

**BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI
ORIGINAL APPLICATION No. 186 of 2024.**

IN THE MATTER OF:

Free Press Journal News Item dated 17/01/2024:

Titled “Sanjay Gandhi National Park faces threat as BMC plans to divert forest land for Bridge reconstruction.”

**REPLY AFFIDAVIT ON BEHALF OF MUMBAI
METROPOLITAN REGION DEVELOPMENT AUTHORITY
– RESPONDENT NO. 6**

PAPERBOOK

ADVOCATE FOR RESPONDENT NO. 6

APSAK CONSULTANTS LLP



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APPLICANT THROUGH

AP Singh

APSAK CONSULTANTS LLP
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M: 9999770795, Email: abhikalp@outlook.com

Dated: 03.12.2025

Place: New Delhi

**BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI
ORIGINAL APPLICATION NO. 186 OF 2024**

IN THE MATTER OF:

Free Press Journal News Item dated 17/01/2024:

Titled "Sanjay Gandhi National Park faces threat as BMC plans to divert forest land for Bridge reconstruction."

**AFFIDAVIT ON BEHALF OF MUMBAI METROPOLITAN
REGION DEVELOPMENT AUTHORITY, I.E.,
RESPONDENT NO. 6**

I, Digvijay Patil, Age : 40 years, currently serving as Superintending Engineer, in Mumbai Metropolitan Region Development Authority, Maharashtra, having my office at BKC, Bandra (E), Mumbai -400 051, do hereby solemnly affirm and state as follows:

1. I, the authorized signatory on behalf of Mumbai Metropolitan Region Development Authority (MMRDA), Maharashtra, file this affidavit on behalf of Respondent No. 6. That I have carefully gone through the News Article which is the subject matter in the present Suo-moto case, and I have also scrutinized the relevant documents with respect to the subject matter of the News Article. I shall endeavour to explain and clarify the issues involved based on the records available with Respondent No. 6 and seek the leave of this Hon'ble Tribunal to file Additional Affidavits to assist this Hon'ble Tribunal as the situation may require.



2. The Article out of which the present concern and matter arise, primarily informs of three of BMC's project proposals, being Shri Krishna Nagar Bridge, Goregaon-Mulund Tunnel Link Road and the Borivali-Thane Twin Tunnel Projects. The Article raised the claim that the said projects utilize portions of the Sanjay Gandhi National Park ("SGNP") in their construction. The Article further highlighted numerous concerns of environmentalists and NGO's regarding environmental degradation, impact on wildlife, forest conservation etc. which arose as a response to the said constructions.

I. BACKGROUND TO THE TWIN ROAD TUNNEL BETWEEN THANE AND BORIVALI.

3. Originally in 2015, the Project Proponent was Maharashtra State Road Development Corporation Ltd. ("MSRDC"), however in 2020 the project was handed over for implementation to Metropolitan Region Development Authority ("MMRDA") making it responsible for construction of the Twin Tube Road Tunnel (Ch 0+ 00 to Ch 11+ 84km) between Thane and Borivali on Design & Build basis ("Project"). That invitation for bids for the "Design and Construction of Twin Tube Road Tunnel, approach road and other civil works between Thane and Borivali in the State of Maharashtra - Package 1 (Ch 0+00 to Ch 5+750 Borivali) and Package 2 (Ch. 5+750 to Ch. 11+840 Thane)" were sent out by MMRDA. The said project consisted of the following packages:



- i. Package-1: Design & Construction of 5.75 Km (Ch. 0+00 to Ch. 5+750 Borivali side) Long Twin Tube Road Tunnel, Approaches and other Civil Works between Thane and Borivali in the State of Maharashtra” (“Package-1”)
 - ii. Package-2: Design & Construction of 6.09 Km (Ch. 5+750 to Ch. 11+840 – Thane side) Long Twin Tube Road Tunnel, Approaches and other Civil Works between Thane and Borivali in the State of Maharashtra (“Package-2”)
4. That M/s Megha Engineering and Infrastructures Limited (“**Contractor**”/ “**MEIL**”) submitted a bid for the tender for Design and Construction of both packages in the Project on 06.04.2023. Consequently, MMRDA evaluated the bid of MEIL as per the tender conditions of the Project. Accordingly, the bid was approved by the Executive Committee of MMRDA during its 275th meeting held on 04.05.2023.
5. That soon after laying down the foundation stone, the Project commenced as the Working Permission was granted by the Forest Department vide letter dated 26.06.2024.
True copy of Working Permission dated 26.06.2024 is annexed herein as **Annexure A-1 (Page No. 19-26)**.

II. REQUIREMENT AND IMPORTANCE OF THE TWIN TUNNEL UNDERGROUND ROAD LINKING THANE TO BORIVALI



6. Currently, Borivali and Thane are separated by approximately 23 kilometres via the Ghodbunder Road, which is congested with heavy traffic creating an inordinately long travel time often exceeding one hour. The said corridor is one of the major routes taken by daily commuters thereby necessitating better connectivity between the two locations. Thus, the Project proposed shall provide direct connectivity between Tikuji-ni-Wadi in Thane District and Borivali in the Mumbai Suburban District, Maharashtra, by significantly reducing the distance to 11.84 kilometres and travel time to under 15 minutes.

7. The Project will ensure better road connectivity allowing faster commute to those travelling between Thane and Borivali. Further, traffic congestion and vehicle idling on the Ghodbunder Road will be significantly decreased. The decrease in traffic congestion will also result in lowering associated carbon emissions in the forest areas from where the Project passes. Additionally, the construction of the tunnel road will contribute to further reduction in greenhouse gas emissions by eliminating prolonged stop-and-go traffic conditions and ensuring smooth traffic flow. These improvements are anticipated to not only reduce the overall carbon footprint of transportation in the corridor but also lower transportation costs for both daily commuters and freight operators. The Detailed Project Report (“DPR”) of the project had been prepared by AECOM and approved by MMRDA in 2022.



True copy of the Satellite Image showing the proposed project passing through the SGNP area is annexed herein as **Annexure A-2 (Page No. 27)**.

8. It is pertinent to mention that a substantial portion of the Project falls within the notified limits of SGNP. It is being respectfully submitted that with the aim to make commute between the two urban areas more accessible and convenient and in light of the need to protect and conserve a National Park of such environmental value, the Project was approved to be made 20-25 meters **Below Ground Level** (“BGL”) and was to be executed entirely through mechanised tunnel boring methods in order to minimize surface disturbance. As the excavation depth is significantly below the typical habitation zones of terrestrial and burrowing fauna, and primarily within hard rock strata, direct impact on wildlife habitat, both surface and subsurface, is expected to be negligible. It is pertinent to note that no tunnel portals, ventilation shafts, or ancillary works are proposed within the notified limits of SGNP.

III. CLEARANCES, APPROVALS AND COMPLIANCES.

9. It is submitted that upon consultation with the State Environment Impact Assessment Authority (“SEIAA”), Department of Environment, Government of Maharashtra, regarding the requirement for Environmental Clearance, the SEIAA Committee had clarified vide letter dated 15.04.2019 that since the proposed project is neither an expressway,



express highway, national highway, nor a major state highway, it does not fall within the purview of the EIA Notification, 2006, and therefore, an Environmental Clearance is not required.

True copy of the Letter dated 15.04.2019 by SEIAA Committee is annexed herein as **Annexure A-3 (Page No. 28)**.

10. Notwithstanding that the Project did not require approval by way of an Environmental Clearance, the Answering Respondent (**MMRDA**) with a view to ensure that no or minimal adverse environmental impact occurs, conducted a detailed Environmental Impact Assessment (“**EIA**”) study.

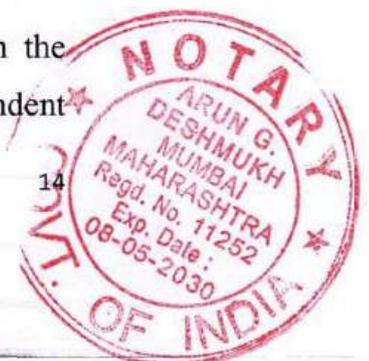
True copy of the Environmental Impact Assessment study is annexed herein as **Annexure A-4 (Page No . 29-286)**

11. Accordingly, the Answering Respondent obtained Wildlife Clearance from the State Board for Wildlife (“**SBWL**”) on 23.10.2023 and National Board for Wildlife (“**NBWL**”) on 07.02.2024 having submitted compliance in June 2025.

True copy of the Wildlife Clearance from the State Board for Wildlife dated 23.10.2023 is annexed herein as **Annexure A-5 (Page No. 287-294)**

True copy of the Wildlife Clearance from the National Board for Wildlife dated 07.02.2024 is annexed herein as **Annexure A-6 (Page No. 295-299)**.

12. That out of abundant caution and in consonance with the salutary Precautionary Principle, the Answering Respondent



commissioned a separate study conducted by the Wildlife Institute of India (“WII”) and it has been ensured that the recommendations from the study are being implemented on site as well.

True copy of the Wildlife Protection Study submitted by Wildlife Institute of India is annexed herein as **Annexure A-7** (Page No. 300-322).

True copy of letter dated 24.07.2025 along with photographs by MEIL ensuring compliance of recommendation by WII are annexed herein as **Annexure A-8** (Page No. 323-332)

13. That the Answering Respondent had applied for Forest Clearance for the diversion of 35.5644 ha of forest land, which forms part of the notified forest area of SGNP for Project. That Clearance for Stage-I has been granted by the Government of India vide letter dated 09.02.2024 subject to certain conditions. However, the Stage-II is still awaited.

True copy of Grant of Forest Clearance Stage-I dated 09.02.2024 is annexed herein as **Annexure A-9** (Page No. 333-335).

14. That in compliance with the conditions stipulated by the Government of India while granting Stage-I Forest Clearance and in furtherance of applicable environmental and forest regulations, the Answering Respondent has furnished a series of undertakings thereby ensuring adherence to the requisite compliances. The undertakings have been provided hereinbelow:



- A. That the Answering Respondent on an Affidavit dated 07.03.2024 gave an Undertaking to comply with the conditions put by the Government of India vide letter dated 09.02.2024.

True copy of affidavit undertaking to comply all requisite conditions is annexed herein as **Annexure A-10** (Page No. 336-339)

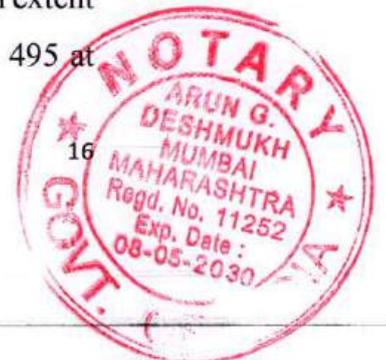
- B. That the Answering Respondent has furnished an Undertaking in order to ensure that the legal status of the forest land shall remained unchanged.

True copy of the Undertaking for legal status of forest land dated 04.03.2024 is annexed herein as **Annexure A-11** (Page No. 340)

- C. That the Answering Respondent has furnished an undertaking in order to ensure that the demarcation of the proposed forest area is being carried out at suitable places as per the direction of the Deputy Conservator Forest concerned at the cost of the User Agency.

True copy of the Undertaking for demarcation dated 04.03.2024 is annexed herein as **Annexure A-12** (Page No. 341)

- D. That as per one of the conditions, the State Government shall carry out Compensatory Afforestation (CA) and its maintenance in the identified non-forest area over an extent of 35.5644 ha. Further, non-forest land in Gut No. 495 at



Village Umravati, Taluka Phulambri, District Aurangabad shall be utilized for this purpose at the cost of the User Agency. The identified non-forest area shall be transferred and mutated in favour of the Forest Department, and the State Government shall notify such mutated area into RF/PF before the final approval is submitted along with the compliance report. The User Agency has complied with the condition by depositing Rs. 2,86,25,217/- (UTR No. MAHBH24061147686) towards the cost of compensatory afforestation in the CAMPA Account. Further, the State Government shall charge the Net Present Value (NPV) of the diverted forest land measuring 35.5644 ha. from the User Agency as per the orders of the Hon'ble Supreme Court dated 28.03.2008 and 09.05.2008 in IA Nos. 826 and 566 with related IAs in W.P. (C) No. 202/1995 and the ministry guideline.

True copy of letter dated 04.03.2024 showing deposition of cost towards the cost of the compensatory afforestation and NPV in CAMPA Account is annexed herein as **Annexure A-13 (Page No. 342)**.

- E. That Compensatory Afforestation (CA) scheme had to be implemented as per the provision of Sl No. 4 of the Schedule II of the Van (Samrakshan Evam Samvardhan) Rules, 2023. It is submitted that the Answering Respondent has no role in implementation of the CA Scheme and the same will be implemented by the Aurangabad Forest Division.



F. That the Answering Respondent has furnished an Undertaking that all the funds received from the User Agency under the project shall be transferred/deposited to CAMPA fund only through E-Portal. (<https://parivesh.nic.in/>)

True copy of the Undertaking dated 04.03.2024 for deposit of CAMPA fund is annexed herein as **Annexure A-14 (Page No. 343)**

G. That the Answering Respondent has furnished an Undertaking that all the conditions recommended by the SC NBWL and the Regional Empowered Committee (REC) shall be strictly complied with and implemented at the cost of the project.

True copy of the Undertaking dated 04.03.2024 for compliance of NBWL & REC conditions is annexed herein as **Annexure A-15 (Page No. 344)**

H. That the Answering Respondent has furnished an Undertaking that no vertical/surface vents/shafts/other vertical openings are permitted inside the SGNP and no exhaust pollution will be released in to SGNP.

True copy of the Undertaking dated 04.03.2024 for no vertical openings inside SGNP is annexed herein as **Annexure A-16 (Page No. 345)**



I. That a Proper Muck Disposal Plan has been implemented by the Answering Respondent to handle and dispose the muck generated during the execution of the project. An Undertaking is furnished by the Answering Respondent that proper muck disposal plan shall be implemented and in any way muck disposal is not done in the forest area.

True copy of muck disposal plan is annexed herein as **Annexure A-17 (Page No. 346-362)**.

True copy of the Undertaking dated 04.03.2024 for muck disposal is annexed herein as **Annexure A-18 (Page No. 363)**

J. That the Answering Respondent has furnished an Undertaking that work shall be carried out only as per the timings that may be prescribed by the Chief Wildlife Warden (CWLW).

True copy of the Undertaking dated 04.03.2024 for work timings is annexed herein as **Annexure A-19 (Page No. 364)**

K. That the Answering Respondent has furnished an Undertaking that no labour camps/office, etc. shall be built in the forest area.

True copy of the Undertaking dated 04.03.2024 for labour camps/office is annexed herein as **Annexure A-20 (Page No. 365)**



- L. That the Answering Respondent has furnished an Undertaking that the User Agency shall ensure proper drainage system to flush out wastage throughout the tunnel and any way such waste/garbage shall not be disposed inside the tunnel area.

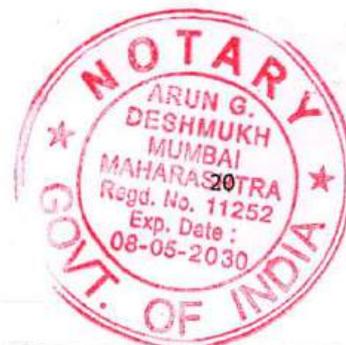
True copy of the Undertaking dated 04.03.2024 for disposal of waste/garbage is annexed herein as **Annexure A-21 (Page No. 366)**

- M. That the Answering Respondent has furnished an Undertaking that the User Agency at the project cost shall restore the area and compensate for the damage for the flora and fauna of the SGNP in case of any adverse impact(s) occurs during construction and operation phase throughout the project life due to construction of proposed tunnel.

True copy of Undertaking dated 04.03.2024 for restoration/compensation is annexed herein as **Annexure A-22 (Page No. 367)**

- N. That the Answering Respondent has furnished an Undertaking that tree felling shall be carried out wherever necessary under the strict supervision of the Forest Department.

True copy of Undertaking dated 04.03.2024 for Tree Felling is annexed herein as **Annexure A-23 (Page No. 368)**



O. That the Answering Respondent has furnished an Undertaking that all mitigation measures as suggested in the reports submitted by the State Government shall be implemented by the concerned agency at the project cost. True copy of Undertaking dated 04.03.2024 for mitigation measures is annexed herein as **Annexure A-24 (Page No. 369)**

P. That a Proper Disaster Management Plan has been implemented by the Answering Respondent to reduce the risk of loss of human life and property in the event of earthquake and other natural hazards. The Answering Respondent has furnished an Undertaking that the User Agency shall prepare and implement disaster management plan as per the relevant rules and regulations to that extent, if required for such tunnel projects.

True copy of the Disaster Management Plan is annexed herein as **Annexure A-25 (Page No. ³⁷⁰⁻⁴⁰⁸)**

True copy of Undertaking dated 04.03.2024 for Disaster Management Plan is annexed herein as **Annexure A-26 (Page No. 409)**

Q. That the Answering Respondent had submitted an application for Forest Rights Act (FRA) Certificate to the respective Collectors of Thane and Mumbai Suburban Districts which is being processed. An Undertaking is furnished by the answering respondents that FRA Certificate will be submitted after the due process is



completed. Further, it is requested that as per the above undertaking (and also ensuring settlement rights under the Schedule Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (2 of 2007) and compliance to all such conditions), we request that the State Government shall issue order for working permission and diversion as the case may be.

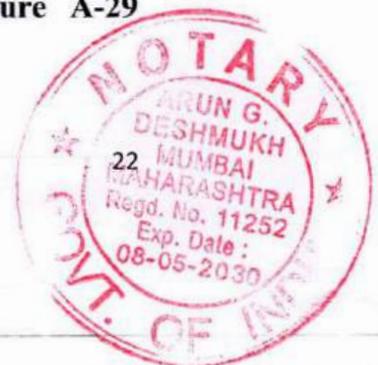
True copy of Undertaking dated 04.03.2024 for FRA certificate is annexed herein as **Annexure A-27 (Page No. 410)**

R. That the Answering Respondent has furnished an Undertaking that the User Agency shall obtain Environmental Clearance as per the provisions of the Environmental (Protection) Act, 1986, if applicable.

True copy of Undertaking dated 04.03.2024 for Environmental Clearance is annexed herein as **Annexure A-28 (Page No. 411)**

S. That the Answering Respondent has furnished an Undertaking that sufficient firewood, preferably the alternate fuel, shall be provided by the User Agency to the labourers after purchasing the same from the State Forest Department or the Forest Development Corporation, or any other legal source of alternate fuel.

