001 (0.002)	-
Mercury as Hg	mg/l	-	< 0.001	-	< 0.001	0.001	0.001
Cadmium as Cd	mg/l	-	< 0.001	-	< 0.001	0.003	0.003

Item	Unit	Line 11 Corridor 1				Acceptable Limits (Permissible Limit) (IS 10500:2018)	WHO (drinking water)
		GW-1 Horniman Circle	GW-2 CSMT	GW-3 Byculla	GW-4 Sewri		
Selenium as Se	mg/l	-	< 0.005	-	< 0.005	0.01	0.01
Arsenic as As	mg/l	-	< 0.005	-	< 0.005	0.01 (0.05)	0.01
Cyanide as Cn	mg/l	-	< 0.05	-	< 0.05	0.05	0.07
Zinc as Zn	mg/l	-	< 0.01	-	< 0.01	5 (15)	-
Hexavalent Chromium as Cr^{+6}	mg/l	-	< 0.05	-	< 0.05	0.1	0.05
Total Alkalinity as $CaCO_3$	mg/l	-	**250**	-	116	200 (600)	-
Aluminum as Al	mg/l	-	< 0.01	-	< 0.01	0.03 (0.2)	-
Boron as B	mg/l	-	< 0.05	-	< 0.05	0.5 (1.0)	0.5
Barium as Ba	mg/l	-	< 0.01	-	< 0.01	0.7	1.3
Anionic detergents (as MBAS)	mg/l	-	< 0.04	-	< 0.04	0.2 (1)	
Coliform	MPN/100ml	-	Absent	-	Absent	-	-
E-Coli	MPN/100ml	-	Absent	-	Absent	-	0

Source EIA report for Metro Line-11, (Anik Depot to Gateway of India), Dec, 2024, MMRC, IS 10500 : 2018 Indian Standard DRINKING WATER — SPECIFICATION / Guidelines for Drinking-water Quality, (WHO)

Table 4.7.4 Effluent Water Survey Results (Dry Season) and Applicable Water Quality Standards in India

Item	Unit	Line 11 Corridor 1				Effluent water (Discharge of Environmental Pollutants)	Japan
		SW-1 Anik Depot North	SW-2 Anik Depot South	SW-3 Wadala	SW-4 CGS Colony		
Colour, Hazen		<5.0	<5.0	<5.0	<5.0	Agreeable	-
pH@ 25°C		6.9	6.7	7.5	7.3	5.5-9.0	5.8-8.6
Total Dissolved Solids@180°C	mg/l	430	1140	3000	3000	-	-
Calcium as Ca	mg/l	45	41.6	68.8	62.4	-	-
Chlorides as Cl^-	mg/l	65	30	1470	1400	-	-
Iron as Fe	mg/l	0.04	0.044	0.06	0.056	3.0	10
Magnesium as Mg	mg/l	19.4	34.5	157	108	-	-
Sulphate as SO_4^{2-}	mg/l	95	140	250	190	-	-
Alkalinity as $CaCO_3$	mg/l	200	250	344	270	-	-
Hardness as $CaCO_3$	mg/l	180	246	820	600	-	-
Odour		Agreeable	Agreeable	Agreeable	Agreeable	-	-
Nitrate as NO_3-	mg/l	<0.5	<5.0	<5.0	<0.5	-	-

Item	Unit	Line 11 Corridor 1				Effluent water (Discharge of Environmental Pollutants)	Japan
		SW-1 Anik Depot North	SW-2 Anik Depot South	SW-3 Wadala	SW-4 CGS Colony		
Dissolved Oxygen	mg/l	3.8	3.2	3.2	3.1	-	-
Electrical Conductance @ 25°C,	µS/cm	671.8	1781.2	4687.5	4375	-	-
Chemical Oxygen Demand	mg/l	10	40	20	40	250	160
Turbidity	N.T.U	<1.0	<1.0	<1.0	<1.0	-	-
BOD@20°C 5days	mg/l	1.8	2.1	1.6	2.2	30	160
Hexavalent Chromium as Cr^{+6}	mg/l	<0.05	<0.05	<0.05	<0.05	0.1	0.2
Copper as Cu	mg/l	0.034	0.017	<0.01	<0.01	3.0	3.0
Manganese as Mn	mg/l	<0.01	<0.01	0.506	0.461	2.0	10
Zinc as Zn	mg/l	<0.01	<0.01	0.077	0.011	5.0	2.0
Lead as Pb	mg/l	<0.005	<0.005	<0.005	<0.005	0.1	0.1
Cadmium as Cd	mg/l	<0.001	<0.001	<0.001	<0.001	2.0	0.03
Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	0.01	0.005
Iron as Fe	mg/l	0.107	0.029	0.158	0.06	-	-
Sodium as Na	mg/l	42	261	704	720	-	-
Potassium as K	mg/l	11	19	52	58	-	-
Coliform	MPN /100ml	>1600	>1600	>1600	>1600	-	-

Source: JST, THE ENVIRONMENT (PROTECTION) RULES, 1986, MoEF, Environmental Quality Standards for Water Pollution, MoE Japan

Table 4.7.5 Effluent Water Survey Results (Rainy Season) and Applicable Water Quality Standards in India

Item	Unit	Line 11 Corridor 1				Effluent water (Discharge of Environmental Pollutants)	Japan
		SW-1 Anik Depot North	SW-2 Anik Depot South	SW-3 Wadala	SW-4 CGS Colony		
Colour, Hazen		<5.0	<5.0	<5.0	<5.0	Agreeable	-
pH@ 25°C		6.91	6.9	6.95	6.83	5.5-9.0	5.8-8.6
Total Dissolved Solids@180°C	mg/l	190	1510	1120	1420	-	-
Calcium as Ca	mg/l	25	53	46.5	52	-	-
Chlorides as Cl^-	mg/l	24	550	400	635	-	-
Iron as Fe	mg/l	0.05	0.056	0.066	0.048	3.0	10
Magnesium as Mg	mg/l	8.8	46.2	25.3	35	-	-
Sulphate as SO_4^{2-}	mg/l	17	113	99	95	-	-

Item	Unit	Line 11 Corridor 1				Effluent water (Discharge of Environmental Pollutants)	Japan
		SW-1 Anik Depot North	SW-2 Anik Depot South	SW-3 Wadala	SW-4 CGS Colony		
Alkalinity as $CaCO_3$	mg/l	212	192	184	228	-	-
Hardness as $CaCO_3$	mg/l	98	322	220	276	-	-
Odour		Agreeable	Agreeable	Agreeable	Agreeable	-	-
Nitrate as NO_3-	mg/l	<0.5	<0.5	<0.5	<0.5	-	-
Dissolved Oxygen	mg/l	3	2.8	3	2.8	-	-
Electrical Conductance @ 25°C,	µS/cm	308	2520	1854	2350	-	-
Chemical Oxygen Demand	mg/l	20	30	30	38	250	160
Turbidity	N.T.U	<1.0	<1.0	<1.0	<1.0	-	-
BOD@20°C 5days	mg/l	<0.05	<0.05	<0.05	<0.05	30	160
Hexavalent Chromium as Cr^{+6}	mg/l	1.6	2	1.8	2	0.1	0.2
Copper as Cu	mg/l	0.012	0.02	<0.01	<0.01	3.0	3.0
Manganese as Mn	mg/l	<0.01	<0.01	0.43	0.23	2.0	10
Zinc as Zn	mg/l	<0.01	<0.01	0.06	0.02	5.0	2.0
Lead as Pb	mg/l	<0.005	<0.005	<0.005	<0.005	0.1	0.1
Cadmium as Cd	mg/l	<0.001	<0.001	<0.001	<0.001	2.0	0.03
Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	0.01	0.005
Iron as Fe	mg/l	0.03	0.014	0.12	0.054	-	-
Sodium as Na	mg/l	38	211	542	540	-	-
Potassium as K	mg/l	14	16	50	48	-	-
Coliform	MPN /100ml	>1600	>1600	>1600	>1600	-	-

Source: JST, THE ENVIRONMENT (PROTECTION) RULES, 1986, MoEF, Environmental Quality Standards for Water Pollution, MoE Japan

4.7.1.3 Waste

(1) Survey

1) Municipal Solid Waste

Currently, approximately 6,500 to 8,000 tons of waste are generated daily in Mumbai, and the majority is transported and treated at the Kanjurmarg and Deonar landfill sites[43].

2) Wastewater

There are currently seven sewage treatment plants in operation in Worli, Dharavi, Ghatkopar, Bhandup, Bandra, Versova, and Malad, with a total treatment capacity of approximately 1,886 million liters per day. However, due to aging and breakdowns, the actual treatment capacity is about 1,000 million liters per day, which is slightly more than 50% of the planned capacity. Therefore, the Brihanmumbai Municipal Corporation (BMC) plans to increase treatment capacity by an additional 2,500 million liters per day by 2026. Once these new facilities become operational, it is expected that almost all of the city's wastewater (approximately 3,500 million liters per day) will be treatable.

3) Muck Disposal

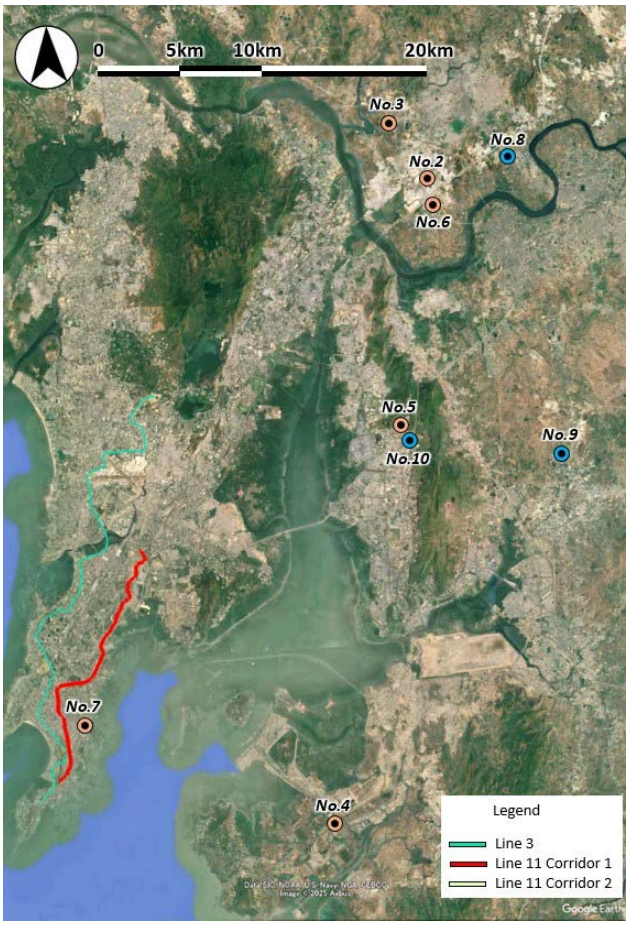
In the construction of Mumbai Metro Line 3, the disposal sites listed in the table below were utilized. When the capacity of a given site was reached, alternative sites were selected and used for waste management. It is expected that a similar approach will be adopted during the construction of Line 11. However, since many of the disposal sites are located at a distance of approximately 40–50 km from the Line 11 project area, the transportation and handling costs are anticipated to be relatively high. At present, the following two locations are identified as candidate disposal sites capable of accepting waste.

Table 4.7.6 List of Muck Disposal Sites (Used / In Use / Available)

No.	Muck Disposal Site Location	Current Status
1	Ambernath Industrial Area	Closed
2	Village Dapode, Tal-Bhivandi, Dist-Thane	Closed
3	Village Kalwar, Tal- Bhivandi, Dist-Thane	Closed
4	Navi Mumbai SEZ, Dronagiri, P-A2, Tal Panvel	Closed
5	MIDC- Mahape, Navi Mumbai	Closed
6	Village Mankoli, Tal- Bhivandi, Dist-Thane	Closed
7	MbPT	Closed
8	Village Ranjnoli, Tal-Bhivandi, Dist-Thane	**Active**
9	Mumbai Waste Management Limited, Plot No. P-32, MIDC, Taloja, Tal: Panvel, Dist: Raigad	**Acceptable**
10	Trans Thane Waste Management Association P-128, Shil-Mahape Road, Next to L&T Infotech Ltd. Mahape, Navi Mumbai	**Acceptable**

Source: JST, MMRC

[43] https://timesofindia.indiatimes.com/city/mumbai/bmc-expects-687-crore-from-user-fees-for-waste-collection/articleshow/117959599.cms?utm_source=chatgpt.com



Source: Prepared by the JST based on MMRC and Google Earth

Figure 4.7.1 Location Map of Muck Disposal Sites (Used / In Use / Available)

Table 4.7.7 Details of Available Hazardous Waste Disposal Sites

Name	No.9 M/s. Mumbai Waste Management Limited, Taloja, Navi Mumbai	No.10 M/s. Trans Thane Waste Management Association, Mahape, Navi Mumbai
Address	M/s. Mumbai Waste Management Limited, Plot No. P-32, MIDC, Taloja, Tal: Panvel, Dist: Raigad	M/s. Trans Thane Waste Management Association P-128, Shil-Mahape Road, Next to L&T Infotech Ltd. Mahape, Navi Mumbai-400105
Area allocation as per revised order dated 11.12.2008	A] Mumbai and Suburban Mumbai, Districts, Panvel, Khalapur & Uran Talukas of Raigad Districts and Thane District excluding Thane-Belapur Industrial Area. B] Alibaug, Karjat, Mahad, Mangaon, Mhasala, Poladpur, Pen Shriwardhan, Sudhagad, Talukas of Raigad District. Sindhudurg, & Ratnagiri District.	Thane- Belapur Industrial Area, Dist- Thane. The incinerable waste from this area is sent to CHWTSDF at Taloja, dist: Raigad.
Area of Facility	40 ha	7 ha
Notification	10.09.2001	24.03.1999
Land lease agreement	24.02.2002	09.05.2000
Consent to Establish issued on	02.01.2002	02.01.2002
Consent to Operate issued details	Valid up to 28/02/2025 for Secured Landfill : 120,000 t/year Incineration : 30,000 t/year	valid up to 30/09/2023 for Secured landfill.
Life of Facility	20 Years- Service 30 Years- Post Monitoring and maintenance	5.0 Year – Service 30 Years- Post Monitoring & Maintenance

Name	No.9 M/s. Mumbai Waste Management Limited, Taloja, Navi Mumbai	No.10 M/s. Trans Thane Waste Management Association, Mahape, Navi Mumbai
Capacity of the Facility	SLF- 120,000 t/year	SLF- 10,000 t/year
	1. INC – 1. 5 TPH. 2. INC- 1.5 TPH	No Facility (Incinerable HW sent to Taloja)
Cost of disposal per tons of waste per MT	DLF -Rs. 2056 LAT -Rs. 3500 to 3700 INC- Rs 31000	DLF -Rs. 1200 LAT -Rs. 2500
HW Received at Facility till 31/03/2021	DLF: 681,119 t LAT: 1,354,129 t INC: 357,687 t Total: 2,393,007 t	DLF: 471,123 t LAT: 84,445 t Total: 555,568 t

Note: SLF=Sanitary Landfill Facility, TPH= Tons per Hour, HW=Hazardous Waste, INC=Incineration, DLF= Designated Landfill、LAT＝Land Treatment

Source: JST

(2) Prediction

As shown in the table below, a total of 2,603,000 m³ of excavated soil is expected to be generated from the depot, underground station construction sites, and other related facilities. Assuming a bulk density of cohesive soil at 1.8 t/m³, this corresponds to approximately 4,685,400 tons. As described in Chapter 10: Project Implementation Plan, the construction period for civil works is scheduled for 68 months, which means that an annual average of approximately 827,000 tons of excavated soil will be generated. This amount is nearly 6.4 times greater than the combined annual disposal capacity of the two identified facilities (approximately 130,000 tons). Therefore, in order to reduce the volume transported to disposal sites, the reuse and recycling of excavated soil is an essential requirement. For reference, the Mumbai Metro Line 3 Project, which generated 8,044,098 m³ of excavated soil, about three times that of the present Project (based on MMRCL's data up to September 2021), implemented the following reuse measures in addition to disposal at designated sites. Therefore, for this Project as well, it is necessary to explore, to the maximum extent possible, the potential reuse of excavated soil in coordination with other ongoing road and port development projects, and such reuse should be considered as one of the viable options. In the event that the excavated soil is actually utilized as embankment material, the contractor shall prepare and submit the required documentation, including an Environmental Management Plan (EMP) with provisions for soil testing and analysis, to the Maharashtra Coastal Zone Management Authority and/or the State Environment Impact Assessment Authority. The proposed reuse shall only proceed following the completion of the official review and approval process.

- Utilization as reclamation material for Terminal 4 of Jawaharlal Nehru Port Trust (JNPT);
- Use as road sub-base material;
- Use as railway ballast;
- Recycling as construction materials[44].

The excavated soil to be generated from the Line 11 Project is comparatively of good quality and, similar to the case where Mumbai Port Authority (MbPA) accepted excavated soil from the Line 3 Project, it is

[44] MUMBAI METRO LINE 3 (Colaba-Bandra-SEEPZ) Part-I: Updated Environmental Impact Assessment, February, 2020, MMRC

deemed suitable for reuse in multiple applications. MbPA is planning the redevelopment of approximately 250 ha of waterfront areas, and considering the projected annual sea-level rise of 4.5 mm forecasted by the World Meteorological Organization, excavated soil can be effectively used as embankment material for such redevelopment. This approach is consistent with the priority measures set out in the Mumbai Climate Action Plan (MCAP, 2022) for waste management, which emphasize "decentralized treatment" and "prioritization of segregation and reuse."

Table 4.7.8 Estimated Volume of Excavated Soil Generated by Mumbai Metro Line 11 Project

Corridor 1	
Stations Cut and Cover	
Stations	1,258,400
Entrance/Ventilation Etc	188,760
Ramp	3,080
Tunnel TBM (Single-Track Twin Tubes)	
Ramp~Wadala Depot	25,902
Wadala Depot~CGS colony	83,838
CGS colony~Ganesh Nagar	88,384
Ganesh Nagar~BPT hospital	65,774
BPT hospital~Sewri	124,444
Sewri~Hay Bunder	112,792
Hay Bunder~Darukhana	73,058
Darukhana~Byculla	86,798
Byculla~Nagpada Junction	102,670
Nagpada Junction~Bhendi Bazaar	102,954
Bhendi Bazaar~CSMT	111,116
CSMT~Horniman Circle	71,096
Horniman Circle~Gateway of India	65,184
Gateway of India~Dead end	33,494
Cross passage Tunnel	4,290
Total (m^3)	**2,603,000**

Source: : JST

Table 4.7.9 Status of Excavated Soil Acceptance by MbPA



Satellite Imagery from May 2010



Satellite Imagery from March 2025

Source: : Prepared by the JST based on Google Earth

4.7.1.4 Soil Contamination

(1) Survey

Soil sampling was conducted along Corridor 1 during the dry season in March 2025 and the rainy season in June 2025. The results are summarized below. With regard to the rainy season survey results at Nagpada Junction (S-5), the location was paved with concrete, and therefore sampling could not be conducted; the site was recorded as unmeasured. In India, soil environmental standards are stipulated in the Environment (Protection) (Management of Contaminated Sites) Rules, 2025. The survey results were compared with the Response levels specified therein. With respect to pH, values during the dry season indicated a slightly alkaline range (7.9–8.7), whereas during the rainy season they declined to a neutral to slightly alkaline range (7.2–8.3), suggesting the influence of dilution and infiltration caused by rainfall. Regarding electrical conductivity, the dry season showed wide variability among sites (26–500 µS/cm), while in the rainy season values converged within the range of 200–350 µS/cm, confirming the effect of leaching and homogenization due to rainfall. With respect to heavy metal concentrations, chromium (Cr) slightly exceeded the standard at 2 locations in the dry season, which may be attributed to industrial activities. However, as Bombay Island, where Mumbai is located, is primarily composed of basaltic rock that contains relatively high concentrations of metallic elements, natural origins are also considered possible. Concentrations of other metals were below the standards in both seasons, with most locations showing significant decreases during the monsoon season, often falling below the standard values or the detection limit. This is presumed to be a result of the strong influence of rainfall-induced dilution and surface runoff.

Table 4.7.10 Dry season Survey Results

Item	Unit	S-1 Anik Depot	S-2 Ganesh Nagar	S-3 Sewri	S-4 Byculla	S-5 Nagpada Junction	S-6 CSMT Metro	S-7 Gateway of India	Response Level (RL) [mg/kg]
pH		8.47	8.72	8	7.94	8.06	8.35	7.91	-
Conductivity	µS/cm	264.3	264.3	292.2	139.7	502.1	493.5	373.4	-
Chromium as Cr	mg/kg	68	83	82	**105**	**102**	44	65	87
Lead as Pb	mg/kg	18	8.6	29	100	52	107	314	600
Cadmium as Cd	mg/kg	0.3	0.04	0.09	0.5	0.22	0.2	0.13	22
Arsenic as As	mg/kg	4.1	0.35	<0.05	1.36	3.4	8.4	6.2	76
Mercury as Hg	mg/kg	0.8	0.13	0.2	0.47	0.16	1.29	2.05	50

Source: JST, Environment Protection (Management of Contaminated Sites) Rules, 2025, Gazette of India, 24 July 2025, Annexure I (Schedule I)

Table 4.7.11 Rainy season Survey Results

Item	Unit	S-1 Anik Depot	S-2 Ganesh Nagar	S-3 Sewri	S-4 Byculla	S-5 Nagpada Junction	S-6 CSMT Metro	S-7 Gateway of India	Response Level (RL) [mg/kg]
pH		8.06	8.32	7.94	7.87	N/A	7.66	7.27	-
Conductivity	µS/cm	229.9	206.8	319.4	354.7		268.69	275.9	-
Chromium as Cr	mg/kg	60	48	62	43.5		28	72	87
Lead as Pb	mg/kg	1.4	8.86	43	35.7		<0.02	<0.02	600
Cadmium as Cd	mg/kg	0.44	0.05	0.12	0.2		0.73	0.49	22

Item	Unit	S-1 Anik Depot	S-2 Ganesh Nagar	S-3 Sewri	S-4 Byculla	S-5 Nagpada Junction	S-6 CSMT Metro	S-7 Gateway of India	Response Level (RL) [mg/kg]
Arsenic as As	mg/kg	<0.05	<0.05	<0.02	<0.02		<0.02	<0.02	76
Mercury as Hg	mg/kg	0.67	0.55	0.6	1.16		1.29	0.49	50

Source: JST, Environment Protection (Management of Contaminated Sites) Rules, 2025, Gazette of India, 24 July 2025, Annexure I (Schedule I)

(2) Prediction

As described in the section on Waste, a total of 2,603,000 m³ of excavated soil is expected to be generated from the depot, underground station construction sites, and other facilities, most of which can be utilized as embankment material for MbPA's waterfront redevelopment plan. Although no large-scale pollution-emitting facilities are present in the area, the results of the assessment against national standards indicate that chromium concentrations exceeded the permissible limits at all locations. Therefore, attention to potential environmental risks and continuous monitoring are considered necessary. In addition, even for parameters that were below the reference values in this study, if excavated soil is found to be severely contaminated, periodic soil sampling and analysis shall be conducted to prevent the spread of contamination. As major soil contamination countermeasures other than sampling, during the construction stage, regular maintenance and replacement of heavy equipment parts and prevention of oil leakage should be implemented, and during the operation stage, measures such as the introduction of oil traps at the depot, as well as the installation of septic tanks and drainage outlets, should be considered.

4.7.1.5 Noise

(1) Survey

Noise measurements were conducted for Corridor 1 in May. In addition, noise surveys were carried out between March and May 2025 at four locations where special consideration is required due to the presence of sensitive receptors. The day–night average noise levels are presented below and compared against the domestic standards for commercial areas. The rationale for applying the commercial area standard is that all monitoring locations are situated along arterial or general roads which are highly likely to be designated as commercial areas. Environmental noise was measured over a 24-hour period using a digital sound level meter. The results are as follows: at three locations in Corridor, the noise standards were exceeded. The primary sources of noise were identified as road traffic, commercial facilities, and crowd-related activities along the project corridor. Furthermore, at the four locations where sensitive receptors are present, the noise standards were also exceeded during both day and night periods. The noise standards in India are stipulated in EPA-1986, Noise Pollution (Regulation and Control) Rules, 2000, PCLS/02/1992, IVth Edition. In addition, the most sensitive receptors potentially affected by noise and vibration from the project are shown in the table below.

Table 4.7.12 Noise Standards Applicable in India

Category of Area/Zone	Day Time	Night Time	Regulation
I. Industrial Area	75 dB	70 dB	EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition.
II. Commercial Area	65 dB	55 dB	
III. Residential Area	55 dB	45 dB	
IV. Silence Area	50 dB	40 dB	
Industrial Area/ Commercial Area	70 dB	70 dB	Environmental, Health, and Safety Guidelines, IFC
Residential Area	55 dB	45 dB	

Source: EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition./ Environmental, Health, and Safety Guidelines, IFC

Table 4.7.13 Survey Results

Location name & Land mark		Day time (AM 6:00 – PM 10:00)				Night time (PM 10:00- AM 6:00)			
		Lmax	Lmin	Leq	Standard	Lmax	Lmin	Leq	Standard
Corridor 1									
1	Anik Depot	63.91	59.27	61.93	65	56.88	46.80	52.73	55
2	Ganesh Nagar	66.85	61.48	64.35		55.56	48.31	52.27	
3	Sewri	80.11	63.60	**74.33**		59.01	54.64	**56.58**	
4	Byculla	65.10	58.28	**65.10**		51.73	46.10	48.19	
5	Nagpada Junction	68.29	59.62	64.93		55.24	47.69	52.00	
6	Bhendi Bazaar	70.11	60.43	**65.76**		56.59	50.11	53.07	
7	CSMT Metro	62.74	54.43	59.41		69.10	62.24	**65.31**	
8	Gateway of India	62.88	61.12	62.88		54.23	52.01	52.32	

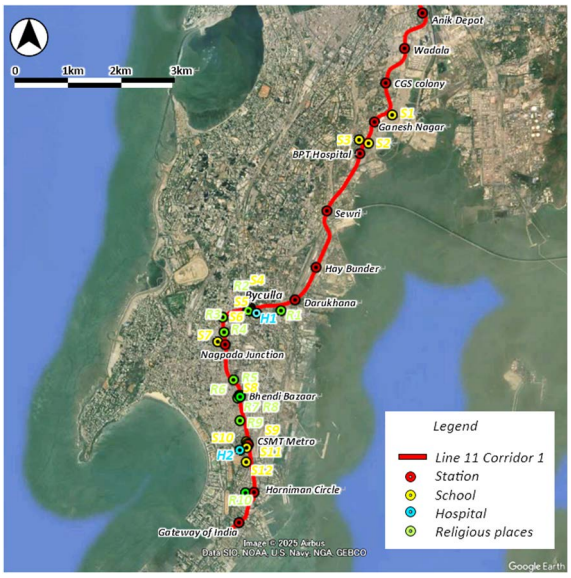
Source: Draft EIA report for Mumbai Metro Line-11, Dec, 2024

Table 4.7.14 List of Noise-Sensitive Receptors along the Project Corridor

No.	Name of structure	Structure Use	Closest St.	Distance from alignment	Survey result
Schools					
S1	Vidyalankar Institute of Technology	college	Ganesh Nagar	140m	
S2	Korba Mithagar Upper Primary Hindi School	school	BPT Hospital	117m	
S3	Nadkarni Park Municipal School	school	BPT Hospital	168m	
S4	Regina Pacis convent High School	school	Byculla	27m	
S5	Antonio De souza High School / Englich Primary school	school	Byculla	25m	
S6	Anza school	school	Byculla	43m	
S7	Maharashtra College of Arts Science and Commerce	college	Nagpada Junction	159m	
S8	Saifi High School	school	Bhendi Bazaar	19m	**Day: 68.8 dB Night: 65.3 dB**
S9	Sir JJ College Of Architecture	college	CSMT Metro	37m	**Day: 65.8 dB Night: 62.1 dB**
S10	Government Institute of Printing Technology	college	CSMT Metro	14m	
S11	Anjuman-I-Islam's Allana Institute of Management Studies	college	CSMT Metro	37m	
S12	Bharda New High School & Junior College	school	CSMT Metro	96m	
Hospitals					
H1	Masina Hospital Trust	hospital	Byculla	140m	**Day: 67.3 dB Night: 61.7 dB**
H2	Cama And Albless Hospital	hospital	CSMT Metro	240m	

No.	Name of structure	Structure Use	Closest St.	Distance from alignment	Survey result
Religious					
R1	Narialwadi Mosque	mosque	Darukhana	116m	
R2	Gloria church	church	Byculla	43m	
R3	Arab Masjid	mosque	Byculla	30m	
R4	Husami Masjid, Madanpura (Dawoodi Bohra)	mosque	Nagpada Junction	30m	**Day: 69.5 dB Night: 64.3 dB**
R5	Saifee Masjid	mosque	Bhendi Bazaar	50m	
R6	Hamidiya Masjid	mosque	Bhendi Bazaar	34m	
R7	Shree Naminath Maharaj Jain Derasar	temple	Bhendi Bazaar	33m	
R8	Shree Shantinath Jain Derasar	temple	Bhendi Bazaar	47m	
R9	Juma Masjid	mosque	CSMT Metro	100m	
R10	St. Thomas' Cathedral	church	Horniman Circle	208m	

Source: : JST



Source: Prepared by the JST based on Google Earth

Figure 4.7.2 Locations of Noise-Sensitive Receptors along the Project Corridor

(2) Prediction

1) Construction Phase

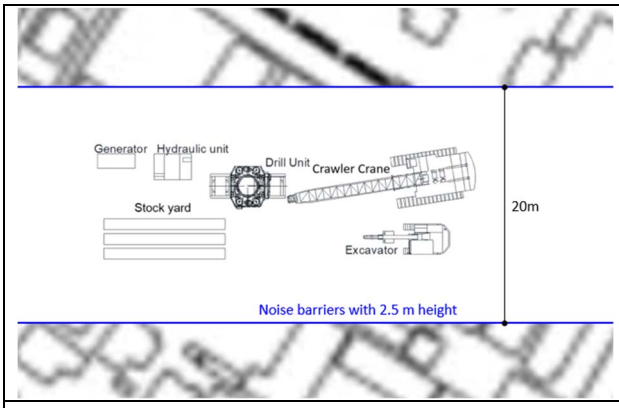
In subway construction, the noisiest construction activity is the installation of steel sheet piles and diaphragm walls using a vibratory hammer (vibratory pile driver), and this activity is therefore the primary subject of noise level prediction. As a mitigation measure, the use of hydraulic vibratory hammers is considered. The major construction equipment typically used includes vibratory hammers, crawler cranes, and generators. The noise output levels for this equipment are shown in the table below. Among the 15 stations to be constructed, 5 stations (Anik Bus Depot, Wadala, CGS Colony, Ganesh Nagar, Sewri) are located on public-private boundary land, 4 stations (BPT Hospital, CSMT Metro, Horniman Circle, Gateway of India) are on arterial roads, and 5 stations (Hay Bunder, Darukhana, Byculla, Nagpada Junction, Bhendi Bazaar) are on general roads. For each category, typical equipment layouts within the construction yard are illustrated below, and noise levels at road

edges and public-private boundaries are predicted accordingly. Since there are no official construction noise standards in India, the standards set by the Tokyo Metropolitan Government have been referenced. Among the three conditions above, the following stations were selected as representative points due to their highest predicted noise levels: Sewri (public-private boundary: 74.33 dB), Gateway of India (on arterial road: 62.88 dB), and Bhendi Bazaar (on general road: 65.76 dB).

Table 4.7.15 Regulatory Standards for Noise from Designated Construction Work

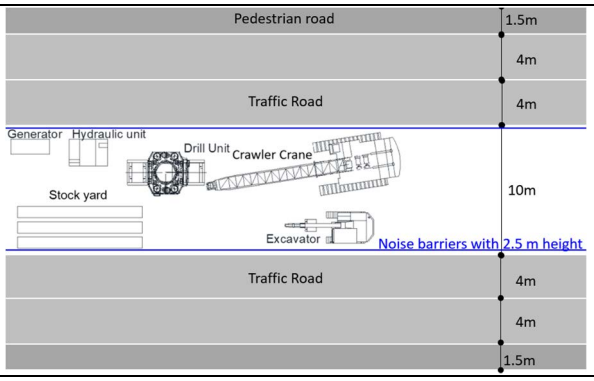
Construction Work Type	Tokyo Metropolitan Government Standard
Piling Work	80 dB

Source: Tokyo Metropolitan Environmental Security Ordinance, Tokyo Metropolitan Government



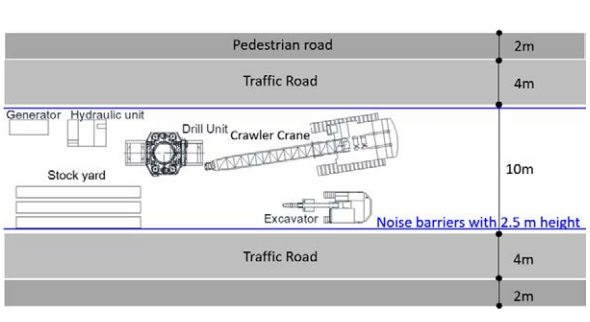


Example of Equipment Arrangement and Construction Conditions on Government-Private Land (Patna Metro)





Example of Equipment Arrangement and Construction Conditions on Arterial Roads (Jakarta MRT)





Example of Equipment Arrangement and Construction Conditions on Local Roads (Mumbai Metro Line 3)

Source: JST

Figure 4.7.3 Typical Layout of Construction Yard for Piling Works

Table 4.7.16 Noise Emissions from Major Equipment Used in Piling Works

Construction Equipment		Noise Level (dB) (Measured at 1 meter from the side of the equipment)
1	Backhoe (0.7m^3)	105
2	Crawler Crane (70 ton)	101
3	Hydraulic Pile Driver	96
4	Generator (200kVA)	92

Source:
- Report on the Study and Testing of the Prevention and Elimination of Construction Noise and Vibration, 1979, Public Works Research Institute, Ministry of Construction, Japan
- Research on Methods of Prediction and Assessing Noise and Vibration Induced by Construction Works (Report No.1), 1981, Public Works Research Institute, Ministry of Construction, Japan
- ASJ Prediction Model 2007 for Construction Noise, 2007, Acoustical Society of Japan
- Noise and Vibration Countermeasure Handbook for Construction, 2009, Japan Construction Machinery and Construction Association

a) Prediction Procedure

The noise level assessment during construction should be considered with the sound level generated by each construction machine located at a different position from the public-private boundary, and the Noise attenuation formula (1) should be used in this assessment. After the calculation, the attenuated noise level of each construction machine should be combined following the formula (2).

$$L_p = L_{p0} - 20log_{10}\left(\frac{r_0}{r}\right) \text{ -------- (1)}$$

Where

L_{p0} : Noise power level at a distance r_0 from the origin

L_p : Noise power level at a distance r from the origin

r_0, r : Distance from the origin at a sound level L_{p0} and L_p $(r_0 = 1m)$

$$L_{CN} = 10 \times \log_{10}\left(\sum_{i=1}^{n} 10^{\left(\frac{Lpi}{10}\right)}\right) \text{ -------- (2)}$$

Where

L_{CN} : Combined Noise level

L_{pi} : Noise power level at distance r from the origin of each construction machine

n : Number of Construction machine

b) Prediction Results

As a result of the prediction, the maximum construction noise levels at a height of 1.5 meters along the public-private boundary were calculated to be 72.4 dB in public-private land areas, 71.4 dB along arterial roads, and 74.2 dB along general roads. In parallel, the actual measured noise levels at the road boundary at representative locations were recorded as 74.33 dB for public-private land, 62.88 dB for arterial roads, and 65.76 dB for general roads. Accordingly, the projected noise levels are estimated at 76.5 dB, 72.0 dB, and 74.8 dB, respectively, as shown in the table below. These predicted values remain below the regulatory limits prescribed by the Tokyo Metropolitan Environmental Ordinance.

Table 4.7.17 Noise Prediction Results

Construction Location	Measured Value (Maximum)	Predicted Value	Combined Value	Tokyo Metropolitan Regulation Standard
Private-Public Boundary Area	74.33 dB	72.4 dB	76.5 dB	80 dB
Major Roadway	62.88 dB	71.4 dB	72.0 dB	
Local Roadway	65.76 dB	74.2 dB	74.8 dB	

Source: :JST, Tokyo Metropolitan Environmental Security Ordinance, Tokyo Metropolitan Government

2) Operation Phase

In Indian cities, road traffic noise is generally dominant, and therefore noise issues related to underground metro sections are rarely observed. Furthermore, no internationally established noise prediction models exist for underground sections. In the case of above-ground sections such as near Anik Depot Station, trains operate at low speeds of approximately 25 km/h, and hence the noise impact during operation is considered minimal.

3) Noise-Sensitive Receptors Requiring Special Consideration

Based on the above survey and prediction results, the noise standards during construction are expected to be met; however, as the baseline noise levels are high, potential impacts are anticipated. Therefore, at each stage, the following required mitigation measures shall be implemented.

a) Construction Phase

- Install appropriate noise suppression devices such as mufflers on heavy machinery and other construction equipment as necessary to ensure noise levels remain within acceptable limits.
- To avoid noise impacts on adjacent residential, commercial, and other sensitive areas, construction activities generating high noise levels should be limited to daytime hours (08:00–20:00). Near educational facilities, nighttime construction should be considered to avoid interfering with school classes.
- Erect 2.5-meter-high fencing around construction sites.
- Employ low-noise types of construction equipment for activities such as piling.

b) Operation Phase

Not applicable.

4.7.1.6 Vibration

(1) Survey

Vibration measurements were conducted along Corridor 1 from March to July 2025. The results are presented below. For Corridor 1, the values shown represent the upper limits of the 80% range of all data at each measurement location, and in all cases the results were below the standard values stipulated under Japan's Vibration Regulation Law.

Table 4.7.18 Survey Results for Corridor 1

Location name	V dB (L_{10})		Japan (dB)
	Daytime (6 am to 10 pm)	Night time (10 pm to 6 am)	
Anik Depot	51.97	51.97	Daytime: 70 dB Night time: 65 dB (Commercial Area)
Wadala	54.12	54.69	
Sewri (L&T, Sewri)	47.54	46.94	
Byculla (Masina Hospital Trust)	67.28	62.19	
Byculla (Monte south, Byculla)	47.24	46.62	
Nagpada Junction (JJ Dharamshala, Nagpada)	53.56	47.54	
Between Nagpada Junction and Bhendi Bazaar (Mirza Ghalib municipal market)	46.62	46.29	
Bhendi Bazaar (Jain Mandir, Pydhonie)	47.24	47.54	
JJ college of art and architecture (Near CSMT Metro)	57.75	50.07	
Maneckji Seth Agiary Parsi Mandir (Between CSMT and Horniman Circle)	46.29	46.29	
Horniman Circle	46.62	46.62	
CSMT	46.94	46.62	

Source: JST; Vibration Regulation Law (Law No. 64 of June 10, 1976), Japan

(2) Prediction

1) Construction Phase

a) Construction Work of Underground Station Buildings

In subway construction, the construction activity that generates the highest level of vibration is the installation of steel sheet piles and diaphragm walls using a vibratory hammer (vibration-type piling machine), which is also the primary source of construction noise. Therefore, this activity has been selected as the subject for vibration level prediction. As a mitigation measure, the use of hydraulic vibratory hammers—similar to the noise control measures—is proposed.

The primary construction machinery typically includes vibratory hammers, crawler cranes, and generators. Their vibration levels are presented in the table below. For the vibration level prediction, the machinery layout within the construction yards on public-private boundary areas, arterial roads, and local roads is assumed to be the same as in the noise prediction analysis. The vibration levels are estimated at both the roadside boundary and public-private boundary lines. However, as vibration standards for the construction stage have not been established in India, the reference values stipulated by the Tokyo Metropolitan Government were applied. Among the three different conditions mentioned above, the representative locations with the highest vibration results are Wadala (private/public land: 54.12 dB), Gateway of India (arterial road: 57.75 dB), and Byculla (local road: 67.28 dB).

Table 4.7.19 Vibration Emissions from Major Equipment Used in Piling Works

Construction Equipment		Noise Level (dB) (Measured at 1 meter from the side of the equipment)
1	Backhoe (0.7m^3)	63
2	Crawler Crane (70 ton)	40
3	Hydraulic Pile Driver	55
4	Generator (200kVA)	62

Source:

- Report on the Study and Testing of the Prevention and Elimination of Construction Noise and Vibration, 1979, Public Works Research Institute, Ministry of Construction, Japan
- Research on Methods of Prediction and Assessing Noise and Vibration Induced by Construction Works (Report No.1), 1981, Public Works Research Institute, Ministry of Construction, Japan
- ASJ Prediction Model 2007 for Construction Noise, 2007, Acoustical Society of Japan
- Noise and Vibration Countermeasure Handbook for Construction, 2009, Japan Construction Machinery and Construction Association

i) Prediction Procedure

The vibration level assessment during construction should be considered the same as the case of noise with the level generated by each construction machine located at a different position from the public-private boundary, and the vibration attenuation formula (1) should be used in this assessment. After the calculation, the attenuated vibration level of each construction machine should be combined following the formula (2).

$$VL = VL_0 + 15log_{10}\left(\frac{r_0}{r}\right)^n + 8.68(r_0 - r)\alpha \quad \text{-------- (1)}$$

Where

VL : Vibration level at a distance r from the origin

VL_0 : Vibration level at a distance r_0 from the origin

r_0, r : Distance from the origin at a vibration level VL_0 and VL $(r_0 = 7m)$

n : Geometric attenuation Surface wave: n = 0.5

α : Ground attenuation Clay layer: α = 0.02

$$L_{CV} = 10 \times \log_{10}\left(\sum_{i=1}^{n} 10^{\left(\frac{VLi}{10}\right)}\right) \quad \text{-------- (2)}$$

Where

L_{CV} : Combined Vibration level

VLi : Vibration level at distance r from the origin of each construction machine

n : Number of Construction machine

ii) Prediction Results

As a result of the prediction, the vibration levels during construction were calculated as 63.41 dB at property boundaries, 61.36 dB along arterial roads, and 62.90 dB along local roads. Field measurements of vibration levels at road boundaries indicated values of 54.12 dB at Wadala (property boundary), 57.75 dB at Gateway of India (arterial road), and 67.28 dB at Byculla (local road). Accordingly, the predicted values, as shown in the table below, were 63.90 dB at Wadala

(property boundary), 62.93 dB at Gateway of India (arterial road), and 68.63 dB at Byculla (local road). Taking into account these road traffic vibrations, the construction-induced vibration levels were found to remain below the regulatory standards established by the Tokyo Metropolitan Government.

Table 4.7.20 Predicted Vibration Levels (Underground Station Construction)

Construction Location	Measured Value (Maximum)	Predicted Value	Combined Value	Tokyo Metropolitan Regulation Standard
Private-Public Boundary Area	54.12 dB	63.41 dB	63.90 dB	70 dB
Major Roadway	57.75 dB	61.36 dB	62.93 dB	
Local Roadway	67.28 dB	62.90 dB	68.63 dB	

Source: Survey Team; Tokyo Metropolitan Environmental Preservation Ordinance, Tokyo

b) TBM Operation

In the inter-station sections, vibrations generated during the passage of the TBM at a depth of approximately 25 m are estimated to fall within the range of 55–60 dB. As previously noted, the average TBM passing depth in this Project is 22 m; therefore, based on the vibration attenuation formula (1) presented on the preceding page, vibrations equivalent to approximately seismic intensity 1 (61 dB) are predicted. Furthermore, according to the composite vibration level formula (2) shown on the preceding page, the vibration levels incorporating the road traffic vibration values from the above table are calculated to be in the range of 61.81–68.2 dB, which also remain below the regulatory standards of the Tokyo Metropolitan Government. However, in the event that complaints are raised by residents along the alignment, the following countermeasures may be considered:

1. Vibration monitoring shall be conducted during TBM excavation, and excavation work in this section shall be limited to daytime hours (7:00–20:00), with nighttime operations suspended.
2. In the event of complaints from residents, the TBM's thrust pressure and vibration levels shall be reduced during excavation.
3. The length of the section where vibration may affect a single residential building is approximately 40 meters. Considering that daytime-only excavation allows for a daily advance of more than 5 meters, the duration of excavation for this section is estimated at approximately 8 days. Accordingly, excavation shall proceed after explaining to residents that the vibration will be temporary and obtaining their understanding[45].

Table 4.7.21 Predicted Vibration Levels (TBM Operation)

Construction Location	Measured Value (Maximum)	Predicted Value	Combined Value	Tokyo Metropolitan Regulation Standard
Private-Public Boundary Area	54.12 dB	61 dB	61.81 dB	70 dB
Major Roadway	57.75 dB		62.68 dB	
Local Roadway	67.28 dB		68.20 dB	

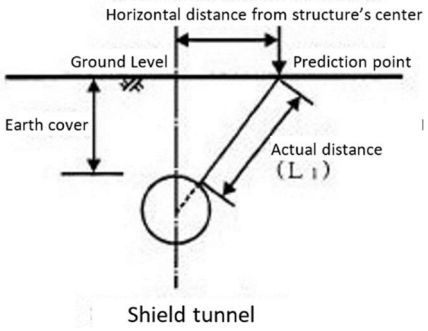
Source: Survey Team; Tokyo Metropolitan Environmental Preservation Ordinance, Tokyo

[45] CHARACTERISTICS OF GROUND VIBRATION AND NOISE FROM HARD ROCK TBM, Journal of the Japan Society of Civil Engineers, No.623/VI-43, 57-67, 1999.6

2) Operation Phase

As a vibration prediction method for underground sections of single-shield tunnels, the following prediction formula developed by Tokyo Metro Co., Ltd. (formerly Teito Rapid Transit Authority) is commonly used.

$$VL = K - A \times \log L + 25 \times \log(V/50) - 24 \times \log(W/20) + X$$



Where

VL : Vertical vibration predicted level at a surface point of the earth (dB)

L : Actual distance from outside of the tunnel to a prediction point (m)

V : Velocity (V=80 km/h)

W : Tunnel weight (17 tf/m)

K : Constant value for classified structure (K = 68dB)

A : Weighting factor of distance (Diluvium = 14)

X : Other weighting factor X = X1 + X2

X1 : Linear Correction (Straight section = 0)

X2 : Correction for reduction weight of rolling stock (All section = -5)

As a result of the prediction, the ground surface vibration levels generated by the operation of the Mumbai Metro were found to be approximately 55 dB at all representative locations (property boundaries, arterial roads, and local roads) in the sections where train speed is at its maximum. On the other hand, based on the survey results, the road traffic vibration levels at the representative locations were as shown in the table below. When the composite vibration levels were compared with the Japanese regulatory standards, it was confirmed that the results at all locations remained below the applicable standards.

Table 4.7.22 Predicted Vibration Levels (During Operation)

Construction Location	Time	Measured Value (Maximum)	Predicted Value	Combined Value	Regulatory Standards in Japan
Private-Public Boundary Area	Day time	54.12 dB	55.6 dB	57.93 dB	Day time: 70 dB Night time: 65 dB (Commercial Area)
	Night time	54.69 dB		58.18 dB	
Major Roadway	Day time	57.75 dB	55.1 dB	59.63 dB	
	Night time	50.07 dB		56.29 dB	
Local Roadway	Day time	67.28 dB	55.3 dB	67.55 dB	
	Night time	62.19 dB		63 dB	

Source: JST; Vibration Regulation Law (Law No. 64 of June 10, 1976), Japan

3) Vibration-Sensitive Receptors and Buildings Requiring Special Consideration

Based on the above survey and prediction results, no significant vibration impacts are anticipated during either the construction or operation stages. However, in addition to regular monitoring, the implementation of the following mitigation measures should be considered.

a) During Construction

- To ensure that vibrations from heavy equipment and other construction machinery remain within permissible limits, vibration control devices shall be installed as necessary.
- To avoid vibration impacts on adjacent residential and commercial areas, as well as other sensitive locations, construction activities generating significant vibrations shall be limited to daytime hours (08:00–20:00). In the vicinity of educational facilities, nighttime implementation may also be considered so as not to disturb classes.
- Restrictions on daytime and nighttime operation of heavy vehicles, including speed limits and rerouting of traffic, shall be applied in accordance to the rules, regulation and permission of State Trasport Department.
- Vibration-absorbing mats shall be installed along the running lanes of heavy equipment and large vehicles.
- Low-vibration type machinery, such as pile drivers, shall be employed.
- In the event that cracks should occur, MMRC will determine whether compensation is to be provided through consultations with the building owners.

b) During Operation

- Adoption of Elastic Rail Pads and Anti-Vibration Sleepers

4.7.1.7 Land Subsidence

For the construction of two underground tunnels with a diameter of 6 meters each, Tunnel Boring Machines (TBMs) are planned to be employed. In large-scale excavation works such as tunnel and underground station construction, there is a possibility that significant voids may form within the geological strata, potentially leading to ground settlement in the upper layers. However, according to the results of the Standard Penetration Test (SPT) from the existing geotechnical surveys, the area along the Mumbai Metro alignment does not correspond to soft ground conditions. Furthermore, the Detailed Project Report (DPR) indicates that ground subsidence due to groundwater drawdown in underground sections is not anticipated. Taking into account the local geology, abundant groundwater, and advanced construction technologies, the possibility of settlement is considered to be very low. Nevertheless, as the potential for ground settlement cannot be completely ruled out, appropriate monitoring and mitigation measures are deemed necessary.

4.7.1.8 Offensive Odour

Sources of offensive odours are generally associated with the generation of waste and garbage. During the construction phase, construction yards and surrounding work areas are expected to be the primary sources of odor. In the operational phase, the main sources will be the depot and individual stations. The

extent of the impact depends not only on the waste collection systems in place but also on the methods of storage at each point of generation.

4.7.2 Natural Environment

4.7.2.1 Protected and Regulated Areas

(1) Protected Area (including National Park and Key Biodiversity Areas)

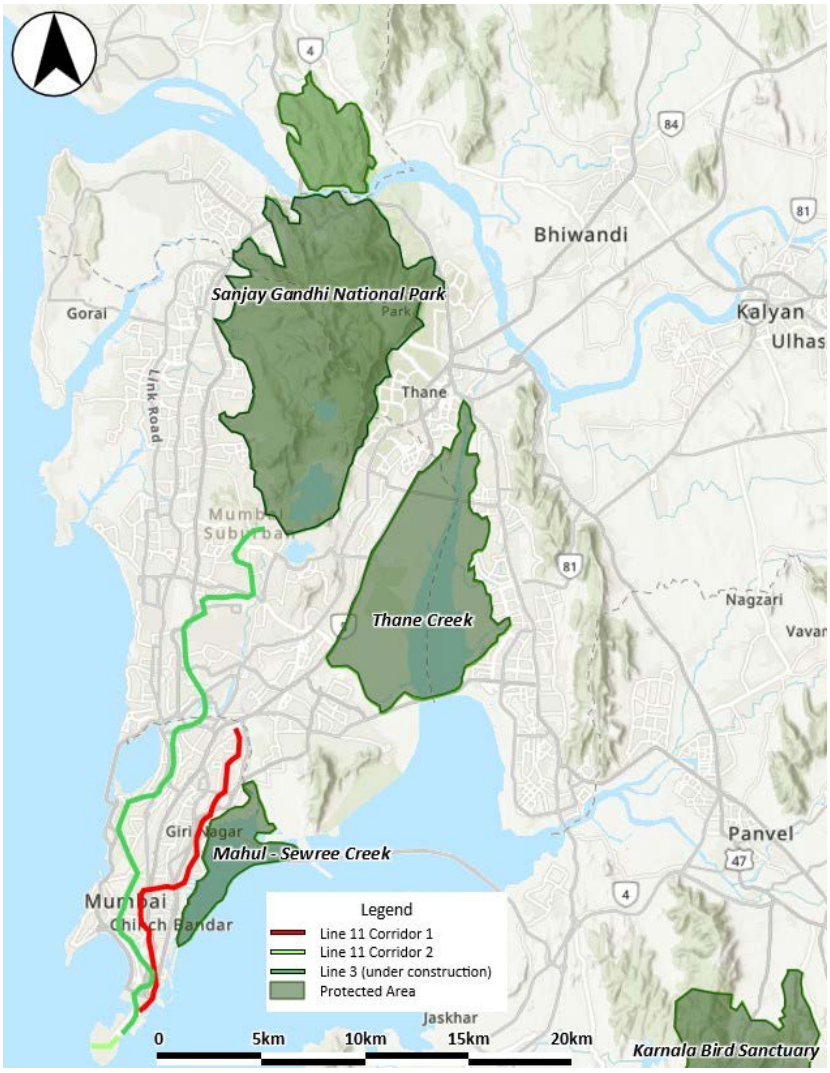
In the state of Maharashtra, a total of 30 protected areas has been designated, including wildlife sanctuaries, bird sanctuaries, and national parks, as shown in the table below. Among them, three sites—Mahul - Sewree Creek (minimum distance: approx. 0.35 km), Thane Creek (minimum distance: approx. 5.5 km), and Sanjay Gandhi National Park (minimum distance: approx. 10 km)—located along the alignments of Corridor 1, have been designated as Key Biodiversity Areas (KBAs). Of these, Mahul - Sewree Creek, which is the closest to the project section, was identified as a KBA based on the baseline survey conducted in 2004. The northern coastal area of the creek is densely covered with mangrove forests and is off-limits to the general public. The entire Corridor 1 alignment is underground. The section that approaches the creek most closely is approximately 0.35 km from the alignment, and the nearest cut-and-cover station area is located about 0.75 km away. However, as shown in the figure below, industrial zones and port areas lie between the alignment and the creek. Therefore, the alignment of this project does not overlap with any of the protected areas. In addition, the Coastal Regulation Zone (CRZ) Category I, which will be described in the following section, is also considered a de facto protected area where development activities are prohibited. However, the alignment of the present Project does not overlap with this zone.

Table 4.7.23 Protected area in Maharashtra State

Sl.	Name	District	Type of Protected area
1	Tadoba National Park and Andhari Tiger Reserve	Chandrapur	National Park
2	Navegaon National Park	Gondia	National Park
3	Nagzira Wildlife Sanctuary	Gondia/Bhandara	Wildlife Sanctuary
4	Pench Tiger Reserve	Nagpur	National Park
5	Mahendri Reserve Forest	Amaravati	Wildlife Sanctuary
6	Melghat Tiger Reserve	Amaravati	Wildlife Sanctuary
7	Hatnur Dam	Jalgaon	Wildlife Sanctuary
8	Jaikwadi Wildlife Sanctuary	Aurangabad/Ahmadnagar	Wildlife Sanctuary
9	Jawaharlal Nehru Bustard Sanctuary	Ahmadnagar/Solapur	Wildlife Sanctuary
10	Amboli-Tilari Reserve Forest	Sindhudurg/Kolhapur	Wildlife Sanctuary
11	Radhanagari Wildlife Sanctuary	Kolhapur	Wildlife Sanctuary
12	Chandoli National Park	Ratnagiri/Satara/Sangli/Kolhapur	National Park
13	Koyna Wildlife Sanctuary	Ratnagiri/Satara	Wildlife Sanctuary
14	Mahabaleshwar Reserve Forest	Satara	Reserve Forest
15	Burnt Island (Bandra) Vengurla Rocks	Sindhudurg	Wildlife Sanctuary
16	Ujjani Reservoir	Ahmadnagar/Solapur/Pune	Water Reservoir
17	Phansad Wildlife Sanctuary	Raigad	Wildlife Sanctuary
18	INS - Shivaji and adjoining areas, Lonavla	Raigad	Wildlife Sanctuary
19	Karnala Bird Sanctuary	Raigad	Wildlife Sanctuary

Sl.	Name	District	Type of Protected area
20	Bhimashankar Wildlife Sanctuary	Raigad/Thane/Pune	Wildlife Sanctuary
21	Harishchandragad-Kalsubai Wildlife Sanctuary	Thane	Wildlife Sanctuary
22	Mahul - Sewree Creek	Mumbai City/Mumbai Suburban	Creek
23	Thane Creek	Mumbai Suburban/Thane	Creek
24	Sanjay Gandhi National Park	Mumbai Suburban/Thane/Palaghar	National Park
25	Tansa Wildlife Sanctuary	Thane/Palaghar	Wildlife Sanctuary
26	Gangapur Dam and grasslands	Nashik	Wildlife Sanctuary
27	Ozar and adjoining grassland	Nashik	Wildlife Sanctuary
28	Nandur Madhmeshwar Wildlife Sanctuary	Nashik	Wildlife Sanctuary
29	Taloda Reserve Forest	Nandurbar	Reserve Forest
30	Toranmal Reserve Forest	Nandurbar	Reserve Forest

Source: keybiodiversityareas.org



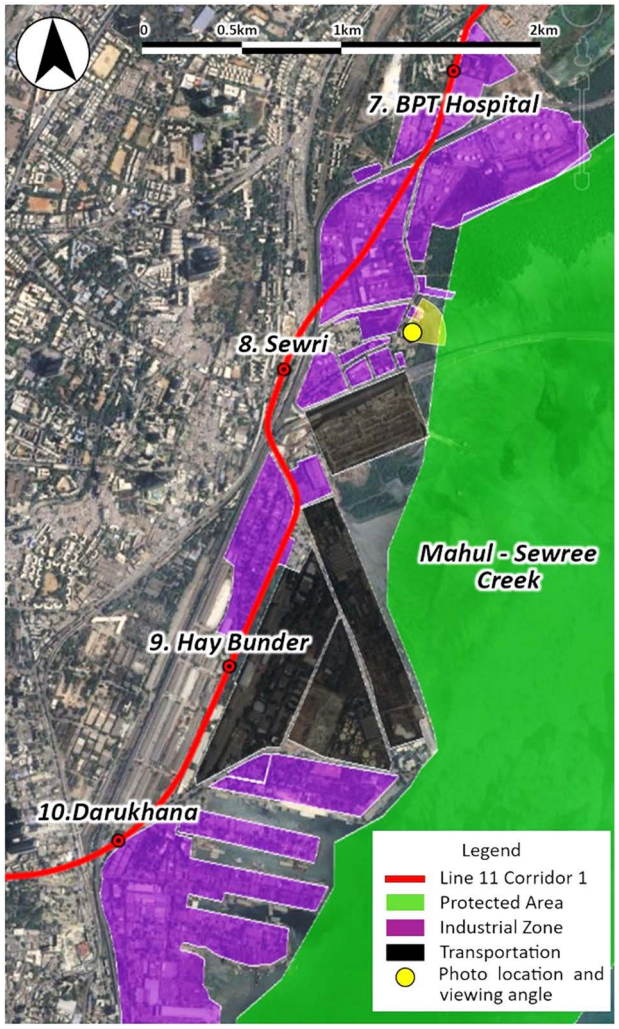
Source: Created by the JICA Study Team based on the figure from keybiodiversityareas.org

Figure 4.7.4 Location Relationship between Mumbai Metro and Key Biodiversity Areas

Table 4.7.24 Overview of Protected Areas in Proximity to the Project Area

Protected Area Name	Summary	Related information
Mahul - Sewree Creek	• Year Established / Area: Registered in 1900 as Thane - Mahul Sewree Flamingo Sanctuary / 1,000 ha • Purpose: Conservation of mangrove forests and wintering grounds for migratory birds • Major Species (IUCN Category): Fauna: Vulture (CR), Sandpiper (EN), Eagle (VU), Flamingo (NT, LC) Flora: Mangroves (LC)	• Classified as an estuarine area under the Indian Forest Act, 1927 • Region of national and international significance for biodiversity, landscape, or cultural heritage • Designated as both a Key Biodiversity Area (KBA) and Important Bird Area (IBA)
Thane Creek	• Year Established / Area: Registered in 2015 as Thane Creek Flamingo Sanctuary / 1,690 ha • Purpose: Conservation of mangrove forests and wintering grounds for migratory birds • Designated as a Ramsar Wetland (2022) • Major Species (IUCN Category): Fauna: White-tailed Eagle (VU), Flamingo (NT, LC), Stork (LC), Sandpiper (NT, LC), Starling (LC), Wren (LC), Flora: Mangroves (LC)	• Classified as a marine sanctuary under the Wildlife (Protection) Act, 1972 • Region of national and international significance for biodiversity, landscape, or cultural heritage • Designated as both a KBA and IBA
Sanjay Gandhi National Park	• Year Established / Area: 1969 / 8,700 ha • Purpose: Conservation of wildlife including rare species • Major Species (IUCN Category): • Fauna: Vulture (CR, EN, NT), White-tailed Eagle (VU), Dove (VU, LC), Drongo (LC), Painted Stork (LC), Kingfisher (NT), Crocodile (VU), Leopard (VU), Monkey (LC), Wild Boar (LC), Deer (VU, LC), Barking Deer (LC), Serow (VU), Turtle (LC), Gecko (LC) Flora: Teak (EN), Bamboo, Kino tree (NT)	• Classified as a reserved forest under the Indian Forest Act, 1927 • Region of national and international significance for biodiversity, landscape, or cultural heritage • Designated as both a KBA and IBA • IUCN Management Category II (National Park)

Source: keybiodiversityareas.org, IUCN



Source: Prepared by the JST based on the land use map received from MMRC, protected area data from keybiodiversityareas.org, and Google Earth

Figure 4.7.5 Alignment of Corridor 1 of Line 11 and Its Proximity to Mahul - Sewree Creek



Source: JST

Figure 4.7.6 Mahul - Sewree Creek

(2) Regulated Areas (Coastal Regulation Zone: CRZ)

As shown in the figure below, a portion of Corridor 1 passes through CRZ Category II or III areas. Category II (already developed urban areas) is defined as "areas that fall within the legally designated

limits of a town or municipality and where development has already extended up to the shoreline," and it is explicitly stated that construction is permitted. In particular, construction is permitted only on the landward side of existing roads or authorized structures, under which this Project is considered to fall. This Project is classified as an infrastructure project and constitutes a permitted activity. With respect to Category III (relatively undeveloped areas), construction related to fisheries facilities, as well as public infrastructure such as roads and railways, is also permitted. Therefore, Categories II and III are not areas designated by national or local governments under laws or ordinances with the primary objective of nature conservation, but rather zones designated with the primary objective of promoting sustainable development. Accordingly, they do not fall under the category of protected areas as defined in the JICA Guidelines. However, from the perspective of development control and regulation of unplanned development, MMRCL is required to submit a Simplified Environmental Management Plan (EMP), including provisions for the handling of excavated soil and construction debris, mitigation measures for impacts on groundwater and surface water, and noise and vibration countermeasures, to the Maharashtra Coastal Zone Management Authority (MCZMA) and to the State Environment Impact Assessment Authority (SEIAA), and to obtain approval (CRZ clearance) prior to the commencement of any construction or development activities. In terms of the timeline for obtaining approval, it should be considered that preparation of the CRZ map and project layout plan, based on the finalized project land during the detailed design stage, will require approximately 1 to 1.5 months, followed by an additional 3 to 6 months for review and approval by the competent authorities. Accordingly, the process of obtaining CRZ clearance may take up to 7 to 8 months in total. Therefore, counting backward from the scheduled commencement of construction in June 2028, the project land boundaries must be finalized and the permit application process must commence no later than the end of September 2027.



Source: Prepared by the JST based on the National Centre for Sustainable Coastal Management

Figure 4.7.7 Coastal Regulation Zones (CRZ) along the Mumbai Metro Line 11 Corridor

4.7.2.2 Biodiversity

(1) Survey

1) Along Line 11

Ecological surveys were conducted along the alignment of Corridor 1 in May 2024 and July 2025. The survey covered an area of 100 meters on both sides of the selected alignment, and the identified flora and fauna species are shown in the table below. Most of the identified species are not classified as endangered. However, one plant species categorized as Vulnerable was identified. It was confirmed, however, that this species was artificially planted and does not constitute a wild species.

Table 4.7.25 Identified Flora and Fauna

No.	Taxonomic Category	Scientific Name	Common Name	IUCN Category
Fauna (tree)				
1. Anik Depot				
1	Fabaceae	*Samanea saman*	Rain tree	LC
2	Fabaceae	*Pongamia pinnata*	Karanj	-
3	Moraceae	*Ficus hispida*	Kala Umber	LC
4	Moraceae	*Ficus religiosa*	Pipal	LC
5	Caesalpiniaceae	*Delonix regia*	Gulmohar	LC
2. Wadala				
6	Meliaceae	*Azadirachta indica*	Neem	LC
7	Malvaceae	*Thespesia populnea*	Indian Tulip Tree	LC
8	Moringaceae	*Moringa oleifera*	Shevga	LC
	Moraceae	*Ficus religiosa*	Pipal	LC
3. CGS Colony				
	Malvaceae	*Thespesia populnea*	Indian Tulip Tree	LC
	Moringaceae	*Moringa oleifera*	Shevga	LC
	Meliaceae	*Azadirachta indica*	Neem	LC
	Caesalpiniaceae	*Delonix regia*	Gulmohar	LC
	Moraceae	*Ficus hispida*	Kala Umber	LC
	Moraceae	*Ficus religiosa*	Pipal	LC
	Fabaceae	*Pongamia pinnata*	Karanj	-
9	Magnoliaceae	*Michelia champaca*	Champa	LC
10	Fabaceae	*Pithecellobium dulce*	Vilayati Chinch	LC
11	Annonaceae	*Polyanthia longifolia*	False Ashoka	NE
12	Caesalpiniaceae	*Peltophorum pterocarpum*	Pila gulmohar	LC
4. Ganesh Nagar				
	Fabaceae	*Samanea saman*	Rain tree	LC
	Moraceae	*Ficus religiosa*	Pipal	LC
5. BPT Hospital				
	Fabaceae	*Samanea saman*	Rain tree	LC
	Annonaceae	*Polyanthia longifolia*	False Ashoka	NE
13	Arecaceae	*Caryota urens*	Fish Tail Farm	LC
	Fabaceae	*Pongamia pinnata*	Karanj	-
	Magnoliaceae	*Michelia champaca*	Champa	LC
	Fabaceae	*Pithecellobium dulce*	Vilayati Chinch	LC
	Annonaceae	*Polyanthia longifolia*	False Ashoka	NE
6. Sewri				
14	Anacardiaceae	*Mangifera indica*	Mango	DD
15	Combretaceae	*Terminalia catappa*	Almond	LC
7. Hay Bunder				
	Malvaceae	*Thespesia populnea*	Indian Tulip Tree	LC
	Caesalpiniaceae	*Peltophorum pterocarpum*	Pila gulmohar	LC
	Moringaceae	*Moringa oleifera*	Shevga	LC
16	Moraceae	*Ficus benghalensis*	Banyan	NE
	Combretaceae	*Terminalia catappa*	Almond	LC
	Fabaceae	*Samanea saman*	Rain tree	LC

No.	Taxonomic Category	Scientific Name	Common Name	IUCN Category
8. Darukhana				
	Caesalpiniaceae	*Peltophorum pterocarpum*	Pila gulmohar	LC
17	terculiaceae	*Pterospermum acerifolium*	Muchkund tree	LC
	Malvaceae	*Thespesia populnea*	Indian Tulip Tree	LC
9. Byculla				
	Caesalpiniaceae	*Peltophorum pterocarpum*	Pila gulmohar	LC
	Fabaceae	*Samanea saman*	Rain tree	LC
	Moraceae	*Ficus benghalensis*	Banyan	NE
	Combretaceae	*Terminalia catappa*	Almond	LC
	Moraceae	*Ficus religiosa*	Pipal	LC
10. Nagpada Junction				
18	Lecythidaceae	*Barringtonia acutangula*	Samundra Phal	LC
19	Sterculiaceae	*Stercularia foetida*	Jungli Badam	-
	Caesalpiniaceae	*Peltophorum pterocarpum*	Pila gulmohar	LC
11. Bhendi Bazaar				
	Sterculiaceae	*Stercularia foetida*	Jungli Badam	-
	Annonaceae	*Polyanthia longifolia*	False Ashoka	NE
20	Apocynaceae	*Tabernaemontana divaricata*	Tagar	LC
21	Moraceae	*Ficus racemosa*	Umber	LC
12. CSMT Metro				
	Caesalpiniaceae	*Peltophorum pterocarpum*	Pila gulmohar	LC
22	Apocynaceae	*Alstonia scholaris*	Saptaparni	LC
	Moraceae	*Ficus religiosa*	Pipal	LC
	Magnoliaceae	*Michelia champaca*	Champa	LC
	Sterculiaceae	*Stercularia foetida*	Jungli Badam	-
13. Horniman Circle				
	Moraceae	*Ficus religiosa*	Pipal	LC
	Fabaceae	*Pongamia pinnata*	Karanj	-
	Caesalpiniaceae	*Peltophorum pterocarpum*	Pila gulmohar	LC
	Sterculiaceae	*Stercularia foetida*	Jungli Badam	-
	Moraceae	*Ficus benghalensis*	Banyan	NE
	Combretaceae	*Terminalia cataapa*	Almond	LC
	Anacardiaceae	*Mangifera indica*	Mango	DD
23	Caesalpiniaceae	*Senna siamea*	Kasod	-
14. Gateway of India				
	Magnoliaceae	*Michelia champaca*	Champa	LC
24	Aracaceae	*Roystonea regia*	Royal Palm	LC
	Sterculiaceae	*Stercularia foetida*	Jungli Badam	-
25	Aracaceae	*Cocos nucifera*	Coconut Palm	NE
	Caesalpiniaceae	*Peltophorum pterocarpum*	Pila gulmohar	LC
26	Lythraceae	*Lagerstroemia speciosa*	Tamhan	LC
	Malvaceae	*Thespesia populnea*	Indian Tulip Tree	LC
	Moraceae	*Ficus racemosa*	Umber	LC
27	Sapotaceae	*Mimusops elengi*	Bakul	LC
	Caesalpiniaceae	*Saraca asoca*	Sita ashoka	VU

No.	Taxonomic Category	Scientific Name	Common Name	IUCN Category
Fauna				
Mammal				
1	Rodentia	*Squirrels, rats, and other rodents*		
2	Chiroptera	*Bats and other chiropterans*		
Reptiles				
Dry Season				
1	Agamidae	*Calotes versicolor*	Garden Lizard	LC
2	Scincidae	*Mabuya carinata*	Common Skink	LC
3	Colubridae	*Ptyas mucosa*	Indian rat snake	LC
Amphibians				
Dry Season				
1	Dicroglossidae	*Hoplobatrachus tigerinus*	Indian Bullfrog	LC
2	Bufonidae	*Duttaphrynus melanostictus*	Common Toad	LC
3	Hylidae	*Hyla arborea*	Green Frog	LC
Aves				
Dry Season				
1	Corvidae	*Corvus splendens*	House crow	LC
2	Columbidae	*Columba livia*	Rock Dove	LC
3	Accipitridae	*Milvus migrans*	Black Kite	LC
4	Sturnidae	*Acridotheres tristis*	Common Myna	LC
5	Cisticolidae	*Orthotomus sutorius*	Common Tailorbird	LC
6	Pycnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	LC
7	Alcedinidae	*Halcyon smyrnensi*	White-throated Kingfisher	LC
8	Passeridae	*Passer domesticus*	House Sparrow	LC
9	Psittacidae	*Psittacula krameria*	Rose-ringed parakeet	LC
10	Dicruridae	*Dicrurus leucophaeus*	Ashy Drongo	LC
11	Cisticolidae	*Prinia socialis*	Ashy Prinia	LC
12	Cuculidae	*Eudynamys scolopaceus*	Asian Koel	LC
13	Apodidae	*Cypsiurus balasiensis*	Asian Palm Swift	LC
14	Accipitridae	*Haliastur indus*	Brahminy Kite	LC
15	Ardeidae	*Bubulcus ibis*	Cattle Egret	LC
16	Alcedinidae	*Alcedo atthis*	Common Kingfisher	LC
17	Megalaimidae	*Psilopogon haemacephalus*	Coppersmith Barbet	LC
Rainy Season				
18	Corvidae	*Corus spendens*	House Crow	LC
19	Passeridae	*Passer domesticus*	House Sparrow	LC
20	Columbidae	*Columba livia*	Pigeon	LC
21	Ardeidae	*Bubulcus ibis*	Cattle Egret	LC
22	Ardeidae	*Egretta garzetta*	Little Egret	LC
23	Ardeidae	*Ardeola grayii*	Black headed gull	LC
24	Accipitridae	*Milvus migrans*	Black Kite	LC
Insect				
Dry Season				
1	Calliphoridae	*Calliphora vomitoria*	Blue bottle fly	-
2	Sarcophagidae	*Sarcophaga carnaria*	Sarcophaga fly	-
3	Meloidae	-	Blister beetle	-
4	Chrysomelidae	*Bruchus rufimanus*	Bruchid Beetle	-

No.	Taxonomic Category	Scientific Name	Common Name	IUCN Category
5	Cerambycidae	-	Long horned beetle	-
6	Aphrophoridae	-	Spitting bug	-
7	Pseudococcidae	-	Mealy bug	-
8	Erebidae	*Spirama retorta*	Indian owlet moth	-
9	Crambidae	*Hymenoptychis sordida*	Pneumatophore moth	-
10	Geometridae	-	Geometrid moth	-
11	Erebidae	*Erebus macrops*	Indian owl moth	-
12	Crambidae	*Diaphania indica*	Cucumber moth	-
13	Erebidae	*Amata huebneri*	Wasp moth	-
14	Apidae	-	Carpenter bee	-
15	-	-	Damselfly	-
16	-	-	Termites	-
17	-	-	Aphids	-
18	Apidae	*Apis dorsata*	Rock honey bee	-
19	Apidae	*Apis mellifera*	Western honey bee	DD

Note: Vulnerable (VU), Least Concern (LC), Data Deficient (DD), Not Evaluated (NE)

Source: JST, Draft Environment Impact Assessment (EIA) for Metro Line 11 (Anik Depot to Gateway of India), Dec, 2024, MMRC, IUCN Red list

2) Veermata Jijabai Bhosale Udyan and Zoo

To the north of the planned Byculla Station site lies the Veermata Jijabai Bhosale Udyan, commonly known as Byculla Zoo, which functions both as a botanical garden and a zoological park. Established in 1861, this facility spans approximately 22 hectares and is home to a wide variety of animal species. Surrounded by beautifully maintained gardens, it is a popular destination for families, nature enthusiasts, and wildlife lovers. The area closest to Mumbai Metro Line 11 Corridor 1 within the zoo houses indoor enclosures for penguins. As previously mentioned, when the tunnel boring machine (TBM) passes approximately 25 meters underground near this vicinity, the anticipated vibration level is estimated to be between 55 dB and 60 dB. Given that the average depth of TBM passage for this project is 22 meters, the resulting vibration corresponds roughly to a seismic intensity of 1 (approximately 60 dB). Therefore, the impact is expected to be minor. Relevant countermeasures are outlined in the section on vibration. The figure below illustrates the layout of the zoo area, and the table presents the list of animal species currently housed at the facility.



Source: : Prepared by the JICA Study Team based on Google Earth

Figure 4.7.8 Veermata Jijabai Bhosale Udyan Botanical Garden and Zoo

Table 4.7.26 List of Bird, Mammal, and Reptile Species Housed at the Veermata Jijabai Bhosale Udyan Zoo (Byculla Zoo)

No.	Scientific Name	Common Name	IUCN Category
Aves			
1	*Anthracoceros malabaricus*	Hornbill Indian Pied	NT
2	*Pavo cristatus*	Indian Peafowl	LC
3	*Nycticorax nycticorax*	Heron Night	LC
4	*Psittacula eupatria*	Parakeet Alexandrine	NT
5	*Pelecanus onocrotalus*	Pelican Rosy / White	LC
6	*Leptoptilos dubius*	Stork Adjutant	NT
7	*Mycteria leucocephala*	Stork Painted	LC
8	*Melopsittacus undulates*	Budgerigar	LC
9	*Nymphicus hollandicus*	Cockatiel grey + White	-
10	*Grus japonicus*	Crane Crowned Red	LC
11	*Dromaius novaehollandiae*	Emu	LC
12	*Ara militaris*	Macaw Military	VU
13	*Psittacus erithacus*	Parrot African Grey	EN
14	*Spheniscus humboldti*	Humboldt Penguin	VU
15	*Chrysolophus pictus*	Pheasant Golden	LC
Mammals			
16	*Elephas maximus*	Elephant Indian	EN
17	*Macaca mulatta*	Macaque Rhesus	LC
18	*Panthera pardus*	Leopard	VU
19	*Canis lupus*	Golden Jackal	LC
20	*Melarsus ursinus*	Sloth Bear	VU
21	*Hyaena hyaena*	Striped Hyena	NT
22	*Panthera tigris tigris*	Royal Bengal Tiger	EN
23	*Muntiacus Muntjack*	Barking Deer	LC
24	*Cervus unicolor*	Sambar Deer	VU
25	*Axis axis*	Spotted Deer	LC

No.	Scientific Name	Common Name	IUCN Category
26	*Hippopotamus amphibius*	Hippopotamus	VU
Reptiles			
27	*Gavialis gangeticus*	Crocodile Long Snouted	CR
28	*Crocodylus palustris*	Crocodile Marsh (Mugger)	VU
29	*Python molurus*	Python Indian Rock	NT
30	*Ptyas mucosus*	Rat Snake	LC
31	*Melanochelys trijuga*	Turtle Indian Black	LC
32	*Lissemys punctata*	Indian Flapshell Turtle	VU
33	*Geochelone elegans*	Indian Star Tortoise	VU
34	*Trachemys scipta elegans*	Red Eared Slider	-

Note: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC)
Source: Annual Report for the Year 2024–2025, Veermata Jijabai Bhosale Botanical Udyan & Zoo



Entrance of Byculla Zoo



Interior of the Penguin Enclosure

Source: JST

Figure 4.7.9 Entrance of Veermata Jijabai Bhosale Botanical Udyan & Zoo and Penguin Enclosure

3) Tree Survey

In the proposed alignment of the Mumbai Metro Line 11, the majority of the route passes through urban areas or along arterial roads, and no passage through forested areas is envisaged. Therefore, large-scale forest clearance will not be required. According to the 2024 survey, a total of 1,905 trees is expected to be felled. The estimated number of trees to be felled at each station construction site is shown in the table below. However, the final number of trees to be removed will be confirmed following the detailed tree survey to be conducted in subsequent stages. With regard to compensatory afforestation, the Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975 (as amended in 2023) stipulates that "a number of trees equivalent to the age of the transplanted tree, of the same species or of other locally endemic/indigenous species, shall be planted, and transplantation shall only be undertaken under the supervision of experts." In accordance with this Act, the project proponent is required to submit documentation to the municipal tree management authority of Mumbai. Based on the age of the trees subject to transplantation or felling, the number of trees to be planted will be determined by the tree officers of the authority. According to MMRC, the following actions are planned: a detailed tree survey will be conducted to finalize the number of affected trees

and determine the required number of compensatory plantings based on tree age, after which an application will be submitted to the Tree Authority of the BMC. From the time of application to the issuance of the No Objection Certificate (NOC), approximately three to four months will be required, including on-site inspections by the BMC, public notifications, objection hearings, and deliberations. However, for large-scale projects such as this project, public interest tends to be high, often resulting in numerous objections and additional review procedures, and therefore, it is expected that the approval process may take several more months.

Table 4.7.27 Number of Trees to be Felled within the Construction Areas of Each Station of the Mumbai Metro Line 11

Station	Estimated Number of Trees to be Felled	Station	Estimated Number of Trees to be Felled
Anik Depot	623	Darukhana	65
Wadala	92	Byculla	98
CGS Colony	217	Nagpada Junction	69
Ganesh Nagar	67	Bhindi Bazar	17
BPT Hospital	191	CST Metro	75
Sewri	84	Horniman Circle	50
Hay Bunder	223	Gateway of India	34
		Sum	**1,905**

Source: JST, Draft Environment Impact Assessment (EIA) for Metro Line 11 (Anik Depot to Gateway of India), Dec, 2024, MMRC

(2) Prediction

In association with this Project, tree felling in urban areas and impacts on flora and fauna are anticipated. Accordingly, the following mitigation measures are proposed. In the case of the Mumbai Metro Line 3 Construction Project, more than 20,000 compensatory plantations were required as part of the environmental compliance conditions. However, as the availability of planting space along the urban corridor was limited, compensatory planting was carried out within the Goregaon area of Sanjay Gandhi National Park and within the jurisdiction of the Brihanmumbai Municipal Corporation (BMC), encompassing both Mumbai City and Mumbai Suburban areas, resulting in the planting of more than 23,000 trees. Similar compensatory plantation measures will be implemented for the present project in accordance with Tree act revised in 2023.

1) Mitigation Measures for Tree Felling and Compensatory Plantation

- Compensatory planting shall prioritize native and vulnerable species (Saraca asoca, Dalbergia latifolia).
- Plantation shall be carried out as far as possible within project areas such as station facilities and depots.
- In compliance with relevant laws, transplantation of mature trees shall be conducted step by step under the supervision of arboriculturist and horticulturist experts and continued with verification of survival rates.

2) Considerations for Fauna and Surrounding Ecosystems

- For adjacent facilities such as Byculla Zoo, low-vibration construction methods shall be

adopted, buffer materials installed, and continuous monitoring of vibration and noise conducted.

3) Preventive Measures

- To secure the required number of plantations, alternative sites such as public lands, parks, and school premises shall be utilized as much as possible. Green space development shall also be incorporated into surrounding station area plans and along other metro lines in Mumbai. This activity shall form part of the landscaping and beautification plan for each station and will be implemented after completion of the station construction works.
- Establishment of a dedicated structure: A specialized subcontractor independent from the construction JV shall be appointed exclusively for plantation works, with a separately allocated budget.
- Ensuring transparency in monitoring: A compliance report on compensatory plantation, accompanied by photographic documentation, shall be submitted to the BMC Tree Authority on a semi-annual basis.
- Mandatory maintenance: The General Consultant (GC) engaged by MMRC shall conduct regular audits on environmental and tree management activities as part of its routine duties.

4.7.2.3 Hydrology

(1) Entire Mumbai Metro Network

According to the Dynamic Ground Water Resources of Maharashtra, 2024, the total annual groundwater recharge in Mumbai is 14,777,000 m³, while the total annual groundwater extraction from the irrigation, industrial, and domestic sectors amounts to 6,801,400 m³. Therefore, the groundwater extraction rate is 46.0%. Based on the groundwater exploitation classification shown in the table below, Mumbai is categorized as a "Safe" area in terms of groundwater use.

Table 4.7.28 Category of Groundwater Exploitation Rate

Stage of Ground Water Extraction	Category
Less than 70%	Safe
From 70% to 90%	Semi-Critical
From 90% to 100%	Critical
Over 100%	Over Exploited

Source: DYNAMIC GROUND WATER RESOURCES OF MAHARASHTRA, 2024

(2) Underground Sections

Since impacts on the hydrogeological environment are anticipated in the areas surrounding the project site, including the TBM (Tunnel Boring Machine) sections, the following mitigation measures should be implemented:

- Install sheet piles at excavation sites to prevent groundwater inflow.
- Use a closed-type TBM to maintain underground water pressure.
- Monitor groundwater levels using construction wells.

(3) Depot area

Flood control measures for the depot are closely related to the design of the Finished Ground Level (FGL), retaining walls, and embankments, and therefore require careful consideration during the design stage:

- Finished Ground Level (FGL): The FGL should be set higher than the design flood level, with an appropriate drainage gradient and adjusted to match the existing ground level.
- Retaining Walls: These should be designed to prevent erosion, ensure structural stability, and enhance durability.
- Embankments: To reduce flood risk, embankments should be constructed with suitable materials and include slope protection.

In the operation phase, oil used during train washing and maintenance will result in oily wastewater, which must be filtered through oil pits and treatment tanks before being discharged into the drainage system.

4.7.2.4 Topography and Geology

(1) Topography

According to Section 2.2.3 "Geological Survey" of Chapter 2, the survey team reviewed the topographic and longitudinal drawings collected from MMRC. The survey was conducted mainly using drones, while in certain sections (from the RBI Monetary Museum to Regal Circle) it was carried out with a total station due to military confidentiality restrictions. The survey area covered a width of 70 m on either side of the track centerline and included the extraction of building and road boundaries as well as elevation measurements on a 10 m grid. In heritage conservation districts, restrictions on surveying imposed certain limitations, leaving some issues with accuracy. For Corridor 1, the necessary topographic data had already been obtained, and it was deemed sufficient for confirming land acquisition areas and identifying affected structures; therefore, no additional surveys were conducted. In this survey, information on ongoing building, bridge, and underground tunnel projects was also collected and incorporated into the survey drawings. For future detailed design, re-surveys are recommended for sections where surveying restrictions are in place. Moreover, given that numerous development projects are underway along the alignment, the updated drawings should be prepared.

(2) Geology

According to Section 2.2.3 "Geological Survey" of Chapter 2, Mumbai is underlain by basalt formed by volcanic activity approximately 65 million years ago, with the surface covered by reclaimed soil and alluvial deposits. For Corridor 1, in addition to the review of the 2018 DPR, MMRC planned a new geological survey in 2024, and investigations are currently being carried out at 110 locations. The subsurface is divided into layers of alluvial soil, weathered basalt, and basalt bedrock. While the overall geological condition is stable, localized areas of advanced weathering have been identified. Previous investigations (such as at Orange Gate and the MRT Line 3) confirmed that the ground consists of alluvium down to GL-10 m, weathered rock down to GL-15 m, and stable bedrock at greater depths.

Amygdaloidal basalt, though slightly weaker in strength, is evaluated together with basalt on the basis of strength and degree of weathering. In general, ground conditions are considered stable below GL-15 m, with minimal adverse impacts expected for underground tunnel construction. The uniaxial compressive strength of the bedrock exceeds 50 MN/m², classifying it as "Strong" and confirming that it possesses sufficient strength.

4.7.3 Social Environment

4.7.3.1 Land acquisition/ Resettlement

The land affected for this project is approximately 422.7 hectares, of which approximately 48 hectares are private land. The socio-economic baseline survey identified 801 affected households (2,718 individuals), of which 692 households (2,362 individuals) are subject to relocation. Informal settlement households constitute approximately 70.9% of the total, with the majority concentrated in Wadala Depot (69.9%) and Anik Depot (26.8%).

Table 4.7.29 Preliminary Information on Affected Private Land, Buildings, and Households

Impacts	Permanent	temporary	Total
Total Affected Land (m²)			**422,718**
Affected Public Land	203,528	170,818	374,346
Affected Private Land	23,664	24,708	48,372
Impacts	**Official**	**Unofficial**	**Total**
Total PAH (households)	233	568	801
Total PAP (people)	937	1,718	2,718
Relocated residents household	138	554	692
Relocated residents	603	1,759	2,362
Tenants	211	-	211
Households relocated for economic reasons	84	18	102
Vulnerable PAH	8	243	251
Worker / Employees*	-	-	376

* The socioeconomic baseline survey for Anik Depot has not been conducted; while the number of PAHs is included, the number of PAPs is not.

Source: Prepared by the JST based on the 2024–25 BSES

4.7.3.2 Poverty

According to the Socio-Economic Baseline Survey, the number of households below BPL is 251, the majority of whom are informal residents of Wadala Depot. The high proportion of low-income households indicates that economic support and livelihood assistance are crucial during the resident relocation and resettlement process.

4.7.3.3 Indigenous and ethnic people

Indigenous peoples are not impacted by the Project; therefore, the preparation of an Indigenous Peoples Plan (IPP) is not required.

4.7.3.4 Local economy such as employment and livelihood, etc.

The occupational composition of PAHs is diverse, with the largest group being regular employees or service-related workers (30.7%), followed by housewife (17.3%), Unskilled labor (17.3%), Business (16.3%), and Skilled labour (15.5%). Other notable occupations include manual laborers, security personnel, and house maids, and skilled labor includes drivers, mechanics, tailors, caterers, etc. For households undergoing economic relocation due to land acquisition or resident resettlement, appropriate support tailored to the household's capabilities and circumstances, along with opportunities for vocational training is required.

4.7.3.5 Land use and utilization of local resources

As this Project is to be implemented in an already urbanized area, it will not result in significant changes in land use. Based on the results of site reconnaissance and interviews conducted with local farmers regarding the utilization of regional resources, all interviewees expressed the view that no loss of land use or local resources is expected as a result of the Project.

4.7.3.6 Water use and its rights

According to Socio-Economic Baseline Surveys, it has been confirmed that nearby river water and lake water are not used for economic purposes such as fishing. They are also not used for daily activities like laundry or dishwashing. For drinking water, tap water supplied via water pipelines is used.

4.7.3.7 Existing social infrastructure and services

Field surveys revealed the presence of 2 hospitals, 12 educational facilities including schools and universities, and 8 religious facilities along Corridor 1. As stated in the Noise and Vibration section, some noise impact is anticipated during both construction and operation phases. Therefore, necessary mitigation measures must be implemented during both stages. During the construction period, to ensure safe access to facilities requiring special consideration, such as hospitals and schools, traffic guidance and warning signs will be installed. Additionally, measures such as detour routes based on traffic congestion conditions should be implemented as necessary.

4.7.3.8 Maldistribution of benefit and damage

According to interviews conducted at the station surveys and stake holder meetings, during the construction phase, temporary negative impacts such as noise, dust, and traffic restrictions are expected to reduce ease of access, raising concerns that foot traffic to roadside shops may decline, thereby adversely affecting existing businesses. Additionally, in areas surrounding the construction site, an increase in waste and deterioration of sanitary conditions have been pointed out as factors that could lower the quality of life for local residents.
On the other hand, some shop owners expressed expectations of increased income, as construction workers may become new customers, suggesting short-term economic benefits.

During the operation phase, improvements in traffic convenience and comfort are anticipated to result in increased customer flow and expanded commercial opportunities, particularly for businesses located

near stations. Furthermore, the rise in land prices is expected to benefit landowners and property holders through increased asset value.

However, there are also concerns that rent increases may place economic pressure on existing tenants. In light of such uneven distribution of benefits and adverse impacts, the implementation of appropriate mitigation measures is required.

4.7.3.9 Local conflict of interest

In relation to the above, considering the interests of various stakeholders within the community, traffic congestion during the construction phase is recognized as a significant concern for both residents and business operators. Specific measures, such as traffic control and the establishment of detour routes, are necessary to minimize negative environmental and living impacts, including noise and increases in commuting/travel time. With regard to business activities, factors such as the placement and scale of construction barriers can have a considerable impact, therefore, a thorough explanation to stakeholders and a comprehensive consensus-building process are essential prior to implementation.

In the operation phase, the project is expected to bring significant benefits after the commencement of operations, including an improvement in air and noise quality due to the reduction in road traffic volume. This represents a clear advantage that directly contributes to the improved quality of life for the entire community.

In the target area, it is common for long-term tenants to occupy properties at relatively low rental rates. From the project, the landowners may desire to review rental agreements and revise terms, including rent adjustments, based on market principles. However, the state of Maharashtra has legal protections such as the Maharashtra Rent Control Act (1999) exist to prevent unjustified rent hikes. Therefore, when revising rent or renewing lease contracts, it is important to respect the rights of tenants and consider the implementation of fair adjustment mechanisms.

In case of any disputes arise during the project, it is required that a fair and swift resolution is sought through mediation, in accordance with the Grievance Redress Mechanism (GRM) (Refer to 4.18.5).

4.7.3.10 Cultural Heritage

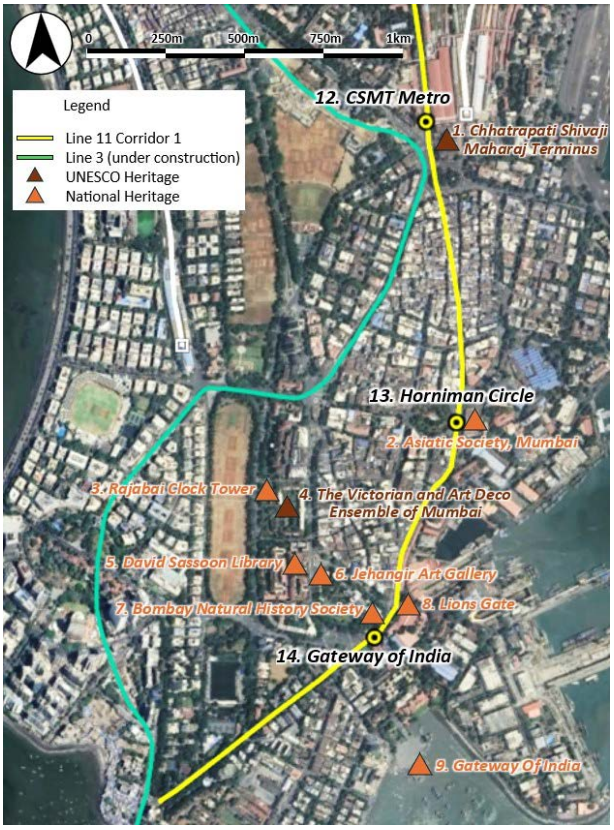
(1) Overview of Cultural Heritage

There are nine heritage buildings along Corridor-1 of Line 11, as shown in the table below, including the Chhatrapati-Sivaji Terminus (CSMT) Station and the Victorian and Art Deco Ensemble of Mumbai (VADEM), a UNESCO-listed World Heritage Site. The CSMT station was inscribed on the World Heritage List in 2004, as an outstanding example of late 19th-century railroad architecture in the British Commonwealth, reflecting the interplay between Victorian Gothic Revival architecture and traditional Indian architectural influences. Regarding VADEM, reflecting the development of architecture and urban planning over two centuries, it was inscribed on the World Heritage List in 2018 as an important example of the exchange of human values between Europe and India.

Table 4.7.30 Lists of heritage buildings along the alignment Line 11 Corridor-1

No.	Name of structure	Category	Structure Use	Closest St.	Distance from alignment
1	Chhatrapati Shivaji Maharaj Terminus	UNESCO	Station	CSMT	156m
2	Asiatic Society, Mumbai	National	Library	Horniman Circle	42m
3	Rajabai Clock Tower	National	Tower	Regal Circle	523m
4	The Victorian and Art Deco Ensemble of Mumbai	UNESCO	Collection of buildings	Regal Circle	281m
5	David Sasoon Library	National	Library	Regal Circle	280m
6	Jehangir Art Gallery	National	Gallery	Regal Circle	280m
7	Bombay Natural History Society	National	NGO center	Regal Circle	194m
8	Lions Gate	National	Gate	Regal Circle	290m
9	Gateway of India	National	Arch-monument	Regal Circle	428m

Source: JST



Source: JST

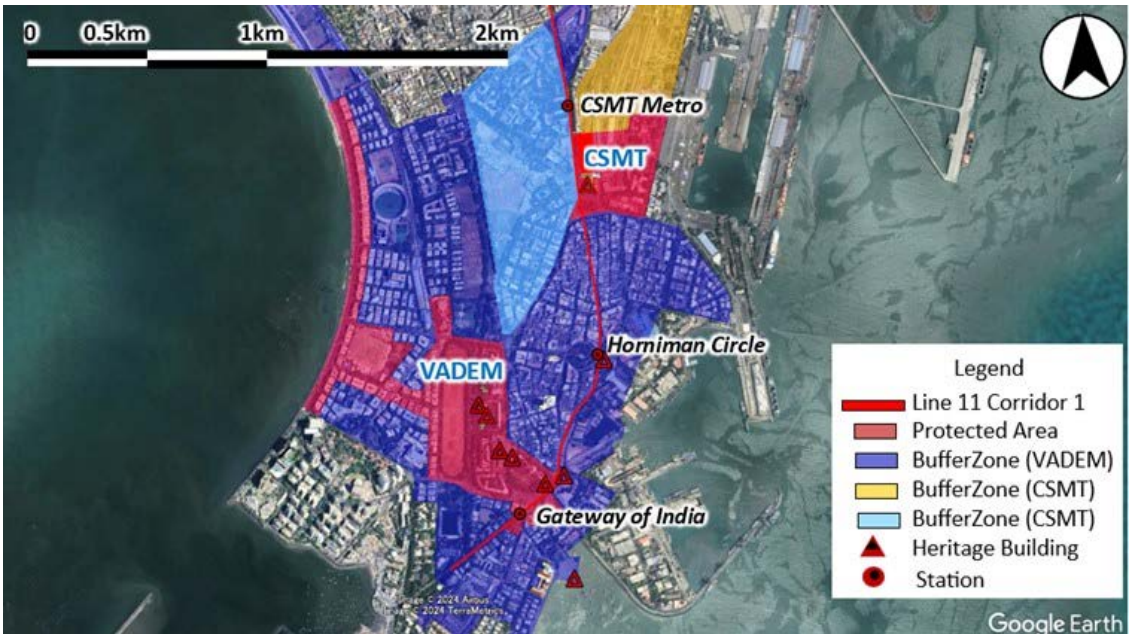
Figure 4.7.10 Map of heritage buildings along the alignment Line 11 Corridor-1

(2) World Heritage Regulations and Guidelines

1) UNESCO Regulations

World Heritage Sites are required to have World Heritage Area (Protected Area) containing the Property and Buffer Zone. According to UNESCO's Operational Guidelines for the Implementation of the World Heritage Convention (revised in 2023), a World Heritage Area is defined as a property on the World Heritage List with appropriate boundaries established to ensure its protection and management through appropriate long-term legislative, regulatory, institutional, and/or traditional

means. It is stated that the boundaries should be established to ensure that the outstanding universal value and integrity and/or authenticity of the property are adequately represented. Buffer zones are defined as areas surrounding a nominated property that have been established through legal or customary means to regulate complementary uses and development for the purpose of effective protection of the nominated property. The buffer zones are described as areas in the immediate vicinity of the property that should include important landscapes and areas or features that have important functions that support the property and its protection. The World Heritage Areas and Buffer Zones of CSMT and VADEM are as shown in the figure below. They were established by the State of India at the time of application for World Heritage listing and approved by the International Council on Monuments and Sites (ICOMOS).



Source: JST

Figure 4.7.11 Map of protected areas and buffer zones of World Heritage Sites

Although not directly stated in UNESCO's World Heritage Convention (1972) and its Operational Guidelines (revised 2023), Article 5 of the World Heritage Convention states that States Parties have an obligation to protect the World Heritage within their own countries by developing the necessary legal, scientific and technical means to preserve the heritage under conditions suitable to their own. In addition, the Operational Guidelines for the Implementation of the World Heritage Convention include conditions, assessments, and response measures for implementing development projects planned for implementation in and around heritage sites, confirming that the Convention does not prohibit development activities in and around heritage sites. According to the Guidance and Toolkit for Impact Assessment in the World Heritage Context (2022), States Parties are obliged to notify the UNESCO World Heritage Centre before considering any proposed action that may affect a World Heritage property. The Center will review this information in close coordination with the Advisory Bodies and, if it considers that the situation at the World Heritage Site warrants the attention of the World Heritage Committee, States Parties will submit a report on the conservation status of the property at the Committee's next meeting. Following its review of the case, the Committee may take

any action contemplated, including requesting an impact assessment or recommending a review of an existing impact assessment. If the Committee requests an impact assessment, it states that the Party is responsible for carrying out the impact assessment as requested by the Committee in accordance with the latest version of the Guidance and submitting the results for review. According to interviews conducted during the survey with heritage conservation consultants Abha Narain Lambah Associates, this project is integrated into Mumbai's urban planning. When the CSMT and VADEM were inscribed as World Heritage sites, the Mumbai Metro project plan was also submitted to UNESCO and approved prior to the inscription. Therefore, UNESCO is aware of this project plan.

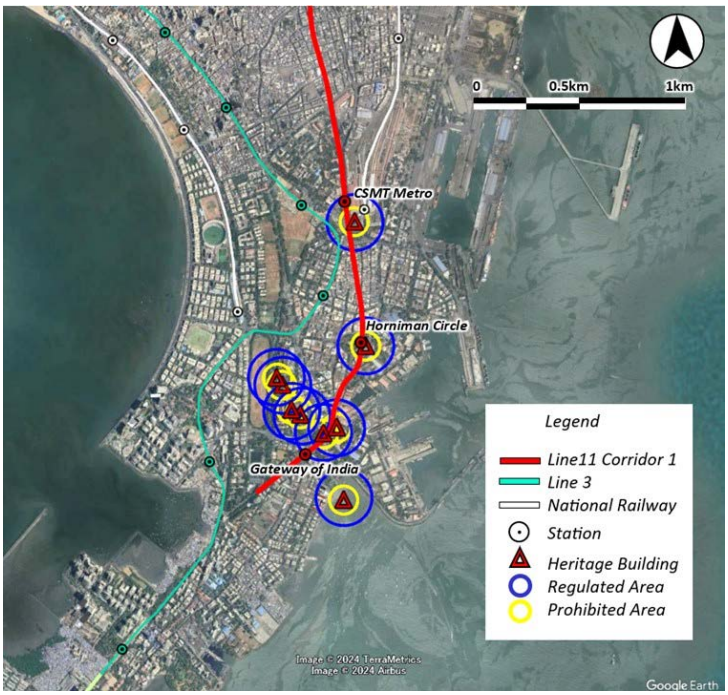
2) Regulations under Indian domestic law

According to the Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010, a national law of India, all construction projects are restricted within 100m from the boundary of the Prohibited Area and 200m from the boundary of the Regulated Area of the heritage site, and permission must be obtained before any project can be undertaken. Prohibited Area is defined as the area within 100m in all directions of the heritage site, and in principle it is a non-construction area. In exceptional cases, when the central government determines that it is necessary and convenient to carry out public works, etc., and that there will be no significant adverse impact on the preservation, safety, or access to the heritage surroundings, it may issue an order and permit construction work to be carried out in the area, considering the public benefit.

The Regulated Area is defined as an area within 200m on all sides of the heritage site, and construction work can be carried out within the Regulated Area upon application to and approval from the competent authorities. The following figure shows the regulated construction area for this project in accordance with the above-mentioned domestic laws. For the Horniman Circle station, the planned station site overlaps the Prohibited Area, so it is necessary to confirm whether construction can be implemented and to consider mitigation measures. On the other hand, the CSMT Metro Station and Regal Circle Station are included in the regulated area of the CSMT and VADEM, which are World Heritage sites, but not in the prohibited area, so the impact of the project is mitigated. MMRC, through Brihanmumbai Municipal Corporation (BMC), is required to consult with the Mumbai Heritage Conservation Committee (MHCC) regarding the necessary procedures in accordance with national law, and based on the advice of the MHCC, the project is to be implemented after obtaining the necessary approvals. MMRC has confirmed that similar procedures have been implemented for Metro Line 3. For the Metro Line 11, MMRC has confirmed to BMC that MMRC will submit the necessary documents for the approval procedures, such as the list of affected buildings for this project, and will proceed with the MHCC's deliberation and confirmation procedures during the DD phase. MMRC will consider mitigation measures for the targeted historical and cultural heritage sites in this study, together with confirmation of the necessary procedures.

Regarding the impact of this project on cultural heritage, there is a possibility that noise and vibration may affect historical buildings and other structures within the World Heritage site mentioned above during construction and after the metro begins operation. Therefore, it is necessary to implement

mitigation measures appropriate for each stage of construction and operation. During construction, measures will be taken to minimize the impact of noise and vibration and to preserve buildings and other structures. During metro operation, the impact of vibration will be monitored. However, since this project is an underground metro project and distance to the cultural heritage will be taken enough, there will be no other affect to the cultural heritage.



Source: JST

Figure 4.7.12 Line 11 Corridor-1 Heritage building construction regulation area

(3) Consistency with JICA Guideline

1) JICA Guidelines FAQ Exceptions

The provisions in Appendix 1 “Consistency with Laws, Standards, Plans, etc.” of the JICA Environmental and Social Considerations Guidelines (2022) state: "Projects must, in principle, be implemented outside areas specifically designated by the government through laws, standards, etc., for the purpose of nature conservation or cultural heritage protection (except where the project's primary purpose is to enhance or restore the protection of such designated areas). Furthermore, projects must not cause significant impacts on such designated areas."

CSMT and VADEM are areas listed on the World Heritage List established under the UNESCO World Heritage Convention. Since the alignment and stations of Line 11 Corridor 1 are located within their respective protected areas, as stated in the FAQ of the JICA Environmental and Social Considerations Guidelines (2022) shown in Table 5.1.1, the project must meet the exception provisions for implementation within protected areas when unavoidable.

Table 4.7.31 JICA Guidelines FAQ: Five Conditions for Exceptionally Permitting Project Implementation in Protected Areas

Questions	Answers
The project must, in principle, be implemented outside the designated area, except in cases where the primary purpose is to enhance or restore the protection of areas specifically designated by the host country's government through laws and regulations for the purpose of nature conservation or cultural heritage protection. What are the exceptional circumstances under which implementation is permitted?	The provisions in Appendix 1 of the Environmental and Social Guidelines, "Consistency with Laws, Standards, Plans, etc.," state: "Projects must, in principle, be implemented outside areas specifically designated by the host country government through laws, regulations, etc., for the purpose of enhancing or restoring the protection of nature or cultural heritage, except where the primary objective of the project is to enhance or restore the protection of such designated areas. Furthermore, projects must not have a significant impact on such designated areas." Project formulation and implementation within such areas is permitted only when all of the following conditions are met, referencing provisions such as those of the International Finance Corporation (IFC): There exists no feasible alternative location for implementation outside areas specifically designated by the host country government through laws, regulations, etc., for the purpose of protecting nature or cultural heritage (hereinafter referred to as "the designated area"). Development activities within the designated area are permitted under the host country's domestic laws. The project implementing agency must comply with laws, ordinances, protected area management plans, etc., concerning the area. The project implementing agency must consult with the management authority of the area, surrounding local communities, and other appropriate stakeholders, and obtain agreement on project implementation. The project implementing agency must implement additional programs as necessary to ensure the area is effectively managed according to its conservation objectives. ※1: IFC regulations include the following annotation: "Implementing additional programs may not be necessary for projects that do not create a new footprint."

Source: Frequently Asked Questions Regarding Environmental and Social Consideration Guidelines (July 20, 2011 (Revised January 4, 2022))

The results of the five condition evaluations shown in Table 4.7.32 are presented in the table below.

Table 4.7.32 JICA Guidelines' Five Conditions and Current Evaluation Results

Evaluation Criteria	Evaluation Results • Generally meets all criteria	Findings from this investigation
(1) There exists no feasible alternative plan in areas other than those specifically designated by the government through laws and regulations for the purpose of nature conservation or cultural heritage protection.	• As outlined in Chapter 4, ,no alternative alignments or station locations exist for the route passing through the protected area, nor for the station locations, due to economic considerations.	Alternative route proposals avoiding the protected area (refer to Chapter 4) were examined. However, due to significant natural, social, and economic impacts as described below, no alternative route capable of achieving the substantive objectives exists other than the route passing through the current World Heritage protected area. The following presents the assessment results regarding the negative impacts on nature and society, as well as the economic viability, of routes avoiding the protected area. [Natural Environment]: Because it does not connect to the CSMT Station, the national railway station with the highest passenger volume on Bombay Island, passenger demand falls significantly short, failing to contribute to greenhouse gas reduction. [Social Environment]: Resettlement /land acquisition and proximity to nature reserves present no significant difference from the plan passing through the World Heritage protected area and cannot be avoided. [Economic Impacts]: Since it does not connect to the CSMT station, passenger demand is significantly lower. Furthermore, access to the CSMT area requires walking, rickshaws, or taxis, making it susceptible to traffic congestion. This results in longer travel times compared to rail and lower convenience for passengers.

Evaluation Criteria	Evaluation Results • Generally meets all criteria	Findings from this investigation
(2) Development activities in the region must be permitted under the domestic laws of the partner country.	• UNESCO World Heritage Regulations and Operational Guidelines for Implementation, along with Indian domestic laws (such as the Ancient Monuments and Archaeological Sites and Remains Act) and development implementation guidelines for protected areas based on them, conditionally permit the construction of infrastructure within protected zones. Similarly, during the construction of Mumbai Metro Line 3, work was carried out within the CSMT regulated zone. The necessary documentation was submitted to the Mumbai Heritage Conservation Committee (MHCC), which reviews heritage conservation and development plans for Mumbai City. Construction proceeded only after obtaining a No Objection Certificate (NOC) and approval.	The UNESCO World Heritage Convention and its Operational Guidelines for Implementation state that the management and protection of heritage sites are entrusted to the States Parties, and do not prohibit development activities within or around the assets themselves. ① Convention Concerning the Protection of the World Cultural and Natural Heritage (1972) It states that "States Parties shall undertake the necessary legal, scientific, and technical measures appropriate to their own conditions to protect World Heritage sites within their territory and to ensure their conservation." (Article 5) ② Operational Guidelines for the Implementation of the World Heritage Convention (2022) "Environmental impact assessments, heritage impact assessments, and/or strategic environmental assessments shall be ensured as prerequisites for development projects planned within or in the vicinity of a property. These assessments shall identify potential positive and negative impacts of development alternatives on the Outstanding Universal Value of the property and recommend mitigation measures to prevent deterioration or other negative impacts on cultural assets or natural heritage within the property or its wider surroundings." It further states: "States Parties shall be obliged to notify the UNESCO Committee in advance when authorizing or undertaking major works that may affect World Heritage properties." ([II.F Protection and Management]Paragraphs 118bis and 172) Furthermore, the following domestic laws and guidelines contain provisions permitting development:① The Ancient Monuments And Archaeological Sites And Remains (Amendment And Validation) Act 2010 "Within the prohibited construction zones of protected areas, when deemed necessary or expedient for the execution of public works or projects essential to the public, consideration of the public interest may permit such public works or projects to be carried out within the prohibited zones by order." (Selection 20A.Declaration of prohibited area and carrying out public work or other works in prohibited area) ② Model Heritage Regulations 2011 Responsibilities, restrictions, permits, and other provisions regarding heritage and development within heritage zones are outlined. Section 8.2 details restrictions on development, redevelopment, repairs, etc., stating that "consultation with the Heritage Conservation Committee (in Mumbai, the Mumbai Heritage Conservation Committee) is required for development. Construction or other works may proceed only after obtaining permission based on the Heritage Conservation Committee's advice." (Section 8. Development Control)
(3) Project implementing agencies and other relevant parties shall comply with laws, ordinances, protected area management plans, and other regulations pertaining to the region.	• The project implementing agency (MMRC) will follow appropriate procedures and take necessary actions to comply with Indian domestic laws, the UNESCO World Heritage Convention, and the guidelines for its implementation.	MMRC plans to develop and comply with an environmental and social assessment following the processes outlined in the following laws and guidelines, primarily under the support of JICA. - Convention Concerning the Protection of the World Cultural and Natural Heritage 1972 - UNESCO Operational Guidelines for the Implementation of the World Heritage Convention 2023

Evaluation Criteria	Evaluation Results • Generally meets all criteria	Findings from this investigation
		- UNESCO Guidance and Toolkit for Impact Assessments in a World Heritage context 2022 - The Ancient Monuments and Archaeological Sites and Remains (Amendment And Validation) Act 2010 - Model Heritage Regulations 2011 - JICA Guidelines for Environmental and Social Considerations 2022
(4) The implementing agency and other relevant parties have consulted with the management authority of the region, the surrounding local communities, and other appropriate stakeholders, and have reached agreement on the project implementation.	• MMRC will conduct an environmental assessment in compliance with applicable laws and regulations, and plans to consult with and obtain agreement from local communities and other stakeholders during the process.	The reserve's administrators are the Municipal Corporation of Greater Mumbai and Indian Railways, with MHCC serving as the environmental assessment approval body. We will review the content of the EIA/SIA, engage in discussions with the operator, and seek confirmation to build consensus with stakeholders, such as BMC, MHCC, Heritage specialist consultants, Heritage Administrators, etc .
(5) To ensure the region is effectively managed in accordance with its conservation objectives, the project implementing agency and others shall implement additional programs as necessary.※1 ※ 1: In projects with no new occupancy, it may not be necessary to implement additional programs.	• MMRC implements mitigation measures in the environmental assessment process at the request of MHCC, the reviewing and approving authority for protected areas.	The mitigation measures and monitoring plans required for implementation within the ESIA to be prepared shall be discussed with the project implementing agency, protected area managers, and approving organizations, and implemented. Furthermore, if additional programs are necessary, discussions shall be held with relevant agencies to promote their implementation.

Source: Prepared by JST based on JICA Environmental and Social Considerations Guidelines 2022 FAQ

2) Indian Domestic laws

Regarding Condition 2 mentioned above (2) Development activities within the same region must be permitted under the domestic laws of the partner country, the confirmation details of India's laws and regulations, as well as the opinion of the project implementing agency, MMRC, are shown in the table below.

Table 4.7.33 Legal provisions concerning development within protected areas and the views of the Government of India, etc.

Related Laws and Regulations	Description (Excerpt)	MMRC's Viewpoint on Legislation
The Ancient Monuments and Archaeological Sites and Remains (Amendment And Validation) Act 2010	As stated below, the construction of public works within the protected area may be permitted. "PROHIBITED AND REGULATED AREAS" 20A. (3) In a case where the Central Government or the Director-General, as the case may be, is satisfied that-- (a) it is necessary or expedient for carrying out such public work or any project essential to the public; or (b) such other work or project, in its opinion, shall not have any substantial adverse impact on the preservation, safety, security of, or, access to, the monument or its immediate surrounding, it or he may, notwithstanding anything contained in sub-section (2), in exceptional cases and having regard to the public interest, by order and for reasons to be recorded in writing, permit, such public work or project essential to the public or other constructions, to be carried out in a prohibited area: Regarding the procedures for handling and preserving archaeological or historical discoveries made during construction, Chapter 6, Articles 21 to 25 state: "Upon discovering historical findings, promptly report them to the responsible federal government authority, and the government shall determine its acquisition authority." "Until acquisition authority is determined, the objects may not be moved without permission and must be securely stored in accordance with the orders of the responsible authority." "After acquisition authority is determined, the relevant authorities shall consult on subsequent measures."	(1) We recognize that the Mumbai Metro Line 11 Corridor 1 project is a public works initiative that also benefits the public. (2) We recognize that obtaining the necessary permits and approvals for construction and also procedure for responding to historical discoveries during construction is required under the Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act. (3) We plan to proceed with the necessary procedures once the alignment and station locations have been finalized.
Model Heritage Regulations 2011	The following outlines the permit and approval procedures for development within heritage sites and protected areas. 8 DEVELOPMENT CONTROL 8.4 DEVELOPMENT PERMISSION FOR HERITAGE PRECINCTS / NATURAL FEATURE AREAS In case of notified streets, precincts, areas and natural feature areas, development permissions shall be granted in accordance with Urban Design Guidelines prescribed for respective streets, precincts / natural feature areas which shall be framed by the Commissioner/CEO, Municipal Corporation / Municipal Council / Nagar Panchayat or Vice-Chairman, Development Authority or District Collector on the advice of the Heritage Conservation Committee. Before finalizing the same, the draft shall be published in the official gazette and in leading newspapers in English and the local language for the purpose of inviting objections and suggestions from the public. All objections and suggestions received from public within a period of 30 days from the date of publication in the official gazette shall be considered by the Commissioner/CEO, Municipal Corporation / Municipal Council / Nagar Panchayat/ Vice-Chairman, Development Authority / District Collector / Heritage Conservation Committee.	(1) We acknowledge that the permits and procedures listed on the right require approval from the Mumbai authorities, following advice from the Mumbai Heritage Conservation Committee (MHCC). (2) During the construction of Mumbai Metro Line 3 in the past, similar procedures were followed for construction in the CSMT area, resulting in the issuance of a No Objection Certificate (NOC) and approval prior to construction.

Related Laws and Regulations	Description (Excerpt)	MMRC's Viewpoint on Legislation
	After consideration of the above suggestions and objections, the agency concerned, acting on the advice of the Heritage Conservation Committee shall modify, if necessary, the aforesaid Urban Design Guidelines for streets, precincts, and natural features areas and forward the same to Government for notification. Provided that pending consideration of suggestions and objections and pending final sanction of the Government, the commissioner/CEO, Municipal Corporation / Municipal Council / Nagar Panchayat or Vice-Chairman, Development Authority or District Collector/ Heritage Conservation Committee shall give due regard to the draft regulations while considering applications for development / redevelopment etc. of heritage buildings, streets, heritage precincts, areas, listed natural features.	

Source: JST

Below is an overview of the process by which MMRC obtained a No Objection Certificate (NOC) in accordance with domestic law for the construction of Mumbai Metro Line 3, which passes through the heritage area. MMRC requested an NOC application to MHCC. In response, MHCC expressed concern that the alignment would pass through Dr. D.N. Road in front of the CSMT World Heritage Station and requested the following:

- Consideration of an open-space route to minimize impact on the heritage zone
- Information on the locations of open-cut and tunnel construction sections
- Map of heritage structures and heritage areas along Route 3, along with preservation and restoration strategies for damage
- Information on the design of above-ground structures that do not obstruct sidewalks

MMRC provided necessary information in collaboration with historical building experts. Furthermore, after reviewing alternative proposals, it explained that the current plan is the optimal solution. This conclusion was based on the significant impact route changes would have on commuter convenience and intermodal connectivity, as well as the potential effects on other heritage structures due to narrow road widths elsewhere. The explanation included construction mitigation measures. In response, MHCC maintained its position that further consideration of alternative plans is necessary and stated that construction would only be permitted if excavation work on Dr. D.N. Road is not carried out.

MMRC, noting that one year had passed without clear agreement from MHCC, requested a joint site inspection by the Municipal Commissioner and sought consideration based on D.C. Regulation No. 67(2). This regulation allows the Municipal Commissioner to approve construction within the archaeological site area as a special case, regardless of MHCC's advice. The site inspection primarily confirmed the following points:

- The station entrances and exits are exclusively via elevators, with locations determined considering road width, tree placement, and pedestrian flow.
- Dr. D.N. The road width is sufficient, and there will be no impact on historical structures along the roadside during construction.

- Above-ground structures such as stairs and elevators can be designed to minimize visual impact on the heritage district and respect the historical context in terms of design, scale, and materials.
- All archaeological or historical finds discovered during construction will be preserved.

The Municipal Commissioner, having reviewed the results of the site inspection and received a detailed explanation of the construction works from MMRC, confirmed that Metro Line 3 is of paramount importance to Mumbai and that no other viable alternative exists. Consequently, the Commissioner issued the NOC subject to the following conditions.

- The design and height of above-ground structures such as stairwells, elevator and escalator openings, and ramps require timely approval from MHCC
- MMRC shall take measures to ensure that the historical structures along Dr. D.N. Road are not structurally affected.
- MMRC shall take preventive measures to minimize disruption to traffic flow and pedestrian movement on Dr. D.N. Road during construction.
- MMRC shall implement special measures for the continuous monitoring of historical structures under construction, involving experts in the field.

4.7.3.11 Gender

In Mumbai's public transportation system, gender-sensitive measures are advancing, including the introduction of priority seating for women on buses and women-only buses. On railways, all trains attach women-only cars, and the metro also provides designated women-only spaces. Furthermore, other examples within India's metro and railway systems include gender-sensitive measures at station facilities such as separate restrooms for men and women, unisex restrooms, and nursing rooms. Measures to ensure women can use facilities safely, such as deploying female security personnel, installing bright lighting, and introducing CCTV, are also being advanced. Surveys targeting women showed high demand for gender-sensitive measures like women-only cars, separate restrooms, and female security personnel. Therefore, these considerations must also be incorporated into this project.

4.7.3.12 Children's right

India's Child and Adolescent Labor Act of 1986 was significantly amended in 2016. Under the amendments, children under the age of 14 are prohibited from working in all industries and occupations, and adolescents aged 14 to 18 are prohibited from working in hazardous industries such as chemical handling, mining, explosives and fireworks manufacturing, and high-temperature furnaces. All other work is legal under approved circumstances. On the other hand, according to data released by the Ministry of Labor and Employment in 2022, the number of registered cases of violations of the above domestic law in Maharashtra State has been decreasing year by year, with 90 cases in 2018, 53 cases in 2019, and 29 cases in 2020[46]. However, it is also possible that there are cases that have not been detected or reported.

[46] Rehabilitation of Child Labourers, Ministry of Labour & Employment (https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1807727&utm_) （Viewed in July 2025）

To ensure that the employment opportunities created by this project are limited to workers who meet the minimum age requirement and do not include children, the contract with the contractor must include the conditions specified in the aforementioned law.

4.7.3.13 Health (Infectious diseases such as HIV/AIDS, etc.)

Based on the results of the interview survey conducted with healthcare workers and station surveys, the majority of respondents did not report any specific cases of hygiene issues or infectious diseases. However, COVID-19 (including its variants) was cited as a commonly prevalent infection in the community. In addition, concerns were raised regarding mosquito-borne diseases such as dengue fever and malaria during the construction period.

Furthermore, HIV/AIDS is recognized as a public health risk, and therefore, adequate consideration must be given to the risk of infection among temporary labor populations, including construction workers, through preventive awareness training programs and public health measures.

4.7.3.14 Labor environment including labor safety

The following laws and regulations govern the working environment: The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 (BOCW Act - Central), Contract Labor (Regulation & Abolition) Act, 1970, Inter-State Migrant Workmen Act, 1979, Minimum Wages Act 1948, The payment Wages Act 1936, ESIC 1948, WC 1923, Payment of Bonus Act 1965, Equal Remuneration Act 1976, Payment of Gratuity Act 1972, EPFO. These primary laws should be complied during construction. During construction, various working environments are anticipated, such as underground operations and work adapted to road traffic conditions. Consequently, various types of occupational safety risks exist. Consideration must be given to each risk, and appropriate environmental measures must be implemented.

(The Occupational Safety, Health and Working Conditions (OSH) Code, 2020, the Industrial Relations Code (2020), the Code on Social Security (2020), the Code on Wages (2019), though enacted by the Government of India, has not yet been notified for enforcement, as the corresponding Central and State Rules are under finalization. Accordingly, the provisions of the said Code shall not be applicable as of the date of this Contract. However, in the event that the OSH Code, 2020 and its Rules are notified and brought into force during the currency of this Contract, the Contractor shall ensure full compliance with all applicable provisions of the Code and associated Rules from the effective date of their enforcement, without any additional financial implications to the Employer.)

4.7.4 Others

4.7.4.1 Accidents

An examination of the trend in traffic accidents within Mumbai shows that the number of injury accidents and injured persons declined significantly in 2020. This reduction is considered to have resulted from the mobility restrictions associated with the COVID-19 pandemic. Thereafter, from 2021 onwards, the numbers began to increase again, and by 2023 they had reached a high level close to that

of 2019. On the other hand, the number of serious accidents and fatalities showed no significant fluctuations between 2019 and 2023, remaining largely stable throughout the years. This indicates that while the occurrence of fatal accidents has been relatively stable, the overall trend in accidents is strongly influenced by the increase or decrease in non-fatal accidents. As described in the section on Waste Management, a substantial volume of excavated soil is expected to be generated from the depot, underground station construction sites, and other facilities. Consequently, the operation of transport vehicles for excavated soil may increase the potential risk of traffic accidents. It is therefore necessary to strengthen traffic safety through strict implementation of diversion plans approved by the relevant government authorities and by placing traffic control personnel at the entrances and exits of construction sites. Also, accidents occurred at construction site i.e., working at height, release of toxic gases & deficiencies of oxygen in confined spaces, failure of lifting hoisting through cranes/gantries, opening of cutouts, electrocution, fire, etc., so to prevent following steps shall be followed at site;

- Method Statement, SOP & work permit, lifting plan shall be followed
- Monitoring for oxygen deficiency, toxic gases & dust levels with continuous monitoring & alarms
- Awareness training shall be conducted.
- Safety posters & signages shall be displayed
- Barricading/closed of opening cutouts
- Mock drills shall be conducted timely
- Fire & Electrical prevention
- Record near misses and implement CAPA (Corrective and Preventive Actions).

During the operation stage, accidents caused by passengers falling from the platform are anticipated. However, for Mumbai Metro Line 11, as with Line 3, all stations will be equipped with full-height platform screen doors. This measure will physically prevent contact between trains and passengers.

Table 4.7.34 Traffic Accident Statistics in Mumbai

Items	2019	2020	2021	2022	2023
The number of injury accidents	2,336	1,388	1,668	1,509	2,125
The number of injured	2,925	1,740	1,944	1,715	2,611
The number of serious accidents	420	338	377	351	351
Death toll	447	350	387	365	374

Source: Mumbai Road Safety Annual Report 2023, Mumbai Police Traffic Control Division

4.7.4.2 Cross-border impact and climate change

Given that the Project is expected to contribute to a significant reduction in greenhouse gas (GHG) emissions, it may be classified as a climate change mitigation project. Therefore, based on the "JICA Climate-FIT (Climate Finance Impact Tool) – Mitigation Version 6.0, 3. Modal Shift through Railway, etc. (Passenger)" (hereinafter referred to as the "JICA Support Tool (Railway)"), an estimation of the Project's mitigation impact (i.e., GHG emission reductions and removals) was conducted as outlined below. In line with the planned opening year of 2032, the target years for estimation are set as 2032, 2042, and 2052.

(1) Applicability Conditions

This project satisfies the following applicability conditions stipulated in the JICA Support Tool for Climate Change Measures (Railway), and therefore, the tool is deemed appropriate for calculating the greenhouse gas (GHG) emission reductions resulting from the project:

① Development of transport system(s) that can realize an efficient urban or intercity passenger transport such as MRT (Mass Rapid Transit), railway, monorail, LRT (Light Rail Transit), BRT (Bus Rapid Transit) and trunk bus.

② The baseline transport modes should be buses, private cars, taxis, existing railways and aircrafts etc.

(2) Methodology of Emission Reduction Calculation

The emission reduction from the project activity is determined as the differences between the GHG emission of baseline scenario (e.g. existing mode of transportation such as buses, private car, taxi, motorbike) and project scenario (e.g. railway).

$$ER_y = BE_y - PE_y$$

ER_y : GHG emission reduction through the project in year y (t-CO_2e/y)

BE_y : GHG emission from the baseline scenario in year y (t-CO_2e/y)

PE_y : GHG emission from the project scenario in year y (t-CO_2e/y)

1) Calculation of Baseline Emission

Baseline GHG emission is calculated based on the transportation activity (in passenger-km or multiplying number of passenger and average trip distance) completed by the project 2, share of passengers by baseline transport modes and CO_2 emission factor per passenger-km. CO_2 emission factor per passenger-km can be set by dividing CO_2 emission factor per km by average occupation rate.

$$BE_y = \sum_i (BPKM_y \times MS_{i,y} \times EF_{PKM,i})$$

$BPKM_y$: Passenger transportation volume/activity by Corridor 1 in year y (passenger-km/y)

Table 4.7.35 BPKMy by Corridor 1 in year y (passenger-km/y)

BPKM y	Corridor 1
2032	1,626,300,963
2042	2,051,528,300
2052	2,304,474,152

Source: Prepared by the JST based on Draft EIA report for Mumbai Metro Line-11, Aug, 2024, MMRC

$MS_{i,y}$: Share of passengers by transport mode i in the baseline scenario in year y (%)

Table 4.7.36 Share of passengers by transport mode i in the baseline scenario in year y (%)

Transport mode	Share （%）
Private car	16
Bus	24
Motorcycle	21
Auto-rickshaw	19
National Railways	20

Source: Draft EIA report for Mumbai Metro Line-11, Aug, 2024, MMRC

$EF_{PKM,i}$: CO_2 emission factor of transport mode i (t-CO_2/passenger-km)

Table 4.7.37 CO_2 emission f3actor of transport mode i (t-CO_2/passenger-km)

Transport mode	CO_2 emission factor (t-CO_2/人 km)
Private car	0.0001300
Bus	0.0000570
Motorcycle	0.0000500
Auto-rickshaw	0.0000458
National Railways	0.0000170

Source: Based on the supplementary table of the Climate Change Mitigation Support Tool (JICA Climate-FIT) Version 6.0; the emission factor for auto-rickshaws is estimated based on the GoHUA guidelines.

Based on the above, the GHG emissions under the baseline scenario in year y are as shown in the table below.

Table 4.7.38 Baseline Emissions (BEy) for Mumbai Metro Line 11 in Year y (t-CO_2e/year)

***BE* y**	**Corridor 1**
2032	92,838
2042	117,114
2052	131,552

Source: JST

2) Calculation of Project Emission

Since data on electricity and fuel consumption associated with the operation (traction) of Corridor 1 is unavailable for this project, the project emissions during operation are estimated by multiplying the passenger-kilometers with the CO_2 emission factor per passenger-kilometer for rail-based transit systems.

$$PE_y = BPKM_y \times EF_{PKM,MRT}$$

$EF_{PKM,MRT}$: CO_2 emission factor of Corridor 1 (t-CO_2/passenger-km)

Based on the above, the GHG emissions under the project scenario for year y are as shown in the table below.

Table 4.7.39 Project Emissions (PEy) of Corridor 1 (Traction) in Year y (t-CO_2e/year)

BE y (traction)	Corridor 1
2032	27,647
2042	34,876
2052	39,176

Source: JST

On the other hand, based on documentation received from DMRC, it is observed that electricity consumption is approximately in a 60:40 ratio between traction and facilities. Accordingly, electricity consumption at stations, depots, and other facilities is estimated as shown below.

Table 4.7.40 A Brief of Energy Consumption of DMRC's lines

S.No.	Description			Unit (In MU) for (FY 2018-19)	% share
1	Traction			647.65	60.13%
2	Non Traction	a) Underground stations	213.20 MU	416.21	38.64%
		b) Elevated stations	102.15 MU		
		c) Property Development	71.21 MU		
		d) Depot and MB	29.65 MU		
3	Losses and error			13.27	1.23%
	Total			1,077.13	100.00%

Source: DMRC

Table 4.7.41 Project Emissions (PEy) of Corridor 1 (Non traction) in Year y (t-CO_2e/year)

BE y (Non traction)	Corridor 1
2032	18,431
2042	23,251
2052	26,117

Source: JST

Based on the above, the estimated CO_2 emission reductions for the Corridor 1 project are as shown in the table below. It is estimated that CO_2 emissions will be reduced by 46,759 tons in 2032, 58,987 tons in 2042, and 66,259 tons in 2052. Therefore, the Corridor 1 project is expected to make a significant contribution to the reduction of greenhouse gas emissions.

Table 4.7.42 Estimated ERy (t-CO_2e/y) for Corridor 1 in Year y

Year	*BE*	*PE* (traction)	*PE* (Non traction)	*ER*
2032	92,838	27,647	18,431	**46,759**
2042	117,114	34,876	23,251	**58,987**
2052	131,552	39,176	26,117	**66,259**

Source: JST

4.7.4.3 Disposal Sites, Casting Yards, Borrow Areas, and Quarries

(1) Disposal site

The candidate disposal sites for excavated construction soil are shown in Figure 4.7.1 and Table 4.7.7, and the surrounding environmental conditions of these sites are described in the following sections. It should be noted that the final disposal site will be designated by the Brihanmumbai Municipal

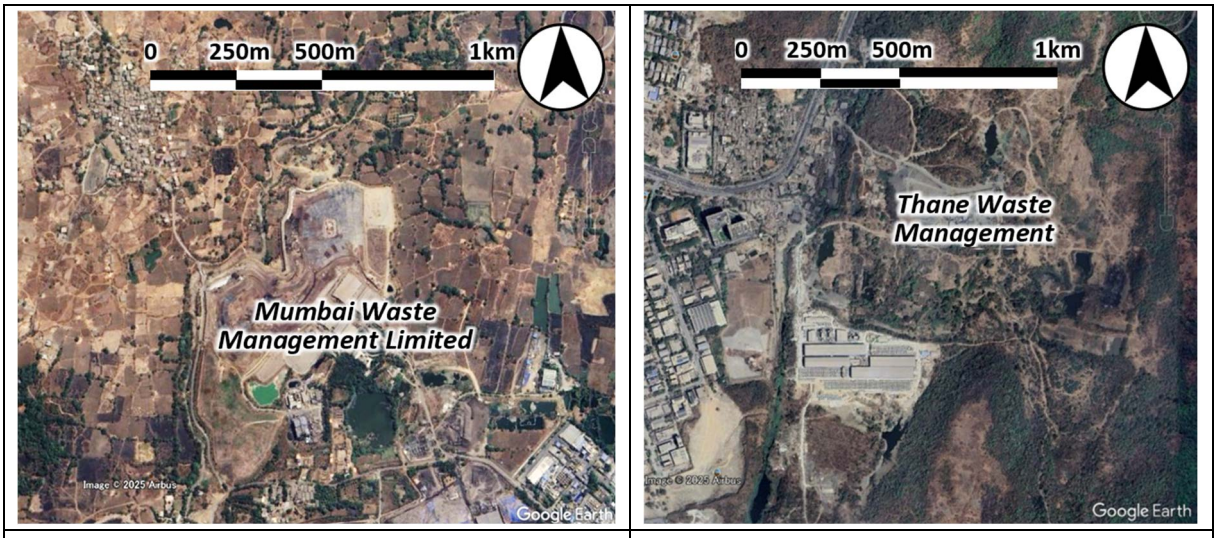
Corporation based on the procedures stipulated under the Construction and Demolition Waste Management Rules, 2025 (effective from 1 April 2026), prior to the commencement of construction works. Therefore, the candidate sites indicated herein are subject to change.

1) Mumbai Waste Management Limited

It is located approximately 25 km northeast of the Project area and is surrounded by agricultural land. The nearest residential settlement is situated approximately 0.5 km to the west-northwest.

2) Thane Waste Management

It is located approximately 18 km east-northeast of the Project area. The western side of the site is characterized by an industrial and residential zone, while the eastern hinterland is crossed by a low mountain range with an elevation of approximately 200 m. The nearest residential settlement is located approximately 0.5 km to the west-northwest.



Mumbai Waste Management Limited.	Thone Waste Management

Source: JST based on Google Earth

Figure 4.7.13 Candidate disposal sites

(2) Casting Yard

MMRC plans to continue using the casting yard currently utilized under the Mumbai Metro Line-3 Project. The location map and the surrounding environmental conditions are presented below. The entire area was originally used as a casting yard; however, over the years, the occupied area has gradually decreased, with the Mumbai Monorail depot now located to the west and high-rise residential developments established to the east, resulting in the present land use configuration.



Source: JST based on Google Earth

Figure 4.7.14 Candidate site of Casting Yard

(3) Borrow Areas, and Quarries

With regard to borrow areas and quarries, the selection and evaluation of potential sites will be carried out by the interim consultant or supervision consultant engaged directly by MMRC at the stage when the construction planning documents are prepared for tendering. Therefore, it is not feasible at this stage to identify candidate sites. Based on the information developed during this process, the construction contractor awarded the work will propose candidate locations, which will subsequently be reviewed and approved by the supervision consultant prior to commencement of use.

4.8 Impact Assessment

This section describes the anticipated environmental and social impacts during the pre-construction, construction, and operation phases of the Project. The impact predictions were carried out based on the results of the scoping exercise, analysis of project components, and baseline information, including findings from field surveys. During the scoping stage, the assessment scope included not only the main Project components but also associated facilities such as disposal sites, casting yards, borrow areas, and quarries. However, except for the casting yard, the locations of these associated facilities had not been finalized at the time of completion of the Preparatory Survey; therefore, the final impact assessment for these facilities has been omitted at this stage. Accordingly, the detailed environmental and social impact assessment for these items will be conducted during the subsequent phase of the Project. For reference in future assessment, a simplified impact assessment format is attached as an appendix. In addition, as disposal sites are managed by entities other than the Project proponent, mitigation measures and monitoring plans are not addressed herein. Furthermore, since the magnitude of impacts varies depending on the candidate disposal sites, the impact assessment for disposal sites is limited to a checklist-based evaluation, consistent with the approach adopted during the scoping stage.

The results of the environmental and social impact assessment for the main Project components are presented in the following table, together with the results from the scoping stage for comparison.

Table 4.8.1 Evaluation Results for Facilities (Including the Depot and Casting Yard)

Category	No.	Impact Item	Evaluation				Reason for evaluation
			Scoping		Based on Survey		
			Pre-CS/CS	OS	Pre-CS/CS	OS	
Pollution	1	Air pollution	✓		B-	B±	**CS:** Temporary impacts on air quality are anticipated due to emissions of exhaust gases (NOx, SOx) from construction machinery and vehicles, as well as dust generation ($PM_{2.5}$, PM_{10}) associated with construction activities. **OS:** - A positive impact is expected as a result of reduced traffic volume along the Mumbai Metro corridor. - Emission gas (NOx, SOx) will have a negative impact on the air quality by equipment at Depot.
	2	Water Quality	✓	✓	B-	B-	**CS:** - Turbid water will be generated in surface water and ground water along Mumbai metro due to civil works. - Turbid water will be generated at a proposed site for depot due to soil filling works. - There is a possibility of discharged organic wastewater from the base campsite. **OS:** - There is a possibility of discharged organic wastewater from the toilet installed at every station and the depot. - There is possibility of impact due to discharge of treated wastewater from Depot.
	3	Waste	✓	✓	B-	B-	**CS:** - General waste and excreta will be generated from the base campsite. - Construction waste such as soil and deforestation trees are generated. - Muck due to tunnel excavation is generated and some of them may be not suitable for reuse. **OS:** General waste and excreta will be generated from every station and a depot.
	4	Soil contamination	✓	✓	B-	B-	**CS:** - Oil leaks from construction equipment may cause soil contamination. - There is a potential risk of soil contamination due to oil leakage from construction machinery and other heavy equipment. **OS:** - Soil contamination may be generated at a depot due to oil leaks of heavy machine and rolling stock coating. - Inappropriate management of transformer will cause oil leakage. Consequently, it will contaminate the soil.
	5	Noise and vibration	✓	✓	B-	B±	**CS:** Noise and vibration will be generated by construction machineries and vehicles. **OS:** - Reduction of noise and vibration through modal shift by the opening of the Mumbai Metro. Predicted vibration levels in underground sections remain below standards; however, monitoring is required for further reduction and for impacts within World Heritage areas. - Noise impact is anticipated from the Depot.
	6	Ground subsidence	✓	✓	B-	B-	**CS:** SPT results indicate no soft ground; DPR notes no risk of subsidence from groundwater pumping. However, monitoring and mitigation are required as risk cannot be entirely excluded. **OS:** There is no significant impact. However, monitoring in the operation phase should be necessary as a follow-up observation and maintenance.
	7	Offensive odor	✓	✓	B-	B-	**CS:** Offensive odor may occur depending on the volume of general waste etc. from construction sites and basecamp. **OS:** Offensive odor may occur depending on the volume of general waste etc. from every station and the depot.

Category	No.	Impact Item	Evaluation				Reason for evaluation
			Scoping		Based on Survey		
			Pre-CS/CS	OS	Pre-CS/CS	OS	
Natural Environment	8	Protected area	✓		B-	D	**CS:** Although the station construction area and the alignment of the project approach within 1 km of Mahul - Sewree Creek, the project alignment does not overlap with the protected area, and industrial and port zones lie between the creek and the alignment, so significant impacts are not anticipated. However, as the area possesses rare ecological functions within Mumbai's urban environment, general precautionary measures must be taken during both the construction and operation phases to mitigate the impacts of various types of pollution caused by the project. **OS:** According to the prediction results, noise and vibration levels in the underground section near Mahul - Sewree Creek are low, and therefore, the impact on the protected area is considered to be minor.
	9	Biodiversity	✓	✓	B-	B-	**CS:** Adverse ecological impacts expected due to construction of underground stations and depot, including effects on captive animals in Byculla Park and tree felling. **OS:** Insufficient maintenance of planted/transplanted trees may result in low survival rates.
	10	Hydrology	✓		B-	D	**CS:** Indicators on groundwater extraction classify Mumbai as a safe category; impacts on hydrological conditions are expected to be minor, though slight effects may occur around TBM sections and the depot. **OS:** Operation of the Mumbai Metro may not cause any impact on surrounding hydrology.
	11	Geology and Topography	✓	✓	D	D	**CS/OS:** Topography and geology are generally stable with no major constraints for underground structures; existing surveys ensure required accuracy, and strong basalt underlies the alluvial layer.
Social Environment	12	Land acquisition/ Resettlement	✓		A-	D	**Pre-CS / CS:** Approximately 48ha of private land and 801 affected households were confirmed within the depot and station area, of which 692 households are to be resettled. For formal residents, compensation for land and asset losses will be provided at a rate of at least twice the minimum market price. Therefore, it is assumed that household livelihoods will be hardly affected. For informal residents, housing and commercial space will be provided, along with support during and after resettlement. Therefore, it is assumed that the impact on their lives will be minimal. **OS:** Land acquisition and resident relocation are scheduled to be completed before construction begins. Therefore, no impact is anticipated.
	13	Poverty	✓		A-	D	**Pre-CS:** 175 households under poverty line living in the project affected areas are affected due to resettlement. **OS:** Since there is no land acquisition and resettlement during the operation phase, operation activities that have a negative impact on people with poor class are not expected.
Social Environment	14	Indigenous and ethnic people	✓		D	D	**Pre-CS and CS:** Indigenous people was not observed in the project affected areas based on the socio-economic baselined survey. **OS:** No impact is expected with the reasons same as the case of Pre-CS and CS.
Social Environment	15	Local economy such as employment and livelihood, etc.	✓		B±	B±	**Pre-CS and CS:** - New employment and job opportunity may be created with the construction of Mumbai Metro. - Land acquisition and resettlement may negatively affect the livelihoods of affected residents. - Fencing of construction areas may hinder access and cause business losses or other negative impacts.

Category	No.	Impact Item	Evaluation				Reason for evaluation
			Scoping		Based on Survey		
			Pre-CS/CS	OS	Pre-CS/CS	OS	
							OS: - New employment may be created with the opening of Mumbai Metro. - A positive impact for the local economy will be generated such as timesaving for traveling within Mumbai city and alleviation of traffic congestion.
	16	Land use and utilization of local resources	✓	✓	D	D	**CS:** Construction work in the area will not bring any significant changes in the land use pattern. The development of station buildings will not have any major significant impact on the future land use. **OS:** Operation of metro in the area will not bring any significant changes in the land use, since no land acquisition or resettlement is anticipated during the operation phase.
Social Environment	17	Water use and its rights	✓	✓	B-	D	**CS:** Land acquisition and construction work such as TBM method may affect drinking water sources such as wells. **OS:** There is no impact on water use because of no land acquisition in the operation phase.
	18	Existing social infrastructure and services	✓		B-	B+	**Pre-CS and CS:** - A negative impact on sensitive facilities such as schools, hospitals, and community centres may occur due to land acquisition and traffic issues such as congestion and accidents. - The impact of the relocation of underground facilities is expected due to the construction work, which cause a temporal power outage in the surrounding area. **OS:** Improvement of accessibility by installing Mumbai Metro stations is expected, by which there is a possibility of a positive impact on the use of social infrastructure such as school, hospital, etc.
	19	Maldistribution of benefit and damage	✓	✓	B-	D	**CS:** Depending on the construction area, accessibility and safety may be reduced due to road closure restrictions or detour routes. **OS:** Outstanding maldistribution of benefit is not expected.
	20	Local conflict of interest	✓		B-	D	**CS:** - Depending on the location and scope of the construction fencing, it may negatively impact the business operations of shops along the road. - Residents and municipalities may demand that construction contractor should supply employment opportunities equally as construction workers. - Pollution status may cause conflict along the construction affected areas **OS:** Outstanding impact on local conflict of interest is not expected.
Social Environment	21	Cultural Heritage	✓	✓	B-	B±	**Pre-CS/CS:** Based on the survey and forecast results, vibration impacts during construction are not anticipated. However, in addition to regular monitoring, implementation of mitigation measures will be considered. **OS:** -The location of stations along the World Heritage sites in Mumbai Metro is expected to improve accessibility for tourism and increase tourist usage. - Based on the survey and forecast results, vibration impacts during operation are not anticipated. However, in addition to regular monitoring, implementation of mitigation measures will be considered.

Category	No.	Impact Item	Evaluation				Reason for evaluation
			Scoping		Based on Survey		
			Pre-CS/CS	OS	Pre-CS/CS	OS	
	22	Gender	✓	✓	B-	B-	**CS:** There may be a gender gap regarding wage, salary, and treatment as construction workers. **OS:** - Employment opportunities for women will be limited concerning Metro operation. - Female passengers may give up getting on a train because of being afraid of congestion on the train during commuting time.
	23	Children's right	✓		B-	D	**CS:** - There might be a possibility of child labour in construction sites. - Construction work may interfere with going to educational facilities. **OS:** There is no impact on children's rights by Mumbai Metro operation.
	24	Health (Infectious diseases such as HIV/AIDS, etc.)	✓	✓	B-	D	**CS:** Infectious diseases such as HIV/AIDS, COVID-19, Malaria, and Dengue may be spread by the inflow of construction workers. **OS:** The opening and operation of the metro is unlikely to be a contributing factor to the spread of HIV/AIDS.
	25	Labor environment including labor safety	✓	✓	B-	D	**CS:** Occupational injuries / disease may occur with inappropriate labor environment including safety management in the construction sites and labour colony. **OS:** There is no big change in the labor environment for residents by Mumbai Metro operation.
Others	26	Accidents	✓	✓	B-	D	**CS:** - Since construction-related vehicles use arterial roads on the Mumbai Metro Corridors, there is a possibility of increasing traffic accidents. - Detour and caused traffic congestions may increase the number of traffic accidents. -All construction related Accident / incident prevention system **OS:** Platform screen doors prevent physical contact between trains and passengers.
	27	Cross-border impact and climate change	✓	✓	B-	B+	**CS:** Greenhouse gas emissions will increase by reducing the absorbed amount of greenhouse gas by cutting street trees along the alignment, operation of construction heavy machinery, and construction of structures. **OS:** Due to the operation of the Mumbai Metro, traffic volume along the metro corridor is expected to decrease, leading to a reduction in GHG emissions. On the other hand, the operation of the metro itself will result in GHG emissions due to electricity consumption. However, considering the overall balance, the reduction in emissions is expected to exceed the emissions from metro operations, and thus, the project is anticipated to contribute to the reduction of GHG emissions.

Note: Pre-CS: Pre-Construction Stage, CS: Construction Stage, OS: Operation Stage

A+/-: Significant positive/negative impact is expected, B+/-: Positive/Negative impact is expected to some extent, D: No impact is expected

Source: JST

Table 4.8.2 Evaluation Results for Associated Facilities (Disposal site)

Nb	Impact Item	Evaluation		Reason for evaluation
		Scoping	Based on Survey	
		Pre-CS/CS	Pre-CS/CS	
Pollution				
1	Air pollution	✓	✓	Nitrogen oxides (NOx), sulfur oxides (SOx), and particulate matter (PM_{10} and $PM_{2.5}$) may be generated temporarily due to the operation of construction machinery and dump trucks.
2	Water Quality	✓	✓	In the absence of proper drainage facilities, rainfall runoff may potentially affect surrounding water bodies.
3	Waste	✓	✓	Scattered waste may cause adverse impacts on nearby residents.
4	Soil Contamination	✓	✓	As wastewater is discharged into drainage channels, soil contamination is not anticipated; however, if drainage channels are not provided, leachate and wastewater may potentially affect the surrounding environment.
5	Noise and Vibration	✓	✓	Noise and vibration are expected to be generated due to the operation of transport vehicles and construction equipment.
6	Ground subsidence			Activities that may cause land subsidence are not anticipated.
7	Offensive odor	✓	✓	At disposal sites, depending on the type of waste and the methods and duration of storage, there is a potential for the generation of offensive odors affecting the surrounding area.
8	Bottom sediment			Activities that may deteriorate sediment quality are not anticipated.
Natural Environment				
9	Protected area	✓	✓	If protected areas are located in the vicinity, there is a potential for adverse impacts.
10	Biodiversity	✓	✓	Land modification activities and/or the presence of surrounding green spaces may potentially affect the local ecosystem.
11	Hydrology			Activities that may affect hydrological conditions are not anticipated.
12	Geology and Topography	✓	✓	If a candidate site is located on a slope, site grading and land formation will be required.
Social Environment				
13	Land acquisition/ Resettlement			As a municipally registered disposal site will be used, no land acquisition or involuntary resettlement is anticipated.
14	Poverty	✓	✓	If vulnerable or low-income communities are present in the surrounding area, potential impacts may occur.
15	Indigenous and ethnic people	✓	✓	If ethnic minorities or Indigenous Peoples reside in the surrounding area, potential impacts may occur.
16	Local economy such as employment and livelihood, etc.			Activities that may affect local employment, livelihoods, or the regional economy are not anticipated.
17	Land use and utilization of local resources	✓	✓	If the volume of disposed material exceeds the planned capacity, expansion of the disposal area may potentially affect surrounding community resources.
18	Water use and its rights	✓	✓	If the volume of disposed material exceeds the planned capacity, expansion of the disposal area may potentially affect surrounding water use.
19	Existing social infrastructure and services	✓	✓	If sensitive receptors (such as residential areas, schools, or medical facilities) are located nearby, an increase in traffic accidents may be a concern due to increased haulage traffic.
20	Social institutions such as			Activities that may affect social capital, community organizations, or local decision-making institutions are not anticipated.

Nb	Impact Item	Evaluation		Reason for evaluation
		Scoping	Based on Survey	
		Pre-CS/CS	Pre-CS/CS	
	social infrastructure and local decision - making institutions			
21	Maldistribution of benefit and damage			Activities that may cause inequitable distribution of project benefits and adverse impacts are not anticipated.
22	Local conflict of interest	✓	✓	If the volume of disposed material exceeds the planned capacity, expansion of the disposal area may result in conflicts of interest between landowners and surrounding residents, if any.
23	Cultural Heritage	✓	✓	If cultural heritage sites are located in the surrounding area, potential impacts may occur.
24	Landscape	✓	✓	If the volume of disposed material exceeds the planned capacity, expansion of the disposal area may potentially affect the surrounding landscape and visual amenity.
25	Gender			No gender-related impacts are anticipated.
26	Children's right			No impacts on children's rights are anticipated.
27	Health (Infectious diseases such as HIV/AIDS, etc.)			No impacts related to communicable diseases are anticipated.
28	Labor environment including labor safety	✓	✓	A safe and appropriate working environment shall be ensured in accordance with applicable laws and regulations.
Others				
29	Accidents	✓	✓	As haulage vehicles will use surrounding roads for Mumbai Metro construction activities, there is a potential increase in traffic accidents.
30	Cross border impact and climate change			No impacts related to climate change, such as large-scale deforestation or significant increases in greenhouse gas emissions, are anticipated.

Source: JST

4.9 Environmental Management Plan

An environmental management plan has been developed to address the negative and potentially negative impact items, including appropriate mitigation measures. These measures are to be implemented and considered at each stage of the project to minimize environmental and social negative impacts while ensuring the achievement of the project objectives. Furthermore, the mitigation measures and their associated implementation costs are listed below. The following table outlines the mitigation measures corresponding to the impact items that were rated as "A-" or "B-" in the previously presented impact assessment results table.

Table 4.9.1 Proposed Mitigation Measures against expected Impacts (Pre-Construction or Construction Phase)

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
1-a	Air pollution	Temporary impacts on air quality are anticipated due to emissions of exhaust gases (NO_x, SO_x) from construction machinery and vehicles, as well as dust generation ($PM_{2.5}$, PM_{10}) associated with construction activities.	Air quality in construction areas will be sampled to ensure a proper working environment.			10,000 / site·year 250,000 / unit (as continuous monitoring sensor)
1-b			Regular preventive maintenance of construction equipment and vehicles, with daily inspections to ensure optimal working conditions.	Construction Contractor	MMRC	Contractor's responsibility
1-c			The proper work schedules should be considered not to concentrate the construction equipment at a certain point for a long time.			
1-d			To reduce the dust, the periodic water spray should be taken.			20,000 / site·year; total 2,800,000 for entire line
1-e			The construction site is fenced as high as 2.5 m.			Contractor's responsibility
1-f			Detours will be arranged to mitigate traffic congestion.			
2-a	Water Quality	• Turbid water will be generated in surface water and groundwater along the Corridors due to civil and excavation works. • Turbid water will be generated at a proposed site for depot due to soil filling works. • There is a possibility of discharged organic wastewater at an installed base campsite.	Washing the construction tools in limited areas where there are appropriate facilities for water treatment for discharge	Construction Contractor	MMRC	Contractor's responsibility
2-b			In construction works near water bodies, turbid wastewater shall be treated at designated sites and released again.			7,000 / site·year
2-c			Temporary sanitation facilities with septic tanks such as portable (mobile) toilets and garbage bins will be provided by the contractors to ensure that the domestic wastes to be generated by the construction personals are properly handled and not thrown into the drainage to prevent further pollution.			Contractor's responsibility
3	Waste	• General waste and excreta will be generated from the base campsite. • Construction waste such as soil and deforestation trees are generated. • Muck due to tunnel excavation is generated and some of them may be not suitable for reuse.	In accordance with the instructions of the competent authority and applicable regulations, construction waste generated from the construction and camp sites should be transported to the designated sites and disposed of.	Construction Contractor	MMRC	Round-trip transport cost (70 km): 48,000 / unit

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
4-a	Soil contamination	• Excavated soil at the construction site may be contaminated. • Oil leaks from constriction equipment may cause soil contamination.	In accordance with the instructions of the competent authority and applicable regulations, the excavated soil shall be transported to the designated sites and disposed of.	Construction Contractor	MMRC	Round-trip transport cost (70 km): 48,000 / unit
4-b			Daily maintenance of construction equipment and vehicles.			Contractor's responsibility
4-c			Soil sampling and laboratory analysis in order to check soil contamination shall be done.			7,500 / site·year
5-a	Noise and vibration	Noise and vibration will be generated by construction machineries and vehicles.	Noise and vibration from machinery shall be controlled using mufflers, vibration mats, and other devices.	Construction Contractor	MMRC	Contractor's responsibility
5-b			Low-noise and low-vibration machinery shall be used as far as practicable for piling and similar works.			
5-c			Noise and vibration shall be monitored regularly; high-impact works limited to daytime (6:00–22:00).			Noise: 4,500 / site·year Vibration: 400,000 / all sites·year
5-d			Construction sites shall be enclosed with a 2.5 m fence.			Contractor's responsibility
5-e			Daytime and Nighttime restrictions on heavy vehicle traffic, speed, and routes shall be applied in accordance to the rules, regulation and permission of State Trasport Department.		Transport Department, Government of Maharashtra	
5-f			If complaints arise, TBM pressure and vibration shall be reduced, and residents shall be informed that the vibration is temporary.		MMRC	
5-g			In the event that cracks should occur, MMRC will determine whether compensation is to be provided through consultations with the building owners.			Contractor's or MMRC's responsibility
6-a	Ground subsidence	SPT results show no soft ground; DPR indicates no subsidence risk from groundwater pumping, but monitoring and mitigation are still required.	Application of appropriate construction measures such as earth retaining wall, penetration of piles to the support layer, and etc.	Construction Contractor	MMRC	Contractor's responsibility
6-b			Application of ground reinforcement measures such as sand pile method to the soft-ground areas, if any.			
6-c			Continuous monitoring using settlement gauges and settlement plates.			

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
7	Offensive odor	Offensive odor may be issued depending on the volume of general waste, etc. from base camp sites.	Regular cleaning and collection of the general waste from camp sites with appropriate stock places and facilities to prevent offensive odor.	Construction Contractor	MMRC	Contractor's responsibility
8	Protected Area	The station installation area and the alignment pass within less than 1 km of Mahul - Sewree Creek; however, the project alignment does not overlap with the protected area. Furthermore, industrial zones and port areas lie between the Creek and the alignment, and therefore, significant impacts are not anticipated. However, the area may have ecological functions in the urban environment of Mumbai. Therefore, general considerations to mitigate impacts from the project regarding pollution items shall be taken.	Same as "5. Noise and vibration".	Construction Contractor	MMRC	Contractor's responsibility
9-a	Biodiversity	Construction of underground stations and depot may adversely affect the ecosystem, including captive animals in Byculla Park and tree felling.	Compensatory planting to prioritize native and vulnerable species (*Saraca asoca, Dalbergia latifolia*).	Construction Contractor	MMRC	Transplantation cost: 60,000 / tree Felling cost: 10,000 / tree (including 3 years of maintenance for each)
9-b			Plantation shall be carried out as much as possible within project areas such as station facilities and depots.			
9-c			To secure the required number of plantations, alternative sites such as public land, parks, and school premises shall be utilized as much as possible. Green space development shall also be incorporated into surrounding station area plans and along other metro lines in Mumbai. This activity shall form part of the landscaping and beautification plan for each station and will be implemented after completion of the station construction works.	Construction Contractor and MMRC	MMRC and BMC Tree Authority	
9-d			In compliance with relevant laws, transplantation of mature trees shall be implemented step by step under the supervision of arboricultural and horticulturist experts, with continuation subject to confirmation of survival rates.			
9-e			A dedicated subcontractor independent from the construction JV shall be appointed exclusively for plantation works, with a separately managed budget.			
9-f			Same as "5. Noise and vibration".			
10-a	Hydrology	Indicators classify Mumbai as safe for groundwater extraction; impacts are minor	Sheet pile should be installed at the excavation work site in order to water sealing.	Construction Contractor	MMRC	Contractor's responsibility

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
10-b		overall but slight effects may occur around TBM sections and the depot.	Closed mold type of TBM should be used in order to keep groundwater pressure.			
10-c			Groundwater monitoring using construction well.			7,000 / site·year
11	Land acquisition/ Resettlement	• Approximately 48ha of private land and 801 affected households were confirmed within the depot and station area, of which 692 households are to be resettled. • For formal residents, compensation for land and asset losses will be provided at a rate of at least twice the minimum market price. Therefore, it is assumed that household livelihoods will be hardly affected. For informal residents, housing and commercial space will be provided, along with support during and after resettlement. Therefore, it is assumed that the impact on their lives will be minimal.	Resettlement implementation with necessary procedures based on RAP (SIA Report) including: - Full compensation of relocation costs prior to implementation - Provision of Resettlement and Rehabilitation (R&R) support - Operational grievance redress mechanism - Livelihood restoration program - Monitoring scheme - Special assistance for vulnerable groups	MMRC	Government of Maharashtra	Expense of Government of Maharashtra
12	Poverty	175 households under poverty line living in the project affected areas are affected due to resettlement.	Monitoring of resettlement support based on the RAP (SIA) entitlement matrix, including appropriate compensation, assistance, and livelihood restoration programs.	MMRC	Government of Maharashtra	Expense of Government of Maharashtra
13-a	Local economy such as employment and livelihood, etc.	Land acquisition and resettlement may negatively affect the livelihoods of affected residents.	Implementation of appropriate compensation, assistance, and monitoring based on the RAP (SIA) livelihood restoration program.	MMRC	Government of Maharashtra	Expense of Government of Maharashtra
13-b		Fencing of construction areas may hinder access and cause business losses or other adverse impacts.	Minimize impacts on business activities from construction fencing by securing road width in front of shops, etc.			
14	Water use and its rights	Land acquisition and construction work such as TBM method may affect drinking water sources such as wells.	If the water quality deems to decline, appropriate water treatment measures such as water shielding and infiltration control should be implemented.	Construction Contractor	MMRC	Contractor's responsibility 7,000 / site·year
15-a	Existing social infrastructure and services	• A negative impact on sensitive facilities such as schools, hospitals, and community centers may be occurred depending on land acquisition and traffic issues such as congestion and accidents.	Make sure to provide safe access to sensitive facilities such as hospital, school, etc. during the construction period by installing traffic guides and warning signs, and if required, measures such as detour route should be set up based on the traffic congestion condition.	Construction Contractor	MMRC	Contractor's responsibility

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
15-b		• The impact of the relocation of underground facilities is expected due to the construction work, which cause a temporal power outage in the surrounding area.	In cooperation with the relevant authorities, the relocation of underground utilities will be carried out to minimize adverse impacts on the local community.			
16	Maldistribution of benefit and damage	In some construction areas, road crossing bans or detours may reduce accessibility and safety.	During construction, ensure safe access to sensitive facilities (hospitals, schools, etc.) by installing traffic guidance and warning signs, and implement detours as needed based on traffic congestion.	Construction Contractor	MMRC	Contractor's responsibility
17-a	Local conflict of interest	Fencing of construction areas may hinder access and cause business losses or other adverse impacts.	Same as "13-b"	Construction Contractor	MMRC	Contractor's responsibility
17-b		Residents and municipalities may demand that construction contractor should supply employment opportunities equally as construction workers.	Give employment opportunities to residents and municipalities evenly.			
17-c		Pollution status may cause conflict along the construction affected areas	If the residents and pedestrians complain about the construction activities, the consultant of the supervision and contractors should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.			
18	Cultural Heritage	Survey and prediction results show no vibration impacts during construction; however, regular monitoring and mitigation should be considered.	Same as "5. Noise and vibration".			
19	Gender	There may be a gender gap regarding wage, salary, and treatment as construction workers.	There must be care that there is no discrimination between male and female in employment and payment of wages/salaries.	Construction Contractor	MMRC	Contractor's responsibility
20-a	Children's right	There might be a possibility of child labour in construction sites.	Child deployment prohibition policy to be implemented as per law.	Construction Contractor	MMRC	Contractor's responsibility
20-b			Age verification in screening process through Government approved ID cards to be ensured.			
20-c			Awareness posters shall display.			
20-d		Construction work may interfere with going to educational facilities.	Educational institutes shall be provided with adequate & safe access.			

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
21-a	Health (Infectious diseases such as HIV/AIDS, etc.)	Infectious diseases such as HIV/AIDS Malaria and Dengue may be spread by the inflow of construction workers.	Arrange HIV/AIDS counselling through qualified NGOs; ensure confidentiality.	Construction Contractor	MMRC	Contractor's responsibility
21-b			Organize HIV/AIDS awareness activities (street plays, short films).			
21-c			Dos & Don'ts posters shall be displayed at site & labor camps.			
21-d			Condom promotion programs shall be conducted, and free condom distribution arrangement shall be ensured.			
21-e			Regular health checkup camps Awareness & training shall be arranged for Malaria & Dengue.			
21-f			Housekeeping & hygiene shall be maintained at project site & labor colony and fogging shall be done at both.			
22-a	Labor environment including labor safety	Occupational injuries / disease may occur with inappropriate labor environment including safety management in the construction sites and labour colony.	For the Project Site safety, measures below will be included: • Site specific SHE&W policy, Construction SHE&W Plan in line with condition of contract, on site emergency preparedness plan & Labors accommodation plan shall be implemented. • Underground safety measures – monitoring for oxygen deficiency, toxic gases & dust levels with continuous monitoring & alarms • Strict entry/exit protocols along with tally-boards in underground tunnel. • Work permit system shall be followed. • Medical facilities – Ambulance, emergency contact nos. displayed & tie up with nearby hospitals. • Tied up all local authorities such as Fire, police, Disaster Management & BMC (Municipal Corporation) • Electrical & Fire safety measures to be implemented. LOTO system to be ensured. • Proper ventilation system shall be provided at the underground tunnel working area. • Fatigue management - Regulations for working hours, rest breaks, and night shift management. • Ensure SCABA equipment use in tunnels. • Job specific trainings (on site & classroom) shall be conducted on timely. • Safety signages shall be displayed at all prominent location.	Construction Contractor	MMRC	Contractor's responsibility

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
22-a			• PPEs compliance: Safety helmet & shoes, reflective safety jacket and job specific PPEs (Goggle, Ear plugs, dust mask, Full body harness, breathing apparatus) • Housekeeping & hygiene shall be maintained at site. • Work at height: Standard & approved scaffolding system & fall protection shall be used/implemented. • Availability of Rest shelters.			
22-b			For the Labor colony, measures below will be included: • Provide clean drinking water, sanitation, canteens, and bathrooms. • Construct separate kitchens as per labor capacity. • Fire preventions & emergency preparedness to be implemented • First aid facilities shall be available • Maintain effective drainage, garbage disposal, and sewage systems. • Housekeeping & hygiene shall be maintained • Construct separate kitchen shall be provided according to labor strength			
23-a	Accidents	• Since construction-related vehicles use arterial roads on the Corridors, there is a possibility of increasing traffic accidents. • Detour and caused traffic congestions may increase the number of traffic accidents.	For Traffic: • Traffic management plan shall be implemented in consultation with respective area authorities. • Install standard traffic signs and diversion boards. • Separate pedestrians' pathways with signs shall be provided • Conduct drivers' defensive driving training and safety vehicle checks; use GPS tracking.	Construction Contractor	MMRC	Contractor's responsibility
23-b		All construction related Accident / incident prevention system	• Zero Accident Vision: Must adopt "Zero Harm Policy". • Method Statement, SOP & work permit shall be followed • Awareness training shall be conducted. • Safety posters & signages shall be displayed • Mock drills shall be conducted timely • Fire & Electrical prevention • Record near misses and implement CAPA (Corrective and Preventive Actions).			
24	Cross-border impact and climate change	Greenhouse gas emissions will increase slightly by reducing the absorbed amount of greenhouse gas by cutting street trees along the Corridors, operation of construction heavy machinery, and construction of structures.	Same as "9. Biodiversity".			

Source: JST, MMRC

Table 4.9.2 Proposed Mitigation Measures against expected Impacts (Operation Phase)

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
1	Air pollution	Emission gas (NOx, SOx) will have a negative impact on the air quality by equipment at Depot.	Sampling to assess surrounding impacts	MMRC	Maharashtra Pollution Control Board (MPCB)	10,000 / site·year
2-a	Water Quality	There is a possibility of discharged organic wastewater from the toilet installed at every station and the depot.	Regular maintenance of toilets, Sewage Treatment Plant (STP), Effluent Treatment Plant (ETP) and related facilities at stations and depots.	MMRC	Maharashtra Pollution Control Board (MPCB)	Included in MMRC operating costs
2-b			Sampling to assess surrounding impacts			7,000 / site·year
2-c		There is possibility of impact due to discharge of treated wastewater from Depot.	Adequate arrangement of treating the workshop wastewater to the standard will be provided such as Oil-Water Separator and Sedimentation Tank.			Included in MMRC operating costs
3	Waste	General waste and excreta will be generated from every station and the depot.	Installation of enough garbage bin at appropriate location in stations and the depot and collection rules based on local collection systems.	MMRC	Maharashtra Pollution Control Board (MPCB)	Included in MMRC operating costs
4-a	Soil contamination	Soil contamination may occur at a depot due to oil leaks of related facilities, rolling stock coating.	Necessary facilities and equipment for preventing leaking oil shall be prepared at the depot and the receiving substations.	MMRC	Maharashtra Pollution Control Board (MPCB)	Included in MMRC operating costs
4-b			Sampling to assess surrounding impacts			7,500 / site·year
4-c		Inappropriate management of transformer will cause oil leakage. Consequently, it will contaminate the soil.	Regular preventive maintenance service of transformer should be strictly implemented			Included in MMRC operating costs
5-a	Noise and vibration	Modal shift from Mumbai Metro reduces noise and vibration; underground vibration levels predicted below standards, but further reduction and monitoring in World Heritage areas are required.	Conduct monitoring of vibration impacts during train operations in the World Heritage area.	MMRC	Maharashtra Pollution Control Board (MPCB)	Included in MMRC operating costs (Reference: Vibration: 400,000 / all sites·year)
5-b			Introduction and maintenance of elastic rail pads and vibration-reducing sleepers			Included in MMRC operating costs

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
5-c		Noise impact is anticipated from the Depot.	Sampling to assess surrounding impacts			Noise: 4,500 / site·year
6	Ground Subsidence	Monitoring in the operation phase should be necessary as a follow-up observation and maintenance.	Continuous monitoring with settlement gauges and settlement plates	MMRC	Government of Maharashtra	Included in MMRC operating costs
7-a	Offensive odor	Offensive odor may be issued depending on the volume of general waste etc. from every station and the depot.	Regular cleaning and collection of the general waste from stations and depot.	MMRC	Maharashtra Pollution Control Board (MPCB)	Included in MMRC operating costs
7-b			Installation of appropriate garbage bin with cover.			
8-a	Biodiversity	Insufficient maintenance of planted/transplanted trees may lower survival rates.	A compliance report on compensatory plantation, accompanied by photographic documentation, shall be submitted to the Tree Authority on a semi-annual basis.	MMRC: For 3 years after plantation BMC: Thereafter	BMC Tree Authority	Maintenance Cost Included
8-b			The General Consultant (GC) engaged by MMRC shall conduct regular audits on environmental and tree management activities as part of its routine duties.			
9	Cultural Heritage	Noise and vibration from Metro operations may affect historic buildings, and monitoring is necessary.	Same as “4. Noise and vibration”.			
10-a	Gender	• Employment opportunities for women will be limited concerning Metro operation. • Female passengers may give up getting on a train because of being afraid of congestion on the train during commuting time.	Active employment of female staff for MMRC with fair conditions	MMRC	Government of Maharashtra	Included in MMRC operating costs
10-b			Keep provision of the designated seat for women on the train, enough number of toilet and other facilities as much as possible.			