True copy of Undertaking dated 04.03.2024 for firewood to labourers is annexed herein as **Annexure A-29 (Page No. 412)**



T. That the Answering Respondent has furnished an Undertaking that no, additional or new path will be constructed inside the forest area for the transportation of construction material materials for execution of the project work.

True copy of Undertaking dated 04.03.2024 for no additional/new path is annexed herein as **Annexure A-30 (Page No. 413)**

U. That the Answering Respondent has furnished an Undertaking that the forest land proposed to be diverted shall under no circumstances be transferred or sublet to any other agencies, department or person without prior approval of Government of India.

True copy of Undertaking dated 04.03.2024 for no subletting of diverted forest land is annexed herein as **Annexure A-31 (Page No. 414)**

V. That the Answering Respondent has furnished an Undertaking that the total forest area utilized for the project shall not exceed 35.5644 ha and the forest area diverted shall not be used for any purpose other than those shown in the diversion proposal.

True copy of undertaking dated 04.03.2024 for project area not exceeding 35.5644 ha is annexed herein as **Annexure A-32 (Page No. 415)**.



W. That the Answering Respondent has furnished an Undertaking that MMRDA and the State Government shall ensure compliances to the all acts, rules, regulation and guidelines of the Ministry, for the time being in force, as applicable to the subject project.

True copy of undertaking dated 04.03.2024 for compliances to the all acts, rules, regulations and guidelines is annexed herein as **Annexure A-33 (Page No. 416)**.

X. That the Answering Respondent has furnished an Undertaking that any other condition that the Regional Office, Nagpur may impose from time to time in the interest of afforestation, conservation and management of flora and fauna in the area shall be complied by the User Agency.

True copy of Undertaking dated 04.03.2024 for other conditions imposed by Regional Office, Nagpur is annexed herein as **Annexure A-34 (Page No. 417)**.

Y. That the Answering Respondent has furnished an Undertaking that in the event of failure to comply with any of the above conditions the User Agency is liable for penal action as per the rules/guidelines issued under Van (Sanrakshan Evam Samvardhan) Adhiniyam, 1980

True copy of Undertaking dated 04.03.2024 for other conditions imposed by Regional Office, Nagpur is annexed herein as **Annexure A-35 (Page No. 418)**.



Z. That the Answering Respondent has furnished an Undertaking that it shall submit a Compliance Report on the above conditions through online or offline.

True copy of undertaking dated 04.03.2024 for compliance report on conditions is annexed herein as **Annexure A-36** (Page No. 419).

15. As highlighted above, the meticulous compliance of all relevant conditions as well as requisite clearances and approvals have been duly obtained by the Answering Respondent in undertaking the Project. That the concerns regarding environment degradation and other adverse impacts which may arise from implementation of such project are considered seriously by the Answering Respondent and has been duly addressed.

16. It is humbly submitted that no new facts and grounds have been pleaded in this Affidavit.

Dated: 03.12.2025

Place: New Delhi.

ADVOCATE FOR RESPONDENT NO. 6

DEPONENT

Through

AP Singh

APSAK CONSULTANTS LLP

Advocate for Respondent No. 6
80, Second Floor, Golf Links,
New Delhi-110003
M: 9999770795, Email: abhikalp@outlook.com



A handwritten signature in blue ink, appearing to be 'Jas', written over a horizontal line.

VERIFICATION

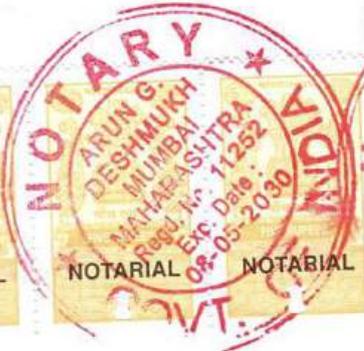
I, the above-named deponent, do hereby solemnly verify that the contents of the aforesaid affidavit are true and correct to the best of my knowledge and belief and nothing has been concealed therefrom.

Verified at Mumbai on this 03rd day of December, 2025.

DEPONENT



BEFORE ME
[Signature]
ARUN G. DESHMUKH
REG. NO. 11252 B.Com., LL.B.,
ADVOCATE HIGH COURT
NOTARY GOVT. OF INDIA
C/11, Laxmi Kiosk, Balarama Bldg.,
Basement Near Family Court, BKC, Bandra-61



NOTAR. REGISTER ENTRY
Sr No 1278 Page No 26
Date 03/12/2025



महाराष्ट्र वन विभाग
☎: ०२२-२८६९२६६८/ २८६९२५९६
apccfwlmumbai@mahaforest.gov.in



महाराष्ट्र शासन
महसूल व वन विभाग
अपर प्रधान मुख्य वनसंरक्षक
वन्यजीव पश्चिम प्रदेश मुंबई
जुनी एम.एच.बी. कॉलनी, एल.टी.रोड, बोरीवली
(पश्चिम), मुंबई - 400091



जा.क्र.कक्ष-3/जमीन/FCA/प्र.क्र.149/ 555 /2024-25

दिनांक: 26 /06/2024

कार्यरिभ आदेश

विषय : Diversion of 35.5644 ha. forest land for construction of twin tube tunnel 2 lanes each side from tikuji ni wadi in thane district to borivali to mumbai suburban District in the state of maharashtra of total 11.8 alignment (including tunnel length of about 10.03 km) which passes below the sanjay gandhi national park SGNP in thane and mumbai sub urban district in the state of maharashtra.

- संदर्भ :- 1) Ministry of Environment, Forest & Climate Change, Regional Office, Nagpur's Letter Proposal No.FP/MH/ROAD/428417/ 2023/2832, दि.09/02/2024.
2) मुख्य वनसंरक्षक व संचालक संजय गांधी राष्ट्रीय उद्यान, बोरीवली यांचेकडील पत्र क्र.कक्ष-2/जमीन/1113, दि.13/03/2024.
3) या कार्यालयाचे पत्र जा.क्र.कक्ष-3/जमीन/FCA/प्र.क्र.143/1142, दि.14 /03/2024.
4) कार्यकारी अभियंता, एम.एम.आर.डी.ए. बांद्रा, मुंबई यांचेकडील पत्र क्र.ED/MMRDA/TBTT/WLP/2024/301, दि.13/03/2024 व पत्र क्र.782, दि. 24/06/2024.
5) मुख्य वनसंरक्षक व संचालक संजय गांधी राष्ट्रीय उद्यान, बोरीवली यांचेकडील पत्र क्र.कक्ष-2/जमीन/228, दि.24/06/2024.
6) या कार्यालयाचे पत्र जा.क्र.कक्ष-3/जमीन/FCA/प्र.क्र.143/212 , दि. 25 /06/2024.

विषयांकीत प्रकरणी संदर्भिय पत्र क्र. 1 अन्वये वन (संवर्धन) अधिनियम, 1980 अंतर्गत केंद्र शासनाने Diversion of 35.5644 ha. forest land for construction of twin tube tunnel 2 lanes each side from tikuji ni wadi in thane district to borivali to mumbai suburban District in the state of maharashtra of total 11.8 alignment (including tunnel length of about 10.03 km) which passes below the sanjay gandhi national park SGNP in thane and mumbai sub urban district in the state of maharashtra बाबतच्या प्रस्तावास 1 ते 29 अटींचे अधीन राहून तत्वतः मान्यता प्रदान केली आहे. त्याअनुषंगाने मुख्य वनसंरक्षक व संचालक संजय गांधी राष्ट्रीय उद्यान, बोरीवली यांनी 1 ते 29 अटींची पूर्तता प्रकल्प यंत्रणेकडून झाल्याचे खात्री करून पूर्तता अहवाल संदर्भ क्र. 2 व 5 अन्वये या कार्यालयास सादर केलेला आहे. सदर अहवाल या कार्यालयाचे संदर्भिय पत्र क्र. 3 व 6 अन्वये अपर प्रधान मुख्य वनसंरक्षक व केंद्रस्थ अधिकारी, महाराष्ट्र राज्य, नागपूर यांना पाठविण्यात आलेला आहे.

2.00 केंद्र शासनाचे पर्यावरण, वन व जलवायू परिवर्तन मंत्रालय भारत सरकार नवी दिल्ली यांचेकडील पत्र क्र. एफ-11/306-214/एफसी दिनांक 07.05.2015 महाराष्ट्र शासन परिपत्रक क्र. एफएलडी-2015/प्र.क्र.-77/फ-10 दिनांक 01.07.2015 व महाराष्ट्र शासन परिपत्रक क्र. FLD-2015/प्रक्र.77/फ-10, दिनांक 01.03.2017 अन्वये वन (संवर्धन) अधिनियम, 1980 अंतर्गत नवीन रस्ते करणे, अस्तीत्वात असलेले महामार्गाचे रुंदीकरण, ट्रान्समिशन लाईन, पाण्याची पाईप लाईन, ऑप्टिकल फायबर केबल लाईन, रेल्वे लाईन इत्यादी एकरेषिय (Linear) प्रकल्पांना तत्वतः मान्यता दिल्यानंतर सदर तत्वतः मान्यतेच्या पत्रातील पर्यायी वनीकरणाची रक्कम, नक्त वर्तमान मूल्य रक्कम (NPV), वन्यजीव संवर्धन आराखडा, औषधी वनस्पतीचे रोपवन इत्यादी कामांबाबत आवश्यक पूर्ण देय रक्कम

..2...

(Compensatory levies) भरणा प्रकल्प यंत्रणेकडून केल्यानंतर तसेच आवश्यक त्या ठिकाणी पर्यायी वनीकरणासाठीची वनेत्तर जमीन वन विभागाकडे हस्तांतरण (Transfer) व वन विभागाचे नावे (Mutation) झालेनंतर प्रकल्पाचे काम जलद गतीने सुरू करून सुविधा उपलब्ध होण्याचे दृष्टीने प्रकल्पा अंतर्गत वन जमीनीवरील झाडे तोडण्यास तसेच काम सुरू करणेस परवानगी देणेसाठी संबंधित मुख्य वनसंरक्षक तसेच वन्यजीव विभागाच्या अखत्यारीतील अपर प्रधान मुख्य वनसंरक्षक वन्यजीव पश्चिम प्रदेश मुंबई यांना प्राधिकृत करण्यात आलेले आहे. त्या अनुषंगाने सदरचे काम सुरू करण्यास परवानगी देणेस हरकत नसून पुढील आदेश होणेबाबत प्रकल्प यंत्रणेने संदर्भिय पत्र क्र.4 अन्वये विनंती केली आहे.

3.00 प्रकल्प यंत्रणेने, पर्यायी वनीकरण, नक्त वर्तमान मूल्य, व वृक्षतोडीची रक्कम इ. रक्कमा विहित मार्गे कॅम्पा सदरी जमा केलेल्या आहेत. केंद्र शासनाचे दिनांक 07.05.2015. महाराष्ट्र शासनाकडील परिपत्रक क्र. एफएलडी-2015/प्रक्र-77/फ-10 दिनांक 01.07.2015 व महाराष्ट्र शासन परिपत्रक क्र. FLD- 2015/प्रक्र.77/फ-10, दिनांक 01.03.2017 अन्वये दिलेल्या अधिकाराचा वापर करून कार्यकारी अभियंता, मुंबई महानगर प्रदेश विकास प्राधिकरण, बांद्रा, मुंबई - 400 051 यांना विषयांकित काम सुरू करण्यासाठी खालील अटी व शर्तीचे अधीन राहून कार्यारंभ आदेश (Working Permission) देण्यात येत आहे :-

1. प्रकल्प यंत्रणा वन (संवर्धन) अधिनियम, 1980 अंतर्गत केंद्र शासनाचे तत्वतः मान्यता दिलेल्या आदेशातील सर्व अटीचे अनुपालन करेल.
2. प्रकल्प यंत्रणा तत्वतः मान्यता आदेशातील सर्व अटी व शर्तीचे तंतोतंत अनुपालन करेल याची मुख्य वनसंरक्षक व संचालक संजय गांधी राष्ट्रीय उद्यान, बोरीवली हे खात्री करतील व त्याबाबतचा अहवाल या कार्यालयास वेळोवेळी सादर करतील.
3. वन (संवर्धन) अधिनियम, 1980 अंतर्गत केलेले नियम, मार्गदर्शक सूचना व या आदेशातील तसेच केंद्र शासनाचे तत्वतः मान्यता आदेशातील अटीपैकी कोणत्याही अटीचे अनुपालन न करणे हे वन (संवर्धन) अधिनियम, 1980 चा भंग ठरेल आणि त्याप्रमाणे याबाबत वैधानिक कारवाई करण्यात येईल.
4. सदर प्रस्तावांतर्गत वृक्षतोड अंतर्भूत आहे.
5. मजुरांचे वास्तव्यासाठी वनक्षेत्रात तात्पुरते शोड उभारता येणार नाही.
6. सदर आदेश केंद्र शासनाकडील मार्गदर्शक सूचना क्र. 11-306/2014-FC(pt) दिनांक 28.08.2015 प्रमाणे 1 वर्षापर्यंत वैध राहतील.
7. प्रधान मुख्य वनसंरक्षक (वन्यजीव) महाराष्ट्र राज्य, नागपूर यांचेकडील पत्र क्र. 5268, दि.20/02/2024 रोजीच्या पत्रातील विहित अटी व शर्तीचे पालन प्रकल्प यंत्रणेने करावे व याबाबत मुख्य वनसंरक्षक व संचालक, संजय गांधी राष्ट्रीय उद्यान, बोरीवली यांनी प्रकल्प यंत्रणेवर नियंत्रण ठेवावे.
8. प्रधान मुख्य वनसंरक्षक (वन्यजीव) महाराष्ट्र राज्य, नागपूर यांचेकडील पत्र क्र. 356, दि.13/05/2024 मध्ये नमूद केले नुसार सदर क्षेत्र संजय गांधी राष्ट्रीय उद्यानाच्या पर्यावरण संवेदनशील क्षेत्रामध्ये असल्यामुळे प्रस्तावित क्षेत्राबाबत पर्यावरण संवेदनशील संनियंत्रण समितीची मान्यता घेण्याच्या अधीन राहून सदरची Working Permission देण्यात येत आहे.



अनुसूची

Village	Taluka	District	S.No.	Area (ha)	Legal Status
Manpada	Thane	Thane	59 A/1 PT	1.5537	Finally Acquired Forest
			59 A/1 PT	0.7652	Finally Acquired Forest
Majiwada	Thane	Thane	420	0.0708	Reserved Forest
Boriwade	Thane	Thane	80	1.6048	Finally Acquired Forest
Yeur	Thane	Thane	20 PT	0.0593	Finally Acquired Forest
			23(63)	1.2316	Private Forest
			106(37)	9.5612	Reserved Forest
			106(37)	3.5814	Reserved Forest
Chene	Thane	Thane	101 PT	1.3591	Finally Acquired Forest
Magathane	Borivali	Mumbai Suburban	Sur.No.34 B	15.7771	Unclassed Forest
			Total Area	35.56 Ha	



(एस. व्ही. रामाराव)
अपर प्रधान मुख्य वनसंरक्षक
वन्यजीव पश्चिम प्रदेश
मुंबई

प्रति,

कार्यकारी अभियंता,
मुंबई महानगर प्रदेश विकास प्राधिकरण,
बांद्रा, मुंबई - 400 051.

प्रतिलिपी : अपर प्रधान मुख्य वनसंरक्षक व केंद्रस्थ अधिकारी, महाराष्ट्र राज्य, नागपूर यांना माहितीसाठी.

प्रतिलिपी : जिल्हाधिकारी मुंबई उपनगर यांना माहितीसाठी सख्खेह अग्रेषित.

प्रतिलिपी : मुख्य वनसंरक्षक व संचालक संजय गांधी राष्ट्रीय उद्यान, बोरीवली यांना माहिती व आवश्यक कार्यवाहीसाठी.

2.00 मुख्य वनसंरक्षक व संचालक संजय गांधी राष्ट्रीय उद्यान, बोरीवली यांना कळविण्यात येते की, वरील आदेशाची प्रत जिल्हाधिकारी मुंबई उपनगर, जिल्हा परिषद मुंबई उपनगर, स्थानिक संस्था, पंचायत, नगरपालिका, नगरपरिषद आणि संबंधित शासकीय कार्यालयांचे प्रमुख यांना पाठविण्यात यावी. तसेच त्यांनी वरील आदेश त्यांच्या कार्यालयातील सूचना फलकावर व वरील कार्यालय प्रमुखांच्या सूचना फलकावर सर्वसामान्य जनतेच्या माहितीसाठी आदेशाची प्रत मिळाल्यापासून प्रदर्शित केले जातील याची खात्री करावी.

कार्यकारी अभियंता, मुंबई महानगर प्रदेश विकास प्राधिकरण, बांद्रा, मुंबई - 400 051 यांना निर्देशित करण्यात येते की, वन मंजूरीचे आदेश सर्व्हे क्रमांक, गट क्रमांक त्यांचे क्षेत्र आणि वैधानिक दर्जा ई. आणि केंद्र शासनाने तत्वतः मान्यतेच्या आदेशात घातलेल्या अटी व शर्ती यांच्यासह एक स्थानिक भाषेतील व एक इंग्रजी भाषेतील प्रसिद्ध अशा दोन दैनिक वृत्तपत्रात प्रसारित करावेत आणि त्याची प्रत मुख्य वनसंरक्षक व संचालक संजय गांधी राष्ट्रीय उद्यान, बोरीवली यांना देण्यात यावी.

स्थानिक स्वराज्य संस्था, पंचायत, नगरपालिका, नगरपरिषद, संबंधित शासकीय कार्यालयांचे प्रमुख यांनी आदेशाची प्रत मिळाल्यापासून 30 दिवसापर्यंत सदर आदेश सूचना फलकावर प्रदर्शित करावेत.

Maharashtra Forest Department**4:022-28692668/28692596 apccfwlmumbai@mahaforest.gov.in****Government of Maharashtra****Revenue and Forest Department****Additional Principal Chief Conservator of Forests Wildlife Western Region Mumbai Old
M.H.B. Colony, L.T. Road, Borivali (West), Mumbai - 400091****Ja.No. Room-3/Land/FCA/P.No. 149/ 555 /2024-25****Date: 26/06/2024****Start command**

Subject : Diversion of 35.5644 ha. forest land for construction of twin tube tunnel 2 lanes each side from tikuji ni wadi in thane district to borivali to mumbai suburban District in the state of maharashtra of total 11.8 alignment (including tunnel length of about 10.03 km) which passes below the sanjay gandhi national park SGNP in thane and mumbai sub urban district in the state of maharashtra.

Reference :-

- 1)** Ministry of Environment, Forest & Climate Change, Regional Office, Nagpur's Letter Proposal No.FP/MH/ROAD/428417/2023/2832, दि. 09/02/2024.
- 2)** Letter from Chief Conservator of Forests and Director Sanjay Gandhi National Park, Borivali No. Room-2/Land/1113, dated 13/03/2024.
- 3)** This office's letter No. Room-3/Land/FCA/Pro.No. 143/1142, dated 14/03/2024.
- 4)** Letter No. ED/MMRDA/TBTT/WLP/2024/301, dated 13/03/2024 and letter No. 782, dated 24/06/2024 from Executive Engineer, MMRDA Bandra, Mumbai.
- 5)** Letter from Chief Conservator of Forests and Director Sanjay Gandhi National Park, Borivali No. Room-2/Land/228, dated 24/06/2024.
- 6)** This office's letter No. Room-3/Land/FCA/Pro.No. 143/212, dated 25/06/2024.

In the subject matter, the Central Government has given in-principle approval vide Reference Letter No. 1 under the Forest (Conservation) Act, 1980 for the proposal for Diversion of 35.5644 ha. forest land for construction of twin tube tunnel 2 lanes each side from tikuji ni wadi in thane district to borivali to mumbai suburban District in the state of maharashtra of

total 11.8 alignment (including tunnel length of about 10.03 km) which passes below the sanjay gandhi national park SGNP in thane and mumbai sub urban district in the state of maharashtra subject to conditions 1 to 29. Accordingly, the Chief Conservator of Forests and Director Sanjay Gandhi National Park, Borivali has submitted a compliance report vide Reference Letter No. 2 and 5 to this office after verifying that the conditions 1 to 29 have been fulfilled by the project team. The said report is the reference letter of this office. 3 and 6 have been sent to the Additional Principal Chief Conservator of Forests and Central Officer, Maharashtra State, Nagpur.

2.00 p.m Ministry of Environment, Forest and Climate Change, Government of India, New Delhi, vide letter No. F-11/306-214/FC dated 07.05.2015 Maharashtra Government Circular No. FLD-2015/Pr.Kr.-77/F-10 dated 01.07.2015 and Maharashtra Government Circular No. FLD-2015/Pr.Kr.77/F-10, dated 01.03.2017, after in-principle approval of linear projects such as construction of new roads, widening of existing highways, transmission lines, water pipe lines, optical fiber cable lines, railway lines, etc. under the Forest (Conservation) Act, 1980, the amount of alternative afforestation, net present value (NPV), wildlife conservation plan, medicinal plant plantation, etc. in the said in-principle approval letter shall be paid in full in respect of the works.

After payment of (Compensatory levies) by the project authority and after transfer of non-forest land for alternative afforestation to the Forest Department where necessary and after mutation of the Forest Department, the concerned Chief Conservator of Forests and the Additional Chief Conservator of Forests, Wildlife, Western Region, Mumbai under the jurisdiction of the Wildlife Department have been authorized to allow felling of trees on the forest land and start the work under the project in order to provide facilities at a fast pace. Accordingly, there is no objection to allowing the commencement of the said work and the project authority has requested for further orders under reference letter No. 4.

3.00 The project system, afforestation, net present value, and tree felling amount is. The amount has been deposited in the campa through the prescribed channel. Central Government dated 07.05.2015. In exercise of the powers conferred by the Maharashtra Government vide Circular No. FA-2015/PKR-77/F-10 dated 01.07.2015 and Maharashtra Government Circular No. FLD-2015/PKR. 77/F-10, dated 01.03.2017, the Executive Engineer, Mumbai Metropolitan Region Development Authority, Bandra, Mumbai - 400 051 is hereby granted a Working Permission to commence the subject work subject to the following terms and conditions:-

1. The project management will comply with all the conditions of the order given in-principle approval by the Central Government under the Forest (Conservation) Act, 1980.
2. The Chief Conservator of Forests and Director, Sanjay Gandhi National Park, Borivali will ensure that the project management strictly complies with all the terms and conditions of the approval order and submit a report to this office from time to time.

3. Non-compliance with any of the rules, guidelines and conditions made under the Forest (Conservation) Act, 1980 and this order as well as the in-principal approval order of the Central Government shall constitute a violation of the Forest (Conservation) Act, 1980 and legal action shall be taken accordingly.

4. The proposal includes tree felling.

5. Temporary sheds cannot be erected in forest areas for the accommodation of laborers.

6. The said orders shall remain valid for 1 year as per Central Government Circular No. 11-306/2014-FC(pt) dated 28.08.2015.

7. The project organization should comply with the terms and conditions laid down in the letter No. 5268 dated 20/02/2024 from the Principal Chief Conservator of Forests (Wildlife), Maharashtra State, Nagpur and the Chief Conservator of Forests and Director, Sanjay Gandhi National Park, Borivali should keep control over the project organization in this regard.

8. Principal Chief Conservator of Forests (Wildlife) Maharashtra State, Nagpur vide letter No. 356, dated 13/05/2024 stated that since the said area is in the environmentally sensitive area of Sanjay Gandhi National Park, the said Working Permission is being granted subject to the approval of the Environmentally Sensitive Management Committee regarding the proposed area.

Village	Taluka	District	S.No	Area (ha)	Legal Status
Manpada	Thane	Thane	59 A/1 PT	1.5537	Finally Acquired Forest
			59 A/1 PT	0.7652	Finally Acquired Forest
Majiwada	Thane	Thane	420	0.0708	Reseverd Forest
Borivali	Thane	Thane	80	1.6048	Finally Acquired Forest
Yeur	Thane	Thane	PT	0.0593	Finally Acquired Forest

Chene	Thane	Thane	101PT	1.3591	Finally Acquired Forest
Magathane	Borivali	Mumbai Suburban	Sur.No.34 B	15.7771	Unclassed Forest
			Total Area	35.56	

Ramie Ras (S. V. Rama Rao)
Additional Principal Chief Conservator of
Forests Wildlife Western Region
Mumbai

- per,

Executive Engineer,

Mumbai Metropolitan Region Development

Authority, Bandra, Mumbai - 400 051.

Copy to: Additional Principal Chief Conservator of Forests and Central Officer, Maharashtra State, Nagpur for information.

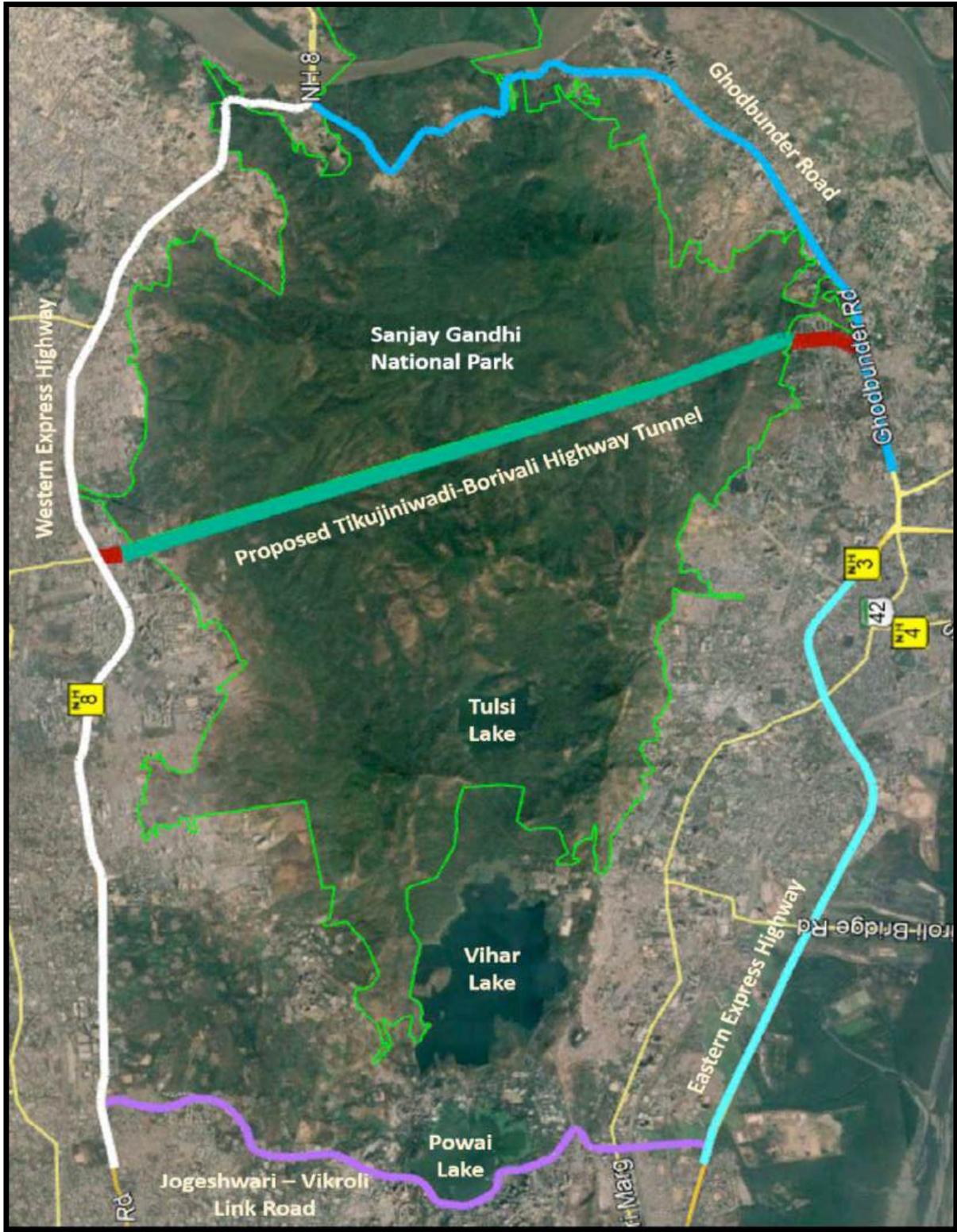
Copy: Kindly forwarded to the District Collector, Mumbai Suburban for information.

Copy: Chief Conservator of Forests and Director Sanjay Gandhi National Park, Borivali for information and necessary action.

2.00 Chief Conservator of Forests and Director Sanjay Gandhi National Park, Borivali is informed that a copy of the above order may be sent to the District Collector, Mumbai Suburban, Zilla Parishad, Mumbai Suburban, Local Bodies, Panchayats, Municipalities, Municipal Councils and Heads of the concerned Government Offices. They should also ensure that the above order is displayed on the notice board in their offices and on the notice board of the Heads of the above offices for the information of the general public after receiving the copy of the order.

The Executive Engineer, Mumbai Metropolitan Region Development Authority, Bandra, Mumbai 400 051 is directed to publish the forest approval orders along with the survey number, group number, their area and statutory status and the terms and conditions laid down in the approval order in principle by the Central Government in two popular daily newspapers, one in the local language and one in the English language, and a copy thereof should be given to the Chief Conservator of Forests and Director Sanjay Gandhi National Park, Borivali.

The heads of local self-government bodies, panchayats, municipalities, municipal councils, and relevant government offices should display the said order on the notice board within 30 days from the date of receipt of the copy of the order.



Satellite image showing the proposed TBTT line passing through the SGNP area

STATE ENVIRONMENT IMPACT ASSESSMENT AUTHORITY

SEIAA -2019/CR-32/SEIAA
 Environment Department,
 217(Annex), Mantralaya,
 Mumbai- 400 032.
 Date: 07/04/2019.

To,
Maharashtra State Road Development Corporation Ltd.,
 Opp. Bandra Reclamation Bus Depo.
 Near Lilavati Hospital, Bandra (W),
 Mumbai 400050, Maharashtra, India

Sub: Clarification regarding applicability of Environmental Clearance for Proposed Construction of Twin-Tube (3 Lanes Each) Tunnel from Tikuji Ni Wadi in Thane District to Borivali in Mumbai Suburban District.

Ref: Your letter no. MSRDC/02/JMD (Eng 1)/Tunnel/File no 12/2019/2013 dated 18.03.2019

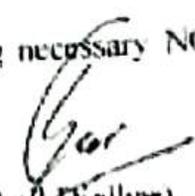
This has reference to your above referred letter seeking clarification regarding applicability of environmental clearance for Proposed Construction of Twin-Tube (3 Lanes Each) Tunnel from Tikuji Ni Wadi in Thane District to Borivali in Mumbai Suburban District.

You have informed that you are proposing to construct Twin tube, 3 Lanes (each side) tunnel of about 10.8 km, which passes through below the Sanjay Gandhi National Park (SGNP), connecting Western Express Highway (WEH) near Borivali and Ghodbunder road (of Thane) Near Tikujiniwadi. This link passes through Municipal Limits of Mira Bhayander Municipal Corporation area from Ch.00/000 to Ch.04/400 and thereafter it passes through Thane city urban area from Ch.04/400 to Ch.14/900. The proposed tunnels will reduce the Thane-Borivali travel distance by 10 km further reduce the travel time by 20-25 minutes.

You have also submitted undertaking that the proposed road is not Expressway, Express Highway, National Highway, Major State Highway.

In view of the above, it is to inform you that the aforesaid proposed activity does not require prior environmental clearance subject to condition that no activity mentioned in the Schedule of the Environment Impact Assessment Notification, 2006 (amended till date) is carried out on the location of the proposed project.

This letter should not be considered as exemption from obtaining necessary NOC/permission from any other Government Authorities.


 (Arun Dighe)
 Principal Secretary &
 Member Secretary, SEIAA

**Environment Impact Assessment (EIA) and
Environment Management Plan (EMP)**

Project

**Proposed Construction of Twin Tube (2 Lanes Each) Highway Tunnel
Between Tikuji-ni-wadi in Thane District and Borivali in Mumbai
Suburban District in the State of Maharashtra**

Project Proponent



Mumbai Metropolitan Regional Development Authority, Mumbai

Prepared By

**Dr. N. C. Kankal, EIA Coordinator
164, Ramesh Estate, Besa-Ghogali Road, Nagpur – 440 034
Mobile: 9423685941, Email: kankalnana@gmail.com**

DECLARATION BY EXPERTS

Name of EIA Coordinator : Dr. Nanasaheb Chindhaji Kankal
Period of Involvement : 3rd February, 2020 till date
Contact : Bungala No. 164, Besa-Ghogali Road
 Ghogali, Nagpur - 440 034
 Mobile: 9423685941, Email: kankalnana@gmail.com

Functional Area Experts/Participants:

Sr. No.	Functional Area	Experts/Contributions
1.	Air Pollution	M/S Bioraj Laboratories, Pune
2.	Noise Pollution	M/S Bioraj Laboratories, Pune
3.	Water Pollution	M/S Bioraj Laboratories, Pune
4.	Soil Conservation	M/S Bioraj Laboratories, Pune
5.	Solid Hazardous Waste, RH	Pre-feasibility Report (M/SAECOM)
6.	Socio-economic	Anil P. Shende (FAE-SE)
7.	Ecology and Biodiversity	Dr. N. C. Kankal (FAE-EB)
8.	Hydro-geology	Pre-feasibility Report (M/SAECOM)
9.	Geology	Pre-feasibility Report (M/SAECOM)
10.	Air Quality Modeling	Dr. Atul Vanerkar (FAE-AQ)
11.	Noise Modeling	Dr. Atul Vanerkar (FAE-NV)
12.	Land Use	Mr. Bhushan Kachawe (FAE-LU)

Declaration:

I, Dr. Nanasaheb Chindhaji Kankal, confirm that the above-mentioned experts have participated in the process of preparation of the EIA Report for the “Proposed Twin Tube (2 Lanes Each) Highway Tunnel from Tikuji-Ni-Wadi in Thane District to Borivali in Mumbai Suburban District” in the state of Maharashtra, proposed by M/S MMRDA (Project Proponent). I also confirm that the consultant shall be fully accountable for any mis-leading information mentioned in the statements.

Signature : 

Designation : EIA Coordinator

Date :

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Chapter 1

Introduction

Background

Maharashtra State Road Development Corporation Limited (MSRDC) was appointed by the Government of Maharashtra as the implementing agency for the “Proposed Twin Tube (2 lanes Each) Highway Tunnel from Tikuji-Ni-Wadi in Thane District to Borivali in Mumbai Suburban District in the State of Maharashtra”. However, the Government of Maharashtra changed the implementing agency for the proposed project and appointed Mumbai Metropolitan Regional Development Authority as the new implementing agency. Accordingly, MSRDC handed over the project to MMRDA on 21 August, 2021.

1.1 Purpose of the EIA Study

Thane Ghodbunder Road (SH-42) is a major link road connecting Mumbai-Ahmadabad Road (NH-8) part of Golden Quadrilateral near Ghodbunder to Mumbai-Agra Road (NH-3) near Kapurbawadi. This link passes through Municipal Limits of Mira Bhayander Municipal Corporation area from Ch.00/000 to Ch.04/400 and thereafter it passes through Thane city urban area from Ch.04/400 to Ch.14/900. This is an important East-West link and carries heavy commercial traffic between NH-3 and NH-8. The Road from Thane to Ghodbunder was constructed and maintained in the past by PWD. The road was handed over to MSRDC on 5th June, 2000 for widening and improvements on BOT basis with concession period up to 31st December, 2020. The road widening project was completed in year 2002 with the expenditure of Rs.72Cr and tolling was started from 1st December, 2002. Further widening and improvements of Rs.100Cr along with securitization of toll took place in 2006 with the upfront payment of Rs.141Cr. The concession period was of 15 years i.e. up to year 2020.

Presently, Thane is not directly connected to Borivali. The existing alignment connects Thane (from Tikuji-ni-wadi) and Borivali via Thane Ghodbunder road having length of 23 km. It is proposed to explore the possibility of another shorter route as a tunnel and economical alignment passing through Sanjay Gandhi National Park (SGNP) including proper and faster layoffs from NH-8 (Western Express Highway) and Ghodbunder road NH-3. An elevated road has also been planned along the Ghodbunder road. The need of connecting the northern suburb of Borivali to Thane through a tunnel passing through SGNP, which is one of the highest visited national parks within city limits in Asia and Yeoor hills has been foreseen. The two ends of the proposed tunnel have been separated by a chain of hills, most of which are a part of the SGNP.

As per the plans, there will be two tunnels of two lanes each running parallel to each other at distance of approximately 50m and connected with each other through intermediate tunnels for emergency situations. The alignment has been finalized in such a way that there will be zero disturbances to the ecosystem of the SGNP especially the flora and fauna found in the rich biodiversity of the National Park.