Source: JST, MMRC

4.10 Environmental Monitoring Plan

In the Mumbai Metro construction project, an Environmental Monitoring Plan (EMoP) has been established as outlined below to verify the effectiveness of the mitigation measures set for each environmental and social consideration item.

Table 4.10.1 Environmental Monitoring Plan (Pre-Construction and Construction Phase) proposed by the survey

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
1-a	Air pollution	Air quality in construction areas will be sampled to ensure a proper working environment.	Sampling survey using the same method as the baseline: SO_2, CO, NO_2, O_3, PM_{10}, $PM_{2.5}$	**CPCB 2009** SO_2: 80μg/m³ CO: 2mg/m³ NO_2: 80μg/m³ O_3: 100μg/m³ PM_{10}: 100μg/m³ $PM_{2.5}$: 60μg/m³	Construction areas of all stations, batching plants, and casting yards	Construction Contractor	Twice a week (construction period)	10,000 / site·year 250,000 / unit (as continuous monitoring sensor)
1-b		Regular preventive maintenance of construction equipment and vehicles, with daily inspections to ensure optimal working conditions.	Verification of maintenance inspection records	-	All construction areas, batching plants, and casting yards		Monthly during the construction period	Contractor's responsibility
1-c		The proper work schedules should be considered not to concentrate the construction equipment at a certain point for a long time.	Construction plan / schedule					
1-d		To reduce the dust, the periodical water spray should be taken.	Record of sprinkler truck operation				Continuous during dust-generating construction	20,000 / site·year; total 2,800,000 for entire line
1-e		The construction site is fenced as high as 2.5 m.	Visual confirmation of installation of fences				Before commencement of construction	Contractor's responsibility
1-f		Detours will be arranged to mitigate traffic congestion.	Verification of construction and diversion plans					
2-a	Water pollution	Washing the construction tools in limited areas where there are appropriate facilities for water treatment for discharge	Visual confirmation of appropriate operation of washing activities	-	All construction areas, batching plants, and casting yards	Construction Contractor	Monthly during the construction period	Contractor's responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
2-b		In construction works near water bodies, turbid wastewater shall be treated at designated sites and released again.	Sampling survey using the same method as the baseline Surface water and Wastewater: Color, odor, turbidity, pH, conductivity, total hardness, chlorides, iron, total dissolved solids, sulfates, nitrates, lead, copper, manganese, mercury, cadmium, zinc, total chromium, hexavalent chromium, total alkalinity, calcium, magnesium, sodium, potassium, dissolved oxygen, BOD, COD, Suspended Solid Groundwater: Color, odor, taste, turbidity, pH, chlorides, iron, total dissolved solids, sulfates, nitrates, fluoride, lead, copper, manganese, phenolic compounds, mercury, cadmium, arsenic, cyanide, zinc, detergents, total chromium, hexavalent chromium, total alkalinity, aluminum, boron, coliforms, E. coli, Suspended Solid	Surface water: **CPCB Water Quality Criteria – Designated Best Use Classification (Class A–E)** Wastewater: **General Standards for Discharge of Environmental Pollutants in Environment (Protection) Rules, 1986** Groundwater: IS **10500 : 2018, Indian Standard, DRINKING WATER — SPECIFICATIO N** (Individual standard values omitted)	<u>Surface water:</u> Around the station site <u>Wastewater</u>: all construction sites at stations, batching plants, casting yards <u>Groundwater:</u> Monitoring wells at each construction site		<u>Surface water and groundwater</u> Once each in hot, rainy and dry seasons during construction <u>Wastewater</u> Quarterly during construction	7,000 / site·year
2-c		Temporary sanitation facilities with septic tanks such as portable (mobile) toilets and garbage bins will be provided by the contractors to ensure that the domestic wastes to be generated by the construction personals are properly handled and not thrown into the drainage to prevent further pollution.	Disposal records and visual inspection	-	All construction areas, batching plants, and casting yards		Monthly during the construction period	Contractor's responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
3	Waste	In accordance with the instructions of the competent authority and applicable regulations, construction waste generated from the construction and camp sites should be transported to the designated sites and disposed of.	• The volume of waste including soil, vegetation, existing railway structures, and garbage • The condition of storage and transportation for the generated waste • Voices and complaints from the local community	-	All construction areas, batching plants, and casting yards	Construction Contractor	Monthly during the construction period	Round-trip transport cost (70 km): 48,000 / unit
4-a	Soil contamination	In accordance with the instructions of the competent authority and applicable regulations, the excavated soil shall be transported to the designated sites and disposed of.	Same as “3 Waste”					
4-b		Daily maintenance of construction equipment and vehicles.	Same as “1-b”					
4-c		Soil sampling and laboratory analysis in order to check soil contamination shall be done.	Baseline-method sampling: pH, EC, total chromium, Cr^{6+}, Pb, Cd, As, Hg	**EP (Contaminated Sites) Rules, 2025** T-Cr: 87mg/kg Cr^{6+}: 78mg/kg Pb: 600mg/kg Cd: 22mg/kg As: 76mg/kg Hg: 50mg/kg	All construction areas, batching plants, and casting yards	Construction Contractor	Once each in hot, rainy and dry seasons during construction	7,500 / site·year
5-a	Noise and vibration	Noise and vibration from machinery shall be controlled using mufflers, vibration mats, and other devices.	- Visual inspection of required equipment installation - Construction records (working hours) - Equipment usage records	-	All construction areas, batching plants, and casting yards	Construction Contractor	[Noise] Continuous during construction period [Vibration]	Contractor’s responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
5-b		Low-noise and low-vibration machinery shall be used as far as practicable for piling and similar works.					Underground sections: periodic measurement during construction	
5-c		Noise and vibration shall be monitored regularly; high-impact works limited to daytime (6:00–22:00).	Same methods as the baseline survey [Noise] LAeq [Vibration] Lv	[Noise] **EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition** Commercial Area Daytime:65 dB Nighttime: 55 dB Construction site 80dB **(Tokyo)** [Vibration] Commercial Area Daytime: 70 dB Night time: 65 dB **(Japan)** Construction site 70dB **(Tokyo)**			[Noise] Twice a week during construction period [Vibration] Underground sections: periodic measurement during construction	Noise: 4,500 / site·year Vibration: 400,000 / all sites·year
5-d		Construction sites shall be enclosed with a 2.5 m fence.	Same as “1-e”					

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
5-e		Nighttime restrictions on heavy vehicle traffic, speed, and routes shall be applied in accordance to the rules, regulation and permission of State Trasport Department.	Monthly reports (traffic safety items) and visual inspection	-	All construction areas, batching plants, and casting yards	Construction Contractor	Monthly during the construction period	Contractor's responsibility
5-f		If complaints arise, TBM pressure and vibration shall be reduced, and residents shall be informed that the vibration is temporary.	-Verification of monthly construction records -Complaints and feedback from nearby residents			Construction Contractor and MMRC		
5-g		In the event that cracks should occur, MMRC will determine whether compensation is to be provided through consultations with the building owners.					At the time of the incident	Contractor's or MMRC's responsibility
6-a	Ground subsidence	Application of appropriate construction measures such as earth retaining wall, penetration of piles to the support layer, and etc.	• Daily site checks by managers/environment officers • Review of monthly construction/monitoring reports	-	All construction areas	Construction Contractor	Monthly during the construction period	Contractor's responsibility
6-b		Application of ground reinforcement measures such as sand pile method to the soft-ground areas, if any.						
6-c		Continuous monitoring using settlement gauges and settlement plates.					Continuous (construction period)	
7	Offensive odor	Regular cleaning and collection of the general waste from camp sites with appropriate stock places and facilities to prevent offensive odor.	• Monthly reports (environmental items) and visual inspection • Confirmation of complaints or feedback from the community regarding odors	-	All construction areas	Construction Contractor	Monthly during the construction period	Contractor's responsibility
8	Protected Area	Same as "5. Noise and vibration".						
9-a	Biodiversity	Compensatory planting to prioritize native and vulnerable species (*Saraca asoca, Dalbergia latifolia*).	Verification of felling/transplantation/plantation plans	-	All planting areas	Construction Contractor	Monthly during the construction period	Transplantation cost: 60,000 / tree

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
9-b		Plantation shall be carried out as much as possible within project areas such as station facilities and depots.	Review of monthly reports on tree planting progress					Felling cost: 10,000 / tree (including 3 years of maintenance for each)
9-c		To secure the required number of plantations, alternative sites such as public land, parks, and school premises shall be utilized as much as possible. Green space development shall also be incorporated into surrounding station area plans and along other metro lines in Mumbai. This activity shall form part of the landscaping and beautification plan for each station and will be implemented after completion of the station construction works.			All construction areas and alternative plantation sites	Construction Contractor and MMRC		
9-d		In compliance with relevant laws, transplantation of mature trees shall be implemented step by step under the supervision of arboricultural and horticulturist experts, with continuation subject to confirmation of survival rates.						
9-e		A dedicated subcontractor independent from the construction JV shall be appointed exclusively for plantation works, with a separately managed budget.						
9-f		Same as “5. Noise and vibration”.						
10-a	Hydrology	Sheet pile should be installed at the excavation work site in order to water sealing.	Monthly reports (construction records) and visual inspection	-	All construction areas	Construction Contractor	Monthly during the construction period	Contractor’s responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
10-b		Closed mold type of TBM should be used in order to keep groundwater pressure.					During TBM operation	
10-c		Groundwater monitoring using construction well.	Measurement of groundwater level		Monitoring wells at each construction site		Twice annually during the construction phase (once in the rainy season and once in the dry season)	7,000 / site·year
11	Land acquisition/ Resettlement	Resettlement implementation with necessary procedures based on RAP (SIA Report) including: - Full compensation of relocation costs prior to implementation - Provision of Resettlement and Rehabilitation (R&R) support - Operational grievance redress mechanism - Livelihood restoration program - Monitoring scheme - Special assistance for vulnerable groups	Monitoring of RAP implementation progress (using the format attached in Chapter 5): - Consultations/communications with affected persons - Verification of payment records - Site inspections - Confirmation of complaints/feedback from affected persons (compensation, social assistance, relocation status, etc.) - Status of income and livelihood restoration of affected persons - Conditions in the project area - Grievances and opinions of affected persons	-	Project-affected areas and residences of affected households	MMRC	RAP implementation progress: monthly until final payment and completion of relocation	Expense of Government of Maharashtra
12	Poverty	Monitoring of resettlement support based on the RAP (SIA) entitlement matrix, including appropriate compensation, assistance, and livelihood restoration programs.	Same as “11. Land acquisition/ Resettlement”					
13-a	Local economy such as employment and livelihood, etc.	Implementation of appropriate compensation, assistance, and monitoring based on the RAP (SIA) livelihood restoration program.	Same as “11. Land acquisition/ Resettlement”					

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
13-b		Minimize impacts on business activities from construction fencing by securing road width in front of shops, etc.	Verification of construction fence locations	-	Construction areas	Construction Contractor	Before construction commencement	Contractor's responsibility
14	Water use and its rights	If the water quality deems to decline, appropriate water treatment measures such as water shielding and infiltration control should be implemented.	Same as "2. Water pollution"					
15-a	Existing social infrastructure and services	Make sure to provide safe access to sensitive facilities such as hospital, school, etc. during the construction period by installing traffic guides and warning signs, and if required, measures such as detour route should be set up based on the traffic congestion condition.	• Record and site observation • Confirmation of voices and complaints Status of electricity supply • Voices and complaints from the local community	-	Project affected area	Construction Contractor with relevant bodies	Before construction commencement and when complaints are heard in this regard	Contractor's responsibility
15-b		In cooperation with the relevant authorities, the relocation of underground utilities will be carried out to minimize adverse impacts on the local community.	• Record and site inspection • Interviews with concerned organizations • Confirmation of voices and complaints Safety of access roads to these sensitive facilities • Status of installation of signs, etc. • Traffic congestion • Voices and complaints from the local community	Construction Contractor	Construction areas and surrounding area	Construction sites and the surrounding area		
16	Maldistribution of benefit and damage	During construction, ensure safe access to sensitive facilities (hospitals, schools, etc.) by installing traffic guidance and warning signs, and implement detours as needed based on traffic congestion.	Same as "15-a"					
17-a	Local conflict of interest	Same as "13-b"						

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
17-b		Give employment opportunities to residents and municipalities evenly.	• Verification of employment status • Voices and complaints from the local community	-	Project affected area	Construction Contractor	Before construction commencement and when complaints are heard in this regard	Contractor's responsibility
17-c		If the residents and pedestrians complain about the construction activities, the consultant of the supervision and contractors should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.	Confirmation of voices and complaints from the residents and pedestrians	Government of Maharashtra Construction Contractor	Construction areas	Construction Contractor and MMRC		
18	Cultural Heritage	Same as "5. Noise and vibration".						
19	Gender	There must be care that there is no discrimination between male and female in employment and payment of wages/salaries.	Confirmation of equal pay for equal work based on the employment agreements. (If inadequate documents are identified, provide guidance to the contractor and require improvements.)	-	Construction areas	Construction Contractor	Before construction commencement and at the time of employment	Contractor's responsibility
20-a	Children's right	Child deployment prohibition policy to be implemented as per law.	• Voices and complaints from the local community and the construction workers • Existence of child labor • Confirmation of the construction contract • Site observation	-	Project affected area	Construction Contractor	Before construction commencement and at the time of employment	Contractor's responsibility
20-b		Age verification in screening process through Government approved ID cards to be ensured.						
20-c		Awareness posters shall display.						
20-d		Educational institutes shall be provided with adequate & safe access.	Same as "15-b".					
21-a	Health (Infectious diseases such as HIV/AIDS, etc.)	Arrange HIV/AIDS counselling through qualified NGOs; ensure confidentiality.	• Confirmation of health checklist of the workers and preferably of the local community • Implementation of Training • Interviews with concerned organizations • Confirmation of voices and complaints • Visual observation	-	Construction areas and surrounding area	Construction Contractor	Monthly during the construction period and when complaints are heard in this regard	Contractor's responsibility
21-b		Organize HIV/AIDS awareness activities (street plays, short films).						
21-c		Dos & Don'ts posters shall be displayed at site & labor camps.						

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
21-d		Condom promotion programs shall be conducted, and free condom distribution arrangement shall be ensured.						
21-e		Regular health checkup camps Awareness & training shall be arranged for Malaria & Dengue.						
21-f		Housekeeping & hygiene shall be maintained at project site & labor colony and fogging shall be done at both.						
22-a	Labor environment including labor safety	For the Project Site safety, measures below will be included: • Site specific SHE&W policy, Construction SHE&W Plan in line with condition of contract, on site emergency preparedness plan & Labors accommodation plan shall be implemented. • Underground safety measures – monitoring for oxygen deficiency, toxic gases & dust levels with continuous monitoring & alarms • Strict entry/exit protocols along with tally-boards in underground tunnel. • Work permit system shall be followed. • Medical facilities – Ambulance, emergency contact nos. displayed & tie up with nearby hospitals.	• Confirmation of accidents records • Confirmation of health checklist of workers • Medical checkup of workers • Number of cases that suffered from heat strokes and other occupational health problems • Voice and complaints from the workers	-	Construction sites and surrounding area	Construction Contractor	Monthly and when complaints are heard in this regard	Contractor's responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
		• Tied up all local authorities such as Fire, police, Disaster Management & BMC (Municipal Corporation) • Electrical & Fire safety measures to be implemented. LOTO system to be ensured. • Proper ventilation system shall be provided at the underground tunnel working area. • Fatigue management - Regulations for working hours, rest breaks, and night shift management. • Ensure SCABA equipment use in tunnels. • Job specific trainings (on site & classroom) shall be conducted on timely. • Safety signages shall be displayed at all prominent location. • PPEs compliance: Safety helmet & shoes, reflective safety jacket and job specific PPEs (Goggle, Ear plugs, dust mask, Full body harness, breathing apparatus) • Housekeeping & hygiene shall be maintained at site. • Work at height: Standard & approved scaffolding system & fall protection shall be used/implemented. • Availability of Rest shelters.						

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
22-b		For the Labor colony, measures below will be included: • Provide clean drinking water, sanitation, canteens, and bathrooms. • Construct separate kitchens as per labor capacity. • Fire preventions & emergency preparedness to be implemented • First aid facilities shall be available • Maintain effective drainage, garbage disposal, and sewage systems. • Housekeeping & hygiene shall be maintained • Construct separate kitchen shall be provided according to labor strength						
23-a	Accidents	Mitigation Measures for Traffic will include the following: • Traffic management plan shall be implemented in consultation with respective area authorities. • Install standard traffic signs and diversion boards. • Separate pedestrians' pathways with signs shall be provided • Conduct drivers' defensive driving training and safety vehicle checks; use GPS tracking. Deploy traffic personnel along construction sections to assist traffic flow.	• Confirmation of accidents record • Record and site inspection • Interview with concerned organizations • Voices and complaints from the local community	-	Construction sites and surrounding area	Construction Contractor	Monthly and when complaints are heard in this regard	Contractor's responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
23-b		• Zero Accident Vision: Must adopt "Zero Harm Policy". • Method Statement, SOP & work permit shall be followed • Awareness training shall be conducted. • Safety posters & signages shall be displayed • Mock drills shall be conducted timely • Fire & Electrical prevention • Record near misses and implement CAPA (Corrective and Preventive Actions).						
24	Cross-border impact and climate change	Same as "9. Biodiversity"						

Source: JST, MMRC

Table 4.10.2 Environmental Monitoring Plan (Operation Phase) proposed by the survey

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
1	Air pollution	Sampling to assess surrounding impacts	Sampling survey using the same method as the baseline: SO_2, CO, NO_2, O_3, PM_{10}, $PM_{2.5}$	**CPCB 2009** SO_2: 80μg/m^3 CO: 2mg/m^3 NO_2: 80μg/m^3 O_3: 100μg/m^3 PM_{10}: 100μg/m^3 $PM_{2.5}$:60μg/m^3	Depot site	MMRC	Monthly	10,000 / site·year
2-a	Water Quality	Regular maintenance of toilets, Sewage Treatment Plant (STP), Effluent Treatment Plant (ETP) and related facilities at stations and depots.	Verification through visual inspection and cleaning records	-	Every station and Depot sites	MMRC	After commencement of operation: every six months for 2 years	Included in MMRC operating costs
2-b		Sampling to assess surrounding impacts	Sampling survey using the same method as the baseline Drainage: Color, odor, turbidity, pH, conductivity, total hardness, chlorides, iron, total dissolved solids, sulfates, nitrates, lead, copper, manganese, mercury, cadmium, zinc, total chromium, hexavalent chromium, total alkalinity, calcium, magnesium, sodium, potassium, dissolved oxygen, BOD, COD	<u>Wastewater:</u> **General Standards for Discharge of Environmental Pollutants in Environment (Protection) Rules, 1986** (Individual standard values omitted)	Depot site		Monthly	7,000 / site·year
2-c		Adequate arrangement of treating the workshop wastewater to the standard will be provided such as Oil-Water Separator and Sedimentation Tank.	Verification through visual inspection and cleaning records	-			After commencement of operation: every six months for 2 years	Included in MMRC operating costs
3	Waste	Installation of enough garbage bin at appropriate location in stations and the depot and collection rules based on local collection systems.	• Confirmation of waste disposal forms • Waste management condition • Voices and complaints from the local community and passenger	-	Every station and Depot sites	MMRC	Twice a year for the first two year	Included in MMRC operating costs

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
4-a	Soil contamination	Necessary facilities and equipment for preventing leaking oil shall be prepared at the depot and the receiving substations.	Verification through visual inspection and maintenance records	-	Depot and Receiving substations	MMRC	Twice a year for the first two year	Included in MMRC operating costs
4-b		Sampling to assess surrounding impacts	Baseline-method sampling: pH, EC, total chromium, Cr^{6+}, Pb, Cd, As, Hg	**EP (Contaminated Sites) Rules, 2025** T-Cr: 87mg/kg Cr^{6+}: 78mg/kg Pb: 600mg/kg Cd: 22mg/kg As: 76mg/kg Hg: 50mg/kg	Depot site		Once each in hot, rainy and dry seasons	7,500 / site·year
4-c		Regular preventive maintenance service of transformer should be strictly implemented	Maintenance record of transformer	-	Receiving substations		Twice a year for the first two year	Included in MMRC operating costs
5-a	Noise and vibration	Conduct monitoring of vibration impacts during train operations in the World Heritage area.	• Vibration level (Lv) • Voices and complaints from the World Heritage area	Commercial Area Daytime: 70 dB Night time: 65 dB	World Heritage area	MMRC	Once each in hot, rainy and dry seasons for the first year, and once a year for the following two years.	Included in MMRC operating costs (Reference: 400,000 / all sites·year)
5-b		Introduction and maintenance of elastic rail pads and vibration-reducing sleepers	Records and site observations	-	Entire metro line	MMRC	Twice a year for the first two year	Included in MMRC operating costs

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
5-c		Sampling to assess surrounding impacts	Same methods as the baseline survey [Noise] LAeq	**EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition** Commercial Area Daytime:65 dB Nighttime:55 dB	Depot site	MMRC	Monthly	4,500 / site·year
6	Ground subsidence	Continuous monitoring with settlement gauges and settlement plates	Records and site observations	-	Entire metro line	MMRC	Twice a year for the first two year	Included in MMRC operating costs
7-a	Offensive odor	Regular cleaning and collection of the general waste from stations and depot.	• Record and Site observation • Confirmation of voices and complaints Odor • Voices and complaints from the passenger and the local community	-	Every station, Depot sites and the surrounding area	MMRC	Twice a year for the first two year	Included in MMRC operating costs
7-b		Installation of appropriate garbage bin with cover.						
8-a	Biodiversity	A compliance report on compensatory plantation, accompanied by photographic documentation, shall be submitted to the Tree Authority on a semi-annual basis.	Compliance report and site observations	-	All planting areas and alternative plantation sites	MMRC: For 3 years after plantation BMC: Thereafter	Compliance report submission: After planting: biannually for 3 years Confirmation of tree survival rate: After planting: annually for 3 years	Maintenance Cost Included
8-b		The General Consultant (GC) engaged by MMRC shall conduct regular audits on environmental and tree management activities as part of its routine duties.						

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
9	Cultural Heritage	Same as "5. Noise and vibration".						
10-a	Gender	Active employment of female staff for MMRC with fair conditions	• Confirmation of employment record • Verification of Gender Training Records • Confirmation of voices and complaints from female staff of MMRC	-	HQ of MMRC	MMRC	Twice a year for the first two year	Included in MMRC operating costs
10-b		Keep provision of the designated seat for women on the train, enough number of toilet and other facilities as much as possible.	• Site observation • Confirmation of voices and complaints from female passengers • Status of introduction of the designated seat and facilities for female		Every station			

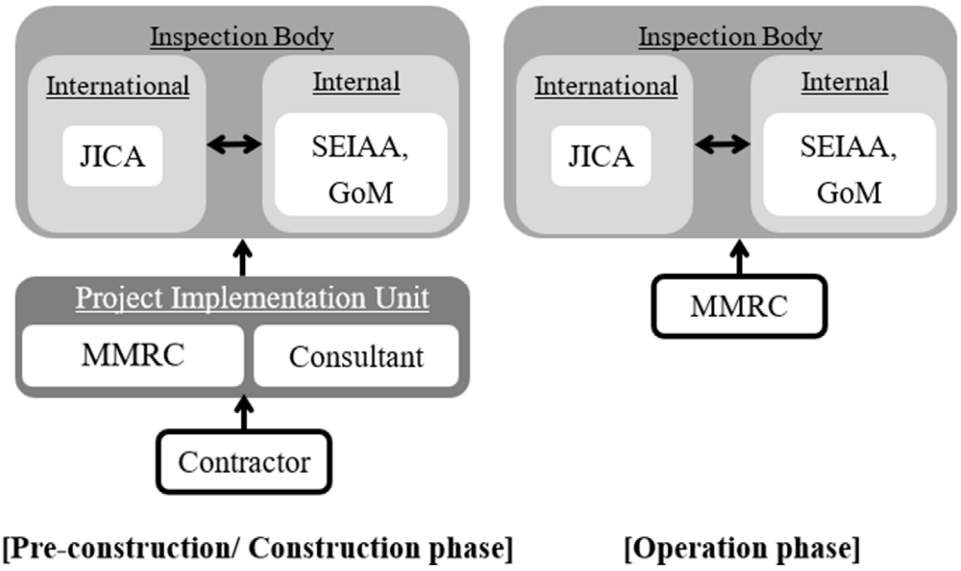
Source: JST, MMRC

4.11 Project Implementation Structure

4.11.1 Mitigation Measures and Monitoring Plan

This section outlines the implementation framework for the proposed mitigation measures and the corresponding monitoring plan. During the pre-construction and construction phases, the contractor will report to the Project Implementation Unit (PIU), and the PIU will submit regular progress reports to JICA. The reporting frequency from the PIU to JICA will be on a quarterly basis. As needed, the PIU will also report to the State Environment Impact Assessment Authority, Maharashtra (SEIAA-Maharashtra) - Mumbai's environmental supervisory authority—and follow its guidance. During the operation phase, MMRC will act as the responsible agency and submit regular reports to JICA. These reports will be provided twice a year for the first three years after the commencement of operation. In addition, MMRC, similar to the pre-construction and construction phases, will report to the SEIAA on an as-needed basis and seek necessary instructions.

Regarding MMRC's staffing structure, at present, MMRC has not employed in-house specialists for EIA and SIA. Therefore, all consultations related to EIA/SIA studies and environmental and social considerations are currently handled by subcontracted consultants. Moving forward, MMRC will need to actively recruit personnel in accordance with the scale and progress of the project. For example, in the case of DMRC, the EIA/SIA unit initially started with only a few members; however, through small-scale annual recruitment, the department has now grown to comprise more than a dozen personnel.



Source: JST

Figure 4.11.1 Implementation Framework During Construction and Operation Phases

4.11.2 Grievance Redress Mechanism for Environmental and Social Considerations

Grievances from residents and stakeholders shall be handled by either the Government of Maharashtra (GoM), which is the responsible in the construction of Cuffe Parade Station on Mumbai Metro Line 3, a 24-hour grievance redress mechanism (GRM) was established, comprising an on-site booth, a toll-free

hotline, and e-mail channels for receiving complaints from the public[47]. For this Project as well, the existing MMRC grievance redress mechanism will be applied as the basis. A grievance reception booth will be established at the MMRC headquarters, and submissions will be accepted through toll-free telephone, e-mail, and an official web form. Complaints will be electronically registered immediately, with formal responses issued within 15 days by the Field Level Grievance Redressal Committee (FLGRC). Unresolved cases are referred to and reviewed by Senior Level Grievance Redressal Committee (SLGRC).

Table 4.11.1 Composition and Roles of Grievance Redressal Committees in MMRC

Level	Committee Name	Composition (Examples)	Main Roles	Indicative Processing Time (Recommendation)
Field Level	Field Level Grievance Redressal Committee (FLGRC)	- Site Construction Manager - MMRC Site Officer - Representative of Survey agency - Representative of Supporting NGO, if requested - Representative of Project-Affected Persons (PAPs)	Immediate response to routine/minor grievances arising on-site (e.g., noise, vibration, traffic regulation, compensation issues). Ensures prompt initial action.	Within 15 days
Senior Level	Senior Level Grievance Redressal Committee (SLGRC)	- Senior MMRC Headquarters Officers - NGO Representative, if requested - PAP Representative - Independent Chairperson (e.g., subject-matter expert, legal professional)	Reviews cases unresolved by FLGRC. Conducts hearings and investigations for re-evaluation.	Within 30 days

Source: MMRC, Social Due Diligence Report, October 2018, MMRDA

[47] Grievance Redressal Mechanism Cuffe Parade Metro Station, 2018, MMRC

B. [Land Acquisition and Resettlement]

4.12 Objective of the Survey

The objective of the survey is to review and revise the draft Social Impact Assessment (SIA) report prepared by MMRC based on the survey conducted during August to October 2024 and updated in July 2025. Supplementary surveys are conducted to meet the JICA guidelines. This chapter is presented in the form of a Resettlement Action Plan (RAP), incorporating the requirements of JICA, which align with the SIA framework followed in India.

4.13 The Necessity of Land Acquisition and Resettlement

4.13.1 Affected Project Component and Project Area

The land acquisition and resettlement required by the Project are summarized in . Private land acquisition is necessary for Corridor-1, covering an area of 48,372 m², while no private land is required for Corridor-2.

Table 4.13.1 Affected Project Component and Land Requirements

Items	Project Components	Total land required	Private land
Alignment	Corridor-1: 17.51 km (Underground)	Corridor-1: 422,718 m^2	Corridor-1: 48,372 m^2
Station	Corridor-1: 14 (Underground) Corridor-2: 1 (Underground)		
Depot	Corridor-1: 27,662 m^2 Anik Depot		

Source: JST based on draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

4.13.2 Efforts to Avoid or Minimize the Impact

Attempts have been made during the designing of the project to minimize land acquisition, resettlement and adverse impacts on people in the project area through the suitable engineering designs. Steps have already been made to adjust the station size, confine the project area in the government land and in the available Right of Way (ROW) of roads where feasible.

However, there will be some unavoidable land acquisition for which adequate compensation has been considered. During the Detailed Design (D/D) stage, the Project will make further efforts to minimize impacts and disruptions as much as possible.

4.14 Legal Framework of Land Acquisition and Resettlement

4.14.1 Laws and Regulations of India and Maharashtra State

4.14.1.1 Summary of Applicable Laws and Regulations

This Project will be implemented in accordance with the relevant laws and regulations of the Government of India and the State Government, while also ensuring consistency with the JICA Guidelines. An overview of the legal framework applicable to this Project is provided below.

For this project, the land acquisition process will be carried out in accordance with Maharashtra Regional

Town Planning Act 1966. Compensation will be calculated based on the provisions of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (LARR 2013). The Resettlement and Rehabilitation Policy (R&R) will be guided by the Resettlement and Rehabilitation Policy for the Mumbai Urban Transport Project (MUTP).

Table 4.14.1 Legal framework related to this project

Related laws and regulations	Overview and Application to This Project
Land acquisition process and compensation	
Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCTLARR 2013)	• This Act was implemented on 1 January 2014 and applies to all public projects as well as private projects (limited to relatively large-scale private entities as defined under the Companies Act, 2013). • It stipulates the procedures for land acquisition, the compensation policy, and the items and calculation methods for compensation *** Applicable for the land acquisition and compensation for this project**
Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Maharashtra) Rules, 2014	• This Act was implemented on 27 August 2014 and provides specific provisions regarding the relevant authorities and their roles in the land acquisition process within the State of Maharashtra.
Resettlement and rehabilitation policy and scheme	
Resettlement and Rehabilitation Policy for Mumbai Urban Transport Project (MUTP R&R 2000)	• This was applied to the Mumbai Urban Transport Project implemented with assistance from the World Bank. It was approved by the Government of Maharashtra through the State Assembly in 1997 and revised in 2000. The policy is consistent with the World Bank's Operational Policy OP 4.12 on Involuntary Resettlement. • It stipulates the definition of eligible persons for compensation, including informal settlers without legal titles or ownership documents, and provides guidance on the treatment of the cut-off date. *** Applicable for the resettlement and rehabilitation policy for this project**
The Maharashtra Regional and Town Planning (Amendment) Act, 2017 (MRTP Act)	• It provides a framework for the planned urban development across the entire state, including provisions on the formulation of regional and local development plans, land use regulation, development control regulations, procedures for obtaining development permissions, and environmental protection.
Development Control and Promotion Regulations (DCPR) 2034	• A detailed rulebook formulated under the MRTP Act, the DCPR outlines urban planning and development regulations for the Mumbai Metropolitan Region. It is enforced by the Brihanmumbai Municipal Corporation (BMC) and provides comprehensive guidelines on land use zoning, building standards, and redevelopment policies. *** Reference for the In-situ rehabilitation scheme**
Others	
Maharashtra Rent Control Act, 1999	• It aims to regulate rental agreements between tenants and landlords in Maharashtra, including Mumbai. It specifically sets detailed provisions on rent ceilings, eviction restrictions, maintenance responsibilities, and the rights of legal heirs, with a strong emphasis on protecting tenants' rights.

Source: JST based on relevant laws and regulations

4.14.1.2 RFCTLARR Act (2013) and Maharashtra State Rules (2014)

The basic law on land acquisition and compensation for resettlement in India is the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (LARR Act 2013), which came into effect on January 1, 2014. An outline of the processes stipulated by the LARR Act 2013 is shown in the table below. Corresponding to this land acquisition law, the Maharashtra State Rules 2014 — the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Maharashtra) Rules, 2014 — were enacted on August 27, 2014. The

Maharashtra State Rules 2014 specifically define the relevant agencies and their roles.

The method for determining land prices under LARR Act, 2013 is stipulated in Chapter 4, Article 26. It requires that the market value of comparable land in the vicinity be assessed using two methods, with the higher of the two to be adopted. The valuation of buildings and other structures attached to the land is calculated using a methodology applied to the procurement of such structures in public works, based on unit prices that are updated annually. This is considered to reflect fair market value. Furthermore, the Act provides for the addition of solatium (compensation for emotional distress) to both the land and building values. As specified in the First Schedule of LARR Act 2013, the final compensation paid to the landowner is calculated as: Compensation = (Market value of the land as per sec 26 of LARR act x Multiplier factor in case of urban areas (one)) + Value of assets as per sec 29 of the act + solatium equivalent to 100%. Therefore, compensation under the Project is equal to or greater than the replacement cost of equivalent land and structures. In addition, in case of the land compensation, based on the direct purchase scheme of Maharashtra, 25% will be added to the compensation amount.

Table 4.14.2 Overview of Compensation and Assistance Provisions under the Land Acquisition Act (2013)

Item	Description
a. Establishment of a Public Oversight and Dispute Resolution Mechanism	• Establishment of a specialized body (LARR Authority) to resolve disputes related to land acquisition, resettlement, and livelihood restoration (Article 51)
b. Scope of Persons Covered by the Act	• Compensation is provided to landowners. • Those who lose their livelihoods due to land acquisition are eligible for rehabilitation and resettlement support.
c. Scope of Compensable Asset Losses	• Land, as well as buildings and attached structures on the land, are also subject to compensation.
d. Consultation Process	• Except in cases of "urgent acquisition" (Article 9), all projects involving land purchase by administrative authorities require a multi-stage consultation process, including social impact assessment and prior consent from affected households (Article 4(1)).
e. Land Price	• The higher of either the average registered sale price of comparable nearby land (based on the Stamp Duty Act) or the average sale price of comparable nearby land over the past three years (Article 26) or Ready Reckoner Rate decided by the Government.
f. Building Price	• The valuation based on the standard calculation method used by the State Public Works Department (PWD) for constructing buildings in public works, along with annually updated unit prices for materials.
g. Total Payment Amount for Land Acquisition	• Compensation = (Market value of the land as per section 26 of LARR act x Multiplier factor in case of urban areas (one)) + Value of assets as per section 29 of the act + solatium equivalent to 100%.

Source: Land Acquisition Act 1894, Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (LARR) Act, 2013

4.14.1.3 Mumbai Urban Transport Project Resettlement and Rehabilitation Policy, 1997 (Revised in 2000)

The Government of Maharashtra applies the "Mumbai Urban Transport Project Resettlement and Rehabilitation Policy, 1997 (revised in 2000)" to urban transport projects. This policy complies with the World Bank's safeguard policies and ensures measures aligned with international standards, including the definition of eligible persons for compensation, support for resettlement and rehabilitation including non-titleholders, and assistance during the transitional period.

Table 4.14.3 Resettlement and Rehabilitation Policy

items	Key points
Eligible Persons for Compensation and Assistance	• Land and building owners, as well as their tenants and users, are defined as PAPs. • Support for relocation and resettlement is guaranteed for all Project Affected Persons, including non-title holders.
cut-off date	• For non-title holders, the cut-off-date is defined as the completion date of the baseline survey. Any structures or occupants established after the cut-off-date will not be eligible for Resettlement and Rehabilitation (R&R) assistance. • If more than one year has passed since the baseline survey and the RAP, the baseline survey shall be updated.
Scope of Compensation and Assistance	• Compensation for losses shall be provided at full replacement cost or alternate rehabilitation tenement prior to actual relocation. • Support shall also be provided during relocation and the transitional period in the resettlement site.
Resettlement Options	• If relocation in urban areas is preferred, the following options are offered: - Non titleholder residential PAPs: Free residential units with an area of 20.91 m² - Titleholder residential PAPs: Free residential units with a minimum area of 20.91 m². Additional 48.77m² can be provided at cost depending on the size of the original building. - Commercial PAPs (both non-title and title holder): Free commercial units with a minimum area of 20.91 m². Additional 48.77m² can be provided at cost depending on the size of the original building.
Support for Vulnerable Groups	• Special attention should be given to the needs of the vulnerable groups. • Additional support is required for socially vulnerable households, such as female-headed households, persons with disabilities, and the elderly.

Source: JST based on the policy document

4.14.1.4 Maharashtra Regional and Town Planning Act, 1966 (amended in 2017)

In Schedule 5 of the Land Acquisition Act, 2013, the Maharashtra Regional and Town Planning Act, 1966 is listed among the state laws regulating land acquisition in Maharashtra. This Act permits land acquisition for public purposes based on regional and town planning, allowing either payment of agreed compensation or granting additional floor area ratio (Floor Space Index: FSI) or transferable development rights (TDR). In particular, it stipulates that any land use changes after the publication of a draft regional plan require approval from the planning authority.

4.14.1.5 Maharashtra Slum Areas Act, 1971 and Slum Rehabilitation Act (SRA Act), 1995

To address slum areas within the state of Maharashtra, the Maharashtra Slum Areas Act provides a fundamental framework for improving living conditions in slum areas, protecting the rights of slum dwellers, and facilitating redevelopment. The Act has undergone multiple revisions reflecting challenges from slum redevelopment efforts and related laws and regulations, and it applies to the slum resettlement process of this project.

Complementing the Maharashtra Slum Areas Act (1971), SRA Act (1995) was established to provide a new specific framework for slum redevelopment, the Slum Rehabilitation Scheme (SRS), has been established. The SRS sets guidelines including the provision of free housing to slum dwellers and procedures for resettlement, outlining concrete methods for redevelopment implementation. It also includes a basic framework for incentives to developers. Furthermore, the Slum Rehabilitation Authority (SRA) was established as the implementing and supervisory agency for the SRS and slum redevelopment projects.

4.14.2 JICA Guidelines

The key principles of JICA guidelines on involuntary resettlement are summarized below.

1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
   If avoidance is not possible even after such examination, effective measures to minimize impacts and to compensate for losses must be taken upon agreement with the affected people.
2. Project affected people, such as people to be resettled involuntarily and/or people who may lose their livelihoods by the project, must be provided sufficient compensations and supports by the project proponents in a timely manner. Compensations must be calculated at full replacement cost as much as possible, and provided in advance.
   Project proponents must make efforts for the affected people to improve or at least restore their standards of living, income opportunities and production levels to the pre-project levels.
   Measures to achieve this may include: Providing land or monetary compensations for losses of land or assets, supporting for alternative sustainable livelihood, supporting for expenses necessary for relocation, and supporting for re-establishment of communities at resettlement sites.
3. Compensation standards are disclosed and consistently applied.
   The project affected persons need to be aware of the compensation standards.
   In principle, the contents of the individual compensation to be agreed are explained to the project affected persons in writing, and the project affected persons can confirm the contents at any time.
4. Appropriate participation of the project affected people and their communities must be promoted in the planning, implementation and monitoring of measures against involuntary resettlement and loss of livelihood.
5. For projects that result in large-scale involuntary resettlement, a Resettlement Action Plans (RAP) must be prepared and made available to the public prior to the resettlement and provision of compensation and support.
   In preparing the RAP, consultations must be held with the project affected people and communities, based on sufficient information made available to them in advance.
   When consultations are held, explanations must be given in languages and forms that are understandable to the project affected people.
   It is desirable that the RAP includes elements laid out in the Environmental and Social Standard (ESS) 5 of the World Bank's environmental and social policies.

Above principles are complemented by World Bank ESS5, since it is stated in JICA Guideline that "JICA confirms that environmental and social considerations of a project do not deviate significantly from the World Bank's environmental and social policies.". Additional key principle based on World Bank ESS5 is as follows.

1. the Borrower will, as part of the environmental and social assessment, conduct a baseline survey to identify the persons who will be affected by the project, to establish an inventory of land and assets to be affected, to determine who will be eligible for compensation and assistance, and to discourage ineligible persons, such as opportunistic settlers, from claiming benefits.(ESS5 para20).
2. Affected persons may be classified as persons:
   (a) Who have formal legal rights to land or assets
   (b) Who do not have formal legal rights to land or assets, but have a claim to land or assets that is recognized or recognizable under national law; or
   (c) Who have no recognizable legal right or claim to the land or assets they occupy or use. (ESS5 para10) the Borrower will offer affected persons compensation at replacement cost, and other assistance as may be necessary to help them improve or at least restore their standards of living or livelihoods, subject to the provisions of paragraph 26 through 36 of this ESS. (ESS5 para 12)
3. Where livelihoods of displaced persons are land-based, or where land is collectively owned, the Borrower will offer the displaced persons an option for replacement land in accordance with paragraph 35(a), unless it can be demonstrated to the Bank's satisfaction that equivalent replacement land is unavailable. (ESS5 para14)
4. Transitional support will be provided as necessary to all economically displaced persons, based on a reasonable estimate of the time required to restore their income earning capacity, production levels, and standards of living. (ESS5 para36)
5. Particular attention will be paid to gender aspects and the needs of the poor and the vulnerable. (ESS5 para26)
6. To address the issues identified in the environmental and social assessment, the Borrower will prepare a plan proportionate to the risks and impacts associated with the project (ESS5 para21)

In addition to the above core principles on the JICA policy, it also emphasized a detailed resettlement policy inclusive of all the above points; a project-specific resettlement plan; an institutional framework for implementation; a monitoring and evaluation mechanism; the schedule for implementation; and, a detailed Financial Plan, etc.

Source: JICA Guidelines for Category B Environmental and Social Consideration Reports (March 2025)

4.14.3 The Gap between JICA Guidelines and Indian Legislation

This project, particularly the development of Corridor 1 (Line 11), is expected to impact land acquisition, resettlement, and livelihoods. Therefore, the discrepancies between JICA's social safeguards guidelines and Indian regulations are summarized in the table below.

Table 4.14.4 The Gap between JICA Guidelines and Indian Legislation

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	**LARR 2013** **Article 4 and Article 8(1)(c):** Only the minimum land necessary for project implementation shall be acquired. **Article 8(2):** The administrative authority overseeing land acquisition and environmental impacts shall verify and supervise that resident displacement due to the project is minimized, that impacts on infrastructure and the natural environment are kept to a minimum, and that the adverse effects on affected individuals are avoided or mitigated to the greatest extent possible.	No	Through project planning and design, feasible alternatives shall be formulated and evaluated using assessment methods that adequately consider involuntary resettlement and loss of livelihoods, ensuring that options with the least impact are selected.
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	**LARR 2013** **Chapter II:** Conduct social impact assessments on affected persons during land acquisition, publish draft compensation and support policies, and formulate final compensation and support policies that incorporate the opinions and suggestions of affected persons. **Article 3(c):**The scope of compensation and support covers land and asset owners as well as those whose primary livelihood depends on the land to be acquired. **R&R MUTP 2000** 3(a) By examining feasible alternatives, minimize resettlement and prioritize various elements of the project.	No	Ensure that alternatives for the planned route have been examined with a focus on minimizing impacts.
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost, must be sufficiently compensated and supported so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	**LARR 2013** **Article 3(p), Article 27, and Article 29:** The scope of assets and losses eligible for compensation includes land, buildings attached to the land, and structures attached to the buildings. **Article 26:**Land price shall be the higher of the average registered sale price of nearby land or the notified market price. **Article 28(5):**Compensation includes expenses necessary for relocating residences and business premises.	No	Regardless of ownership status of land and assets, tenancy, or length of residence, households displaced by this project will be consulted to provide relocation inconvenience allowances that include livelihood support grants, moving assistance grants, and compensation for disrupted income opportunities. Additional support funds and skills training will be discussed for households classified as socially vulnerable.
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	**LARR 2013** **Article 26:**The land price shall be the higher of the average registered sale price of comparable nearby land (based on the Stamp Duty Act) or the average sale price of comparable nearby	Although there is no explicit instruction to compensate at replacement cost,	Structure value will be assessed using area unit prices based on market prices without considering depreciation, with discussions

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
	Valuation and compensation for losses shall be determined by the replacement cost. (WB OP4.12 Para 10)	land over the past three years. **Article 29:**Experts shall be consulted to determine the market value of trees, crops, and similar assets. **Article 30:**An equal amount of solatium shall be paid in addition to the total compensation amount.	an additional payment based on the adopted market land price is mandated, with solatium at a rate of 1.0 times in urban areas and 2.0 times in suburban areas.	to include an additional 100% solatium. For land prices, 100% solatium will be added to the market rate. Additionally, 25% will be added to the compensation amount under direct purchase scheme. Ultimately, since all the project area falls under in urban areas, the compensation amount is expected to be twice the market price (solatium 1.0x plus urban area 1.0) and in case of land, 25% will be added, indicating that compensation under this project is likely to exceed replacement cost.
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	**LARR 2013** **Article 46(4):** No alterations to the land shall be made until compensation and support payments are completed. **R&R MUTP 2000, 3(b):** Just prior to actual relocation, affected persons shall be compensated for their losses at replacement cost.	No	Discussions will be held to ensure that a sufficient grace period is provided between the payment of compensation and support for land and assets and the relocation.
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	**LARR 2013** **Article 6(1):** The Social Impact Assessment (SIA) shall be widely disclosed by posting at municipal offices and on websites. **Article 18:** The Resettlement and Rehabilitation (R&R) plan shall be widely disclosed by posting at municipal offices and on websites. **LARR Maharashtra 2014** **Article 5(13):** The finalized SIA shall be published. **Article 8(1):** The expert group's evaluation and advice on the SIA shall be published in two local-language newspapers and posted on the state government website. **Article 13(1)(2):** The finalized R&R shall be publicized by publication at municipal offices. **R&R MUTP 2000** **14(b):** The draft Resettlement Action Plan (RAP) shall be shared with affected persons, NGOs, and the general public through community meetings, and finalized taking into account the opinions of affected persons.	No	The implementing agency is currently preparing the resettlement plan and livelihood restoration plan in accordance with the law. Going forward, it will be confirmed that responses aligned with the JICA guidelines are implemented and that the plans are made publicly available.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	**LARR 2013** Article 4(2): At the start of the Social Impact Assessment (SIA), a notification shall be issued in the local language, publicly displayed in the affected area, and posted on the websites of the district and municipal offices as well as relevant administrative agencies. Article 5: When conducting the SIA, a public hearing shall be held in the affected area to ensure that the opinions of PAHs are accurately	No	Regarding Corridor 1 of Route 11, the first SHM was conducted in September 2024. In the JICA supplementary survey, the first SHM was additionally conducted in August 2025, and the second

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
		recorded in the SIA report. Article 16(5)(6): Public hearings on the draft Resettlement and Rehabilitation (R&R) plan shall be conducted after widely publicizing the date, time, and venue. The R&R report, along with a document summarizing the opinions of PAHs, shall be submitted to the District Collector. **LARR MH 2014** Article 5(1): After drafting the SIA report, the date and venue of the public hearing shall be published in two local-language newspapers at least 15 days prior to the hearing. Article 5(5)(6): The SIA shall be finalized taking into account opinions and proposals from the public hearing, and the recordings and minutes of the hearing shall be submitted to relevant agencies. Article 11(5)(6): After drafting the R&R plan, the date and venue of the public hearing shall be published in two local-language newspapers at least 15 days prior to the hearing.		SHM in September 2025.
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	**LARR 2013** **Article 5:** When conducting the Social Impact Assessment (SIA), public hearings shall be held to ensure that the opinions of households subject to the SIA are incorporated. **Article 6:** The SIA shall be prepared and published in the language of the project area and disclosed on the website. **LARR MH2014** **Article 5(9):** Public hearings shall be conducted in the local language.	No	In SHM, confirmation and consultation will be conducted in local languages, taking into consideration the need for communication in local languages.
9	Appropriate participation of affected people must be promoted in the planning, implementation, and monitoring of resettlement action plans. (JICA GL)	**LARR 2013** **Article 5:** When conducting the Social Impact Assessment (SIA), public hearings shall be held to ensure that the opinions of households subject to the SIA are incorporated. **Article 50:** The state shall establish a committee to monitor the implementation of the Resettlement Action Plan (RAP). LARR Maharashtra 2014 **Article 20:** The state shall establish a project-level Resettlement and Rehabilitation (R&R) committee to provide advice on the R&R plan, monitor progress every three months, and conduct post-implementation monitoring. **Article 21:** The state shall establish a monitoring committee to oversee the implementation of R&R every six months. R&R MUTP 2000 **14(b):** The Resettlement Action Plan (RAP) must be prepared with the participation of the PAPs.	There are no provisions regarding the participation of affected persons during the implementation and monitoring stages of the plan.	Efforts should be made to ensure the participation of affected persons during the implementation and monitoring stages of the RAP. Specifically, during the implementation stage, NGOs or consultants responsible for execution should be encouraged to conduct individual interviews with Project Affected Households (PAHs). During the monitoring stage, it is recommended to include provisions requiring PAH participation in participatory surveys, group monitoring, and sample surveys conducted by external monitoring experts.

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	**LARR 2013** **Article 7 :**SIA reviews shall be conducted by a group of experts including representatives from the municipalities where the projects are to be implemented. **Article 15:** The Collector shall accept objections to the acquisition area, acquisition purpose, and SIA survey results. **Article 16:** The R&R proposal shall be made public through public hearings, etc., and opinions and objections shall be recorded and finalized by the Collector and the Government. **Article 50**: The state shall establish a committee to monitor the implementation of R&R. **Article 64:** Complaints regarding land surveys, compensation amounts, payment recipients, and eligibility for support and relocation shall be submitted to the implementing authority through the Collector. **MUTP R&R 2000** **15:** Two-tier Grievance Redress Mechanism (GRM) will be established. A senior office at the local level will first consider grievance of PAPs in consultation with the concerned NGO, and unresolved cases will be reviewed by a higher-level committee by the Government to ensure fair and transparent resolution.	No	Confirm two-tier GRM is established and operational, including status of SIA reviews, acceptance of appeals, record keeping, resolution, etc. as stipulated by law, and confirm the ease of access and the smoothness and speed of complaint resolution.
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey, preferably at the project identification stage, to prevent a subsequent influx of encroachers who wish to take advance of such benefits. (WB OP4.12 Para.6)	**LARR 2013** **Article 4:** When an administrative agency intends to acquire land for public purposes, it shall consult with the municipality and conduct an SIA. **MUTP R&R 2000** **6 (a)** The completion date of the baseline survey shall be the cut-off-date. Buildings newly constructed after the cut-off-date and their residents shall not be subject to R&R.	For titleholders, the date of the preliminary notification will be set as the cut-off-date, and for non-title holders, the date of completion of the baseline survey will be set as the cutoff date.	The provisional cut-off-date of Corridor 1 has been set on 20th September 2025. The official cut-off-date will be set on the completion date of MMRC' baseline survey.
12	Eligibility of benefits includes; the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of baseline survey but have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	**MUTP R&R 2000** **6 (a)** Regular residents shall be eligible for R&R until the actual resettlement. Irregular residents shall be eligible for R&R only if they are recorded in the baseline survey (the completion date of the baseline survey is the cutoff date). If there is a gap of more than one year between the baseline	No	For non-titleholders, they are eligible for R&R assistance regardless of the length of their residence, as per the R&R MUTP 2000.

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	**LARR 2013** **Appendix 2:** One of the options for compensation for loss of land ownership is the provision of replacement land.	No farmland or tenant farmers are affected. Therefore not applicable to this project.	No farmland or tenant farmers are affected. Therefore not applicable to this project.
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	**LARR 2013** **Appendix 2:** Provide relocation households with lump-sum payments or employment opportunities (employment opportunities, lump-sum payments, or 20-year pensions in the relevant business), one year of living expenses (monthly payments), relocation compensation, etc.	No	This project will provide relocation assistance and support for livelihood to households that are forced to relocate. Discuss additional support and skills training to households that are socially vulnerable.
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	**LARR 2013** **Article 41:** Land acquisition in the settlements of designated castes and tribes shall be avoided as far as possible, and additional support shall be provided to those affected when necessary. **LARR MH 2014** **Article 17 (4):** In cases involving involuntary relocation of designated castes and tribes, the state government shall prepare a development plan. **MUTP R&R 2000** **12(c)** Additional resettlement packages shall be provided to vulnerable groups such as female heads of households, persons with disabilities, and the elderly.	The definition of socially vulnerable groups may be too narrow.	Additional support will be provided to vulnerable PAH who meet the following conditions: those with incomes below the poverty line, households headed by women, persons with disabilities, and elderly persons (aged 60 or older) who have no support from other family members.

Source: JST based on the relevant laws

4.14.4 Land Acquisition and Resettlement Policy

Based on the above gap analysis, the land acquisition and resettlement policy to be adopted in the Project are described below.

I. The Government of India will use the Project Resettlement Policy (the Project Policy) for the Project specifically because existing national laws and regulations have not been designed to address involuntary resettlement according to international practice, including JICA's policy. The Project Policy is aimed at filling-in any gaps in what local laws and regulations cannot provide in order to help ensure that PAPs are able to rehabilitate themselves to at least their pre-project condition. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Where there are gaps between the Indian legal framework for resettlement and JICA's Policy on Involuntary Resettlement, practicable mutually agreeable approaches will be designed consistent with Government practices and JICA's Policy.

II. Land acquisition and involuntary resettlement will be **avoided** where feasible, or **minimized**, reduced, mitigated by identifying possible alternative project designs that have the least adverse impact on the communities in the project area

III. Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods or resources will be **fully compensated** and assisted so that they can improve, or at least restore, their former economic and social conditions.

IV. Compensation and rehabilitation support will be provided to any PAPs, that is, any person or household or business which on account of project implementation would have his, her or their:
- Standard of living adversely affected;
- Right, title, or interest in any house, interest in, or right to use, any land (including premises, agricultural land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
- Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; or
- Social and cultural activities and relationships are affected or any other losses that may be identified during the process of resettlement planning.

V. All affected people will be eligible for compensation and rehabilitation assistance, **irrespective of tenure status**, social or economic standing, and any such factors that may discriminate against the achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives. All PAPs residing, working, doing business, and/or cultivating land within the project-impacted areas **as of the date of the latest baseline survey** and inventory of lost assets, are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity, and production levels.

VI. PAPs that **lose only part of their physical assets** will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of the remaining land and structures will be agreed upon during the resettlement planning process.

VII. People **temporarily affected** are to be considered PAPs and appropriate support will be considered.

VIII. Where a **host community** is affected by the development of a resettlement site in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.

IX. The **resettlement plans** will be designed in accordance with MUTP Policy, and JICA guidelines on Involuntary Resettlement.

X. The Resettlement Plan will be **translated** into local languages and **disclosed** for the reference of PAPs as well as other interested groups.

XI. Payment for land and/or non-land assets will be based on the principle of the **replacement cost**.

XII. Resettlement assistance will be provided not only for an immediate loss but also for **a transition period** needed to restore the livelihood and standards of living of PAPs.

XIII. The resettlement plan must consider the needs of those most **vulnerable** to the adverse impacts of resettlement (including the poor, those without legal title to land, and women, children, elderly, and disabled) and ensure they are considered in resettlement planning and mitigation measures identified. Assistance should be provided to help them improve their socio-economic status.

XIV. PAPs will be **involved** in the process of developing and implementing resettlement plans.

XV. PAPs and their communities will be **consulted** about the project, the rights and options available to them, proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.

XVI. Adequate **budgetary support** will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the Government.

XVII. **Displacement does not occur before the provision of compensation and other assistance** required for relocation. Sufficient civic infrastructure must be provided in the resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. (Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be ongoing activities.)

XVIII. Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

XIX. Appropriate reporting (including auditing and redress functions), monitoring, and evaluation mechanisms, will be identified and set in place as part of the resettlement management system. If numbers of resettlement is large, an external monitoring group will be hired by the project and will evaluate the resettlement process and final outcome. Such groups may include qualified NGOs, research institutions or universities.

Cut-off-date of Eligibility

The cut-off-date of eligibility refers to the date prior to which the occupation or use of the project area makes residents/users of the same eligible to be categorized as PAPs and be eligible to Project entitlements. In the Project, the cut-off dates will be set as follows and these dates will be disclosed to each affected area by the relevant local governments and will be disclosed to their populations. This date will be disclosed to each affected village by the relevant local governments and the villages have disclosed to their populations. The establishment of the eligibility cut-off date is intended to prevent the influx of ineligible non-residents who might take advantage of Project entitlements.

- Corridor-1: Provisional cut-off date on completion date of JICA supplementary baseline survey (20 September 2025). Official cut-off-date will be set at the completion of MMRC's baseline survey.

Principle of Replacement Cost

All compensation for land and non-land assets belonging to titleholders (eligible as per the cut-off date) shall be provided in accordance with the provisions of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (LARR) Act, 2013.

Non-titleholders/tenants of household/ commercial/ shops (eligible as per the cut-off date) will be allotted new tenements on an ownership basis.

In case of cash compensation, the replacement cost will be calculated without depreciation and without deductions towards taxes or transaction costs subject to provisions of applicable laws.

4.15 Scope of Land Acquisition and Resettlement Impact

4.15.1 Survey Method

The methodology for conducting SIA study of the proposed project involves review of topographical survey drawings, field visits, data collection and stakeholder consultations, as described as below.

a) Site observation and preliminary assessment

Initial site visits and assessments were conducted to identify potentially affected structures based on the General Alignment Drawings from the Detailed Project Report (DPR) shared by MMRC.

b) Baseline socio-economic survey (BSES)

A baseline socio-economic survey was conducted to interview Project-Affected Families (PAFs), including structure owners, tenants, squatters, kiosk operators, small business owners, and workers dependent on affected land/structures. The survey aimed to collect information on their socio-economic conditions.

c) Consultation with concerned stakeholders

Stakeholder consultations were conducted through various formats to capture diverse community perspectives.

- **Informal stakeholder meetings (SHM):** At the start of the BSES for this survey, a total of 17 informal SHMs were conducted to collect opinions from residents regarding the project, as supplementary surveys by JICA. The implementation methods were decided in consultation with MMRC and information about the SHM clearly stated that they were part of the MMRC and JICA project surveys.
- **Focus Group Discussion (FGDs):** A total of 25 FGDs were conducted, targeting specific groups such as women, shop owners, transport operators, and vulnerable populations. These discussions helped gather group-specific concerns, expectations, and needs
- **Station Area interviews:** Structured interviews were conducted with 160 commuters in the proposed station areas. The survey collected both quantitative and qualitative data, including demographic profiles, travel behavior, satisfaction with the current living environment, and perceptions of key quality-of-life factors.
- **Formal stakeholder meetings (SHM):** Two formal Stakeholder Meetings (SHMs) are planned to be organized by MMRC. The first SHM will aim to explain the project, including some plan changes, while the second SHM will present proposed mitigation measures and compensation policies and gather feedback from key stakeholders.

d) Data compilation and analysis

Collected data are analyzed to understand the scale of the impact as well as understanding PAP's demographic, social, and economic characteristics which are essential for designing effective resettlement and rehabilitation plans.

4.15.2 Cut-off-date (COD)

The provisional cut-off-date for Corridor-1 was set as 20th September 2025, the end of the JICA supplementary baseline survey. The baseline survey may be revised by the MMRC following the finalization of the alignment and station design.

4.15.3 Key Impact of the Project

Based on the BSES survey, a total of 801 Project-Affected Households (PAHs), 2,718 Project Affected People (PAPs) were identified. The table below provides an overview of the scale of impacts based on the current survey results.

Table 4.15.1 Tentative information of affected land, structures and households

Impacts on Land	Permanent	Temporary	Total
Total Affected Land (m^2)			**422,718**
Affected Public Land	203,528	170,818	374,346
Affected Private Land	23,664	24,708	48,372
Impacts on Household and Structures	**Title holder**	**Non-title holder**	**Total**
Total PAH (household)	233	568	801
Total PAP (people)*	937	1,781	2,718
Displaced PAH	138	554	692
Displaced PAP*	603	1,759	2,362
Tenant PAH	211	-	211
Economically displaced PAH	84	18	102
Vulnerable PAH	8	243	251
Worker / Employees	-	-	376
Total Affected Structures (structures)			
Number of Affected Structures	14	564	578
Number of Common/Community Property Resources (CPR)	1	5	6

Source: JST based on BSES 2024-25



No. 2 Wadala Station



No. 7 Hay Bunder Station



No. 10 Nagpara Junction Station (Memni building)



No. 11 Bhendi Bazaar Station

Source: JST

Figure 4.15.1 Photos of the Affected Location

4.15.4 Socio-economic Survey

4.15.4.1 Summary of the Impact

Based on the BSES conducted in the Corridor-1, the overall impact of the Project is summarized in the table below. Since the corridor is primarily underground, the impacts are concentrated around station areas. Therefore, project affected land, structures, and households are categorized by stations. Among the affected households, owners and tenants are classified as titleholders, while squatters and resettled families are considered non-titleholders.

Table 4.15.2 Summary of Affected Area and People

No	Station	Land (m^2)		Structure (units)	Titleholders (PAH)		Non-titleholder (PAH)	
		Government	Private		Owner	Tenant	Squatters	Resettled
1	Anik Depot	3,580.0	17,490.0	152	0	0	152	0
2	Wadala Depot	8,260.0	0	397	0	0	0	397
3	CGS Colony	1,989.9	0	0	0	0	0	0
4	Ganesh Nagar	0	1,494.6	0	0	0	0	0
5	BPT Hospital	1,174.0	0	0	0	0	0	0
6	Sewri	4,950.0	0	7	0	0	7	0
7	Hay Bunder	1,065.0	0	7	0	0	7	0
8	Darukhana	1,100.0	0	1	0	0	1	0
9	Byculla	0	1,531.0	11	0	0	11	0

No	Station	Land (m^2)		Structure (units)	Titleholders (PAH)		Non-titleholder (PAH)	
		Government	Private		Owner	Tenant	Squatters	Resettled
10	Nagpada Junction	0	1,143.4	104	1	100	4	0
11	Bhendi Bazaar	2,005.0	0	111	10	111	0	0
12	CSMT Metro	714.0	0	0	0	0	0	0
13	Horniman Circle	1,155.0	0	0	0	0	0	0
14	Gateway of India	1,040.4	0	0	0	0	0	0
Grand-Total		27,033.3	21,659.0	790	11	211	182	397

Source: JST based on BSES 2024-25

4.15.4.2 Land Requirement

The project requires land for different purposes. According to the draft SIA shared by MMRC, land is mainly required for construction of stations and allied services, Construction of Depot including laying of stabling lines, workshops, washing lines, administrative buildings and Water, Sewage and Effluent treatment systems in addition to storage facilities. Details of land requirement are given in Table 4.15.3 and Table 4.15.4. The total permanent land requirement for the project is 227,192.3 m^2 including 158,500 m^2 land for Depot. In terms of private land, permanent land requirement is 23,664 m^2, whereas temporary land requirement is 48,372 m^2.

Table 4.15.3 Permanent and Temporary Land Requirement

No.	Corridor/ Facilities	Land Requirement (m^2)		
		Government	Private	Total
Permanent Land				
1	Station & facilities	21,448	6,174	27,662
2	Running Sections	3,580	-	3,580
3	Depot	158,500	17,490	175,990
4	Staff Quarters	10,000	-	10,000
5	Receiving Sub Station	10,000	-	10,000
	Subtotal	**203,528**	**23,664**	**227,192**
Temporary Land				
1	Temporary Office/ Site Office	8,000	-	8,000
2	For Construction of U/G section and Stations by cut & cover	42,818	24,708	67,526
3	Segment Casting Yards	120,000	-	120,000
	Subtotal	**170,818**	**24,708**	**195,526**
	Grand Total	**374,346**	**48,372**	**422,718**

Source: Draft SIA report prepared by MMRC for Corridor-1 in August 2024 and revised in July 2025

Table 4.15.4 Permanent Land Requirement

No.	Station	Area (m^2)	Type of Land	Owner
1	Anik Depot	17,490.0 3,580.0	Private Government	- BEST
2	Wadala Depot	8,260.0	Government	MMRDA
3	CGS Colony	1,989.9	Government	CPWD
4	Ganesh Nagar	1,494.6	Private	-
5	BPT Hospital	1,174.0	Government	MbPA
6	Sewri	4,950.0	Government	MbPA

No.	Station	Area (m^2)	Type of Land	Owner
7	Hay Bunder	1,065.0	Government	MbPA
8	Darukhana	1,100.0	Government	MbPA
9	Byculla	1,531.0	Private	-
10	Nagpada Junction	1,143.4	Private	-
11	Bhendi Bazaar	2,005.0	Private	Road
12	CSMT Metro	714.0	Government	Road
13	Horniman Circle	1,155.0	Government	Road
14	Gateway of India	1,040.4	Government	-
Total		**48,692.3**		
	Anik Bus Depot	158,500.0	Government	BEST
Grand-Total		**207,192.3**		

* Excl Staff Quarter and RSS area of 2,000 m^2

Source: Draft SIA report prepared by MMRC for Corridor-1 in August 2024 and revised in July 2025

4.15.4.3 Project Affected Households and People

A total of 801 Project-Affected Households (PAHs) and 2,718 Project-Affected Persons (PAPs) have been identified. Non-titleholder PAHs account for approximately 70.9% of the total, with the majority concentrated in the Wadala Depot (69.9%) and Anik Depot (26.8%) station area. Of the total PAHs, 692 households and 2,362 PAPs are considered displaced, meaning their structures, or a combination of structures, land, and sources of income, are impacted by the project. A detailed breakdown of these figures is provided on the table below.

Table 4.15.5 Project Affected Households/People and Displaced Households/People

No.	Station	Total		Non-titleholders		Displaced	
		PAH	PAP	PAH	PAP	PAH	PAP
1	Anik Depot	152	485	152	485	152	485
2	Wadala Depot	397	1,262	397	1,262	397	1,262
6	Sewri	7	7	7	7	0	0
7	Hay Bunder	7	22	7	22	6	21
8	Darukhana	1	1	1	1	0	0
9	Byculla	11	11	0	0	0	0
10	Nagpada Junction	105	425	4	4	39	165
11	Bhendi Bazaar	121	505	0	0	99	438
	Total	**801**	**2,718**	**568**	**1,781**	**692**	**2,362**
	%	**100%**	**100%**	**70.9%**	**65.5%**	**86.4%**	**86.9%**

Note: Survey at Anik Depot has not been covered as of July 2025.

Source: JST based on BSES 2024-25

4.15.4.4 Project Affected Structures

The types and legal status of affected structures are summarized in the table below. While the total number of affected structures is 578, the total number of affected units comes to 790 when counting individual units within the housing complexes at Nagpada Junction and Bhendi Bazaar. The majority of these are residential use, accounting for 80.9%. Commercial use make up 11.6%, while residential-cum-commercial use account for 3.7%. Currently data is unavailable for the remaining 2.5%.

Table 4.15.6 Project Affected Structures by Legal Status

		Residential		Commercial		Residential & Commercial		No data	Total
		Title	Nontitle	Title	Nontitle	Title	Nontitle		
1	Anik Depot	0	128	0	8	0	0	16	152
2	Wadala Depot	0	367	0	1	0	29	0	397
6	Sewri	0	0	0	7	0	0	0	7
7	Hay Bunder	0	6	0	1	0	0	0	7
8	Darukhana	0	0	0	1	0	0	0	1
9	Byculla	0	0	11	0	0	0	0	11
10	Nagpada Junction	39	0	61	0	0	0	4	104
11	Bhendi Bazaar	99	0	12	0	0	0	0	111
	Total	**138**	**501**	**84**	**18**	**0**	**29**	**20**	**790**
	%	**17.5%**	**63.4%**	**10.6%**	**2.3%**	**0.0%**	**3.7%**	**2.5%**	**100.0%**

Note: Information on Anik Depot is not included as of July 2025

Source: JST based on BSES 2024-25

4.15.4.5 Loss of Property Resources (CPR)

A total of six CPRs will be affected by the Project. Within Anik Depot, which is a residential area for non-titleholders, the community center, preschool (currently closed), and public toilets on the site will be demolished and need to be rebuilt at the resettlement location. Additionally, the community temple in Sewri and Hay Bunder is located on government land and will need to be relocated to a nearby area. The care facility inside a building near Nagpada station is a tenant and may be re-tenanted after redevelopment. Although not subject to relocation, two Jain temples in Bhendi Bazaar will require appropriate measures to mitigate construction-related impacts. A list of CPRs is provided in and some photos of CPRs are provided in Table 4.15.7.

Table 4.15.7 Affected CPRs

	Station	Temple	Community center	Preschool/ nursing home	Others (public toilet)	Total
1	Anik Depot	0	1	1	1	3
2	Wadala Depot	0	0	0	0	0
6	Sewri	1	0	0	0	1
7	Hay Bunder	1	0	0	0	1
8	Darukhana	0	0	0	0	0
9	Byculla	0	0	0	0	0
10	Nagpada Junction	0	0	1	0	1
11	Bhendi Bazaar	0	0	0	0	0
	Total	2	1	2	1	6

Source: JST based on BSES 2024-25



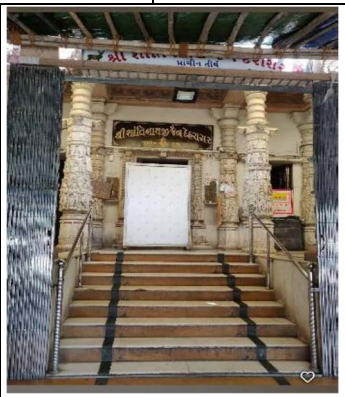
Community center at Anik Depot



Clinic at Anik Depot



Hanuman Temple at Sewri



Jain Temples at Bhendi Bazaar



Jain Temples at Bhendi Bazaar

Source: JST based on BSES 2024-25

Figure 4.15.2 Photos of Some Affected CPRs

4.15.4.6 Demographic Characteristics

Among PAPs, 44.4% are female. The gender imbalance is more pronounced in Wadala Depot, where females account for only 42.0%. This gender distribution reflects the pattern of large-scale migration of predominantly male laborers and workers, particularly in the construction, industrial, and informal sectors. On the other hand, in case of Hay Bunder female account for 80.0% of PAPs. In other areas, the proportion of females is closer to the Mumbai City District average of 45.4%, as recorded in the 2011 Census. The average household size of the PAHs is 3.4 which is smaller than the national average of 4.4 members (National Family Health Survey 2019–21), and 4.0 member in Mumbai (Census 2011).

Table 4.15.8 Demographic Characteristics

No.	Station	PAH	PAP				HH size
		Total	Male	Female	Total	Female %	
1	Anik Depot	152	215	225	440	51.1%	3.2
2	Wadala Depot	397	719	520	1239	42.0%	3.2
6	Sewri	7	7	0	7	-	-
7	Hay Bunder	7	2	8	10	80.0%	3.1
8	Darukhana	1	1	0	1	-	-
9	Byculla	11	11	0	11	-	-
10	Nagpada Junction	105	230	195	425	45.9%	4.0
11	Bhendi Bazaar	121	285	226	511	44.2%	4.2
	Total	801	1,470	1,174	2,644	44.4%	3.4

Source: JST based on BSES 2024-25

4.15.4.7 Age Distribution

The largest age group falls within the 31 to 45 years old bracket, comprising 28.5% of the population. This suggests a considerable number of middle-aged individuals, many of whom likely have established careers and families. A significant portion, accounting for 24.7%, includes individuals up to 18 years old, indicating the presence of younger dependents. The age range of 19 to 30 years old represents 22.7% of the population, consisting primarily of the younger working-age segment. A smaller demographic, comprising 5.8%, is aged 61 and above, encompassing elderly individuals who may have distinct resettlement needs.

Table 4.15.9 Age Distribution of PAPs

No.	Station	0-18	19-30	31-45	46-60	Over 61	Total
1	Anik Depot	58	111	113	104	54	440
2	Wadala Depot	401	300	353	208	58	1,320
6	Sewri	0	0	5	2	0	7
7	Hay Bunder	3	4	2	5	1	15
8	Darukhana	0	0	0	1	0	1
9	Byculla	0	3	5	3	0	11
10	Nagpada Junction	21	19	63	34	7	144
11	Bhendi Bazaar	49	52	74	38	5	218
	Total	**532**	**489**	**615**	**395**	**125**	**2,156**
	% of PAPs	**24.7%**	**22.7%**	**28.5%**	**18.3%**	**5.8%**	**100.0%**

Source: JST based on BSES 2024-25

4.15.4.8 Households by Religion

The religious composition of the PAHs are as follows: Muslim (49.9%), followed by Hindu (29.7%), Buddhist (11.4%), Parsi (1.3%) and Christian (0.5%). For 7.2% of households, religious affiliation was not recorded. Compared to the broader population in Greater Mumbai, where Hindus account for 60.7% and Muslims for 25.1% (Census 2011), the proportion of Muslim households among the PAHs is significantly higher. Buddhist population is particularly high in Anik Depot. Understanding these demographics is essential to ensure culturally sensitive stakeholder engagement, communication, and support throughout the project cycle.

Table 4.15.10 Profile of Religion of PAHs

No.	Station	Hindu	Muslim	Buddhist	Christian	Parsi	No data	Total
1	Anik Depot	28	0	89	0	0	27	144
2	Wadala Depot	183	184	0	4	0	29	400
6	Sewri	6	1	0	0	0	0	7
7	Hay Bunder	7	0	0	0	0	0	7
8	Darukhana	0	1	0	0	0	0	1
9	Byculla	4	7	0	0	0	0	11
10	Nagpada Junction	0	90	0	0	10	0	100
11	Bhendi Bazaar	4	107	0	0	0	0	111
Total		**232**	**390**	**89**	**4**	**10**	**56**	**781**
%		**29.7%**	**49.9%**	**11.4%**	**0.5%**	**1.3%**	**7.2%**	**100%**

Source: JST based on BSES 2024-25

4.15.4.9 Social class

The social class distribution among the PAHs indicates that a majority belong to the General category (67.9%), followed by Scheduled Castes (SC) at 16.5%, Other Backward Classes (OBC) at 8.9%, and Scheduled Tribes (ST) at 0.3%. Although data was not available for 6.6% of respondents, interviews conducted in the target areas confirmed that no indigenous peoples or ethnic minorities are present. The livelihood patterns including occupation and income of ST members at Anik Depot mirror those of the surrounding community. Social profile is important for assessing social vulnerability and ensuring that resettlement and compensation measures are inclusive and equitable.

Table 4.15.11 Profile of Social Class of PAHs

No.	Station	General	OBC	SC	ST	No data	Total
1	Anik Depot	9	14	94	2	25	144
2	Wadala Depot	303	42	26	0	26	397
6	Sewri	0	6	1	0	0	7
7	Hay Bunder	0	0	7	0	0	7
8	Darukhana	1	0	0	0	0	1
9	Byculla	5	6	0	0	0	11
10	Nagpada Junction	99	1	0	0	0	100
11	Bhendi Bazaar	111	0	0	0	0	111
Total		**528**	**69**	**128**	**2**	**51**	**778**
%		**67.9%**	**8.9%**	**16.5%**	**0.3%**	**6.6%**	**100.0%**

OBC: Other Backward Classes, SC: Scheduled Caste, ST: Scheduled Tribe

Source: JST based on BSES 2024-25

4.15.4.10 Education Status

The educational attainment of the PAPs varies across a broad spectrum. The largest proportion has secondary education (42.6%), followed by those who have completed primary education (22.1%). A significant number without education (11.5%) and attained higher secondary education (13.9%). A smaller segment holds university-level qualifications (9.2%), and diplomas and graduate degrees, and professional degrees (0.7%). This diverse educational profile reflects a range of skill levels and employability potential, which should be carefully considered in the design and implementation of livelihood restoration and rehabilitation programs.

Table 4.15.12 Education Status of PAPs

No.	Station	Illiterate	Primary	Secondary	Higher Secondary	Pre-University	University or Above	Total
1	Anik Depot	18	54	187	85	77	11	432
2	Wadala Depot	204	303	587	161	66	0	1,321
6	Sewri	0	0	2	4	0	1	7
7	Hay Bunder	0	4	7	2	2	0	15
8	Darukhana	0	0	0	1	0	0	1
9	Byculla	0	0	3	3	5	0	11
10	Nagpada Junction	19	33	47	18	24	3	144
11	Bhendi Bazaar	6	80	83	24	24	0	217
	Total	**247**	**474**	**916**	**298**	**198**	**15**	**2,148**
	% of PAHs	**11.5%**	**22.1%**	**42.6%**	**13.9%**	**9.2%**	**0.7%**	**100.0%**

Source: JST based on BSES 2024-25

4.15.4.11 Occupation

A majority of PAPs (67.1%) above the age of 18 are employed, indicating an active workforce that will require livelihood restoration support. The remaining 32.9% are not employed, which includes unemployed individuals, students, and retirees.

The occupational profile of the working PAPs is diverse. The most common category is formal employment or service-related jobs (30.7%), followed by housewife (17.3%), Unskilled labor (17.3%), Business (16.3%), and Skilled labour (15.5%). Other notable occupations include manual laborers, security personnel, and house maids, and skilled labor includes drivers, mechanics, tailors, caterers, etc.

Table 4.15.13 Type of Occupation of PAPs

No.	District	Job/ Service	Business	Skilled labour	Unskilled labour	Housewife	Others	Total
1	Anik Depot	152	4	5	22	77	38	146
2	Wadala Depot	152	39	125	125	127	74	642
6	Sewri	0	6	1	0	0	0	7
7	Hay Bunder	0	0	0	1	3	2	6
8	Darukhana	0	1	0	0	0	0	1
9	Byculla	0	11	0	0	0	0	11
10	Nagpada Junction	6	76	6	14	8	4	114
11	Bhendi Bazaar	22	40	31	25	34	4	156
	Total	**332**	**177**	**168**	**187**	**249**	**122**	**1,083**
	% of PAHs	**30.7%**	**16.3%**	**15.5%**	**17.3%**	**23.0%**	**11.3%**	**100.0%**

Source: JST based on BSES 2024-25

4.15.4.12 Monthly Household Income

The monthly income levels of the PAHs indicate that the largest segment earns less than INR 15,000 (60.3%), with the majority of this group concentrated in the Wadala Depot area. The income bracket of INR 15,001–30,000 accounts for 26.6%, followed by INR 30,001–50,000 at 9.2%. Smaller proportions fall within higher income categories: INR 50,001–100,000 (3.5%) and above INR 100,001 (0.4%). The high proportion of low-income households highlights the importance of targeted financial assistance and livelihood support in the resettlement and rehabilitation process.

Table 4.15.14 Monthly Income of PAHs

No.	Station	Less than INR 15,000	INR 15,001 – 300,000	INR 30,001 – 50,000	INR 50,001 – 100,000	Above INR 100,000
1	Anik Depot	17	34	5	5	1
2	Wadala Depot	213	30	4	1	0
6	Sewri	1	6	0	0	0
7	Hay Bunder	3	3	0	0	0
8	Darukhana	0	0	1	0	0
9	Byculla	0	10	1	0	0
10	Nagpada Junction	30	57	6	5	1
11	Bhendi Bazaar	62	4	33	8	0
	Total	**326**	**144**	**50**	**19**	**2**
	% of surveyed PAHs	**60.3%**	**26.6%**	**9.2%**	**3.5%**	**0.4%**

Source: JST based on BSES 2024-25

4.15.4.13 Access to basic service

The following table presents data on access to basic services among PAHs, including cooking fuel, electricity, piped water supply, and toilet/sewage. The results indicate that74.8% of the surveyed PAHs have access to LPG gas for cooking, while only 38.1% have access to electricity. Piped water supply is available to 74.8% of households, whereas only 25.7% have access to toilet facilities.

Table 4.15.15 Access to Basic Services of PAPs

	Station	Cooking fuel	Electricity	Water	Toilet
1	Anik Depot	109	-	109	0
2	Wadala Depot	371	278	371	2
6	Sewri	7	7	7	0
7	Hay Bunder	7	-	7	0
8	Darukhana	1	1	1	0
9	Byculla	11	11	11	8
10	Nagpada Junction	100	9	100	98
11	Bhendi Bazaar	111	0	111	99
	Total	**717**	**306**	**717**	**207**
	% of surveyed PAHs	**89.5%**	**38.2%**	**89.5%**	**25.8%**

Cooking fuel: LPG gas / Water: Piped water supply

Source: JST based on BSES 2024-25

4.15.4.14 Vulnerability

Vulnerable groups in this Project are defined as 1) Female-headed households, 2) Households with elder people without means of support, 3) Households with disabled members, and 4) Households under the poverty line. Those households are considered vulnerable because they may have limited time or opportunities to engage in economic activities and may have to engage in additional caretaking tasks aside from income-generating activities. Therefore, they may have low coping ability against possible negative impacts from the Project. The survey informed that 251 PAHs which is 31.2% of total PAHs surveyed are categorized as vulnerable households.

Table 4.15.16 Vulnerability Status of PAHs

No.	Station	Female-headed PAH	PAH with elderly with no immediate support member	PAH with a disabled member	PAH below the poverty line
1	Anik Depot	10	0	3	0
2	Wadala Depot	43	8	11	168
6	Sewri	0	0	0	0
7	Hay Bunder	0	0	0	0
8	Darukhana	0	0	0	0
9	Byculla	0	0	0	0
10	Nagpada Junction	1	0	0	0
11	Bhendi Bazaar	0	0	0	7
	Total	**54**	**8**	**14**	**175**

Note: PAH below the poverty line is those who have BPL cards.
Some households fall into multiple categories.

Source: JST based on BSES 2024-25

4.15.4.15 Station Area Survey

To analyse satisfaction with existing social infrastructure and services, we conducted a questionnaire-based survey of 160 pedestrians likely to use the metro near each planned station for this project. The demographic breakdown of respondents was approximately 60% male and 40% female. Age groups were predominantly young to middle-aged working adults, with those aged 25-39 and 40-59 comprising about 90% of the sample. Religiously, approximately 85% identified as Hindu. Regarding monthly income, the income brackets of INR 20,000-40,000 and INR 40,000-60,000 accounted for about 48% of respondents. Detailed attribute distribution is shown in the figure below.

Variable	Category	No. of Respondents	Percentage
Sex	Female	65	40.63%
	Male	95	59.38%
Age	Under 18 Years	1	0.63%
	18 to 24 Years	10	6.25%
	25 to 39 Years	79	49.38%
	40 to 59 Years	63	39.38%
	Above 60 Years	7	4.38%
Occupation	Business	16	10.00%
	Profession	9	5.63%
	Retired	5	3.13%
	Service	119	74.38%
	Student	11	6.88%
Religion	Christian	8	5.00%
	Hindu	134	83.75%
	Hindu	1	0.63%
	Jain	7	4.38%
	Muslim	10	6.25%
Income (Monthly)	10000-20000	23	14.38%
	10001-20000	2	1.25%
	20001-40000	45	28.13%
	40001-60000	32	20.00%
	60001-80000	19	11.88%
	80001-1 Lakh	9	5.63%
	More than 1 Lakh	14	8.75%
	NA (students/Retired)	16	10.00%

Source: JST

Figure 4.15.3 Attributes of Survey Respondents



Source: JST

Figure 4.15.4 Photo taken during the station front survey

The questionnaire assessed residents' perceptions of their living environment using a five-point scale ranging from “very satisfied” to “not satisfied” across 12 items related to access to residential areas, social infrastructure, and environmental factors. The survey results are shown in the table below.