1.2 Identification of the Project

M/S Mumbai Metropolitan Regional Development Authority has been appointed as the implementation agency for the “Proposed Twin Tube (2 lanes each) Highway Tunnel from Tikuji-ni-wadi in Thane District to Borivali in Mumbai Suburban District in the State of Maharashtra”. The proposed tunnel meant to connect northern suburb of Borivali and Thane. Currently, the 23km distance between Thane and Borivali via Ghodbunder Road takes almost an hour and at times, even more if there is a traffic jam. Thane and Borivali in north Mumbai are separated by a chain of hills, most of which are a part of the Sanjay Gandhi National Park (SGNP). The proposed tunnel will deviate from Ghodbunder Road hills. It will then connect with Ektanagar on Western Express Highway (WEH) in Borivali. The project will be a twin tunnel with two-lanes on each carriageway (total 4 lanes).

1.3 Sanjay Gandhi National Park (SGNP)

Sanjay Gandhi National Park (SGNP) is an 87 km² protected reserve forest area near Mumbai, Maharashtra State, India that was established in 1996 with headquarters in Borivali. It is notable as one of the major national parks existing within a metropolis limit and is one of the most visited parks in the world. The rich flora and fauna of SGNP attracts more than 2 million visitors every year. Among the four National Parks in the State of Maharashtra, Sanjay Gandhi National Park (SGNP) is a beautifully preserved green oasis within the confines of Bombay metropolis. The Brihanmumbai Municipal Corporation acquired the catchment areas of the Tulsi and Vihar lakes and also added the land from the government dairy of Aarey under protection.

The SGNP area has a long history dating back to the 4th century BCE. Tourists also enjoy visiting the 2400-year-old Kanheri caves sculpted out of the rocky cliffs which lie within the park. The Kanheri Caves in the centre of the park were an important Buddhist learning centre and pilgrimage site sculpted by Buddhist monks between the 9th and the 1st centuries BCE. The park exhibits an amazing diversity of terrain-beginning at just 30 m above sea level and height near Kanheri caves being 486m, mainly hilly forest area. SGNP (previously known as Krishnagiri Upawan and later as Borivali National Park is situated about 25 km north from the heart of Bombay city and is only 8 km from the shores of the Arabian Sea. It lays between 72° 53' and 72° 50' east longitude and 19° 08' and 19° 21' north latitude. The southern boundary of the park is formed by the Shore of Vihar Lake, on the east by the townships of Bhandup, Mulund and Thane and on the west by Goregaon, Malad, Kandivli and Borivli. The northern boundary extends beyond Bassein Creek and includes the Nagla forest block. The lower westerly reaches of Krishnagiri Upawan and the northern end of Chenna forest. The major sources of water in the park are Tulsi and Vihar lakes, Dahisar and Rewat nallas. Dahisar river, which originates from Tulsi Lake flows through the forest of Magathana village and joins Manori creek which finally meets Arabian sea. Rewat nalla originates near Avaghade hill (SW of Yeur village) and flows northwards, finally joining Bassein creek. This nalla is locally known as Laxmi river, while near its origin it is known as 'Vagbacha khonda'. SGNP is one of the most highly visited national parks in the country. Over 30 lakh people visit it every year. Another tourist spot is the historic Kanheri caves built by Budhist monks almost 2000 years ago. This site is looked after by the Archeological Survey of India. The caves are arranged in several Viharas or Monasteries, solitary cells for

hermits, lecture halls and temples. The location of Sanjay Gandhi National Park is shown in **Figure 1.1**.

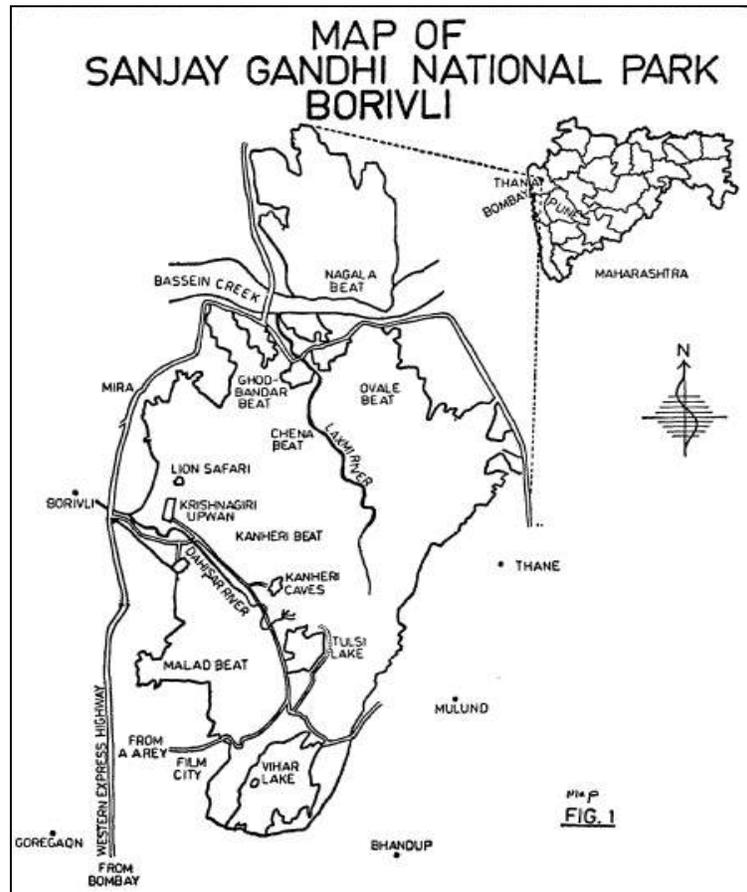


Figure 1.1: Location of Sanjay Gandhi National Park, Mumbai

1.4 Project Location and Connectivity

The proposed Twin tube, 2 lanes (each side) highway tunnel passes below the Sanjay Gandhi National Park (SGPN), connecting western express highway (WEH) near Borivali and Ghodbunder road (Thane) near Tikuji-ni-wadi. The project passes through Magathane village of Borivali, and Yeoor, Chene, Boriwade, Majiwada and Manpada villages of Thane district. Major arterial roads in this region are western express highway leading to NH-8 and eastern express highway leading to NH3. At present main east-west connecting links between these two major arterial roads from Bandra to Dahisar on western express highway and Sion to Mulund on eastern express highway as shown below:

- (1) Bandra – Sion Road
- (2) Santacruz – Chembur Link Road (SCLR)
- (3) Andheri – Ghatkopar (Kurala) Link Road (AGLR)
- (4) Jogeshwari – Vikroli Link Road (JVLR)

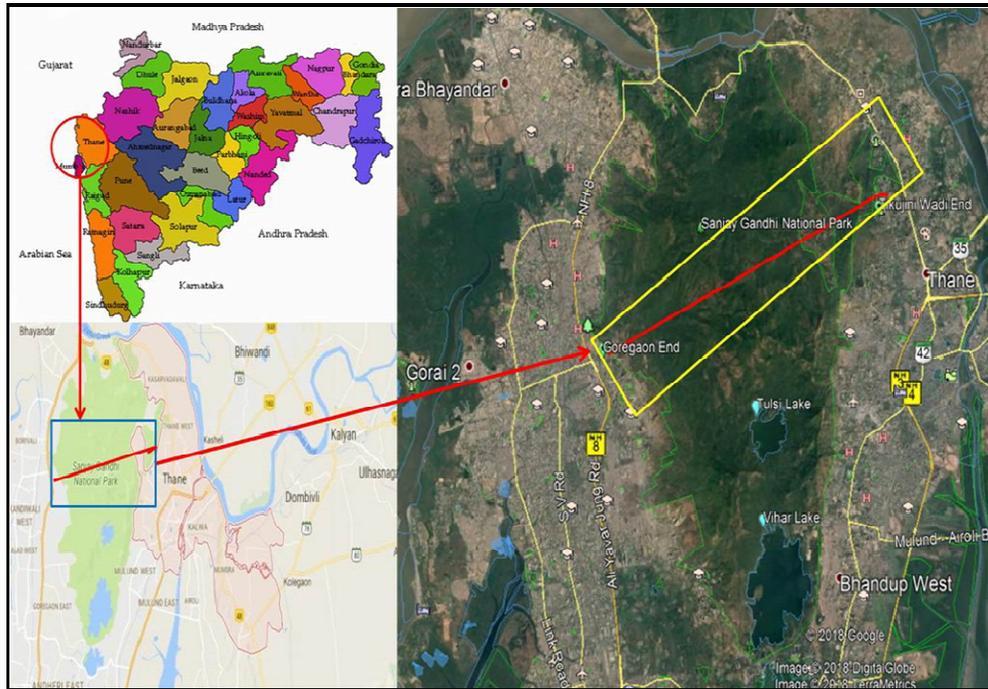


Figure 1.2: Location of the Proposed Tunnel Project

1.5 Identification of Project Proponent and EIA Consultant

Project Proponent

Mumbai Metropolitan Regional Development Authority (MMRDA)

Address for Correspondence:

Executive Engineer

Mumbai Metropolitan Regional Development Authority (MMRDA)

Bandra Kurla Complex, Bandra (E)

Mumbai-400 051

Telephone – 022-26591234/022-26590001/4000

EIA Consultant

The proposed project is about 11.8km from Borivali to Thane passing below ground SGNP will not required any Environmental Clearance (EC) from the Central or State level Authority. The project needs only Forest Clearance from Forest Department and Wildlife clearance from NBWL, which are under process. Dr. N.C. Kankal, retired Senior Principal Scientist from National Environmental Engineering Research Institute (NEERI), Nagpur has prepared the detailed report on EIA/EMP for the proposed. This report has been submitted towards fulfillment of the required deliverables.

1.6 Objectives of EIA Study

- ∞ Determination of baseline conditions using primary data generation and secondary data available from existing reports / studies carried out and historical data from government published reports.
- ∞ Detailed description of all elements of the project activities during the pre-construction, construction and operational phases. The elements has been analyzed include the infrastructures of the project including drainage features, roads, waste collection, disposal and management and utility requirements.
- ∞ Identifying the sources of pollution and assessing the impacts on the environment due to proposed tunnel development project. Analysis and assessment of designs to ensure environmental soundness, sustainability and regulatory compliance of the designs has been studied.
- ∞ Preparation of EIA and environmental management program (EMP) documents with recommendations on preventive and imitative measures for limiting the impacts on environment to the desired levels during various stages of the project. Development of a suitable post study monitoring program to comply with various environmental regulations has also been done.
- ∞ Risk Assessment (RA) and disaster management plan (DMP) including the probable risks prevention and precautionary measures to be followed in the event of emergency situations.

1.7 Justification for the Project and its Importance to the Country and Region

Current population of MMR region is about 18.5 million (2011 Census) and out of this population about 70% population resides in Mumbai Suburb (east-west) and Thane region. Major developments are also happening in this region. The need for connectivity between two suburbs (east - west) has been studied with respect to projected increase in population, traffic volume and response from existing transportation network as summarized below:

A study conducted by Mumbai Metropolitan Region Development Authority (MMRDA) entitled "Comprehensive Transportation study for Mumbai Metropolitan City" has analysis three preferred different development scenarios. Some of the results of analysis providing a feeling of increase in traffic as follows:

After reviewing the growth of population, employment and extended goods vehicles travel by 2031 as compared to 2005:

- ∞ 1.63 times growth in population
- ∞ 2.04 times growth in employment
- ∞ 4.00 times growth in external goods travel
- ∞ A growth factor of 3.00 has been assumed for internal goods vehicles travel by 2031.

External travel demand, vehicle entering, leaving or passing through the MMR play a crucial role, connecting the study area with the state and the rest of the India principally along the national and state highway, Eastern Express Highway, Sion-Panvel Highway Thane-Godbunder Road, etc., corridors connecting the Ports (Wadala Truck Terminal Road, Rafi Ahmed Kidwai Road, PD'Mello Road, NH4B, SH54 etc.) economic growth in the catchment area of the connective road systems.

Over a period of 16 years (2005-21) it is estimated that the private vehicle (two wheeler and car) modal share will increase from 12.8% to around 21.5%. IPT trips (Auto Rickshaw and Taxi) area expected to decrease from 9.1% to around 5.6% in three different growth scenarios reflecting the increase in private vehicle ownership and walk to metro.

It is therefore, considering the potentials increase in demand and limited available connectivity strengthening of existing roads have been proposed by removing bottlenecks and additional connectivity is proposed. The proposed route intends to connect with NH-8 and NH-3 thus improving east - west connectivity. Both these Highways; especially Western Express Highway (5+5 lane wide) experiences huge traffic jams between 8 am to 12 noon in the morning and 6 pm to 11 pm in the evening with average travel speed reduced to less than 20 km/hr, resulting in huge fuel loss, causing major air and noise pollution in the city.

Due to non-availability of east-west connectivity, vehicles coming from NH-8 (Ahmadabad) and Western Suburbs, (Goregaon to Mira Bhyander) and going to Thane or to eastern suburbs have to travel up to Ghodbunder, take Thane-Ghodbunder Link and then to their destination in eastern suburbs. Similarly, vehicles from Nashik, Kalyan-Dombivali, Navi Mumbai, Thane and Eastern suburbs going to western suburbs have to take Thane-Ghodbunder link and from Ghodbunder they have to travel to their destination. Thus, large numbers of vehicles have to take huge detour leading to wastage of time, fuel and resulting in more air and noise pollution. Considering present east-west traffic volume and future increase; at least two to three new connectivity links between JVLR and Thane Ghodbunder road needs to be developed.

1.8 Site Selection Criteria

Three alternative routes/options were analyzed. Three portals on either side were identified and respective alignments were evaluated. Many possible alignments due to involvement of forest and defense land extent were rejected. Other possible alignments (Option 1, Option 2 and Option 3) are discussed subsequently. Out of three, Option 2 was finalized for further studies in consultation with MMRDA.

- ∞ Direct connectivity to NH-8 and NH-3 Thane-Godbunder Road at both eastern and western end respectively through cut-n-cover/access roads
- ∞ The proposed western end of portal is far away from the boundary of SGNP while the proposed eastern end also lies outside the national park
- ∞ The site doesn't infringe the boundary of SGNP above ground
- ∞ The land is under SRA scheme and can be easily available
- ∞ 95% of total proposed alignment is within Sanjay Gandhi National Park. However, no SGNP land will be required for the proposed construction

- ∞ Significant population of slum area at western end outside national park at present which is the part of BMC's redevelopment plan
- ∞ Moderate amount of Project Affected Persons (PAP's) is involved
- ∞ Alignment is crossing one identified stream flowing from south to north in Middle East of SGNP. However, the alignment is proposed to be underground within the National Park, in order not to affect any of the surface water sources and the habitation
- ∞ No agricultural land is involved for the proposed construction

The location of proposed project alignment (Option 2) has been shown in **Figure 1.3**.



Figure 1.3: Existing Road Link and Proposed Connectivity Thane - Borivali Underneath of SGNP

1.9 Alignment Survey

Alignment survey has been carried out for fixed alignment location and topographical survey prepared around surrounding right of way (RoW). Topographical surveys make it possible to measure the steepness of slopes as well as detailed terrain.

Contour survey has been carried out by observing spot levels at 10m x 10m Grid and /or as per the client's specifications. They are plotted on the drawings and the contours are drawn using the Auto Civil or Auto plotters software. Contours are interpolated at 0.5 006D intervals and/or as specified by the clients. Generally, additional levels are taken to show the exact profile of the land.

The terrain in this region is hilly with elevation between 30m (98 ft.) and 480m (1570 ft.) and the location of proposed tunnel alignment (option 2) has been shown in **Figure 1.4**.

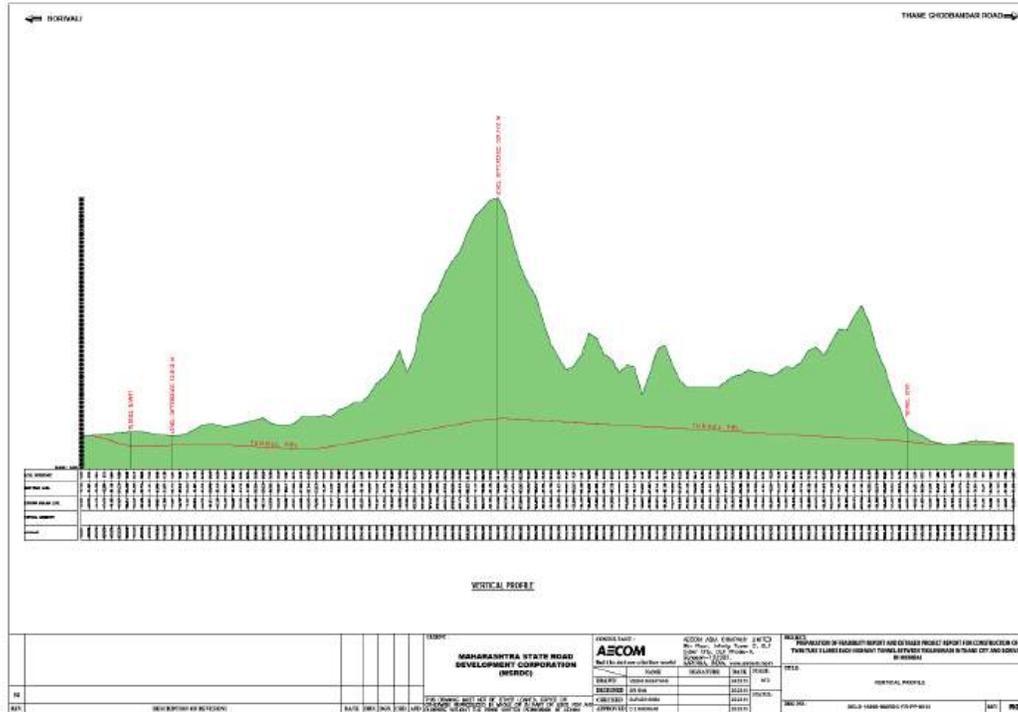


Figure 1.4: Vertical Profile of the Tunnel Alignment

1.10 Project Benefits

In view of the increasing traffic load on Thane-Godbunder road, it is necessary to look for an alternative. Road tunnels were adopted in past only where other practicable means of road were not possible mostly for the highways in hilly terrains. Urban tunnels were often discouraged due to an expensive option. However, it is increasingly difficult to provide the additional road space that may be required. Currently the local community has to bear these costs as they are not recognized or accounted for in the normal evaluation of alternatives.