Analysis revealed that while most respondents are generally satisfied with access to major social infrastructure, their residential environment, and noise levels, significant concerns exist regarding traffic safety, the availability of green spaces, and air pollution. The construction of Line 11 is expected to positively impact the concerns regarding traffic improvements and air pollution, thereby contributing to an enhanced quality of social life. Furthermore, for certain segments dissatisfied with access to key infrastructure, utilizing Line 11 could potentially alleviate these issues.

Table 4.15.17 Survey on Quality of Living Environment: Respondent Satisfaction

Quality of Living Environment						
Living environment	Very Satisfied	Somewhat Satisfied	Neither	Somewhat not satisfied	Not Satisfied	Total
Living location	49	100	5	6	0	160
Access to Bus stop	20	122	10	5	3	160
Access to office	44	98	10	5	3	160
Access to school	40	101	13	4	2	160
Access to hospital/clinic	38	111	7	2	2	160
Access to shopping centre	27	121	5	6	1	160
Access to movie theatre	20	124	10	5	1	160
Overall housing conditions	43	100	8	7	2	160
Traffic safety	2	64	43	39	12	160
Green environment	4	39	39	59	19	160
Air pollution	1	35	12	66	46	160
Noise	27	121	5	6	1	160

Source: JST

Additionally, the station-front survey included a simultaneous interview survey where respondents evaluated the importance of various factors related to their living environment. Respondents were asked to rate the importance of nine factors related to their living environment on a five-point scale ranging from “essential” to “unnecessary.” The purpose was to analyze what residents prioritize in their living environment and identify the areas most critical to their quality of life. The survey results are summarized in the table below.

Table 4.15.18 Importance of Related Elements in the Living Environment

Importance of living environment						
Related elements in living environment	Must	Very Important	Important	Less Important	Not Necessary	Total
Cost of living	72	65	23	0	0	160
Living Space	38	92	29	1	0	160
Closeness to Job/education	56	81	23	0	0	160
Access to hospital/medical care	71	65	24	0	0	160
Less transit to destinations	29	96	35	0	0	160
Convenient and busy neighborhood	32	76	46	4	2	160
Silent environment	36	82	37	4	1	160
Green environment	49	84	25	1	1	160
Clean air	72	60	26	1	1	160

Source: JST

Analysis of the importance of living environments revealed that living expenses, access to hospitals/medical care, and clean air were the most crucial factors which the majority of respondents deemed "essential" or "very important". Living space, proximity to workplaces/educational institutions, fewer transportation options to destinations, and green environments were also rated as "very important" by a significant proportion. On the other hand, responses regarding quiet environments showed some variation, and opinions were divided on convenient, bustling areas, indicating lower importance compared to other items. Accessibility to social infrastructure and services is a crucial element for residents' daily lives and must be fully considered in the construction of Line 11.

Additionally, regarding needs for the metro, we surveyed respondents to rate the importance of improvement measures for station facilities, operational aspects, safety, and gender considerations on a five-point scale. The survey results showed that for station facilities, demand was highest for restrooms, followed by elevators and lighting, while demand for prayer rooms was low. Regarding operational aspects, fare and frequency were rated most important by the majority, while many also rated crowding and route options as very important. For safety, access to/from stations and safety during use were rated most important, with harassment response coming next. Regarding improvement measures, the introduction of CCTV was rated as having the highest demand. While opinions varied on women-only cars and female security personnel, data specifically from women showed approximately 85% considered women-only cars important and about 95% considered female security personnel important. Both were found to be high priorities for women's needs, indicating the necessity for consideration from a gender perspective. Specific results are shown in the table below.

Table 4.15.19 Metro Needs Survey Results

Design and Operational Challenges and Needs for the Metro						
Issue of Design and Operations	**Most important**	**Very important**	**Important**	**Less important**	**Not important**	**Total**
Station Facilities						
Elevators	93	52	13	0	2	160
Lamps	79	69	10	0	2	160
Prayer Room	18	9	12	54	67	160
Stairs	44	50	63	2	1	160
Steps	65	61	32	0	2	160
Toilet	125	23	10	0	2	160
Transport Services						
Crowdedness	24	98	35	3	0	160
Fare	89	35	34	2	0	160
Routes	34	94	32	0	0	160
Timing	75	61	24	0	0	160
Safety Issues						
Access to/from Stations	94	44	21	0	1	160
Harassment Concerns	80	58	18	4	0	160
Safe travel concerns	94	40	25	1	0	160
Improvement Ideas						
CCTV Surveillance	99	44	17	0	0	160
Hotline Service	63	70	26	1	0	160

Design and Operational Challenges and Needs for the Metro						
Issue of Design and Operations	Most important	Very important	Important	Less important	Not important	Total
Improved Lighting	57	68	34	0	1	160
Women only security personnel	64	31	32	31	2	160
Women-only Cars	50	36	20	22	32	160

Source: JST

4.16 Gender Mainstreaming

4.16.1 Analysis

4.16.1.1 Policy

The Government of India is implementing initiatives to ensure equal legal rights for men and women through the policies outlined in the table below. In 2024, the Fourth Women's Policy was enacted in Maharashtra State with the aim of achieving comprehensive empowerment for women. Under this policy, implementation plans were formulated for eight priority areas, including health, nutrition, and welfare, education and skill development, gender-sensitive governance and political participation, and the elimination of sexual and gender-based violence (SGBV). The policy also clarified the responsible departments, set indicators, and established a committee system at the state, district, and sub-district levels to monitor progress. Specifically, regarding the eradication of gender-based violence, measures include establishing Internal Committee in all organizations to prevent sexual harassment in the office, and setting up one-stop service windows called Bharosa Cells at each police headquarters to strengthen support for victims, particularly women and children.

In addition, Indian domestic law stipulates that 33% of seats in the lower house of parliament and all state assemblies must be allocated to women. In Maharashtra state, since 2011, a bill has been passed and implemented to increase the quota for female councilors from the previous 33% to 50% in local councils (Gram Panchayats) and municipal councils in urban areas. Additionally, in the recruitment of state government employees, a 33% quota for women has been established in the Maharashtra Public Service Commission (MPSC) examination, applicable to general administrative positions, educational roles, and police departments.

Table 4.16.1 Gender-sensitive laws, policies, and guidelines

General policy targeting women	• **Fourth Women's Policy, 2023:** It was introduced to promote women's empowerment in eight priority areas (health, education, violence eradication, livelihood support, infrastructure, political participation, natural resources, and sports) targeting Maharashtra State. Indicators and implementation plans were set for each field, and a three-tier committee system was established at the state, prefecture, and district levels to monitor the progress of the implementation plans.
Laws prohibiting gender-based violence and harassment	• **Dowry Prohibition Act, 1961:** Penalties for demanding dowry - Dowry for the benefit of the wife or heirs. • **The Sexual Harassment of Women at Work Place (Prevention, Protection and) Act, 2013 (POSH):** Internal Grievance Committee, Regional Grievance Committee, Employer Obligations, District Officer Obligations and Authority
Laws related to relocation and compensation	• **The Hindu Women's Right to Property Act, 1937:** Property rights of Hindu widows • **The Hindu Succession (Amendment) Act, 2005:** Hindu women are granted the right to be joint heirs or joint legal heirs, just like male heirs. Under Islamic law, ownership is very complicated.
Labor law	• **The Equal Remuneration Act, 1976:** equal pay for men and women

Reserved employment slots for women	• **Constitution 1993:** The constitutional amendment stipulates that one-third of the leaders of gram panchayat village councils, or the position of sarpanch, should be reserved for women. • **The Constitution (One Hundred and Twenty-Eighth Amendment) Act, 2023 (Women's Reservation Bill):** The goal is to reserve 33% of seats in the House of Representatives and all state legislatures for women. Implementation is expected to begin in 2029, and the quota for women will remain in effect for 15 years after the amendment comes into force.
Support for women entrepreneurs	• **Stand Up India Scheme 2016:** ➢ **Purpose: Supporting entrepreneurship among women starting their first business and entrepreneurs from designated castes and tribes (greenfield enterprises).** ➢ **Support Details:** Support for establishing a company, obtaining loans, and other support necessary for business success. ➢ **Bank loans (including term loans and working capital):** Between INR 10 lakh (US$ 14,000/approx. 2 million yen) and INR 1 crore (US$ 140,000/approx. 20 million yen). ➢ **Target Seminar:** Manufacturing, service industries, agriculture-related activities, and trade. ➢ A new scheme is scheduled to start in September 2025, targeting approximately 500,000 new female and SC/ST entrepreneurs, with the maximum amount increased to 2 crore rupees.

Source: JST

4.16.1.2 Situation of female employees at MMRC

As of April 2025, MMRC had a total staff of 277 employees, of whom 44 were women. Among these, there were 8 female engineers and 24 women in managerial positions. The top executive role, Managing Director, is also held by a woman.MMRC also implements gender considerations in accordance with domestic law. In terms of preventing sexual violence and harassment, it has established an Anti-Sexual Harassment Policy, which clearly states that "all employees are guaranteed equal employment opportunities regardless of gender, race, religion, marital status, or disability, and that sexual harassment in the workplace is not tolerated as a serious violation."

4.16.1.3 Women's Use of Public Transportation in Mumbai

In Mumbai's bus transportation system, the introduction of priority seats for women and women-only buses is progressing. In addition, all trains have women-only cars, and women-only spaces are also provided in the metro system.

Observations during the field survey confirmed that women regularly use buses and auto-rickshaws, though their numbers were smaller compared to male passengers. In a survey conducted in April 2025 at a train station, 160 individuals—including 65 women who could potentially be users—were interviewed about their quality of life (QOL), daily mobility patterns and frequency, and their needs for facilities and services in the metro. The survey results showed that women's mobility patterns mainly involve commuting to work or school using public transportation on a daily basis. For other activities such as leisure, shopping, and medical visits, which are less frequent, women tend to use taxis, motorcycles, auto rickshaws, and other means of transportation as needed. The most commonly used transportation means for commuting and commuting to school were railways, followed by buses, motorcycles, taxis, auto rickshaws, private cars, and walking. In the four FGDs targeting women, railways and buses were primarily cited as the main transportation means currently used, but there were reports of severe issues regarding congestion and safety during nighttime and morning hours.

4.16.1.4 Requests from female public transport users in Mumbai

From February to March and June 2025, we conducted four interviews with female participants in focus group discussions (FGDs) to gather opinions on services that should be provided for female passengers. During these interviews, participants raised the following opinions and requests: affordable fares, women-only cars, easy-to-understand signage, appropriate frequency of service, placement of female security guards and security cameras in station buildings to improve safety, and clean facilities and restrooms. Additionally, in the survey conducted at the station entrance, we conducted interviews with female passengers regarding the priority of facilities and services they expect from the metro. Among the priorities, improvements to station facilities such as restrooms, stairs, elevators, and ramps, appropriate fares and operating frequencies, and measures to prevent harassment and enhance safety were highlighted. Specific measures mentioned included the deployment of female-only security personnel, the installation of CCTV cameras, and the establishment of a hotline. Given this situation, there is a need for transportation options that prioritize women's safety. Therefore, when designing and operating Line 11, MMRCL should incorporate considerations based on these women's opinions.

4.16.1.5 Examples of gender mainstreaming in metro projects in India

We collected information on gender mainstreaming in the design and activities of metro projects in India. Many metro operators plan to aggressively recruit female employees in a variety of positions.

Table 4.16.2 Examples of gender mainstreaming in other metro and railway projects in India

Timing and challenges	Examples of gender-related strategies
Station design	• Set up a women's consultation desk at the station
Employment during the construction phase	（No information found）
Employment during the operation phase	• 30% of train drivers are to be female. • 80% of metro employees are to be female. • Established stations operated and managed exclusively by female employees. • Assigned female employees who have undergone martial arts training to stations and trains.
Vehicle operation	• Throughout the day, one car (32 seats) in each 6-car or 8-car train are reserved for women. • All cars have seats reserved for women. • All cars have seats reserved for the elderly, women, and people with disabilities. • Half of one car in each train are reserved as a women's zone. • One women-only train run during the morning and evening rush hours.

Source: JST



Indian Railways uses pink cars to indicate women-only cars.



Female drivers on the Namma Metro



Chennai Metro has stationed female staff members trained in martial arts at stations and on trains to ensure women's safety and enable rapid response.



Tape indicating the women-only zone inside a train in Hyderabad

Source: https://www.financialexpress.com/infrastructure/railways/unique-initiative-for-women-safety-indian-railways-nfr-zone-earmark-coaches-with-pink-for-easy-identification/1661659/
https://bangaloremirror.indiatimes.com/bangalore/cover-story/at-namma-metro-women-are-at-the-wheel/articleshow/56860979.cms
https://wcag.chennaimetrorail.org/pink-squad/
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Figure 4.16.1 Examples of gender integration in other metro and railway projects in India

4.16.2 Proposals for gender-sensitive activities

4.16.2.1 Gender consideration in station design

The Gender Action Plan (GAP) for the Mumbai Metro Line 3 confirmed that the station facilities were designed with the gender considerations shown in the table below.

Table 4.16.3 Gender-sensitive planning for Mumbai Metro station facilities

Facilities	Gender-sensitive planning
Train car	Each car will have seats reserved for women, and there will also be cars reserved exclusively for women. Each car will be equipped with an emergency alarm system.
Separate restrooms for men and women	Installment of separate restrooms for men and women for both passengers and station staff at all stations. The restrooms will be equipped with children's toilets, sanitary product vending machines, and touchless trash cans with lids.
Escalator	Install saree guards on escalators inside stations.
Deployment of female security guards	Female security guards have been stationed at stations to increase the safety and comfort of female passengers.
Separate security gates for men and women	Two rows of security gates for men and women are installed at all stations. In addition, the physical examination area for women is separated by booths so that they cannot be seen by others.
CCTV camera	CCTV cameras have been installed inside stations and on trains to prevent accidents and crimes.
Information guidance and provision	Information about the helpline desk and number will be provided on all trains and in station buildings. Information about a mobile phone application designed to ensure the safety of female passengers will also be posted on train information displays.
Establishment of a helpline desk and hotline	Female passengers can file complaints when they encounter undesirable situations. Set up a prominent window staffed by trained personnel. Establish a system for reporting cases handled at the window.Set up a hotline with a direct line to the nearest police station.
Lights	Install lighting that is bright enough to ensure the safety of passengers with disabilities and female passengers.
Platform	The platform will be designed to provide a good view and eliminate blind spots to prevent and deter crime, allowing female passengers to use the platform comfortably.

Source： JST

In addition, the investigation team proposes the following two measures: 1) Install spaces within station buildings where infants and their mothers can breastfeed. 2) Install diaper changing tables in restrooms at stations.

4.16.2.2 Employment during the construction phase

During the field survey in Mumbai, we visited the metro construction site and saw very few female construction workers. We also conducted focus group discussions (FGDs) with women to hear their opinions on employment opportunities at construction sites. Few women expressed a desire to be actively employed as construction workers, but many expressed an interest in jobs that indirectly support construction work, such as clerical work, cleaning, and catering.

GAP prepared in Mumbai Metro Line 3 summarizes special measures for women working in construction, including the provision of free accommodation facilities separated by gender, the establishment of childcare facilities where female workers can leave their children during the day (one cabin and one attendant must be provided for groups of 25 to 50 female workers), the establishment of a reporting centre for sexual violence and sexual harassment, and exemption from night work for female workers. and the implementation of measures such as awareness campaigns and the provision of free medical services to prevent the spread of HIV/AIDS. Additionally, it has been confirmed that the MMRC plans to monitor contractors to ensure they do not engage in wage discrimination between men and women for work of equal value by including specific clauses in tender documents.

4.16.2.3 Employment during the operational phase

Regarding staff employment after the start of operations, MMRC has a responsibility to hire workers and staff of all levels equally from men and women and proposes to actively promote the employment of female staff. In the initial stages of operation, it is expected that technology transfer and human resource development will be carried out by staff from the already operating Mumbai Metro to ensure smooth operations and training for newly hired staff.

4.16.3 Monitoring plan for women's participation and gender mainstreaming during the operational phase of the Mumbai metro

4.16.3.1 QOL Survey and Customer Satisfaction Survey

We propose monitoring citizens' QOL indicators during the operational phase of this project and conducting customer satisfaction surveys of metro passengers to assess the positive impact of this project on the local community. The purpose of monitoring QOL is to measure the impact of this project on the general public in Mumbai, while the purpose of the customer satisfaction survey is to receive feedback from passengers in order to improve the quality of this project's services.

During the operational phase, it is desirable for MMRCL to conduct surveys annually. DMRC conducts online customer satisfaction surveys every year, and MMRCL is also expected to conduct similar surveys.

The survey respondents should be sampled equally from both men and women and the survey results

should be analyzed not only for overall trends but also for separate trends for men and women. In addition to gender considerations, the survey respondents should cover all occupations to reflect the diverse social composition of Mumbai.

The main questions for the survey are shown in the table below.

In addition to these surveys, MMRCL should analyze the opinions of Metro users and passengers submitted through suggestion boxes, websites, and emails, broken down by gender.

Through these monitoring and surveys, MMRC will create valuable opportunities for women in Maharashtra State and Mumbai City to express their opinions and participate in local decision-making processes.

Table 4.16.4 Overview of Proposed QOL Monitoring and Customer Satisfaction Survey

Target	2,000-3,000 Mumbai Metro passengers (equal numbers of men and women)
Frequency	Once a year
Method	Online survey or household interview survey
QOL indicator	• Household income and expenditure • Access to social services(Office, Schools, Hospitals, and Shopping center etc.) • Present QOL satisfaction (Access to office, schools, hospitals, shopping center, and theaters/, housing conditions, traffic safety, green environment, air pollution, noise, etc.) • Relative importance of QOL items
Customer Satisfaction Survey	Subway satisfaction (convenience, accessibility, affordability, facilities, information, customer service, security, safety including women-only cars, environmental impact)

Source：JST

4.16.3.2 Proposal for monitoring gender integration in MMRC organizations

We suggest the following 23 indicators in order to monitor the degree of gender integration achieved within the MMRC organization. We propose conducting an evaluation once a year at the initial stage of the budget review for the following fiscal year to monitor the results for that year, identify issues for the following fiscal year, and secure the necessary budget. Gender issues such as the development of female staff capabilities are not only women's issues but also issues related to the mindset of men. Therefore, it is desirable that this internal survey be led by female leaders and that the survey team consist of an equal number of men and women.

Table 4.16.5 Proposed monitoring indicators for gender mainstreaming

organizational policy	
MMRC	1. A gender action plan has been formulated.
organizational structure	
MMRC	**[Female Executives]** 2. Increase in the number and percentage of female executives 3. Percentage of female executives (planned and actual) **[Female Staff and Engineers]** 4. Increase in the number and percentage of female staff and engineers 5. Percentage of female staff positions (planned and actual) 6. Policy on female employment (details) **[Work Environment]** 7. Improvements to the workplace environment 8. Job satisfaction among female employees

	[Capacity Building for Female Engineers] 9. Participation in various training programs (by gender) 10. Identification of training needs for female engineers and staff 11. Improvement of female engineers' abilities and skills **[Harassment and SGBV in the Workplace]** 12. Number of reports of harassment and SGBV (sexual and gender-based violence) in the workplace (by type) 13. Harassment and SGBV training (number of sessions, number of participants by gender) 14. Changes in staff understanding and awareness of harassment and SGBV **[Participation in Decision-Making]** 15. Increased participation of female members in the Gender Action Plan Committee 16. The Gender Action Plan Committee is held at times that are convenient for female members to attend 17. Incorporating gender-specific needs into the Gender Action Plan
Impact of this project on gender empowerment	
RAP Implementation (Support for restoring livelihoods after relocation)	**[Women's Participation in Vocational Training]** 18. Increase in the number and percentage of female residents participating in vocational training 19. Skills and techniques acquired by women
MMRC	**[Employment of Women]** 20. Number and percentage of women employed in this project (civil engineering, construction, cafeteria, other skilled/unskilled labor)

Source: JST

4.17 Consideration for people with disabilities

4.17.1 Laws, systems, and projects related to consideration for people with disabilities

Barrier-free measures for station facilities are designed in accordance with the barrier-free guidelines issued by the Indian Ministry of Urban Development, "Harmonized Guidelines and Space Standards for Barrier Free Built Environment for Persons with Disability and Elderly Persons in the year 2016" (including the 2021 revised version), and the barrier-free standards for station facilities in the Indian National Building Code (NBC2016).

The station facilities for this project will be designed in accordance with the guidelines and basic provisions confirmed in the DPR, taking into consideration the needs of people with disabilities (physical, visual, hearing, internal diseases, etc.).

4.17.2 Adopted barrier-free design

The design standards for barrier-free design listed in the DPR are shown in the table below.

In addition, it is expected that the State Urban Development and Housing Bureau and the Local Transportation Bureau, which supervise and oversee the MMRC, will take the lead in implementing this project to improve traffic safety by reorganizing the road space around stations and improving traffic signals and intersections.

Table 4.17.1 Barrier-free design standards for Mumbai Metro railway facilities

Facilities	Main standards
Station entrance	• Station entrances and exits should be wide enough (minimum width of 1800 mm), and ramps should be installed if there is a difference in height. • It is desirable to provide parking spaces for wheelchair users near station entrances and exits, ensuring that there is sufficient space for maneuvering.

Facilities	Main standards
Reservation and Information Counter	• Reservation counters and information counters shall be designed with sufficient space to allow wheelchair users to access them smoothly. • At least one counter shall be 750 to 800 mm high. • At least one counter shall be equipped with an induction loop system to assist people with hearing impairments, and at least one counter staff member should be proficient in sign language. • A pictogram map showing all services provided at the counter shall be installed.
Concourse	• There should be no height differences in the concourse. If height differences are unavoidable, install ramps. • The concourse floor should be made of non-slip material. • Install braille blocks for the visually impaired, and warning blocks in high-traffic areas and in front of entrances to stairs and elevators. • Install rest areas and benches at regular intervals.
Staircase	• For details on staircase standards, refer to the staircase guidelines in NBC 2016. • Steps should be uniform, with a tread width of at least 300 mm and a riser height of at least 150 mm. • Install continuous handrails on both sides (including walls, if applicable) and place warning blocks at the beginning and end of the stairs.
Elevator	• Install lifts (elevators) to enable people with physical disabilities to move between floors. • For detailed elevator standards, refer to the elevator guidelines in NBC2016. • Call buttons should be installed at a height of 800 to 1000 mm from the floor and should be operable with light pressure. Braille should also be incorporated. • Elevator floor indicators and door status must be displayed both visually and audibly.
Restrooms	• Install restrooms and sinks with widths suitable for wheelchair users, etc. Install handrails, etc., in appropriate locations. • Install continuous braille blocks to enable access for visually impaired individuals.
Public drinking fountains	• Drinking water facilities shall be equipped with a water inlet and control device at the front, and shall be manual or manual/foot-operated. • It is desirable to have devices that are low in height and easy for wheelchair users to use.
Ticket gate	• Braille blocks for visually impaired people shall be installed continuously at one of the ticket gates.
Platform	• Braille guide blocks for visually impaired passengers shall be installed at least 600 mm from the edge of the platform. • The platform surface shall be made of non-slip material and shall be level. • There shall be no gaps or steps between the platform and the vehicle entrance. • Accessible routes and elevators shall be provided to ensure connectivity between all platforms. • Rest areas or benches shall be provided.
Train car	• Vehicle doors and passageways shall be wide enough for wheelchair users (minimum 900 mm). • The gap between vehicle doors and platforms shall be kept to a minimum (less than 12 mm if possible). • Identification marks shall be installed on vehicle doors accessible to wheelchair users. • It is desirable to secure space for wheelchair users next to vehicle doors, and to clearly indicate the space using international access symbols both inside and outside the vehicle. • A sufficient number of designated seats for people with disabilities and the elderly shall be installed near vehicle doors.

Facilities	Main standards
Information	• Signage should be easy to read by using large font sizes, clear contrast, and bright lighting. Pictograms should also be used to ensure universal accessibility. • In addition to printed timetables, it is desirable to provide braille versions of travel information such as fare tables. • It is desirable to install electronic bulletin boards on platforms to quickly and clearly convey information to people with hearing impairments. • It is desirable to provide an announcement system that conveys station names and door locations by voice for visually impaired individuals. • Fire alarm boxes, emergency call buttons, lighting panels, and other alarm devices must be installed at a height of 800 to 1000 mm from the floor. They should also be displayed with high-contrast text and Braille for easy visibility. • In the event of an emergency, the alarm system should include auditory alarm devices with voice instructions for visually impaired passengers to assist them in finding the emergency exits. For hearing-impaired passengers, non-auditory alarm devices (flash beacons, vibration alarms, etc.) should be installed in visible locations throughout all areas used by passengers.

Source: JST



Installation of dedicated wheelchair spaces inside train car



The flap gate opens wide to allow wheelchairs to pass through.



Install tactile guide blocks leading to ticket counters, restrooms, platforms, and other locations.



Put up signs in easy-to-see spots for places like restrooms, elevators, and parking lots.

Source: JST

Figure 4.17.1 Reference photos of barrier-free designs for railway facilities

4.17.3 Proposals for measures

The Indian Railways offers tickets at a discount of 25-75% of the regular fare to passengers with a Unique Disability ID or disability certificate, as well as one accompanying person. We propose that Mumbai Metro introduce similar price adjustments in the future to promote social and economic participation and integration for all.

4.18 Compensation and Assistance Policy

4.18.1 Eligibility Criteria

All interested parties of private land to be acquired for the project are entitled for compensation as per the LARR 2013. The eligibility and entitlements for non-titleholders will be as per the MMRC and MUTP R&R Policy. As per the MUTP R&R policy all legitimate occupants of land and building will be eligible for the benefits of R&R. PAPs who are squatters and not legal titleholder of land and buildings shall also be eligible for R&R if enumerated during the BSES survey.

4.18.2 Compensation and Entitlement Policy

The basic items of compensation and assistance for each category are described as follows. All monetary values increase by 5% every year unless the rate of inflation is less than 5% as per LARR Act. No income tax will be levied/deducted from compensation paid in respect of the award or agreement.

(1) Loss of Land: compensation for the loss of land at their replacement value;
(2) Loss of Structure: compensation for structures and other immovable assets at their replacement value for owners, provision of readily available units for tenants;
(3) Loss of crops/trees: compensation for standing crops/trees at their replacement value;
(4) Loss of CPR: re-building and/or restoration of community resources/facilities;
(5) Loss of Income: assistance for loss of business/wage income;
(6) Resettlement Assistance: package of assistance to cover the necessary expenses to shift residence or business premises to the new location;
(7) Livelihood restoration program
(8) Additional assistance: additional assistance package for vulnerable groups

4.18.2.1 Loss of Land

Compensation for land will be determined in accordance with the existing laws.

- **Landowner**: (1) Cash compensation for the replacement cost of land based on the ready reckoner value of land in the area as per the LARR 2013 (which is 200%) with additional of 25% under direct purchase scheme; or (2) If requested, consider the award of TDR/FSI[48] as an alternative to the cash compensation.
- **Land lease holder**: Cash compensation for the unexpired period of lease according to LARR 2013.

With regard to underground land use, there is no legal provision for compensation. Under MMRC's specific rule, in cases where permanent underground structures are constructed, landowners on the surface will be compensated with an amount equivalent to 50% of the full RRR (100%).

[48] TDR (Transferable Development Rights) / FSI (Floor Space Index) is a system adopted in Maharashtra as a means of compensation for land acquisition. Landowners can utilize the development rights or floor space index, calculated based on market value, for development on other land, or alternatively, they may sell these rights

4.18.2.2 Loss of Structure

For titleholders, MMRC will provide the choice of compensation for the structure as per LARR 2013, or provide built residential units or commercial units of similar size. For non-titleholders provide built residential units or commercial units to tenants and squatters as per MUTP R&R Policy.

- **Landlords / Structure Owners (titleholder)**: Cash compensation equivalent to cost of construction of floor space occupied prior to resettlement as per the LARR 2013 (which is 200%).
- **Tenants (titleholder)**: (1) In case of residential use, free residential unit of 25 m^2 in the "in-situ rehabilitation building" (with up to a maximum of 70 m^2 at actual cost exceeding 25 m^2. (2) In case of commercial use, free shop or business unit equivalent to existing floor size (up to a maximum of 70 m^2) in the "in-situ rehabilitation building".
- **Occupants / Squatters (non-titleholders)**: (1) In case of residential use, free residential unit of 25 m^2 in the "R&R colony" will be provided. (2) In case of commercial use, free shop or business unit equivalent to existing floor size (up to a maximum of 70 m^2). PAHs would be allowed to take away the materials salvaged from their dismantled houses and shops within 15 days and no charges will be levied upon them.

4.18.2.3 Loss of Trees/Crops

Standing trees and crops will be compensated based on the market value at the time of acquisition.

4.18.2.4 Restoration of CPR

CPR will be restored/relocated outside the RoW of the project, if necessary, in consultation with users of such facilities.

4.18.2.5 Loss of Income

According to the type of income loss, following assistance will be provided.

- **Employees residing in the affected structures:** Amount equivalent to the fare of twelve quarterly season tickets for excess distance to compensate for the additional commute.
- **Employees / business owners who lose their source of livelihood:** A lump sum compensation equivalent to one year's income.
- **Temporary income loss:** Measures for mitigating the loss of business opportunities, and enrollment in the Livelihood Restoration Program

4.18.2.6 Resettlement Assistance

For affected family, the following will be provided as per the MUTP Policy.

- One-time shifting allowance in terms of labour and transport is arranged for to cover the cost of moving household or business belongings.

4.18.2.7 Livelihood Restoration Program (LPR)

One eligible member from each PAH that experiences loss of livelihood due to displacement or project-related impacts will be enrolled in the LRP. Details of the LRP are provided in Section 4.18.3.

4.18.2.8 Additional Assistances

Vulnerable households, defined as women-headed households, a household with elderly without immediate support, a household with disabled members, and a household below the poverty line, will be provided with additional assistances in addition to other compensations and assistance. As per MUTP policy, these households will receive special attention, including priority for ground floor units and support with loan arrangements.

4.18.2.9 Preference for Resettlement/Relocation Method

Preferences regarding resettlement and relocation methods among potentially displaced PAHs were recorded during the BSES survey. Of the 684 respondents, 96.1% indicated a preference for receiving a housing or building unit, regardless of whether their loss was residential or commercial in nature.

Table 4.18.1 Preference for Compensation Method

No.	Station	House/Building	Cash	Land	Job	Compensation
1	Anik Depot	119	0	0	0	0
2	Wadala Depot	348	5	1	1	2
6	Sewri	7	0	0	0	0
7	Hay Bunder	7	0	0	0	0
8	Darukhana	1	0	0	0	0
9	Byculla	11	0	0	0	0
10	Nagpada Junction	83	2	0	0	2
11	Bhendi Bazaar	81	0	0	0	14
	Total	**657**	**7**	**1**	**1**	**18**
	% of respondent	**96.1%**	**1.0%**	**0.1%**	**0.1%**	**2.6%**

Note: Compensation means good compensation in general

Source: JST based on BSES 2024-25

4.18.2.10 Measures for Residents Along the Metro Line

The metro project, while improving transportation access, could also lead to gentrification, where rising land and property values along the line make it difficult for low-income residents to continue living there. Comprehensive and organized research results on the rate of land value appreciation along the metro line are limited. However, a literature review suggests that after the opening of Metro Line 1, real estate prices in the area increased by 10-20% over a few years[49]. Furthermore, real estate information websites report that residential property prices rose by 25-35%, and rental rates by 20-25%, with a cumulative increase of approximately threefold over a 10-year period[50].

In Mumbai, several protective measures have been implemented to mitigate the impact of this rising land value on low-income populations. For instance, the Rent Control Act of 1999 was enacted to protect low-income tenants from steep rent increases or eviction demands during redevelopment and land value

[49] "Transport Policy, The Impact of Metro Rail on Real Estate/ Property Markets and Travel Behaviour: A Study of Mumbai Metro Corridor, 2018", "Transport Policy, Can land value capture make PPP's competitive in fares? A Mumbai case study, 2018"

[50] "Housivity, Mumbai Metro Expansion & Property Prices Impact, July 2025"、"Times Property, Mumbai Metro Line 1: Route, Stations, Timings, Fare And Real Estate Impact (2025 Update), July 2025"

appreciation by setting limits on rent hikes. Additionally, the customary "Pagadi System", which involves paying a lump sum to secure a low-rent tenancy almost in perpetuity, is often applied. Furthermore, in Cess Buildings, which house many low-income tenants, a system is in place where only maintenance costs are collected as rent, making them less susceptible to the effects of rising land values.

The Maharashtra State Housing Policy mandates that a portion of the development area in housing projects linked to infrastructure development be reserved for low-income housing. Private developers who cooperate with this policy are provided with incentives, such as accelerated development approval, reduced development fees, and an additional floor space index (FSI). For slum dwellers, a Slum Redevelopment Scheme is available, which provides a mechanism to receive free housing and improved living conditions from the government. This scheme requires residents to form housing societies and apply for a redevelopment plan.

On the other hand, the draft TOD (Transit-Oriented Development) regulations explicitly stipulate a residential unit size composition requirement, mandating that 20% of the maximum permissible FSI be allocated to small- and medium-sized dwelling units.

4.18.3 Livelihood Restoration Program

4.18.3.1 Eligible Groups for LRP

Impact on the livelihood of PAHs means the loss of earning sources based on which households survive and progress. It includes physical resources like land, and business assets as well as business opportunities, employment, and other economic activities.

Based on the survey, PAHs will experience a loss of earning sources mainly due to the loss of shops/business structures and rented structures. Associated wage earners will also experience losses in their income. In addition, the displaced households compelling physical relocation due to the Project will experience temporary dislocation in their income and workdays. The beneficiaries of this project are displaced PAHs, workers/employees, and roadside shops who may experience temporary income loss.

4.18.3.2 Measures to Restore Income and Livelihood

The LRP focuses on the improvement or at least restoration of income and livelihood during and after relocation. The following are the possible LRP proposed in the Project. The appropriate skills development training will be identified, and the program will be developed by the RAP implementation agency.

(1) Assistance in accessing employment information

MMRC, in collaboration with local authorities and contractors, will provide necessary information regarding employment opportunities generated by the project. This aims to ensure that PAHs are given priority in accessing employment. Coordination among local residents, MMRC, local authorities, and contractors will also be reflected in the Terms of Reference (TOR) of the RAP implementation agency.

(2) Direct Access to Project-Related Jobs

Employment opportunities during both the construction and operation phases are as follows.

- **Construction Phase Opportunities**: Metro construction requires both skilled and unskilled labor, creating temporary employment for local residents. Unskilled workers can be engaged as site laborers, material handlers, and support staff with minimal qualifications. Skilled workers include electricians, welders, mechanics, and heavy machinery operators, which align with the expressed demand for vocational training in welding and automotive maintenance. MMRC will facilitate access by organizing job fairs, contractor portals, and information centers where residents can apply directly.
- **Operational Phase Opportunities:** Once operational, the metro will require roles such as station cleaning, facility management, ticketing, customer service, security, and maintenance. Station staff and retail businesses in commercial spaces attached to stations can provide stable, long-term income. Local residents particularly benefit from reduced commuting costs and time.

Other metro projects, including Line 3, have demonstrated similar outcomes: contractors are often mandated to employ local residents, with reports indicating that 20–30% of construction workers are hired locally. This significantly contributes to income restoration for resettled households.

(3) Indirect Employment and Wider Benefits

Beyond direct employment, the metro line enhances overall access within the city. For example, Line 11 connects Wadala, Sewri, and Byculla to central Mumbai, improving access to major employment hubs. Reduced travel time and costs are expected to increase workforce participation, particularly for women and low-income groups.

New commercial activity along the corridor and around stations will also create additional opportunities in retail, food services, and logistics. This can open further income avenues for residents of affected areas such as Bhindi Bazaar and Nagpada.

(4) Provision of skill training programs

Vocational training programs are designed to equip residents with marketable skills. For unskilled and semi-skilled workers, the Government of Maharashtra (e.g., DVET, MSBSVET) offers specialized training aligned with the National Skill Qualification Framework (NSQF), ensuring accredited and employable outcomes.

Programs are supported under schemes such as Pramod Mahajan Kaushalya Vikas Yojana and ITI courses, with durations ranging from 3 to 24 months. Training is delivered through Industrial Training Institutes (ITIs), skill development centers, and partner agencies, with online options also available.

Examples of requested training from interviews and FGDs include:

- **Electricians, Welding, Automobile Maintenance:** ITI trades include electrician (2 years), welder (1–2 years), automobile mechanic, and automobile engineering technician (2 years). Training covers wiring, fabrication, and vehicle repair, allowing employment in workshops.
- **Social Media, Digital Marketing, Graphic Design:** One-year NSQF-compliant programs

cover basic computing tools and skills relevant for digital commerce and freelancing. MCED also provides short-term digital marketing courses.

- **Business Management:** Integrated into MCED entrepreneurship modules, covering inventory management, accounting, and operations, useful for shopkeepers restarting businesses.
- **Tailoring and Sewing:** ITIs provide training for tailoring and basic sewing machine operations (1 year), often enabling women in dense areas such as Nagpada to engage in home-based businesses.
- **Cooking and Food Processing:** NSQF courses cover cooking skills, hygiene, and food processing (e.g., snacks, packaged foods), linked to opportunities in street vending and small eateries.
- **Beauty and Wellness:** Short-term (3–6 months) courses offered at skill centers prepare participants for salon-based self-employment.
- **Poultry Farming:** MCED's livestock management program covers goat-rearing, dairy, and poultry, focusing on breeding, feeding, and sales, promoting agricultural micro-enterprises at low initial costs.

(5) Access to credit through community-managed funds

After skills training, financial support is crucial for PAHs to utilize their acquired skills for income generation. Under this project, initial investment for small business start-ups will be provided through community-managed funds. Training programs will also include financial management and business operations.

In Mumbai, women's groups, SHGs (Self-Help Groups), and micro-credit groups are active in promoting the economic self-reliance of low-income residents, particularly women:

- **Women's Groups:** Informal or semi-formal groups focusing on mutual support, savings, and micro-lending, managing pooled contributions or external funding to meet needs such as emergencies or business start-ups.
- **SHGs:** Groups of 10–20 women (aged 18–50) who engage in collective savings and internal lending, and often link with banks for external financing.
- **Micro-Credit Groups:** Groups that manage pooled contributions collectively and recycle repayments into income-generating activities, often integrated with SHGs or women's associations.

4.18.4 Entitlement Matrix

The Entitlement Matrix outlines category-wise details of compensation and resettlement benefits applicable to PAPs. It reflects provisions from both the LARR 2013 for legal compensation and MUTP R&R policy for rehabilitation and resettlement benefits. Table 4.18.2 below presents the Entitlement Matrix for the proposed project. Both titleholders and non-titleholders are eligible for entitlements.

Table 4.18.2 Entitlement Matrix

Category	Entitle person	Compensation and Assistance
Land (titleholder)	Non-Resident landowners	• Replacement cost of the lost land as per LARR 2013 (200%) and additional 25% for the direct purchase method. • In case of underground use: 50% of the lost land as per Ready Recknor Rate.
	Non-Resident Lessees	• Compensation for the unexpired period of lease according to LARR 2013.
Land and Building (titleholder)	Resident Landlord	Choice of 1) cash compensation or 2) unit provision 1) cash compensation • Replacement cost of the lost land as per LARR 2013 (200%) and additional 25% for the direct purchase method. • Replacement cost of the lost structure as per the LARR 2013 (200%). 2) unit provision • Floor space of 25 m^2 (269sqft) in R&R colony
	Resident Lessees	• Compensation for the unexpired period of lease as per the LARR 2013, taking into agreement
	Tenants, Sub-tenants of buildings	• Residential: Floor space of 25 m^2 (269sqft) in R&R colony • Shops & business: Floor space equal to self-occupied floor area, subject to maximum of 70 m^2 for one unit (First 20.91 m^2 is free of cost).
Building (non-titleholder)	Structure owners, tenants	Choice of 1) cash compensation or 2) unit provision 1) cash compensation • Replacement cost as per MMRC policy. 2) unit provisio • Residential: Floor space of 25 m^2 (269sqft) in R&R colony • Shops & business: Floor space equal to self-occupied floor area, subject to maximum of 70 m^2 for one unit (First 20.91 m^2 is free of cost).
Livelihood	Employees residing in affected structures (Residential area is affected)	• Amount equivalent to the fare of twelve quarterly season tickets for excess distance by suburban railway.
	Employees / business owners who lose their source of livelihood (Workplace is affected)	• A lump sum compensation equivalent to one year's income, as determined by R&R Agency' valuation committee. • The rehabilitation package includes access to employment information, appropriate skills development programs, and credit through community operated funds.
	Temporary income loss	• The rehabilitation package includes access to employment information, appropriate skills development programs, and credit through community operated funds.
Any displaced PAHs	Shifting, Resettlement, and Rehabilitation support	• One-time shifting allowance for which labour and transport is arranged • The rehabilitation package includes access to employment information, appropriate skills development programs, and credit through community operated funds.
Vulnerable people	Additional support	• Preferential allocation of a ground-floor unit (apartment) at the relocation site and assistance with loan arrangements, as per MUTP policy.

Source: JST based on draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

4.19 Grievance Redress Mechanism

Grievances from residents and stakeholders shall be handled by either the Government of Maharashtra (GoM), which is the responsible in the construction of Cuffe Parade Station on Mumbai Metro Line 3, a 24-hour grievance redress mechanism (GRM) was established, comprising an on-site booth, a toll-free hotline, and e-mail channels for receiving complaints from the public[51]. For this Project as well, the existing MMRC grievance redress mechanism will be applied as the basis. A grievance reception booth

[51] Grievance Redressal Mechanism Cuffe Parade Metro Station, 2018, MMRC

will be established at the MMRC headquarters, and submissions will be accepted through toll-free telephone, e-mail, and an official web form. Complaints will be electronically registered immediately, with formal responses issued within 15 days by the Field Level Grievance Redressal Committee (FLGRC). Unresolved cases are referred to and reviewed by Senior Level Grievance Redressal Committee (SLGRC).

Table 4.19.1 Composition and Roles of Grievance Redressal Committees in MMRC

Level	Committee Name	Composition (Examples)	Main Roles	Indicative Processing Time (Recommendation)
Field Level	Field Level Grievance Redressal Committee (FLGRC)	- Site Construction Manager - MMRC Site Officer - Representative of Survey agency - Representative of Supporting NGO, if requested - Representative of Project-Affected Persons (PAPs)	Immediate response to routine/minor grievances arising on-site (e.g., noise, vibration, traffic regulation, compensation issues). Ensures prompt initial action.	Within 15 days
Senior Level	Senior Level Grievance Redressal Committee (SLGRC)	- Senior MMRC Headquarters Officers - NGO Representative, if requested - PAP Representative - Independent Chairperson (e.g., subject-matter expert, legal professional)	Reviews cases unresolved by FLGRC. Conducts hearings and investigations for re-evaluation.	Within 30 days

Source: MMRC, Social Due Diligence Report, October 2018, MMRDA

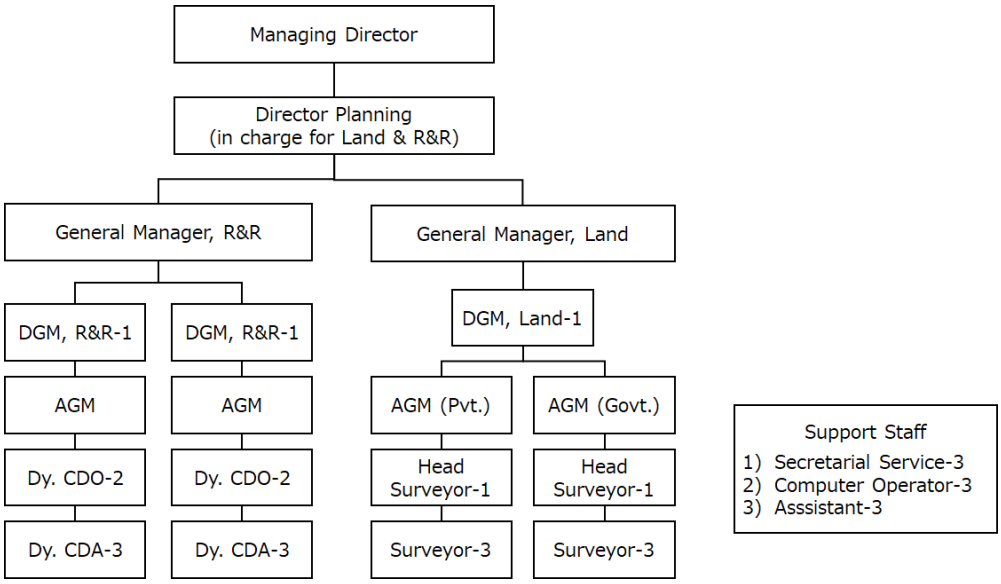
4.20 Implementation Arrangement

4.20.1 Institutional Framework

The implementation of Resettlement Action Plan (RAP) requires involvement of various institutions at different stages of project cycle. This section deals with roles and responsibilities of various institutions for the successful implementation of the RAP. The institutions to be involved in the process are as follows:

1. Project Management Unit of MMRCL.
2. Resettlement and Rehabilitation Division of MMRCL.
3. NGOs Support during Implementation and Post Resettlement Phase.
4. Public Relation Consultant.
5. Grievance Redress Committee.

The institutional framework for RAP implementation is shown in Figure 4.20.1



Source: JST based on draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

Figure 4.20.1 Institutional Framework

4.20.1.1 PMU of Mumbai Metro Rail Corporation Limited (MMRCL)

Project Management Unit (PMU) of MMRCL is responsible for planning and implementation of resettlement and rehabilitation components of the proposed project. The PMU will coordinate with all the implementing agencies and monitor the progress of the project. The PMU is also responsible for the delivery of entitlements, supervising the work of the Project Management Consultants (PMC), NGO, Public Relation Consultant etc. It will provide logistical support for the purpose of reviewing the progress of project implementation. It will generate Quarterly Progress Report (QPR) for effective management decision. The PMU headed by Project Director (PD) will be responsible for overall planning, acquisition of land, supervision of all activities related to resettlement and rehabilitation of the proposed project with active support from R&R department of MMRCL during preparation, implementation and post implementation phase.

4.20.1.2 Resettlement and Rehabilitation Department of MMRCL

MMRCL has a Land and Resettlement and Rehabilitation Department which shall look after land acquisition and resettlement and rehabilitation activities. The General Manager of Land/ R&R department (Additional Collector) and other staff will provide technical support for effective implementation of resettlement and rehabilitation activities of the project. The R&R department of MMRCL shall work closely with other PMU staff for better coordination and implementation of R&R activities. The MMRCL shall ensure that all issues related to land acquisition, resettlement and rehabilitation are handled according to the policies/guidelines as is laid down in this report. The overall responsibility of the division is planning, supervision, and implementation of all components of R&R. It would also coordinate with the respective General Managers to ensure the implementation of various R & R activities that require the inputs of the respective officers from the environment, finance, legal and PR section of the PMU.

4.20.1.3 NGOs Support during Implementation and Post Resettlement Phase

The NGO plays a very crucial role in implementation of resettlement and rehabilitation activities. The NGO will be appointed by PMU of MMRCL to extend implementation support to MMRCL in the form of assisting affected families/persons during relocation, if considered necessary by MMRCL. The responsibilities of NGO will be assisting MMRCL in conducting regular consultations, survey, issue of identity cards, assisting affected families/ persons during and post resettlement phase, formation of co-operative societies, providing training for managing the societies etc. An experienced NGO working in the field of resettlement and rehabilitation may be hired by MMRCL for implementation of SIA.

4.20.1.4 Implementation Support of Consultant

During the implementation phase of RAP, MMRCL may appoint a consultant to assist MMRCL in implementation of resettlement plan, if considered necessary by MMRCL. The consultant will carry out due diligence in the implementation of resettlement and rehabilitation programs as per the provisions of R&R Policy of MUTP, 1997(Amended in 2000) through periodic monitoring. The consultant will be responsible for following:

- Preparation of database of affected structures, families, persons,
- Verification of database through field survey,
- Improve monitoring system,
- Capacity building,
- Regular follow up implementation activities and other relevant activities.

4.20.1.5 Public Relation Consultant

MMRCL already have Public Relation Department to support in public relations and to ensure availability of information to the affected families/ persons, traders and concerned third parties to create an environment that is supportive of the process of Resettlement and Rehabilitation. The Public Relation Department would coordinate with GM of R &R Department and the PR agency in information sharing on the R&R activities of the proposed metro project and coverage in the R&R activities in the print and electronic media.

4.20.2 Roles and Responsibilities of Other Agencies involved in the RAP Process

Role of stakeholders of resettlement plan is presented in the table below.

Table 4.20.1 Roles and Responsibilities of Agencies

Position	Responsibility
Project Director-(PMU), MMRCL	• Overall planning and supervision of all project activities; • Exercise of administrative approval for finance & execution related activities; • Supervision and control over responsible officers in PMU • Coordination with JICA, Govt. of India, Govt. of Maharashtra and other concerned agencies
GM Land and R&R Division, MMRCL	• Planning, supervision and implementation of R&R components; • Report to Project Director, PMU; • Supervision and control over the Managers, Officers and support staff in the division; • Liaison and coordination with PMU, Land and Estate Management Cell, Engineering Cell, NGOs, PAPs & other stakeholders;

Position	Responsibility
	• Prepare and submit all reports and communication to Project Director; • The administrative domain of GM R&R include: ➢ Approval of eligibility list Approval of Progress Reports ➢ Procurement of Consultancy services for R&R components; ➢ Disclosure of information to requesters and external agencies; ➢ Release of payment to Consultants and NGO
NGO	• Assist MMRCL in conducting public consultation, survey, issue of identity cards, • Organize meeting with PAPs assist them during relocation; • Explain the entitlements and R&R policy provisions; • Acting as catalysts between PAPs and project authorities; • Serve as initial step to redress grievances; • Assist the PAPs in redressing grievances with Project Authorities; • Provide support for post resettlement activities such as registration of Cooperative Societies and training related to maintain the building etc. • Report to GM R&R • Prepare monthly progress reports and submit to GM R&R
Implementation Support of Consultant	• Preparation of database of affected structures, families, persons; • Verification of database through field survey; • Improve monitoring system; • Capacity building, • Regular follow up implementation activities and other relevant activities. • Report to GM R&R
Public Relation Department	• Coordinate with the GM R&R • Coordinate with PR agency in information sharing on R&R activities of the project • Ensure availability of information to PAPs and other stakeholders • Coverage of progress of R&R activities in the print and electronic media
Grievance Redressal Committee	• FLGRC address grievances relating to individual eligibility and entitlement • SLGRC review decisions of FLGRC on grievance petitions filed by PAPs.
Independent Evaluation	• Mid - term and end term Evaluation of the implementation of the various provisions and activities planned in the RAP; • Review the plan implementation in light of the targets, budget and duration that had been laid down in the plan.

Source: Draft SIA Report for Corridor-1 prepared in August 2024 revised in July 2025

4.21 Implementation schedule

The implementation schedule for resettlement plan will be scheduled as per the overall project implementation. All activities related to the land acquisition and resettlement must be planned to ensure that Land is acquired/ in possession prior to commencement of civil works. Public consultation, internal monitoring and grievance redressal will be undertaken intermittently throughout the project duration. However, the schedule is subject to modification depending on the progress of the project activities. As part of advance actions, Project Authority will establish the GRC and initiate the resettlement implementation. The R&R activities of proposed project are divided into three broad categories based on the stages of work and process of implementation. The details of activities involved in these three phases are project preparation phase, RP implementation phase and Monitoring and Evaluation phase.

4.21.1 Pre- Implementation Stage

Setting up institutions for the resettlement activities is not required since Resettlement and Rehabilitation division is in place in MMRCL who would look after the activities related with acquisition of land and resettlement and rehabilitation issues.

4.21.2 RAP Implementation Stage

The RAP, at this stage, needs to be approved and will be disclosed to the PAPs. Upon the approval of RAP, all the arrangements for fixing the compensation and the disbursement needs to be done which includes payment of all eligible assistance; relocation of PAPs; initiation of economic rehabilitation measures; site preparation for delivering the site to contractors for construction and finally commencement of the civil work. Considering the lengthy and time taking process for land acquisition, this step shall be taken up by the Project Authority in advance. However, the resettlement and rehabilitation fund will be monitored as part of the RAP implementation at this stage. Internal monitoring will be the responsibility of Project Authority which will start in early stage of the project when implementation of RAP starts and will continue till the completion of the implementation of RAP. The Project Authority will be responsible for carrying out the monitoring on quarterly basis.

4.21.3 RAP Implementation Schedule

The RAP implementation schedule for this Project is estimated to be 18 months from the finalization of the affected land, as shown in the table below.

Table 4.21.1 RAP Implementation Schedule

Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Preparation stage																		
Identification of Required Land																		
Revision of RAP																		
Public Consultation																		
Disclosure of RAP																		
Notification of Land Acquisition																		
Valuation of Structures for Compensation																		
Implementation stage																		
Payment for Land Acquisition																		
Payment for Relocation of PAPs																		
Relocation site arrangement																		
Monitoring stage																		
Internal monitoring																		
External monitoring																		

Source: JST based on Draft SIA Report for Corridor-1 prepared in August 2024 revised in July 2025

4.22 Land Acquisition and Resettlement Budget (N/A)

4.23 Monitoring and Evaluation

Monitoring and evaluation are critical activities in involuntary resettlement. Monitoring involves periodic checking to ascertain whether activities are progressing as per schedule while evaluation is essentially to assess the performance of PAPs at the end of the project. For this purpose, a monitoring

and evaluation (M&E) program is required to be developed to provide feedback to project management which will help keep the programs on schedule and make them successful. Monitoring provides both a working system for effective implementation of the RAP by the project managers, and an information channel for the PAPs to assess how their needs are met.

Monitoring will give particular attention to the project affected vulnerable groups such as scheduled castes, BPL families, women headed households, widows, old aged and the disabled. RAP implementation will be monitored both internally and externally. Project Authority will be responsible for internal monitoring through and will prepare quarterly reports on the progress of RAP implementation. An Independent Evaluation Consultant may be hired by Project Authority for mid and end term evaluation of RAP implementation.

4.23.1 Internal Monitoring

The internal monitoring for RAP implementation will be carried out by Land and R&R Department of MMRC. The main objectives of internal monitoring are to:

- measure and report progress against the RAP schedule;
- verify that agreed entitlements are delivered in full to affected people;
- identify any problems, issues or cases of hardship resulting from the resettlement process, and to develop appropriate corrective actions, or where problems are systemic refer them to the management team;
- monitor the effectiveness of the grievance system

Internal monitoring will focus on measuring progress against the schedule of actions defined in the RAP. Since the District Government (District Collector) is responsible for the implementation of land acquisition and compensation payments, coordination will be required during monitoring. Activities to be undertaken by the Project Authority will include:

- Liaison with the Land Acquisition team, construction contractor and project affected communities to review and report progress against the RAP;
- Verification of land acquisition and compensation entitlements are being delivered in accordance with the RAP;
- Verification of agreed measures to restore or enhance living standards are being implemented;
- Verification of agreed measures to restore or enhance livelihood are being implemented;
- Identification of any problems, issues, or cases of hardship resulting from resettlement process;
- Through household interviews, assess project affected peoples' satisfaction with resettlement outcomes;
- Collection of records of grievances, follow up that appropriate corrective actions have been undertaken and that outcomes are satisfactory;

The monitoring indicators suggested have been given in the table below Table 4.23.1.

Table 4.23.1 Monitoring Parameters

Indicators	Parameters Indicators
Physical	• Extent of land acquired

Indicators	Parameters Indicators
	• Number of structures dismantled • Number of land owners and private structure owners paid compensation • Number of families affected • Number of PAPs receiving assistance/compensation • Number of PAPs provided transport facilities/ shifting allowance
Financial	• Amount of compensation paid for land/structure • Cash grant for shifting oustees • Amount paid for training and capacity building of staffs • Amount for restoration of CPR (Common Property Resource)
Social	• Area and type of house and facility at resettlement site • Number of times GRC met • Number of appeals placed before grievance redressal cell • Number of grievances referred and addressed by GRC • Number of PAPs approached court • Women concern
Economic	• Entitlement of PAPs-land/cash • Planning of Income Restoration Program • Implementation of Income Restoration Program • Number of PAPs employed in the Project
Grievance	• Consultation for grievance redressal • PAPs knowledge about their entitlements • Cases referred to court, pending and settled • Number of grievance cell meetings • Number of cases disposed by GRC to the satisfaction of PAPs.

Source: JST based on Draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

Field Offices will be responsible for monitoring the day-to-day resettlement activities of the project. Baseline socio-economic census and land acquisition data provide the necessary benchmark for field level monitoring.

4.23.2 External Monitoring

As mentioned earlier, an Independent Evaluation Agency (IEA) will be hired by the Project Authority for mid and end term evaluation. The table below summarizes the objectives, risk factors, and evaluation items of external monitoring for this project.

Table 4.23.2 External Monitoring Objectives and Indicators

Objectives	• The negative impact on persons affected by the project will be minimized. • Persons losing assets to the project shall be compensated at replacement cost. • The project-affected persons will be assisted in improving or regaining their standard of living. • Vulnerable groups will be identified and assisted in improving their standard of living.
Risk Factor	• Resettlement plan implementation may take longer time than anticipated • Institutional arrangement may not function as efficiently as expected • NGOs may not perform the task as efficiently as expected • Unexpected number of grievances • Finding a suitable rehabilitation site for displaced population • PAPs falling below their existing standard of living
Outcomes and Impacts	• Satisfaction of land owners with the compensation and assistance paid • Satisfaction of structure owner with compensation and assistance

	• Type of use of compensation and assistance by structure owner • % of PAPs adopted the skill acquired through training as only economic activity • % of PAPs adopted the skill acquired through training as secondary economic activity • % PAPs got trained in the skill of their choice • Role of NGO in helping PAPs in selecting trade for skill improvement • Types of grievances received • No. of grievances forwarded to GRC and time taken to solve the grievances • % of PAPs aware about the GRC mechanism • % of PAPs aware about the entitlement framework mechanism • PAPs opinion about NGO approach and accessibility

Source: Draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

4.23.3 Monitoring Frequency and Reporting

Internal monitoring will be conducted on a monthly basis, with progress reports prepared quarterly. The independent evaluation consultant will submit an annual evaluation report to MMRC, assessing whether the resettlement objectives have been achieved, particularly in terms of livelihood and living standards restoration or improvement, and will provide appropriate recommendations for further enhancement.

4.24 Stakeholder Meeting

4.24.1 Overview of SHM implemented by MMRC

Line 11 Corridor 1

In the SIA survey conducted by MMRC, the first SHM was conducted from August 6 to 26, 2024. Among the planned station construction sites along Corridor 1, eight locations were selected where a significant number of PAHs are anticipated. A total of 90 individuals, including shop owners, informal residents, and other residents, participated in the consultation. The overview of the first SHM, which has been completed, is summarized in the table below.

Table 4.24.1 Overview of the first SHM of Corridor 1

No.	Date	Venue	Male	Female	Total
1	2024/8/24(Sat), 26 (Mon)	Anik Bus Depot	11	0	11
2	2024/8/6 (Tue)	Wadala Station	7	2	9
3	2024/8/6 (Tue)	Sewri Station	10	0	10
4	2024/8/7 (Wed)	Byculla Station	17	0	17
5	2024/8/24 (Sat)	Crawford Market Station	16	1	17
6	2024/8/24 (Sat)	CSMT Metro Station	7	0	7
7	2024/8/8 (Thu)	Horniman Circle Station	8	0	8
8	2024/8/8 (Thu)	Regal Circle Station	11	0	11
Total			**87**	**3**	**90**

Source: Prepared by the JST based on the Draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

The stakeholder consultation primarily focused on discussions regarding land acquisition, potentially affected structures, the presence of important Common Property Resources (CPRs), and compensation and other forms of support. Residents whose land or buildings would be affected raised questions concerning resettlement and compensation, and in particular, informal settlers expressed concerns about the fairness of compensation. On the other hand, residents who would not be directly affected showed

interest in using the metro and expressed their expectations for the project. Key comments from residents and responses from the implementing agency during the first round of the Stakeholder Meeting (SHM) are summarized below.

Table 4.24.2 Discussion during the 1st SHM for Corridor 1

Item	Opinions from residents	Answers from executive agency
Land acquisition, Resettlement	Necessity of Land Acquisition, Compensation Details, and Schedule for Compensation Payments and Resident Relocation	Compensation and support for landowners will be provided in accordance with the Land Acquisition Act 2013 and the R&R MUTP policy, while residents without land ownership will receive compensation and support based on the R&R MUTP policy.
Impacts on shops	Effects on Shops and Compensation Arrangements	In accordance with the Land Acquisition Act 2013, support will be provided for compensation, skill development, and the creation of alternative income opportunities.
Job opportunities	Whether local workers are prioritized to be employed during the construction period.	Construction work will be carried out by contractors, but efforts will be made to prioritize local workers based on their experience and skills.
Metro service frequency	How frequently will the metro run?	The service frequency based on the operation plan will depend on peak and off-peak hours as well as passenger volume. The Detailed Project Report (DPR) is currently being prepared, and this matter is under review within it.
Route alignment	What will be the connectivity and routes of the metro?	The route is planned to connect from Anik Depot through Byculla, Bhendi Bazar, CSMT, and other stations, ending at Regal Circle.
Construction schedule	How long will it take to commence the construction of this route?	The DPR is currently being prepared, after which the approval process is scheduled to begin. The timeline depends on the progress of the approval process.
Access to Metro	The location and convenience of station entrances and exits	The metro station entrances are located on both sides of the metro line, selected to be convenient and easily accessible locations.

Source: Prepared by the JST based on the Draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025



Implementation in the vicinity of Anik Depot Station



Implementation in the vicinity of Anik Depot Station



Implementation in the vicinity of Wadala Station



Implementation in the vicinity of Crawford Market Station



Implementation in the vicinity of Horniman Circle Station



Implementation in the vicinity of Regal Circle Station

Source: Prepared by the JST based on the Draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

Figure 4.24.1 Photo of the 1st SHM for Corridor 1

4.24.2 Overview of the Supplementary SHM Conducted by the JICA Study

As mentioned above, the first SHM conducted by MMRC had a limited number of participants, with particularly low female participation. Therefore, the JICA survey planned and conducted complementary SHMs and FGDs.

4.24.2.1 Stakeholder Analysis

The local stakeholders relevant to this project are listed below, and their opinions will be gathered and reflected in the project through individual consultations, SHM, FGD, etc.

Table 4.24.3 Stakeholder Analysis

Stakeholder	Relevance to the Project
Ministry of Environment Forest and Climate Change (MoEFCC)	The national authority responsible for environmental matters.
Environment Impact Assessment Agency at Centre level (EIAA)	The central authority overseeing the EIA process. It supervises Category A projects' EIAs and has the authority to issue TOR, EIA approvals, and EC.
Central Pollution control board (CPCB)	The national authority responsible for matters related to pollution control. It has the obligation to monitor pollution conditions after the issuance of the EC.
Mumbai Metro Railway Corporation (MMRC)	The implementing agency for this project, responsible for preparing the project plan, conducting technical studies, and preparing the EIA, SIA, and RAP.
Dharavi Redevelopment Project Pvt Ltd (DRPPL)	The implementing agency for the Dharavi slum redevelopment project, responsible for preparing the development plan, acquiring land for Dharavi Station, and relocating residents.
UNESCO	An organization responsible for the legal protection of World Heritage sites and their management through urban planning policies, monitoring impacts on heritage buildings.
Mumbai Heritage Conservation Committee (MHCC)	The body responsible for reviewing heritage protection and development plans, and providing advice for the issuance of the No Objection Certificate (NOC).
Slum Redevelopment Authority (SRA)	The authority that supervises, coordinates, and ensures compliance with regulations for slum redevelopment. It works with project proponents to promote the provision of housing for slum resettlement sites.
Tourism related association	Since this project involves construction in a heritage area, tourism-related organizations are considered to have concerns and interests regarding impacts during construction and operation.
Transport related association	Existing transport operators (such as two-wheelers association) have expressed concerns about business opportunities during construction and operation of the project.
Residents and shops along the alignment	Local residents and shop owners are considered to have concerns and interests regarding business opportunities during construction and operation.
Vulnerable groups, such as women-headed households, the elderly, and persons with disabilities	They have concerns regarding the impacts and safety during construction, as well as interest in universal design features of stations and vehicles.
NGOs	NGOs engaged in environmental conservation, heritage preservation, and support for the urban poor are considered to have concerns and interests regarding the impacts of this project.

Source: JST

4.24.2.2 Informal SHM

At the start of the survey, DPR approval had not yet been obtained, and it was indicated that SHMs should be held only after DFR approval. This is intended to avoid external pressures that could lead to speculation and excessive compensation demands in the early planning stages, as well as to prevent confusion caused by route changes prior to approval. Therefore, during the JICA supplementary survey, small-scale and informal SHMs were conducted to understand the concerns and requests of residents along the corridor. The implementation method was decided in consultation with MMRC, and the SHMs clearly stated that they were part of the MMRC and JICA project surveys to ensure as much formality as possible. This section discusses the issues raised in these SHMs.

A total of 17 informal SHMs were conducted, primarily in areas around the proposed station construction sites. The meeting venues were selected based on the distribution of PAPs and the ease of access from each area. In order to ensure that interested residents could freely participate, the meetings were publicized through various means, including information sharing by local community leaders, dissemination via WhatsApp groups, and notices posted near community centers in the respective areas. To encourage the active participation of women, outreach was conducted through community leaders, and female staff were assigned to provide explanations and facilitate the meetings. Additionally, chairs were arranged at the venues to create a comfortable setting where participants could sit and engage in discussions calmly.



Notices posted in front of community centers

The outline of the informal SHM is summarized in Table 4.24.4. A total of 401 people attended the meeting, of which around 34.7% were female participants.

Table 4.24.4 Outline of the informal SHM for Corridor-1

No.	Date	Location	Metro Station	Total	Male	Female
1	28-2-2025	Indira Nagar, Sewri West	Hey Bunder	15	9	6
2	28-2-2025	Darukhana, Rey Road	Hey Bunder	15	10	5
3	01-3-2025	Bora Bazar	CST	15	11	4
4	06-3-2025	BDB chawl	Sewri	120	77	43
5	20-3-2025	Transit Camp, Wadala	Wadala	30	17	13
6	20-3-2025	Ganesh Nagar, Wadala	Ganesh Nagar	25	11	14
7	21-3-2025	Gateway of India	Gateway of India	43	41	2
8	23-3-2025	Sion Koliwada	Anik Depot	14	9	5
9	25-3-2025	Sitaram Prakash College	BPT Hospital	12	8	4
10	25-3-2025	Five Garden	BPT Hospital	22	13	9
11	26-3-2025	Byculla	Byculla	10	6	4
12	26-3-2025	Kamathipura	Nagpada	11	6	5
13	27-3-2025	Ballard Estate	Horniman Circle	15	11	4
14	27-3-2025	Jacob Circle	Nagpada	12	7	5
15	13-3-2025	Antop Hill	CGS Colony	12	4	8
16	18-3-2025	Sangam Nagar	Ganesh Nagar	15	12	3
17	19-3-2025	Mazgaon	Nagpada	15	10	5
Total				401	262	139

Source: JST based on BSES 2024-25

During the SHMs, several recurring themes and location-specific issues emerged, as outlined in the table below. Key opinions from residents included expectations for the promotion of tourism and local businesses, as well as strong hopes for improved transportation convenience and reduced travel times.

Additionally, it was noted that affordable fares, integration with existing infrastructure, and improved last-mile connectivity are expected to increase passenger numbers, which could help alleviate traffic congestion. On the other hand, concerns were raised regarding land acquisition and resident relocation, with requests for clear explanations about compensation. There were also mentions of the need for traffic management during construction and considerations related to safety, crime, and public security.

It was conveyed that these opinions are valuable to understand anticipated impact and to consider mitigation measures as well as compensation policy and that they will be incorporated in the finalization of the plan as much as possible.

Table 4.24.5 Issues Concerns and Raised in the Informal SHMs

Items	Main opinions from residents
Accessibility and economic opportunities	• Stakeholders across multiple locations expressed their expectation that metro project would enhance accessibility to various parts of the city, thereby improving employment opportunities for residents. Provided that metro it is affordable and reaches areas with employment potential. • At Gateway of India, a major tourist destination, participants highlighted the metro's potential to improve accessibility for tourists and support the local tourism economy.
Need for affordable and reliable services	• In CST, stakeholders emphasized the importance of affordable fares to ensure the metro benefits all sections of society. The conclusion underscored the need for a fare structure that is accessible to the public and for strategies to mitigate negative impacts on local businesses. • The meeting in Jacob Circle revealed a strong local interest in the metro project, coupled with the expectation that the services would be affordable and reliable for short-distance travel to truly benefit the community and reduce traffic.
Direct connectivity to key areas and reduced travel time	• In Ganesh Nagar (Wadala), stakeholders expressed optimism about the metro providing direct connectivity to commercial hubs like Mumbai Central and CSMT, leading to reduced travel times.
Crime and reduced security	• In Darukhana, a concern was raised about the potential for increased crime rates once the metro becomes operational. The conclusion emphasized the need for robust security measures to mitigate such risks and ensure the safety of the community.
Accessibility for vulnerable groups and better last-mile connectivity	• Ballard Estate mentioned about limited parking space, the inadequacy of existing bus services, and accessibility challenges for elderly and disabled individuals due to unsafe pedestrian crossings. The need for integrated planning of parking facilities, improved feeder bus services, and safe pedestrian infrastructure was stressed. • The discussion in Kamathipura focused on the heavy traffic congestion in the area and the expectation that the metro would alleviate this. However, the need for efficient feeder bus services and better last-mile connectivity to ensure the metro's effectiveness was also emphasized.
Land acquisition, resettlement, and rehabilitation	• Participants in Wadala and Sewri raised questions related to land acquisition, potential resettlement of residents, and the need for fair compensation and comprehensive rehabilitation packages. • Stressed the importance of addressing land ownership issues, providing adequate compensation, and implementing effective resettlement and rehabilitation measures with community support.
Need for feedback mechanisms	• The meeting in Transit Camp (Wadala) expectations were expressed for improved access to major markets through this project, while concerns were raised regarding securing relocation sites for residents. Continuous feedback mechanisms are necessary concerning resettlement and relocation throughout the project lifecycle.

Source: JST based on BSES 2024-25



Informal meeting at Wadala | Informal meeting at Byculla

Informal meeting at Ganesh Nagar | Informal meeting at Colaba

Source: JST

Figure 4.24.2 Photos of Informal SHM

4.24.2.3 First SHM during JICA Supplementary Survey

The first SHM organized by MMRC was held over two days, on August 22–23, across four locations. The venues were selected considering accessibility from each area as well as the regions where alternative alignments had been examined. The SHM was announced not only through the MMRC website and notice boards of relevant government offices but also via phone calls to affected persons and information sharing through community leaders and WhatsApp, ensuring broad outreach.

The objective of the first SHM was to provide an overview of the project, including alignment and station locations, to explain the status of alternative alignment studies and environmental impacts, and to present information on land acquisition and compensation. Presentation materials were prepared in English, Hindi, and Marathi and were used appropriately according to the participants present. A total of 121 people attended across the four venues, including 17 women.

The first venue had the largest number of participants, while the second included the expected participation of nearby residents. Although efforts were made to encourage women's participation in advance, attendance was limited due to festival preparations and rainy weather. Through FGDs, women's opinions regarding the Project have already been collected; therefore, the initial SHM is considered sufficient at this stage. Given that the second SHM will provide more detailed explanations of the Project's impacts and compensation measures, it is necessary to make additional efforts to engage

more women. These efforts should include accounting for the event's timing and inviting female community leaders.

Table 4.24.6 Outline of the 1st formal SHM for Corridor-1 during JICA Supplementary Survey

No.	Date	Time	Venue	Metro Station	Total	Male	Female
1	22-8-2025	10:00-13:00	Antop Hill, Wadala	CGS Colony	81	70	11
2	22-8-2025	15:00-18:00	MbPA Hall	Sewri	08	07	01
3	23-8-2025	10:00-13:00	M.H. Saboo Saddik College of Engineering Hall	Nagpada	18	15	03
4	23-8-2025	15:00-18:00	Prerna Hall	CSMT	14	12	02
				Total	121	104	17

Source: JST

The main issues raised by participants focused on eligibility and content of compensation, along with requests regarding the appropriateness and convenience of the proposed alignment. Additional opinions were expressed concerning environmental aspects such as flood prevention, tree transplantation, and disposal of excavated soil. In response, MMRC explained that compensation would be provided based on survey results and applicable laws, alignment and station locations were determined according to technical feasibility, and environmental measures would be implemented in line with regulatory requirements. With the explanation provided from MMRC in SHMs on the concerns raised in informal SHMs especially on land acquisition and resettlement as well as compensation policy, there were no objections or resistances from the participants towards the Project.

Table 4.24.7 Issues Concerns and Raised in the 1st formal SHMs during JICA Supplementary Survey

Items	Main opinions from residents	Response from MMRC
Eligibility	Which structure will be affected and when do we know that?	The impact will be confirmed through surveys, and only affected parties will receive compensation. The survey will use a color-coded system: Red = Permanent requirement with impact on ground/ rehabilitation or relocation with housing will be provided; Green = compensation or rent payment; Yellow = no impact on ground but impact below the ground/ compensation as per MMRC policy shall be provided.
	What will be the compensation for both tenants and landlords, and legal vs. rental shops?	Both landlords and tenants are eligible for compensation under applicable laws (MUTP Policy, RFCTLARR Act 2013, etc.).
Compensation	What kind of compensation will be provided for residential buildings?	225 sqft units will be replaced with 269 sqft units depending upon the units available with MMRC while undertaking rehabilitation. Eligible people can choose between housing or cash compensation.
	How will business loss and relocation be compensated?	Compensation or alternative shop space (Gala) will be provided as per zoning and government policy.
	What is the provision for religious facilities?	Religious facilities will also be compensated or relocated depending on the zone of impact. Alternate sites will be provided nearby wherever possible.
Employment generation	Are there employment generation and local hiring?	The project will provide employment opportunities during both construction (skilled/unskilled labor) and operations (housekeeping, retail, ticketing, etc.).
Alternative route	Sewri East (Hay Bunder) alignment is inconvenient due to low population, so request to shift alignment to Sewri West.	Route changes or new stations will be considered depending on technical feasibility and land availability.
	Anza school and Masina school ground is empty, so alignment change will avoid demolishing Memni building.	We have noted your response and will explore how the land requirement can be minimized.

Items	Main opinions from residents	Response from MMRC
	A station should be developed at Crawford Market as planned earlier, which attracts very high daily footfall. There Is a major commercial hub with dense commuter traffic.	Plan for Crawford Market station was explored. Presence of the JJ Flyover makes it difficult to construct a station below or around the area. Due to technical feasibility issues, it was not included in the final alignment.
Convenience	Considering the upcoming Dharavi redevelopment, Line 11 should be extended to Dharavi as BKC commercial hub is also in the nearby vicinity.	Extension to Dharavi is subject to government approval.
	Direct integration is proposed between Metro Line 4 and Metro Line 11 to improve Thane–Colaba connectivity.	Operation between Line 4 (elevated) and Line 11 (underground) is technically and strategically not feasible. For long-distance travel, suburban rail is recommended as an alternative.
	Request for upgrading to 8-coach trains in the future.	Currently, 6-coach trains are planned. The increased passenger demand shall be catered through increased frequency.
Environment and others	What is station land requirements and flood risks during construction.	Each station will require 2,000-4,000 sqm of land. Station entry/ exits, metro ancillary buildings will be built higher than the flood levels and equipped with flood gates to prevent waterlogging.
	Request for early implementation of tree transplantation/plantation.	Approximately 2,208 trees will be affected. Compensatory plantation will be carried out, and transplantation will begin once necessary permissions are obtained.
	How much sand will be excavated and how will it be disposed of?	Around 300,000 tonnes of material are expected. Disposal will be carried out at approved sites in compliance with government regulations

Source: JST



1st SHM in CGS Colony



1st SHM in Sewri



1st SHM in Nagpada



1st SHM in CSMT

Source: JST

Figure 4.24.3 Photos of 1st formal SHM during JICA Supplementary Survey

4.24.2.4 Second SHM during JICA Supplementary Survey

The second SHM took place on September 23 in two locations chosen for their accessibility. Similar to the 1st SHM, the announcement was publicized on the MMRC website and the information was disseminated to on local government offices and through their notice boards. Additionally, direct contact was made with affected people via phone calls and through community leaders, and local politicians and NGOs were also invited. Furthermore, specific efforts were made to invite local women's group, and micro credit groups to encourage women to participate in the meeting. As a result, of the 66 total participants, 28 were women, which accounted for approximately 42.4% of attendees.

Table 4.24.8 Outline of the 2nd formal SHM during JICA Supplementary Survey

No.	Date	Time	Venue	Metro Station	Total	Male	Female
2	23-9-2025	10:45-13:00	Sewri Koli Samaj Hall	Sewri	50	26	24
4	23-9-2025	15:00-18:00	Prerna Hall	CSMT	16	12	4
				Total	66	38	28

Source: JST

In the 2nd SHM, the survey results expected impact as well as mitigation measures and compensation policy including entitlement matrix were discussed.

In the context of resettlement and compensation, discussions focused on key issues such as housing eligibility, the final tenement size, the request for house-for-house compensation, and the notification process for affected households. In response, the MMRC explained the tenement compensation policy and its process and offered their contact details for follow-up questions or inquiries.

Questions regarding the project planning and operation include alignment extensions, integration into the multimodal hub, and the future structure of ticketing and concessions, with MMRC explaining its current plans and consideration status. The issue of heritage buildings was also raised, to which MMRC responded by assuring participants that necessary measures are planned and that required permissions will be obtained in consultation with relevant authorities.

With the explanation by MMRC, the Project was well received by the participants, with no formal resistance or opposition raised.

Table 4.24.9 Issues Concerns and Raised in the 2nd formal SHMs during JICA Supplementary Survey

Items	Main opinions from residents	Response from MMRC
Eligibility	**Eligibility:** Will residents who already relocated from Pawai to Wadala in 2005 (Government land) be eligible?	If an individual has already received housing benefits under a previous scheme (per 2019 rules), they are generally not eligible again, unless their house is directly affected by the current Metro project.
	Process: How residents will be informed if their house is in the "red, yellow, or green" affected categories?	MMRCL staff will conduct a door-to-door survey and notify households 5–6 days in advance of the visit.
	Coordination: Concerns about potential conflict with an already approved SRA project in the area.	If an SRA project is already approved, MMRCL cannot halt that scheme. Compensation/rehabilitation will be settled mutually through SRA and MMRCL as per rules.

Items	Main opinions from residents	Response from MMRC
Compensation	**Housing size:** Houses shown were 225 sq. ft.; a Government Resolution (GR) mentioned a minimum of 400 sq. ft.	SRA will provide 269 sq. ft. tenements, as the earlier 225 sq. ft. norm has been revised. Decisions on housing area adhere to SRA/MHADA policies and applicable government rules.
	Request: Demand for house-for-house compensation and required documentation.	House-for-house will be provided as per applicable SRA/MHADA rules and eligibility. Required documents include Aadhaar, voter card, electricity bill, or other proof of residency.
	Social Impact: Concern that resettlement and project work will affect livelihoods and children's education.	MMRCL acknowledged these concerns and stated that social impacts will be taken into account during planning and resettlement through the Resettlement Action Plan (RAP) process.
Employment generation	**Local Employment:** Request for employment opportunities for local youth during and after the project.	Opportunities exist across various departments and during construction (drivers, ticketing staff, etc.). Residents may apply, but MMRCL cannot guarantee employment.
Convenience	**Connectivity:** Plan to link Anik Depot and Pratiksha Nagar, limited access to Somaiyya Hospital, and status of Multi-Modal Integration (MMI) land.	Integration is being planned via the MMI hub, and connectivity to Somaiyya Hospital is planned. They are planning for pickup/drop and parking spaces for Line 11 MMI.
	Alignment: Suggestions to extend the alignment beyond Anik Depot to Bandra–Dharavi, or change the alignment from Bhakti Park to C.G.S. Colony.	Alignment extension is possible in principle if the Government requests it. Other proposals require detailed technical submission via email for review.
	Fares/Ticketing: What the fare structure will be, the roles of MMRDA and MMRCL, and concessions for students.	There will be common ticketing and unified pricing decided by the Fare Fixation Committee. Student concessions (monthly/annual passes) and other discounts are under consideration, but decisions for Line 11 are currently premature.
Environment and others	**Heritage:** How heritage structures (e.g., at CSMT) and buffer zones are taken into consideration.	Permissions are taken from relevant agencies like MHCC and State Archaeology, and heritage buffers are part of the process.
	Utilities/Safety: Concerns about housing in areas with three gas pipelines and coordination with other utility works.	MMRCL will coordinate with relevant agencies (gas, water pipeline authorities) and local authorities to manage utilities and minimize impacts.
	Project Details: Questions about the exact amount of land required for Metro work and the commencement date.	Construction is planned to begin January 2027. Exact land requirements and affected households will be finalized during the baseline survey and demarcation following the finalized alignment.

Source: JST



2nd SHM in Sewri



2nd SHM in CSMT

Source: JST

Figure 4.24.4 Photos of 2nd formal SHM during JICA Supplementary Survey

In addition to the above, separate individual interviews were conducted with relevant NGOs and specialists who were unable to attend the Stakeholder Meeting (SHM). The results indicated that the NGOs expressed expectations for social benefits, such as housing provision for the poor and affordable transportation, while heritage conservation specialists provided key points regarding applications and reporting to the management authorities. The details are summarized in the table below.

Table 4.24.10 Interview Results with NGOs and Specialists

Organization	Profile	Comments on the Project
Apnalaya	Supports the poor (Experience in supporting the poor in the Anik Depot and Wadala areas)	• The metro should be affordable and safe, and it is crucial that it becomes a means of free movement for women, children, and the elderly. • The project is considered a major benefit as it provides an opportunity for non-regular residents to obtain legal housing (tenements
Children Aadhar NGO	Supports the poor and youth.	• Traffic congestion and dust during the construction phase are concerns. • Expects youth to have access to employment opportunities during and after construction • Attention is required as some areas are prone to waterlogging during the monsoon season
Abha Narain Lambah Associates	Heritage conservation consultant (Experience providing consultancy for the Mumbai Metro Line 3 heritage conservation)	• It is understood that reporting to UNESCO involves the following: establishing a system to deploy heritage monitoring specialists during the construction phase and conduct regular monitoring reports. • To obtain the NOC from MHCC, the following review is necessary: a) During the planning stage, conduct a building survey (inventory, façade, etc.) around the alignment and explain conservation and mitigation measures; and b) During the construction stage, explain any changes from the planning stage and the above-ground design, mainly to be reviewed for landscape-related issues.

Source: JST

4.24.3 Overview of the Supplementary FGD Conducted by the JICA Study

As part of SIA, a series of Focus Group Discussions (FGDs) were conducted with various stakeholder groups to understand their specific concerns and expectations regarding the proposed project. A total of 25 FGDs were organized with diverse groups, including women, transport operators, business owners, tourism service providers, healthcare workers, and teachers/students, each of whom may hold unique perspectives on the project.

The FGDs were arranged in advance over several days using approaches tailored to each group. For example, support from community leaders for organizing women groups; direct visits were made to taxi

stands to engage transport operators; tourism guide agencies were informed using registration lists; and colleges were requested to coordinate meetings with teachers and students.

Table 4.24.11 provides the details of the FGDs.