Therefore, road tunnel passing below SGNP is being proposed which will provide benefits as given below:

- ∞ Fast and smooth movement of traffic from Thane to Borivali.
- ∞ Distance between Thane and Borivali is also expected to reduce/save by over 10 km.
- ∞ Travel time saving by 20 to 25 minutes
- ∞ This will also result in avoidance of traffic jams and saving fossil fuel
- ∞ Protecting environment due to reduced vehicular emissions.
- ∞ No disturbance to existing township.
- ∞ Tunnels reduce noise, air pollution, community disharmony and are visually attractive unlike surface roads.
- ∞ The intangible costs, such as effect on community health, air pollution and noise level make tunneling viable, if they are assessed.

- ∞ Construction costs are used to compare alternative transportation routes and in case other factors are considered, then tunneling would become a viable option.

1.11 Salient Features of the Project

Salient features of the proposed project given by MMRDA, the Authority are given below:

- ∞ Construction of new 4-lane twin tunnel starts at Thane, at Tikuji-niwadi and ends at NH-8 at Ektanagar, Borivali east.
- ∞ Tunnel will be connected with cross passages
- ∞ Vertical Clearance in the tunnel will be 5.50m and width 13.1m
- ∞ Two twin tunnels are at about 50m apart in base
- ∞ Each tunnel will consist of unidirectional two lanes
- ∞ Gradient proposed in tunnel is +2.5% (1 in 40) in 500m stretch
- ∞ The tunnel alignment will be passing through below SGNP
- ∞ Therefore, environment and forest zones won't be disturbed
- ∞ The tunnel will be bored by Tunnel Boring Machine (TBM)
- ∞ The expected construction period will be about 3 years
- ∞ Fire extinguishers/water hoses, smoke detectors shall be provided at intervals inside tunnel
- ∞ A project safety plan (PSP) is to be formulated during and after construction considering the relevant acts and IS: 4756-1978
- ∞ Adequate ventilation shall be created by natural or mechanical means to ventilate the tunnel
- ∞ Well illuminated retro-reflective light sign boards shall be installed at entrance and inside the tunnel at appropriate locations.

The environmental setting and magnitude of operation of the proposed project have been presented in **Table 1.1**.

Table 1.1: Environmental Setting and Magnitude of Operation of the Project

Sr. No.	Particulars	Details
1	Project Location	
	Nature and size of the project	Proposed Project from Tikujiniwadi Thane to Borivali East Highway Tunnel
	Location of the proposed project	Northern suburb of Borivali East to Thane Tikujini-wadi through a highway tunnel passing underneath/beneath ground through SGNP having a total length of 10.8 km.
	Geographical Location (Coordinate)	Latitude : 19°10'19.36" N to 19°14'29.43"N Longitude : 72°52'18.15"E to 72°58'07.54"E
	Toposheet No.	47A-15,16
2	Area Details	
	Total Length of the Tunnel Project	11.8 Km
	Total Area of Land Acquisition	42.46 ha of forest area underground tunnel of SGNP
	Right of Way	41 m land width for taking tunnel alignment
3	Environmental Setting and Sensitivity	
	No. of affected villages by Land acquisition	The project passes through Magathane village of Borivali, and Yeoor, Chene, Boriwade, Majiwada, and Manpada villages of Thane district. Tunnel passing underneath ground through SGNP, no village will be affected by the tunnel
	Nearest major settlement	Tikuji-ni-wadi Thane and Ektanagar Borivali East
	Nearest Villages	Magathane (Borivali) and Yeoor, Chene, Boriwade, Majiwada, and Manpada (Thane)
	Nearest Road	Ghodbunder Road (NH-3) East and Western Express Highway (NH-8) West
	Nearest Railway Stations	Thane and Borivali Railway Stations
	Nearest Air Port	Mumbai Air Port
	National Parks/Wildlife Sanctury/Biosphere Reserve/ RF/PF with in 10km radius	Sanjay Gandhi National Park (SGNP), proposed tunnel passing below the SGNP
	Archaeological Site	Kanheri Caves locate within the National Park from 1st Century BC a well-known Buddhist establishment, 2.5 km away from project site
	Nearest Water Bodies	Tulasi Lake 4.9km, (south)
	Impact on Water bodies	No rivers/streams will be affected by the proposed project as the tunnel will be deep underground the SGNP
	Streams/Nallah	Total 28 Nallahs/streams (major are Ravat Nallah and Dahisar River), mostly dry in summer
	Terrain	Largely semi mountainous with only few patches of level land. On the western side a uniform slop along the existing DP road alignment till Trimurty road 30m before forest boundary (RL of 25.884m). On the eastern side a gradual slope till Neelkanth Woods Circle and gentle slope till Mulla Bagh Junction. Mainly hilly forest area. The highest near Kanheri caves being 486 m
	Seismic Zone	Zone IV
Climate	Temperature: 17. 5°C – 33°C	

Sr. No.	Particulars	Details
		Humidity: 50% - 80% Rainfall: 2000-2500mm
	Proposed Bridges	Not Applicable
	Proposed Underpasses/ Flyover including Pedestrian underpass	Underpass Tunnel 10.8 km long Flyovers: Nil
4	Utility Requirement	
	Basic Requirements	Fresh Water : ____ m ³ /day Fuel Consumption : ____ Power Consumption : ____ Manpower : ____ No.
5	Project Design Criteria	
	Design Speed	100 -120km/hr
	Tunnel Connected	With Cross Passages
	Vertical Clearance in the tunnel	5.50m and width 13.1m
	Distance of two twin tunnels	50m apart in base
	Tunnel Boring Methodology	Tunnel Boring Machine (TBM)
	Construction Period	About 3 Years
	Proposed Toll Plazas	Not Applicable
6	Safety Measures	
	Ventilation	Quality of tunnel ventilation, size and grade of lighting, traffic control system, safety walks, fire/life safety system etc. Structural and technical safety installation will comply with National and international regulations and standards.
	Lighting	Regular tunnel lighting throughout the day and year except from the entry zone
	No of Structures Affected	Proposed Tunnel passing underneath SGNP
7	Environmental Management Plan	
	R & R Plan:	Project affected persons (PAFs) & (PAPs) – NIL
	Resettlement Action Plan (RAP) including Land Acquisition Budget	No R & R Plan required as the tunnel passing below the SGNP
	Existing trees at East Portal Existing trees at West Portal	Approximately 100 Trees and shrubs Approximately 70 Trees and shrubs
	Green Belt Development (total plantation and area)	As per IRC SP 21:2009 /MoRTH Code/Guidelines About 14 ha (33%) of total area of 42.46 ha Plantation about 28000@ 2000/ha
8	Project Cost	
	Total Project Cost	INR 3000 Cr.

1.12 Scope of the EIA/EMP Study

The first step for EIA study is known as scoping and screening as given below:

- ∞ Preliminary environmental examination
- ∞ Identification and more focused of environmental impact assessment/issues
- ∞ Their broad mitigation measures

The main basic aim of the study is to assess the magnitude of actual and potential environmental concerns due to construction of 4 lane green field new underground tunnel. This is also to ensure that the environmental considerations are given due weight-age in the design of proposed project and improvement being studied. Environmental screening of the study area has the following major objectives:

- ∞ To assess baseline environmental scenario of the project
- ∞ Identification of the primary data collection / environmental monitoring locations as per the environmental scenario of the project
- ∞ The primary environmental data collections includes:
 - Ambient Air Quality Monitoring (AAQM)
 - Noise Level
 - Water Quality (surface and groundwater)
 - Soil Quality
 - Ecology and Bio-diversity
 - Socio-economic
- ∞ Environmental screening in terms of sensitive receptors (SEZ, PN, Archeological/historical places in the area of impacts)
- ∞ Types of environmental assessment required
- ∞ Delineate major environmental issues
- ∞ Identification of potential hotspots
- ∞ Identification of environmental Impact Assessment (EIA)
- ∞ Tunnel construction methodology / technology and its impacts
- ∞ Changes in aquifer recharge and hydrology
- ∞ Magnitude of potential impacts and ensure that environmental considerations while designing and proposed highway tunnel improvement

1.13 Environmental Screening

The purpose of the environmental screening is to identify key environmental issues for the proposed project began with the adoption of an environmental screening procedure during the feasibility stage. The process of screening is to identify key environmental issues such as environmental sensitive receptors along/around the selected alignment, change of land-use, impacts on surface and ground water bodies, availability of burrow areas, impact on community facilities, impact on flora and fauna and protected area, etc. The task is completed after review of policies, regulations and institutional arrangements. Review of the existing legislations, institution and policies relevant to the EIA at the National and State levels has been done and as per the requirements at various stages of the project have been identified.

As per MOEF&CC Highway project activity is under 7(f), Category A and Category B should be New National Highway or State Highway respectively, if it is greater than 30km in length, involving additional right of way (RoW) greater than 20km with general condition, if any, shall be apply. However, the proposed highway tunnel project of 10.8km in length only. The project proponent (PP) submitted an application to the authority for the grant of ToR under highway project Category 7(f) B1 as per EIA Notification 2006. Based on the application draft ToR, MoEFCC has returned application of ToR stating that the proposed project is not admissible under EIA Notification and will not require Environmental Clearance (EC) from Government of Maharashtra. However, as the project is passing underground through core area of Sanjay Gandhi National Park (SGNP) and having about 42.46 Ha of forest area, it will require forest clearance from forest department and wildlife clearance from National Board of Wildlife (NBWL). The detail has been obtained from SGNP Forest Office, Borivali / Revenue Department / SGNP Wildlife Office. To fulfill the MMRDA requirement and request the EIA/EMP study is being carried out.

1.14 Policies, Legal and Administrative Framework

The Ministry of Environment, Forest and Climate change (MoEF&CC), Government of India, in its Notification S.O. 1533 dated September 14, 2006 and its amendments dated 1st December, 2009 and 22nd August, 2013 has made it mandatory to obtain Environmental Clearance (EC) for any expansion, widening or construction of a new road project before its implementation. As a requirement for seeking Environmental Clearance (EC), the consultants are required to prepare the detailed Environmental Impact Assessment (EIA) Report and the Environmental Management Plan (EMP) for getting environmental clearances from the Ministry of Environment, Forest and Climate Change (MoEF&CC). Statutory permissions and clearances required during construction and operation of the project and legal framework are summarized in **Table 1.2**.

Table 1.2: Summary of Relevant Environmental Acts Legal Framework and Guidelines

Sr. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for Applicability	Authority
1	Forest (Conservation) Act as amended to date	1980	To check deforestation by restricting conversion of forested areas into non-forested areas purposes. Clear any forest land of naturally green trees for the purpose	Yes	Proposed project is passing underground the Reserve forest of SGNP Forest core of 57.02 ha of forest area is identified along the tunnel alignment falls in Notified protected forest areas as per FCA, 1980	Forest Clearance from MOEF&CC and Wildlife Clearance from NBWL. Forest Department, Govt. of Maharashtra
2	Environmental (Protection) Act, and Rules as amended to date	1986	To protect and improve overall environmental pollution	Yes	As all environmental notifications, rules and schedules are issued under this act	MoEF&CC Gol, State Dept. of Environment, CPCB, MPCB
3.	Environmental Impact Assessment (EIA) Notification, as amended to date	2006	For conducting EIA studies and obtaining EC from MOEF&CC/SEIAA Categorization of project 'A' and 'B' for environmental safeguard	No	MoEF&CC has returned application of TOR stating that the proposed project is not admissible under EIA Notification	Not Applicable
4.	The Water (Prevention and Control of Pollution) Act as amended to date	1974	Provision to control water pollution by controlling discharge of wastewater effluent in to the environment as per the prescribed norms	Yes	Project will use water resources and also discharge treated sewage. The casting Yards and RMC plant will require consent under Water Act	Maharashtra Pollution Control Board (MPCB)
5.	The Water (Prevention & control of pollution) Cess Act, Cess Rules as amended to date	1977, 1978	Provide Levy and Cess on water consumed to generate resources for prevention and control water pollution	Yes	Project will use water resources and will discharge treated sewage and thus will have to pay Cess on water consumed with a view to generate resources	MPCB

Sr. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for Applicability	Authority
6.	The Air (Prevention & Control of Pollution) Act as amended in 1987	1981	To effective prevention and control/abatement of air pollution controlling emission and air pollutants according to prescribed standards	Yes	This act will be applicable during construction; for obtaining NOC for establishment of batching plant, and casting yards, construction camp	MPCB
7.	Noise Pollution (Regulation and Control) rules and amended to date	2000	Noise pollution regulation and controls noise standards permissible value (day/Night) for: Zone A: Industrial Zone B: Commercial Zone C: Residential Zone D: Silence	Yes	This act will be applicable as vehicular noise, construction machineries on project routes required to assess for future years and necessary protection measure need to be considered during design.	MPCB
8.	Wildlife Protection Act, as amended to date	1972	Provide protection of listed species of Flora and fauna Declare protection of Wildlife Sanctuary, National Park Ban on any Industrial process inside protected area. No objection to be obtained from Indian Board of Wildlife and State Legislature	Yes	Proposed project is passing underground through protected area (SGNP) core area	National Board for Wildlife (NBWL)
9.	The Ancient Monuments & Archaeological Sites and Remains (Amendment and Validation) Act, 2010 and as amended to date	2010	Protection and Conservation of Cultural and Historical remains found in the project area	No	The proposed project route is passing at distance more than 2km (2000 m) from Kanheri Caves in SGNP	Archaeological Survey of India, Dept. of Archaeology

Sr. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for Applicability	Authority
10.	Hazardous and other wastes (Management and Transboundary Movement Rules	2016	Handling and managing hazardous waste collection, reception, storage, transportation and disposal, filling of annual return under rule, authorization by CPCB to vendor to use of waste, fine as levied by SPCB & approval by CPCB	Yes	Hazardous Waste shall be generated due to the activities like maintenance and repair works on vehicle	MPCB
11.	Solid Waste Management Rules and amended to date, 2016	2000	Solid waste shall segregate, stored in separate streams: Biodegradable, Non-biodegradable & domestic to be collect in suitable bins and hand over to waste collectors for further purposes	Yes	Proposed project will generate organic and recyclable waste from construction depots, offices and labor camps of all packages.	MPCB
12.	Biomedical Waste Management Rule	2016	The Rules shall apply who will generate, collect, receive, store, transport, treat, dispose / handle bio-medical wastes. It includes a hospital, nursing home, clinic, dispensary, veterinary, animal house, pathology, blood bank etc. Such waste is handed without any adverse effects on human health and the environment. Biomedical waste to be separated from solid waste. Bio-medical treatment facilities like incinerator, autoclave etc. has to be ensured	Yes	Project may generate bio-medical waste from Occupation Health and First Aid Centers from all Contractor sites office etc.	MPCB

Sr. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for Applicability	Authority
13.	Construction and Demolition Waste Management Rules	2016	Responsibility of waste collection, segregation, storage of construction and demolition (C & D) wastes as directed by the concerned local authority. Waste generator shall ensure that the waste does not get mixed and disposed off separately waste generates 20 Ton/day or 300 Tons/project has to prepare waste management plan. Waste generators has to store the waste within their premises or has to supply to city level collection center and should avoid all kinds of obstruction to traffic/public or in drains	Yes	Construction and Demolition wastes from the project activities needs Waste Disposal and Management Plan for the musk from the tunnel construction project	MPCB
14.	Plastic Waste Management Rules	2016	Requirement of plastic waste management includes: Recycling of plastic as per IS 14534:1998. Thermo plastic shall processed and disposed as per the guideline. Open burning of the waste should not take place	Yes	Plastic waste from construction activities of the project	MPCB
15.	E-Waste (Management) Rules	2016	Rules applies to every manufacturer, producer, consumer, collection centers, dealers, e-retailer, re-furbisher, dismantler and recyclers involved in manufacturer, sale, transfer, purchase, collection, storage and processing of e-waste listed in Scheduled-II including their components, consumables, parts and spares etc.	Yes	E-waste generation form construction activity	MPCB

Sr. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for Applicability	Authority
16.	Central Motor Vehicle Act and as amended to date	1988	Empowers ST Authority to enforce standards for vehicular pollution from August 1997 the pollution under control certificate is issued to reduce vehicular emissions and for matters connected there with or incidental there to:	Yes	All vehicles used for construction will used to comply with the provision of this Act	State Motor Vehicles Department
17.	Development Control Regulations, 1997 under MCGM Act	1988	Conservation of listed buildings, areas, artifacts, structures and precincts of historical and/or aesthetical and /or architectural and/or cultural values (Heritage building/heritage precincts	No	No identified heritage structure under the proposed project	Mumbai Heritage Committee
18.	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act	2013	R & R Policy of the Government of Maharashtra for MUTP was formulated and in its objectives is sought Set out rules for fair compensation and acquisition of land	Yes	Proposed project shall have land acquisition of land for the interchanges at west and east ends of the tunnel project	Revenue Department Government of Maharashtra
19.	Petroleum Act and the Rules, 2002	1934	Petroleum Act related to the import, transport, storage, production, refining and blending of petroleum. It may be any liquid hydrocarbon or mixture of hydrocarbons and inflammable mixture (liquid, solid viscous) and including natural gas and refinery gas	Yes	Borivali to Tikuji-ni-wadi Tunnel Project will involve storage and transportation of fuel for operation of construction machineries	Chief Controller of Explosive

Sr. No.	Act/Rules	Year	Objective	Applicable Yes/No	Reason for Applicability	Authority
20.	The Maharashtra (urban areas) Protection of Trees Act (As modified up to 1st January, 2016)	1975	Restriction on felling of trees and liability of planting and preservation of trees. In any urban areas notwithstanding any custom, uses, contract or law for the time being in force, no person shall fell any tree or cause to any tree to be felled in any land, whether of his ownership or otherwise, situated within urban area except the previous permission of the Tree officer.	Yes	Proposed project involves removal of trees coming in the proposed construction of interchanges, entry, exit to tunnel	Tree Authority, MCGM, Mumbai and TMC, Thane
21.	Coastal Regulation Zone	2011	To regulate activities in the coastal zone to protect ecologically sensitive areas	No	The proposed tunnel project does not pass along CRZ	Ministry of Environment, Forest, & Climate Change (MOEF&CC)
22.	Minor Mineral and concession Rules	1960	For opening new quarry	Yes	Regulate use of minor minerals like stone, soil, river, sand etc.	District Collector
23.	The Mining Act	1952	The mining act has been notified for safe and sound mining activity	Yes	Construction of proposed tunnel highway will require aggregates. These will be procured	Department of Mining, Govt. of Maharashtra
24.	Batteries (Management & Handling) Amendment Rules	2010	Management and handling of used lead batteries	Yes	Proposed project shall require batteries and thus safe disposal of used lead batteries	MPCB
25.	The National Highway Act	1956	For Land Acquisition	Yes	This act will be applicable as there will be acquisition of land for widening, geometric improvements and bypasses	NHAI Revenue Department Govt. of Maharashtra state

CPCB: Central Pollution Control Board

MPCB: Maharashtra Pollution Control Board

MOEF&CC: Ministry of Environment, Forest and Climate Change

1.15 Structure of the Report

The entire report is prepared based on the generic structure of EIA document given at APPENDIX III of the EIA Notification No. S.O. 1533 dated 14th September, 2006 at MOEFCC, New Delhi. The report has been divided into 12 Chapters as described below:

Chapter 1: Introduction - It gives information about project proponent (PP) i.e. Mumbai Metropolitan Regional Development Authority and the proposed project including its location, justification, importance, surrounding areas, site selection criteria etc. It also outlined the statutory requirement of obtaining prior environmental clearance, steps to be followed for the same and basic purpose, scope and methodology of EIA study.

Chapter 2: Project Description - It includes project description and infrastructure facilities incorporating environmental activities of the project proponent for setting up the proposed project for the tunnel project. It also gives information about methodology of construction of tunnel, sources of pollution and pollution controlling facilities to be provided i.e. water and wastewater generation, air and noise pollution control system, safety measures etc.

Chapter 3: Analysis of Alternatives (Technology and Site) - Identifies the description of each alternative, advantages and disadvantages of the alternatives and mitigation measures.

Chapter 4: Description of Environment - which includes baseline environmental study giving details about status of meteorology, air quality, noise, water, land, ecology, and socio-economic environment of the study area based on information collected through primary field study or from secondary sources.

Chapter 5: Anticipated Environmental Impact and Mitigation Measures - Identification of impacts and its mitigation measures, which identifies the impacts of various environmental parameters weather beneficial or deleterious for the construction and operation phases of the project. It also quantifies significant impacts of the proposed project on various environmental components.

Chapter 6: Environmental Monitoring Program – It provides details of monitoring plan of various environmental parameters as well as its frequency of monitoring.

Chapter 7: Additional Studies – It includes Public Consultations, Risk Assessment, R & R action plan.

Chapter 8: Project Benefits – Benefits due to the proposed project including improvement in physical infrastructure, social infrastructure, employment potential and CSR activities by the proponents.

Chapter 9: Environmental Cost Benefit Analysis

Chapter 10: Environmental Management Plan (EMP) – Incorporating measures to be adopted for mitigation of anticipated adverse impacts, safety measures if any, post project monitoring program for environmental parameters, green belt development etc.

Chapter 11: Summary and Conclusion – It includes overall justification of the project.

Chapter 12: Disclosure of Consultant – It gives the profile of the consultant engaged for the monitoring and preparation of EIA Report.

Chapter 2

Project Description

2.1 Type of Project

Mumbai Metropolitan Regional Development Authority (MMRDA) herein after called as project proponent (PP) has been appointed by the Government of Maharashtra as the implementing agency for the “Proposed Twin Tube (2 Lanes Each) Highway Tunnel from Tikuji-Ni-Wadi in Thane District to Borivali in Mumbai Suburban District the state of Maharashtra”. The proposed tunnel meant to connect northern suburb of Borivali and Thane. Thane and Borivali in North Mumbai are separated by a chain of hills, most of which is a part of the Sanjay Gandhi National Park (SGNP).

This proposed project of construction of new state highway tunnel is less than 30km in length will not categorize as 7(f) ‘A’ or ‘B’ of the schedule as per the MOEF&CC Notification dated September 14, 2006 and its subsequent amendments. It is therefore, environmental clearance (EC) from the State Expert Appraisal Committee (SEAC), Maharashtra will not be required for this type of the highway tunnel project.

2.2 Location of the Project

The proposed tunnel will deviate from Ghodbunder road to Tikuji-ni-wadi in Thane and cover 11.8 km beneath the ground through SGNP and Yeoor hills. It will then connect Ektanagar on western express highway (WEH) in Borivali, Mumbai. Based on the survey carried out by AECOM the project is located at coordinates 19°24’09.76’’N – 72°87’48.41’’E and 19°23’09.83’’N – 72°96’12.90’’E. **Figure 2.1** illustrates the major roadway network and the proposed highway tunnel alignment passing through underground of SGNP.

2.3 Land Requirement

The project proponent decided to construct the proposed tunnel route which is passing underground through Sanjay Gandhi National Park (SGNP). The major land use (>95%) along the proposed tunnel route is under SGNP and most of the land belongs to Government on both western and eastern side of the tunnel. The western and eastern ends of the tunnel are away from the SGNP boundary. No National Park land required for the construction of tunnel and other related facilities. The topography along the alignment is undulating on a hilly terrain. However, the alignment is proposed to be underground within the National Park limits in order not to affect any of the surface features and habitation etc. Total length of the proposed tunnel is about 11.8 km. Total land requirement involving twin tube, 2 lanes each (total 4 lanes) worked out about 42.46 ha. The highway tunnel will result in

decongestion of roads, minimizing road accidents and environmental pollution that are generated by other means of transport. This includes both air and noise pollution. The proposed tunnel, being underground will provide lesser direct contact with the populace, thereby reducing its impact as well as provide better overall security. The present tunnel underground route has been finalized based on least disturbances to the environment, human habitations, national park, aquatic body and avoiding archeological monuments and other sensitive locations, etc. Due to proposed underground tunnel route, there will not be any disturbance to breeding grounds, animal burrows and migratory routes along the tunnel alignment.

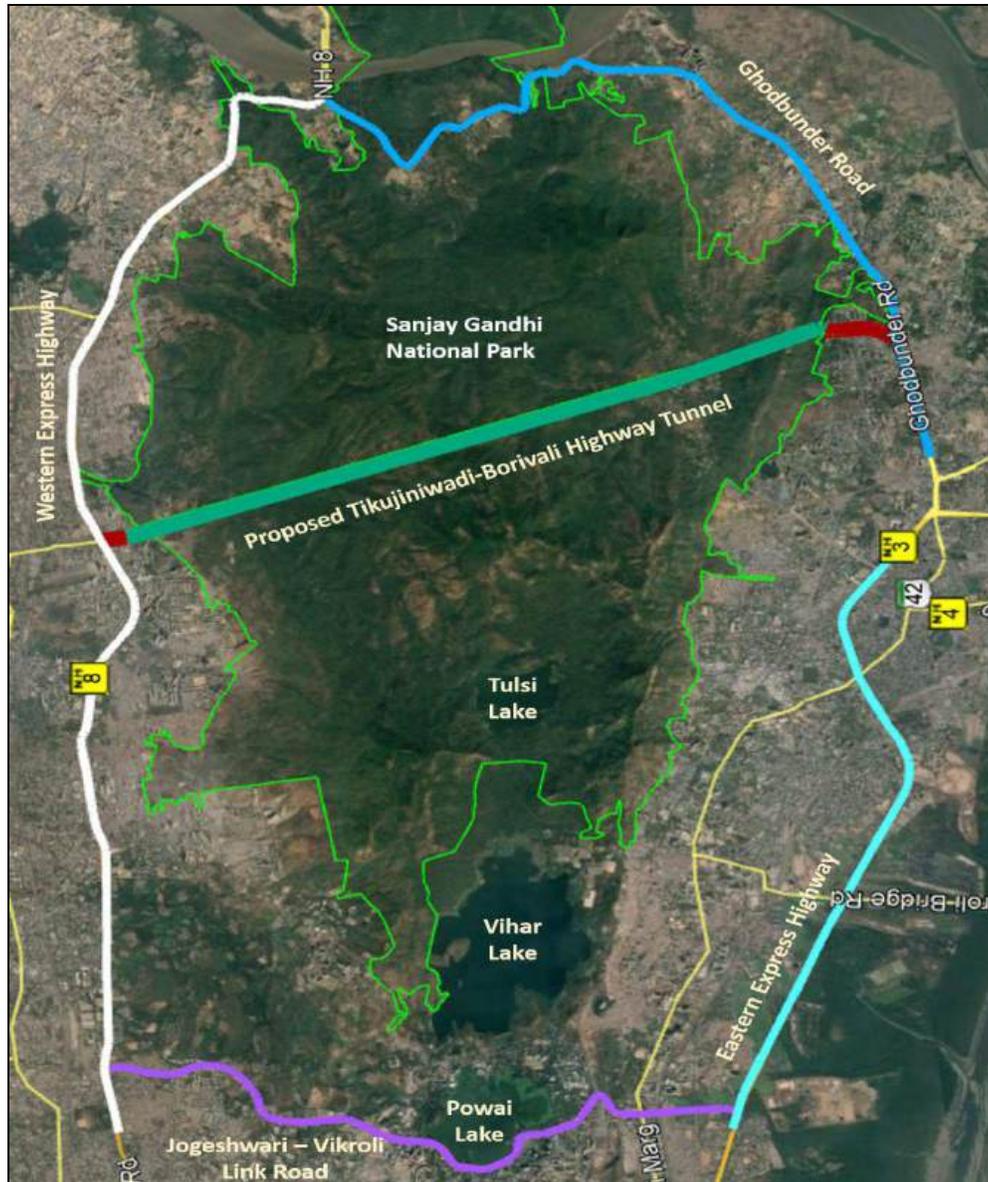


Figure 2.1: Major Roadway Network and the Proposed Highway underground Tunnel

2.4 Need of the Project

Current population of MMR region is about 18.5 million (2011 Census) and out of this about 70% resides in Mumbai Suburb (East-West) and Thane. Major developments are also happening in this region. The need for connectivity between two suburbs has been studied with respect to projected increase in population, traffic volumes and response from existing transportation network as summarized below:

After reviewing the growth of population by MMRDA, employment and external goods vehicle travel by 2031 as compared to 2005;

- ∞ 1.63% growth in population
- ∞ 2.04 times growth in employment
- ∞ 4.00 times growth in external goods travel

Therefore, a growth factor of 3.0 has been assumed for internal goods vehicles travel by 2031. The external travel demand, vehicle entering, leaving or passing through the MMR, play a crucial role, connecting the study area with the state and the rest of India principally along the national and state highways.

Over a period of 16 years (2005-21), it is estimated that, the private vehicles (two wheeler and cars) modal share will increase from 12.8% to around 21.5%. IPT trips (auto rickshaw and taxi) are expected to decrease from 9.1% to around 5.6% in three different growth scenarios reflecting the increase in private vehicle ownership and walk to metro. Therefore, considering the potential increase in demand and limited available connectivity, strengthening of existing roads have been proposed by removing bottlenecks and additional connectivity is proposed as per the following background:

- ∞ Thane Ghodbunder road (SH-42) is a major link road connecting Mumbai-Ahmadabad (NH-8) part of Golden Quadrilateral near Ghodbunder to Mumbai-Agra (NH-3) near Kuberwadi.
- ∞ This is an important east-west link, carries heavy commercial traffic between NH-3 and NH-8.
- ∞ Presently, Thane is not directly connected to Borivali. The existing alignment connects Thane and Borivali via Ghodbunder road having length of 23km.
- ∞ Therefore, it is proposed to explore the possibility of another shorter route as a tunnel and economical alignment passing through SGNP including proper and faster layoffs from NH-8 and NH-3.
- ∞ The need of connecting the northern suburb of Borivali to Thane through a tunnel passing through SGNP, which is one of the highest visited national parks within city limits in Asia and Yeoor hills, has been foreseen.
- ∞ The two ends of the proposed tunnel have been separated by a chain of hills, most of which are the part of the national park.
- ∞ As per the proposed plans, there will be two tunnels of three lanes each running parallel to each other at a distance of approximately 50m and

connected with each other through intermediate tunnels for emergency situations.

- ∞ The alignment will be finalized in such a way that there will be zero disturbances to the ecosystem of the national park especially the fauna found in the rich biodiversity of the park.
- ∞ The proposed project will cut down the jam, the pollution it causes, cut down the fuel expenses and more importantly it will save time.
- ∞ The total travel time will further reduce by about 20-25 minutes.
- ∞ The travel distance will be saved by 13km (50%)
- ∞ There will be no disturbance to the existing township.
- ∞ There will be fast and smooth movement of traffic and will be environmental friendly.
- ∞ This project will reduce the congestion on the Ghodbunder road using the tunnel in future.

2.5 Benefits of the Proposed Project

In view of increasing traffic load on Thane Ghodbunder road, it is necessary to look for an alternative. Therefore road tunnel passing below SGNP is being proposed which will provide fast and smooth movement of traffic from Thane to Borivali. The distance between Thane and Borivali is also expected to reduce by over 10km. This will also result in avoidance of traffic jams and saving fossil fuel and protecting environment due to reduced vehicular emissions.

The main benefits are:

- ∞ Distance saving for Thane to Borivali by about 10 km
- ∞ No disruption to existing township
- ∞ Travel time saving 20 to 25 minutes
- ∞ Tunnels reduce noise, air pollution, community disharmony and are visually attractive unlike surface roads.
- ∞ Construction costs are used to compare alternative transportation routes and in case other factors are considered, then tunneling would become a viable option.

2.6 Salient Features of the Project

The salient features of the project provided by MMRDA, the Authority, given below:

- ∞ Construction of new 4-line, 11.8Km long twin tunnel starts at Thane side at Tikuji-ni-wadi, and ends on NH-8 at Ekata Nagar, Borivali
- ∞ Tunnels will be connected with cross passes
- ∞ Vertical clearance in the tunnel will be 5.50m and width 13.1m

- ∞ Two twin tunnels are at about 50m apart in base
- ∞ Each tunnel will consists of unidirectional three lanes
- ∞ Gradient proposed in Tunnel is $\pm 2.5\%$ (1 in 40) in 500m stretch
- ∞ The tunnel alignment will pass through Sanjay Gandhi National Park (SGNP)
- ∞ The environment and forest zones won't be disturbed
- ∞ The tunnel will be bored by Tunnel Boring Machine (TBM)
- ∞ The expected construction period is about 3 years
- ∞ Fire extinguishers / water hoses, smoke detectors shall be provided at intervals inside the tunnels
- ∞ The project safety plan (PSP) is to be formulated during construction and after construction considering the relevant acts (IS:4756-1978).
- ∞ Adequate ventilation system shall be created by natural or mechanical means to ventilate the tunnel
- ∞ Well illuminated retro reflective/led light sign boards shall be installed at the entrance and inside the tunnel at appropriate location.

2.7 Tunnel Design and Construction

Tunnels are distinguished from open roads in respect of conditions such as:

- ∞ Limitation of spaces
- ∞ Little or no lateral movement
- ∞ Regular lighting throughout the day and year, except from the entry zone
- ∞ Difficulties in estimating gradients
- ∞ Difficulties in estimating distances to vehicle in front
- ∞ Risk of fire in a confined space
- ∞ Other safety measures, breakdown services, etc.

These require that a number of design elements will differ to those of the open road. Maintenance and operations shall ensure a constant level of safety in the tunnel.

Important elements in the tunnel design and construction method are:

- ∞ Selection of the appropriate construction method and equipment in the planning and construction phases
- ∞ Uniform standards for tunnels along the same road with corresponding traffic type and volume
- ∞ Tunnels are therefore placed in categories which determine the required geometric specifications and features

2.7.1 Selection of Tunnel Category

The traffic volume is normally given in Annual Average Daily Traffic Volume (AADT). AADT is the total annual traffic divided by 365 and is given as the total traffic volume in both directions. The tunnel category is estimated according to the estimated traffic volume of 20 years after opening i.e. AADT(20). Where the traffic volume varies throughout the day or over the years, or where there is considerable uncertainty AADT(20), the tunnel category may be based on the selected criteria. The tunnel category based upon traffic volume and tunnel length. The tunnel categories are the basis for a specific cross-section, number of traffic lanes, need for emergency lay-bays and turning point together with safety equipment.

The proposed tunnel system for Thane-Borivali consisting of 2 tubes each having unidirectional 2 lane traffic and having regular interconnections is being considered. The ventilation being considered as having 50MW load and assuming that the project proponent are not allowing explosives, toxics and fuels to be carried through these tunnels as any mishap with the vehicles carrying such loads will cause huge damage to other traffic and permanent to the tunnel.

2.7.2 Tunnel Cross Section

The geometry of the tunnel is very important aspect of tunnel design. The main objectives of road tunnel are to ensure safe transit of traffic for which the facility is designed at least cost. The geometry of the tunnel depends upon projected traffic volume, provision of ventilation system, geometry of the area and provision of pedestrian traffic. The completion of the tunnel depends upon the number of traffic lanes required considering future projected traffic and the number and width of footpath / walkways, Curbs, crash barrier and drains required to be provided.

Keeping in view the traffic calculation, type and forecast, it has been proposed to have twin tube three lanes each highway tunnel. As per IRC: SP: 84-2014, typical cross section for 3 lane tunnel excavation type construction is proposed as shown below:

- ∞ In case of twin tube tunnels, each tunnel tube with unidirectional traffic, tunnel will be connected at fixed distances of about 300m through passages vehicular or pedestrian.
- ∞ There is a provision of lay-byes at every 750m to park at least 6 vehicles along the length of the tunnel with one lane width
- ∞ The clear distance between the 2 tubes shall be kept depending upon the type of strata and structural stability
- ∞ A road tunnel cross section must be able to accommodate the horizontal and vertical traffic clearance, as well as the other required elements.

The typical cross sections elements are including given in **Table 2.1**.