Table 4.24.11 Overview of FGDs

No.	Date	Location	Target	Total	Male	Female
1	08-03-2025	Bhendi Bazar	Shop owners	10	10	0
2	25-04-2025	Sewri	Shop owners	9	9	0
3	26-04-2025	Wadala	Shop owners	14	13	1
4	04-04-2025	Horniman Circle	Taxi Union	12	12	0
5	08-04-2025	Byculla	Taxi Union	8	8	0
6	16-05-2025	Colaba and Fort area	Taxi Union	11	11	0
7	21-03-2025	CST and Fort area	Bus conductors	10	10	0
8	21-03-2025	Gateway of India	Tour Operators	20	20	0
9	08-04-2025	Gateway of India	Local Tourists	16	15	1
10	02-04-2025	CST railway station	Health care Provider	12	12	0
11	09-04-2025	Sewri	Health care Provider	15	0	15
12	04-06-2025	Darukana	Community healthcare worker	9	0	9
13	26-04-2025	Byculla, Burhani Junior College	Teachers	14	4	10
14	02-05-2025	CST, Barrister A.R. Antulay College of Law	Teachers	8	4	4
15	02-05-2025	CST, Anjuman Islam Institute	Teachers and Students	8	4	4
16	29-04-2025	Blind School	Students	20	20	0
17	11-06-2025	Chinchbandar	Loading labourers	14	14	0
18	08-06-2025	Wadala	Housing Society Members	30	18	12
19	08-03-2025	Hay Bunder	Women	120	0	120
20	22-03-2025	Wadala	Women	18	0	18
21	12-06-2025	Byculla	Women	28	0	28
22	12-06-2025	Sewri	Women	45	0	45
23	17-06-2025	Kalachowki	Senior Citizens	15	12	3
24	20-06-2025	Byculla	Senior Citizens	14	10	4
25	29-06-2025	Antop Hill	Senior Citizens	16	11	5
	Total			496	217	279

Source: JST based on BSES 2024-25

The discussions from the FGDs are summarized in the table below. Common issues and expectations across groups include, during the construction phase, difficulties in commuting and moving due to traffic congestion and road or sidewalk closures, health and safety impacts from noise, dust, and vibrations, and concerns about a decrease in customers or users. In the operational phase, there is a shared expectation of improved convenience through reduced commuting and travel times and better access, while concerns about crowding and deteriorating safety around stations, as well as requests for safety measures such as surveillance cameras and security personnel, were widely raised.

Meanwhile, group-specific issues and expectations include: for shop owners, support to address barriers and revenue loss during construction; for taxi unions, impacts on drivers and customers; for teachers and students, safety considerations for students with disabilities; for healthcare providers, ensuring ambulance access; for laborers, difficulties in transporting goods and employment opportunities at construction sites; for women, dedicated facilities, childcare rooms, and placement of female staff; for

blind school students, tactile and audio support and the development of navigation apps; and for senior citizens, the installation of barrier-free facilities.

Table 4.24.12 Issues and Expectation raised during FGDs

Group	Construction stage	Operation stage
Shop Owners	• Concern over worsened traffic congestion, noise, and safety. • Customer reduction due to construction barriers; some shops consider online or home delivery sales. • Clear guidance for customers and support for affected shop owners is needed.	• Expect more customers and business opportunities due to improved transport. Station exits should be near markets, with commercial and vendor zones provided.
Taxi Association	• Concern over reduced customers due to traffic congestion, road closures, and decreased parking. Noise and exhaust emissions are also problematic.	• Concern that customer numbers may decrease if routes connecting major tourist sites are established, leading to reduced income. Some drivers may need to look for alternative employment.
Travel Agencies / Tourists	• Temporary impact from noise and restricted access; however, tourist numbers are not expected to drop significantly. • Considering changes to business models, such as online bookings and pick-up services. • Hope for early completion as construction may negatively affect travel experiences.	• Expect an increase in tourists due to improved access to attractions. • Concerns over crowding, pickpocketing, safety, and inadequate signage. • Recommend placing surveillance cameras and female security personnel in and around stations to ensure safety.
Healthcare Providers	• Concern over restricted access for ambulances and potential patient decrease. • Propose phased construction, clear guidance, and noise/dust mitigation.	• Expect improved accessibility for patients and staff. • Request consideration for elderly and disabled people.
Teachers / Students	• Concerned about commuting difficulties due to traffic congestion, noise, dust, and road closures. • Alternative transport (e.g., shuttle buses) and discounted student passes are needed.	• Expect reduced commuting time and cost, and more employment opportunities. • Consideration of the usability of students with disabilities is necessary.
Laborers	• Dust and road closures make transporting carts and goods difficult. • Hope for construction-related employment opportunities such as material transport and traffic management.	• Recommend lower fares for laborers. • Stations should provide lighting, seating, clean toilets, and security personnel.
Blind School Students	• Familiar routes disrupted by detours; noise reduces safety. • Alternative transport, shuttle services, and information on safe routes are needed.	• Expect reduced travel costs and time, enabling independent mobility. • Require tactile blocks, audio guidance, barrier-free stations, navigation apps, and well-trained station staff.
Housing Society	• Concern over worsened health and safety due to noise, dust, and congestion. • Suggest shuttle services for elderly, grocery/medicine delivery, and clear communication on progress, road closures, and safety measures.	• Expect reduced commuting time and improved access to hospitals. • Concerns about crowding, street vendors, privacy, and safety.
Women	• Construction sites should ensure clean toilets, childcare, and safety measures; female staff should be deployed for ticketing, security, and traffic management • Provide rest areas for pregnant or nursing mothers; increase security cameras, female officers, and panic buttons.	• Expect improved mobility through reasonable fares, women-only vehicles, and enhanced safety measures.
Senior Citizens	• Noise, dust, and vibration make daily life difficult; dust may affect health. • Consider using grocery/medicine delivery and community-based shared transport services.	• Expect improved access to hospitals, markets, and family. • Concern over increased crowding and reduced safety; expect enhanced security such as cameras. • Require facilities for elderly and disabled (elevators, clean toilets, resting benches, clear signage).

Source: JST



FGD with Women at Sewri



FGD with owners and tenants at Mazgaon (Nagpada)



FGD with teachers of disabled school at Sewri



FGD with Teachers at Anjuman Islam Institute

Source: JST based on BSES 2024-25

Figure 4.24.5 Photos of FGDs

Furthermore, individual interviews were conducted with relevant NGOs and specialists who were unable to attend the Stakeholder Meeting (SHM). As a result, NGOs highlighted the significance of providing housing for the poor, the importance of affordable transportation, and points to consider during the construction period. Additionally, specialists in archaeological site preservation indicated matters to be noted regarding applications and reporting to the management authority. Details are as shown in the table below.

Table 4.24.13 Comments from NGOs and experts

Organization Name	Organization Overview	Comments on the Project
Apnalay	Supports the poor, having experiences in supporting the poor in the Anik Depot and Wadala areas	• The metro should be affordable and safe, and it is crucial that it provides a means for women, children, and the elderly to move freely • It is considered a significant benefit as it will provide an opportunity for informal residents to obtain legal housing (tenements)
Children Aadhar NGO	Supports the poor and youth	• Traffic congestion and dust during construction are a concern. • It is expected that youth will have access to employment opportunities during the construction and operation phases • Attention must be paid to areas that inundate (flood) during the monsoon season.
Abha Narain Lambah Associates	Heritage consultant, having experience providing support as an archaeological and heritage consultant for Mumbai Metro Line 3	• The understanding regarding reporting to UNESCO is as follows: A system is in place to deploy archaeological monitoring experts during the construction phase and provide regular monitoring reports. • To obtain the NOC (No Objection Certificate) from the MHCC (Mumbai Heritage Conservation Committee), the following must be done: a) During the planning phase, an inventory/survey of buildings (facades, etc.) around the alignment must

Organization Name	Organization Overview	Comments on the Project
		be conducted, and conservation/mitigation measures explained; and b) During the construction phase, any changes from the planning stage and the above-ground design must be explained, and the plans primarily reviewed for visual impact/landscape concerns

Source: JST

4.24.4 Key Measures Adopted in the Project

Through SHMs and FGDs, various opinions and concerns were raised. The main comments have generally been reflected in the "Environmental Management Plan" and "Environmental Monitoring Plan" of the EIA, as well as in the "Entitlement Matrix" and "Gender Action Plan" of the SIA/RAP. The correspondence table is presented below.

Table 4.24.14 Stakeholders comments and incorporation into the Project

Comments	Incorporation into the Project
Impacts during Construction	
Concerns on Dust, Noise, and Vibration	Mitigation measures such as dust suppression by water spraying, installation of mufflers and other noise reduction devices, and the use of low-noise and low-vibration machinery are included in the "Environmental Management Plan". These items are also reflected in the contractor's monitoring requirements under the "Environmental Monitoring Plan".
Impacts due to traffic congestion and road closures	Measures such as diversion routes based on traffic conditions and installation of warning signs are included in the "Environmental Management Plan". In particular, in congested commercial areas, it is important to share construction plans in advance with residents and users of the area to ensure their understanding and cooperation.
Compensation and Livelihood Support	
Decrease in customers due to construction fences	In order to avoid business loss, mitigation measures such as ensuring sufficient pedestrian space, adjusting construction fence and maintaining the visibility of shop signboards will be implemented and are to be monitored. These are reflected in the "Environmental Mitigation Plan", and "Environmental Monitoring Plan".
Decrease in customers due to reliance on public transport	Taxi services are expected to continue as feeder services between stations and destinations. Residents have also emphasized the importance of last-mile connectivity, and the demand has been confirmed. Collaboration between MMRC and transport operators' associations will be required.
Compensation for non-title holders and tenants	Provision of cash compensation or housing/commercial units is reflected in the "Entitlement Matrix". Moreover, non-title holders who are allotted government-provided units will also be able to obtain ownership rights of those structures.
Expectations for preferential employment opportunities	The "Entitlement Matrix" proposes the provision of employment information and opportunities, while the "Environmental Management Plan" includes the promotion of equal employment opportunities in collaboration with local authorities.
Financial support for business resumption and start-up	A community-managed fund has been proposed under the "Livelihood Restoration Program".
Support for Vulnerable Groups	
Requests for facilities for women, the elderly, and persons with disabilities	Facilities such as elevators, clean toilets, resting benches, and signage, as well as the needs of female passengers including women-only coaches, have already been addressed through the adoption of international standards of universal design in Metro Line 3, which serves as the basis for this Project. Furthermore, the deployment of female security staff and the establishment of helplines for safety are specified in the "Gender Action Plan", and their implementation and operation must be confirmed through monitoring.
Measures to support vulnerable groups	Close coordination with district authorities and elderly associations is necessary, along with clear communication from the authorities on progress, road closures, and safety measures.

Source: JST

CHAPTER 5 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS/ LAND ACQUISITION AND RESETTLEMENT (CORRIDOR 2)

A. [Environmental and Social Considerations]

5.1 Overview of Project Components

The components of the project are outlined below. As stated at the beginning of this report, Corridor 2 of the Mumbai Metro Line 11, which was originally included in our scope at the commencement of the survey, was ultimately excluded from our scope due to procedural delays on the Indian side. However, as surveys related to Corridor 2 had continued until the decision was made, the results—although partially incomplete—are presented in this chapter.

Table 5.1.1 Project Components

Category	Description
Civil Engineering	Construction of tracks Construction of underground stations
Other Related Facilities	Quarry sites, soil collection sites, disposal sites Construction yards

Source: JST

5.2 Related Projects

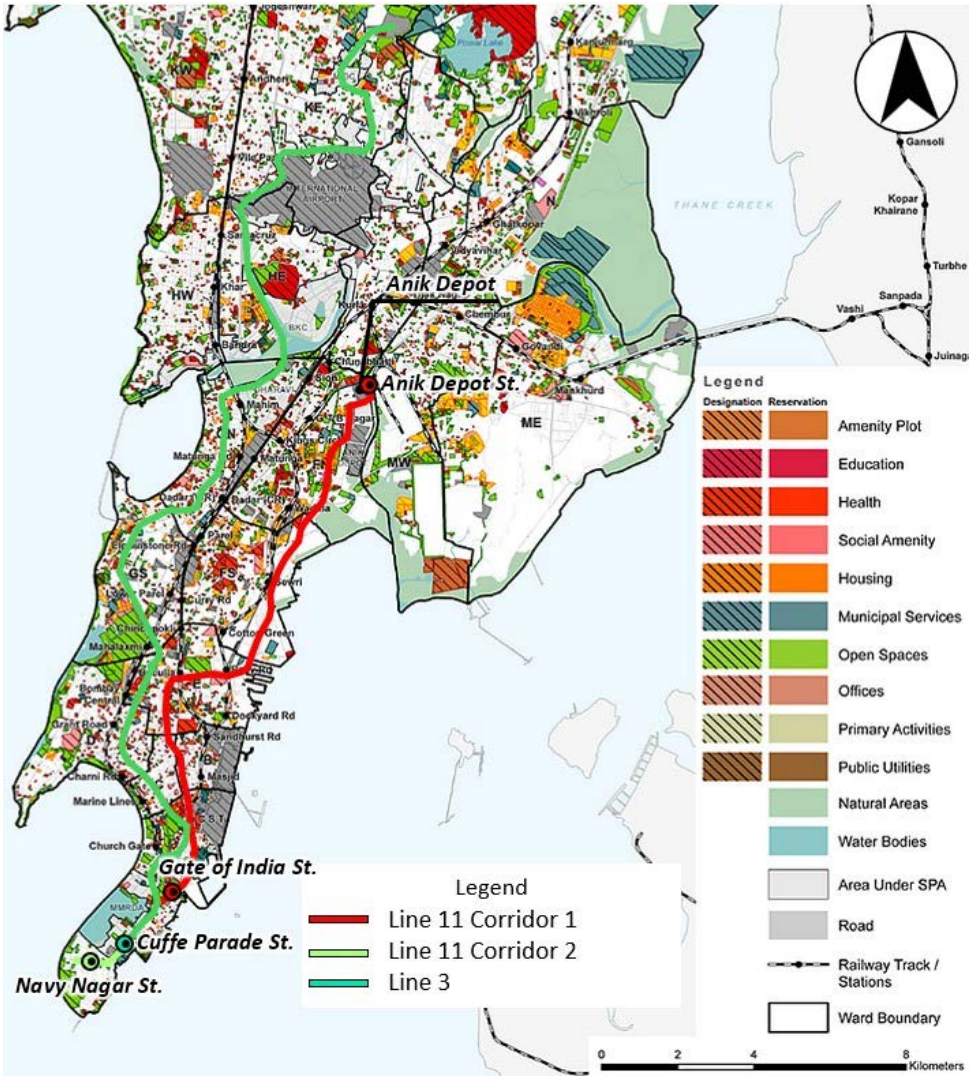
A project with a high degree of relevance to the present undertaking is the Mumbai Metro Line 3 Construction Project (financed by ODA loan). Commenced in 2016, the project covers a total length of 33.5 km. Of this, the 12.69 km section from the northern terminus at Aarey Colony Station to the Bandra-Kurla Complex (BKC), the central business district, was opened to service in October 2024 as Phase 1. The section between BKC Station and Worli commenced operation in May 2025. Furthermore, the Phase 3 section, which runs along the western side of Bombay Island from Worli Station to the southern terminus at Cuffe Parade Station – the portion most closely related to Line 11 – commenced operation on October 9, 2025[52], thus marking the full opening of Line 3. Since the line has been brought into operation and no further construction impacts are anticipated, no cumulative or secondary impacts with Line 3 are expected to occur.

5.3 Environmental Conditions

5.3.1 Land Use

Corridor 2 starts from Cuffe Parade Station, the terminus of the already operational Line 3, continues southward, and extends to the loop line beyond Navy Nagar Station.

[52] https://timesofindia.indiatimes.com/business/infrastructure/mumbai-metro-line-3-pm-modi-metro-inauguration-phase-2-aqua-line-top-things-to-know-route-timing-fare-stations-connectivity-passenger-capacity/articleshow/124382537.cms



Source: Prepared by the JST based on the Draft Mumbai Development Plan 2014–34

Figure 5.3.1 Land Use Along Mumbai Metro Lines 3 and 11

Table 5.3.1 Environmental Conditions along Corridors 2 of Mumbai Metro Line 11

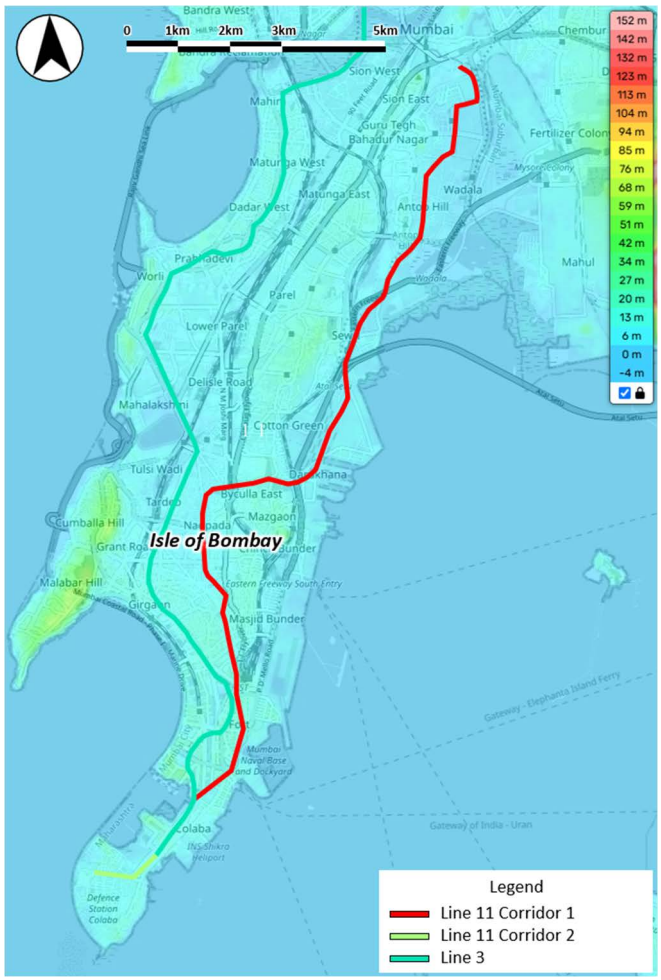
Corridor 2 of Line 11

Navy Nagar

Source: JST

5.3.2 Topography and Geology

Corridor 2 is located at the southernmost tip of the island, where the elevation is low, and with the exception of certain sections at the extreme southern end, remains below 10 m.

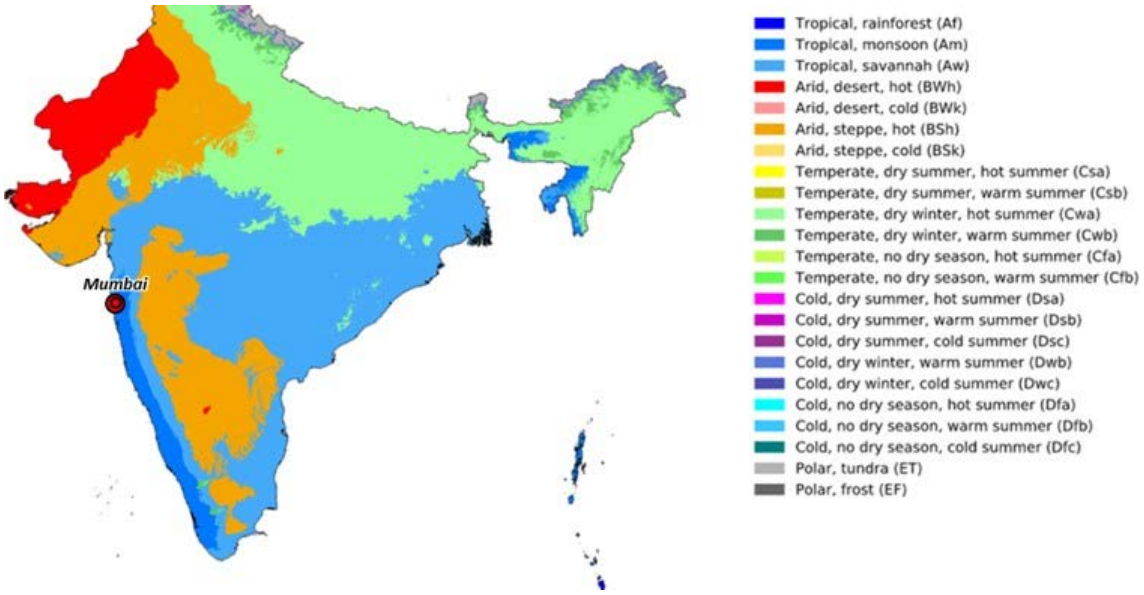


Source: Prepared by JST based on topographic-map.com

Figure 5.3.2 Topography Along the Mumbai Metro Route

5.3.3 Meteorology

India spans a vast territory and is classified into 23 Köppen climate zones. The climate of Mumbai City, where this project is located, falls under the tropical savanna climate (Aw). The monsoon season lasts from June to September, during which more than 90% of the annual precipitation of approximately 2,500 mm occurs. The dry season extends from November to May and is generally warm with minimal rainfall. Although the humidity slightly decreases during the dry season, it does not become extremely dry. The average daily temperature difference between the monsoon and dry seasons in Mumbai is only 5.8°C. The monthly average maximum temperature ranges narrowly from 29.7°C in July to 34.1°C in May.



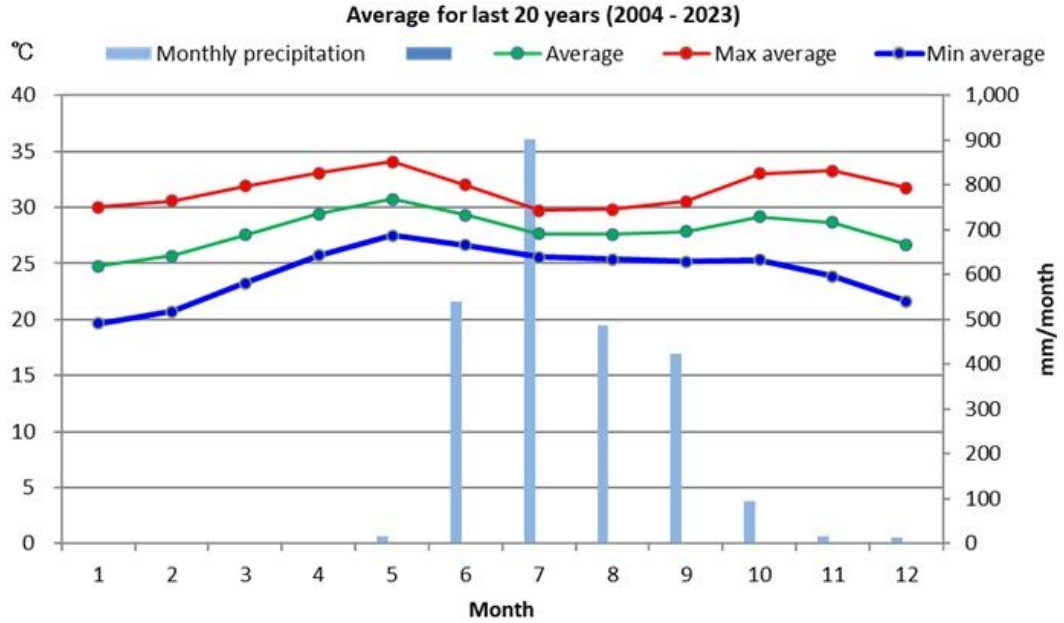
Source: Peel, M. C., Finlayson, B. L., and McMahon, T. A. (2007) (University of Melbourne)

Figure 5.3.3 Köppen Climate Classification in India

Table 5.3.2 Monthly Rainfall and Average Temperature in Mumbai

Place	Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mumbai	Rainfall (mm)	0.2	1.3	2.5	1.0	16.8	539.6	901.0	486.8	423.4	93.8	14.8	14.3	2495.4
	Avg Temp (°C)	24.8	25.7	27.6	29.4	30.7	29.3	27.6	27.6	27.9	29.2	28.7	26.7	27.9
	Avg Max Temp (°C)	30.0	30.6	31.9	33.1	34.1	32.0	29.7	29.8	30.5	33.0	33.3	31.7	-
	Avg Min Temp (°C)	19.6	20.7	23.3	25.7	27.5	26.6	25.6	25.4	25.2	25.3	23.8	21.6	-

Source: Prepared by JST based on data from Japan Meteorological Agency (ClimatView: Monthly Climate Statistics Tool)



Source: Prepared by JST based on data from Japan Meteorological Agency (ClimatView: Monthly Climate Statistics Tool)

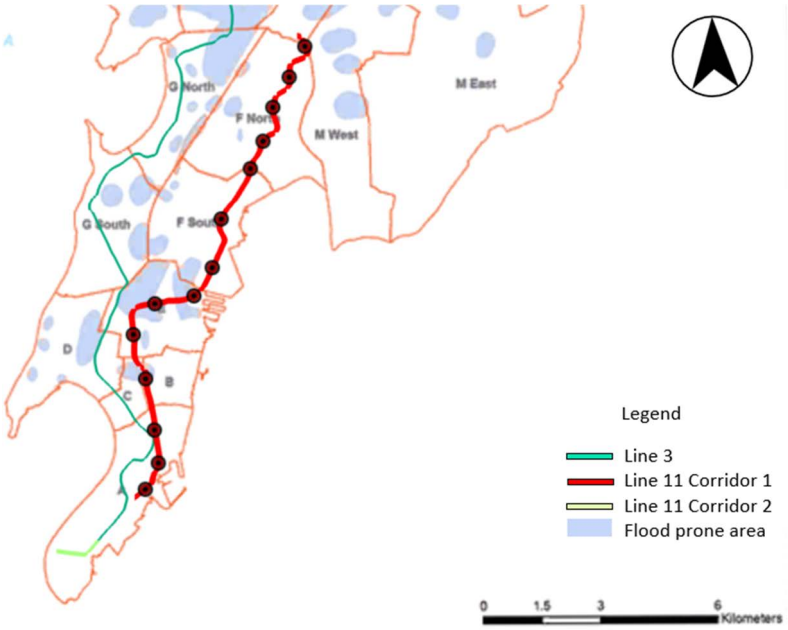
Figure 5.3.4 Monthly Rainfall and Average Temperature in Mumbai

5.3.4 Natural Disasters

According to the "District Disaster Management Plan 2022" issued by the Municipal Corporation of Greater Mumbai, the city has not suffered major disasters such as earthquakes or monsoon-induced floods in the past and is considered to have a relatively stable climate. However, in recent years, intense rainfall has increased due to climate change, causing frequent incidents of inundation and waterlogging.

5.3.4.1 Flooding (Including Inundation and Waterlogging)

Due to the low elevation—below 10 meters except for some parts of the southern end—Mumbai is susceptible to flooding during the monsoon season. In July 2005, rainfall of 900 mm was recorded within a few hours, equivalent to 45% of the annual total. The areas inundated during this event are shown below. In recent years, flooding and waterlogging caused by heavy rainfall have become a nearly annual occurrence, and urgent drainage measures are needed[53]. Although no cyclone-related disasters have occurred since 1882, in June 2020, Cyclone Nisarga brought heavy rainfall to Alibag, located about 100 km south of Mumbai[54]. In May 2025, rainfall of 90 mm/hour was recorded in Mumbai, causing flooding at Acharya Atre Chowk Station of Metro Line 3, which had just opened that month. Approximately 1.1 million liters of rainwater accumulated at a construction-closed station entrance, leading to retaining wall collapse and flooding of station premises and tracks, resulting in a suspension of operations for several days[55].



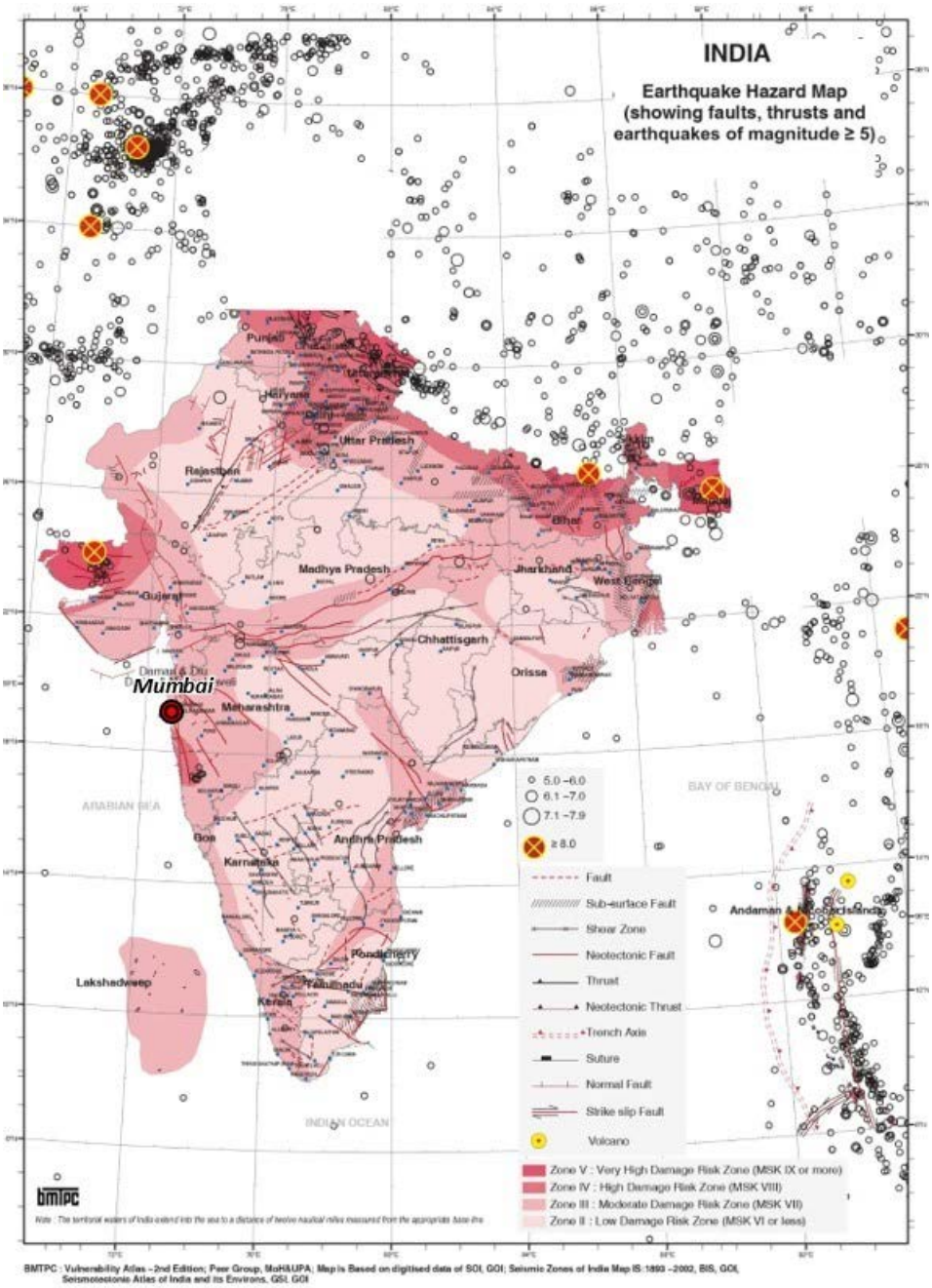
Source: Prepared by JST based on data from "Mapping the Unmeasurable? Spatial Analysis of Vulnerability to Climate Change and Climate Variability," 2014, Alex de Sherbinin

Figure 5.3.5 Inundation Area from the July 2005 Flood

[53] DISTRICT DISASTER MANAGEMENT PLAN, MUMBAI CITY DISTRICT, 2022
[54] https://www.afpbb.com/articles/-/3286457
[55] https://www.hindustantimes.com/cities/mumbai-news/11-million-litres-of-water-in-an-under-construction-pit-at-aac-led-to-its-collapse-101748373858448.html?utm_source=chatgpt.com

5.3.4.2 Earthquakes

According to the seismic zoning map published by the Bureau of Indian Standards, the project site falls within Zone III, indicating a moderate-risk area. The map below shows the epicenters of earthquakes with a magnitude of 5.0 or greater that occurred in India and surrounding regions between 1893 and 2002. No earthquakes of magnitude 5 or greater have been observed near Mumbai City. The closest epicenter was located approximately 100 km north of Mumbai, where a magnitude 6 earthquake was recorded in the past.



Source: Building Materials and Technology Promotion Council

Figure 5.3.6 Epicenters of Earthquakes (Magnitude ≥ 5.0) in India and Surrounding Areas

5.4 Local Legal Frameworks for Environmental and Social Considerations

5.4.1 Environmental Laws and Regulations

5.4.1.1 Environmental Policy, Strategy, and Legal Framework

India has enacted various environmental laws, including the foundational Environment (Protection) Act, 1986, which came into force in May 1986. In addition, the National Environment Policy was introduced in May 2006, followed by the Environment Impact Assessment Notification, 2006 in September of the same year, which stipulates project categories, screening and scoping procedures, and public consultations required for environmental permitting. These procedures fall under the supervision of the Impact Assessment Division of the Ministry of Environment, Forest and Climate Change (MoEFCC).

5.4.1.2 EIA-Related Institutions

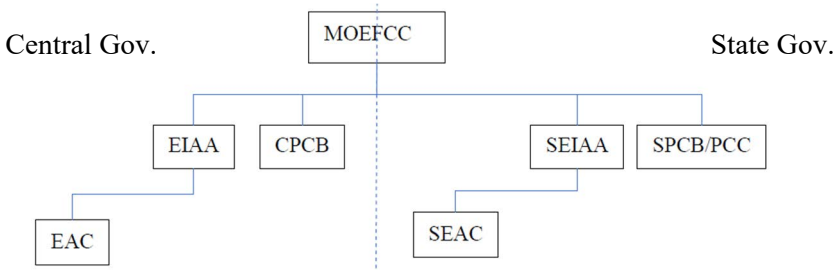
Key organizations involved in Environmental Impact Assessment (EIA) in India include the MoEFCC, which is responsible for establishing EIA-related legislation; the Environmental Impact Assessment Authority (EIAA), which acts as the supervisory body for Category A projects; and the Expert Appraisal Committee (EAC), which is responsible for reviewing Category A projects.

Table 5.4.1 EIA-Related Organizations and Their Roles

Organization name	Role
Ministry of Environment Forest and Climate Change (MoEFCC)	The national organization responsible for overseeing environmental matters. It is the parent organization of both the EIAA and SEIAA.
Environment Impact Assessment Authority at Centre level (EIAA)	The central organization overseeing EIA procedures. It operates under MoEFCC and serves as the supervisory authority for Category A projects, with the authority to issue Terms of Reference (TOR), EIA approvals, and Environmental Clearance (EC). After issuing EC, it is responsible for compliance monitoring. Additionally, it has the authority to appoint the EAC, receive applications from project proponents, issue TOR/EIA to proponents, receive draft EIA reports, publish EIA summaries online, convey collected comments to the proponents, forward revised EIA reports to the EAC, and decide whether or not to accept the EAC's recommendations and approve the projects.
Expert Appraisal Committee (EAC)	A central expert committee that conducts EIA reviews. Its members are appointed by MoEFCC. For Category A projects, the headquarters of MoEFCC issues EC based on the EAC's recommendations.
State level environment Impact assessment authority (SEIAA)	The state-level authority overseeing EIA procedures. It acts as the supervisory authority for Category B1 and B2 projects and has the authority to issue Environmental Clearance (EC) for Category B projects.
Central Pollution control board (CPCB)	The national organization is overseeing pollution control. It announces and organizes public hearings for Category A projects and submits the No Objection Certificate (NOC) and public hearing minutes to the EIAA. It is also responsible for post-EC pollution monitoring.
State Expert Appraisal Committee (SEAC)	The state-level expert committee responsible for EIA reviews. Its members are appointed by the state government and notified by the central government.
State Pollution control board/ Pollution Control Committee (SPCB/PCC)	State government organizations are responsible for pollution control. They announce and organize public hearings for Category B projects and submit the NOC and public hearing minutes to the SEIAA. They are also responsible for post-EC pollution monitoring.
National Environment Appellate Authority (NEAA)	An independent body separated from ministries and state governments, responsible for handling appeals on environmental matters. It allows appeals against EC decisions in response to requests raised during public hearings.
Cabinet Committee on Investment (CCI)	Established in January 2013, this committee participates in the EC process. Headed by the Prime Minister, the CCI sets deadlines for identifying and approving investment projects over INR 10 billion in sectors such as infrastructure and manufacturing. It reviews the approval or rejection processes by relevant ministries and agencies and holds the authority to make EC decisions.

Organization name	Role
National Green Tribunal (NGT)	A special court dedicated to environmental matters. It handles lawsuits concerning environmental conservation, forest protection, and compensation for damage resulting from violations of environmental laws or project approval conditions.
Regional center of the Ministry of Environment and Forest	Supports the activities of EACs in each state. Specific roles include preparing materials for public consultations, developing training materials, and providing education and training to local organizations and governments.
Public/ NGO	Citizens or NGOs directly or indirectly affected by projects may access EIA summaries. During public hearings, they may raise concerns about projects or submit written comments.

Source: Environment Impact Assessment Guidebook for Japanese Companies' Overseas Project development- India-, IGES



Source: Environment Impact Assessment Guidebook for Japanese Companies' Overseas Project development- India-, IGES

Figure 5.4.1 Organizational Structure of MoEFCC and EIA-Related Divisions

5.4.1.3 Environmental Management Laws

(1) Environment (Protection) Act, 1986

Enforced in May 1986, the Act is positioned as a so-called Basic Environmental Law, forming the basic framework for environmental protection, and consists of a total of 4 chapters and 26 sections. The Environment (Protection) Act stipulates the responsibilities of the central government for the prevention, management, and reduction of environmental pollution. The central government is granted the authority to formulate appropriate rules and regulations in order to achieve the objectives stipulated under the Environment (Protection) Act. The term "environment" as defined in the Environment (Protection) Act is: "Environment includes water, air, and land, and the inter-relationship which exists among and between water, air, and land, and human beings, other living creatures, plants, micro-organisms, and property." The authority to prevent, regulate, and reduce factors that pollute or cause damage to this defined "environment" is stipulated under the Environment (Protection) Act. In areas where prevention and regulation of environmental impact are necessary, the central government is authorized to establish relevant rules.

(2) Environment Impact Assessment Notification, 2006

Environmental Impact Assessment (EIA) in India is positioned, under the Environment (Protection) Act, as one of the principal procedures for the review and approval of new or modified projects, based on the National Environment Policy (2006). The EIA procedures are stipulated in the Environment Impact Assessment Notification, 2006. This Notification (2006) prescribes the Environmental Clearance (EC), reviewing organizations, project category classifications, procedures for screening and scoping, methods for applying for EC, validity period of EC, post-EC monitoring, transfer of EC, and various prescribed forms. In India's EIA system, there is no system of EIA ordinances established by local governments.

As shown in the following table, India's environmental categories are divided into three groups: A, B1, and B2. While the distinction between Category A and the other categories is relatively clear, the distinction within Category B1 and lower is partially ambiguous and is determined during the screening process. Moreover, depending on the category, the supervisory authority for issuing EC, the reviewing organization, and other required documents differ.

Table 5.4.2 Overview of Supervisory and Reviewing Authorities by Category in India

Category	EIA Supervisory Authority	Reviewing Organization	EIA	Environmental Clearance (EC)	Monitoring
A	MoEFCC	EAC	Required	Need approval	Required
B1	SEIAA	SEAC	Required	Need approval	Required
B2 (Excluding Mineral Mining)	SEIAA	SEAC	N/A	Need approval from SEIAA	Required
B2 (Mineral Mining)	DEIAA	DEAC	N/A	Need approval from SEIAA	Required
Non-EC project	N/A	N/A	N/A	N/A	Required

Note: MoEFCC: Ministry of Environment, Forest and Climate Change, SEIAA: State Environment Impact Assessment Authority, SEAC: State Expert Appraisal Committee, DEIAA: District Environment Impact Assessment Authority, DEAC: District Expert Appraisal Committee

Source: Environment Impact Assessment Notification 2006

(3) Coastal Regulation Zone (CRZ) Notification, 2019

This notification, established under the Environmental Protection Act, aims to conserve India's coastal environment and promote sustainable development. It is a revised version of the 2011 notification. Its primary objectives are to protect coastal ecosystems, give priority to sustaining the livelihoods of local communities such as those engaged in fisheries, and to promote sustainable development while taking into account risks from sea-level rise due to climate change and from natural disasters. The scope of application covers the coastal area extending 500 m landward from the High Tide Line (HTL), land within 50 m along water bodies subject to tidal influence, and marine areas including their seabed up to 12 nautical miles within the territorial waters. With the exception of the Andaman & Nicobar Islands and the Lakshadweep Islands, the notification applies to the entire mainland coast of India and all its coastal water bodies. The CRZ is classified into the four categories shown in the table below, with Category I being the most significant, followed in order by II and III. While Categories I–III cover terrestrial and brackish water areas, Category IV pertains to coastal marine areas and tidal water bodies. Project proponents are required to obtain CRZ clearance prior to commencement of any construction or development activities. Depending on the category and the scale of the project, the MoEFCC or the relevant State Government/Coastal Zone Management Authority will conduct the review.

Table 5.4.3 Overview of Supervisory and Review Authorities by CRZ Category

Category	Target Area	Reviewing Authority	Main Submission Documents
I	Environmentally most critical areas (mangroves, coral reefs, sand dunes, national parks, etc.)	MoEFCC	- Application Form - CRZ Map (HTL/LTL demarcation map, scale 1:4000) - Project Layout Plan and Technical Specifications - Environmental Impact Assessment (EIA) and - Environmental Management Plan (EMP) - Risk Assessment and Disaster Management Plan

Category	Target Area	Reviewing Authority	Main Submission Documents
			- Public Hearing Records (as applicable) - Consent Letters/NOC from Relevant Authorities
II	Already developed urban areas	State Government or Union Territory Coastal Zone Management Authority	- Application Form - CRZ Map (HTL/LTL Demarcation Map) - Project Layout Plan - Simplified Environmental Management Plan (EMP) - Consent Letters/NOC from Relevant Authorities
III	Relatively undeveloped areas (further divided into III-A and III-B based on population density)		
IV	Coastal marine areas and tidal water bodies	MoEFCC	Same as Category I
Prohibited Activities	Establishment or expansion of new industrial facilities; manufacture or storage of hazardous materials; reclamation or alteration of natural waterways; discharge of untreated wastewater; extraction of sandstone; alteration of sand dunes; disposal of plastic waste; extraction of groundwater; etc.		
Permitted Activities	Port facilities, disaster management facilities, tourism (eco-tourism), traditional fishing, pipelines, desalination plants, and other activities permitted subject to the implementation of environmental mitigation measures.		

Source: CRZ Notification, 2019

5.4.1.4 Environmental Screening of the Project

(1) Screening under Environmental Impact Assessment Notification 2006

EIA is not required to be conducted as all railway projects are exempted from Environmental Clearance procedures in India.

(2) Screening based on JICA Guidelines

The project is classified as "Category A" in the JICA Guidelines promulgated in January 2022, because it corresponds with the condition that it is likely to have significant adverse impacts on the environment and society as a railway sector.

5.4.1.5 Study Policy of the Project

Although the project is exempt from environmental clearance procedures in India, the JICA Guidelines define "Environmental assessment includes an assessment of potential environmental and social impacts that may be caused by the project, an analysis of alternative plans, as well as adequate mitigation measures and monitoring plans, in accordance with laws or regulations of the host countries." Accordingly, the Environment assessment procedures for Mumbai metro line 11 project carried out as per MoEFCC guidelines (EIA Notification, 2006) along with JICA guidelines. The following table presents the results of the gap analysis between the JICA Guidelines and the relevant domestic laws and regulations of India.

Table 5.4.4 Discrepancies between the JICA Guidelines and Indian Domestic Regulations

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Basic Principles	• Environmental and social impacts caused by projects must be assessed and examined at the earliest possible planning stage. Alternatives or mitigation measures must be examined, in order to avoid such impacts as much as possible, and to minimize, reduce or mitigate them when such avoidance is impossible. The result of the examinations must be reflected into the project plan. • Such examinations must be endeavored to include an analysis of environmental and social costs and benefits in the most quantitative terms possible, as well as a qualitative analysis, and to be in a close harmony with the economic, financial, institutional, social, and technical analyses of projects. • The findings of the examination of environmental and social considerations, including alternatives and mitigation measures, must be documented as an independent document or as a part of other documents. Environmental assessment reports must be prepared for projects with potential significant impacts. • For projects which may have significant impacts in particular, or for controversial projects, a committee of experts may be formed so that projects may seek their opinions, in order to increase accountability.	**Early-stage identification, avoidance/minimization of impacts, examination of alternatives and mitigation measures, and reflection in the project plan** EIA Notification, 2006: The procedural stages of Environmental Clearance (Screening / Scoping / Public Consultation / Appraisal) require consideration from the initial planning stage (Para 7(i)). Annex III prescribes the mandatory components of the EIA report, explicitly including: "4. Impacts and Mitigation Measures," "5. Analysis of Alternatives (technology/site)," and "10. Environmental Management Plan (EMP)." **Quantitative cost-benefit evaluation (supplemented by qualitative assessment) and consistency with economic, financial, institutional, social, and technical analyses** EIA Notification, 2006: Annex III stipulates "9. Environmental Cost-Benefit Analysis (where recommended during the scoping stage)." Impact assessment (both quantitative and qualitative) is integrated with "4. Impacts and Mitigation Measures," "6. Environmental Monitoring Programme," and "10. EMP" for alignment with technical and operational analyses of the project. **Documentation of results (including alternatives and mitigation measures) as a standalone report or as part of other documents; preparation of an Environmental Impact Assessment report for projects with significant impacts** *IA Notification, 2006*: The obligation to submit an EIA report and its structure is stipulated in Annex III and Annex III-A (summary). Following the public consultation procedure (Annex IV), the final EIA, public hearing recordings, and related materials are submitted in accordance with Annex V for appraisal. For new, expansion, or modification projects, an EIA/Environmental Clearance is required pursuant to Para 2 and Para 7. **For projects with significant impacts or subject to considerable objections, establishment of a committee composed of experts to enhance accountability and obtain opinions** EIA Notification, 2006: The composition and authority of the Central/State Expert Appraisal Committee (EAC/SEAC) are stipulated (Para 4, Para 5, and Annex VI). Based on Annex V, the EAC/SEAC conducts appraisal and provides recommendations, with conditions or grounds for rejection explicitly recorded in the minutes.	Although no significant divergence is observed with the EIA Notification, 2006, this project falls outside its scope of application; therefore, the JICA Guidelines shall be followed.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Examination of Measures	• Multiple alternatives must be examined in order to avoid or minimize adverse impacts by the project and to choose better project options in terms of environmental and social • considerations. In the examination of measures, priority is to be given to avoidance of environmental impacts. When this is not possible, minimization, reduction, and then mitigation of the impacts must be considered, in accordance with the mitigation hierarchy. Compensation measures must be examined only when significant impacts are still remain even with the aforementioned measures. • Appropriate plans and systems for measures, such as monitoring plans and environmental management plans, must be prepared. The costs of implementing such plans and systems, and the financial methods to fund such costs, must be determined. For projects with particularly significant impacts, detailed environmental management plans must be prepared.	**Examination of Alternatives / Mitigation Hierarchy (Avoidance→Minimization→Reduction→Mitigation→[Compensation only when unavoidable])** EIA Notification, 2006: Para 7 (Scoping requires the Terms of Reference to mandate the examination of alternatives and mitigation measures). Annex III "Analysis of Alternatives"; Annex III "Anticipated Impacts & Mitigation Measures" (including avoidance, minimization, and offsetting of impacts); Annex III "Environmental Management Plan (EMP)." **Environmental Management Plan (EMP), Monitoring Plan, Institutional Arrangements / Cost and Financing, and Detailed EMP for Projects with Significant Impacts** EIA Notification, 2006: Annex III "Environmental Monitoring Programme" (parameters, methods, frequency, reporting schedule, and budget); Annex III "EMP" (description of organizational arrangements and implementation responsibilities). Para 10: Biannual compliance reporting is mandatory with respect to Environmental Clearance conditions. CRZ Notification, 2019 (applicable to projects in Coastal Regulation Zones): Requires States/Union Territories to prepare detailed EMPs and integrate them into the Coastal Zone Management Plan (CZMP).	Although no significant divergence is observed with the EIA Notification, 2006, this project falls outside its scope of application; therefore, the JICA Guidelines shall be followed. In addition, as the CRZ Notification, 2019 constitutes India's specific coastal regulation, the procedures stipulated therein shall be observed.
Scope of Impacts to Be Assessed	• The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water use, climate change, biodiversity, and Ecosystem services, including trans-boundary or global scale impacts. These also include social considerations such as: Migration of population including involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor peoples and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. • In addition to the direct and immediate impacts of projects, derivative, secondary, and cumulative impacts as well as impacts associated with indivisible projects are also to be examined and assessed to a reasonable extent. It is also desirable to consider the impacts through a project life cycle.	**Wide-ranging Environmental and Social Impacts (air, water, soil, waste, accidents, water use, climate change, biodiversity, ecosystem services, human health and safety, natural environment [including transboundary and global impacts], and social aspects: resettlement, livelihoods, land use, community structures, vulnerable groups, equity, gender, cultural heritage, communicable diseases, labour conditions, etc.)** Environment (Protection) Act, 1986: Comprehensive objective to protect the "human environment" (Sec.3, Sec.6). EIA Notification, 2006: Annex III "Anticipated Environmental Impacts and Mitigation Measures" covers impacts on air quality, water quality, soil, waste, accident prevention, human health and safety; Annex III "Impact on Biodiversity & Socio-Economic Environment" includes flora and fauna, forests, ecosystems, agriculture, cultural heritage, socio-economic aspects (employment, livelihoods, resettlement, etc.); Annex III "Environmental Monitoring Programme" requires monitoring plans for air, water, soil, and noise. Wildlife (Protection) Act, 1972: Impact assessment for protected areas and endangered species (as applicable). Biological Diversity Act, 2002: Regulation of access to and conservation of biodiversity and genetic resources. Factories Act, 1948 / Occupational Safety, Health and Working Conditions Code, 2020: Ensures occupational safety and working conditions.	Although no significant divergence is observed with the EIA Notification, 2006, this project is outside its scope of application; therefore, the JICA Guidelines shall be followed.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
		Consideration not only of direct impacts but also indirect, secondary, and cumulative impacts, as well as impacts of associated/integrated projects and over the entire project life cycle EIA Notification, 2006: Annex III "Cumulative Environmental Impact Assessment" requires inclusion of impacts from related projects; Annex III "Project Description" requires description of all project life cycle stages (construction, operation, decommissioning); Para 7(i) stipulates that the scope of assessment must define the range of direct, indirect, and cumulative impacts during the scoping stage.	
Compliance with Laws, Standards, and Plans	• Projects must comply with the laws, ordinances, and standards related to environmental and social considerations established by host country governments, including local governments. Projects must also conform to the environmental and social consideration policies and plans of the host country governments. • In principle, Projects must be undertaken outside of areas that are specifically designated for conservation of nature or cultural heritages by the host county governments, unless the main purpose of the Projects is to promote or restore the protection of such areas. Also, projects shall not cause significant adverse impacts on such designated conservation areas.	**Compliance with National and Local Government Laws, Standards, and Policies on Environmental and Social Considerations** Environment (Protection) Act, 1986 (Sec.3, Sec.6): The Central Government sets standards necessary for environmental protection. Air (Prevention and Control of Pollution) Act, 1981; Water (Prevention and Control of Pollution) Act, 1974: Establishes emission standards and permitting requirements. EIA Notification, 2006 (MoEFCC): Environmental Clearance (EC) is mandatory for projects. Maharashtra Pollution Control Board (MPCB) Regulations: State-level issuance of "Consent to Establish" and "Consent to Operate." Maharashtra State Environment Policy (2010): Sets objectives for sustainable development, climate change mitigation, and water resource protection. Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975 (amended 2023): Requires permits for tree felling in urban areas and mandates compensatory plantation. Solid Waste Management Rules, 2016 (under EPA 1986): Implemented by MPCB within the state. **Implementation of Projects Outside Designated Areas (must not cause significant impacts on legally protected natural or cultural heritage sites)** Wildlife (Protection) Act, 1972: Development activities in national parks, wildlife sanctuaries, and reserved forests are prohibited in principle and subject to strict permitting. Forest (Conservation) Act, 1980: Diversion of forest land requires prior approval from the Central Government and entails compensatory afforestation obligations. Ancient Monuments and Archaeological Sites and Remains (AMASR) Act, 1958: Prohibits development within 200 m of protected monuments; the 200–500 m zone is a regulated area. CRZ Notification, 2019 (under EPA 1986): Development within Coastal Regulation Zones (CRZ-I to CRZ-IV) is prohibited in principle, with limited regulated exceptions. Maharashtra Regional and Town Planning Act, 1966: Imposes restrictions on construction in designated protected areas (green belts, conservation zones) under state-level urban planning.	Compliance with the relevant laws and regulations of India shall be ensured.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
		Heritage Regulations for Greater Mumbai (1995, revised 2012): Restricts development within heritage buildings and precincts in Mumbai designated as cultural heritage at the state level.	
Social Acceptability	• Projects must be adequately coordinated so that they are accepted in a socially appropriate manner for the countries and areas where the projects are planned. For Projects with potentially significant environmental and social impacts, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans are examined. The outcome of such consultations must be incorporated into the project plans. • Appropriate considerations must be given to vulnerable social groups, such as women, children, elderly peoples, people in poverty, indigenous peoples, persons with disabilities, refugees, internally displaced persons, and minorities. Such vulnerable social groups are susceptible to environmental and social impacts and may have little access to decision-making processes within society.	**Stakeholder consultation, information disclosure, and incorporation of alternative options from an early stage** EIA Notification, 2006: Para 7(i) & Annex IV: Public Consultation is mandatory (required for Category A and B1 projects). Public Hearings are hosted by the State Pollution Control Board (SPCB) / Maharashtra Pollution Control Board (MPCB), and opinions from local residents are recorded. The Draft EIA Report, including information on alternatives and mitigation measures, must be disclosed in advance and its outcomes reflected in the final EIA. Right to Information (RTI) Act, 2005: Provides a legal framework for residents to request disclosure of environmental documents and permitting information. Maharashtra PCB Regulations: Specify detailed state-level procedures for conducting public hearings (notice, comment period, and verbatim recording). **Consideration for socially vulnerable groups (women, children, the elderly, the poor, indigenous peoples, persons with disabilities, minorities, etc.)** Constitution of India: Arts. 15, 21, and 46 provide constitutional bases for non-discrimination and protection of vulnerable groups (including women, children, and SC/ST). EIA Notification, 2006: Annex III ("Impact on Socio-Economic Environment") requires assessment of livelihoods, employment, health, safety, and resettlement impacts. Annex IV (Public Consultation) specifies that arrangements should enable vulnerable groups to express views. Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA): Requires consent of indigenous/forest-dwelling communities (Gram Sabha approval) at the time of forest diversion. Maharashtra State Women's Policy (revised 2013): Sets state-level commitments to protect the rights of women and children and requires due consideration in development planning.	Although no significant divergence is observed with the EIA Notification, 2006, this project does not fall under its applicability; therefore, the JICA Guidelines shall be followed.
Climate Change	• For projects that are expected to generate more than a certain amount of greenhouse gas emissions, the total amount of greenhouse gas emissions will be estimated and disclosed before the project implementation.	EIA Notification, 2006: Annex III "Anticipated Environmental Impacts and Mitigation Measures" requires assessment of air pollutants, including greenhouse gas (GHG) emissions, under the Air Environment section. Where an Environmental Cost-Benefit Analysis is mandated, climate change impacts are also included within the scope of assessment. However, there is no explicit provision that directly obliges the numerical estimation and disclosure of GHG emissions.	The JICA Guidelines shall be followed.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Biodiversity	• Projects must not involve significant conversion or significant degradation of critical habitats or critical forests. • Illegal logging of forests must be avoided. Project proponents need to obtain logging permits from regulatory agencies, and are encouraged to obtain forest certifications for forestry projects, in order to ensure the prevention of illegal logging.	**No significant conversion or degradation of critical habitats or critical forests** Environment (Protection) Act, 1986: Sec.3 and Sec.6 empower the Government to designate "Ecologically Sensitive Areas (ESA)" and restrict development activities. Various notifications (e.g., Western Ghats ESA Notification) regulate conversion of protected forests and habitats. Forest (Conservation) Act, 1980: Sec.2 requires prior approval of the Central Government for the diversion of forest land to non-forest purposes. Large-scale deforestation or conversion of forests for development projects is in principle restricted.	This project does not involve significant conversion or degradation of critical habitats or critical forests, nor does it entail illegal logging; therefore, it is not applicable.
Involuntary Resettlement and Loss of Livelihood	• Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. If avoidance is not possible even after such examination, effective measures to minimize impacts and to compensate for losses must be taken upon agreement with the affected people. • Project affected people, such as people to be resettled involuntarily and/or people who may lose their livelihoods by the project, must be provided sufficient compensations and supports by the project proponents in a timely manner. Compensations must be calculated at full replacement cost as much as possible, and provided in advance. Project proponents must make efforts for the affected people to improve or at least restore their standards of living, income opportunities and production levels to the pre-project levels. Measures to achieve this may include: Providing land or monetary compensations for losses of land or assets, supporting for alternative sustainable livelihood, supporting for expenses necessary for relocation, and supporting for re-establishment of communities at resettlement sites. • Compensation standards are disclosed and consistently applied. The project affected persons need to be aware of the compensation standards. In principle, the contents of the • individual compensation to be agreed are explained to the project affected persons in writing, and the project affected persons can confirm the contents at any time. • Appropriate participation of the project affected people and their communities must be promoted in the planning, implementation and monitoring of measures against involuntary resettlement and loss of livelihood.	**Land Acquisition and Minimization of Its Impacts** The Right To Fair Compensation And Transparency In Land Acquisition, Rehabilitation And Resettlement Act, 2013 （LARR2013） Article 4 and Article 8(1)(c): Only the minimum land necessary for project implementation shall be acquired. Article 8(2): The administrative authority overseeing land acquisition and environmental impacts shall verify and supervise that resident displacement due to the project is minimized, that impacts on infrastructure and the natural environment are kept to a minimum, and that the adverse effects on affected individuals are avoided or mitigated to the greatest extent possible. Chapter II: Conduct social impact assessments on affected persons during land acquisition, publish draft compensation and support policies, and formulate final compensation and support policies that incorporate the opinions and suggestions of affected persons. Resettlement & Rehabilitation Policy, Mumbai Urban Transport Project, 2000 (R&R MUTP 2000) 3(a): By examining feasible alternatives, minimize resettlement and prioritize various elements of the project. **Compensation Policy** LARR2013 Article 3(c): The scope of compensation and support covers land and asset owners as well as those whose primary livelihood depends on the land to be acquired. Article 3(p), Article 27, and Article 29: The scope of assets and losses eligible for compensation includes land, buildings attached to the land, and structures attached to the buildings. Article 26: Land price shall be the higher of the average registered sale price of nearby land or the notified market price. Article 28(5): Compensation includes expenses necessary for relocating residences and business premises.	Follow JICA guidelines

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
	• For projects that result in large-scale involuntary resettlement, a Resettlement Action Plans (RAP) must be prepared and made available to the public prior to the resettlement and provision of compensation and support. In preparing the RAP, consultations must be held with the project affected people and communities, based on sufficient information made available to them in advance. When consultations are held, explanations must be given in languages and forms that are understandable to the project affected people. It is desirable that the RAP includes elements laid out in the Environmental and Social Standard (ESS) 5 of the World Bank's environmental and social policies.	R&R MUTP 2000 3(b): Just prior to actual relocation, affected persons shall be compensated for their losses at replacement cost. To be discussed according to each law, standard, and restriction.	
Indigenous Peoples	• Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. If avoidance is not possible even after such examination, effective measures for indigenous peoples must be taken to minimize the impacts and to compensate for the losses. • When projects may have adverse impacts on indigenous peoples, all of their rights in relation to land and resources must be respected in accordance with the spirit of the relevant international declarations and treaties, including the United Nations Declaration on the Rights of Indigenous Peoples. Efforts must be made to obtain the Free, Prior, and Informed Consent (FPIC) of the affected indigenous peoples. • Measures for the affected indigenous peoples must be prepared as an Indigenous Peoples Plan (IPP), which may constitute as a part of other documents for environmental and social considerations, and must be made public in compliance with the relevant laws and ordinances of the host country. In preparing the IPP, efforts must be made to obtain the FPIC of the affected indigenous peoples based on sufficient information made available to them in advance. When consultations are held, explanations are given in languages and forms that are understandable to the indigenous peoples concerned. It is desirable that the IPP includes the elements laid out in the ESS 7 of the World Bank's environmental and social policies.	LARR 2013 Article 41: Land acquisition in the settlements of designated castes and tribes shall be avoided as far as possible, and additional support shall be provided to those affected when necessary. LARR MH 2014 Article 17 (4): In cases involving involuntary relocation of designated castes and tribes, the state government shall prepare a development plan.	Corridor 2 identified no indigenous peoples within the project area; therefore, no Indigenous Peoples Plan will be prepared.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Monitoring	• During the project implementation, project proponents monitor whether any unforeseeable situations occur, and the performance and effectiveness of the planned mitigation measures. Project proponents take appropriate measures based on the results of such monitoring. • In cases where sufficient monitoring is deemed essential for appropriate environmental and social considerations, such as projects for which mitigation measures should be implemented while monitoring their effectiveness, Project proponents must ensure that the project plans include feasible monitoring plans. • Project proponents should make efforts to make the monitoring results available to local stakeholders involved in the project. • When third parties point out specifically that environmental and social considerations are not being fully undertaken, project proponents should make efforts to reach an agreement on the procedures to resolve the problems, through forums for discussions and examinations of the countermeasures with participation of stakeholders involved in the projects, based on sufficient information disclosure.	**Additional measures based on unforeseen circumstances, the status of mitigation implementation, and assessment of effectiveness** EIA Notification, 2006: Annex III "Environmental Monitoring Programme" specifies the methods, frequency, and reporting procedures for monitoring environmental parameters (air, water, soil, noise). Para 10 requires project proponents to submit compliance reports on Environmental Clearance (EC) conditions on a half-yearly basis to MoEFCC and the State Pollution Control Board (SPCB). **Formulation of monitoring plans and ensuring feasibility of implementation** EIA Notification, 2006: Annex III "Environmental Management Plan (EMP)" requires a detailed plan including responsible institutions, organizational arrangements, financing, and monitoring schedules. Annex III "Monitoring Programme" mandates specification of monitoring methods, frequency, and sampling locations. **Disclosure of monitoring results (to local stakeholders)** EIA Notification, 2006: Annex IV (Public Consultation) requires disclosure of information during public hearings and incorporation of stakeholder inputs. Para 10 also provides that compliance reports submitted must be made available for public inspection, as specified in MoEFCC guidelines. Right to Information Act, 2005: Enables residents to formally request disclosure of monitoring reports. Maharashtra Pollution Control Board (MPCB) Regulations: Require, for certain projects, the publication of EC compliance reports on the MPCB website. **Response to third-party observations and establishment of forums for consultation** EIA Notification, 2006: Public Hearing (Annex IV) provides a formal mechanism for local residents and NGOs to submit opinions. The Expert Appraisal Committee (EAC) / State Expert Appraisal Committee (SEAC) consider such third-party observations and public comments when making recommendations (Para 4, 5). National Green Tribunal (NGT) Act, 2010: Provides a legal forum for third parties (citizens, NGOs, etc.) to challenge inadequate environmental and social considerations, and enables adjudication, mediation, and remedial orders.	Although no significant divergence is observed with the EIA Notification, 2006, this project is outside its applicability; therefore, the JICA Guidelines shall be followed.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Grievance Redress Mechanism	• A mechanism for handling concerns and grievances from people and communities affected by the project's environmental and social impacts must be in place. • The grievance redress mechanism needs to be easily accessible for the project affected people and communities. Project proponents disseminate the information about the grievance redress mechanism through consultations with local stakeholders. The project affected people and communities must not be disadvantaged by filing a grievance. • Project proponents should make efforts to respond promptly to the grievances they receive, taking into account the concerns and needs of the project affected people and communities.	**Establishment of a grievance redress mechanism** EIA Notification, 2006: Public Hearing (Annexure IV) provides an official forum for affected residents to raise opinions and grievances. The Expert Appraisal Committee (EAC) / State Expert Appraisal Committee (SEAC) make recommendations taking into account the concerns expressed by residents. National Green Tribunal (NGT) Act, 2010: Provides a judicial grievance redress mechanism for environmental disputes, enabling residents and NGOs to file petitions directly. **Mechanisms that are easily accessible, widely known, and without adverse consequences for complainants** Right to Information (RTI) Act, 2005: Enables residents to easily obtain information on environmental permits, monitoring results, and project-related data. Maharashtra Pollution Control Board (MPCB) Regulations: Provide complaint reception desks and online portals to allow residents to file complaints directly. Companies Act, 2013 (CSR Policy): Encourages large enterprises to establish systems for receiving grievances and feedback from communities as part of Corporate Social Responsibility activities. **Prompt response and due consideration of concerns** EIA Notification, 2006: Opinions expressed at public hearings must be recorded verbatim and are required to be reflected in the final EIA report. NGT Act, 2010: Requires that grievances, once admitted, be heard expeditiously and remedial orders be issued. MPCB Regulations: Empower the Board to conduct site inspections and issue corrective orders promptly upon receiving environmental complaints.	Although no significant divergence is observed with the EIA Notification, 2006 and other relevant laws, this project falls outside the applicability of the EIA Notification, 2006; therefore, the JICA Guidelines shall be followed.

Target Item	JICA Guidelines	Related Act, Regulation	Policy in This Survey
Information Disclosure	• In principle, project proponents disclose information about environmental and social considerations of their projects. JICA assists the project proponents through implementing cooperation projects as needed. • JICA discloses important information about environmental and social considerations at the key stages of cooperation projects, in an appropriate manner in accordance with the JICA Guidelines. • JICA discusses and agrees with project proponents on the frameworks that ensure information disclosure at the early stage of cooperation projects. • The information to be disclosed has to include environmental and social considerations, as well as the project information. • In addition to the information to be disclosed, JICA provides information about environmental and social considerations to third parties to the extent possible in response to their requests. • JICA actively encourages project proponents to disclose and present information about environmental and social considerations of their projects to local stakeholders. • Project proponents disclose information well in advance when they have consultations with local stakeholders in cooperation with JICA. On such occasions, JICA supports project proponents in preparation of documents in an official or widely used language(s) and in a form understandable by local peoples. • JICA discloses information on its website in Japanese, English, official language(s) and/or language(s) widely used in the host countries. It also provides the relevant reports for public reading at the JICA library and at related overseas offices. • JICA pays due consideration to the confidentiality of the commercial and other matters of project proponents, taking into account their competitive relationships. JICA encourages project proponents to exclude confidential information from any documents on environmental considerations that they submit which may later be subject to public disclosure. JICA takes into account the management of information of project proponents, and discloses their documents subject to their approval. Any information that is prohibited from public disclosure in the agreement documents between JICA and project proponents may be disclosed only upon obtaining the approval of the project proponents or in accordance with legal requirements.	**Proactive disclosure of environmental and social information (disclosure at key project stages)** EIA Notification, 2006: Para 7(i): At the Scoping/ToR stage, disclosure of EIA contents (alternatives, mitigation measures, etc.) is required. Annexure IV (Public Consultation): Draft EIA Report must be disclosed in advance, with a mandatory summary in the local language, and stakeholder opinions must be recorded. Annexure V: At the time of final EIA submission, the public hearing proceedings and video recording must be attached and disclosed. **Ensuring a framework for early-stage disclosure** EIA Notification, 2006: Specifies the scope and method of disclosure when issuing the Terms of Reference (ToR). Right to Information (RTI) Act, 2005: Sec.2(j), Sec.4(1)(c),(d) ensure early disclosure of administrative documents and permit-related information. **Disclosure of environmental and social information together with project-related information** Environment (Protection) Act, 1986: Rules under Sec.3 and Sec.6 mandate disclosure of Environmental Clearance (EC) applications and conditions. Maharashtra Pollution Control Board (MPCB) Regulations: Conditions for Consent to Establish/Operate are disclosed on the MPCB website. **Response to information requests from third parties** RTI Act, 2005: Sec.6 enables residents to request environmental documents. **Disclosure to local stakeholders (official/local languages)** EIA Notification, 2006: Annexure IV requires that the summary of the Draft EIA Report be provided in the local language (e.g., Marathi). MPCB Regulations: Notices of public hearings must be published in Marathi-language newspapers. **Web-based disclosure (multi-language disclosure)** MoEFCC Circulars (2009 onwards): EIA reports and EC conditions must be uploaded on the MoEFCC website. MPCB website: Publishes Consent and EC compliance reports (in English and Marathi). **Protection of commercial confidentiality and sensitive information** RTI Act, 2005: Sec.8(1)(d) exempts trade secrets and intellectual property from disclosure. EIA Notification, 2006: Draft/Final EIA reports must not contain confidential information. Companies Act, 2013: Corporate information disclosure under CSR reporting is limited to the extent that it does not cause competitive disadvantage.	Although no significant divergence is observed with the EIA Notification, 2006 and other relevant laws, this project falls outside the applicability of the EIA Notification, 2006; therefore, the JICA Guidelines shall be followed.

Source: JST

5.4.1.6 Other Environment-Related Permissions and Licenses Required for This Project

As previously stated, this project is not subject to the environmental clearance procedures under the Indian national system. However, the project proponent is required to undertake various procedures with the State of Maharashtra and the Municipal Corporation of Greater Mumbai, as shown below. The application timing for these various permissions and licenses is primarily before construction, during construction, and during operation. Under the Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975 (as amended in 2023), provisions are stipulated regarding the number of compensatory trees to be planted in relation to the number of trees felled or transplanted due to a project. During the construction of the Mumbai Metro Line 3, the Tree Authority guidelines of the Municipal Corporation of Greater Mumbai required compensatory planting at a ratio of three times the number of trees felled or cut, and twice the number of trees transplanted (non-survived). In contrast, the revised version of the Act in 2023 stipulates that "a number of trees equivalent to the age of the transplanted tree, of the same species or of other locally endemic/indigenous species, shall be planted, and transplantation shall only be carried out under the supervision of qualified horticultural experts.". Similarly, Compensatory plantation in lieu of trees felled (cut) in accordance with revised version of tree act in 2023.

Table 5.4.5 Main Permissions and Licenses Required

Item	Acts/ Rules	Concerned Agency	Stage
Consent to Establish and Consent to Operate for Batching plant, maintenance depot and workshop activities	The Water (Prevention and Control of Pollution) Act, 1974, amended 1988 and The Air (Prevention and Control of Pollution) Act 1981, amended 1987, and The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (Combined consent regime)	Maharashtra State Pollution Control Board	Pre-Construction (Consent to Establish), and Before operation (Consent to Operate)
CRZ Clearance	CRZ Notification 2019	Maharashtra Coastal Zone Management Authority / State Environment Impact Assessment Authority	Pre-Construction
Tree conservation and management	Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975, amended in 2023	Tree Authority, Brihanmumbai Municipal Corporation (BMC), Garden Department	Pre-construction
C&D Waste Management Plan	C&D Waste Management Rules, 2025 (Effective from 1st April 2026)	Brihanmumbai Municipal Corporation	Pre-construction
Permission for extraction of ground water	Environment (Protection) Act, 1986	CGWA (Local Unit)	Pre-construction as well as for operation
Generation, handling, storage and transportation of hazardous waste	Hazardous and Other wastes (Management & Transboundary Movement) Rules, 2016	Maharashtra State Pollution Control Board	Construction and Operation
Development permission near World Heritage Structures	Brihanmumbai Municipal Corporation (BMC) (BMC Act, 1888)	Mumbai Heritage committee, Brihanmumbai Municipal Corporation	Pre-construction

Source: EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC

5.4.1.7 Other Environment-Related Laws and Regulations

Other environment-related laws and regulations are shown as below.

Table 5.4.6 Other Environment-Related Laws and Regulations

Classification	Laws / Systems / Guidelines etc.
Air	Air (Prevention and Control of Pollution) Act, 1981 Air (Prevention and Control of Pollution) Rules, 1982 Revised National Ambient Air Quality Standards, Notification, 2009
Water	Water (Prevention and Control of Pollution) Act, 1974 Water (Prevention and Control of Pollution) Rules, 1975 IS 10500 : 2012 Indian Standard DRINKING WATER — SPECIFICATION
Waste	Bio medical waste Management Rules, 2016 The Batteries (Management and Handling) Rules, 2011 Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 C&D Waste Management Rules, 2025 (Effective from 1st April 2026) Solid Waste Management Rules,2016 (as amended by the Solid Waste Management (Amendment) Rules,2020) Fly Ash Utilization Notification 2021 E-Waste Management Rules, 2022 Battery Waste Management (Amendment) Rules, 2023
Soil	Environment Protection (Management of Contaminated Sites) Rules, 2025
Noise	Noise Pollution (Regulation and Control) Rules, 2000 (Amendment 2002, 2006) EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition.
Biodiversity	Wildlife Protection Act, 1972 The Maharashtra (Urban area) protection and preservation of Trees Act 1975 and its amendments The Wild Life (Protection) Amendment Act, 2002 The wild life (Protection) Rules, 1995 Biological Diversity Act, 2002 Indian forest Act,1927 Forest conservation act, 1980, 1988, etc. National forest policy, 1988 Forest rights act, 2006 Forest conservation amendment rules, 2003
Cultural and Historical Heritage	Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010
Labor environment including labor safety	Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996, (BOCW Act-Central) Contract Labor (Regulation & Abolition) Act, 1970 Inter-State Migrant Workmen Act, 1979 Minimum Wages Act 1948 The payment Wages Act 1936, ESIC 1948, WC 1923 Payment of Bonus Act 1965 Equal Remuneration Act 1976 Payment of Gratuity Act 1972, EPFO
Others	Coastal Regulation Zone notification, 2019

Source: JST

5.5 Comparative study of alternatives (Including No project)

5.5.1 Current Situation and Related Projects

As described below, alternative alignment studies for the urban railway connecting the densely populated areas of Dharavi / Anik / Wadala in the north and the CSMT area in the south of Bombay Island are being conducted. Regarding the area in question, as previously mentioned in Chapter 1, the construction projects for Mumbai Metro Line 3 and Line 11—which connect the city center to the southern tip of Mumbai and provide interchange with CSMT Station (636,000 passengers/day) and Churchgate Station (505,000 passengers/day)[56], the busiest Indian Railways stations located on Bombay Island—are positioned as priority projects within the Mumbai Metropolitan Region, based on the revised Mumbai Metro Master Plan of 2017. These lines are expected to serve as alternative routes to alleviate congestion on Indian Railways, where the peak-hour maximum passenger load factor reaches 250%. This project corresponds to the eastern corridor (Line 11), following the western corridor (Line 3).

The railway systems currently operating in this area include the Indian Railways' Western Line, Central Line, and Harbor Line, as well as the Mumbai Monorail and Mumbai Metro Line 3. While Indian Railways experiences severe congestion during morning and evening peak hours, the Mumbai Monorail suffers from poor connectivity with Indian Railways and infrequent services (15 to 20-minute intervals on weekdays, 30 to 40-minute intervals on holidays), leading to a decline in the number of users—from a peak of 6.166 million in FY2015–2016 to 3.636 million in FY2022–2023[57]—with current daily ridership at only 18,000 passengers[58]. Furthermore, since Mumbai Metro Line 3 has been in operation for less than one-year, public recognition among Mumbai residents is still in progress. As such, it has not yet fulfilled its role in serving as an alternative transportation option or promoting modal shift from Indian Railways.



Indian Railways Morning Rush Hour Conditions



Mumbai Monorail Utilization Status



Mumbai Metro Line 3 Utilization Status

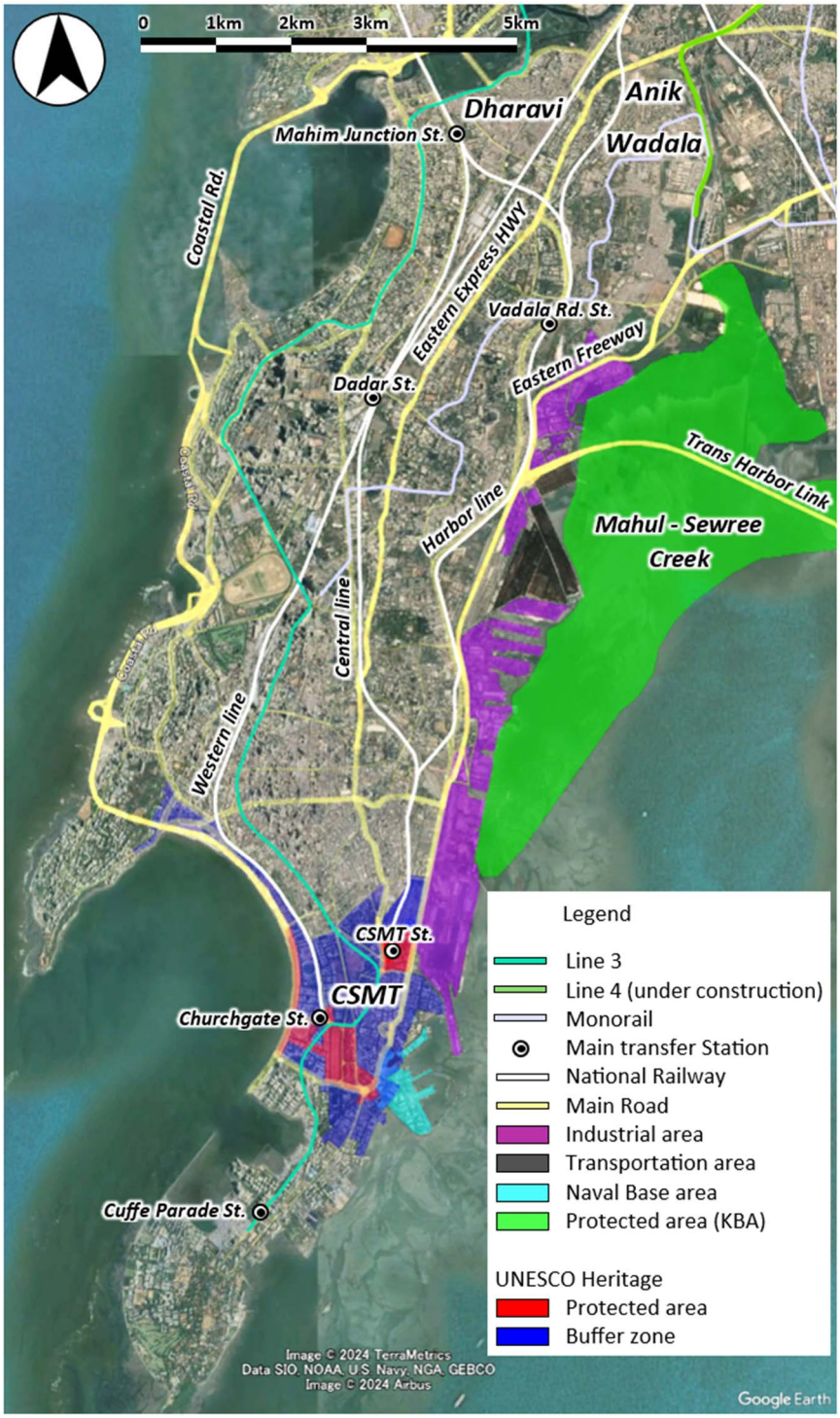
Source: JST

Figure 5.5.1 Utilization Status of Indian Railways and Mumbai Monorail

The Mumbai Metro Line 3, which is highly related to the present project, was initiated in 2016 under a Japanese ODA loan. With the commencement of operations on October 9, 2025, for the section between

[56] https://timesofindia.indiatimes.com/city/mumbai/thane-is-busiest-railway-station-in-mumbai/articleshow/20129363.cms
[57] https://www.financialexpress.com/business/railways-mumbais-monorail-sees-uptick-in-ridership-but-commuters-still-prefer-taking-metro-heres-why-3024112/
[58] https://timesofindia.indiatimes.com/10-years-of-mumbai-monorail-the-joyride-that-never-took-off/articleshow/113566872.cms

Worli Station and Cuffe Parade Station, the entire Line 3 has now been fully opened to service[59].



Source: Prepared by the JST based on Google Earth

Figure 5.5.2 Road and Railway Network and Land Use Conditions, etc. on Bombay Island

[59] https://timesofindia.indiatimes.com/business/infrastructure/mumbai-metro-line-3-pm-modi-metro-inauguration-phase-2-aqua-line-top-things-to-know-route-timing-fare-stations-connectivity-passenger-capacity/articleshow/124382537.cms

5.5.2 Alternatives Study

5.5.2.1 Evaluation Methods

As an evaluation method, regardless of whether the criteria are quantitative or qualitative, the best alternative among all options (e.g., the alternative that ensures constructability and safety throughout the entire alignment, minimizes land acquisition area, or maximizes passenger demand) will receive the full score. For other alternatives, a proportional (or inversely proportional) allocation method will be applied, where the score is calculated by multiplying the allocated points by the ratio of the given alternative to the best alternative (see example below). However, this does not apply to qualitative evaluation items. Additionally, the minimum score for each item is set at 1 point.

Table 5.5.1 Evaluation method for each alternative (e.g., Depot)

No.	Evaluation item	Weighting	Alt. 1		Alt. 2		Alt. 3	
1	Site area (For accommodation evaluation of rolling stock, the alternative with the largest site area receives full score.	15	15 ha (Largest area receives full score)	15	12 ha 15 × (12 / 15) = 12	12	10 ha 15 × (10 /15) = 10	10
2	Land acquisition (For impact assessment, the alternative with the minimum land acquisition area receives full score.)	15	15 ha 15×(3/15) = 3	3	10 ha 15×(3/10)=4.5	4.5	3 ha (Minimum area receives full score)	15

Source: JST

5.5.3 Alternative Analysis for Corridor 2 of Line 11

As previously mentioned, Mumbai Metro Line 3, spanning 33.8 km from Aarey Colony Station at the northern end, where the depot is also located, to Cuffe Parade Station, will be opened by October 2025. As shown in the figure below, the approximately 1.5 km section extending westward from Cuffe Parade Station constitutes the extension section, with Navy Nagar Station planned as an intermediate station.



Source: JST based on Google Earth

Figure 5.5.3 Corridor 2 of Line 11

5.5.3.1 Depot

As previously mentioned, the depot is located at Aarey Colony St., and since the extended section will also share it, there are no plans to construct a new depot.

5.5.3.2 Alignment

As previously mentioned, Corridor 2 of Line 11 has a short extension of approximately 1.5 km. The planned Navy Nagar St. is located along a connecting underground section from Cuffe Parade St. Given a concern from land acquisition and resettlement, the only feasible alignment is beneath the main road, leaving no preferable alternative routes. Therefore, horizontal and vertical alignment alternatives (elevated, ground, or underground) were not considered. Additionally, With regard to the "No Project" alternative, it is judged preferable to implement the project, given the chronic traffic congestion, the worsening air pollution, as well as considerations from socio-economic and climate change mitigation perspectives.

- Cut & Cover Method (Excavation and Backfilling)

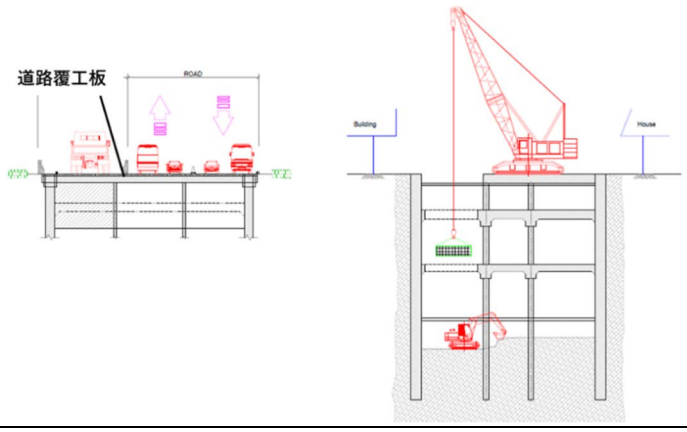
Cut & cover method involves excavating from the surface to construct the required underground structures at a designated depth, then backfilling and restoring the surface. Compared to other tunneling methods, this approach requires surface excavation, leading to significant impacts on road traffic and the surrounding environment in the construction area. Generally, this method is advantageous in terms of safety and cost-effectiveness when the installation depth is shallow and land use restrictions are minimal. It also offers greater flexibility in tunnel cross-section design, making it widely used for station construction.