Table 2.1: Typical Cross Sections Elements

Sr. No.	Elements
1.	Travel lanes
2.	Shoulders
3.	Sidewalks / Curbs
4.	Tunnel Drainage
5.	Tunnel Ventilation
6.	Tunnel Lighting
7.	Tunnel Utilities and Power
8.	Water supply pipes for Firefighting
9.	Cabinets for hose reels and fire extinguishers
10.	Signals and signs above roadway lanes
11.	CCTV Surveillance Cameras
12.	Emergency Telephones
13.	Fire and Safety Protection
14.	Communication Antennae / Equipment
15.	Monitoring equipment of noxious emission and visibility
16.	Emergency egress illuminated signs at low level (so that they are visible in case of a fire or smoke condition)

2.7.2.1 Cross Section with NATM

The shape of the tunnel is largely dependent on the method used to construct the tunnel, structural considerations and on the ground conditions. Selection of the type of the tunnel is an iterative process taking in to account of many factors including depth of tunnel, number of traffic lanes, type of ground traversed and available construction methodologies. The tunnel cross section geometrical configuration must satisfy the required traffic lanes, shoulders of safety walks, suitable spaces for ventilation, lights, traffic control system, fire / life safety systems, etc. **Figure 2.2** showing the cross section of tunnel with NATM methodology as below:

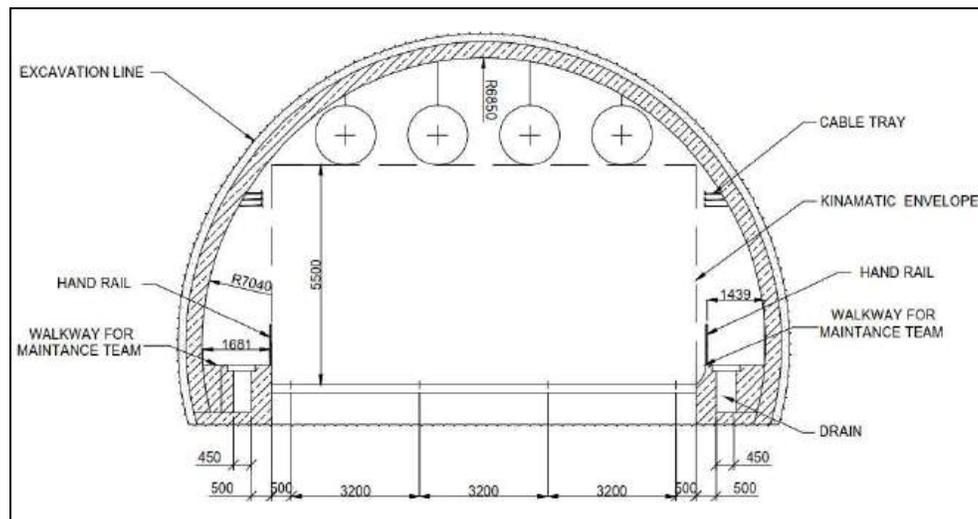


Figure 2.2: Showing Cross Section of Tunnel with NATM

2.7.2.2 Cross Section with TBM

The TBM diameter is a concern as increase in tunnel diameter size involves huge cost variance. The best suited cross section which fulfills the projected traffic volume calculations, cost and stability is given below as (Figure 2.3):

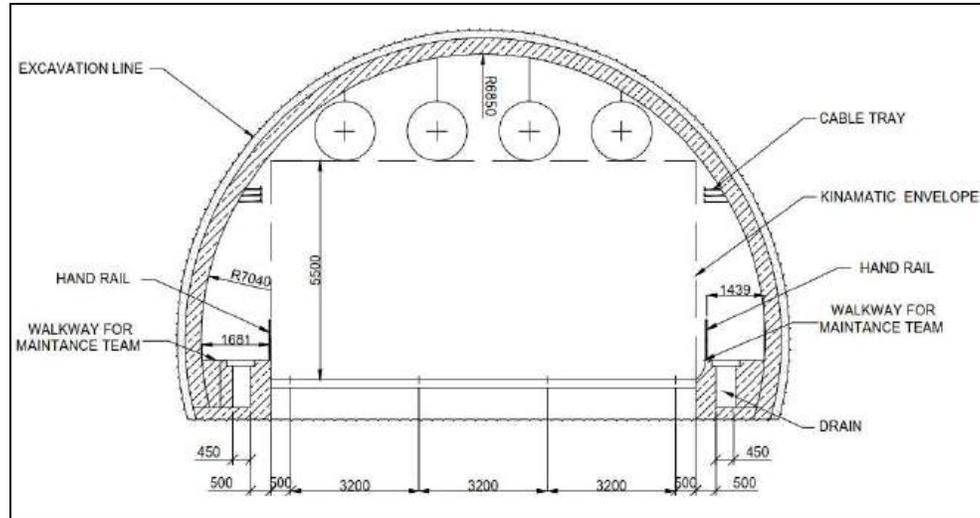


Figure 2.3: Showing Cross Section of Tunnel with TBM

2.7.3 Technology and Process Description: Tunnel Construction Methodology

Keeping in view the alignment, topography, overburden for the proposed project for both the parallel tunnel, the project proponent can use Drill and Blast / NATM or Bored Tunnel Method using tunnel boring machine as per the following methods:

(i) New Austrian Tunneling Method (NATM)

This method is known as New Austrian Tunneling Method (NATM), more than method is a philosophy of excavating tunnels, in which using the rock mass strength as structure to support the excavation. There are different methods to excavate a tunnel following NATM philosophy and one of them is using drill and blast approach, wherein for mining we use explosives. Drilling rigs are used to bore blast holes on the proposed tunnel surface to a designated depth for blasting. Explosive and timed detonators are then placed in the blast holes. Once blasting is carried out, waste rocks and soils are transported out of the tunnel before further blasting. The construction is carried out in a cyclic excavation process of repeated steps of excavation followed by the application of relevant, thin and flexible, primary support, both of which depend on existing ground conditions and ground behavior. This method mainly using standard equipment and allowing access to the tunnel excavation face at almost any time is very flexible in situations or areas that require a change in the structural analysis or in the design and as a result of this also require changes in the support measures.

Depending on the project conditions (e.g. shallow soft ground tunnel, deep rock tunnel) and the results of the geotechnical measurements, the requirements for a

specific support are determined. Contractual arrangements must be flexible to ensure that the most economical type and amount of support is used. The typical support elements in NATM are concrete and rock dowels. Steel ribs or lattice girders provide limited early support before the concrete hardens and ensure correct profile geometry. If ground conditions require support at or ahead of the excavation face, face dowels, concrete, or canopies of pipes are installed as required.

The excavation cross-section is subdivided into top heading, bench and invert depending on both ground conditions and logistical requirement (i.e. to facilitate the use of standard plant and machinery). Side drift galleries are provided to limit the size of large excavation faces and surface settlements.

NATM tunnels in connection with the wide variety of auxiliary construction methods enables to achieve safe and economic tunnel construction even in situations with changing or unforeseen ground conditions. It allows reacting in both directions depending on the ground either changing to the less favorable or towards the more favorable side. This flexibility makes this method the most advantageous tunneling method in many projects. In this method the project proponent can design a most economical and suitable shape depending upon geology the optimally used.

(ii) **Tunnel Boring Machine (TBM)**

a) **Circular Tunnel Boring Machine (TBM)**

Keeping in view the present ground conditions, length of the tunnel and time frame there is a possibility of using a Tunnel Boring Machine (TBM). For the present geological conditions different options are available from Double shield TBM or Single shield. These are ideal for excavation of long tunnels in hard rock.

In TBM, excavation normally have a circular section launched in June 2015 as shown in **Figure 2.4**.

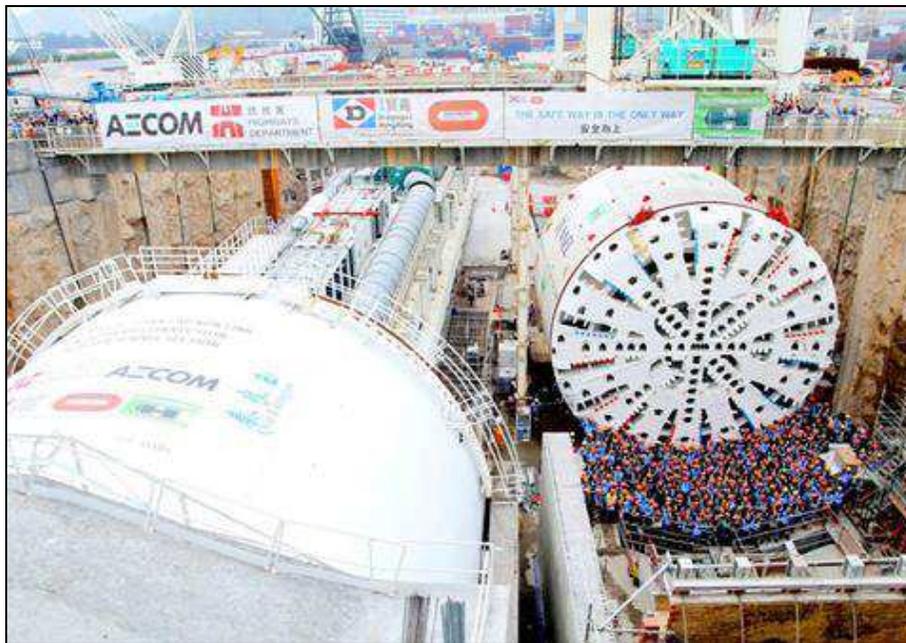


Figure 2.4: World's Largest Circular Tunnel Boring Machine (17.6m dia.)

b) Rectangular Tunnel Boring Machine (TBM)

Recently rectangular sections are also possible with specialized machine. These are more expensive than circular ones. The merit of such machine is that the excavated area is optimally utilized. The picture of a rectangular TBM is presented in **Figure 2.5**.

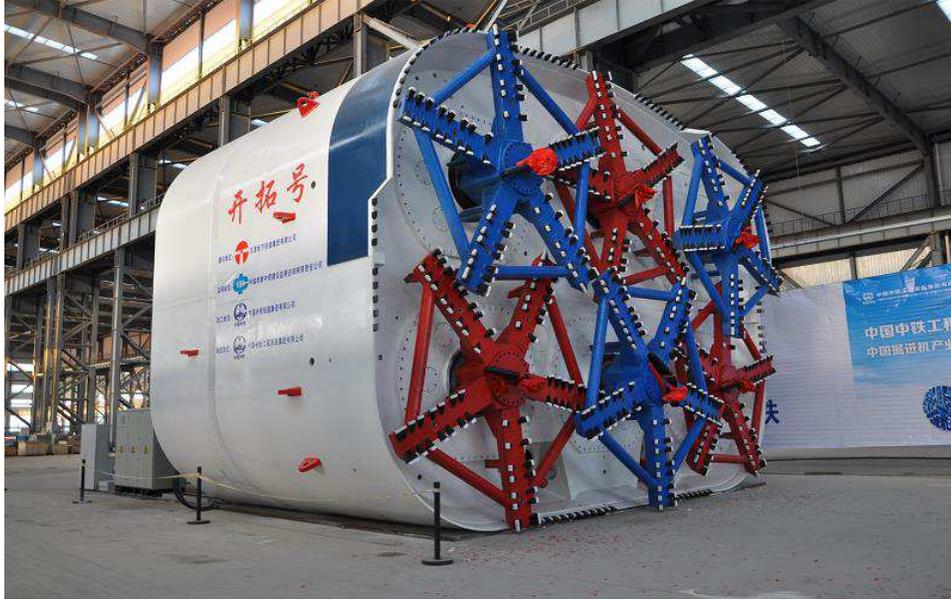


Figure 2.5: Rectangular Tunnel Boring Machine (RTBM)

The rectangular TBMs in the past have been manufactured by German, Chinese and Japanese manufacturers. The machines have either had an integrated road header for excavation or were soft ground EPBs. These machines are usually employed for construction of urban pedestrian and traffic underpasses and underground utilizes ducts. Most rectangular TBMs are actually pipe jacking TBMs end therefore as per principle limited to 100m tunnel length as the complete tunnel is jacked from the launching shaft.

The existing machines have multiple cutter heads and cut an almost rectangular face. Due to inherent design these machines have coverage of slightly less than the whole face. These machine works well in shallow overburden.

The loads on a deep tunnel can be significant. The tunnel is up to 300m deep in basalt rock which is quite strong and having 2 lanes traffic. In a rectangular tunnel of the size, the segments joints will experience significant shear load which is problematic. Another difficulty envisaged with such machines for the proposed project is the small bearings and drive which can be built in a machine with many small cutter heads which are not suitable for hard rock excavation and the related high loads.

The overlapping cutter heads of rectangular shield have only been soft ground cutter heads with scrapers but not disk cutters. Considering present scenario rectangular TBM seems not suitable for the proposed project.

Process by TBM Technology

- ∞ Probe Drilling (when needed)
- ∞ Grouting (when needed)
- ∞ Excavation (or blasting)
- ∞ Supporting
- ∞ Transportation of muck
- ∞ Lining or coating/sealing
- ∞ Draining
- ∞ Ventilation

2.7.4 Selection of Construction Method

For selection of construction method for the proposed project need to address the following points:

- ∞ Disturbance to the National Park (SGNP)
- ∞ Rate of progress leading to construction time required
- ∞ Cost of construction

2.7.4.1 Disturbance in the National Park (SGNP)

Comparison of Vibration due to Blasting and TBM mining: AECOM have considerable experience of blasting on surface in the proximity of domesticated animals. Their experts do specialize in what is called “High Liability” blasting. This means most of the blasting was done near structure. The most common was blasting in residential areas that had many domestic animals (dogs). They never received any complaint about vibration disturbing the animals. So it is assume and indicate that the animals were not bothered by blasting vibration.

“Drill and blast construction produces vibration from both the blast, travelling through ground and from pressure of the blast travelling through the air. Unlike TBM vibration, which is steady, blasting will be felt as quick impulses lasting for several seconds several times a day. Vibration from the blasts would be barely perceptible and not enough to damage structure.”

This does not address the issue relating to animal sensitivity but it does not indicate that vibration created by blasting underground is less than surface blasting. As the depth of cover increases, the intensity of vibration will decrease due to the damping effect of the different mediums (soil/rocks) the waves will cross.

Human Body Perception and Response: The human body can detect magnitudes of vibration lower than those which would normally cause mechanical or structural problems. The “discomfort” or ‘annoyance” produce by whole body vibration is a very influential factor and may be one of the limiting parameters in the design of the structure.

Data on human exposure to vibration has been incorporated into AS 2670: Evaluation of human exposure to whole-body vibration.

Vibration exposure limits are given as a function of:

- ∞ Direction of motion either horizontal or vertical
- ∞ Frequency of vibrations
- ∞ Exposure of time
- ∞ In most sensitive cases the allowable vibration is 3mm/sec.
- ∞ Also it can be said that Peak Particle Velocity (PPV) <1 mm/sec are not detectable for human beings whereas PPV >10 mm/sec are clearly detectable.

2.7.4.2 Rate of Progress Leading to Construction Time Required

The process of excavation is quite high in TBM as compared to drill and blast but the initial time required for start of excavation in terms of equipment and deployment at site for TBM is quite high. Below is a schedule prepared on ideal progress in this type of rocks with TBM and drill and blast method.

Machinery and Equipment: As it is clear from the cross section discussed above to execute a circular section with TBM whereas in NATM the work can excavate as per schedule of dimensions and requirements making the NATM section more optimized. The minimum excavation area in NATM is 123.3 m² whereas in TBM it is worked out 132 m². Similarly the concrete requirement for 1m of tunnel with TBM is 8m³ more than NATM. As construction method is different it need some different items during construction i.e. do not need rock bolts, wire mesh or shotcrete in TBM. Raw material requirement for NATM and TBM provided in **Table 2.2** and **Table 2.3** respectively.

Table 2.2: Raw Material Required for Tunnel Construction with NATM

Item No.	Item	Quantity	Total Quantity
A1	NATM Excavation 1m		10800m
A11	Rock	123.29 m ³	13,31,532 m ³
A2	Supports		
A21	Rockbolts (SD 32mm, dia 4m long)	7 Nos.	75,600 Nos.
A22	Shotcrete (M25, 200mm thick)	5.24 m ³	24,192 m ³
A23	Wire mesh (150*8*150) double layer	168.22 kg	18,16,776 kg
A24	Lattice Girder	0.374 Tone	40,392 Tone
A3	Permanent Work		
A31	Concrete (Final lining)	10.1 m ³	1,09,080 m ³
A32	Steel (Final lining)	0.808 Tone	87,264 Tone
A33	Geotextile Membrane	26 m ²	2,80,800 m ²
A34	PVC Membrane	26 m ²	2,80,800 m ²
A35	Other Concrete	5.02 m ³	54,216 m ³
A36	Other Steel	0.3012 Tone	32,256 Tone
A4	Instrumentation	1 m	-
A5	E and M		
A51	Ventilation	1 No.	
A52	Electrical	1 No.	
A53	Detection and Fire Fighting	1 No.	
A54	Communication and control	1 No.	

Table 2.3: Raw Material Required for Tunnel Construction with TBM

Item No.	Item	Quantity (Unit)	Total Quantity
1.	Tunnel		
(a)	Operation	1 m	10,800 m
(b)	Concrete	18 m ³	1,94,400 m ³
(c)	Reinforcement	2 Tone	21,600 Tone
(d)	Invert/1 st stage Concrete	3 m ³	32,400 m ³
(e)	Gasket	45 m	4,86,000 m
(f)	Connecting Bolts	22 items	2,37,600 items
(g)	Grouting	7 m ³	75,600 m ³
2.	E & M		
(h)	Illumination	1 No.	
(i)	Firefighting	1 No.	
(j)	Detection	1 No.	
(k)	Communication	1 No.	

2.7.4.3 Cost of Construction

One of the factors governing the decision on NATM or TBM method is cost. Presently we will discuss only the difference in cost between these two methods. There are number of common factors like ventilation, illumination, firefighting requirement etc. the cost of these are not considered for evaluating the difference between these two methods. The maximum excavation area in NATM is 123.3m² whereas in TBM it is 132 m². Similarly, the concrete required for 1m of tunnel with TBM is 8m³ more than NATM. As construction methodology is different may need some different items during construction i.e. rock bolts, wire mesh or shotcrete in TBM. Therefore, the cost of construction of tunnel by NATM and TBM methods are computed as 1591 Cr. and 2287 Cr. respectively. The total cost of construction for twin tubes by TBM shall be expensive by about 696 Cr. **Table 2.4** shows the approximate cost of tunneling by these two methods:

Table 2.4: Comparison of Cost of Construction by NATM and TBM Methods

Sr. No.	Particulars	Cost-NATM (Rs.)	Cost-TBM (Rs.)
1	Total cost per meter (m)	7,76,414	11,16,048
2.	Total cost per km	77,64,14,493	1,11,60,47,802
3.	Total amount for one tube	7,95,82,45,493	11,43,94,89,802
4.	Total amount for two tubes	15,91,64,90,986	22,87,89,79,604
	Approximately Cost of Project	1591 Cr.	2287 Cr
	Difference of cost of two methods	696 Cr.	

Source: Feasibility Report - AECOM

2.7.4.4 Options of Methodology

- ∞ It is concluded from the above table, it indicates the total cost of construction for twin tubes by TBM shall be more expensive (14.37%).
- ∞ In TBM need to have a circular section whereas in a NATM can optimize the section and can go with modified horseshoe type.