Site conditions of other project (Jakarta)



Site conditions of Line 3



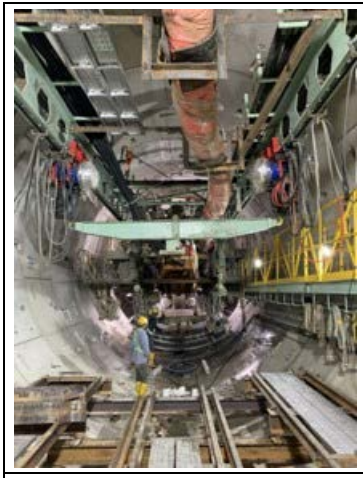
Explanation: Mainly used for station tunnels. Excavation is carried out from the ground surface, such as roads, to construct the tunnel structure.

Source: JST

Figure 5.5.4 Cut & Cover Method

- TBM (Tunnel Boring Machine) Method

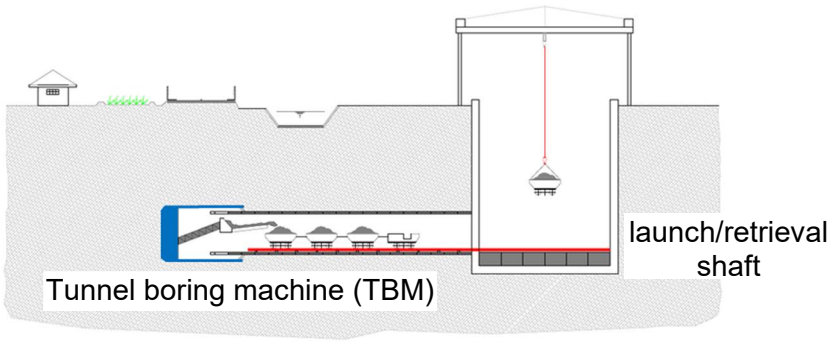
TBM method utilizes a robust steel shell, known as a shield, to advance the tunnel through the ground while preventing soil collapse. The outer shell and shield segments serve as tunnel lining and reaction support. This method minimizes surface impact but has limitations in modifying the tunnel cross-section compared to NATM, as the tunnel diameter is determined by the TBM's external dimensions. Additionally, launch and retrieval shafts must be constructed for TBM operation. Since many processes are automated, the need for workers to enter hazardous excavation zones is reduced, significantly lowering the risk of labor accidents.



Site conditions of other project (Jakarta)



Site conditions of Line 3



Explanation: Mainly used for inter-station tunnels. TBM is deployed from the shaft to construct the tunnel structure using reinforced concrete shield segments while minimizing impacts on surface structures.

Source: JST

Figure 5.5.5 TBM (Tunnel Boring Machine) Method

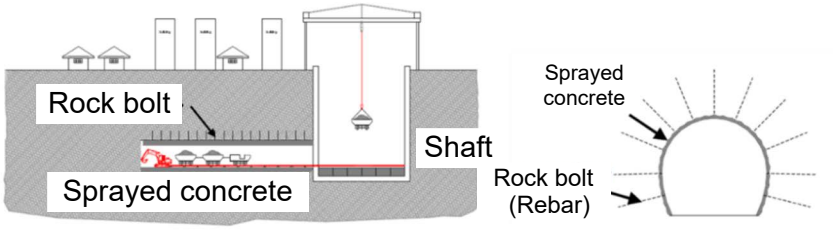
- New Austrian Tunneling Method (NATM)

NATM involves excavation using blasting, machinery, or manual labor, while taking advantage of the self-supporting function of the surrounding ground. After excavation, shotcrete, rock bolts, and steel support structures are used to stabilize the ground, allowing for progress in tunnel construction (typically used for mountainous regions). Like TBM, it minimizes surface impact. Compared to TBM, NATM generally allows for more flexible cross-sectional design, enabling adjustments to tunnel profiles for stations and shafts. However, since it relies on the self-supporting nature of the ground, there is a risk of unexpected ground collapse or deformation.





Site conditions of Line 3



Explanation: Excavation is carried out using blasting, machinery, or manual labor. Due to the ability to change the cross-sectional shape, this method is used for constructing station structures and connecting sections of stations beneath dense urban areas, where surface construction is difficult.

Source: JST

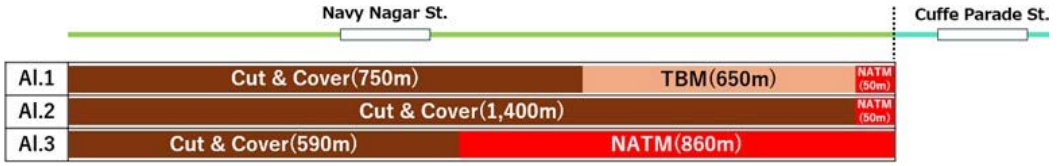
Figure 5.5.6 New Austrian Tunneling Method (NATM)

As a result of the alternative evaluation, Alt. 1 received the highest evaluation in terms of construction and environmental social considerations and was therefore selected as the recommended plan.

Table 5.5.2 Alternative Analysis for Corridor 2 of Line 11

No.	Evaluation item		Weighting	Alt. 1		Alt. 2		Alt. 3	
Construction									
1	Method	Cut & Cover	-	750 m		1,400 m		590 m	
		TBM	-	650 m		0 m		0 m	
		NATM	-	50 m		50 m		860 m	
	Cost		**10**	Approx. 25 billion yen*	**10**	Approx. 25 billion yen *	**10**	Approx. 37 billion yen *	**6.8**
2	**Period**		**10**	2 years	**10**	2.5 years	**8**	3.5 years	**5.7**
Social and economic									
3	Impact on traffic during construction		5	Due to the relatively long cut-and-cover section, it has an impact on traffic congestion.	4	Due to the longest cut-and-cover section, it has the most impact on traffic congestion.	2	Cut-and-cover section is the shortest, so the impact on traffic congestion is minimal.	5
Environmental and social considerations									
4	Land acquisition	Permanent	5	2,519 m^2	5	2,519 m^2	5	2,519 m^2	5
		Temporary	5	62,676 m^2	5	77,479 m^2	4	70,142 m^2	4.5
5	No. of affected structures		5	2,001 m^2	5	3,519 m^2	2.8	1,991 m^2	5
6	**No. of affected households**		**10**	0 (because all affected structures are public buildings)	**10**	0 (because all affected structures are public buildings)	**10**	0 (because all affected structures are public buildings)	**10**
7	No. of logged tree		5	124 trees	5	140 trees	4.3	120 trees	4.8
合計			**55**	**Recommended**	**48.9**		41.3		41.8

Note: TBM: Tunnel Boring Machine, NATM: New Austrian Tunneling Method
*1 INR = 1.70 JPY (JICA rate: October 2024)
Source: JST, MMRC, EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC



Source: JST

Figure 5.5.7 Construction length by method for each alternative

5.6 Screening and Scoping Plan for Environmental and Social Considerations

This section outlines the screening and scoping plan and survey TOR based on the environmental and social positive and negative impacts expected from the prioritized alternatives, using information obtained from field surveys and existing literature.

5.6.1 Scoping

The primary environmental and social considerations for this project are the construction of the underground tracks and station buildings for Corridor 2 of Line 11. The impact factors, affected items, and the extent of the impacts, which are the results of scoping, are shown in the table below. Additionally, scoping results for related facilities, such as quarries, disposal sites, and casting yards needed during the construction phase, are also presented. The evaluation is based on the pre-construction and construction phases. For quarries areas, the responsibility for developing environmental management and monitoring plans lies with the project proponent, MMRC and their construction contractor. Subsequently, based on the detailed design by the project proponent, the construction contractor will develop the construction plan, including details of the related facilities, and once approved by Government of India, the contractor will begin using the related facilities. Meanwhile, as candidate locations for disposal sites and casting yards have already been narrowed down, as described below, the environmental and social impact assessment has been carried out on the assumption that these identified candidate sites will be utilized.

Table 5.6.1 Scoping for the Facilities construction of Corridor 2

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
Pollution				
1	Air pollution	✓		**CS:** Emission gas (NOx, SOx) and dust ($PM_{2.5}$, PM_{10}) are caused temporarily by some heavy machines and dump trucks. **OS:** Positive impact will be offered by the decrease of traffic along the Corridors.
2	Water Quality	✓	✓	**CS:** - Turbid water will be generated in surface water and ground water along the Corridors due to civil and excavation works. - There is a possibility of being discharged with organic wastewater at an installed base campsite. **OS:** There is a possibility of organic wastewater discharged from the toilet installed at every station and the depot.
3	Waste	✓	✓	**CS:** - It is predicted that construction waste such as soil and logged trees is generated. - General waste and excreta will be generated from the base campsite. **OS:** General waste and excreta will be generated from every station and a depot, etc.
4	Soil contamination	✓		**CS:** Excavated soil at the construction site may be contaminated. **OS:** Activities that could lead to soil contamination are not anticipated.

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
5	Noise and vibration	✓	✓	**CS:** Noise and vibration will be generated by heavy construction machines, dump trucks, concrete placing work, and traffic congestion due to traffic control. **OS:** Mumbai Metro can contribute to reducing traffic noise and vibration through traffic volume reduction, but Mumbai Metro may emit additional noise and vibration from its operation.
6	Ground subsidence	✓	✓	**CS/OS:** Construction activities that have a negative impact on underground water such as large-scale digging and water pumping are not scheduled in this project. But there is still a possibility of ground subsidence in case the foundation under the elevated section is soft.
7	Offensive odor	✓	✓	**CS:** Offensive odor may be emitted depending on the volume of general waste from basecamp sites. **OS:** Offensive odor may be emitted depending on the volume of general waste from every station and depot.
8	Bottom Sediment			**CS/OS:** The section does not involve crossing a river, so no impact on the sediment is expected.
Natural Environment				
9	Protected area			**CS/OS:** There are no protected areas along the Corridor.
10	Biodiversity	✓		**CS:** Construction of underground stations and the depot may impact the ecosystem through tree logging. **OS:** Insufficient maintenance of planted trees may lead to a reduced survival rate.
11	Hydrology	✓		**CS:** Construction activities that have a negative impact on underground water such as large-scale digging and water pumping are not scheduled in this project. However, some impact on hydrology around the project site will occur in case of high groundwater level. **OS:** Construction activities which have a negative impact to underground water, such as large- scale digging and water pumping, are not scheduled.
12	Geology and Topography	✓	✓	**CS/OS:** No significant geomorphological or geological features are present in the project area; however, the assessment is carried out on the basis of the natural condition survey results.
Social Environment				
13	Land acquisition/ Resettlement			**Pre-CS:** Land acquisition or resettlement is not anticipated along the Corridor. **OS:** Since there is no land acquisition during operation, there is no expected impact.
14	Poverty	✓		**Pre-CS:** Impact will be evaluated based on the characteristics of the local community around the project area. **OS:** Since no land acquisition is required during operation, activities that could negatively affect the impoverished population are not anticipated.
15	Indigenous and ethnic people	✓		**Pre-CS:** The impact on indigenous and ethnic people is evaluated based on characteristics of local society around the project area. **OS:** Since land acquisition and resettlement will be completed before construction, operation activities that have a negative impact on indigenous and ethnic people are not expected.
16	Local economy such as employment and livelihood, etc.	✓		**Pre-CS/CS:** With opening of Mumbai Metro, drivers of route buses and three wheelers, which are overlapping their operation area of transportation, may suffer negative impacts on their livelihoods. **OS:** - New employment may be created with opening of Mumbai Metro. - A positive impact for the local economy will be generated such as timesaving for traveling within Mumbai city and alleviation of traffic congestion.
17	Land use and utilization of local resources	✓	✓	**CS:** Since land acquisition will not occur, no activities that would cause negative impacts are anticipated. **OS:** Although land acquisition or similar issues will not arise during operation, there is a potential risk of negative impacts due to haphazard development along the railway line, particularly around the stations, as well as the use of local resources.

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
18	Water use and its rights	✓		**CS:** Land acquisition and construction work may affect drinking water sources such as wells. **OS:** Since land acquisition and similar activities will not occur during operation, there will be no impact on water usage. However, irrigation facilities and drinking water infrastructure (such as water supply systems and wells) located within the project area (underground tracks and a station) may be affected during the construction period. If they are not repaired or properly maintained, there is a possibility that these impacts will persist into the operational phase.
19	Existing social infrastructure and services	✓		**CS:** - A negative impact on sensitive facilities such as schools, hospitals, and community centers may occur depending on land acquisition and traffic issues such as congestion and accidents. - The impact of the relocation of underground facilities is expected due to the construction work. **OS:** Improvement of accessibility by installing Mumbai Metro stations is expected, by which there is a possibility of a positive impact on the use of social infrastructure such as school, hospital, etc.
20	Social institutions such as social infrastructure and local decision - making institutions			**CS:** Since the construction is mainly conducted in the central part of the existing road and underground, there is no possibility of local community severance. **OS:** There is no community severance because Mumbai metro will be constructed by underground structures for most of all sections.
21	Maldistribution of benefit and damage	✓	✓	**CS:** Due to the project area, there is a possibility that there may be uneven distribution of benefits and damages, such as road closures, detour routes, and other restrictions, depending on the location. **OS:** Opening of Mumbai Metro may impact the operating profits of bus companies and rickshaw unions that operate along the same routes.
22	Local conflict of interest	✓		**CS:** Residents and municipalities may demand that construction contractor should supply employment opportunities equally as construction workers. **OS:** It is predicted that there is no local conflict of interest because Mumbai Metro services are evenly accessible for local communities.
23	Cultural Heritage	✓	✓	**Pre-CS/CS:** At the current alignment, there is a possibility that it may pass near some historical buildings. However, the final alignment will be confirmed, and any potential impacts will be reassessed at that stage. **OS:** There is no impact on religious and historical buildings because of no-additional land acquisition at the operation stage. However, the impact of vibration from Mumbai Metro operation should be reviewed.
24	Landscape			**CS/OS:** This project is an underground development, so there is little to no expected impact on the landscape.
25	Gender	✓	✓	**CS:** There may be a gender gap regarding wage, salary, and treatment as construction workers. **OS:** Employment opportunities for women may be limited concerning Mumbai Metro operation because the opportunities may not be the same for females despite having the same qualifications and abilities as males. Additionally, female passengers may give up getting on trains for fear of congestion on the train during commuting time.
26	Children's right	✓		**CS:** Negative impact on children's rights is not estimated by the project, but the impact possibility should be evaluated based on the information collected by the field survey. **OS:** There is no impact on children's rights by Mumbai Metro operation.
27	Health (Infectious diseases such as HIV/AIDS, etc.)	✓	✓	**CS:** Infectious diseases such as STD, COVID-19, etc. may be spread by the inflow of construction workers. Additionally, Land use changes by soil cutting and soil filling may create new habitats for mosquitoes that can mediate dengue fever. **OS:** There is a possibility that STD and other infectious diseases spread by increasing the number of settlers and travellers after Mumbai Metro operation.

No.	Impact item	Evaluation		Reason for evaluation
		Pre-CS CS	OS	
28	Labor environment including labor safety	✓	✓	**CS:** It is necessary to improve the labor environment for construction workers following related laws and regulations. **OS:** - There is no big change in the labor environment for residents by Mumbai Metro operation. - Appropriate labor environment for working staff needs to be secured following related laws and regulations.
Others				
29	Accidents	✓	✓	**CS:** here is a possibility of increased traffic accidents due to construction-related vehicles using the main roads along the alignment. **OS:** Risk of passenger falls from the platform
30	Cross-border impact and climate change	✓	✓	**CS:** Greenhouse gas emissions will increase slightly by cutting street trees along the Corridors, operation of construction heavy machinery, and construction of structures. **OS:** Since the traffic volume along the Corridors will reduce due to Mumbai Metro operation, the reduction of greenhouse gases can be expected. On the other hand, it is also conceivable that greenhouse gases will be generated due to the electric consumption by Mumbai Metro operation.

Note: ✓: Items to be assessed, Pre-CS: Pre-Construction Stage, CS: Construction Stage, OS: Operation Stage

Source: JST

Table 5.6.2 Scoping for the Related Facilities usage (Quarry, Dumping site, and Construction Yard)

No.	Impact item	Evaluation	Reason for evaluation
		CS	
Pollution			
1	Air pollution	✓	Nitrogen oxides (NOx), sulfur oxides (SOx), and particulate matter (PM_{10} and $PM_{2.5}$) are generated temporarily due to the operation of certain construction machinery and dump trucks.
2	Water Quality	✓	If the drainage is undeveloped, it may affect the surrounding water sources during rainfall.
3	Waste	✓	Surplus materials will be generated.
4	Soil contamination	✓	Temporary soil contamination due to oil leakage may be caused by using fuel for heavy machines and vehicles.
5	Noise and vibration	✓	Noise and vibration are caused by construction heavy machinery and dump trucks.
6	Ground subsidence		No activity that will cause land subsidence is expected.
7	Offensive odor	✓	Potential generation of offensive odors affecting the surrounding area, depending on the type of waste and the storage method and duration.
8	Bottom Sediment		No activity that will deteriorate bottom sediment is expected.
Natural Environment			
9	Protected area	✓	If there are protected areas in the vicinity of the related facilities, it may affect the conservation area.
10	Biodiversity	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and the ecosystem may be affected. There is also a possibility of logging trees.
11	Hydrology		No activity that will cause changes to hydrology is expected.
12	Geography and topography	✓	If the valuable geography and topography exist in the vicinity of the related facilities, it may affect geography and topography.
Social Environment			
13	Land acquisition/ Resettlement		As a basic policy, the registered site by the local government should be utilized, so there will be no land acquisition, resettlement or economic displacement.
14	Poverty	✓	If there are impoverished communities living in the vicinity, potential impacts could be anticipated.
15	Indigenous and ethnic people	✓	If there are ethnic minorities or indigenous communities living in the vicinity, potential impacts could be anticipated.

No.	Impact item	Evaluation	Reason for evaluation
		CS	
16	Local economy such as employment and livelihood, etc.		No activity that will impact on local economy and livelihood is expected.
17	Land use and utilization of local resources	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and Land use and utilization of local resources may be affected.
18	Water use and its rights	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and water use and its rights may be affected.
19	Existing social infrastructure and services	✓	Existing roads, schools, hospitals, and community centers may be temporarily affected due to frequent dump truck traffic.
20	Social institutions such as social infrastructure and local decision - making institutions		No activity that will impact social institutions is expected.
21	Maldistribution of benefit and damage		No activity that will impact distribution of benefit and damage is expected.
22	Local conflict of interest	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and local conflict may occur between the owner and residents.
23	Cultural Heritage	✓	Some negative impacts may occur if there is a cultural heritage near the project area.
24	Landscape	✓	If the need for soil and crushed stones exceeds the expectations, the excavation range may be expanded and the landscape may be affected.
25	Gender		No activity that will impact on gender is expected.
26	Children's right		No activity that will impact on children's rights is expected.
27	Health (Infectious diseases such as HIV/AIDS, etc.)		No activity that will impact on health is expected.
28	Labor environment including labor safety	✓	It is necessary to secure an appropriate working environment following relevant laws.
Others			
29	Accidents	✓	The use of surrounding roads by delivery and construction vehicles for Mumbai Metro project may increase the likelihood of traffic accidents.
30	Cross border impact and climate change		Cross-border impacts and impact on climate change are not expected.

Note: ✓: Items to be assessed, CS: Construction Stage

Source: JST

5.6.2 Methodology of Environmental Baseline Survey and Analysis

The contents and analysis methods of the surveys conducted by MMRC and the JICA Survey Team, as well as the survey locations and coverage areas, are presented below. In addition, in order to understand the socio-economic conditions along Corridors 2, an interview survey was conducted with 10 respondents at Navy Nagar station.

Table 5.6.3 Environermental Baseline Survey and Analysis

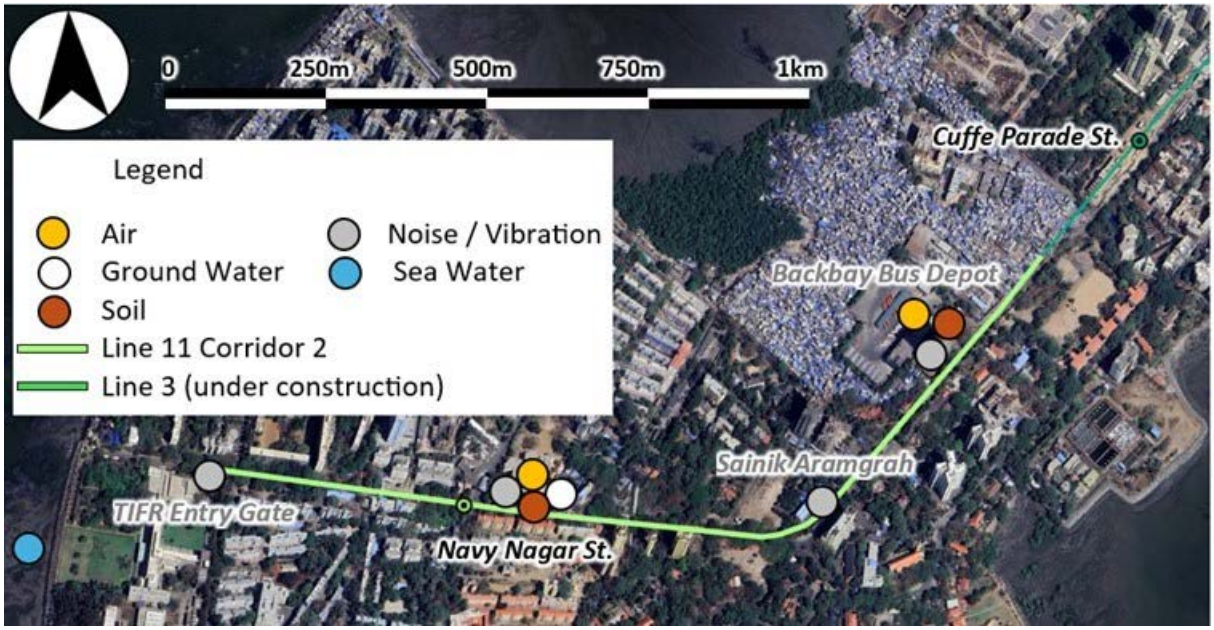
No.	Impact Item	Survey Item	Survey Analysis
Pollution Control			
1	Air Pollution	① Field survey (1) Survey Locations: Two locations along Corridor 2 (Back Bay Bus Depot, Navy Nagar) (2) Survey Items: SO_2, CO, NO_2, O_3, PM_{10}, $PM_{2.5}$ (3) Frequency: At least once each during the monsoon and dry seasons	① A comparison will be made between the survey results and the existing survey results as well as the standard values. ② The contents, method, duration, and scope of the construction works, the types of construction machinery, the operation locations, the operation period, the number of construction vehicle movements, the duration, and the traffic

No.	Impact Item	Survey Item	Survey Analysis
		(excluding rainy days), with 24-hour measurements ② Impact During Construction	routes will be confirmed to the extent possible.
2	Water Quality	① Field survey **Groundwater** (1) Survey locations: One location along Corridor 2 (Navy Nagar) (2) Items: Colour, odour, taste, turbidity, pH, chloride compounds, iron, total dissolved solids, sulphate, nitrate, fluoride, lead, copper, manganese, phenolic compounds, mercury, cadmium, arsenic, cyanide, zinc, detergents, hexavalent chromium, total alkalinity, aluminium, boron, coliform group, coliform bacteria (3) Frequency: Once each during rainy and dry seasons **Seawater** (1) Survey location: Western end of Corridor 2 of Mumbai Metro Line 11 (2) Items: Same as for groundwater (3) Frequency: Once each during rainy and dry seasons ② Impacts during construction and operation phases	① A comparison will be made between the survey results and the existing survey results as well as the standard values. ② The contents, method, duration, and scope of the construction works, the types of construction machinery, the operation locations, the operation period, the number of construction vehicle movements, the duration, and the traffic routes will be confirmed to the extent possible.
3	Waste	Construction waste disposal method Note: The construction waste disposal site currently in use has been identified.	Information collection on registered construction waste disposal sites along the Line 3 corridor or, if necessary, site investigation will be conducted. In addition, interviews with relevant ministries regarding records of construction waste disposal and quantitative forecasts will be conducted.
4	Soil Contamination	① Field survey (1) Survey locations: 2 locations along Corridor 2 (Backbay Bus Depot, Navy Nagar) (2) Items: pH, electrical conductivity, lead, mercury, cadmium, arsenic, cyanide, hexavalent chromium (3) Frequency: Once each during rainy and dry seasons ② Impacts during operation phase	① Comparison between survey results, existing survey results, and standard values ② Hearing with MMRC
5	Noise and Vibration	① Field survey (1) Survey locations: 4 locations along Corridor 2 (Backbay Bus Depot, Sainik Aramgrah, Navy Nagar, TIFR Entry Gate) (2) Items: Environmental noise (LAeq, 24 hours continuous / weekdays), Environmental vibration (24 hours / weekdays) (3) Frequency: Once (dry season) ② Noise and vibration levels during construction and operation phases in representative sections ③ Impacts during construction phase	① Comparison between survey results, existing survey results, and standard values ② Noise: Quantitative prediction (At the road boundary of representative elevated sections and at locations requiring consideration – Traffic noise / LAeq dB(A)) Vibration: Quantitative prediction (At the road boundary of representative underground sections and at locations requiring consideration – Traffic vibration / Lv dB) ③As much as possible, confirmation of construction details, methods, duration, scope, types of construction machinery, operating positions, operating durations, number of construction vehicles in operation, duration, and travel routes
6	Land Subsidence	Impacts during construction phase	Utilization of results from previously conducted topographic surveys and subsurface ground investigations, as well as hearing with MMRC.
7	Offensive Odors	Impacts during construction and operation phases	Information collection regarding offensive odors expected to be generated from base camps, stations, and depots.

No.	Impact Item	Survey Item	Survey Analysis
Natural Environment			
8	Biodiversity	① Field survey (1) Survey area: Within 100 meters on both sides from the alignment of Corridor 2 (2) Survey items: Terrestrial flora and fauna affected by the construction project, species names, scientific names, IUCN, Red List, distribution maps, identification photos, nesting, spawning status. Especially, Sisav (Dalbergia latifolia), Sita Ashok (Saraca asoca) are to be surveyed. (3) Frequency: Once each in rainy and dry seasons Note: Interviews with experts or professors shall be conducted as necessary. ② Confirmation of land use patterns	①② Information collection through existing data review and field survey
9	Tree counting	① Field survey (1) Survey area: Review of species and number of trees to be relocated or felled due to station and depot construction of Corridor 2 (2) Survey items: Number of each tree species and IUCN Red List (3) Frequency: Once Note: For species categorized as VU or higher (including CR, EN) on the IUCN list, location information shall also be included (e.g., Dalbergia latifolia and Saraca asoca). Interviews with experts or professors shall also be conducted as necessary.	Utilization of existing survey data and hearing with MMRC
10	Hydrology	① Survey on past flood and inundation history ② Impacts during construction phase	① Information collection ② Utilization of results from previously conducted topographic surveys and subsurface ground investigations, as well as hearing with MMRC
11	Topography and Geology	Impacts during construction phase	Utilization of results from previously conducted topographic surveys and subsurface ground investigations, as well as hearing with MMRC
Social Environment			
12	Land acquisition/ Resettlement	Refer to "B.[Land Acquisition and Resettlement]"	
13	Poverty	Impact on Poverty	Utilization of interview survey results and social impact survey results
14	Indigenous and ethnic people	Refer to "B.[Land Acquisition and Resettlement]"	
15	Local economy such as employment and livelihood, etc.	Impact on employment and livelihoods in the local economy	Utilization of existing data and interview survey results
16	Land use and utilization of local resources	Confirmation of land use and local resource use	Utilization of existing data and interview survey results
17	Water use and its rights	Confirmation of water use conditions by residents along the alignment	Utilization of existing data and interview survey results
18	Existing social infrastructure and services	① Field Survey (1) Survey Area: Within approximately a 200-meter radius along the Corridors 2 (2) Survey Items: Distribution of hospitals, schools, religious sites, community centers, etc. (including interview surveys) (3) Frequency: Once ② Distribution of Underground Utilities	① Utilization of existing data, on-site inspections, and results from interview surveys ② Utilization of existing CAD data
19	Social institutions such as social	① Restrictions on Road Crossings and Setting of Detour Routes	Utilization of existing data, interview survey results, and social impact survey results

No.	Impact Item	Survey Item	Survey Analysis
	infrastructure and local decision - making institutions	② Collection of Opinions from Bus Companies and Rickshaw Unions Regarding This Project	
20	Local conflict of interest	Impact on Conflicts of Interest within the Community	Utilization of existing data and interview survey results
21	Cultural Heritage	Cultural and Historical Heritage in the Vicinity of the Project Area	Utilization of existing data and interview survey results
22	Gender	Refer to "B. [Land Acquisition and Resettlement]"	
23	Children's right	Impact on Children's Rights	Confirmation of Relevant Domestic Laws and the Existence of Child Labor
24	Health (Infectious diseases such as HIV/AIDS, etc.)	① Incidence Rate of Infectious Diseases in the Project Area Vicinity ② Relevant Implementing Organizations	Utilization of existing data and interview survey results
25	Labor environment including labor safety	① Confirmation of Relevant Indian Laws and International Standards ② Verification of Occupational Safety Measures at Construction Sites	① Information collection ② On-site inspection and interviews
Others			
26	Accidents	Number of traffic accidents and reasons for accidents along the corridor	Review of existing documents and on-site surveys. Where possible, interviews will be conducted with local police stations or municipal authorities within the jurisdiction.
27	Cross border impact and climate change	Estimation of greenhouse gas emissions and reduction amounts resulting from this project	Utilization of collected data and interviews with MMRC, as well as application of JICA Climate FIT.
28	Soil Borrow Pits, Disposal Sites, and Construction Yards	Basic information including total capacity, remaining capacity, year of registration, owner, photographic documentation, name of permits, responsible agencies, and details of administrative procedures Note: Hearings with relevant ministries regarding the actual performance of waste disposal will also be conducted.	Information will be collected, or site surveys will be conducted as necessary, for registered borrow pits, disposal sites, and construction yards along Corridors 2.
29	Stakeholder Meeting	Public consultations will be conducted jointly with the social environment survey.	

Source: JST



Source: EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC, Prepared by the JST based on Google Earth

Figure 5.6.1 EIA Survey Locations and Survey Area of Corridor 2

5.7 EIA Survey Results

The MMRC conducted studies on various environmental and social impact considerations, and the EIA/SIA reports for Corridor 2 were shared with the JICA Survey Team in July 2024. The Survey Team thoroughly reviewed these EIA/SIA reports and conducted supplementary investigations from March to July 2025. The results are presented below.

5.7.1 Pollution Control

5.7.1.1 Air Pollution

(1) Survey

In Mumbai, ambient air quality measurements were conducted most recently by the World Health Organization (WHO) in 2018 and 2019. In particular, with respect to PM_{10}, Mumbai was ranked 41st and 81st from the bottom among approximately 5,000 cities worldwide, recording concentrations of 165 µg/m³ in 2018 and 125 µg/m³ in 2019, respectively[60]. However, under the National Clean Air Programme (NCAP), launched across India in 2019, the Government set a target of reducing PM_{10} levels by 40% from 2017 values by 2026. In Mumbai, the PM_{10} concentration in 2017 was 161 µg/m³, whereas the preliminary figure for 2024 is 94 µg/m³, reflecting a reduction of approximately 42%, which indicates that the NCAP target has already been achieved. Nevertheless, the National Ambient Air Quality Standards (NAAQ) annual average target of 60 µg/m³ has not yet been met, and efforts to further improve air quality are ongoing.

With respect to the surveys, for Corridor 2, the dry season surveys were conducted in April and May 2023, and the monsoon season surveys in June and July of the same year. At all locations along Corridor 2, the values were below the standard, indicating an improving trend in air quality. The main sources of air pollution include the rapid population growth and the consequent increase in vehicular emissions, traditional cooking practices, operations of thermal power plants, and smoke emissions from brick production. However, apart from vehicular traffic along the project corridor, there are no major pollution-emitting facilities located within the project area. In India, the standards for ambient air quality are stipulated under the notification issued by the Central Pollution Control Board (CPCB) dated 18 November 2009.

Table 5.7.1 The existing survey results and applicable ambient air quality standards in India (Unit: µg/m³)

Measurement location/Period		PM_{10}	$PM_{2.5}$	CO	NO_2	SO_2	O_3
Unit		µg/m³	µg/m³	mg/m³	µg/m³	µg/m³	µg/m³
Corridor 2							
1. Navy Nagar St.							
Dry season	1st–2nd, Apr	52.23	30.36	0.44	16.65	12.76	12.85
	3rd–4th, Apr	55.27	28.28	0.47	15.93	13.03	11.87
	10th–11th,Apr	61.15	32.44	0.82	17.68	14.44	15.22
	11th-12th,Apr	59.86	30.36	0.77	16.65	13.78	14.75
	17th–18th,Apr	56.40	27.86	0.52	13.70	11.80	12.03

[60] WHO Air Quality Database (Update 2022), WHO

Measurement location/Period		PM_{10}	$PM_{2.5}$	CO	NO_2	SO_2	O_3
Unit		µg/m³	µg/m³	mg/m³	µg/m³	µg/m³	µg/m³
	18th-19th,Apr	57.66	28.28	0.50	12.93	10.85	11.52
	24th-25th,Apr	57.50	29.94	0.77	13.25	11.70	11.81
	25th-26th,Apr	59.27	30.77	0.80	14.11	12.53	10.89
	6th-7th,May	60.56	27.03	0.52	14.19	11.71	10.33
	7th-8th,May	61.54	27.86	0.53	14.93	12.46	11.16
	12th-13th,May	61.15	27.86	0.59	15.47	12.58	11.29
	13th-14th,May	62.15	28.69	0.51	15.94	13.20	12.12
	15th-16th,May	60.56	28.69	0.50	16.34	14.58	10.95
	16th-17th,May	61.54	27.86	0.52	16.68	14.20	11.98
	24th-25th,May	60.33	26.61	0.43	16.51	13.33	11.26
	25th-26th,May	59.72	25.78	0.45	16.41	13.58	11.03
Rainy season	6th-7th,Jun	61.15	27.03	0.52	14.19	11.71	10.33
	7th-8th,Jun	62.15	27.86	0.53	14.93	12.46	11.16
	14th-15th,Jun	61.15	27.86	0.59	15.47	12.58	11.29
	15th-16th,Jun	62.15	28.69	0.51	15.94	13.20	12.12
	20th-21st,Jun	60.56	28.69	0.50	16.34	14.58	10.95
	21st-22nd,Jun	61.54	27.86	0.52	16.68	14.20	11.98
	30th,Jun-1st,Jul	60.33	26.61	0.43	16.51	13.33	11.26
	1st-2nd,Jul	59.72	25.78	0.45	16.41	13.58	11.03
2. BackBay Bus Depot							
	5th–6th, Apr	60.59	31.19	0.51	17.36	14.21	15.06
	6th–7th, Apr	57.03	29.11	0.49	16.25	13.39	14.43
	10th–11th,Apr	62.33	31.60	0.68	15.47	12.21	13.77
	11th-12th,Apr	58.68	29.52	0.73	17.18	14.76	12.66
	17th–18th,Apr	63.47	33.27	0.63	14.40	13.68	14.32
	18th-19th,Apr	64.42	34.10	0.65	13.68	12.27	13.37
	24th-25th,Apr	60.45	31.19	0.60	15.22	12.25	13.84
Dry season	25th-26th,Apr	61.03	32.85	0.66	15.54	13.63	12.73
	6th-7th,May	62.92	31.60	0.59	16.85	14.33	12.38
	7th-8th,May	62.30	32.85	0.58	17.35	15.20	12.73
	12th-13th,May	63.51	30.77	0.59	17.42	13.45	13.34
	13th-14th,May	63.06	32.02	0.66	18.03	14.58	13.69
	15th-16th,May	62.92	29.94	0.56	17.92	15.32	12.91
	16th-17th,May	62.48	31.60	0.58	18.26	15.70	13.26
	24th-25th,May	61.89	30.77	0.47	18.09	14.45	12.86
	25th-26th,May	60.71	32.85	0.50	17.99	14.82	12.51
	6th-7th,Jun	62.92	31.60	0.59	16.85	14.33	12.38
	7th-8th,Jun	62.30	32.85	0.58	17.35	15.20	12.73
	14th-15th,Jun	63.51	30.77	0.59	17.42	13.45	13.34
Rainy season	15th-16th,Jun	63.06	32.02	0.66	18.03	14.58	13.69
	20th-21st,Jun	62.92	29.94	0.56	17.92	15.32	12.91
	21st-22nd,Jun	62.48	31.60	0.58	18.26	15.70	13.26
	30th,Jun-1st,Jul	61.89	30.77	0.47	18.09	14.45	12.86
	1st-2nd,Jul	60.71	32.85	0.50	17.99	14.82	12.51
CPCB 2009		100 (24hrs)	60 (24hrs)	2 (8hr)	80 (24hrs)	80 (24hrs)	100 (8hrs)
WHO		150 (24hrs)	75 (24hrs)	-	120 (1hr)	125 (24hrs)	60 (8hrs)

Note: Exceedances of the standard values are indicated in bold.

Source: Draft EIA report for Mumbai Metro Line-11, Aug, 2024, MMRC, EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC, Central Pollution Control Board Notification dated 18th Nov. 2009/ WHO global air quality guidelines (AQG), WHO

1) Particulate Matter (PM_{10} and $PM_{2.5}$)

PM_{10} refers to particulate matter with a diameter of 10 μm or less, and $PM_{2.5}$ refers to particulate matter with a diameter of 2.5 μm or less. $PM_{2.5}$ is generally defined as fine particulate matter. The main components of particulate matter are sulfates, nitrates, ammonia, sodium chloride, black carbon, mineral dust, water, etc., and it consists of a complex mixture of organic and inorganic solid and liquid particles suspended in the air. Dust was monitored through continuous 24-hour measurement of PM_{10} and $PM_{2.5}$. For Corridor 2, surveys were conducted in both the dry and rainy seasons, but little seasonal variation was observed.

2) Carbon Monoxide (CO)

Carbon monoxide is a tasteless, odourless toxic gas that is mainly generated from incomplete combustion of carbon. That is, when there is insufficient oxygen to produce carbon dioxide (CO_2), only half the oxygen binds with carbon, resulting in the formation of carbon monoxide. It is also generated from the combustion of fossil fuels, automobile exhaust, and industrial smoke. Inhalation of carbon monoxide impedes the transport of oxygen in the bloodstream, resulting in cellular and tissue dysfunction due to oxygen deficiency. Excessive inhalation can lead to death. The 8-hour concentration of carbon monoxide was below the national standard of 2 mg/m^3 at all sites in both seasons.

3) Nitrogen Dioxide (NO_2)

Nitric oxide (NO) and nitrogen dioxide (NO_2) are the major nitrogen oxides. They are generated by vehicle operation and maintenance, as well as from private power generation equipment. Human effects depend on nitrogen and oxygen concentration, reaction time, temperature, etc., and excessive intake of nitrogen oxides may cause bronchitis and edema. According to the MMRC's survey, 24-hour continuous monitoring of NO_2 concentrations in the environment was conducted, and all sites recorded levels below the national standard of 80 $\mu g/m^3$.

4) Sulphur Dioxide (SO_2)

The main sources of sulfur dioxide include combustion of fuels such as oil, production of chemical products, and automobile exhaust. In severe cases, respiratory diseases and inflammation of the throat and eyes may occur. Sulphur dioxide concentrations were measured continuously over 24 hours at each site, and when comparing the average concentrations with the national standards, all sites recorded levels below the standard of 80 $\mu g/m^3$.

(2) Prediction

Quantitative predictions were considered, but due to the lack of general environmental data in India—such as wind direction and speed, solar radiation, atmospheric radiation, cloud cover, and atmospheric stability—it was not possible to evaluate the reliability of the predictive results. Therefore, qualitative predictions were carried out.

1) Construction phase

Given the current air environment in Mumbai, heavy machinery and trucks may cause further traffic congestion and deterioration of air quality; however, the impact is not expected to be severe for the following reasons:

- All underground stations will be constructed either on private or public land, or beneath arterial roads and narrow streets. In order to avoid worsening traffic congestion caused by the operation of heavy machinery, measures such as nighttime operations and the provision of detour routes will be implemented, thereby limiting the overall impact.
- Work procedures will be arranged so that the operation of construction machinery does not concentrate for long periods at fixed locations.
- In cases where road closures are unavoidable, detours will be planned in advance through detailed review.

In addition to the above, mitigation measures should be taken to avoid deterioration of air quality, such as the adoption of low-emission heavy machinery and trucks, avoiding unnecessary engine idling, regular sprinkling of water, and installation of fences.

2) Operation phase

With the increasing population of Mumbai, the number of registered vehicles is expected to continue to rise, and traffic volume along the Mumbai Metro Line 11 corridor is also expected to increase. However, after the metro becomes operational in 2031, a modal shift from private cars and buses to the metro is expected, leading to a temporary decrease in traffic volume along the corridor. Furthermore, in order to alleviate current traffic congestion, the construction of high-standard roads and road improvement projects such as overpasses are planned along the corridor, suggesting that Mumbai's air quality will improve. Also, since no air pollutants will be emitted from the metro during operation, and because the replacement of private vehicles is expected to reduce NOx and SOx emissions, Mumbai's air environment is anticipated to improve as a result.

5.7.1.2 Water Quality

(1) Survey

With respect to the groundwater survey, the Corridor 2 surveys were conducted during the dry season (April 2023) and the monsoon season (July 2023). The results are as follows. Groundwater and seawater quality along Corridor 2 were found to be generally below the standard values. Thus, even in cases where residents may use well water for drinking purposes, no issues are presently observed in the water quality environment. However, during the survey, considerable time was required to identify wells. The primary reason for this was that the majority of facilities and households do not utilize well water, indicating that opportunities for citizens to consume well water are almost negligible. In India, the drinking water quality standards are stipulated under IS 10500: 2018, Indian Standard, Drinking Water — Specification, while the seawater standards are prescribed under The Environment (Protection) Rules, 1986.

(2) Prediction

With regard to domestic and industrial wastewater in Mumbai, observations of water quality in surrounding rivers indicate that, particularly in areas adjacent to slums, untreated effluents are discharged together with stormwater into drainage channels, which subsequently flow into rivers and lakes within the city. During the rainy season, rainwater mixed with sewage overflows within the city, leading to the deterioration of sanitary conditions. Additionally, during the excavation work for underground metro stations, turbid water may be generated if the groundwater level is high, which may lead to further water quality degradation. However, in the construction of underground stations, diaphragm walls are installed in various locations to prevent fluctuations in the groundwater level and degradation of groundwater quality, and therefore this impact is not considered to be serious.

On the other hand, at construction sites, mitigation measures to prevent deterioration of water quality, such as the installation of sedimentation tanks and drainage treatment facilities should be taken. During operation, since organic wastewater may be discharged from toilets installed at the station, drainage treatment systems will be installed at the station to maintain water quality.

Table 5.7.2 Groundwater Survey Results and Applicable Water Quality Standards in India

Item	Unit	Navy Nagar, Line 11 Corridor 2				Acceptable Limits (Permissible Limit) (IS 10500:2012)	WHO (drinking water)
		07/04/2023	06/05/2023	14/06/2023	24/07/2023		
Turbidity,	N.T.U	<0.1	<0.1	<0.1	<0.1	1 (5)	Less than 5 N.T.U
Temperature	°C	26.2	26.5	26.3	26.5	-	-
Salinity	PPT	<1	<1	<1	<1	-	-
pH at 25°C		7.68	7.24	7.33	7.28	6.5-8.5	-
Phosphorus	mg/l	<0.1	<0.1	<0.1	<0.1	-	-
Total Nitrogen	mg/l	<0.07	<0.07	<0.07	<0.07	-	-
Phosphate	mg/l	<0.1	<0.1	<0.1	<0.1	-	-
Total Hardness as $CaCO_3$,	mg/l	**224**	218	204	182	200 (600)	-
Chloride as Cl	mg/l	19.99	17.99	16.99	18.99	250 (1000)	-
Total Iron as Fe	mg/l	0.10	0.123	0.13	0.15	0.3	0.3
Total Suspended Solids	mg/l	<2	<2	<2	<2	-	-
Chemical Oxygen Demand (COD)	mg/l	<3.2	<3.2	<3.2	<3.2	-	-
Bio Chemical Oxygen Demand (BOD)	mg/l	<1	<1	<1	<1	-	-
Oil and Grease	mg/l	<2	<2	<2	<2	-	-
Calcium as Ca	mg/l	51.30	70.54	57.71	42.48	75 (200)	-
Magnesium as Mg	mg/l	23.32	10.20	15.55	18.46	30 (100)	-
Sulphates as SO_4	mg/l	30.21	26.83	24.57	35.8	200 (400)	250
Nitrates as NO_3	mg/l	0.11	0.121	0.13	0.21	45	50
Nitrite as NO_2^-	mg/l	<0.1	<0.1	<0.1	<0.1	-	3
Fluorides as F	mg/l	<0.1	<0.1	<0.1	<0.1	1.0 (1.5)	1.5
Silver as Ag	mg/l	<0.01	<0.01	<0.01	<0.01	0.1	0.1
Sulfide as H_2S	mg/l	<0.05	<0.05	<0.05	<0.05	0.05	-
Residual Free Chlorine	mg/l	<0.22	<0.22	<0.22	<0.22	0.2 (1)	-
Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	0.01	0.01
Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	0.05 (1.5)	1.0
Total Chromium	mg/l	<0.01	<0.01	<0.01	<0.01	-	0.05
Manganese as Mn	mg/l	<0.01	<0.01	<0.01	<0.01	0.1 (0.3)	0.1
Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	0.02	0.07
Phenolic Compound as C_6H_5OH	mg/l	<0.001	<0.001	<0.001	<0.001	0.001 (0.002)	-
Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	0.001	0.001
Cadmium as Cd	mg/l	<0.03	<0.03	<0.03	<0.03	0.003	0.003
Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01	0.01	0.01

Item	Unit	Navy Nagar, Line 11 Corridor 2				Acceptable Limits (Permissible Limit) (IS 10500:2012)	WHO (drinking water)
		07/04/2023	06/05/2023	14/06/2023	24/07/2023		
Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	0.01 (0.05)	0.01
Cyanide as Cn	mg/l	<0.1	<0.1	<0.1	<0.1	0.05	0.07
Ammonical Nitrogen as NH_3-N	mg/l	<0.07	<0.07	<0.07	<0.07	-	-
Zinc as Zn	mg/l	<0.01	<0.01	<0.01	<0.01	5 (15)	-
Chromium as Cr^{+6}	mg/l	<0.1	<0.1	<0.1	<0.1	0.05	0.05
Sodium as Na	mg/l	31.2	28.4	25.9	43.26	-	-
Potassium as K	mg/l	1.54	1.02	1.83	2.73	-	-
Electrical Conductivity @ °C		1.36	1.30	1.26	1.13	-	-
Total Alkalinity as $CaCO_3$	mg/l	78	74	-	56	200 (600)	-
Aluminum as Al	mg/l	<0.01	<0.01	<0.01	<0.01	0.03 (0.2)	-
Boron as B	mg/l	<0.01	<0.01	<0.01	<0.01	0.5 (1.0)	0.5
Barium as Ba	mg/l	<0.01	<0.01	<0.01	<0.01	0.7	1.3
Vanadium as V	mg/l	<0.01	<0.01	<0.01	<0.01	-	-
Coliform	MPN/100ml	<2	<2	<2	<2	-	-
E-Coli	MPN/100ml	<2	<2	<2	<2	-	0

Source EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC, IS 10500 : 2012 Indian Standard DRINKING WATER — SPECIFICATION / Guidelines for Drinking-water Quality, (WHO)

Table 5.7.3 Seawater Survey Results and Applicable Water Quality Standards in India

Item	Unit	Off the coast of Navy Nagar, Line 11 Corridor 2				Acceptable Limits (Permissible Limit) (IS 10500:2012)	Japan
		07/04/2023	16/05/2023	14/06/2023	24/07/2023		
Turbidity,	N.T.U	12	11.4	9.4	41.2	-	-
Temperature	^{o}C	26.2	26.5	26.3	26.6	45 ^{o}C at the point of discharge	-
Salinity	PPT	<1	<1	<1	<1	-	-
pH at 25^{o}C		7.68	7.59	7.64	7.51	5.5-9.0	7.0 – 8.3
Phosphorus	mg/l	2.71	2.32	2.06	1.97	-	0.09
Total Nitrogen	mg/l	36.4	32.2	29.4	23.1	-	1.0
Phosphate	mg/l	2.48	2.32	2.06	1.97	-	-
Total Hardness as $CaCO_3$,	mg/l	236	218	212	194	-	-
Chloride as Cl	mg/l	324.90	304.91	153.95	146.95	-	-
Total Iron as Fe	mg/l	1.84	1.48	1.36	1.18	-	-
Total Suspended Solids	mg/l	29900	31800	29800	26780	-	-
Total Dissolved Solids	mg/l	18	14	12	16	-	-
Chemical Oxygen Demand (COD)	mg/l	**274.10**	248.60	235.85	188.04	250	8
Bio Chemical Oxygen Demand (BOD)	mg/l	73	66	63	50	100	-
Oil and Grease	mg/l	<2	<2	<2	<2	20	-
Calcium as Ca	mg/l	52.90	49.69	44.88	41.68	-	-
Magnesium as Mg	mg/l	25.27	22.84	24.3	21.87	-	-
Sulphates as SO_4	mg/l	117.12	112.88	102.74	93.33	-	-
Nitrates as NO_3	mg/l	3.14	2.83	2.44	2.26	-	-
Nitrite as NO_2^-	mg/l	<0.1	<0.1	<0.1	<0.1	-	-
Fluorides as F	mg/l	<0.01	0.92	0.84	0.77	15	-
Sulfide as H_2S	mg/l	<0.01	0.92	0.84	0.77	5.0	-
Residual Free Chlorine	mg/l	<0.22	<0.22	<0.22	<0.22	1.0	-
Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	1.0	-
Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	3.0	-
Total Chromium	mg/l	<0.01	<0.01	<0.01	<0.01	-	-
Manganese as Mn	mg/l	<0.01	<0.01	<0.01	<0.01	-	-
Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	5.0	-
Phenolic Compound as C_6H_5OH	mg/l	<0.001	<0.0001	<0.001	<0.001	5.0	-
Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	0.01	-
Cadmium as Cd	mg/l	<0.003	<0.003	<0.003	<0.01	2.0	-

Item	Unit	Off the coast of Navy Nagar, Line 11 Corridor 2				Acceptable Limits (Permissible Limit) (IS 10500:2012)	Japan
		07/04/2023	16/05/2023	14/06/2023	24/07/2023		
Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01	0.05	-
Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	0.2	-
Cyanide as Cn	mg/l	<0.1	<0.1	<0.1	<0.1	0.2	-
Ammonical Nitrogen as NH_3-N	mg/l	2.38	2.1	1.96	2.24	50	-
Zinc as Zn	mg/l	0.06	0.04	0.04	0.04	15	0.02
Chromium as Cr^{+6}	mg/l	<0.1	<0.1	<0.1	<0.1	-	-
Sodium as Na	mg/l	32.8	31.4	28.3	24.6	-	-
Potassium as K	mg/l	11.3	9.3	8.1	5.9	-	-
Electrical Conductivity @ °C		46	48.9	45.8	41.2	-	-
Total Alkalinity as $CaCO_3$	mg/l	178	163	148	136	-	-
Aluminum as Al	mg/l	<0.01	<0.01	<0.01	<0.01	-	-
Boron as B	mg/l	<0.01	<0.01	<0.01	<0.01	-	-
Barium as Ba	mg/l	<0.01	<0.01	<0.01	<0.01	-	-
Vanadium as V	mg/l	<0.01	<0.01	<0.01	<0.01	-	-
Coliform	MPN/100ml	<2	<2	<2	<2	500	-
E-Coli	MPN/100ml	<2	<2	<2	<2	-	-

Source: EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC, THE ENVIRONMENT (PROTECTION) RULES, 1986, MoEF, Environmental standards for the conservation of the living environment (marine areas), MoE Japan

5.7.1.3 Waste

(1) Survey

1) Municipal Solid Waste

Currently, approximately 6,500 to 8,000 tons of waste are generated daily in Mumbai, and the majority is transported and treated at the Kanjurmarg and Deonar landfill sites[61].

2) Wastewater

There are currently seven sewage treatment plants in operation in Worli, Dharavi, Ghatkopar, Bhandup, Bandra, Versova, and Malad, with a total treatment capacity of approximately 1,886 million liters per day. However, due to aging and breakdowns, the actual treatment capacity is about 1,000 million liters per day, which is slightly more than 50% of the planned capacity. Therefore, the Brihanmumbai Municipal Corporation (BMC) plans to increase treatment capacity by an additional 2,500 million liters per day by 2026. Once these new facilities become operational, it is expected that almost all of the city's wastewater (approximately 3,500 million liters per day) will be treatable.

3) Muck Disposal

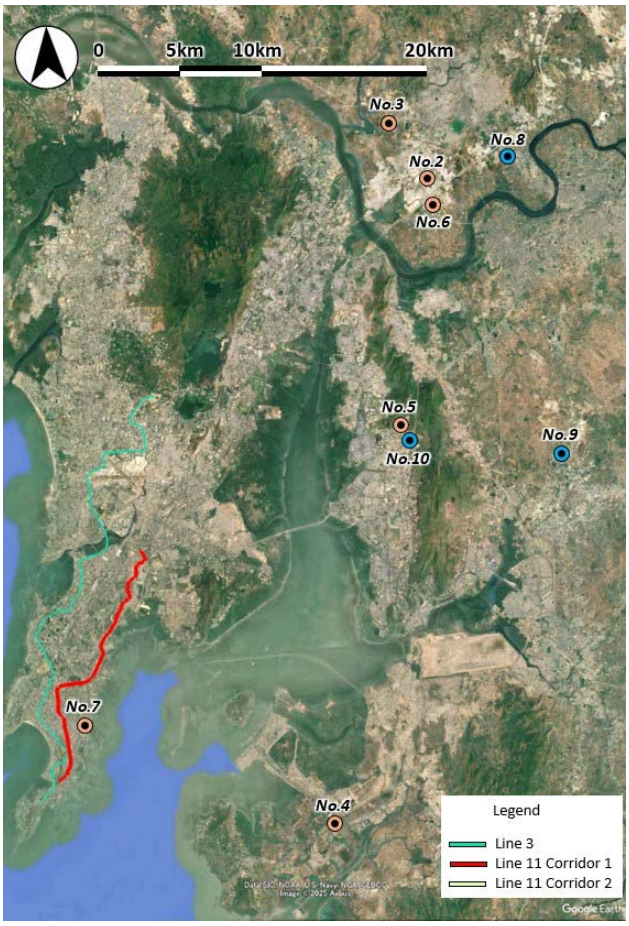
In the construction of Mumbai Metro Line 3, the disposal sites listed in the table below were utilized. When the capacity of a given site was reached, alternative sites were selected and used for waste management. It is expected that a similar approach will be adopted during the construction of Line 11. However, since many of the disposal sites are located at a distance of approximately 40–50 km from the Line 11 project area, the transportation and handling costs are anticipated to be relatively high. At present, the following two locations are identified as candidate disposal sites capable of accepting waste.

Table 5.7.4 List of Muck Disposal Sites (Used / In Use / Available)

No.	Muck Disposal Site Location	Current Status
1	Ambernath Industrial Area	Closed
2	Village Dapode, Tal-Bhivandi, Dist-Thane	Closed
3	Village Kalwar, Tal- Bhivandi, Dist-Thane	Closed
4	Navi Mumbai SEZ, Dronagiri, P-A2, Tal Panvel	Closed
5	MIDC- Mahape, Navi Mumbai	Closed
6	Village Mankoli, Tal- Bhivandi, Dist-Thane	Closed
7	MbPT	Closed
8	Village Ranjnoli, Tal-Bhivandi, Dist-Thane	**Active**
9	Mumbai Waste Management Limited, Plot No. P-32, MIDC, Taloja, Tal: Panvel, Dist: Raigad	**Acceptable**
10	Trans Thane Waste Management Association P-128, Shil-Mahape Road, Next to L&T Infotech Ltd. Mahape, Navi Mumbai	**Acceptable**

Source: : JST, MMRC

[61] https://timesofindia.indiatimes.com/city/mumbai/bmc-expects-687-crore-from-user-fees-for-waste-collection/articleshow/117959599.cms?utm_source=chatgpt.com



Source: : Prepared by the JST based on MMRC and Google Earth

Figure 5.7.1 Location Map of Muck Disposal Sites (Used / In Use / Available)

Table 5.7.5 Details of Available Hazardous Waste Disposal Sites

Name	No.9 M/s. Mumbai Waste Management Limited, Taloja, Navi Mumbai	No.10 M/s. Trans Thane Waste Management Association, Mahape, Navi Mumbai
Address	M/s. Mumbai Waste Management Limited, Plot No. P-32, MIDC, Taloja, Tal: Panvel, Dist: Raigad	M/s. Trans Thane Waste Management Association P-128, Shil-Mahape Road, Next to L&T Infotech Ltd. Mahape, Navi Mumbai-400105
Area allocation as per revised order dated 11.12.2008	A] Mumbai and Suburban Mumbai, Districts, Panvel, Khalapur & Uran Talukas of Raigad Districts and Thane District excluding Thane-Belapur Industrial Area. B] Alibaug, Karjat, Mahad, Mangaon, Mhasala, Poladpur, Pen Shriwardhan, Sudhagad, Talukas of Raigad District. Sindhudurg, & Ratnagiri District.	Thane- Belapur Industrial Area, Dist- Thane. The incinerable waste from this area is sent to CHWTSDF at Taloja, dist: Raigad.
Area of Facility	40 ha	7 ha
Notification	10.09.2001	24.03.1999
Land lease agreement	24.02.2002	09.05.2000
Consent to Establish issued on	02.01.2002	02.01.2002
Consent to Operate issued details	Valid up to 28/02/2025 for Secured Landfill : 120,000 t/year Incineration : 30,000 t/year	valid up to 30/09/2023 for Secured landfill.
Life of Facility	20 Years- Service 30 Years- Post Monitoring and maintenance	5.0 Year – Service 30 Years- Post Monitoring & Maintenance

Name	No.9 M/s. Mumbai Waste Management Limited, Taloja, Navi Mumbai	No.10 M/s. Trans Thane Waste Management Association, Mahape, Navi Mumbai
Capacity of the Facility	SLF- 120,000 t/year	SLF- 10,000 t/year
	1. INC – 1. 5 TPH. 2. INC- 1.5 TPH	No Facility (Incinerable HW sent to Taloja)
Cost of disposal per tons of waste per MT	DLF -Rs. 2056 LAT -Rs. 3500 to 3700 INC- Rs 31000	DLF -Rs. 1200 LAT -Rs. 2500
HW Received at Facility till 31/03/2021	DLF: 681,119 t LAT: 1,354,129 t INC: 357,687 t Total: 2,393,007 t	DLF: 471,123 t LAT: 84,445 t Total: 555,568 t

Note: SLF=Sanitary Landfill Facility, TPH= Tons per Hour, HW=Hazardous Waste, INC=Incineration, DLF= Designated Landfill、LAT＝Land Treatment

Source: JST

(2) Prediction

As shown in the table below, a total of 432,000 m³ of excavated soil is expected to be generated from the underground station construction sites, TBM operation and other related facilities. Assuming a bulk density of cohesive soil at 1.8 t/m³, this corresponds to approximately 777,600 tons. As described in Chapter 10: Project Implementation Plan, the construction period for civil works is scheduled for 68 months, which means that an annual average of approximately 137,000 tons of excavated soil will be generated. This slightly exceeds the annual intake capacity of the two facilities mentioned above, which is 130,000 t. Therefore, in order to reduce the volume transported to disposal sites, the reuse and recycling of excavated soil is an essential requirement. For reference, the Mumbai Metro Line 3 Project, which generated 8,044,098 m³ of excavated soil—about 18.6 times that of the present Project (based on MMRCL's data up to September 2021)—implemented the following reuse measures in addition to disposal at designated sites. Therefore, for this Project as well, it is necessary to explore—to the maximum extent possible, the potential reuse of excavated soil in coordination with other ongoing road and port development projects, and such reuse should be considered as one of the viable options. In the event that the excavated soil is actually utilized as embankment material, the contractor shall prepare and submit the required documentation, including an Environmental Management Plan (EMP) with provisions for soil testing and analysis, to the Maharashtra Coastal Zone Management Authority and/or the State Environment Impact Assessment Authority. The proposed reuse shall only proceed following the completion of the official review and approval process.

- Utilization as reclamation material for Terminal 4 of Jawaharlal Nehru Port Trust (JNPT);
- Use as road sub-base material;
- Use as railway ballast;
- Recycling as construction materials[62]

The excavated soil to be generated from the Line 11 Project is comparatively of good quality and, similar to the case where Mumbai Port Authority (MbPA) accepted excavated soil from the Line 3 Project, it is deemed suitable for reuse in multiple applications. MbPA is planning the redevelopment of

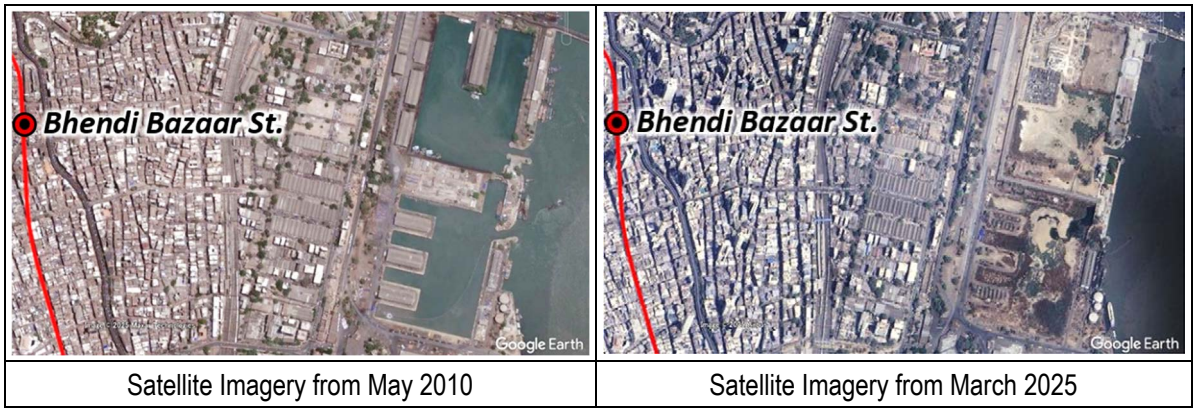
[62] MUMBAI METRO LINE 3 (Colaba-Bandra-SEEPZ) Part-I: Updated Environmental Impact Assessment, February, 2020, MMRC

approximately 250 ha of waterfront areas, and considering the projected annual sea-level rise of 4.5 mm forecasted by the World Meteorological Organization, excavated soil can be effectively used as embankment material for such redevelopment. This approach is consistent with the priority measures set out in the Mumbai Climate Action Plan (MCAP, 2022) for waste management, which emphasize "decentralized treatment" and "prioritization of segregation and reuse."

Table 5.7.6 Estimated Volume of Excavated Soil Generated by Mumbai Metro Line 11 Project

Corridor 2			
Navy Nagar Cut and Cover		**Stabling lines(Cut and Cover)**	
Navy Nagar	109,710	Cut and Cover	140,760
Entrance/Ventilation Etc	10,971		
Tunnel NATM (Single-Track Twin Tubes)		**Stabling lines(NATM:DoubleTrackTwin)**	
Single track section	14,328	NATM	76,906
Tunnel NATM (Double-Track Single Tube)		**Stabling lines(Cut and Cover)**	
Double track section	79,169	**Total (m^3)**	**432,000**

Source: : JST



Satellite Imagery from May 2010 | Satellite Imagery from March 2025

Source: : Prepared by the JST based on Google Earth

Figure 5.7.2 Status of Excavated Soil Acceptance by MbPA

5.7.1.4 Soil Contamination

(1) Survey

Soil sampling was conducted along Corridor 2 between April and June 2023. The results are summarized below. In India, soil environmental standards are stipulated under the Environment Protection (Management of Contaminated Sites) Rules, 2025, and a comparison was made with the Response Levels (RLs) specified for each parameter. The concentrations of heavy metals were found to be below the standard or below the detection limit at all sites except for boron, indicating that environmental risks are limited. Elevated boron levels are presumed to be attributable to industrial or waste-related sources; however, geological factors and influences from coastal or marine environments are also considered possible contributing causes.

Table 5.7.7 Survey Results for Corridor 2

Item	Unit	Backbay Bus Depot	Navy Nagar St.	Response Level (RL) [mg/kg]
pH	-	7.34 - 7.41	7.24 - 7.62	6 - 8
Texture	-	Silt loam	Silt loam	-
Electrical Conductivity	mS/cm	0.562 – 0.612	0.523 – 0.578	-
Total Organic Matter	%	1.54 - 1.68	1.39 - 1.43	-
Porosity	%	19.6 - 23.7	21.4 - 26.2	-
Nitrogen as N	kg/ha	224.7 - 236.2	221.3 - 242.3	-
Potassium as K	mg/kg	403 - 412	323.8 - 374.9	-
Sodium as Na	mg/kg	301- 311	261.5 - 283.7	-
Calcium as Ca	mg/kg	2612 - 2835	2458 - 2612.7	-
Magnesium as Mg	mg/kg	ND	ND	-
Water holding capacity	%	24.3 - 26.7	24.2 - 28.6	-
Permeability	%	2.1 - 2.6	2.2 - 2.8	-
Organic Carbon	%	0.88 - 0.91	0.84 - 0.92	-
Total Phosphate (P_2O_5)		201.4 - 211.4	194.8 - 204.8	-
Chloride as Cl	mg/kg	0.14 - 0.27	0.17 - 0.31	-
Sulphate	mg/kg	4.1 - 4.3	3.29 - 3.64	-
Sulphur	mg/kg	17.4 - 19.8	17.3 - 19.4	500
Copper	mg/kg	24.8 - 28.6	25.4 - 26.8	190
Nickel	mg/kg	3.4 - 5.3	3.2 - 4.1	100
Zinc	mg/kg	51.6 - 54.8	43.9 - 45.7	720
Boron	mg/kg	23.8 - 27.2	22.8 - 26.4	2
Molybdenum	mg/kg	ND	ND	190
Lead	mg/kg	6.4 - 7.8	6.43 - 7.43	600
Mercury	mg/kg	ND	ND	50
Arsenic	mg/kg	ND	ND	76
Iron	mg/kg	101.5 - 109.5	103.7 - 112.4	-
Bicarbonate	%	9.3 - 10.3	9.1 - 9.8	-
Orthophosphate	mg/kg	7.4 - 8.4	7.2 - 7.8	-
Carbonate	%	8.74 – 9.32	8.64 – 9.29	-

Source: EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC, JST, Soil Protection Act, Dutch, Notification of Soil Quality Standard (NEQA), Thailand

(2) Prediction

As described in the section on Waste, a total of 432,000 m³ of excavated soil is expected to be generated from the underground station construction sites, TBM operation and other facilities, most of which can be utilized as embankment material for MbPA's waterfront redevelopment plan. Although no large-scale pollution-emitting facilities are present and the values are also below the standard, if excavated soil is found to be severely contaminated, it is necessary to conduct periodic soil sampling and analysis to prevent the spread of contamination. As major soil contamination countermeasures other than sampling, during the construction stage, regular maintenance and replacement of heavy equipment parts and prevention of oil leakage should be implemented.

5.7.1.5 Noise

(1) Survey

Noise measurements were conducted for Corridor 2 between April and June 2023. The day–night average noise levels are presented below and compared against the domestic standards for commercial areas. The rationale for applying the commercial area standard is that all monitoring locations are situated along arterial or general roads which are highly likely to be designated as commercial areas. Environmental noise was measured over a 24-hour period using a digital sound level meter. The results are as follows: at all locations in Corridor 2, the noise standards were exceeded. The primary sources of noise were identified as road traffic, commercial facilities, and crowd-related activities along the project corridor. The noise standards in India are stipulated in EPA-1986, Noise Pollution (Regulation and Control) Rules, 2000, PCLS/02/1992, IVth Edition. In addition, the most sensitive receptors potentially affected by noise and vibration from the project are shown in the table below.

Table 5.7.8 Noise Standards Applicable in India

Category of Area/Zone	Day Time	Night Time	Regulation
I. Industrial Area	75 dB	70 dB	EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition.
II. Commercial Area	65 dB	55 dB	
III. Residential Area	55 dB	45 dB	
IV. Silence Area	50 dB	40 dB	
Industrial Area/ Commercial Area	70 dB	70 dB	Environmental, Health, and Safety Guidelines, IFC
Residential Area	55 dB	45 dB	

Source: EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition./ Environmental, Health, and Safety Guidelines, IFC

Table 5.7.9 Survey Results

Location name & Land mark		Day time (AM 6:00 – PM 10:00)				Night time (PM 10:00- AM 6:00)			
		Lmax	Lmin	Leq	Standard	Lmax	Lmin	Leq	Standard
Corridor 2									
1	Backbay Bus Depot	-	-	**74.49**	65	-	-	**70.37**	55
2	Sainik Aramgrah	-	-	**73.44**		-	-	**64.25**	
3	Navy Nagar	-	-	**75.39**		-	-	**70.73**	
4	TIFR Entry Gate	-	-	**74.45**		-	-	**67.38**	

Source: EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC

(2) Prediction

1) Construction Phase

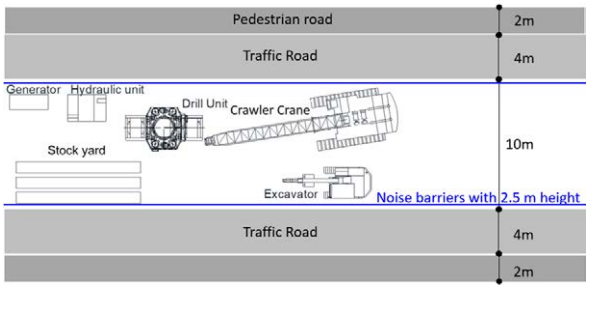
In subway construction, the noisiest construction activity is the installation of steel sheet piles and diaphragm walls using a vibratory hammer (vibratory pile driver), and this activity is therefore the primary subject of noise level prediction. As a mitigation measure, the use of hydraulic vibratory hammers is considered. The major construction equipment typically used includes vibratory hammers, crawler cranes, and generators. The noise output levels for this equipment are shown in the table below. As the planned Navy Nagar Station will be constructed on a local road, an example layout of heavy machinery within the construction yard is presented below, and noise levels at the

roadside are predicted. Since there are no official construction noise standards in India, the standards set by the Tokyo Metropolitan Government have been referenced. Navy Nagar (75.39 dB on a public road) is also cited as a representative location.

Table 5.7.10 Regulatory Standards for Noise from Designated Construction Work

Construction Work Type	Tokyo Metropolitan Government Standard
Piling Work	80 dB

Source: :Tokyo Metropolitan Environmental Security Ordinance, Tokyo Metropolitan Government





Example of Equipment Arrangement and Construction Conditions on Local Roads (Mumbai Metro Line 3)

Source: : JST

Figure 5.7.3 Typical Layout of Construction Yard for Piling Works

Table 5.7.11 Noise Emissions from Major Equipment Used in Piling Works

	Construction Equipment	Noise Level (dB) (Measured at 1 meter from the side of the equipment)
1	Backhoe (0.7m^3)	105
2	Crawler Crane (70 ton)	101
3	Hydraulic Pile Driver	96
4	Generator (200kVA)	92

Source: :
- Report on the Study and Testing of the Prevention and Elimination of Construction Noise and Vibration, 1979, Public Works Research Institute, Ministry of Construction, Japan
- Research on Methods of Prediction and Assessing Noise and Vibration Induced by Construction Works (Report No.1), 1981, Public Works Research Institute, Ministry of Construction, Japan
- ASJ Prediction Model 2007 for Construction Noise, 2007, Acoustical Society of Japan
- Noise and Vibration Countermeasure Handbook for Construction, 2009, Japan Construction Machinery and Construction Association

a) Prediction Procedure

The noise level assessment during construction should be considered with the sound level generated by each construction machine located at a different position from the public-private boundary, and the Noise attenuation formula (1) should be used in this assessment. After the calculation, the attenuated noise level of each construction machine should be combined following the formula (2).

$$L_p = L_{p0} - 20log_{10}\left(\frac{r_0}{r}\right) \quad \text{-------- (1)}$$

Where

L_{p0} : Noise power level at a distance r_0 from the origin

L_p : Noise power level at a distance r from the origin

r_0, r : Distance from the origin at a sound level L_{p0} and L_p $(r_0 = 1m)$

$$L_{CN} = 10 \times \log_{10}\left(\sum_{i=1}^{n} 10^{(\frac{Lpi}{10})}\right) \text{ -------- (2)}$$

Where

L_{CN} : Combined Noise level

L_{pi} : Noise power level at distance r from the origin of each construction machine

n : Number of Construction machine

b) Prediction Results

As a result of the prediction, the maximum construction noise levels at a height of 1.5 meters along the local road were calculated to be 74.2 dB. In parallel, the actual measured noise level at the road boundary at representative locations were recorded as 75.39 dB for local roadway. Accordingly, the projected noise level is estimated at 77.9 dB as shown in the table below. The predicted value remains below the regulatory limits prescribed by the Tokyo Metropolitan Environmental Ordinance.

Table 5.7.12 Noise Prediction Results

Construction Location	Measured Value (Maximum)	Predicted Value	Combined Value	Tokyo Metropolitan Regulation Standard
Local Roadway	75.39 dB	74.2 dB	77.9 dB	80 dB

Source: :JST, Tokyo Metropolitan Environmental Security Ordinance, Tokyo Metropolitan Government

2) Operation Phase

In Indian cities, road traffic noise is generally dominant, and therefore noise issues related to underground metro sections are rarely observed. Furthermore, no internationally established noise prediction models exist for underground sections.

3) Noise-Sensitive Receptors Requiring Special Consideration

Based on the above survey and prediction results, the noise standards during construction are expected to be met; however, as the baseline noise levels are high, potential impacts are anticipated. Therefore, at each stage, the following required mitigation measures should be implemented.

a) Construction Phase

- Install appropriate noise suppression devices such as mufflers on heavy machinery and other construction equipment as necessary to ensure noise levels remain within acceptable limits.
- To avoid noise impacts on adjacent residential, commercial, and other sensitive areas, construction activities generating high noise levels should be limited to daytime hours (08:00–20:00). Near educational facilities, nighttime construction should be considered to avoid interfering with school classes.
- Erect 2.5-meter-high fencing around construction sites.
- Employ low-noise types of construction equipment for activities such as piling.

b) Operation Phase

Not applicable.

5.7.1.6 Vibration

(1) Survey

Vibration measurements were conducted along Corridor 2 in June 2023. The results are presented below. For Corridor 2, the values shown represent the upper limits of the 80% range of all data at each measurement location, and in all cases the results were below the standard values stipulated under Japan's Vibration Regulation Law.

Table 5.7.13 Survey Results for Corridor 1

Location name	V dB			Japan (dB)	
	Maximum	L_{10}	Minimum	Day	Night
Backbay Bus Depot	85.6	**80.1**	68.1	A: 70 B: 65	A: 65 B: 60
Sainik Aramgrah	80.1	**76.3**	68.1		
Navy Nagar	80.1	**76.3**	68.1		
TIFR Entry Gate	77.6	**74.6**	68.1		

Source: EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC, JST, Vibration Regulation Law (Law No. 64 of June 10, 1976), Japan

(2) Prediction

1) Construction Phase

a) Construction Work of Underground Station Buildings

In subway construction, the construction activity that generates the highest level of vibration is the installation of steel sheet piles and diaphragm walls using a vibratory hammer (vibration-type piling machine), which is also the primary source of construction noise. Therefore, this activity has been selected as the subject for vibration level prediction. As a mitigation measure, the use of hydraulic vibratory hammers—similar to the noise control measures—is proposed. The primary construction machinery typically includes vibratory hammers, crawler cranes, and generators. Their vibration levels are presented in the table below. For the vibration level prediction, the machinery layout within the construction yards on local roads is assumed to be the same as in the noise prediction analysis. The vibration levels are estimated at the roadside boundary. However, as vibration standards for the construction stage have not been established in India, the reference values stipulated by the Tokyo Metropolitan Government were applied. Backbay Bus Depot (80.1 dB on a local road), where the vibration results were the highest, is also cited as a representative location.

Table 5.7.14 Vibration Emissions from Major Equipment Used in Piling Works

	Construction Equipment	Noise Level (dB) (Measured at 1 meter from the side of the equipment)
1	Backhoe (0.7m^3)	63
2	Crawler Crane (70 ton)	40
3	Hydraulic Pile Driver	55
4	Generator (200kVA)	62

Source: :
- Report on the Study and Testing of the Prevention and Elimination of Construction Noise and Vibration, 1979, Public Works Research Institute, Ministry of Construction, Japan
- Research on Methods of Prediction and Assessing Noise and Vibration Induced by Construction Works (Report No.1), 1981, Public Works Research Institute, Ministry of Construction, Japan
- ASJ Prediction Model 2007 for Construction Noise, 2007, Acoustical Society of Japan
- Noise and Vibration Countermeasure Handbook for Construction, 2009, Japan Construction Machinery and Construction Association

i) Prediction Procedure

The vibration level assessment during construction should be considered the same as the case of noise with the level generated by each construction machine located at a different position from the public-private boundary, and the vibration attenuation formula (1) should be used in this assessment. After the calculation, the attenuated vibration level of each construction machine should be combined following the formula (2).

$$VL = VL_0 + 15log_{10}\left(\frac{r_0}{r}\right)^n + 8.68(r_0 - r)\alpha \quad \text{-------- (1)}$$

Where

VL : Vibration level at a distance r from the origin

VL_0 : Vibration level at a distance r_0 from the origin

r_0, r : Distance from the origin at a vibration level VL_0 and VL $(r_0 = 7m)$

n : Geometric attenuation Surface wave: n = 0.5

α : Ground attenuation Clay layer: α = 0.02

$$L_{CV} = 10 \times \log_{10}\left(\sum_{i=1}^{n} 10^{(\frac{VLi}{10})}\right) \quad \text{-------- (2)}$$

Where

L_{CV} : Combined Vibration level

VLi : Vibration level at distance r from the origin of each construction machine

n : Number of Construction machine

ii) Prediction Results

As a result of the prediction, the vibration level during construction was calculated as 62.39 dB along local roads. Field measurement of vibration level was 80.1 dB at Backbay Bus Depot (local road). Accordingly, the predicted value, as shown in the table below, is 80.17 dB at Backbay Bus Depot (local road). Although the vibration levels during construction, when combined with road traffic vibrations, exceed the regulatory standards of the Tokyo Metropolitan Government, the incremental increase attributable to construction is only 0.07 dB. Therefore, the impact is

considered to be almost entirely due to road traffic vibrations, and the effect of construction itself can be regarded as negligible.

Table 5.7.15 Predicted Vibration Levels (Underground Station Construction)

Construction Location	Measured Value (Maximum)	Predicted Value	Combined Value	Tokyo Metropolitan Regulation Standard
Local Roadway	80.1 dB	62.39 dB	80.17 dB	70 dB

Source: Survey Team; Tokyo Metropolitan Environmental Preservation Ordinance, Tokyo

b) TBM Operation

In the inter-station sections, vibrations generated during the passage of the TBM at a depth of approximately 25 m are estimated to fall within the range of 55–60 dB. As previously noted, the average TBM passing depth in this Project is 22 m; therefore, based on the vibration attenuation formula (1) presented on the preceding page, vibrations equivalent to approximately seismic intensity 1 (61 dB) are predicted. Furthermore, according to the composite vibration level formula (2) shown on the preceding page, the vibration level incorporating the road traffic vibration values from the above table is calculated as 80.15 dB, which also exceed the regulatory standards of the Tokyo Metropolitan Government, the incremental increase attributable to construction is only 0.05 dB. Therefore, the impact is considered to be almost entirely due to road traffic vibrations, and the effect of construction itself can be regarded as negligible. However, in the event that complaints are raised by residents along the alignment, the following countermeasures may be considered:

1. Vibration monitoring shall be conducted during TBM excavation, and excavation work in this section shall be limited to daytime hours (7:00–20:00), with nighttime operations suspended.
2. In the event of complaints from residents, the TBM's thrust pressure and vibration levels shall be reduced during excavation.
3. The length of the section where vibration may affect a single residential building is approximately 40 meters. Considering that daytime-only excavation allows for a daily advance of more than 5 meters, the duration of excavation for this section is estimated at approximately 8 days. Accordingly, excavation shall proceed after explaining to residents that the vibration will be temporary and obtaining their understanding[63].

Table 5.7.16 Predicted Vibration Levels (TBM Operation)

Construction Location	Measured Value (Maximum)	Predicted Value	Combined Value	Tokyo Metropolitan Regulation Standard
Local Roadway	80.1 dB	61 dB	80.15 dB	70 dB

Source: Survey Team; Tokyo Metropolitan Environmental Preservation Ordinance, Tokyo

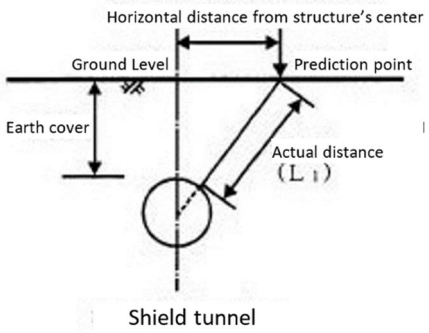
2) Operation Phase

As a vibration prediction method for underground sections of single-shield tunnels, the following prediction formula developed by Tokyo Metro Co., Ltd. (formerly Teito Rapid Transit Authority) is

[63] CHARACTERISTICS OF GROUND VIBRATION AND NOISE FROM HARD ROCK TBM, Journal of the Japan Society of Civil Engineers, No.623/VI-43, 57-67, 1999.6

commonly used.

$$VL = K - A \times \log L + 25 \times \log(V/50) - 24 \times \log(W/20) + X$$



Where

VL : Vertical vibration predicted level at a surface point of the earth (dB)
L : Actual distance from outside of the tunnel to a prediction point (m)
V : Velocity (V=80 km/h)
W : Tunnel weight (17 tf/m)
K : Constant value for classified structure (K = 68dB)
A : Weighting factor of distance (Diluvium = 14)
X : Other weighting factor X = X1 + X2
X1 : Linear Correction (Straight section = 0)
X2 : Correction for reduction weight of rolling stock (All section = -5)

As a result of the prediction, the ground surface vibration level generated by the operation of the Mumbai Metro was found to be approximately 55 dB at a representative location along the local roads in the sections where train speed is at its maximum. On the other hand, based on the survey result, the road traffic vibration level at the representative location was as shown in the table below. A comparison with Japanese regulatory standards shows that the combined vibration level exceeds the standards; however, the incremental increase attributable to the operation of the Mumbai Metro is only 0.01 dB. Therefore, the impact is almost entirely due to road traffic vibrations, and the effect of train operation itself can be regarded as negligible.

Table 5.7.17 Predicted Vibration Levels (During Operation)

Construction Location	Measured Value (Maximum)	Predicted Value	Combined Value	Regulatory Standards in Japan
Local Roadway	80.1 dB	55.3 dB	80.11 dB	Day time: 70 dB Night time: 65 dB (Commercial Area)

Source: JST; Vibration Regulation Law (Law No. 64 of June 10, 1976), Japan

3) Vibration-Sensitive Receptors and Buildings Requiring Special Consideration

Based on the above survey and prediction results, no significant vibration impacts are anticipated during either the construction or operation stages. However, in addition to regular monitoring, the implementation of the following mitigation measures should be considered.

a) During Construction

- To ensure that vibrations from heavy equipment and other construction machinery remain within permissible limits, vibration control devices shall be installed as necessary.
- To avoid vibration impacts on adjacent residential and commercial areas, as well as other sensitive locations, construction activities generating significant vibrations shall be limited to daytime hours (08:00–20:00). In the vicinity of educational facilities, nighttime implementation may also be considered so as not to disturb classes.
- Restrictions on daytime and nighttime operation of heavy vehicles, including speed limits and rerouting of traffic, shall be applied in accordance to the rules, regulation and permission of State Trasport Department.
- Vibration-absorbing mats shall be installed along the running lanes of heavy equipment and large vehicles.
- Low-vibration type machinery, such as pile drivers, shall be employed.
- In the event that cracks should occur, MMRC will determine whether compensation is to be provided through consultations with the building owners.

b) During Operation

- Adoption of Elastic Rail Pads and Anti-Vibration Sleepers

5.7.1.7 Land Subsidence

For the construction of two underground tunnels with a diameter of 6 meters each, Tunnel Boring Machines (TBMs) are planned to be employed. In large-scale excavation works such as tunnel and underground station construction, there is a possibility that significant voids may form within the geological strata, potentially leading to ground settlement in the upper layers. However, according to the results of the Standard Penetration Test (SPT) from the existing geotechnical surveys, the area along the Mumbai Metro alignment does not correspond to soft ground conditions. Furthermore, the Detailed Project Report (DPR) indicates that ground subsidence due to groundwater drawdown in underground sections is not anticipated. Taking into account the local geology, abundant groundwater, and advanced construction technologies, the possibility of settlement is considered to be very low. Nevertheless, as the potential for ground settlement cannot be completely ruled out, appropriate monitoring and mitigation measures are deemed necessary.

5.7.1.8 Offensive Odour

Sources of offensive odours are generally associated with the generation of waste and garbage. During the construction phase, construction yards and surrounding work areas are expected to be the primary sources of odor. In the operational phase, the main sources will be the depot and individual stations. The extent of the impact depends not only on the waste collection systems in place but also on the methods of storage at each point of generation.

5.7.2 Natural Environment

5.7.2.1 Regulated Areas (Coastal Regulation Zone: CRZ)

As shown in the figure below, a portion of Corridor 2 passes through CRZ Category II areas. Category II (already developed urban areas) is defined as "areas that fall within the legally designated limits of a town or municipality and where development has already extended up to the shoreline," and it is explicitly stated that construction is permitted. In particular, construction is permitted only on the landward side of existing roads or authorized structures, under which this Project is considered to fall. This Project is classified as an infrastructure project and constitutes a permitted activity. Categories II are not areas designated by national or local governments under laws or ordinances with the primary objective of nature conservation, but rather zones designated with the primary objective of promoting sustainable development. Accordingly, they do not fall under the category of protected areas as defined in the JICA Guidelines. However, from the perspective of development control and regulation of unplanned development, MMRCL is required to submit a Simplified Environmental Management Plan (EMP), including provisions for the handling of excavated soil and construction debris, mitigation measures for impacts on groundwater and surface water, and noise and vibration countermeasures, to the Maharashtra Coastal Zone Management Authority (MCZMA) and to the State Environment Impact Assessment Authority (SEIAA), and to obtain approval (CRZ clearance) prior to the commencement of any construction or development activities. Provided that the submission documents are complete and the review process proceeds smoothly, the clearance is expected to be granted within approximately three to four months from the date of application. In terms of the timeline for obtaining approval, it is necessary to consider that preparation of the CRZ map and project layout plan, based on the finalized project land during the detailed design stage, will require approximately 1 to 1.5 months, followed by an additional 3 to 6 months for review and approval by the competent authorities. Accordingly, the process of obtaining CRZ clearance may take up to 7 to 8 months in total.



Source: Prepared by the JST based on the National Centre for Sustainable Coastal Management

Figure 5.7.4 Coastal Regulation Zones (CRZ) along the Mumbai Metro Line 11 Corridor

5.7.2.2 Biodiversity

(1) Survey

1) Along Corridor 2

Ecological survey was conducted along the alignment of Corridor 2 in May 2023. The survey covered an area of 100 meters on both sides of the selected alignment, and the identified flora and fauna species are shown in the table below. Most of the identified species are not classified as endangered. However, in Corridor 2, one plant species categorized as Vulnerable was identified. It was confirmed, however, that this species was artificially planted and does not constitute a wild species.

Table 5.7.18 Identified Flora and Fauna

No.	Taxonomic Category	Scientific Name	Common Name	IUCN Category
Fauna (tree)				
1	Fabaceae	*Senegalia catechu*	Acacia Catechu	LC
2	Fabaceae	*Dalbergia latifolia*	Sisav	VU
3	Rubiaceae	*Adina cordifolia*	Hed	-
4	Rubiaceae	*Nauclea arvifolia*	Kalamb	-
5	Fabaceae	*Albizia lebbeck (L.) Benth.*	Siras	LC
6	Moraceae	*Ficus religiosa L.*	Pipal	-
7	Fabaceae	*Saraca asoca*	Sita Ashok	VU
8	Fabaceae	*Delonix regia (Hook.) Raf.*	Gulmohar	-
9	Anacardiaceae	*Mangifera indica*	Mango	DD
10	Fabaceae	*Pongamia pinnata (L)*	Karanja	-
Fauna				
Mammal				
1	Rodentia	*Squirrels, rats, and other rodents*		
2	Chiroptera	*Bats and other chiropterans*		
3	Cercopithecidae	*Monkeys and related species*		
Reptiles				
1	*Lizards and related species*			

Note: Vulnerable (VU), Least Concern (LC), Data Deficient (DD)
Source: EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC, IUCN Red list

2) Tree Survey

In the proposed alignment of Corridor 2, the majority of the route passes along local roads, and no passage through forested areas is envisaged. Therefore, large-scale forest clearance will not be required. According to the 2024 survey, 124 trees are designated for felling along Corridor 2. However, the final number of trees to be felled will be officially determined following the detailed tree survey to be conducted in the subsequent stage. With regard to compensatory afforestation, the Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975 (as amended in 2023) stipulates that "a number of trees equivalent to the age of the transplanted tree, of the same species or of other locally endemic/indigenous species, shall be planted, and transplantation shall only be undertaken under the supervision of experts." In accordance with this Act, the project proponent is required to submit documentation to the municipal tree management authority of Mumbai. Based on the age of the trees subject to transplantation or felling, the number of trees to be planted will be determined by the tree officers of the authority. According to MMRC, the following actions are planned: a detailed tree survey will be conducted to finalize the number of affected trees and determine the required number of compensatory plantings based on tree age, after which an application will be submitted to the Tree Authority of the BMC. From the time of application to the issuance of the No Objection Certificate (NOC), approximately three to four months will be required, including on-site inspections by the BMC, public notifications, objection hearings, and deliberations.

(2) Prediction

In association with this Project, tree felling in urban areas and impacts on flora and fauna are anticipated.

Accordingly, the following mitigation measures are proposed. In the case of the Mumbai Metro Line 3 Construction Project, more than 20,000 compensatory plantations were required as part of the environmental compliance conditions. However, as the availability of planting space along the urban corridor was limited, compensatory planting was carried out within the Goregaon area of Sanjay Gandhi National Park and within the jurisdiction of the Brihanmumbai Municipal Corporation (BMC), encompassing both Mumbai City and Mumbai Suburban areas, resulting in the planting of more than 23,000 trees. Similar compensatory plantation measures will be implemented for the present project in accordance with Tree act revised in 2023.

1) Mitigation Measures for Tree Felling and Compensatory Plantation

- Compensatory planting shall prioritize native and vulnerable species (Saraca asoca, Dalbergia latifolia).
- Plantation shall be carried out as far as possible within project areas such as station facilities.
- In compliance with relevant laws, transplantation of mature trees shall be conducted step by step under the supervision of arboriculturist and horticulturist experts and continued with verification of survival rates.

2) Proposed Preventive Measures (Based on Lessons Learned from Line 3 Unfulfilled Commitments)

- To secure the required number of plantations, alternative sites such as public lands, parks, and school premises shall be utilized as much as possible. Green space development shall also be incorporated into surrounding station area plans and along other metro lines in Mumbai. This activity shall form part of the landscaping and beautification plan for each station and will be implemented after completion of the station construction works.
- Establishment of a dedicated structure: A specialized subcontractor independent from the construction JV shall be appointed exclusively for plantation works, with a separately allocated budget.
- Ensuring transparency in monitoring: A compliance report on compensatory plantation, accompanied by photographic documentation, shall be submitted to the BMC Tree Authority on a semi-annual basis.
- Mandatory maintenance: The General Consultant (GC) engaged by MMRC shall conduct regular audits on environmental and tree management activities as part of its routine duties.

5.7.2.3 Hydrology

(1) Entire Mumbai Metro Network

According to the Dynamic Ground Water Resources of Maharashtra, 2024, the total annual groundwater recharge in Mumbai is 14,777,000 m³, while the total annual groundwater extraction from the irrigation, industrial, and domestic sectors amounts to 6,801,400 m³. Therefore, the groundwater extraction rate is 46.0%. Based on the groundwater exploitation classification shown in the table below, Mumbai is categorized as a “Safe” area in terms of groundwater use.

Table 5.7.19 Category of Groundwater Exploitation Rate

Stage of Ground Water Extraction	Category
Less than 70%	Safe
From 70% to 90%	Semi-Critical
From 90% to 100%	Critical
Over 100%	Over Exploited

Source: DYNAMIC GROUND WATER RESOURCES OF MAHARASHTRA, 2024

(2) Underground Sections

Since impacts on the hydrogeological environment are anticipated in the areas surrounding the project site, including the TBM (Tunnel Boring Machine) sections, the following mitigation measures should be implemented:

- Install sheet piles at excavation sites to prevent groundwater inflow.
- Use a closed-type TBM to maintain underground water pressure.
- Monitor groundwater levels using construction wells.

5.7.2.4 Topography and Geology

(1) Topography

According to Section 2.2.3 "Geological Survey" of Chapter 2, the survey team reviewed the topographic and longitudinal drawings collected from MMRCL. The survey was conducted mainly using drones, while in certain sections (from the RBI Monetary Museum to Regal Circle) it was carried out with a total station due to military confidentiality restrictions. The survey area covered a width of 70 m on either side of the track centerline and included the extraction of building and road boundaries as well as elevation measurements on a 10 m grid. In heritage conservation districts, restrictions on surveying imposed certain limitations, leaving some issues with accuracy. In this survey, information on ongoing building, bridge, and underground tunnel projects was also collected and incorporated into the survey drawings. For future detailed design, re-surveys are recommended for sections where surveying restrictions are in place. Moreover, given that numerous development projects are underway along the alignment, the updated drawings should be prepared.

(2) Geology

According to Section 2.2.3 "Geological Survey" of Chapter 2, Mumbai is underlain by basalt formed by volcanic activity approximately 65 million years ago, with the surface covered by reclaimed soil and alluvial deposits. The subsurface is divided into layers of alluvial soil, weathered basalt, and basalt bedrock. While the overall geological condition is stable, localized areas of advanced weathering have been identified. Previous investigations (such as at Orange Gate and the MRT Line 3) confirmed that the ground consists of alluvium down to GL-10 m, weathered rock down to GL-15 m, and stable bedrock at greater depths. Amygdaloidal basalt, though slightly weaker in strength, is evaluated together with basalt on the basis of strength and degree of weathering. In general, ground conditions are considered stable below GL-15 m, with minimal adverse impacts expected for underground tunnel construction.

The uniaxial compressive strength of the bedrock exceeds 50 MN/m², classifying it as "Strong" and confirming that it possesses sufficient strength.

5.7.3 Social Environment

5.7.3.1 Land acquisition/ Resettlement

According to the draft SIA report prepared in July 2024, Corridor-2, which extends from Cuffe Parade Station to Navy Nagar Station, will require land for station buildings, entrance/exit structures, ventilation shafts, and other associated facilities. All land to be acquired falls under government ownership, with the total area required detailed in the table below. A total of 64,300 m^2 will be affected by the Project, of which 2,500 m^2 will be permanently acquired and 61,800 m^2 will be temporarily required during the construction period. The proposed depot for Corridor-2 will be located at Aarey Milk Colony, in the northern section of Line 3. As this site is already under construction and dedicated to metro operations, no additional land acquisition will be necessary.

Table 5.7.20 Land acquisition area and number of affected buildings

Owner	Building Use	Permanently (m^2)	Temporarily (m^2)	Total (m^2)
Central Government	Army Land	900	800	1,700
	Navy Land	1,600	2,500	4,200
	Tata Institute of Fundamental Research (TIFR)	-	900	900
State Government	Other	-	57,500	57,500
Total		**2,500**	**61,800**	**64,300**

Source: Draft SIA report prepared by MMRC for Corridor-2 in July 2024

5.7.3.2 Poverty

Regarding Corridor 2, only government-owned land acquisition is planned, and no private land acquisition and resettlement is anticipated. Therefore, a socioeconomic baseline survey has not been conducted.

5.7.3.3 Indigenous and ethnic people

Indigenous peoples are not impacted by the Project; therefore, the preparation of an Indigenous Peoples Plan (IPP) is not required.

5.7.3.4 Local economy such as employment and livelihood, etc.

For households undergoing economic relocation due to land acquisition or resident resettlement, appropriate support tailored to the household's capabilities and circumstances, along with opportunities for vocational training is required. However, regarding Corridor 2, no private land acquisition or resettlement is planned.

5.7.3.5 Land use and utilization of local resources

As this Project is to be implemented in an already urbanized area, it will not result in significant changes in land use. Based on the results of site reconnaissance and interviews conducted with local farmers

regarding the utilization of regional resources, all interviewees expressed the view that no loss of land use or local resources is expected as a result of the Project.

5.7.3.6 Water use and its rights

According to Socio-Economic Baseline Surveys, it has been confirmed that nearby river water and lake water are not used for economic purposes such as fishing. They are also not used for daily activities like laundry or dishwashing. For drinking water, tap water supplied via water pipelines is used.

5.7.3.7 Existing social infrastructure and services

According to SIA report for Corridor 2, 14 government-owned structures is confirmed to be affected buildings. As stated in the Noise and Vibration section, some noise impact is anticipated during both construction and operation phases. Therefore, necessary mitigation measures must be implemented during both stages. During the construction period, to ensure safe access to facilities requiring special consideration, such as hospitals and schools, traffic guidance and warning signs will be installed. Additionally, measures such as detour routes based on traffic congestion conditions should be implemented as necessary.

5.7.3.8 Maldistribution of benefit and damage

According to interviews conducted at the station surveys and stake holder meetings, during the construction phase, temporary negative impacts such as noise, dust, and traffic restrictions are expected to reduce ease of access, raising concerns that foot traffic to roadside shops may decline, thereby adversely affecting existing businesses. Additionally, in areas surrounding the construction site, an increase in waste and deterioration of sanitary conditions have been pointed out as factors that could lower the quality of life for local residents.
On the other hand, some shop owners expressed expectations of increased income, as construction workers may become new customers, suggesting short-term economic benefits.

During the operation phase, improvements in traffic convenience and comfort are anticipated to result in increased customer flow and expanded commercial opportunities, particularly for businesses located near stations. Furthermore, the rise in land prices is expected to benefit landowners and property holders through increased asset value.

However, there are also concerns that rent increases may place economic pressure on existing tenants. In light of such uneven distribution of benefits and adverse impacts, the implementation of appropriate mitigation measures is required.

5.7.3.9 Local conflict of interest

In relation to the above, considering the interests of various stakeholders within the community, traffic congestion during the construction phase is recognized as a significant concern for both residents and business operators. Specific measures, such as traffic control and the establishment of detour routes, are necessary to minimize negative environmental and living impacts, including noise and increases in commuting/travel time. With regard to business activities, factors such as the placement and scale of

construction barriers can have a considerable impact, therefore, a thorough explanation to stakeholders and a comprehensive consensus-building process are essential prior to implementation.

In the operation phase, the project is expected to bring significant benefits after the commencement of operations, including an improvement in air and noise quality due to the reduction in road traffic volume. This represents a clear advantage that directly contributes to the improved quality of life for the entire community.

In the target area, it is common for long-term tenants to occupy properties at relatively low rental rates. From the project, the landowners may desire to review rental agreements and revise terms, including rent adjustments, based on market principles. However, the state of Maharashtra has legal protections such as the Maharashtra Rent Control Act (1999) exist to prevent unjustified rent hikes. Therefore, when revising rent or renewing lease contracts, it is important to respect the rights of tenants and consider the implementation of fair adjustment mechanisms.

In case of any disputes arise during the project, it is required that a fair and swift resolution is sought through mediation, in accordance with the Grievance Redress Mechanism (GRM) (Refer to 5.18.5).

5.7.3.10 Cultural Heritage

Along Corridor 2, historical heritage structures are located at a distance, and no cultural heritage sites have been identified in the vicinity of the corridor. Therefore, no impact from this project is anticipated.

5.7.3.11 Gender

In Mumbai's public transportation system, gender-sensitive measures are advancing, including the introduction of priority seating for women on buses and women-only buses. On railways, all trains attach women-only cars, and the metro also provides designated women-only spaces. Furthermore, other examples within India's metro and railway systems include gender-sensitive measures at station facilities such as separate restrooms for men and women and nursing rooms. Measures to ensure women can use facilities safely, such as deploying female security personnel, installing bright lighting, and introducing CCTV, are also being advanced. Surveys targeting women showed high demand for gender-sensitive measures like women-only cars, separate restrooms, and female security personnel. Therefore, based on the demands, measures including the introduction of women-only cars will be incorporated into this project.

5.7.3.12 Children's right

India's Child and Adolescent Labor Act of 1986 was significantly amended in 2016. Under the amendments, children under the age of 14 are prohibited from working in all industries and occupations, and adolescents aged 14 to 18 are prohibited from working in hazardous industries such as chemical handling, mining, explosives and fireworks manufacturing, and high-temperature furnaces. All other work is legal under approved circumstances. On the other hand, according to data released by the Ministry of Labor and Employment in 2022, the number of registered cases of violations of the above domestic law in Maharashtra State has been decreasing year by year, with 90 cases in 2018, 53 cases in

2019, and 29 cases in 2020[64]. However, it is also possible that there are cases that have not been detected or reported.

To ensure that the employment opportunities created by this project are limited to workers who meet the minimum age requirement and do not include children, the contract with the contractor must include the conditions specified in the aforementioned law.

5.7.3.13 Health (Infectious diseases such as HIV/AIDS, etc.)

Based on the results of the interview survey conducted with healthcare workers and station surveys, the majority of respondents did not report any specific cases of hygiene issues or infectious diseases. However, COVID-19 (including its variants) was cited as a commonly prevalent infection in the community. In addition, concerns were raised regarding mosquito-borne diseases such as dengue fever and malaria during the construction period.

Furthermore, HIV/AIDS is recognized as a public health risk, and therefore, adequate consideration must be given to the risk of infection among temporary labor populations, including construction workers, through preventive awareness training programs and public health measures.

5.7.3.14 Labor environment including labor safety

The following laws and regulations govern the working environment: The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 (BOCW Act - Central), Contract Labor (Regulation & Abolition) Act, 1970, Inter-State Migrant Workmen Act, 1979, Minimum Wages Act 1948, The payment Wages Act 1936, ESIC 1948, WC 1923, Payment of Bonus Act 1965, Equal Remuneration Act 1976, Payment of Gratuity Act 1972, EPFO. These primary laws should be complied during construction. During construction, various working environments are anticipated, such as underground operations and work adapted to road traffic conditions. Consequently, various types of occupational safety risks exist. Consideration must be given to each risk, and appropriate environmental measures must be implemented.

(The Occupational Safety, Health and Working Conditions (OSH) Code, 2020, the Industrial Relations Code (2020), the Code on Social Security (2020), the Code on Wages (2019), though enacted by the Government of India, has not yet been notified for enforcement, as the corresponding Central and State Rules are under finalization. Accordingly, the provisions of the said Code shall not be applicable as of the date of this Contract. However, in the event that the OSH Code, 2020 and its Rules are notified and brought into force during the currency of this Contract, the Contractor shall ensure full compliance with all applicable provisions of the Code and associated Rules from the effective date of their enforcement, without any additional financial implications to the Employer.)

[64] Rehabilitation of Child Labourers, Ministry of Labour & Employment (https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1807727&utm_) （Viewed in July 2025）

5.7.4 Others

5.7.4.1 Accidents

An examination of the trend in traffic accidents within Mumbai shows that the number of injury accidents and injured persons declined significantly in 2020. This reduction is considered to have resulted from the mobility restrictions associated with the COVID-19 pandemic. Thereafter, from 2021 onwards, the numbers began to increase again, and by 2023 they had reached a high level close to that of 2019. On the other hand, the number of serious accidents and fatalities showed no significant fluctuations between 2019 and 2023, remaining largely stable throughout the years. This indicates that while the occurrence of fatal accidents has been relatively stable, the overall trend in accidents is strongly influenced by the increase or decrease in non-fatal accidents. As described in the section on Waste Management, a substantial volume of excavated soil is expected to be generated from the underground station construction site, and other facilities. Consequently, the operation of transport vehicles for excavated soil may increase the potential risk of traffic accidents. It is therefore necessary to strengthen traffic safety through strict implementation of diversion plans approved by the relevant government authorities and by placing traffic control personnel at the entrances and exits of construction sites. Also, accidents occurred at construction site i.e., working at height, release of toxic gases & deficiencies of oxygen in confined spaces, failure of lifting hoisting through cranes/gantries, opening of cutouts, electrocution, fire, etc., so to prevent following steps shall be followed at site;

- Method Statement, SOP & work permit, lifting plan shall be followed
- Monitoring for oxygen deficiency, toxic gases & dust levels with continuous monitoring & alarms
- Awareness training shall be conducted.
- Safety posters & signages shall be displayed
- Barricading/closed of opening cutouts
- Mock drills shall be conducted timely
- Fire & Electrical prevention
- Record near misses and implement CAPA (Corrective and Preventive Actions).

During the operation stage, accidents caused by passengers falling from the platform are anticipated. However, for Mumbai Metro Line 11, as with Line 3, all stations will be equipped with full-height platform screen doors. This measure will physically prevent contact between trains and passengers.

Table 5.7.21 Traffic Accident Statistics in Mumbai

Items	2019	2020	2021	2022	2023
The number of injury accidents	2,336	1,388	1,668	1,509	2,125
The number of injured	2,925	1,740	1,944	1,715	2,611
The number of serious accidents	420	338	377	351	351
Death toll	447	350	387	365	374

Source: Mumbai Road Safety Annual Report 2023, Mumbai Police Traffic Control Division

5.7.4.2 Cross-border impact and climate change

Given that the Project is expected to contribute to a significant reduction in greenhouse gas (GHG) emissions, it may be classified as a climate change mitigation project. Therefore, based on the "JICA Climate-FIT (Climate Finance Impact Tool) – Mitigation Version 6.0, 3. Modal Shift through Railway, etc. (Passenger)" (hereinafter referred to as the "JICA Support Tool (Railway)"), an estimation of the Project's mitigation impact (i.e., GHG emission reductions and removals) was conducted as outlined below. In line with the planned opening year of 2031, the target years for estimation are set as 2031, 2041, and 2051.

(1) Applicability Conditions

This project satisfies the following applicability conditions stipulated in the JICA Support Tool for Climate Change Measures (Railway), and therefore, the tool is deemed appropriate for calculating the greenhouse gas (GHG) emission reductions resulting from the project:

① Development of transport system(s) that can realize an efficient urban or intercity passenger transport such as MRT (Mass Rapid Transit), railway, monorail, LRT (Light Rail Transit), BRT (Bus Rapid Transit) and trunk bus.

② The baseline transport modes should be buses, private cars, taxis, existing railways and aircrafts etc.

(2) Methodology of Emission Reduction Calculation

The emission reduction from the project activity is determined as the differences between the GHG emission of baseline scenario (e.g. existing mode of transportation such as buses, private car, taxi, motorbike) and project scenario (e.g. railway).

$$ER_y = BE_y - PE_y$$

ER_y : GHG emission reduction through the project in year y (t-CO_2e/y)

BE_y : GHG emission from the baseline scenario in year y (t-CO_2e/y)

PE_y : GHG emission from the project scenario in year y (t-CO_2e/y)

1) Calculation of Baseline Emission

Baseline GHG emission is calculated based on the transportation activity (in passenger-km or multiplying number of passenger and average trip distance) completed by the project 2, share of passengers by baseline transport modes and CO_2 emission factor per passenger-km. CO_2 emission factor per passenger-km can be set by dividing CO_2 emission factor per km by average occupation rate.

$$BE_y = \sum_i (BPKM_y \times MS_{i,y} \times EF_{PKM,i})$$

$BPKM_y$: Passenger transportation volume/activity by Corridor 2 in year y (passenger-km/y)

Table 5.7.22 BPKMy by Corridor 2 in year y (passenger-km/y)

BPKM y	Corridor 2
2031	85,220,963
2041	92,770,195
2051	101,868,293

Source: Prepared by the JST based on EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC

$MS_{i,y}$: Share of passengers by transport mode i in the baseline scenario in year y (%)

Table 5.7.23 Share of passengers by transport mode i in the baseline scenario in year y (%)

Transport mode	Share （%）
Private car	16
Bus	24
Motorcycle	21
Auto-rickshaw	19
National Railways	20

Source: EIA report for Southern extension of Mumbai Metro Line-3, Cuffe Parade to Navy Nagar, Jul, 2024, MMRC

$EF_{PKM,i}$: CO_2 emission factor of transport mode i (t-CO_2/passenger-km)

Table 5.7.24 CO_2 emission factor of transport mode i (t-CO_2/passenger-km)

Transport mode	CO_2 emission factor (t-CO_2/人 km)
Private car	0.0001300
Bus	0.0000570
Motorcycle	0.0000500
Auto-rickshaw	0.0000458
National Railways	0.0000170

Source: Based on the supplementary table of the Climate Change Mitigation Support Tool (JICA Climate-FIT) Version 6.0; the emission factor for auto-rickshaws is estimated based on the GoHUA guidelines.

Based on the above, the GHG emissions under the baseline scenario in year y are as shown in the table below.

Table 5.7.25 Baseline Emissions (BEy) for Corridor 2 in Year y (t-CO_2e/year)

BE y	Corridor 2
2031	4,865
2041	5,296
2051	5,815

Source: JST

2) Calculation of Project Emission

Since data on electricity and fuel consumption associated with the operation (traction) of Corridor 2 is unavailable for this project, the project emissions during operation are estimated by multiplying the passenger-kilometers with the CO_2 emission factor per passenger-kilometer for rail-based transit systems.

$$PE_y = BPKM_y \times EF_{PKM,MRT}$$

$EF_{PKM,MRT}$: CO_2 emission factor of Mumbai Metro Line 11 (t-CO_2/passenger-km)

Based on the above, the GHG emissions under the project scenario for year y are as shown in the table below.

Table 5.7.26 Project Emissions (PEy) of Corridor 2 (Traction) in Year y (t-CO_2e/year)

BE y (traction)	Corridor 2
2031	1,449
2041	1,577
2051	1,732

Source: JST

On the other hand, based on documentation received from DMRC, it is observed that electricity consumption is approximately in a 60:40 ratio between traction and facilities. Accordingly, electricity consumption at the station and other facilities is estimated as shown below.

Table 5.7.27 A Brief of Energy Consumption of DMRC's lines

S.No.	Description			Unit (In MU) for (FY 2018-19)	% share
1	Traction			647.65	60.13%
2	Non Traction	a) Underground stations	213.20 MU	416.21	38.64%
		b) Elevated stations	102.15 MU		
		c) Property Development	71.21 MU		
		d) Depot and MB	29.65 MU		
3	Losses and error			13.27	1.23%
	Total			1,077.13	100.00%

Source: DMRC

Table 5.7.28 Project Emissions (PEy) of Corridor 2 (Non traction) in Year y (t-CO_2e/year)

BE y (Non traction)	Corridor 2
2031	966
2041	1,051
2051	1,155

Source: JST

Based on the above, the estimated CO_2 emission reductions for Corridor 2 project are as shown in the table below. It is estimated that CO_2 emissions will be reduced by 2,450 tons in 2031, 2,668 tons in 2041, and 2,928 tons in 2051. Therefore, Corridor 2 project is expected to make a slightly contribution to the reduction of greenhouse gas emissions.

Table 5.7.29 Estimated ERy (t-CO_2e/y) for Corridor 2 in Year y

Year	*BE*	*PE* (traction)	*PE* (Non traction)	*ER*
2031	4,865	1,449	966	**2,450**
2041	5,296	1,577	1,051	**2,668**
2051	5,815	1,732	1,155	**2,928**

Source: JST

5.7.4.3 Disposal Sites, Casting Yards, and Quarries

(1) Disposal site

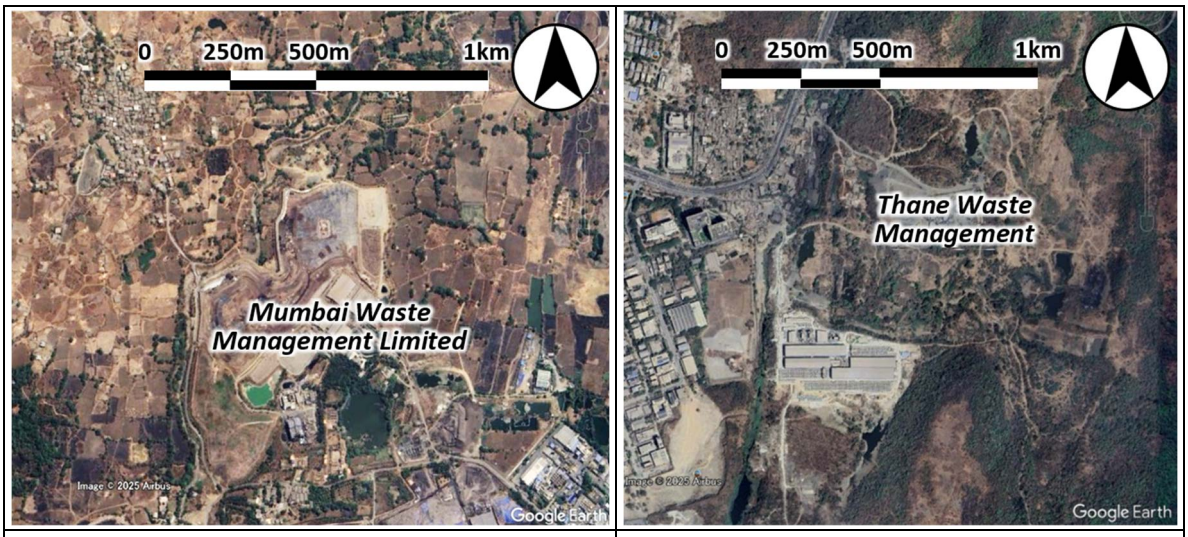
The candidate disposal sites for excavated construction soil are shown in Figure 4.7.1 and Table 4.7.7, and the surrounding environmental conditions of these sites are described in the following sections. It should be noted that the final disposal site will be designated by the Brihanmumbai Municipal Corporation based on the procedures stipulated under the Construction and Demolition Waste Management Rules, 2025 (effective from 1 April 2026), prior to the commencement of construction works. Therefore, the candidate sites indicated herein are subject to change.

1) Mumbai Waste Management Limited

It is located approximately 25 km northeast of the Project area and is surrounded by agricultural land. The nearest residential settlement is situated approximately 0.5 km to the west-northwest.

2) Thane Waste Management

It is located approximately 18 km east-northeast of the Project area. The western side of the site is characterized by an industrial and residential zone, while the eastern hinterland is crossed by a low mountain range with an elevation of approximately 200 m. The nearest residential settlement is located approximately 0.5 km to the west-northwest.



Mumbai Waste Management Limited. | Thone Waste Management

Source: JST based on Google Earth

Figure 5.7.5 Candidate disposal sites

(2) Casting Yard

MMRC plans to continue using the casting yard currently utilized under the Mumbai Metro Line-3 Project. The location map and the surrounding environmental conditions are presented below. The entire area was originally used as a casting yard; however, over the years, the occupied area has gradually decreased, with the Mumbai Monorail depot now located to the west and high-rise residential developments established to the east, resulting in the present land use configuration.



Source: JST based on Google Earth

Figure 5.7.6 Candidate site of Casting Yard

(3) Quarries

With regard to quarries, the selection and evaluation of potential sites will be carried out by the interim consultant or supervision consultant engaged directly by MMRC at the stage when the construction planning documents are prepared for tendering. Therefore, it is not feasible at this stage to identify candidate sites. Based on the information developed during this process, the construction contractor awarded the work will propose candidate locations, which will subsequently be reviewed and approved by the supervision consultant prior to commencement of use.

5.8 Impact Assessment

This section describes the anticipated environmental and social impacts during the pre-construction, construction, and operation phases of the Project. The impact predictions were carried out based on the results of the scoping exercise, analysis of project components, and baseline information, including findings from field surveys. During the scoping phase, impact assessments were also conducted for associated facilities such as quarries and borrow sites in addition to the main project. However, since these associated facilities had not yet been finalized at the time of the preparatory survey, the final impact assessments for them are omitted. Accordingly, environmental impact assessments related to these components will be conducted at a later stage. For reference at that time, a simplified impact assessment format is attached as an appendix. In addition, as disposal sites are managed by entities other than the Project proponent, mitigation measures and monitoring plans are not addressed herein. Furthermore, since the magnitude of impacts varies depending on the candidate disposal sites, the impact assessment

for disposal sites is limited to a checklist-based evaluation, consistent with the approach adopted during the scoping stage.

The results of the environmental and social impact assessment of the main project components are presented in the table below, along with a comparison to the results identified during the scoping phase.

Table 5.8.1 Evaluation Results for Facilities (Including Casting Yard) along Corridor 2

Category	No.	Impact Item	Evaluation				Reason for evaluation
			Scoping		Based on Survey		
			Pre-CS/CS	OS	Pre-CS/CS	OS	
Pollution	1	Air pollution	✓		B-	B+	**CS:** Temporary impacts on air quality are anticipated due to emissions of exhaust gases (NOx, SOx) from construction machinery and vehicles, as well as dust generation ($PM_{2.5}$, PM_{10}) associated with construction activities. **OS:** A positive impact is expected as a result of reduced traffic volume along the Mumbai Metro corridor.
	2	Water Quality	✓	✓	B-	B-	**CS:** - Turbid water will be generated in surface water and ground water along Mumbai metro due to civil works. - There is a possibility of discharged organic wastewater from the base campsite. **OS:** There is a possibility of discharged organic wastewater from the toilet installed at the station.
	3	Waste	✓	✓	B-	B-	**CS:** - General waste and excreta will be generated from the base campsite. - Construction waste such as soil and deforestation trees are generated. - Muck due to tunnel excavation is generated and some of them may be not suitable for reuse. **OS:** General waste and excreta will be generated from the station.
	4	Soil contamination	✓		B-	D	**CS:** - Oil leaks from construction equipment may cause soil contamination. - There is a potential risk of soil contamination due to oil leakage from construction machinery and other heavy equipment. **OS:** Events that could lead to soil contamination are not anticipated..
	5	Noise and vibration	✓	✓	B-	B±	**CS:** Noise and vibration will be generated by construction machineries and vehicles. **OS:** Modal shift from Mumbai Metro operation reduces noise and vibration; underground vibration levels predicted below standards, but further reduction is required.
	6	Ground subsidence	✓	✓	B-	B-	**CS:** SPT results show no soft ground; DPR indicates no subsidence risk from groundwater pumping, but monitoring and mitigation are still required. **OS:** There is no significant impact. However, monitoring in the operation phase should be necessary as a follow-up observation and maintenance.
	7	Offensive odor	✓	✓	B-	B-	**CS:** Offensive odor may occur depending on the volume of general waste etc. from construction sites and basecamp. **OS:** Offensive odor may occur depending on the volume of general waste etc. from the station.
Natural	8	Biodiversity	✓	✓	B-	B-	**CS:** Adverse impacts on the ecosystem are anticipated due to the felling of affected trees associated with the construction of underground stations. **OS:** Insufficient maintenance of planted/transplanted trees may lower survival rates.

Category	No.	Impact Item	Evaluation				Reason for evaluation
			Scoping		Based on Survey		
			Pre-CS/CS	OS	Pre-CS/CS	OS	
	9	Hydrology	✓		B-	D	**CS:** Some impact on hydrology around the project site including TBM sections will occur. **OS:** Operation of the Mumbai Metro may not cause any impact on surrounding hydrology.
	10	Geology and Topography	✓	✓	D	D	**CS/OS:** Topography and geology are generally stable with no major constraints for underground structures; existing surveys ensure required accuracy, and strong basalt underlies the alluvial layer.
Social Environment	11	Poverty	✓		D	D	**Pre-CS:** Land acquisition and resettlement will not occur, so activities affecting the indigent are not anticipated. **OS:** Since there is no land acquisition and resettlement during the operation phase, operation activities that have a negative impact on people with poor class are not expected.
Social Environment	12	Indigenous and ethnic people	✓		D	D	**Pre-CS and CS:** Indigenous people was not observed in the project affected areas based on a survey on private land by the provincial government as well as past statistical data. **OS:** No impact is expected with the reasons same as the case of Pre-CS and CS.
Social Environment	13	Local economy such as employment and livelihood, etc.	✓		B±	B±	**Pre-CS and CS:** - New employment and job opportunity may be created with the construction of Mumbai Metro. - A negative impact on the livelihood of PAPs may be generated due to loss of access by fencing works around the construction areas. **OS:** - New employment may be created with the opening of Mumbai Metro. - A positive impact for the local economy will be generated such as timesaving for traveling within Mumbai city and alleviation of traffic congestion.
Social Environment	14	Land use and utilization of local resources	✓	✓	D	B-	**CS:** Construction work in the area will not bring any significant changes in the land use pattern. The development of station buildings will not have any major significant impact on the future land use. **OS:** There will be no land acquisition or resettlement during the operation phase. Furthermore, as the areas along the alignment are predominantly occupied by government and naval facilities, the likelihood of unplanned development along the alignment or around the stations is considered low.
Social Environment	15	Water use and its rights	✓	✓	B-	D	**CS:** Land acquisition and construction work such as TBM method may affect drinking water sources such as wells. **OS:** There is no impact on water use because of no land acquisition in the operation phase.
Social Environment	16	Existing social infrastructure and services	✓		B-	B+	**Pre-CS and CS:** - A negative impact on sensitive facilities such as schools, hospitals, and community centers may occur due to traffic issues such as congestion and accidents. - The impact of the relocation of underground facilities is expected due to the construction work, which cause a temporal power outage in the surrounding area. **OS:** Improvement of accessibility by installing Mumbai Metro stations is expected, by which there is a possibility of a positive impact on the use of social infrastructure such as school, hospital, etc.

Category	No.	Impact Item	Evaluation				Reason for evaluation
			Scoping		Based on Survey		
			Pre-CS/CS	OS	Pre-CS/CS	OS	
	17	Maldistribution of benefit and damage	✓	✓	B-	D	**CS:** In some construction areas, restrictions on road crossings and detours may reduce accessibility and safety. **OS:** Outstanding maldistribution of benefit is not expected.
	18	Local conflict of interest	✓		B-	D	**CS:** - Resid**ents and municipalities may demand that construction contractor should supply employment opportunities equally as construction workers.** - **Pollut**ion status may cause conflict along the construction affected areas **OS:** Outstanding impact on local conflict of interest is not expected.
Social Environment	19	Cultural Heritage	✓	✓	D	D	**Pre-CS/CS:** Historical/cultural monuments will not be affected by the proposed project development. **OS**: No impact on historical or cultural monuments.
	20	Gender	✓	✓	B-	B-	**CS:** There may be a gender gap regarding wage, salary, and treatment as construction workers. **OS:** - Employ**ment opportunities for women will be limited concerning Metro operation.** - **Female p**assengers may give up getting on a train because of being afraid of congestion on the train during commuting time.
	21	Children's right	✓		B-	D	**CS:** - There migh**t be a possibility of child labour in construction sites.** - **Constructio**n work may interfere with going to educational facilities. **OS:** There is no impact on children's rights by Mumbai Metro operation.
	22	Health (Infectious diseases such as HIV/AIDS, etc.)	✓	✓	B-	D	**CS:** Infectious diseases such as HIV/AIDS, Malaria, and Dengue etc. may be spread by the inflow of construction workers. **OS:** The opening and operation of the metro is unlikely to be a contributing factor to the spread of HIV/AIDS.
	23	Labor environment including labor safety	✓	✓	B-	D	**CS:** Occupational injuries / disease may occur with inappropriate labor environment including safety management in the construction sites, and labour colony. **OS:** There is no big change in the labor environment for residents by Mumbai Metro operation.
Others	24	Accidents	✓	✓	B-	D	**CS:** - Since c**onstruction-related vehicles use arterial roads on the Mumbai Metro Corridors, there is a possibility of increasing traffic accidents.** - **Detour and caused traffic congestions may increase the number of traffic accidents.** - **All cons**truction related Accident / incident prevention system. **OS:** Platform screen doors prevent physical contact between trains and passengers.

Category	No.	Impact Item	Evaluation				Reason for evaluation
			Scoping		Based on Survey		
			Pre-CS/CS	OS	Pre-CS/CS	OS	
	25	Cross-border impact and climate change	✓	✓	B-	B+	**CS:** Greenhouse gas emissions will increase by reducing the absorbed amount of greenhouse gas by cutting street trees along the alignment, operation of construction heavy machinery, and construction of structures. **OS:** Due to the operation of the Mumbai Metro, traffic volume along the metro corridor is expected to decrease, leading to a reduction in GHG emissions. On the other hand, the operation of the metro itself will result in GHG emissions due to electricity consumption. However, considering the overall balance, the reduction in emissions is expected to exceed the emissions from metro operations, and thus, the project is anticipated to contribute to the reduction of GHG emissions.

Note: Pre-CS: Pre-Construction Stage, CS: Construction Stage, OS: Operation Stage
B+/-: Positive/Negative impact is expected to some extent, D: No impact is expected

Source: JST

Table 5.8.2 Evaluation Results for Associated Facilities (Disposal site)

No	Impact Item	Evaluation		Reason for evaluation
		Scoping	Based on Survey	
		Pre-CS/CS	Pre-CS/CS	
Pollution				
1	Air pollution	✓	✓	Nitrogen oxides (NOx), sulfur oxides (SOx), and particulate matter (PM_{10} and $PM_{2.5}$) may be generated temporarily due to the operation of construction machinery and dump trucks.
2	Water Quality	✓	✓	In the absence of proper drainage facilities, rainfall runoff may potentially affect surrounding water bodies.
3	Waste	✓	✓	Scattered waste may cause adverse impacts on nearby residents.
4	Soil Contamination	✓	✓	As wastewater is discharged into drainage channels, soil contamination is not anticipated; however, if drainage channels are not provided, leachate and wastewater may potentially affect the surrounding environment.
5	Noise and Vibration	✓	✓	Noise and vibration are expected to be generated due to the operation of transport vehicles and construction equipment.
6	Ground subsidence			Activities that may cause land subsidence are not anticipated.
7	Offensive odor	✓	✓	At disposal sites, depending on the type of waste and the methods and duration of storage, there is a potential for the generation of offensive odors affecting the surrounding area.
8	Bottom sediment			Activities that may deteriorate sediment quality are not anticipated.
Natural Environment				
9	Protected area	✓	✓	If protected areas are located in the vicinity, there is a potential for adverse impacts.
10	Biodiversity	✓	✓	Land modification activities and/or the presence of surrounding green spaces may potentially affect the local ecosystem.
11	Hydrology			Activities that may affect hydrological conditions are not anticipated.
12	Geology and Topography	✓	✓	If a candidate site is located on a slope, site grading and land formation will be required.

№	Impact Item	Evaluation		Reason for evaluation
		Scoping	Based on Survey	
		Pre-CS/CS	Pre-CS/CS	
Social Environment				
13	Land acquisition/ Resettlement			As a municipally registered disposal site will be used, no land acquisition or involuntary resettlement is anticipated.
14	Poverty	✓	✓	If vulnerable or low-income communities are present in the surrounding area, potential impacts may occur.
15	Indigenous and ethnic people	✓	✓	If ethnic minorities or Indigenous Peoples reside in the surrounding area, potential impacts may occur.
16	Local economy such as employment and livelihood, etc.			Activities that may affect local employment, livelihoods, or the regional economy are not anticipated.
17	Land use and utilization of local resources	✓	✓	If the volume of disposed material exceeds the planned capacity, expansion of the disposal area may potentially affect surrounding community resources.
18	Water use and its rights	✓	✓	If the volume of disposed material exceeds the planned capacity, expansion of the disposal area may potentially affect surrounding water use.
19	Existing social infrastructure and services	✓	✓	If sensitive receptors (such as residential areas, schools, or medical facilities) are located nearby, an increase in traffic accidents may be a concern due to increased haulage traffic.
20	Social institutions such as social infrastructure and local decision - making institutions			Activities that may affect social capital, community organizations, or local decision-making institutions are not anticipated.
21	Maldistribution of benefit and damage			Activities that may cause inequitable distribution of project benefits and adverse impacts are not anticipated.
22	Local conflict of interest	✓	✓	If the volume of disposed material exceeds the planned capacity, expansion of the disposal area may result in conflicts of interest between landowners and surrounding residents, if any.
23	Cultural Heritage	✓	✓	If cultural heritage sites are located in the surrounding area, potential impacts may occur.
24	Landscape	✓	✓	If the volume of disposed material exceeds the planned capacity, expansion of the disposal area may potentially affect the surrounding landscape and visual amenity.
25	Gender			No gender-related impacts are anticipated.
26	Children's right			No impacts on children's rights are anticipated.
27	Health (Infectious diseases such as HIV/AIDS, etc.)			No impacts related to communicable diseases are anticipated.
28	Labor environment including labor safety	✓	✓	A safe and appropriate working environment shall be ensured in accordance with applicable laws and regulations.
Others				
29	Accidents	✓	✓	As haulage vehicles will use surrounding roads for Mumbai Metro construction activities, there is a potential increase in traffic accidents.
30	Cross border impact and climate change			No impacts related to climate change, such as large-scale deforestation or significant increases in greenhouse gas emissions, are anticipated.

Source: JST

5.9 Environmental Management Plan

An environmental management plan has been developed to address the negative and potentially negative impact items, including appropriate mitigation measures. These measures are to be implemented and considered at each stage of the project to minimize environmental and social negative impacts while ensuring the achievement of the project objectives. Furthermore, the mitigation measures and their associated implementation costs are listed below. The following table outlines the mitigation measures corresponding to the impact items that were rated as "A-" or "B-" in the previously presented impact assessment results table.

Table 5.9.1 Proposed Mitigation Measures against expected Impacts (Pre-Construction or Construction Phase)

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
1-a	Air pollution	Temporary impacts on air quality are anticipated due to emissions of exhaust gases (NOx, SOx) from construction machinery and vehicles, as well as dust generation ($PM_{2.5}$, PM_{10}) associated with construction activities.	Air quality in construction areas will be sampled to ensure a proper working environment.			10,000 / site·year 250,000 / unit (as continuous monitoring sensor)
1-b			Regular preventive maintenance of construction equipment and vehicles, with daily inspections to ensure optimal working conditions.	Construction Contractor	MMRC	Contractor's responsibility
1-c			The proper work schedules should be considered not to concentrate the construction equipment at a certain point for a long time.			
1-d			To reduce the dust, the periodic water spray should be taken.			20,000 / site·year; total 2,800,000 for entire line
1-e			The construction site is fenced as high as 2.5 m.			Contractor's responsibility
1-f			Detours will be arranged to mitigate traffic congestion.			
2-a	Water Quality	Turbid water will be generated in surface water and groundwater along the Corridors due to civil and excavation works. There is a possibility of discharged organic wastewater at an installed base campsite.	Washing the construction tools in limited areas where there are appropriate facilities for water treatment for discharge	Construction Contractor	MMRC	Contractor's responsibility
2-b			In construction works near water bodies, turbid wastewater shall be treated at designated sites and released again.			7,000 / site·year
2-c			Temporary sanitation facilities with septic tanks such as portable (mobile) toilets and garbage bins will be provided by the contractors to ensure that the domestic wastes to be generated by the construction personals are properly handled and not thrown into the drainage to prevent further pollution.			Contractor's responsibility
3	Waste	General waste and excreta will be generated from the base campsite. Construction waste such as soil and deforestation trees are generated. Muck due to tunnel excavation is generated and some of them may be not suitable for reuse.	In accordance with the instructions of the competent authority and applicable regulations, construction waste generated from the construction and camp sites should be transported to the designated sites and disposed of.	Construction Contractor	MMRC	Round-trip transport cost (70 km): 48,000 / unit

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
4-a	Soil contamination	Excavated soil at the construction site may be contaminated. Oil leaks from constriction equipment may cause soil contamination.	In accordance with the instructions of the competent authority and applicable regulations, the excavated soil shall be transported to the designated sites and disposed of.	Construction Contractor	MMRC	Round-trip transport cost (70 km): 48,000 / unit
4-b			Daily maintenance of construction equipment and vehicles.			Contractor's responsibility
4-c			Soil sampling and laboratory analysis in order to check soil contamination shall be done.			7,500 / site·year
5-a	Noise and vibration	Noise and vibration will be generated by construction machineries and vehicles.	Noise and vibration from machinery shall be controlled within standards using mufflers, vibration mats, and other devices.	Construction Contractor	MMRC	Contractor's responsibility
5-b			Low-noise and low-vibration machinery shall be used as far as practicable for piling and similar works.			
5-c			Noise and vibration shall be monitored regularly; high-impact works limited to daytime (06:00–22:00), with night work considered near schools.			Noise: 4,500 / site·year Vibration: 400,000 / all sites·year
5-d			Construction sites shall be enclosed with a 2.5 m fence.			Contractor's responsibility
5-e			Daytime and Nighttime restrictions on heavy vehicle traffic, speed, and routes shall be applied in accordance to the rules, regulation and permission of State Trasport Department.		Transport Department, Government of Maharashtra	
5-f			If complaints arise, TBM pressure and vibration shall be reduced, and residents shall be informed that the vibration is temporary.		MMRC	
5-g			In the event that cracks should occur, MMRC will determine whether compensation is to be provided through consultations with the building owners.			Contractor's or MMRC's responsibility
6-a	Ground subsidence	SPT results show no soft ground; DPR indicates no subsidence risk from groundwater pumping, but monitoring and mitigation are still required.	Application of appropriate construction measures such as earth retaining wall, penetration of piles to the support layer, and etc.	Construction Contractor	MMRC	Contractor's responsibility
6-b			Application of ground reinforcement measures such as sand pile method to the soft-ground areas, if any.			
6-c			Continuous monitoring using settlement gauges and settlement plates.			
7	Offensive odor	Offensive odor may be issued depending on the volume of general waste, etc. from base camp sites.	Regular cleaning and collection of the general waste from camp sites with appropriate stock places and facilities to prevent offensive odor.	Construction Contractor	MMRC	Contractor's responsibility

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
8-a	Biodiversity	Construction of underground station may adversely affect the ecosystem, including tree felling.	Compensatory planting to prioritize native and vulnerable species (*Saraca asoca, Dalbergia latifolia*).	Construction Contractor	MMRC	Transplantation cost: 60,000 / tree Felling cost: 10,000 / tree (including 3 years of maintenance for each)
8-b			Plantation shall be carried out as much as possible within project areas such as station facilities.			
8-c			To secure the required number of plantations, alternative sites such as public land, parks, and school premises shall be utilized as much as possible; Green space development shall also be incorporated into surrounding station area development plans and along other metro lines in Mumbai. This activity shall form part of the landscaping and beautification plan for each station and will be implemented after completion of the station construction works..	Construction Contractor and MMRC	MMRC and BMC Tree Authority	
8-d			In compliance with relevant laws, transplantation of mature trees shall be implemented step by step under the supervision of arboricultural and horticultural experts, with continuation subject to confirmation of survival rates.			
8-e			A dedicated subcontractor independent from the construction JV shall be appointed exclusively for plantation works, with a separately managed budget.	MMRC	Mumbai Tree Authority	
8-f			Same as “5. Noise and vibration”.			
9-a	Hydrology	Indicators classify Mumbai as safe for groundwater extraction; impacts are minor overall but slight effects may occur around TBM sections.	Sheet pile should be installed at the excavation work site in order to water sealing.	Construction Contractor	MMRC	Contractor’s responsibility
9-b			Closed mold type of TBM should be used in order to keep groundwater pressure.			
9-c			Groundwater monitoring using construction well.			7,000 / site·year
10	Local economy such as employment and livelihood, etc.	A negative impact on the livelihood of PAPs may be generated due to loss of access by fencing works around the construction areas.	Minimize impacts on business activities from construction fencing by securing road width in front of shops, etc.	MMRC	Government of Maharashtra	Expense of Government of Maharashtra
11	Water use and its rights	Land acquisition and construction work such as TBM method may affect drinking water sources such as wells.	If the water quality deems to decline, appropriate water treatment measures such as water shielding and infiltration control should be implemented.	Construction Contractor	MMRC	Contractor’s responsibility 7,000 / site·year
12-a	Existing social infrastructure and services	A negative impact on sensitive facilities such as schools, hospitals, and community centers may occur due to traffic issues such as congestion and accidents.	Make sure to provide safe access to sensitive facilities such as hospital, school, etc. during the construction period by installing traffic guides and warning signs, and if required, measures such as detour route should be set up based on the traffic congestion condition.	Construction Contractor	MMRC	Contractor’s responsibility

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
12-b		The impact of the relocation of underground facilities is expected due to the construction work, which cause a temporal power outage in the surrounding area.	In cooperation with the relevant authorities, the relocation of underground utilities will be carried out to minimize adverse impacts on the local community.			
13	Maldistribution of benefit and damage	In some construction areas, road crossing bans or detours may reduce accessibility and safety.	During construction, ensure safe access to sensitive facilities (hospitals, schools, etc.) by installing traffic guidance and warning signs, and implement detours as needed based on traffic congestion.	Construction Contractor	MMRC	Contractor's responsibility
14-a	Local conflict of interest	Fencing of construction areas may hinder access and cause business losses or other adverse impacts.	Same as "13-b"	Construction Contractor	MMRC	Contractor's responsibility
14-b		Residents and municipalities may demand that construction contractor should supply employment opportunities equally as construction workers.	Give employment opportunities to residents and municipalities evenly.			
14-c		Pollution status may cause conflict along the construction affected areas	If the residents and pedestrians complain about the construction activities, the consultant of the supervision and contractors should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.			
15	Gender	There may be a gender gap regarding wage, salary, and treatment as construction workers.	There must be care that there is no discrimination between male and female in employment and payment of wages/salaries.	Construction Contractor	MMRC	Contractor's responsibility
16-a	Children's right	There might be a possibility of child labour in construction sites.	Child deployment prohibition policy to be implemented as per law.	Construction Contractor	MMRC	Contractor's responsibility
16-b			Age verification in screening process through Government approved ID cards to be ensured.			
16-c			Awareness posters shall display.			
16-d		Construction work may interfere with going to educational facilities.	Educational institutes shall be provided with adequate & safe access.			
17-a	Health (Infectious diseases such as HIV/AIDS, Malaria and Dengue, etc.)	Infectious diseases such as HIV/AIDS, Malaria and Dengue etc. may be spread by the inflow of construction workers.	Arrange HIV/AIDS counselling through qualified NGOs; ensure confidentiality.	Construction Contractor	MMRC	Contractor's responsibility
17-b			Organize HIV/AIDS awareness activities (street plays, short films).			
17-c			Dos & Don'ts posters shall be displayed at site & labor camps.			
17-d			Condom promotion programs shall be conducted, and free condom distribution arrangement shall be ensured.			
17-e			Regular health checkup camps Awareness & training shall be arranged for Malaria & Dengue.			
17-f			Housekeeping & hygiene shall be maintained at project site & labor colony and fogging shall be done at both.			

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
18-a	Labor environment including labor safety	Occupational injuries / disease may occur with inappropriate labor environment including safety management in the construction sites, and labour colony.	For the Project Site safety, measures below will be included: • Site specific SHE&W policy, Construction SHE&W Plan in line with condition of contract, on site emergency preparedness plan & Labors accommodation plan shall be implemented. • Underground safety measures – monitoring for oxygen deficiency, toxic gases & dust levels with continuous monitoring & alarms • Strict entry/exit protocols along with tally-boards in underground tunnel. • Work permit system shall be followed. • Medical facilities – Ambulance, emergency contact nos. displayed & tie up with nearby hospitals. • Tied up all local authorities such as Fire, police, Disaster Management & BMC (Municipal Corporation) • Electrical & Fire safety measures to be implemented. LOTO system to be ensured. • Proper ventilation system shall be provided at the underground tunnel working area. • Fatigue management - Regulations for working hours, rest breaks, and night shift management. • Ensure SCABA equipment use in tunnels. • Job specific trainings (on site & classroom) shall be conducted on timely. • Safety signages shall be displayed at all prominent location. • PPEs compliance: Safety helmet & shoes, reflective safety jacket and job specific PPEs (Goggle, Ear plugs, dust mask, Full body harness, breathing apparatus) • Housekeeping & hygiene shall be maintained at site. • Work at height: Standard & approved scaffolding system & fall protection shall be used/implemented. • Availability of Rest shelters.	Construction Contractor	MMRC	Contractor's responsibility
18-b			• For the Labor colony, measures below will be included: • Provide clean drinking water, sanitation, canteens, and bathrooms. • Construct separate kitchens as per labor capacity. • Fire preventions & emergency preparedness to be implemented • First aid facilities shall be available • Maintain effective drainage, garbage disposal, and sewage systems. • Housekeeping & hygiene shall be maintained • Construct separate kitchen shall be provided according to labor strength			

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
19-a	Accidents	• Since construction-related vehicles use arterial roads on the Corridors, there is a possibility of increasing traffic accidents. • Detour and caused traffic congestions may increase the number of traffic accidents.	For Traffic: • Traffic management plan shall be implemented in consultation with respective area authorities. • Install standard traffic signs and diversion boards. • Separate pedestrians' pathways with signs shall be provided • Conduct drivers' defensive driving training and safety vehicle checks; use GPS tracking.	Construction Contractor	MMRC	Contractor's responsibility
19-b		All construction related Accident / incident prevention system	• Zero Accident Vision: Must adopt "Zero Harm Policy". • Method Statement, SOP & work permit shall be followed • Awareness training shall be conducted. • Safety posters & signages shall be displayed • Mock drills shall be conducted timely • Fire & Electrical prevention • Record near misses and implement CAPA (Corrective and Preventive Actions).			
20	Cross-border impact and climate change	Greenhouse gas emissions will increase slightly by reducing the absorbed amount of greenhouse gas by cutting street trees along the Corridors, operation of construction heavy machinery, and construction of structures.	Same as "9. Biodiversity".			

Source: JST, MMRC

Table 5.9.2 Proposed Mitigation Measures against expected Impacts (Operation Phase)

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
1-a	Water Quality	There is a possibility of discharged organic wastewater from the toilet installed at the station.	Regular maintenance of toilets, Sewage Treatment Plant (STP), Effluent Treatment Plant (ETP), and related facilities at the station.	MMRC	Maharashtra Pollution Control Board (MPCB)	Included in MMRC operating costs
1-b			Sampling to assess surrounding impacts			7,000 / site·year
2	Waste	General waste and excreta will be generated from the station.	Installation of enough garbage bin at appropriate location in the station and collection rules based on local collection systems.	MMRC	Maharashtra Pollution Control Board (MPCB)	Included in MMRC operating costs

No.	Item	Expected Impact	Mitigation Measure	Implementation Body	Responsibility Body	Cost (INR)
3-a	Noise and vibration	In the underground sections, the predicted results indicated that the vibration impacts would remain below the standard values, but further reduction and monitoring in World Heritage areas are required.	Conduct monitoring of vibration impacts during train operations.	MMRC	Maharashtra Pollution Control Board (MPCB)	Included in MMRC operating costs (Reference: Vibration: 400,000 / all sites·year)
3-b			Introduction and maintenance of elastic rail pads and vibration-reducing sleepers			Included in MMRC operating costs
4	Ground Subsidence	Monitoring in the operation phase should be necessary as a follow-up observation and maintenance.	Continuous monitoring with settlement gauges and settlement plates	MMRC	Government of Maharashtra	Included in MMRC operating costs
5-a	Offensive odor	Offensive odor may be issued depending on the volume of general waste etc. from the station.	Regular cleaning and collection of the general waste from the station.	MMRC	Maharashtra Pollution Control Board (MPCB)	Included in MMRC operating costs
5-b			Installation of appropriate garbage bin with cover.			
6-a	Biodiversity	Insufficient maintenance of planted/transplanted trees may lower survival rates.	A compliance report on compensatory plantation, accompanied by photographic documentation, shall be submitted to the Tree Authority on a semi-annual basis.	MMRC: For 3 years after plantation BMC: Thereafter	BMC Tree Authority	Maintenance Cost Included
6-b			The General Consultant (GC) engaged by MMRC shall conduct regular audits on environmental and tree management activities as part of its routine duties.			
7-a	Gender	• Employment opportunities for women will be limited concerning Metro operation. • Female passengers may give up getting on a train because of being afraid of congestion on the train during commuting time.	Active employment of female staff for MMRC with fair conditions	MMRC	Government of Maharashtra	Included in MMRC operating costs
7-b			Keep provision of the designated seat for women on the train, enough number of toilet and other facilities as much as possible.			

Source: JST, MMRC

5.10 Environmental Monitoring Plan

In Corridor 2 project, an Environmental Monitoring Plan (EMoP) has been established as outlined below to verify the effectiveness of the mitigation measures set for each environmental and social consideration item.

Table 5.10.1 Environmental Monitoring Plan (Pre-Construction and Construction Phase) proposed by the survey

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
1-a	Air pollution	Air quality in construction areas will be sampled to ensure a proper working environment.	Sampling survey using the same method as the baseline: SO_2, CO, NO_2, O_3, PM_{10}, $PM_{2.5}$	**CPCB 2009** SO_2: 80μg/m^3 CO: 2mg/m^3 NO_2: 80μg/m^3 O_3: 100μg/m^3 PM_{10}: 100μg/m^3 $PM_{2.5}$: 60μg/m^3	Construction areas of the station, batching plants, and casting yards	Construction Contractor	Every 2 weeks (construction period)	10,000 / site·year 250,000 / unit (as continuous monitoring sensor)
1-b		Regular preventive maintenance of construction equipment and vehicles, with daily inspections to ensure optimal working conditions.	Verification of maintenance inspection records	-	All construction areas, batching plants, and casting yards		Monthly during the construction period	Contractor's responsibility
1-c		The proper work schedules should be considered not to concentrate the construction equipment at a certain point for a long time.	Construction plan / schedule					
1-d		To reduce the dust, the periodical water spray should be taken.	Record of sprinkler truck operation				Continuous during dust-generating construction	20,000 / site·year; total 2,800,000 for entire line
1-e		The construction site is fenced as high as 2.5 m.	Visual confirmation of installation of fences				Before commencement of construction	Contractor's responsibility
1-f		Detours will be arranged to mitigate traffic congestion.	Verification of construction and diversion plans					
2-a	Water pollution	Washing the construction tools in limited areas where there are appropriate facilities for water treatment for discharge	Visual confirmation of appropriate operation of washing activities	-	All construction areas, batching plants, and casting yards	Construction Contractor	Monthly during the construction period	Contractor's responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
2-b		In construction works near water bodies, turbid waste water shall be treated at designated sites and released again.	Sampling survey using the same method as the baseline Surface water: Color, odor, turbidity, pH, conductivity, total hardness, chlorides, iron, total dissolved solids, sulfates, nitrates, lead, copper, manganese, mercury, cadmium, zinc, total chromium, hexavalent chromium, total alkalinity, calcium, magnesium, sodium, potassium, dissolved oxygen, BOD, COD, Suspended Solid Groundwater: Color, odor, taste, turbidity, pH, chlorides, iron, total dissolved solids, sulfates, nitrates, fluoride, lead, copper, manganese, phenolic compounds, mercury, cadmium, arsenic, cyanide, zinc, detergents, total chromium, hexavalent chromium, total alkalinity, aluminum, boron, coliforms, E. coli, Suspended Solid	Surface water: **General Standards for Discharge of Environmental Pollutants in Environment (Protection) Rules, 1986** Groundwater: IS **10500 : 2018, Indian Standard, DRINKING WATER — SPECIFICATION** (Individual standard values omitted)	<u>Surface water:</u> Around the station site Groundwater: Monitoring wells at the construction site		Once each in rainy, hot and dry seasons during construction	7,000 / site·year
2-c		Temporary sanitation facilities with septic tanks such as portable (mobile) toilets and garbage bins will be provided by the contractors to ensure that the domestic wastes to be generated by the construction personals are properly handled and not thrown into the drainage to prevent further pollution.	Disposal records and visual inspection	-	All construction areas, batching plants, and casting yards		Monthly during the construction period	Contractor's responsibility
3	Waste	In accordance with the instructions of the competent authority and applicable regulations, construction waste generated from the construction and camp sites should be transported to the designated sites and disposed of.	• The volume of waste including soil, vegetation, existing railway structures, and garbage • The condition of storage and transportation for the generated waste • Voices and complaints from the local community	-	All construction areas, batching plants, and casting yards	Construction Contractor	Monthly during the construction period	Round-trip transport cost (70 km): 48,000 / unit
4-a	Soil contamination	In accordance with the instructions of the competent authority and applicable regulations, the excavated soil shall be transported to the designated sites and disposed of.	Same as "3. Waste"					

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
4-b		Daily maintenance of construction equipment and vehicles.	Same as "1-b"					
4-c		Soil sampling and laboratory analysis in order to check soil contamination shall be done.	Baseline-method sampling: pH, EC, total chromium, Cr^{6+}, Pb, Cd, As, Hg	**EP (Contaminated Sites) Rules, 2025** Cr:87mg/kg Cr^{6+}:78mg/kg Pb:600mg/kg Cd:22mg/kg As:76mg/kg Hg:50mg/kg	All construction areas, batching plants, and casting yards	Construction Contractor	Once each in rainy, hot and dry seasons during construction	7,500 / site·year
5-a	Noise and vibration	Noise and vibration from machinery shall be controlled within standards using mufflers, vibration mats, and other devices.	- Visual inspection of required equipment installation - Construction records (working hours) - Equipment usage records	-	All construction areas, batching plants, and casting yards	Construction Contractor	[Noise] Continuous during construction period [Vibration] Underground sections: periodic measurement during construction	Contractor's responsibility
5-b		Low-noise and low-vibration machinery shall be used as far as practicable for piling and similar works.						

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
5-c		Noise and vibration shall be monitored regularly; high-impact works limited to daytime (6:00–22:00), with night work considered near schools.	Same methods as the baseline survey [Noise] LAeq [Vibration] Lv	[Noise] **EPA-1986, Noise pollution (Regulation Control), Rule-2000, PCLS/02/1992, IVth Edition** Commercial Area Daytime:65 dB Nighttime:55 dB Construction site 80dB **(Tokyo)** [Vibration] Commercial Area Daytime: 70 dB Night time: 65 dB **(Japan)** Construction site 70dB **(Tokyo)**			[Noise] Twice a week during construction period [Vibration] Underground sections: periodic measurement during construction	Noise: 4,500 / site·year Vibration: 400,000 / all sites·year
5-d		Construction sites shall be enclosed with a 2.5 m fence.	Same as “1-e”					
5-e		Daytime and Nighttime restrictions on heavy vehicle traffic, speed, and routes shall be applied in accordance to the rules, regulation and permission of State Trasport Department.	Monthly reports (traffic safety items) and visual inspection	-	All construction areas, batching plants, and casting yards	Construction Contractor	Monthly during the construction period	Contractor’s responsibility
5-f		If complaints arise, TBM pressure and vibration shall be reduced, and residents shall be informed that the vibration is temporary.	- Verification of monthly construction records - Complaints and feedback from nearby residents			Construction Contractor and MMRC		
5-g		In the event that cracks should occur, MMRC will determine whether compensation is to be provided through consultations with the building owners.					At the time of the incident	Contractor’s or MMRC’s responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
6-a	Ground subsidence	Application of appropriate construction measures such as earth retaining wall, penetration of piles to the support layer, and etc.	• Daily site checks by managers/environment officers • Review of monthly construction/monitoring reports	-	All construction areas	Construction Contractor	Monthly during the construction period	Contractor's responsibility
6-b		Application of ground reinforcement measures such as sand pile method to the soft-ground areas, if any.						
6-c		Continuous monitoring using settlement gauges and settlement plates.					Continuous (construction period)	
7	Offensive odor	Regular cleaning and collection of the general waste from camp sites with appropriate stock places and facilities to prevent offensive odor.	• Monthly reports (environmental items) and visual inspection • Confirmation of complaints or feedback from the community regarding odors	-	All construction areas	Construction Contractor	Monthly during the construction period	Contractor's responsibility
8-a	Biodiversity	Compensatory planting to prioritize native and vulnerable species (*Saraca asoca, Dalbergia latifolia*).	Verification of felling/transplantation/plantation plans Review of monthly reports on tree planting progress	-	All planting areas	Construction Contractor	Monthly during the construction period	Transplantation cost: 60,000 / tree Felling cost: 10,000 / tree (including 3 years of maintenance for each)
8-b		Plantation shall be carried out as much as possible within project areas such as station facilities.						
8-c		To secure the required number of plantations, alternative sites such as public land, parks, and school premises shall be utilized as much as possible; Green space development shall also be incorporated into surrounding station area development plans and along other metro lines in Mumbai. This activity shall form part of the landscaping and beautification plan for each station and will be implemented after completion of the station construction works..			All planting areas and alternative plantation sites	Construction Contractor and MMRC		

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
8-d		In compliance with relevant laws, transplantation of mature trees shall be implemented step by step under the supervision of arboricultural experts, with continuation subject to confirmation of survival rates.						
8-e		A dedicated subcontractor independent from the construction JV shall be appointed exclusively for plantation works, with a separately managed budget.				MMRC		
8-f		Same as "5. Noise and vibration".						
9-a	Hydrology	Sheet pile should be installed at the excavation work site in order to water sealing.	Monthly reports (construction records) and visual inspection	-	All construction areas	Construction Contractor	Monthly during the construction period	Contractor's responsibility
9-b		Closed mold type of TBM should be used in order to keep groundwater pressure.					During TBM operation	
9-c		Groundwater monitoring using construction well.	Measurement of groundwater level		Monitoring wells at each construction site		Twice annually during the construction phase (once in the rainy season and once in the dry season)	7,000 / site·year
10	Local economy such as employment and livelihood, etc.	Minimize impacts on business activities from construction fencing by securing road width in front of shops, etc.	Verification of construction fence locations	-	Construction areas	Construction Contractor	Before construction commencement	Contractor's responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
11	Water use and its rights	If the water quality deems to decline, appropriate water treatment measures such as water shielding and infiltration control should be implemented.	Same as "2. Water pollution"					
12-a	Existing social infrastructure and services	Make sure to provide safe access to sensitive facilities such as hospital, school, etc. during the construction period by installing traffic guides and warning signs, and if required, measures such as detour route should be set up based on the traffic congestion condition.	• Record and site observation • Confirmation of voices and complaints Status of electricity supply • Voices and complaints from the local community	-	Project affected area	Construction Contractor with relevant bodies	Before construction commencement and when complaints are heard in this regard	Contractor's responsibility
12-b		In cooperation with the relevant authorities, the relocation of underground utilities will be carried out to minimize adverse impacts on the local community.	• Record and site inspection • Interviews with concerned organizations • Confirmation of voices and complaints Safety of access roads to these sensitive facilities • Status of installation of signs, etc. • Traffic congestion • Voices and complaints from the local community	Construction Contractor	Construction areas and surrounding area	Construction sites and the surrounding area		
13	Maldistribution of benefit and damage	During construction, ensure safe access to sensitive facilities (hospitals, schools, etc.) by installing traffic guidance and warning signs, and implement detours as needed based on traffic congestion.	Same as "15-a"					
14-a	Local conflict of interest	Same as "13-b"						
14-b		Give employment opportunities to residents and municipalities evenly.	• Verification of employment status • Voices and complaints from the local community	-	Project affected area	Construction Contractor	Before construction commencement and when complaints are heard in this regard	Contractor's responsibility
14-c		If the residents and pedestrians complain about the construction activities, the consultant of the supervision and contractors should deal with them with a sincere response following the Grievance Redress mechanism and should designate staff in charge of public complaints and communications.	Confirmation of voices and complaints from the residents and pedestrians	Government of Maharashtra Construction Contractor	Construction areas	Construction Contractor and MMRC		

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
15	Gender	There must be care that there is no discrimination between male and female in employment and payment of wages/salaries.	Confirmation of equal pay for equal work based on the employment agreements. (If inadequate documents are identified, provide guidance to the contractor and require improvements.)	-	Construction areas	Construction Contractor	Before construction commencement and at the time of employment	Contractor's responsibility
16-a	Children's right	Child deployment prohibition policy to be implemented as per law.	• Voices and complaints from the local community and the construction workers Existence of child labor • Confirmation of the construction contract • Site observation	-	Project affected area	Construction Contractor	Before construction commencement and at the time of employment	Contractor's responsibility
16-b		Age verification in screening process through Government approved ID cards to be ensured						
16-c		Awareness posters shall display.						
16-d		Educational institutes shall be provided with adequate & safe access.	Same as "12-b"					
17-a	Health (Infectious diseases such as HIV/AIDS, etc.)	Arrange HIV/AIDS counselling through qualified NGOs; ensure confidentiality.	• Confirmation of health checklist of the workers and preferably of the local community • Implementation of Training • Interviews with concerned organizations • Confirmation of voices and complaints	-	Construction areas and surrounding area	Construction Contractor	Monthly during the construction period and when complaints are heard in this regard	Contractor's responsibility
17-b		Organize HIV/AIDS awareness activities (street plays, short films).						
17-c		Dos & Don'ts posters shall be displayed at site & labor camps.						
17-d		Condom promotion programs shall be conducted, and free condom distribution arrangement shall be ensured.						
17-e		Regular health checkup camps Awareness & training shall be arranged for Malaria & Dengue.						
17-f		Housekeeping & hygiene shall be maintained at project site & labor colony and fogging shall be done at both.						

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
18-a	Labor environment including labor safety	For the Project Site safety, measures below will be included: • Site specific SHE&W policy, Construction SHE&W Plan in line with condition of contract, on site emergency preparedness plan & Labors accommodation plan shall be implemented. • Underground safety measures – monitoring for oxygen deficiency, toxic gases & dust levels with continuous monitoring & alarms • Strict entry/exit protocols along with tally-boards in underground tunnel. • Work permit system shall be • followed. • Medical facilities – Ambulance, emergency contact nos. displayed & tie up with nearby hospitals.	• Confirmation of accidents records • Confirmation of health checklist of workers • Medical checkup of workers • Number of cases that suffered from heat strokes and other occupational health problems • Voice and complaints from the workers	-	Construction sites and surrounding area	Construction Contractor	Monthly and when complaints are heard in this regard	Contractor's responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
		• Tied up all local authorities such as Fire, police, Disaster Management & BMC (Municipal Corporation) • Electrical & Fire safety measures to be implemented. LOTO system to be ensured. • Proper ventilation system shall be provided at the underground tunnel working area. • Fatigue management – Regulations for working hours, rest breaks, and night shift management. • Ensure SCABA equipment use in tunnels. • Job specific trainings (on site & classroom) shall be conducted on timely. • Safety signages shall be displayed at all prominent location. • PPEs compliance: Safety helmet & shoes, reflective safety jacket and job specific PPEs (Goggle, Ear plugs, dust mask, Full body harness, breathing apparatus) • Housekeeping & hygiene shall be maintained at site. • Work at height: Standard & • approved scaffolding system & fall protection shall be used/implemented. • Availability of Rest shelters.		-				

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
18-b		For the Labor colony, measures below will be included: • Provide clean drinking water, sanitation, canteens, and bathrooms. • Construct separate kitchens as per labor capacity. • Fire preventions & emergency preparedness to be implemented • First aid facilities shall be available • Maintain effective drainage, garbage disposal, and sewage systems. • Housekeeping & hygiene shall be maintained • Construct separate kitchen shall be provided according to labor strength						
19-a	Accidents	Mitigation Measures for Traffic will include the following: • Traffic management plan shall be implemented in consultation with respective area authorities. • Install standard traffic signs and diversion boards. • Separate pedestrians' pathways with signs shall be provided • Conduct drivers' defensive driving training and safety vehicle checks; use GPS tracking. • Deploy traffic personnel along construction sections to assist traffic flow.	• Confirmation of accidents record • Record and site inspection • Interview with concerned organizations • Voices and complaints from the local community	-	Construction sites and surrounding area	Construction Contractor	Monthly and when complaints are heard in this regard	Contractor's responsibility

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
19-b		• Zero Accident Vision: Must adopt "Zero Harm Policy". • Method Statement, SOP & work permit shall be followed • Awareness training shall be • conducted. •Safety posters & signages shall be displayed • Mock drills shall be conducted timely • Fire & Electrical prevention • Record near misses and implement CAPA (Corrective and Preventive Actions).						
20	Cross-border impact and climate change	Same as "9. Biodiversity"						

Source: JST, MMRC

Table 5.10.2 Environmental Monitoring Plan (Operation Phase) proposed by the survey

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
1-a	Water Quality	Regular maintenance of toilets, Sewage Treatment Plant (STP), Effluent Treatment Plant (ETP), and related facilities at the station.	Verification through visual inspection and cleaning records	-	Navy Nagar station	MMRC	After commencement of operation: every six months for 2 years	Included in MMRC operating costs

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
1-b		Sampling to assess surrounding impacts	Sampling survey using the same method as the baseline Surface water: Color, odor, turbidity, pH, conductivity, total hardness, chlorides, iron, total dissolved solids, sulfates, nitrates, lead, copper, manganese, mercury, cadmium, zinc, total chromium, hexavalent chromium, total alkalinity, calcium, magnesium, sodium, potassium, dissolved oxygen, BOD, COD Groundwater: Color, odor, taste, turbidity, pH, chlorides, iron, total dissolved solids, sulfates, nitrates, fluoride, lead, copper, manganese, phenolic compounds, mercury, cadmium, arsenic, cyanide, zinc, detergents, total chromium, hexavalent chromium, total alkalinity, aluminum, boron, coliforms, E. coli	Surface water: **General Standards for Discharge of Environmental Pollutants in Environment (Protection) Rules, 1986** Groundwater: IS **10500 : 2018, Indian Standard, DRINKING WATER — SPECIFICATION** (Individual standard values omitted)	Surface and groundwater : 3 representative sites		Monthly	7,000 / site·year
2	Waste	Installation of enough garbage bin at appropriate location in the station and collection rules based on local collection systems.	• Confirmation of waste disposal forms • Waste management condition • Voices and complaints from the local community and passenger	-	Navy Nagar station	MMRC	Twice a year for the first two year	Included in MMRC operating costs
3-a	Noise and vibration	Conduct monitoring of vibration impacts during train operations.	Vibration level (Lv)	[Vibration] Commercial Area Daytime: 70 dB Night time: 65 dB	Representative Locations (Operating Section)	MMRC	Once each in hot, rainy and dry seasons for the first year, and once a year for the following two years.	Included in MMRC operating costs (Reference: Vibration: 400,000 / all sites·year)
3-b		Introduction and maintenance of elastic rail pads and vibration-reducing sleepers	Records and site observations	-	Entire metro line	MMRC	Twice a year for the first two year	Included in MMRC operating costs
4	Ground subsidence	Continuous monitoring with settlement gauges and settlement plates	Records and site observations	-	Entire metro line	MMRC	Twice a year for the first two year	Included in MMRC operating costs
5-a	Offensive odor	Regular cleaning and collection of the general waste from the station.	• Record and Site observation	-	Navy Nagar station and	MMRC	Twice a year for the first two year	Included in MMRC operating

No.	Impact Item	Mitigation Measure	Method / Survey Item	Standard	Location	Implementation Body	Period and Frequency	Cost (INR)
5-b		Installation of appropriate garbage bin with cover.	• Confirmation of voices and complaints Odor • Voices and complaints from the passenger and the local community		the surrounding area			costs
6-a	Biodiversity	A compliance report on compensatory plantation, accompanied by photographic documentation, shall be submitted to the Tree Authority on a semi-annual basis.	Compliance report and site observations	-	All planting areas and alternative plantation sites	MMRC: For 3 years after plantation BMC: Thereafter	Compliance Report submission: After planting: biannually for 3 years Confirmation of tree survival rate: After planting: annually for 3 years	Maintenance Cost Included
6-b		The General Consultant (GC) engaged by MMRC shall conduct regular audits on environmental and tree management activities as part of its routine duties.						
7-a	Gender	Active employment of female staff for MMRC with fair conditions	• Confirmation of employment record • Verification of Gender Training Records • Confirmation of voices and complaints from female staff of MMRC	-	HQ of MMRC	MMRC	Twice a year for the first two year	Included in MMRC operating costs
7-b		Keep provision of the designated seat for women on the train, enough number of toilet and other facilities as much as possible.	• Site observation • Confirmation of voices and complaints from female passengers • Status of introduction of the designated seat and facilities for female		Every station			

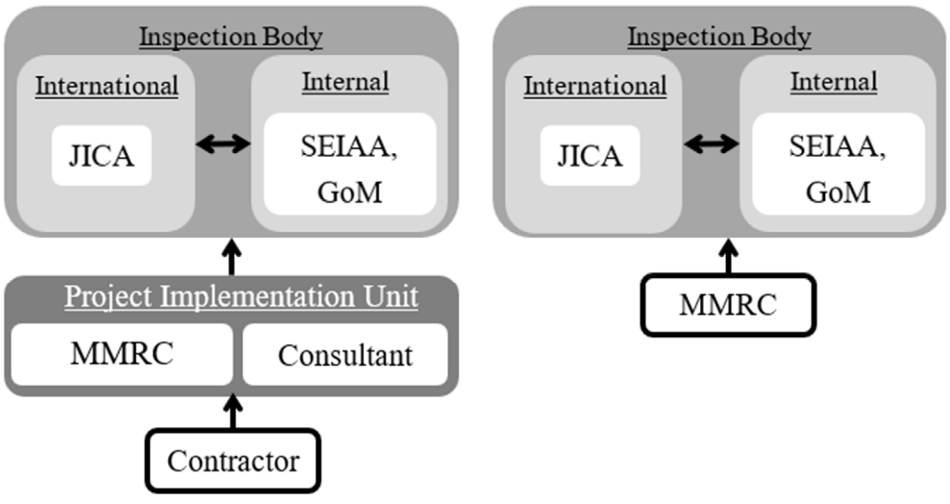
Source: JST, MMRC

5.11 Project Implementation Structure

5.11.1 Mitigation Measures and Monitoring Plan

This section outlines the implementation framework for the proposed mitigation measures and the corresponding monitoring plan. During the pre-construction and construction phases, the contractor will report to the Project Implementation Unit (PIU), and the PIU will submit regular progress reports to JICA. The reporting frequency from the PIU to JICA will be on a quarterly basis. As needed, the PIU will also report to the State Environment Impact Assessment Authority, Maharashtra (SEIAA-Maharashtra) - Mumbai's environmental supervisory authority—and follow its guidance. During the operation phase, MMRC will act as the responsible agency and submit regular reports to JICA. These reports will be provided twice a year for the first three years after the commencement of operation. In addition, MMRC, similar to the pre-construction and construction phases, will report to the SEIAA on an as-needed basis and seek necessary instructions.

Regarding MMRC's staffing structure, at present, MMRC has not employed in-house specialists for EIA and SIA. Therefore, all consultations related to EIA/SIA studies and environmental and social considerations are currently handled by subcontracted consultants. Moving forward, MMRC will need to actively recruit personnel in accordance with the scale and progress of the project. For example, in the case of DMRC, the EIA/SIA unit initially started with only a few members; however, through small-scale annual recruitment, the department has now grown to comprise more than a dozen personnel.



Source: JST

Figure 5.11.1 Implementation Framework During Construction and Operation Phases

5.11.2 Grievance Redress Mechanism for Environmental and Social Considerations

Grievances from residents and stakeholders shall be handled by either the Government of Maharashtra (GoM), which is the responsible in the construction of Cuffe Parade Station on Mumbai Metro Line 3, a 24-hour grievance redress mechanism (GRM) was established, comprising an on-site booth, a toll-free

hotline, and e-mail channels for receiving complaints from the public[65]. For this Project as well, the existing MMRC grievance redress mechanism will be applied as the basis. A grievance reception booth will be established at the MMRC headquarters, and submissions will be accepted through toll-free telephone, e-mail, and an official web form. Complaints will be electronically registered immediately, with formal responses issued within 15 days by the Field Level Grievance Redressal Committee (FLGRC). Unresolved cases are referred to and reviewed by Senior Level Grievance Redressal Committee (SLGRC).

Table 5.11.1 Composition and Roles of Grievance Redressal Committees in MMRC

Level	Committee Name	Composition (Examples)	Main Roles	Indicative Processing Time (Recommendation)
Field Level	Field Level Grievance Redressal Committee (FLGRC)	- Site Construction Manager - MMRC Site Officer - Representative of Survey agency - Representative of Supporting NGO, if requested - Representative of Project-Affected Persons (PAPs)	Immediate response to routine/minor grievances arising on-site (e.g., noise, vibration, traffic regulation, compensation issues). Ensures prompt initial action.	Within 15 days
Senior Level	Senior Level Grievance Redressal Committee (SLGRC)	- Senior MMRC Headquarters Officers - NGO Representative, if requested - PAP Representative - Independent Chairperson (e.g., subject-matter expert, legal professional)	Reviews cases unresolved by FLGRC. Conducts hearings and investigations for re-evaluation.	Within 30 days

Source: MMRC, Social Due Diligence Report, October 2018, MMRDA

[65] Grievance Redressal Mechanism Cuffe Parade Metro Station, 2018, MMRC

B. [Land Acquisition and Resettlement]

5.12 Objective of the Survey

The objective of the survey is to review and revise the draft Social Impact Assessment (SIA) report prepared by MMRC in August 2024 and updated in July 2025. Supplementary surveys are conducted to meet the JICA guidelines. This chapter is presented in the form of a Resettlement Action Plan (RAP), incorporating the requirements of JICA, which align with the SIA framework followed in India. Additionally, while Corridor-2 is excluded from this project, it was initially included in the survey scope and investigated. Therefore, this survey report contains some content regarding Corridor-2.

5.13 The Necessity of Land Acquisition and Resettlement

5.13.1 Affected Project Component and Project Area

The land acquisition and resettlement required by the Project are summarized in Table 5.13.1. No private land is required for Corridor-2.

Table 5.13.1 Affected Project Component and Land Requirements

Items	Project Components	Total land required	Private land
Alignment	Corridor-2: 1.45 km (Underground)	Corridor-2: 64,300 m^2	Corridor-2: N/A
Station	Corridor-2: 1 (Underground)		
Depot	N/A		

Source: JST based on draft SIA report for Corridor-2 prepared by MMRC in July 2024

5.13.2 Efforts to Avoid or Minimize the Impact

Attempts have been made during the designing of the project to minimize land acquisition, resettlement and adverse impacts on people in the project area through the suitable engineering designs. Steps have already been made to adjust the station size, confine the project area in the government land and in the available Right of Way (ROW) of roads where feasible.

However, there will be some unavoidable land acquisition for which adequate compensation has been considered. During the Detailed Design (D/D) stage, the Project will make further efforts to minimize impacts and disruptions as much as possible.

5.14 Legal Framework of Land Acquisition and Resettlement

5.14.1 Laws and Regulations of India and Maharashtra State

5.14.1.1 Summary of Applicable Laws and Regulations

This Project will be implemented in accordance with the relevant laws and regulations of the Government of India and the State Government, while also ensuring consistency with the JICA Guidelines. An overview of the legal framework applicable to this Project is provided below.

For this project, the land acquisition process will be carried out in accordance with Maharashtra Regional Town Planning Act 1966. Compensation will be calculated based on the provisions of the Right to Fair

Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (LARR 2013). The Resettlement and Rehabilitation Policy (R&R) will be guided by the Resettlement and Rehabilitation Policy for the Mumbai Urban Transport Project (MUTP).

Table 5.14.1 Legal framework related to this project

Related laws and regulations	Overview and Application to This Project
Land acquisition process and compensation	
Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (RFCTLARR 2013)	• This Act was implemented on 1 January 2014 and applies to all public projects as well as private projects (limited to relatively large-scale private entities as defined under the Companies Act, 2013). • It stipulates the procedures for land acquisition, the compensation policy, and the items and calculation methods for compensation *** Applicable for the land acquisition and compensation for this project**
Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Maharashtra) Rules, 2014	• This Act was implemented on 27 August 2014 and provides specific provisions regarding the relevant authorities and their roles in the land acquisition process within the State of Maharashtra.
Resettlement and rehabilitation policy and scheme	
Resettlement and Rehabilitation Policy for Mumbai Urban Transport Project (MUTP R&R 2000)	• This was applied to the Mumbai Urban Transport Project implemented with assistance from the World Bank. It was approved by the Government of Maharashtra through the State Assembly in 1997 and revised in 2000. The policy is consistent with the World Bank's Operational Policy OP 4.12 on Involuntary Resettlement. • It stipulates the definition of eligible persons for compensation, including informal settlers without legal titles or ownership documents, and provides guidance on the treatment of the cut-off date. *** Applicable for the resettlement and rehabilitation policy for this project**
The Maharashtra Regional and Town Planning (Amendment) Act, 2017 (MRTP Act)	• It provides a framework for the planned urban development across the entire state, including provisions on the formulation of regional and local development plans, land use regulation, development control regulations, procedures for obtaining development permissions, and environmental protection.
Development Control and Promotion Regulations (DCPR) 2034	• A detailed rulebook formulated under the MRTP Act, the DCPR outlines urban planning and development regulations for the Mumbai Metropolitan Region. It is enforced by the Brihanmumbai Municipal Corporation (BMC) and provides comprehensive guidelines on land use zoning, building standards, and redevelopment policies. *** Reference for the In-situ rehabilitation scheme**
Others	
Maharashtra Rent Control Act, 1999	• It aims to regulate rental agreements between tenants and landlords in Maharashtra, including Mumbai. It specifically sets detailed provisions on rent ceilings, eviction restrictions, maintenance responsibilities, and the rights of legal heirs, with a strong emphasis on protecting tenants' rights.

Source: JST based on relevant laws and regulations

5.14.1.2 RFCTLARR Act (2013) and Maharashtra State Rules (2014)

The basic law on land acquisition and compensation for resettlement in India is the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (LARR Act 2013), which came into effect on January 1, 2014. An outline of the processes stipulated by the LARR Act 2013 is shown in the table below. Corresponding to this land acquisition law, the Maharashtra State Rules 2014 — the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Maharashtra) Rules, 2014 — were enacted on August 27, 2014. The Maharashtra State Rules 2014 specifically define the relevant agencies and their roles.

The method for determining land prices under LARR Act, 2013 is stipulated in Chapter 4, Article 26. It requires that the market value of comparable land in the vicinity be assessed using two methods, with the higher of the two to be adopted. The valuation of buildings and other structures attached to the land is calculated using a methodology applied to the procurement of such structures in public works, based on unit prices that are updated annually. This is considered to reflect fair market value. Furthermore, the Act provides for the addition of solatium (compensation for emotional distress) to both the land and building values. As specified in the First Schedule of LARR Act 2013, the final compensation paid to the landowner is calculated as: Compensation = (Market value of the land as per sec 26 of LARR act x Multiplier factor in case of urban areas (one)) + Value of assets as per sec 29 of the act + solatium equivalent to 100%. Therefore, compensation under the Project is equal to or greater than the replacement cost of equivalent land and structures. In addition, in case of the land compensation, based on the direct purchase scheme of Maharashtra, 25% will be added to the compensation amount.

Table 5.14.2 Overview of Compensation and Assistance Provisions under the Land Acquisition Act (2013)

Item	Description
h. Establishment of a Public Oversight and Dispute Resolution Mechanism	• Establishment of a specialized body (LARR Authority) to resolve disputes related to land acquisition, resettlement, and livelihood restoration (Article 51)
i. Scope of Persons Covered by the Act	• Compensation is provided to landowners. • Those who lose their livelihoods due to land acquisition are eligible for rehabilitation and resettlement support.
j. Scope of Compensable Asset Losses	• Land, as well as buildings and attached structures on the land, are also subject to compensation.
k. Consultation Process	• Except in cases of "urgent acquisition" (Article 9), all projects involving land purchase by administrative authorities require a multi-stage consultation process, including social impact assessment and prior consent from affected households (Article 4(1)).
l. Land Price	• The higher of either the average registered sale price of comparable nearby land (based on the Stamp Duty Act) or the average sale price of comparable nearby land over the past three years (Article 26).
m. Building Price	• The valuation based on the standard calculation method used by the State Public Works Department (PWD) for constructing buildings in public works, along with annually updated unit prices for materials.
n. Total Payment Amount for Land Acquisition	• Compensation = (Market value of the land as per section 26 of LARR act x Multiplier factor in case of urban areas (one)) + Value of assets as per section 29 of the act + solatium equivalent to 100%.

Source: Land Acquisition Act 1894, Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (LARR) Act, 2013

5.14.1.3 Mumbai Urban Transport Project Resettlement and Rehabilitation Policy, 1997 (Revised in 2000)

The Government of Maharashtra applies the "Mumbai Urban Transport Project Resettlement and Rehabilitation Policy, 1997 (revised in 2000)" to urban transport projects. This policy complies with the World Bank's safeguard policies and ensures measures aligned with international standards, including the definition of eligible persons for compensation, support for resettlement and rehabilitation including non-titleholders, and assistance during the transitional period.

Table 5.14.3 Resettlement and Rehabilitation Policy

items	Key points
Eligible Persons for Compensation and Assistance	• Land and building owners, as well as their tenants and users, are defined as PAPs. • Support for relocation and resettlement is guaranteed for all Project Affected Persons, including non-title holders.
cut-off date	• For non-title holders, the cutoff date is defined as the completion date of the baseline survey. Any structures or occupants established after the cutoff date will not be eligible for Resettlement and Rehabilitation (R&R) assistance. • If more than one year has passed since the baseline survey and the RAP, the baseline survey shall be updated.
Scope of Compensation and Assistance	• Compensation for losses shall be provided at full replacement cost prior to actual relocation. • Support shall also be provided during relocation and the transitional period in the resettlement site.
Resettlement Options	• If relocation in urban areas is preferred, the following options are offered: - Non titleholder residential PAPs: Free residential units with an area of 20.91 m² - Titleholder residential PAPs: Free residential units with a minimum area of 20.91 m². Additional 48.77m² can be provided at cost depending on the size of the original building. - Commercial PAPs (both non title and title holder): Free commercial units with a minimum area of 20.91 m². Additional 48.77m² can be provided at cost depending on the size of the original building.
Support for Vulnerable Groups	• Special attention should be given to the needs of the extremely poor groups. • Additional support is required for socially vulnerable households, such as female-headed households, persons with disabilities, and the elderly.

Source: JST based on the policy document

5.14.1.4 Maharashtra Regional and Town Planning Act, 1966 (amended in 2017)

In Schedule 5 of the Land Acquisition Act, 2013, the Maharashtra Regional and Town Planning Act, 1966 is listed among the state laws regulating land acquisition in Maharashtra. This Act permits land acquisition for public purposes based on regional and town planning, allowing either payment of agreed compensation or granting additional floor area ratio (Floor Space Index: FSI) or transferable development rights (TDR). In particular, it stipulates that any land use changes after the publication of a draft regional plan require approval from the planning authority.

5.14.1.5 Maharashtra Slum Areas Act, 1971 and Slum Rehabilitation Act (SRA Act), 1995

To address slum areas within the state of Maharashtra, the Maharashtra Slum Areas Act provides a fundamental framework for improving living conditions in slum areas, protecting the rights of slum dwellers, and facilitating redevelopment. The Act has undergone multiple revisions reflecting challenges from slum redevelopment efforts and related laws and regulations, and it applies to the slum resettlement process of this project.

Complementing the Maharashtra Slum Areas Act (1971), SRA Act (1995) was established to provide a new specific framework for slum redevelopment, the Slum Rehabilitation Scheme (SRS), has been established. The SRS sets guidelines including the provision of free housing to slum dwellers and procedures for resettlement, outlining concrete methods for redevelopment implementation. It also includes a basic framework for incentives to developers. Furthermore, the Slum Rehabilitation Authority (SRA) was established as the implementing and supervisory agency for the SRS and slum redevelopment projects.

5.14.2 JICA Guidelines

The key principles of JICA guidelines on involuntary resettlement are summarized below.

1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.

   If avoidance is not possible even after such examination, effective measures to minimize impacts and to compensate for losses must be taken upon agreement with the affected people.

2. Project affected people, such as people to be resettled involuntarily and/or people who may lose their livelihoods by the project, must be provided sufficient compensations and supports by the project proponents in a timely manner. Compensations must be calculated at full replacement cost as much as possible, and provided in advance.

   Project proponents must make efforts for the affected people to improve or at least restore their standards of living, income opportunities and production levels to the pre-project levels.

   Measures to achieve this may include: Providing land or monetary compensations for losses of land or assets, supporting for alternative sustainable livelihood, supporting for expenses necessary for relocation, and supporting for re-establishment of communities at resettlement sites.

3. Compensation standards are disclosed and consistently applied.

   The project affected persons need to be aware of the compensation standards.

   In principle, the contents of the individual compensation to be agreed are explained to the project affected persons in writing, and the project affected persons can confirm the contents at any time.

4. Appropriate participation of the project affected people and their communities must be promoted in the planning, implementation and monitoring of measures against involuntary resettlement and loss of livelihood.

5. For projects that result in large-scale involuntary resettlement, a Resettlement Action Plans (RAP) must be prepared and made available to the public prior to the resettlement and provision of compensation and support.

   In preparing the RAP, consultations must be held with the project affected people and communities, based on sufficient information made available to them in advance.

   When consultations are held, explanations must be given in languages and forms that are understandable to the project affected people.

   It is desirable that the RAP includes elements laid out in the Environmental and Social Standard (ESS) 5 of the World Bank's environmental and social policies.

Above principles are complemented by World Bank ESS5, since it is stated in JICA Guideline that "JICA confirms that environmental and social considerations of a project do not deviate significantly from the World Bank's environmental and social policies.". Additional key principle based on World Bank ESS5 is as follows.

1. the Borrower will, as part of the environmental and social assessment, conduct a baseline survey to identify the persons who will be affected by the project, to establish an inventory of land and assets to be affected, to determine who will be eligible for compensation and assistance, and to discourage ineligible persons, such as opportunistic settlers, from claiming benefits.(ESS5 para20).
2. Affected persons may be classified as persons:

   (a) Who have formal legal rights to land or assets

   (b) Who do not have formal legal rights to land or assets, but have a claim to land or assets that is recognized or recognizable under national law; or

   (c) Who have no recognizable legal right or claim to the land or assets they occupy or use. (ESS5 para10) the Borrower will offer affected persons compensation at replacement cost, and other assistance as may be necessary to help them improve or at least restore their standards of living or livelihoods, subject to the provisions of paragraph 26 through 36 of this ESS. (ESS5 para 12)
3. Where livelihoods of displaced persons are land-based, or where land is collectively owned, the Borrower will offer the displaced persons an option for replacement land in accordance with paragraph 35(a), unless it can be demonstrated to the Bank's satisfaction that equivalent replacement land is unavailable. (ESS5 para14)
4. Transitional support will be provided as necessary to all economically displaced persons, based on a reasonable estimate of the time required to restore their income earning capacity, production levels, and standards of living. (ESS5 para36)
5. Particular attention will be paid to gender aspects and the needs of the poor and the vulnerable. (ESS5 para26)
6. To address the issues identified in the environmental and social assessment, the Borrower will prepare a plan proportionate to the risks and impacts associated with the project (ESS5 para21)

In addition to the above core principles on the JICA policy, it also emphasized a detailed resettlement policy inclusive of all the above points; a project-specific resettlement plan; an institutional framework for implementation; a monitoring and evaluation mechanism; the schedule for implementation; and, a detailed Financial Plan, etc.

Source: JICA Guidelines for Category B Environmental and Social Consideration Reports (March 2025)

5.14.3 The Gap between JICA Guidelines and Indian Legislation

This project, particularly the development of Corridor 1 (Line 11), is expected to impact land acquisition, resettlement, and livelihoods. Therefore, the discrepancies between JICA's social safeguards guidelines and Indian regulations are summarized in the table below.

Table 5.14.4 The Gap between JICA Guidelines and Indian Legislation

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	**LARR 2013** **Article 4 and Article 8(1)(c):** Only the minimum land necessary for project implementation shall be acquired. **Article 8(2):** The administrative authority overseeing land acquisition and environmental impacts shall verify and supervise that resident displacement due to the project is minimized, that impacts on infrastructure and the natural environment are kept to a minimum, and that the adverse effects on affected individuals are avoided or mitigated to the greatest extent possible.	No	Through project planning and design, feasible alternatives shall be formulated and evaluated using assessment methods that adequately consider involuntary resettlement and loss of livelihoods, ensuring that options with the least impact are selected.
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	**LARR 2013** **Chapter II:**Conduct social impact assessments on affected persons during land acquisition, publish draft compensation and support policies, and formulate final compensation and support policies that incorporate the opinions and suggestions of affected persons. **Article 3(c):**The scope of compensation and support covers land and asset owners as well as those whose primary livelihood depends on the land to be acquired. **R&R MUTP 2000** 3(a) By examining feasible alternatives, minimize resettlement and prioritize various elements of the project.	No	Ensure that alternatives for the planned route have been examined with a focus on minimizing impacts.
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost, must be sufficiently compensated and supported so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	**LARR 2013** **Article 3(p), Article 27, and Article 29:** The scope of assets and losses eligible for compensation includes land, buildings attached to the land, and structures attached to the buildings. **Article 26:**Land price shall be the higher of the average registered sale price of nearby land or the notified market price. **Article 28(5):**Compensation includes expenses necessary for relocating residences and business premises.	No	Regardless of ownership status of land and assets, tenancy, or length of residence, households displaced by this project will be consulted to provide relocation inconvenience allowances that include livelihood support grants, moving assistance grants, and compensation for disrupted income opportunities. Additional support funds and skills training will be discussed for households classified as socially vulnerable.
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL) Valuation and	**LARR 2013** **Article 26:**The land price shall be the higher of the average registered sale price of comparable nearby land (based on the Stamp Duty Act) or the average sale price of comparable nearby land	Although there is no explicit instruction to compensate at replacement cost, an additional payment based on	Structure value of assets will be assessed using area unit prices based on market prices without considering depreciation, with discussions to include an additional 100%

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
	compensation for losses shall be determined by the replacement cost. (WB OP4.12 Para 10)	over the past three years. **Article 29:**Experts shall be consulted to determine the market value of trees, crops, and similar assets. **Article 30:**An equal amount of solatium shall be paid in addition to the total compensation amount.	the adopted market land price is mandated, with solatium at a rate of 1.0 times in urban areas and 2.0 times in suburban areas.	solatium. For land prices, 100% solatium will be added to the market rate. Additionally, 25% will be added to the compensation amount under direct purchase scheme. Ultimately, since all the project area falls under in urban areas, the compensation amount is expected to be twice the market price (solatium 1.0x plus urban area 1.0) and in case of land, 25% will be added, indicating that compensation under this project is likely to exceed replacement cost.
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	**LARR 2013** **Article 46(4):** No alterations to the land shall be made until compensation and support payments are completed. **R&R MUTP 2000, 3(b):** Just prior to actual relocation, affected persons shall be compensated for their losses at replacement cost.	No	Discussions will be held to ensure that a sufficient grace period is provided between the payment of compensation and support for land and assets and the relocation.
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	**LARR 2013** **Article 6(1):** The Social Impact Assessment (SIA) shall be widely disclosed by posting at municipal offices and on websites. **Article 18:** The Resettlement and Rehabilitation (R&R) plan shall be widely disclosed by posting at municipal offices and on websites. **LARR Maharashtra 2014** **Article 5(13):** The finalized SIA shall be published in two local-language newspapers. **Article 8(1):** The expert group's evaluation and advice on the SIA shall be published in two local-language newspapers and posted on the state government website. **Article 13(1)(2):** The finalized R&R shall be publicized by publication in two local newspapers and made available at municipal offices. **R&R MUTP 2000** **14(b):** The draft Resettlement Action Plan (RAP) shall be shared with affected persons, NGOs, and the general public through community meetings, and finalized taking into account the opinions of affected persons.	No	The implementing agency is currently preparing the resettlement plan and livelihood restoration plan in accordance with the law. Going forward, it will be confirmed that responses aligned with the JICA guidelines are implemented and that the plans are made publicly available.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	**LARR 2013** Article 4(2): At the start of the Social Impact Assessment (SIA), a notification shall be issued in the local language, publicly displayed in the affected area, and posted on the websites of the district and municipal offices as well as relevant administrative agencies. Article 5: When conducting the SIA, a public hearing shall be held in the affected area to	No	Regarding Corridor 2, a project explanation was given at the SHM in June 2024. Since there will be no private land acquisition or resettlement, a resettlement plan will not be created.

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
		ensure that the opinions of PAHs are accurately recorded in the SIA report. Article 16(5)(6): Public hearings on the draft Resettlement and Rehabilitation (R&R) plan shall be conducted after widely publicizing the date, time, and venue. The R&R report, along with a document summarizing the opinions of PAHs, shall be submitted to the District Collector. **LARR MH 2014** Article 5(1): After drafting the SIA report, the date and venue of the public hearing shall be published in two local-language newspapers at least 15 days prior to the hearing. Article 5(5)(6): The SIA shall be finalized taking into account opinions and proposals from the public hearing, and the recordings and minutes of the hearing shall be submitted to relevant agencies. Article 11(5)(6): After drafting the R&R plan, the date and venue of the public hearing shall be published in two local-language newspapers at least 15 days prior to the hearing.		
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	**LARR 2013** **Article 5:** When conducting the Social Impact Assessment (SIA), public hearings shall be held to ensure that the opinions of households subject to the SIA are incorporated. **Article 6:** The SIA shall be prepared and published in the language of the project area and disclosed on the websites of the district and municipal offices as well as relevant administrative agencies. **LARR MH2014** **Article 5(9):** Public hearings shall be conducted in the local language.	No	In SHM, confirmation and consultation will be conducted in local languages, taking into consideration the need for communication in local languages.
9	Appropriate participation of affected people must be promoted in the planning, implementation, and monitoring of resettlement action plans. (JICA GL)	**LARR 2013** **Article 5:** When conducting the Social Impact Assessment (SIA), public hearings shall be held to ensure that the opinions of households subject to the SIA are incorporated. **Article 50:** The state shall establish a committee to monitor the implementation of the Resettlement Action Plan (RAP). LARR Maharashtra 2014 **Article 20:** The state shall establish a project-level Resettlement and Rehabilitation (R&R) committee to provide advice on the R&R plan, monitor progress every three months, and conduct post-implementation monitoring. **Article 21:** The state shall establish a monitoring committee to oversee the implementation of R&R every six months. R&R MUTP 2000 **14(b):** The Resettlement Action Plan (RAP) must be prepared with the participation of the PAPs.	There are no provisions regarding the participation of affected persons during the implementation and monitoring stages of the plan.	Efforts should be made to ensure the participation of affected persons during the implementation and monitoring stages of the RAP. Specifically, during the implementation stage, NGOs or consultants responsible for execution should be encouraged to conduct individual interviews with Project Affected Households (PAHs). During the monitoring stage, it is recommended to include provisions requiring PAH participation in participatory surveys, group monitoring, and sample surveys conducted by external monitoring experts.
10	Appropriate and accessible grievance mechanisms must be	**LARR 2013** **Article 7 :**SIA reviews shall be conducted by a group of experts including representatives from	No	Confirm the specific implementation status of SIA reviews, acceptance of

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
	established for the affected people and their communities. (JICA GL)	the municipalities where the projects are to be implemented. **Article 15:** The Collector shall accept objections to the acquisition area, acquisition purpose, and SIA survey results. **Article 16:** The R&R proposal shall be made public through public hearings, etc., and opinions and objections shall be recorded and finalized by the Collector and the Government. **Article 50**: The state shall establish a committee to monitor the implementation of R&R. **Article 64:** Complaints regarding land surveys, compensation amounts, payment recipients, and eligibility for support and relocation shall be submitted to the implementing authority through the Collector. **MUTP R&R 2000** **15:** Two-tier Grievance Redress Mechanism (GRM) will be established. A senior office at the local level will first consider grievance of PAPs in consultation with the concerned NGO, and unresolved cases will be reviewed by a higher-level committee by the Government to ensure fair and transparent resolution.		appeals, record keeping, resolution, etc. as stipulated by law, and confirm the ease of access and the smoothness and speed of complaint resolution.
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey, preferably at the project identification stage, to prevent a subsequent influx of encroachers who wish to take advance of such benefits. (WB OP4.12 Para.6)	**LARR 2013** **Article 4:** When an administrative agency intends to acquire land for public purposes, it shall consult with the municipality and conduct an SIA. **MUTP R&R 2000** **6 (a)** The completion date of the baseline survey shall be the cutoff date. Buildings newly constructed after the cutoff date and their residents shall not be subject to R&R.	For titleholders, the date of the preliminary notification will be set as the cutoff date, and for non-title holders, the date of completion of the baseline survey will be set as the cutoff date.	The cut-off-date of Corridor 2 was set for June 23, 2023, the completion date of the baseline survey based on MUTP R&R 2000.
12	Eligibility of benefits includes; the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of baseline survey but have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	**MUTP R&R 2000** **6 (a)** Regular residents shall be eligible for R&R until the actual resettlement. Irregular residents shall be eligible for R&R only if they are recorded in the baseline survey (the completion date of the baseline survey is the cutoff date). If there is a gap of more than one year between the baseline	No	For non-titleholders, they are eligible for R&R assistance regardless of the length of their residence, as per the R&R MUTP 2000.
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-	**LARR 2013** **Appendix 2:** One of the options for compensation for loss of land ownership is the provision of replacement land.	No farmland or tenant farmers are affected. Therefore not applicable to this project.	No farmland or tenant farmers are affected. Therefore not applicable to this project.

No.	JICAGuideline(2002)	Land Acquisition Act (LARR 2013) / (LARR MH2014) / (R&R MUTP 2000)	GAP	Tentative Policy for This Project
	based. (WB OP4.12 Para.11)			
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	**LARR 2013** **Appendix 2:** Provide relocation households with lump-sum payments or employment opportunities (employment opportunities, lump-sum payments, or 20-year pensions in the relevant business), one year of living expenses (monthly payments), relocation compensation, etc.	No	This project will provide relocation assistance and support for livelihood to households that are forced to relocate. Discuss additional support and skills training to households that are socially vulnerable.
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	**LARR 2013** **Article 41:** Land acquisition in the settlements of designated castes and tribes shall be avoided as far as possible, and additional support shall be provided to those affected when necessary. **LARR MH 2014** **Article 17 (4):** In cases involving involuntary relocation of designated castes and tribes, the state government shall prepare a development plan. **MUTP R&R 2000** **12(c)** Additional resettlement packages shall be provided to vulnerable groups such as female heads of households, persons with disabilities, and the elderly.	The definition of socially vulnerable groups may be too narrow.	Additional support will be provided to vulnerable PAH who meet the following conditions: those with incomes below the poverty line, households headed by women, persons with disabilities, and elderly persons (aged 60 or older) who have no support from other family members.

Source: JST based on the relevant laws

5.14.4 Land Acquisition and Resettlement Policy

Based on the above gap analysis, the land acquisition and resettlement policy to be adopted in the Project are described below.

I. The Government of India will use the Project Resettlement Policy (the Project Policy) for the Project specifically because existing national laws and regulations have not been designed to address involuntary resettlement according to international practice, including JICA's policy. The Project Policy is aimed at filling-in any gaps in what local laws and regulations cannot provide in order to help ensure that PAPs are able to rehabilitate themselves to at least their pre-project condition. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Where there are gaps between the Indian legal framework for resettlement and JICA's Policy on Involuntary Resettlement, practicable mutually agreeable approaches will be designed consistent with Government practices and JICA's Policy.

II. Land acquisition and involuntary resettlement will be **avoided** where feasible, or **minimized**, reduced, mitigated by identifying possible alternative project designs that have the least adverse impact on the communities in the project area

III. Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods or resources will be **fully compensated** and assisted so that they can improve, or at least restore, their former economic and social conditions.

IV. Compensation and rehabilitation support will be provided to any PAPs, that is, any person or household or business which on account of project implementation would have his, her or their:

- Standard of living adversely affected;
- Right, title, or interest in any house, interest in, or right to use, any land (including premises, agricultural land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
- Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; or

- Social and cultural activities and relationships are affected or any other losses that may be identified during the process of resettlement planning.

V. All affected people will be eligible for compensation and rehabilitation assistance, **irrespective of tenure status**, social or economic standing, and any such factors that may discriminate against the achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives. All PAPs residing, working, doing business, and/or cultivating land within the project-impacted areas **as of the date of the latest baseline survey** and inventory of lost assets, are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity, and production levels.

VI. PAPs that **lose only part of their physical assets** will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of the remaining land and structures will be agreed upon during the resettlement planning process.

VII. People **temporarily affected** are to be considered PAPs and appropriate support will be considered.

VIII. Where a **host community** is affected by the development of a resettlement site in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.

IX. The **resettlement plans** will be designed in accordance with Bangladesh's ARIPA 2017, and JICA guidelines on Involuntary Resettlement.

X. The Resettlement Plan will be **translated** into local languages and **disclosed** for the reference of PAPs as well as other interested groups.

XI. Payment for land and/or non-land assets will be based on the principle of the **replacement cost**.

XII. Resettlement assistance will be provided not only for an immediate loss but also for **a transition period** needed to restore the livelihood and standards of living of PAPs.

XIII. The resettlement plan must consider the needs of those most **vulnerable** to the adverse impacts of resettlement (including the poor, those without legal title to land, and women, children, elderly, and disabled) and ensure they are considered in resettlement planning and mitigation measures identified. Assistance should be provided to help them improve their socio-economic status.

XIV. PAPs will be **involved** in the process of developing and implementing resettlement plans.

XV. PAPs and their communities will be **consulted** about the project, the rights and options available to them, proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.

XVI. Adequate **budgetary support** will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the Government.

XVII. **Displacement does not occur before the provision of compensation and other assistance** required for relocation. Sufficient civic infrastructure must be provided in the resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. (Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be ongoing activities.)

XVIII. Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

XIX. Appropriate reporting (including auditing and redress functions), monitoring, and evaluation mechanisms, will be identified and set in place as part of the resettlement management system. If numbers of resettlement is large, an external monitoring group will be hired by the project and will evaluate the resettlement process and final outcome. Such groups may include qualified NGOs, research institutions or universities.

Cut-off-date of Eligibility

The cut-off-date of eligibility refers to the date prior to which the occupation or use of the project area makes residents/users of the same eligible to be categorized as PAPs and be eligible to Project entitlements. In the Project, the cut-off dates will be set as follows and these dates will be disclosed to each affected area by the relevant local governments and will be disclosed to their populations. This date will be disclosed to each affected village by the relevant local governments and the villages have disclosed to their populations. The establishment of the eligibility cut-off date is

intended to prevent the influx of ineligible non-residents who might take advantage of Project entitlements.

- Corridor-2: Cut-off dates on completion date of baseline survey (23 June 2023).

Principle of Replacement Cost

All compensation for land and non-land assets belonging to titleholders (eligible as per the cut-off date) shall be provided in accordance with the provisions of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (LARR) Act, 2013.

Non-titleholders/tenants of household/ commercial/ shops (eligible as per the cut-off date) will be allotted new tenements on an ownership basis.

In case of cash compensation, the replacement cost will be calculated without depreciation and without deductions towards taxes or transaction costs subject to provisions of applicable laws.

5.15 Scope of Land Acquisition and Resettlement Impact

5.15.1 Survey Method

The methodology for conducting SIA study of the proposed project involves review of topographical survey drawings, field visits, data collection and stakeholder consultations, as described as below.

a) Site observation and preliminary assessment

Initial site visits and assessments were conducted to identify potentially affected structures based on the General Alignment Drawings from the Detailed Project Report (DPR) shared by MMRC.

b) Baseline socio-economic survey (BSES)

A baseline socio-economic survey was conducted to interview Project-Affected Families (PAFs), including structure owners, tenants, squatters, kiosk operators, small business owners, and workers dependent on affected land/structures. The survey aimed to collect information on their socio-economic conditions.

c) Consultation with concerned stakeholders

Stakeholder consultations were conducted in two locations to capture diverse community perspectives.

d) Data compilation and analysis

Collected data are analyzed to understand the scale of the impact as well as understanding PAP's demographic, social, and economic characteristics which are essential for designing effective resettlement and rehabilitation plans.

5.15.2 Cut-off-date (COD)

COD for Corridor-2 has been set as 23 June 2023, corresponding to the date of completion of the BSES, based on MUTP R&R 2000. This information was given verbally to the community leaders during the SIA survey. Once the DPR is approved by the Government of Maharashtra, it will be notified through official media, including newspapers. Informal residents who settled in the affected area after the cut-off date will not be eligible for compensation.

5.15.3 Key Impact of the Project

According to the draft SIA report prepared in July 2024, Corridor-2, which extends from Cuffe Parade Station to Navy Nagar Station, will require land for station buildings, entrance/exit structures,

ventilation shafts, and other associated facilities. All land to be acquired falls under government ownership, with the total area required detailed in the table below. A total of 64,300 m^2 will be affected by the Project, of which 2,500 m^2 will be permanently acquired and 61,800 m^2 will be temporarily required during the construction period. The proposed depot for Corridor-2 will be located at Aarey Milk Colony, in the northern section of Line 3. As this site is already under construction and dedicated to metro operations, no additional land acquisition will be necessary.

Table 5.15.1 Land acquisition area and number of affected buildings

Owner	Building Use	Permanently (m^2)	Temporarily (m^2)	Total (m^2)
Central Government	Army Land	900	800	1,700
	Navy Land	1,600	2,500	4,200
	Tata Institute of Fundamental Research (TIFR)	-	900	900
State Government	Other	-	57,500	57,500
Total		**2,500**	**61,800**	**64,300**

Source: Draft SIA report prepared by MMRC for Corridor-2 in July 2024

The baseline survey for Corridor 2 was conducted in June 2023. As shown in the table below, all affected structures are government-owned buildings. A total of 14 structures will be affected. Among them, a boundary wall and a bus stop will be fully affected, while the remaining structures—including primarily boundary walls and other facilities—will be partially affected. After the completion of the Project, MMRC will reconstruct the affected structures and hand them back to the respective owning agencies.

Table 5.15.2 Affected Structure by Type of Use, Degree of Impact and Type of Structure

No.	Type of uUse	Degree of Impact	Type of Structure	Affected Area (m^2)
1	Boundary Wall (Government Office)	Partially	Permanent	72
2	Boundary Wall (Government Office)	Partially	Permanent	-
3	Bus Stop	Fully	Semi-parmanent	4
4	Shed (Military Engineering Department)	Fully	Temporary	22
5	Boundary Wall + Other Structure (Military Use)	Partially	Permanent	98
6	Boundary Wall （Kendriya Vidyalaya）	Partially	Permanent	-
7	Boundary Wall (TIFR: Tata Institute of Fundamental	Partially	Permanent	168
8	Boundary Wall (Government Quarters)	Partially	Permanent	43
9	Boundary Wall (Government Quarters)	Partially	Permanent	123
10	Boundary Wall (Government Quarters)	Partially	Permanent	20
11	Boundary Wall (Government Quarters)	Partially	Permanent	45
12	Boundary Wall (TIFR: Tata Institute of Fundamental	Partially	Permanent	24
13	Bus Stop	Fully	Semi-parmanent	9
14	Bus Stop	Fully	Semi-parmanent	18

Source: Draft SIA report prepared by MMRC for Corridor-2 in July 2024

	
Cuff Parade Station Area	Navy Nagar Station area

Source: Draft SIA report prepared by MMRC for Corridor-2 in July 2024

5.16 Gender Mainstreaming

5.16.1 Analysis

5.16.1.1 Policy

The Government of India is implementing initiatives to ensure equal legal rights for men and women through the policies outlined in the table below. In 2024, the Fourth Women's Policy was enacted in Maharashtra State with the aim of achieving comprehensive empowerment for women. Under this policy, implementation plans were formulated for eight priority areas, including health, nutrition, and welfare, education and skill development, gender-sensitive governance and political participation, and the elimination of sexual and gender-based violence (SGBV). The policy also clarified the responsible departments, set indicators, and established a committee system at the state, district, and sub-district levels to monitor progress. Specifically, regarding the eradication of gender-based violence, measures include establishing Internal Committee in all organizations to prevent sexual harassment in the office, and setting up one-stop service windows called Bharosa Cells at each police headquarters to strengthen support for victims, particularly women and children.

In addition, Indian domestic law stipulates that 33% of seats in the lower house of parliament and all state assemblies must be allocated to women. In Maharashtra state, since 2011, a bill has been passed and implemented to increase the quota for female councilors from the previous 33% to 50% in local councils (Gram Panchayats) and municipal councils in urban areas. Additionally, in the recruitment of state government employees, a 33% quota for women has been established in the Maharashtra Public Service Commission (MPSC) examination, applicable to general administrative positions, educational roles, and police departments.

Table 5.16.1 Gender-sensitive laws, policies, and guidelines

General policy targeting women	• **Fourth Women's Policy, 2023:** It was introduced to promote women's empowerment in eight priority areas (health, education, violence eradication, livelihood support, infrastructure, political participation, natural resources, and sports) targeting Maharashtra State. Indicators and implementation plans were set for each field, and a three-tier committee system was established at the state, prefecture, and district levels to monitor the progress of the implementation plans.

Laws prohibiting gender-based violence and harassment	• **Dowry Prohibition Act, 1961:** Penalties for demanding dowry - Dowry for the benefit of the wife or heirs. • **The Sexual Harassment of Women at Work Place (Prevention, Protection and) Act, 2013 (POSH):** Internal Grievance Committee, Regional Grievance Committee, Employer Obligations, District Officer Obligations and Authority
Laws related to relocation and compensation	• **The Hindu Women's Right to Property Act, 1937:** Property rights of Hindu widows • **The Hindu Succession (Amendment) Act, 2005:** Hindu women are granted the right to be joint heirs or joint legal heirs, just like male heirs. Under Islamic law, ownership is very complicated.
Labor law	• **The Equal Remuneration Act, 1976:** equal pay for men and women
Reserved employment slots for women	• **Constitution 1993:** The constitutional amendment stipulates that one-third of the leaders of gram panchayat village councils, or the position of sarpanch, should be reserved for women. • **The Constitution (One Hundred and Twenty-Eighth Amendment) Act, 2023 (Women's Reservation Bill):** The goal is to reserve 33% of seats in the House of Representatives and all state legislatures for women. Implementation is expected to begin in 2029, and the quota for women will remain in effect for 15 years after the amendment comes into force.
Support for women entrepreneurs	• **Stand Up India Scheme 2016:** ➢ **Purpose: Supporting entrepreneurship among women starting their first business and entrepreneurs from designated castes and tribes (greenfield enterprises).** ➢ **Support Details:** Support for establishing a company, obtaining loans, and other support necessary for business success. ➢ **Bank loans (including term loans and working capital):** Between INR 10 lakh (US$ 14,000/approx. 2 million yen) and INR 1 crore (US$ 140,000/approx. 20 million yen). ➢ **Target Seminar:** Manufacturing, service industries, agriculture-related activities, and trade. ➢ A new scheme is scheduled to start in September 2025, targeting approximately 500,000 new female and SC/ST entrepreneurs, with the maximum amount increased to 2 crore rupees.

Source: JST

5.16.1.2 Situation of female employees at MMRC

As of April 2025, MMRC had a total staff of 277 employees, of whom 44 were women. Among these, there were 8 female engineers and 24 women in managerial positions. The top executive role, Managing Director, is also held by a woman.

MMRC also implements gender considerations in accordance with domestic law. In terms of preventing sexual violence and harassment, it has established an Anti-Sexual Harassment Policy, which clearly states that "all employees are guaranteed equal employment opportunities regardless of gender, race, religion, marital status, or disability, and that sexual harassment in the workplace is not tolerated as a serious violation."

5.16.1.3 Women's Use of Public Transportation in Mumbai

In Mumbai's bus transportation system, the introduction of priority seats for women and women-only buses is progressing. In addition, all trains have women-only cars, and women-only spaces are also provided in the metro system.

Observations during the field survey confirmed that women regularly use buses and auto-rickshaws, though their numbers were smaller compared to male passengers. In a survey conducted in April 2025 at a train station, 160 individuals—including 65 women who could potentially be users—were interviewed about their quality of life (QOL), daily mobility patterns and frequency, and their needs for facilities and services in the metro. The survey results showed that women's mobility patterns mainly involve commuting to work or school using public transportation on a daily basis. For other activities

such as leisure, shopping, and medical visits, which are less frequent, women tend to use taxis, motorcycles, auto rickshaws, and other means of transportation as needed. The most commonly used transportation means for commuting and commuting to school were railways, followed by buses, motorcycles, taxis, auto rickshaws, private cars, and walking. In the four FGDs targeting women, railways and buses were primarily cited as the main transportation means currently used, but there were reports of severe issues regarding congestion and safety during nighttime and morning hours.

5.16.1.4 Requests from female public transport users in Mumbai

From February to March and June 2025, we conducted four interviews with female participants in focus group discussions (FGDs) to gather opinions on services that should be provided for female passengers. During these interviews, participants raised the following opinions and requests: affordable fares, women-only cars, easy-to-understand signage, appropriate frequency of service, placement of female security guards and security cameras in station buildings to improve safety, and clean facilities and restrooms. Additionally, in the survey conducted at the station entrance, we conducted interviews with female passengers regarding the priority of facilities and services they expect from the metro. Among the priorities, improvements to station facilities such as restrooms, stairs, elevators, and ramps, appropriate fares and operating frequencies, and measures to prevent harassment and enhance safety were highlighted. Specific measures mentioned included the deployment of female-only security personnel, the installation of CCTV cameras, and the establishment of a hotline. Given this situation, there is a need for transportation options that prioritize women's safety. Therefore, when designing and operating Line 11, it is essential to incorporate considerations based on women's opinions.

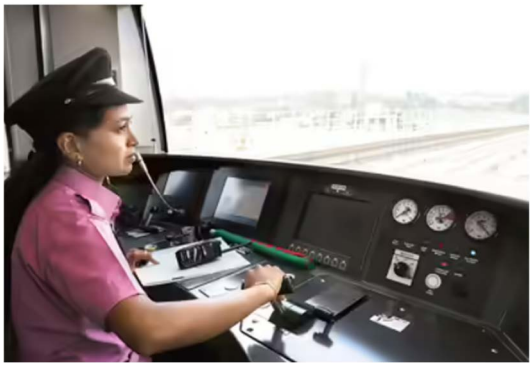
5.16.1.5 Examples of gender mainstreaming in metro projects in India

We collected information on gender mainstreaming in the design and activities of metro projects in India. Many metro operators plan to aggressively recruit female employees in a variety of positions.

Table 5.16.2 Examples of gender mainstreaming in other metro and railway projects in India

Timing and challenges	Examples of gender-related strategies
Station design	• Set up a women's consultation desk at the station
Employment during the construction phase	（No information found）
Employment during the operation phase	• 30% of train drivers are to be female. • 80% of metro employees are to be female. • Established stations operated and managed exclusively by female employees. • Assigned female employees who have undergone martial arts training to stations and trains.
Vehicle operation	• Throughout the day, one car (32 seats) in each 6-car or 8-car train are reserved for women. • All cars have seats reserved for women. • All cars have seats reserved for the elderly, women, and people with disabilities. • Half of one car in each train are reserved as a women's zone. • One women-only train run during the morning and evening rush hours.

Source: JST

	
Indian Railways uses pink cars to indicate women-only cars.	Female drivers on the Namma Metro
	
Chennai Metro has stationed female staff members trained in martial arts at stations and on trains to ensure women's safety and enable rapid response.	Tape indicating the women-only zone inside a train in Hyderabad

Source: https://www.financialexpress.com/infrastructure/railways/unique-initiative-for-women-safety-indian-railways-nfr-zone-earmark-coaches-with-pink-for-easy-identification/1661659/
https://bangaloremirror.indiatimes.com/bangalore/cover-story/at-namma-metro-women-are-at-the-wheel/articleshow/56860979.cms
https://wcag.chennaimetrorail.org/pink-squad/
https://www.thehindu.com/life-and-style/the-ladies-compartment-on-the-metro-is-yet-to-become-an-exclusive-space-that-keeps-men-out/article24013728.ece

Figure 5.16.1 Examples of gender integration in other metro and railway projects in India

5.16.2 Proposals for gender-sensitive activities

5.16.2.1 Gender consideration in station design

The Gender Action Plan (GAP) for the DPR and Corridor 2 of Route 11 confirmed that the station facilities were designed with the gender considerations shown in the table below.

Table 5.16.3 Gender-sensitive planning for Mumbai Metro station facilities

Facilities	Gender-sensitive planning
Train car	Each car will have seats reserved for women, and there will also be cars reserved exclusively for women. Each car will be equipped with an emergency alarm system.
Separate restrooms for men and women	Installment of separate restrooms for men and women for both passengers and station staff at all stations. The restrooms will be equipped with children's toilets, sanitary product vending machines, and touchless trash cans with lids.
escalator	Install saree guards on escalators inside stations.
Deployment of female security guards	Female security guards have been stationed at stations to increase the safety and comfort of female passengers.
Separate security gates for men and women	Two rows of security gates for men and women are installed at all stations. In addition, the physical examination area for women is separated by booths so that they cannot be seen by others.
CCTV camera	CCTV cameras have been installed inside stations and on trains to prevent accidents and crimes.

Facilities	Gender-sensitive planning
Information guidance and provision	Information about the helpline desk and number will be provided on all trains and in station buildings. Information about a mobile phone application designed to ensure the safety of female passengers will also be posted on train information displays.
Establishment of a helpline desk and hotline	Female passengers can file complaints when they encounter undesirable situations. Set up a prominent window staffed by trained personnel. Establish a system for reporting cases handled at the window.Set up a hotline with a direct line to the nearest police station.
Lights	Install lighting that is bright enough to ensure the safety of passengers with disabilities and female passengers.
Platform	The platform will be designed to provide a good view and eliminate blind spots to prevent and deter crime, allowing female passengers to use the platform comfortably.

Source: JST

In addition, the investigation team proposes the following measure: 1) Install spaces within station buildings where infants and their mothers can breastfeed.

5.16.2.2 Employment during the construction phase

During the field survey in Mumbai, we visited the metro construction site and saw very few female construction workers. We also conducted focus group discussions (FGDs) with women to hear their opinions on employment opportunities at construction sites. Few women expressed a desire to be actively employed as construction workers, but many expressed an interest in jobs that indirectly support construction work, such as clerical work, cleaning, and catering.

Corridor 2's GAP summarizes special measures for women working in construction, including the provision of free accommodation facilities separated by gender, the establishment of childcare facilities where female workers can leave their children during the day (one cabin and one attendant must be provided for groups of 25 to 50 female workers), the establishment of a reporting centre for sexual violence and sexual harassment, and exemption from night work for female workers. and the implementation of measures such as awareness campaigns and the provision of free medical services to prevent the spread of HIV/AIDS. Additionally, it has been confirmed that the MMRC plans to monitor contractors to ensure they do not engage in wage discrimination between men and women for work of equal value by including specific clauses in tender documents.

5.16.2.3 Employment during the operational phase

Regarding staff employment after the start of operations, MMRC has a responsibility to hire workers and staff of all levels equally from men and women and proposes to actively promote the employment of female staff. In the initial stages of operation, it is expected that technology transfer and human resource development will be carried out by staff from the already operating Mumbai Metro to ensure smooth operations and training for newly hired staff.

5.16.3 Monitoring plan for women's participation and gender mainstreaming during the operational phase of the Mumbai metro

5.16.3.1 QOL Survey and Customer Satisfaction Survey

We propose monitoring citizens' QOL indicators during the operational phase of this project and conducting customer satisfaction surveys of metro passengers to assess the positive impact of this project on the local community. The purpose of monitoring QOL is to measure the impact of this project on the general public in Mumbai, while the purpose of the customer satisfaction survey is to receive feedback from passengers in order to improve the quality of this project's services.

During the operational phase, it is desirable for MMRC to conduct surveys annually. DMRC conducts online customer satisfaction surveys every year, and MMRC is also expected to conduct similar surveys.

The survey respondents should be sampled equally from both men and women. The survey results should be analyzed not only for overall trends but also for separate trends for men and women. In addition to gender considerations, the survey respondents should cover all occupations to reflect the diverse social composition of Mumbai.

The main questions for the survey are shown in the table below.

In addition to these surveys, it is necessary to analyze the opinions of Metro users and passengers submitted through suggestion boxes, websites, and emails, broken down by gender.

Through these monitoring and surveys, MMRC will create valuable opportunities for women in Maharashtra State and Mumbai City to express their opinions and participate in local decision-making processes.

Table 5.16.4 Overview of Proposed QOL Monitoring and Customer Satisfaction Survey

Target	2,000-3,000 Mumbai Metro passengers (equal numbers of men and women)
Frequency	Once a year
Method	Online survey or household interview survey
QOL indicator	• Household income and expenditure • Access to social services(Office, Schools, Hospitals, and Shopping center etc.) • Present QOL satisfaction (Access to office, schools, hospitals, shopping center, and theaters/, housing conditions, traffic safety, green environment, air pollution, noise, etc.) • Relative importance of QOL items
Customer Satisfaction Survey	Subway satisfaction (convenience, accessibility, affordability, facilities, information, customer service, security, safety including women-only cars, environmental impact)

Source: JST

5.16.3.2 Proposal for monitoring gender integration in MMRC organizations

We suggest the following 23 indicators in order to monitor the degree of gender integration achieved within the MMRC organization. We propose conducting an evaluation once a year at the initial stage of the budget review for the following fiscal year to monitor the results for that year, identify issues for the following fiscal year, and secure the necessary budget. Gender issues such as the development of female staff capabilities are not only women's issues but also issues related to the mindset of men. Therefore, it

is desirable that this internal survey be led by female leaders and that the survey team consist of an equal number of men and women.

Table 5.16.5 Proposed monitoring indicators for gender mainstreaming

organizational policy	
MMRC	21. A gender action plan has been formulated.
organizational structure	
MMRC	**[Gender Training for Employees]** 22. Number of gender training sessions for employees 23. Number of training participants (by gender and age) 24. Changes in gender awareness after training **[Female Executives]** 25. Increase in the number and percentage of female executives 26. Percentage of female executives (planned and actual) **[Female Staff and Engineers]** 27. Increase in the number and percentage of female staff and engineers 28. Percentage of female staff positions (planned and actual) 29. Policy on female employment (details) **[Work Environment]** 30. Improvements to the workplace environment 31. Job satisfaction among female employees **[Capacity Building for Female Engineers]** 32. Participation in various training programs (by gender) 33. Identification of training needs for female engineers and staff 34. Improvement of female engineers' abilities and skills **[Harassment and SGBV in the Workplace]** 35. Number of reports of harassment and SGBV (sexual and gender-based violence) in the workplace (by type) 36. Harassment and SGBV training (number of sessions, number of participants by gender) 37. Changes in staff understanding and awareness of harassment and SGBV **[Participation in Decision-Making]** 38. Increased participation of female members in the Gender Action Plan Committee 39. The Gender Action Plan Committee is held at times that are convenient for female members to attend 40. Incorporating gender-specific needs into the Gender Action Plan
Impact of this project on gender empowerment	
RAP Implementation (Support for restoring livelihoods after relocation)	**[Women's Participation in Vocational Training]** 41. Increase in the number and percentage of female residents participating in vocational training 42. Skills and techniques acquired by women
MMRC	**[Employment of Women]** 43. Number and percentage of women employed in this project (civil engineering, construction, cafeteria, other skilled/unskilled labor)

Source: JST

5.17 Consideration for people with disabilities

5.17.1 Laws, systems, and projects related to consideration for people with disabilities

Barrier-free measures for station facilities are designed in accordance with the barrier-free guidelines issued by the Indian Ministry of Urban Development, "Harmonized Guidelines and Space Standards for Barrier Free Built Environment for Persons with Disability and Elderly Persons in the year 2016" (including the 2021 revised version), and the barrier-free standards for station facilities in the Indian

National Building Code (NBC2016).

The station facilities for this project will be designed in accordance with the guidelines and basic provisions confirmed in the DPR, taking into consideration the needs of people with disabilities (physical, visual, hearing, internal diseases, etc.).

5.17.2 Adopted barrier-free design

The design standards for barrier-free design listed in the DPR are shown in the table below.

In addition, it is expected that the State Urban Development and Housing Bureau and the Local Transportation Bureau, which supervise and oversee the MMRC, will take the lead in implementing this project to improve traffic safety by reorganizing the road space around stations and improving traffic signals and intersections.

Table 5.17.1 Barrier-free design standards for Mumbai Metro railway facilities

Facilities	Main standards
Station entrance	• Station entrances and exits should be wide enough (minimum width of 1800 mm), and ramps should be installed if there is a difference in height. • It is desirable to provide parking spaces for wheelchair users near station entrances and exits, ensuring that there is sufficient space for maneuvering.
Reservation and Information Counter	• Reservation counters and information counters shall be designed with sufficient space to allow wheelchair users to access them smoothly. • At least one counter shall be 750 to 800 mm high. • At least one counter shall be equipped with an induction loop system to assist people with hearing impairments, and at least one counter staff member should be proficient in sign language. • A pictogram map showing all services provided at the counter shall be installed.
Concourse	• There should be no height differences in the concourse. If height differences are unavoidable, install ramps. • The concourse floor should be made of non-slip material. • Install braille blocks for the visually impaired, and warning blocks in high-traffic areas and in front of entrances to stairs and elevators. • Install rest areas and benches at regular intervals.
Staircase	• • For details on staircase standards, refer to the staircase guidelines in NBC 2016. • • Steps should be uniform, with a tread width of at least 300 mm and a riser height of at least 150 mm. • • Install continuous handrails on both sides (including walls, if applicable) and place warning blocks at the beginning and end of the stairs.
Elevator	• Install lifts (elevators) to enable people with physical disabilities to move between floors. • For detailed elevator standards, refer to the elevator guidelines in NBC2016. • Call buttons should be installed at a height of 800 to 1000 mm from the floor and should be operable with light pressure. Braille should also be incorporated. • Elevator floor indicators and door status must be displayed both visually and audibly.
Restrooms	• Install restrooms and sinks with widths suitable for wheelchair users, etc. Install handrails, etc., in appropriate locations. • Install continuous braille blocks to enable access for visually impaired individuals.
Public drinking fountains	• Drinking water facilities shall be equipped with a water inlet and control device at the front, and shall be manual or manual/foot-operated. • It is desirable to have devices that are low in height and easy for wheelchair users to use.
Ticket gate	• Braille blocks for visually impaired people shall be installed continuously at one of the ticket gates.
Platform	• Braille guide blocks for visually impaired passengers shall be installed at least 600 mm from the edge of the platform. • The platform surface shall be made of non-slip material and shall be level. • There shall be no gaps or steps between the platform and the vehicle entrance. • Accessible routes and elevators shall be provided to ensure connectivity between all platforms. • Rest areas or benches shall be provided.

Facilities	Main standards
Train car	• Vehicle doors and passageways shall be wide enough for wheelchair users (minimum 900 mm). • The gap between vehicle doors and platforms shall be kept to a minimum (less than 12 mm if possible). • Identification marks shall be installed on vehicle doors accessible to wheelchair users. • It is desirable to secure space for wheelchair users next to vehicle doors, and to clearly indicate the space using international access symbols both inside and outside the vehicle. • A sufficient number of designated seats for people with disabilities and the elderly shall be installed near vehicle doors.
Information	• Signage should be easy to read by using large font sizes, clear contrast, and bright lighting. Pictograms should also be used to ensure universal accessibility. • In addition to printed timetables, it is desirable to provide braille versions of travel information such as fare tables. • It is desirable to install electronic bulletin boards on platforms to quickly and clearly convey information to people with hearing impairments. • It is desirable to provide an announcement system that conveys station names and door locations by voice for visually impaired individuals. • Fire alarm boxes, emergency call buttons, lighting panels, and other alarm devices must be installed at a height of 800 to 1000 mm from the floor. They should also be displayed with high-contrast text and Braille for easy visibility. • In the event of an emergency, the alarm system should include auditory alarm devices with voice instructions for visually impaired passengers to assist them in finding the emergency exits. For hearing-impaired passengers, non-auditory alarm devices (flash beacons, vibration alarms, etc.) should be installed in visible locations throughout all areas used by passengers.

Source: JST



Installation of dedicated wheelchair spaces inside train car



The flap gate opens wide to allow wheelchairs to pass through.



Install tactile guide blocks leading to ticket counters, restrooms, platforms, and other locations.



Put up signs in easy-to-see spots for places like restrooms, elevators, and parking lots.

Source: JST

Figure 5.17.1 Reference photos of barrier-free designs for railway facilities

5.17.3 Proposals for measures

The Indian Railways offers tickets at a discount of 25-75% of the regular fare to passengers with a Unique Disability ID or disability certificate, as well as one accompanying person. We propose that Mumbai Metro introduce similar price adjustments in the future to promote social and economic participation and integration for all.

5.18 Compensation and Assistance Policy

5.18.1 Eligibility Criteria

All interested parties of private land to be acquired for the project are entitled for compensation as per the LARR 2013. The eligibility and entitlements for non-titleholders will be as per the MMRC and MUTP R&R Policy. As per the MUTP R&R policy all legitimate occupants of land and building will be eligible for the benefits of R&R. PAPs who are squatters and not legal titleholder of land and buildings shall also be eligible for R&R if enumerated during the BSES survey.

5.18.2 Compensation and Entitlement Policy

The basic items of compensation and assistance for each category are described as follows. All monetary values increase by 5% every year unless the rate of inflation is less than 5% as per LARR Act. No income tax will be levied/deducted from compensation paid in respect of the award or agreement.

(1) Loss of Land: compensation for the loss of land;

(2) Loss of Structure: compensation for structures and other immovable assets at their replacement value for owners, provision of readily available units for tenants;

(3) Loss of crops/trees: compensation for standing crops/trees at their replacement value;

(4) Loss of CPR: re-building and/or restoration of community resources/facilities;

(5) Loss of Income: assistance for loss of business/wage income;

(6) Resettlement Assistance: package of assistance to cover the necessary expenses to shift residence or business premises to the new location;

(7) Livelihood restoration program

(8) Additional assistance: additional assistance package for vulnerable groups

5.18.2.1 Loss of Land

Compensation for land will be determined in accordance with the existing laws.

- **Landowner**: (1) Cash compensation for the replacement cost of land based on the ready reckoner value of land in the area as per the LARR 2013 (which is 200%) with additional of 25% under direct purchase scheme; or (2) If requested, consider the award of TDR/FSI[66] as an alternative to the cash compensation.

[66] TDR (Transferable Development Rights) / FSI (Floor Space Index) is a system adopted in Maharashtra as a means of compensation for land acquisition. Landowners can utilize the development rights or floor space index, calculated based on market value, for development on other land, or alternatively, they may sell these rights

- **Land lease holder**: Cash compensation for the unexpired period of lease according to LARR 2013.

  With regard to underground land use, there is no legal provision for compensation. Under MMRC's specific rule, in cases where permanent underground structures are constructed, landowners on the surface will be compensated with an amount equivalent to 50% of the full RRR (100%).

5.18.2.2 Loss of Structure

For titleholders, MMRC will provide the choice of compensation for the structure as per LARR 2013, or provide built residential units or commercial units of similar size. For non-titleholders provide built residential units or commercial units to tenants and squatters as per MUTP R&R Policy.

- **Landlords / Structure Owners (titleholder)**: Cash compensation equivalent to cost of construction of floor space occupied prior to resettlement as per the LARR 2013 (which is 200%).
- **Tenants (titleholder)**: (1) In case of residential use, free residential unit of 25 m^2 in the "in-situ rehabilitation building" (with up to a maximum of 70 m^2 at actual cost exceeding 25 m^2. (2) In case of commercial use, free shop or business unit equivalent to existing floor size (up to a maximum of 70 m^2) in the "in-situ rehabilitation building".
- **Occupants / Squatters (non-titleholders)**: (1) In case of residential use, free residential unit of 25 m^2 in the "R&R colony" will be provided. (2) In case of commercial use, free shop or business unit equivalent to existing floor size (up to a maximum of 70 m^2). PAHs would be allowed to take away the materials salvaged from their dismantled houses and shops within 15 days and no charges will be levied upon them.

5.18.2.3 Loss of Trees/Crops

Standing trees and crops will be compensated based on the market value at the time of acquisition.

5.18.2.4 Restoration of CPR

CPR will be restored/relocated outside the RoW of the project, if necessary, in consultation with users of such facilities.

5.18.2.5 Loss of Income

According to the type of income loss, following assistance will be provided.

- **Employees residing in the affected structures:** Amount equivalent to the fare of twelve quarterly season tickets for excess distance to compensate for the additional commute.
- **Employees / business owners who lose their source of livelihood:** A lump sum compensation equivalent to one year's income.
- **Temporary income loss:** Measures for mitigating the loss of business opportunities, and enrollment in the Livelihood Restoration Program

5.18.2.6 Resettlement Assistance

For affected family, a set of the following will be provided as per the MUTP Policy.

- One-time shifting allowance in terms of labour and transport is arranged for to cover the cost of moving household or business belongings.

5.18.2.7 Livelihood Restoration Program (LPR)

One eligible member from each PAH that experiences loss of livelihood due to displacement or project-related impacts will be enrolled in the LRP.

5.18.2.8 Additional Assistances

Vulnerable households, defined as women-headed households, a household with elderly without immediate support, a household with disabled members, and a household below the poverty line, will be provided with additional assistances in addition to other compensations and assistance. As per MUTP policy, these households will receive special attention, including priority for ground floor units and support with loan arrangements.

5.18.3 Entitlement Matrix

The Entitlement Matrix outlines category-wise details of compensation and resettlement benefits applicable to PAPs. It reflects provisions from both the LARR 2013 for legal compensation and MUTP R&R policy for rehabilitation and resettlement benefits. Table below presents the Entitlement Matrix for the proposed project. Both titleholders and non-titleholders are eligible for entitlements.

Table 5.18.1 Entitlement Matrix

Category	Entitle person	Compensation and Assistance
Land (titleholder)	Non-Resident landowners	• Replacement cost of the lost land as per LARR 2013 (200%) and additional 25% for the direct purchase method. • In case of underground use: 50% of the lost land as per Ready Recknor Rate.
	Non-Resident Lessees	• Compensation for the unexpired period of lease according to LARR 2013.
Land and Building (titleholder)	Resident Landlord	Choice of 1) cash compensation or 2) unit provision 1) cash compensation • Replacement cost of the lost land as per LARR 2013 (200%) and additional 25% for the direct purchase method. • Replacement cost of the lost structure as per the LARR 2013 (200%). 2) unit provision • Floor space of 25 m^2 (269sqft) in R&R colony
	Resident Lessees	• Compensation for the unexpired period of lease as per the LARR 2013, taking into agreement
	Tenants, Sub-tenants of buildings	• Residential: Floor space of 25 m^2 (269sqft) in R&R colony • Shops & business: Floor space equal to self-occupied floor area, subject to maximum of 70 m^2 for one unit (First 20.91 m^2 is free of cost).
Building (non-titleholder)	Structure owners, tenants	Choice of 1) cash compensation or 2) unit provision 1) cash compensation • Replacement cost as per MMRC policy. 2) unit provision • Residential: Floor space of 25 m2 (269sqft) in R&R colony • Shops & business: Floor space equal to self-occupied floor area, subject to maximum of 70 m^2 for one unit (First 20.91 m^2 is free of cost).

Category	Entitle person	Compensation and Assistance
Livelihood	Employees residing in affected structures (Residential area is affected)	• Amount equivalent to the fare of twelve quarterly season tickets for excess distance by suburban railway.
	Employees / business owners who lose their source of livelihood (Workplace is affected)	• A lump sum compensation equivalent to one year's income, as determined by R&R Agency' valuation committee. • The rehabilitation package includes access to employment information, appropriate skills development programs, and credit through community operated funds.
	Temporary income loss	• The rehabilitation package includes access to employment information, appropriate skills development programs, and credit through community operated funds.
Any displaced PAHs	Shifting, Resettlement, and Rehabilitation support	• One-time shifting allowance for which labour and transport is arranged • The rehabilitation package includes access to employment information, appropriate skills development programs, and credit through community operated funds.
Vulnerable people	Additional support	• Preferential allocation of a ground-floor unit (apartment) at the relocation site and assistance with loan arrangements, as per MUTP policy.

Source: JST based on draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

5.19 Grievance Redress Mechanism

Grievances from residents and stakeholders shall be handled by either the Government of Maharashtra (GoM), which is the responsible in the construction of Cuffe Parade Station on Mumbai Metro Line 3, a 24-hour grievance redress mechanism (GRM) was established, comprising an on-site booth, a toll-free hotline, and e-mail channels for receiving complaints from the public[67]. For this Project as well, the existing MMRC grievance redress mechanism will be applied as the basis. A grievance reception booth will be established at the MMRC headquarters, and submissions will be accepted through toll-free telephone, e-mail, and an official web form. Complaints will be electronically registered immediately, with formal responses issued within 15 days by the Field Level Grievance Redressal Committee (FLGRC). Unresolved cases are referred to and reviewed by Senior Level Grievance Redressal Committee (SLGRC).

Table 5.19.1 Composition and Roles of Grievance Redressal Committees in MMRC

Level	Committee Name	Composition (Examples)	Main Roles	Indicative Processing Time (Recommendation)
Field Level	Field Level Grievance Redressal Committee (FLGRC)	- Site Construction Manager - MMRC Site Officer - - Representative of Survey agency - Representative of Supporting NGO, if requested - - Representative of Project-Affected Persons (PAPs)	Immediate response to routine/minor grievances arising on-site (e.g., noise, vibration, traffic regulation, compensation issues). Ensures prompt initial action.	Within 15 days
Senior Level	Senior Level Grievance Redressal Committee (SLGRC)	- Senior MMRC Headquarters Officers - NGO Representative, if requested - PAP Representative - - Independent Chairperson (e.g., subject-matter expert, legal professional)	Reviews cases unresolved by FLGRC. Conducts hearings and investigations for re-evaluation.	Within 30 days

Source: MMRC, Social Due Diligence Report, October 2018, MMRDA

[67] Grievance Redressal Mechanism Cuffe Parade Metro Station, 2018, MMRC

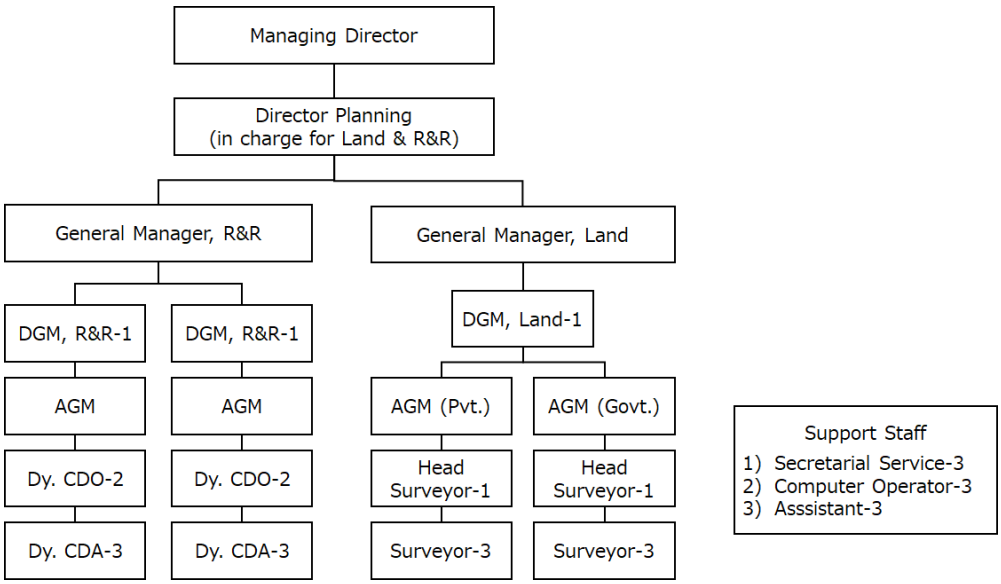
5.20 Implementation Arrangement

5.20.1 Institutional Framework

The implementation of Resettlement Action Plan (RAP) requires involvement of various institutions at different stages of project cycle. This section deals with roles and responsibilities of various institutions for the successful implementation of the RAP. The institutions to be involved in the process are as follows:

1. Project Management Unit of MMRC.
2. Resettlement and Rehabilitation Division of MMRC.
3. NGOs Support during Implementation and Post Resettlement Phase.
4. Public Relation Consultant.
5. Grievance Redress Committee.

The institutional framework for RAP implementation is shown in the figure below..



Source: JST based on draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

Figure 5.20.1 Institutional Framework

5.20.1.1 PMU of Mumbai Metro Rail Corporation Limited (MMRC)

Project Management Unit (PMU) of MMRC is responsible for planning and implementation of resettlement and rehabilitation components of the proposed project. The PMU will coordinate with all the implementing agencies and monitor the progress of the project. The PMU is also responsible for the delivery of entitlements, supervising the work of the Project Management Consultants (PMC), NGO, Public Relation Consultant etc. It will provide logistical support for the purpose of reviewing the progress of project implementation. It will generate Quarterly Progress Report (QPR) for effective management decision. The PMU headed by Project Director (PD) will be responsible for overall planning, acquisition of land, supervision of all activities related to resettlement and rehabilitation of the proposed project with active support from R&R department of MMRC during preparation, implementation and post implementation phase.

5.20.1.2 Resettlement and Rehabilitation Department of MMRC

MMRC has a Land and Resettlement and Rehabilitation Department which shall look after land acquisition and resettlement and rehabilitation activities. The General Manager of Land/ R&R department (Additional Collector) and other staff will provide technical support for effective implementation of resettlement and rehabilitation activities of the project. The R&R department of MMRC shall work closely with other PMU staff for better coordination and implementation of R&R activities. The MMRC shall ensure that all issues related to land acquisition, resettlement and rehabilitation are handled according to the policies/guidelines as is laid down in this report. The overall responsibility of the division is planning, supervision, and implementation of all components of R&R. It would also coordinate with the respective General Managers to ensure the implementation of various R & R activities that require the inputs of the respective officers from the environment, finance, legal and PR section of the PMU.

5.20.1.3 NGOs Support during Implementation and Post Resettlement Phase

The NGO plays a very crucial role in implementation of resettlement and rehabilitation activities. The NGO will be appointed by PMU of MMRC to extend implementation support to MMRC in the form of assisting affected families/persons during relocation, if considered necessary by MMRC. The responsibilities of NGO will be assisting MMRC in conducting regular consultations, survey, issue of identity cards, assisting affected families/ persons during and post resettlement phase, formation of co-operative societies, providing training for managing the societies etc. An experienced NGO working in the field of resettlement and rehabilitation may be hired by MMRC for implementation of SIA.

5.20.1.4 Implementation Support of Consultant

During the implementation phase of RAP, MMRC may appoint a consultant to assist MMRC in implementation of resettlement plan, if considered necessary by MMRC. The consultant will carry out due diligence in the implementation of resettlement and rehabilitation programs as per the provisions of R&R Policy of MUTP, 1997(Amended in 2000) through periodic monitoring. The consultant will be responsible for following:

- Preparation of database of affected structures, families, persons,
- Verification of database through field survey,
- Improve monitoring system,
- Capacity building,
- Regular follow up implementation activities and other relevant activities.

5.20.1.5 Public Relation Consultant

MMRC already have Public Relation Department to support in public relations and to ensure availability of information to the affected families/ persons, traders and concerned third parties to create an environment that is supportive of the process of Resettlement and Rehabilitation. The Public Relation Department would coordinate with GM of R &R Department and the PR agency in information sharing on the R&R activities of the proposed metro project and coverage in the R&R activities in the print and

electronic media.

5.20.2 Roles and Responsibilities of Other Agencies involved in the RAP Process

Role of stakeholders of resettlement plan is presented in the table below.

Table 5.20.1 Roles and Responsibilities of Agencies

Position	Responsibility
Project Director-(PMU), MMRC	• Overall planning and supervision of all project activities; • Exercise of administrative approval for finance & execution related activities; • Supervision and control over responsible officers in PMU • Coordination with JICA, Govt. of India, Govt. of Maharashtra and other concerned agencies
GM Land and R&R Division, MMRC	• Planning, supervision and implementation of R&R components; • Report to Project Director, PMU; • Supervision and control over the Managers, Officers and support staff in the division; • Liaison and coordination with PMU, Land and Estate Management Cell, Engineering Cell, NGOs, PAPs & other stakeholders; • Prepare and submit all reports and communication to Project Director; • The administrative domain of GM R&R include: ➢ Approval of eligibility list Approval of Progress Reports ➢ Procurement of Consultancy services for R&R components; ➢ Disclosure of information to requesters and external agencies; ➢ Release of payment to Consultants and NGO
NGO	• Assist MMRC in conducting public consultation, survey, issue of identity cards, • Organize meeting with PAPs assist them during relocation; • Explain the entitlements and R&R policy provisions; • Acting as catalysts between PAPs and project authorities; • Serve as initial step to redress grievances; • Assist the PAPs in redressing grievances with Project Authorities; • Provide support for post resettlement activities such as registration of Cooperative Societies and training related to maintain the building etc. • Report to GM R&R • Prepare monthly progress reports and submit to GM R&R
Implementation Support of Consultant	• Preparation of database of affected structures, families, persons; • Verification of database through field survey; • Improve monitoring system; • Capacity building, • Regular follow up implementation activities and other relevant activities. • Report to GM R&R
Public Relation Department	• Coordinate with the GM R&R • Coordinate with PR agency in information sharing on R&R activities of the project • Ensure availability of information to PAPs and other stakeholders • Coverage of progress of R&R activities in the print and electronic media
Grievance Redressal Committee	• FLGRC address grievances relating to individual eligibility and entitlement • SLGRC review decisions of FLGRC on grievance petitions filed by PAPs.
Independent Evaluation	• Mid - term and end term Evaluation of the implementation of the various provisions and activities planned in the RAP; • Review the plan implementation in light of the targets, budget and duration that had been laid down in the plan.

Source: Draft SIA Report for Corridor-1 prepared in August 2024 revised in July 2025

5.21 Implementation schedule

The implementation schedule for resettlement plan will be scheduled as per the overall project implementation. All activities related to the land acquisition and resettlement must be planned to ensure that Land is acquired/ in possession prior to commencement of civil works. Public consultation, internal monitoring and grievance redressal will be undertaken intermittently throughout the project duration. However, the schedule is subject to modification depending on the progress of the project activities. As part of advance actions, Project Authority will establish the GRC and initiate the resettlement implementation. The R&R activities of proposed project are divided into three broad categories based on the stages of work and process of implementation. The details of activities involved in these three phases are project preparation phase, RP implementation phase and Monitoring and Evaluation phase

5.21.1 Pre- Implementation Stage

Setting up institutions for the resettlement activities is not required since Resettlement and Rehabilitation division is in place in MMRC who would look after the activities related with acquisition of land and resettlement and rehabilitation issues.

5.21.2 RAP Implementation Stage

The RAP, at this stage, needs to be approved and will be disclosed to the PAPs. Upon the approval of RAP, all the arrangements for fixing the compensation and the disbursement needs to be done which includes payment of all eligible assistance; relocation of PAPs; initiation of economic rehabilitation measures; site preparation for delivering the site to contractors for construction and finally commencement of the civil work. Considering the lengthy and time taking process for land acquisition, this step shall be taken up by the Project Authority in advance. However, the resettlement and rehabilitation fund will be monitored as part of the RAP implementation at this stage. Internal monitoring will be the responsibility of Project Authority which will start in early stage of the project when implementation of RAP starts and will continue till the completion of the implementation of RAP. The Project Authority will be responsible for carrying out the monitoring on quarterly basis.

5.21.3 RAP Implementation Schedule

Since no land acquisition or resettlement is expected for Corridor 2, RAP implementation schedule has not been prepared.

5.22 Land Acquisition and Resettlement Budget (N/A)

5.23 Monitoring and Evaluation

Monitoring and evaluation are critical activities in involuntary resettlement. Monitoring involves periodic checking to ascertain whether activities are progressing as per schedule while evaluation is essentially to assess the performance of PAPs at the end of the project. For this purpose, a monitoring and evaluation (M&E) program is required to be developed to provide feedback to project management

which will help keep the programs on schedule and make them successful. Monitoring provides both a working system for effective implementation of the RAP by the project managers, and an information channel for the PAPs to assess how their needs are being met.

Monitoring will give particular attention to the project affected vulnerable groups such as scheduled castes, BPL families, women headed households, widows, old aged and the disabled. RAP implementation will be monitored both internally and externally. Project Authority will be responsible for internal monitoring through and will prepare quarterly reports on the progress of RAP implementation. An Independent Evaluation Consultant may be hired by Project Authority for mid and end term evaluation of RAP implementation.

5.23.1 Internal Monitoring

The internal monitoring for RAP implementation will be carried out by Land and R&R Department of MMRC. The main objectives of internal monitoring are to:

- measure and report progress against the RAP schedule;
- verify that agreed entitlements are delivered in full to affected people;
- identify any problems, issues or cases of hardship resulting from the resettlement process, and to develop appropriate corrective actions, or where problems are systemic refer them to the management team;
- monitor the effectiveness of the grievance system

Internal monitoring will focus on measuring progress against the schedule of actions defined in the RAP. Since the District Government (District Collector) is responsible for the implementation of land acquisition and compensation payments, coordination will be required during monitoring. Activities to be undertaken by the Project Authority will include:

- Liaison with the Land Acquisition team, construction contractor and project affected communities to review and report progress against the RAP;
- Verification of land acquisition and compensation entitlements are being delivered in accordance with the RAP;
- Verification of agreed measures to restore or enhance living standards are being implemented;
- Verification of agreed measures to restore or enhance livelihood are being implemented;
- Identification of any problems, issues, or cases of hardship resulting from resettlement process;
- Through household interviews, assess project affected peoples' satisfaction with resettlement outcomes;
- Collection of records of grievances, follow up that appropriate corrective actions have been undertaken and that outcomes are satisfactory;

The monitoring indicators suggested have been given in the table below.

Table 5.23.1 Monitoring Parameters

Indicators	Parameters Indicators
Physical	• Extent of land acquired • Number of structures dismantled • Number of land owners and private structure owners paid compensation • Number of families affected • Number of PAPs receiving assistance/compensation • Number of PAPs provided transport facilities/ shifting allowance
Financial	• Amount of compensation paid for land/structure • Cash grant for shifting oustees • Amount paid for training and capacity building of staffs • Amount for restoration of CPR (Common Property Resource)
Social	• Area and type of house and facility at resettlement site • Number of times GRC met • Number of appeals placed before grievance redressal cell • Number of grievances referred and addressed by GRC • Number of PAPs approached court • Women concern
Economic	• Entitlement of PAPs-land/cash • Planning of Income Restoration Program • Implementation of Income Restoration Program • Number of PAPs employed in the Project
Grievance	• Consultation for grievance redressal • PAPs knowledge about their entitlements • Cases referred to court, pending and settled • Number of grievance cell meetings • Number of cases disposed by GRC to the satisfaction of PAPs.

Source: JST based on Draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

Field Offices will be responsible for monitoring the day-to-day resettlement activities of the project. Baseline socio-economic census and land acquisition data provide the necessary benchmark for field level monitoring.

5.24 External Monitoring

As mentioned earlier, an Independent Evaluation Agency (IEA) will be hired by the Project Authority for mid and end term evaluation. The table below summarizes the objectives, risk factors, and evaluation items of external monitoring for this project.

Table 5.24.1 External Monitoring Objectives and Indicators

Objectives	• The negative impact on persons affected by the project will be minimized. • Persons losing assets to the project shall be compensated at replacement cost. • The project-affected persons will be assisted in improving or regaining their standard of living. • Vulnerable groups will be identified and assisted in improving their standard of living.
Risk Factor	• Resettlement plan implementation may take longer time than anticipated • Institutional arrangement may not function as efficiently as expected • NGOs may not perform the task as efficiently as expected • Unexpected number of grievances • Finding a suitable rehabilitation site for displaced population • PAPs falling below their existing standard of living
Outcomes and Impacts	• Satisfaction of land owners with the compensation and assistance paid • Satisfaction of structure owner with compensation and assistance • Type of use of compensation and assistance by structure owner • % of PAPs adopted the skill acquired through training as only economic activity

	• % of PAPs adopted the skill acquired through training as secondary economic activity • % PAPs got trained in the skill of their choice • Role of NGO in helping PAPs in selecting trade for skill improvement • Types of grievances received • No. of grievances forwarded to GRC and time taken to solve the grievances • % of PAPs aware about the GRC mechanism • % of PAPs aware about the entitlement framework mechanism • PAPs opinion about NGO approach and accessibility

Source: Draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

5.24.1 Monitoring Frequency and Reporting

Internal monitoring will be conducted on a monthly basis, with progress reports prepared quarterly. The independent evaluation consultant will submit an annual evaluation report to MMRC, assessing whether the resettlement objectives have been achieved, particularly in terms of livelihood and living standards restoration or improvement, and will provide appropriate recommendations for further enhancement.

5.25 Stakeholder Meeting

5.25.1 Overview of SHM implemented by MMRC

Line 11 Corridor 2

MMRC conducted Stakeholder Hearing Meetings (SHMs) for Line 11 Corridor 2 on June 22 and 23, 2023. The meetings were held twice, targeting the Navy Nagar area's local residents and female teachers. Since this area is a naval residential zone with many residents originating from outside the state, the consultations were conducted in Hindi, the common language among participants.

Table 5.25.1 Overview of the 1st SHM for Corridor 2

No.	Date	Venue	Target	Male	Female	Total
1	2023/6/22 (Sat)	S &T Gate, Near Vijay Chowk, Navy Nagar	Local residents	5	0	5
2	2023/6/23 (Sun)	Kendriya Vidyalaya No 1, Navy Nagar	Female teachers	0	13	13
Total				**5**	**13**	**18**

Source: Prepared by the JST based on the Draft SIA report for Corridor-2 prepared by MMRC in July 2024

At the SHM, explanations were mainly provided regarding the project details, construction scope, affected buildings, land acquisition, and common property resources. Following this, an exchange of opinions was held to gather views and concerns about the project. Participants raised concerns such as congestion during construction, maintenance issues, and the impact on incomes of taxi drivers and others. On the other hand, there was strong interest in the project, with expectations expressed for the extension's necessity, including improved convenience through safe public transportation. Additionally, specific requests were made regarding necessary facilities at stations and surrounding areas, such as maintaining cleanliness and hygiene within the metro premises, ensuring regular train frequency, and introducing online ticketing. The following summarizes the overview of the meetings held in various locations and the content of the discussions.

Table 5.25.2 Discussion during the 1st SHM for Corridor 2

Target	Item	Main opinions from residents
Local residents	Current issues	• In the Navy Nagar area, there is a tendency to prefer private cars as a means of transportation due to long taxi waiting times and insufficient bus service frequency. • The proposed metro project is important to meet the needs for public transportation.
	Positive effects	• Reduction of CO_2 emissions and fuel consumption • Mitigation of air pollution, noise pollution, traffic congestion, and accidents • Improved access to public facilities, saving time and costs, and enhancement of mental health • The metro extension will provide residents in the target area with an alternative means of transportation. • Increase in nearby property values
	Negative effects	• May impact the income of taxi drivers
	Required facilities near the stations	• Online ticketing system
Female teachers	Current issues	• The proposed metro project is necessary because it will improve access for the Navy, their families, and people working in the Navy Nagar area to other parts of Mumbai (though it will not be used directly for military operations).
	Positive effects	• Savings in time and cost • Improved safety, convenience, and connectivity to other areas within the city
	Negative effects	• Maintenance issues • Concerns about congestion during construction
	Required facilities near the stations	• Metro schedules should be displayed on the platforms. • The metro stations should be clean and hygienic. • Regular train frequency should be ensured for the metro service.

Source: Prepared by the JST based on the Draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025

Table 5.25.3 The 1st SHM for Corridor 2 of Line 11 (Already conducted)



1st SHM with residents



1st SHM with teachers

Source: Prepared by the JST based on the Draft SIA report for Corridor-1 prepared by MMRC in August 2024 revised in July 2025