- ∞ The TBM requires limited skilled team to operate and after launching gives a constant high production.
- ∞ Whereas as in NATM the equipment required is common and readily available, but more manpower is required
- ∞ The musk from either TBM single shield or double shield open machine and from drill and blast can be recycled as construction materials.
- ∞ The vibration in TBM is low and constant whereas in NATM it is intermittent and high. The vibration at surface are expected to be quite feeble considering the depth and two interfaces where the waves will get reflected back. One interface is between deeper strong bedrock and weathered rock above, second interface is at the boundary between weathered rock and soil overburden. In both the methodology vibration can be controlled to the desired levels.
- ∞ Both these options are technically feasible
- ∞ Project proponent has to decide the priorities and on which lines they should further for the given options.

2.7.4.5 Adoption of Technology

- ∞ TBM method can be adopted for the proposed project construction according to the assessment of best technology.
- ∞ Bored tunneling by using a Tunnel Boring Machine (TBM) is often used for excavation long tunnels.
- ∞ An effective TBM method requires the selection of appropriate equipment for different rock mass and geological conditions.
- ∞ The TBM may be suitable for excavating tunnels which contain competent rocks that can provide adequate geological stability for boring a long section tunnel without structural support.
- ∞ The process for bored tunneling involves all or some of the following operations:

2.7.4.6 Tunnel Construction Technology

Salient Features of Various Tunnel Construction Technologies

Tunnel Construction Method	Advantages	Disadvantages
Cut and Cover Tunneling	Best method for excavation of shallow tunnel irrespective of shape commonly used for construction of stations	More dust and noise impact may arise, though these can be mitigated through implementation of sufficient control measures; Temporary decks are often installed before bulk excavation to minimize the associated environmental impacts; Larger quantity of C&D materials would be generated from the excavation works, requiring proper handling and disposal

Tunnel Construction Method	Advantages	Disadvantages
Drill and Blast	<p>Potential environmental impacts in terms of noise, dust and visual on sensitive receives are significantly reduced and are restricted to those located near the tunnel portal;</p> <p>Compared with the cut-and cover approach, quantity of C&D materials generated would be much reduced;</p> <p>Compared with the cut-and-cover approach, disturbance to local traffic and associated environmental impacts would be much reduced;</p> <p>Blasting would significantly reduce the duration of vibration, though the vibration level would be higher with bored tunneling</p>	<p>Potential hazard associated with establishment of a temporary magazine site for overnight storage of explosives shall be addressed through avoiding populated areas in the site selection process</p>
Bored Tunneling	<p>Potential environmental impacts in terms of noise, dust, vibration and visual on sensitive receives are significantly reduced and are restricted to those located near the launching and retrieval shafts</p> <p>Compared with the cut-and cover approach, disturbance to local traffic and associated environmental impacts would be much reduced.</p> <p>Compared with the cut-and cover approach, quantity of C & D materials generated would be much reduced; with different work procedures taking place at the same time including excavation and installation of permanent pre cast tunnel walls; TBM is highly efficient.</p> <p>Risk of settlement will be greatly reduced and loss or movement of the underground water table will be avoided, minimizing impact on the building structure</p>	
Sequential Excavation Method	<p>Similar to the drill and blast and bored tunneling methods, only localized potential environmental impacts would</p>	<p>As the method is relatively slow, duration of potential environmental impacts would be longer than that of the other methods</p>

TBM method can be adopted for the proposed project construction according to the assessment of best technology. Bored tunneling by using a Tunnel Boring Machine (TBM) is often used for excavation long tunnels.

An effective TBM method requires the selection of appropriate equipment for different rock mass and geological conditions. The TBM may be suitable for excavating tunnels which contain competent rocks that can provide adequate geological stability for boring a long section tunnel without structural support.

2.7.4.7 Equipment, Traffic Signs and Road Marking

- ∞ A detailed sign / signal plan shall be prepared for the tunnel
- ∞ This has to be done at an early stage in the project as this is essential for the design of the tunnel and can be decisive factor for important construction aspects
- ∞ Detailed regulations for traffic signs and road marking given in manuals shall be followed

Traffic Signs Out-side the Tunnel

- ∞ With regards to traffic safety, signs near the tunnel entrance should be reduced to a minimum.
- ∞ Signs shall be considered with respect to the individual tunnel
- ∞ The prohibition signs e.g. “Height Limit”, “No Overtaking” and “Pedestrians and Cyclists”, etc.
- ∞ Barriers must bear sign “Barrier” or be similarly designed but in red and white
- ∞ “Remote Controlled Barriers for Tunnel Closure”.
- ∞ The barriers should be located at least 50m before the tunnel entrance to ensure sufficient space in the event of evacuation, smoke hazards, etc

Traffic Signs in the Tunnel

- ∞ The number of signs inside the tunnel should be kept to a minimum
- ∞ This applies particularly to large signs as the tunnel cross-section provides only restricted places
- ∞ All signs in the tunnel shall be clearly visible using either built-in or external lighting
- ∞ The following descriptions some signs which are especially appropriate to tunnels
- ∞ All emergency telephones are indicated with service sign “Emergency Telephone”
- ∞ All fire extinguishers are indicated with service sign “Fire Extinguisher”
- ∞ That shall be indicated on the front and reverse; alternatively signs are placed facing oncoming traffic in both directions.

2.8 Requirement of Construction Materials

Use of Natural Resources: The objective was to locate suitable materials for the construction of embankment, sub-grade and top layers of pavement and bridge

structures. The study was carried out to determine the engineering properties of the following materials, which are to be used in construction of tunnel.

- ∞ Borrow areas for locating suitable soils for use in embankment and sub-grade.
- ∞ Quarries for locating hard stone/granular materials for use in sub bases, bases,
- ∞ Bituminous mixes and concrete works
- ∞ Source of fine aggregate for use in DBM/BC layers and cement concrete works.

Borrow Area: The survey of soil from borrows areas for use in embankment and sub-grade layer was conducted along the proposed alignment. The location of borrow areas with their distances from the proposed alignment and the quantities available will be carried out during their actual requirement.

(i) Requirement of Borrow Area Soil (Overburden)

Extensive survey was conducted to locate the potential sources of borrow area soils (overburden) required for the construction of embankment and sub-grade within the proposed project area. The total construction of six lanes, twin tunnel starting from Tikuji-ni-wadi, Thane to Borivali near Mumbai, total length of tunnel is estimated to be 11.8km. Total volume of soil/rocks will be generated from the tunnel excavation is worked out amounting to be 13,78,080m³. As per the requirements, this soil from the overburden may be used as construction materials and remaining can be disposed off at a suitable site is provided. The details of overburden generation presented in **Table 2.5**.

Table 2.5: Borrow Area Soil (Overburden) Generation from the Excavation of Tunnel

Total Length of Tunnel	10.8 km	10800 m
Total 2 lanes (single tunnel)	2 x 3200 mm	6.400 m
Walkways (both side)	1000 +1000=2000 mm	2.0 m
Width (2 lanes+ walkways) 3200 x 2 =6400+2000mm	6.400 m + 2.00 m	8.4 m
Height of tunnel	5500 mm	5.5 m
Amount of Soil/Rocks Generation (2 lanes)	10800 x 11.6 x 5.5m	6,89,040 m ³
Total Volume of Soil/rock Generation (twin lanes)	689040 x 2	13,78,080 m³

2.9 Archaeological Values

The Kanheri Caves, located within the park, form a major point of interest. The caves are said to date from the 1st century BC to the 9th century AD and to have been occupied by a well-organized Buddhist establishment of monks on an ancient trade route connecting a number of Indian sea-ports. These Kanheri caves are at 2.5 km from the project alignment will not impacted by the construction activities.

2.10 Other Infrastructure

Apart from the above mentioned tunnel construction facilities, other facilities, which need to be provided, are briefly described below:

As this is proposed tunnel construction facilities in the area, no major infrastructure facility is provided. For developing Thane-Borivali tunnel highway of 11.8km length will be decided by the project proponent either by NATM or TBM methodology, regular maintenance of trucks, drill, excavators and other equipments etc will be required. These activities will require a bigger workshop for overhauling of major components of equipments and skilled manpower. Offices of the engineers and store for keeping regular maintenance, spares have also been envisaged. Equipment washing bay along with air compressors has also been envisaged. The total maintenance activity will be done by the contractor/project proponent.

2.10.1 Other Facilities (Utilities)

An administration with all infra-structure facilities like, guest house, rest shelter cum first aid station, vocational training centre, chemical laboratory, fire fighting, security, store, primary health centre and small market complex have been envisaged. One canteen is envisaged for providing tea, snacks and meals to the employees by the management as per the requirement.

2.10.2 Water Supply

There is no perennial source of water in the entire leasehold tunnel area which is passing underneath through SGNP. It is being sea costal area the water found to be saline. As no regular water source is available water shall be drawn from nearest Tulsi Lake for the tunnel construction, dust suppression, plantation as well as drinking purposes for the manpower deployed for the work. The area does not fall under the Notified Area under Water Act 1974.

Major requirement of water for construction process of tunnel is given in **Table 2.6**. The total water requirement is estimated to be 500m³/day and corresponding wastewater generation will be about 150m³/day. A small water treatment unit will be installed in the tunnel premises for making potable water for drinking purposes. This will comprises of pressure filter and chlorination. Adequate quantity of drinking water has been considered for drinking purposes in the proposed tunnel complex. As per MOEF&CC guidelines, zero discharge policy will be adopted by utilizing treated wastewater for greenbelt development and horticulture purposes.

Table 2.6: Water Requirement and Water Balance

Items	Water Requirement (m ³ /day)	Wastewater Generation (m ³ /day)
Tunnel construction process	100	50
Drinking and other domestic purposes for project workers	150	100
Dust Suppression at construction site and water sprinkling at roads	100	Nil
Greenbelt development	150	Nil
Total	500	150

2.10.3 Power Supply

Boring of highway tunnel will be done by NATM/TBM methodology for which it is proposed to draw power from 33KV HT line of MSEB passing adjacent to the leasehold area with a step down 33KV/440 V, 500 KVA Transformer for providing power to construction site of highway tunnel and other areas of the proposed project. Electricity will be brought from MSEB.

2.10.4 Manpower

The direct employment potential envisaged is to be around 300. Construction of highway tunnel will generate substantial indirect employment to the tune of 2000 in the vicinity and opening at both ends of tunnel areas. Certain works like canteen services, light motor vehicles etc will be off-loaded on contract.

2.10.5 Illumination

Illumination inside the tunnel, it's both the ends and outside area approximately 100m has been considered as per the requirement.

2.10.6 Rehabilitation and Resettlement (R & R Plan)

As such there is no R & R Policy of MSRDC under CSR. They will implement the R & R policy for the project affected persons including home oustees, land oustees and landless labors, if any.

2.10.7 Project Implementation

All the activities envisaged for the proposed highway tunnel between Thane City and Borivali east will be on contractual basis. The total time required for construction of tunnel will be by TBM method shall be about 4.8 years (56 months) from the date of construction approval of the project whereas with NATM the time taken will be about 5.6 years (66 months). It shows that the time required for the same construction is more (14.3%) for NATM than the TBM.

2.11 Project Cost

The major difference is in the cost of machinery and equipment. As construction methodology is different may need some different items during construction i.e. rock bolts, wire mesh or shotcrete in TBM. Therefore, the cost of construction of tunnel by NATM and TBM methods are computed as 1591 Cr. and 2287 Cr. respectively. The total cost of construction for twin tubes by TBM shall be expensive by about 696 Cr. The equipment and machinery required for both these methods differ so is their cost too. So that TBM methodology being more expensive.

Chapter 3

Analysis of Alternatives (Technology and Site)

3.1 Technology Alternatives

No technology alternatives were considered as the project involves normal tunnel construction project including other related facilities. Keeping in view the alignment, technology, overburden for the proposed project for the parallel highway tunnel construction using drill and blast / New Austrian Tunneling Method (NATM) or Bored Tunnel Method using Tunnel Boring Machine (TBM) is an established construction practice technology worldwide.

3.2 Project Site

This alternatives analysis of project sites is divided in to two parts:

- ∞ Traffic Survey and Projection to know the traffic loads (Traffic Survey)
- ∞ Analysis of Alternatives to know the suitable site options (Alignment)

MMRDA as the project proponent has engaged AECOM to carry out detailed Feasibility Report and including traffic survey and suggest shortage, optimum route alignment from Thane–Borivali Road Tunnel Project. It is, therefore, AECOM has conducted reconnaissance and detailed field verification surveys and finalized the tunnel alignment based on environmental and other developmental constraints for the tunnel routes. The project proponent decided to construct the proposed tunnel route which is passing underground through Sanjay Gandhi National Park (SGNP). The proposed tunnel route is not passing through coastal and estuarine areas, archeological monuments etc. The major land use (>95%) along the proposed tunnel route is under SGNP and most of the land is belongs to Government on both western and eastern portal of the tunnel. The western and eastern ends of the tunnel are away from the SGNP boundary. No National Park land required for the construction of tunnel and other related facilities. The topography along the alignment is undulating on a hilly terrine. However, the alignment is proposed to be underground within the National Park limits in order not to affect any of the surface features and habitation etc.

3.3 Traffic Survey

Traffic survey is prepared to explain the scope, objectives, methodology, findings of options of alternate sites carried out for Tikuji-ni-wadi - Borivali Highway Tunnel (TBHT). The traffic forecasting has been carried out by econometric model and traffic assignment is done using willingness to pay responses and desire line data. The proposed new TBHT corridor is expected to connect the Ghodbunder Road to

western express highway (WEH) via a tunnel section under the SGNP. The study aims to document traffic volumes that would be identify the corresponding lane configuration required for the proposed TBHT corridor carriageway to accommodate the projected 10-year (2032), 20-year (2042) horizon years considering construction of the tunnel will be completed by 2022.

United Nation's year 2014 revision of the World Urbanization Prospects Report identifies MMR as the second most populous urban region in India with an estimation population of 20.7 million people in the urban agglomeration. Mumbai is connected national highways system by NH-3, NH-4, NH-8 and NH-17. Public systems in Mumbai includes the Mumbai Suburban Railway, Monorail, Metro, Brihanmumbai electric supply and transport (BEST, Thane Municipal Transport (TMT), Mira-Bhyander Municipal Transport (MBMT), Navi-Mumbai Municipal Transport (NMMT) Buses, Black-and-yellow meter Taxis, Auto Rickshaws, private Cabs (OLA and Uber) and Ferries etc.

3.3.1 Alignment of Proposed Road

In existing scenario, eastern and western suburbs of Mumbai are connected through Jogeshwari-Vikroli Link Road (JVLR) which connect western expressway at Jogeshwari near Balasaheb Thackeray Trauma Care. This road connects Seepz, Powai, Kanjur and eastern expressway (EEW) near Nehrunagar. This road is to the south of SGNP. Another road which connects eastern and western suburbs is Ghodbunder road. This road connects western express highway at fountain junction and passes throughout Thane west region forming the main artillery road. This road is on the north and east of SGNP. These two roads only offer connectivity to the eastern and western suburbs of Mumbai surrounding the SGNP. MCGM has proposed Goregaon - Mulund Link Road to enhance the present east west connectivity.

The proposed Tikuji-ni-wadi - Borivali Highway tunnel will provide direct connectivity to the eastern and western areas surrounding the SGNP. The alignment of the proposed road is passing underneath through SGNP. Owing to the environmentally sensitive nature of this region, the proposed alignment of the Tikuji-ni-wadi - Borivali Highway would be through a tunnel under the existing national park forest area. West end of the tunnel of the proposed highway would extend up to the western express highway at Magathane Junction by improving existing Jai Maharashtra Road. Magathane is a major junction on western express highway which connects Borivali west to Borivali east. Dattapada Road which forms western arm of Magathane junction further connects with FM Cariappa Flyover to cross-over western railway and joins Swami Vivekanand Road at Dr. Shyamaprasad Mukherji Chowk. At Magathane junction at existing Dattapada flyover of 4 lane divided carriageway is provided for the through traffic on western express highway. East of the tunnel of the proposed Tikuji-ni-wadi - Borivali highway tunnel would extend up to the Ghodbunder Road at Mulla Baug junction through a proposed widening of existing TMC DP Road. **Figure 3.1** illustrates the major roadway network and the proposed highway tunnel alignment passing through underground of SGNP.



Figure 3.1: Major Roadways Network and the Proposed Highway Tunnel Alignment

To determine the existing travel patterns in the study area and to project the future traffic volumes onto the proposed new corridor the vicinity areas were divided into traffic zones. The roadway network in the vicinity of SGNP was studied to identify the appropriate locations for traffic data collection.

3.3.2 Types of Traffic Survey

- ∞ Classified Traffic Volume Count (CVC)
- ∞ Turning Movement Count (TMC)
- ∞ Origin-Destination Count (O-D)
- ∞ Willingness to Pay (WTP)

3.3.2.1 Classified Traffic Volume Count (CVC)

M/s AECOM recorded moving traffic for continuous period of 7 days by installing video camera at following 4 locations to have clear view of the moving traffic.

- ∞ Magathane Midblock (WEH)
- ∞ Fountain Midblock (WEH)
- ∞ Kapurbawdi Midblock (Ghodbunder Road)
- ∞ Powai Midblock (JVLR)

AECOM have used video-graphic system to survey the roadway volume and classification. As traffic count has to be taken at traffic signals, 2 video cameras were installed at each location for both up and down sides. In total 8 cameras were installed to carry out traffic volume count. The traffic recording period was decided 7 days. Each day traffic volume is tabulated into spreadsheet in hourly basis. This recording segregated into the types of vehicles such as Cars, Trucks, MAV etc.

3.3.2.2 Turning Movement Count (TMC)

This traffic survey involves capturing vehicle-turning movements and its composition in an intersection. This information is vital for Magathane Junction's Improvement, Signaling, Planning the Pedestrian Crossing etc. Also, it provides the peak hour turning movement information. AECOM collected data by video-graphic. Hourly turning movement counts were charted in excel sheet. These exercises were carried out for 12 hours duration (8 to 20 hrs) at the Magathane junction. These turning movements were further analyzed and converted in to passenger car units (PCUs). Traffic movement counts of total in-flow volume at morning peak hour at recorded Magathane junction as 8756 vehicle/hr and 7208 PCU/hrs respectively.

3.3.2.3 Origin-Destination (O-D) Survey and Willingness to Pay

This traffic survey identifies the travel pattern of vehicle along a network. This survey spots where most vehicles originate in a network and finish their journey and it also shows how often they take this path. This was done using roadside interviews collected manually from them. In addition to the O-D survey willingness to pay questionnaire were also carried out at the following 3 locations:

- (i) Fountain Midblock (WEH)
- (ii) Kapurbawdi Midblock (Ghodbunder Road)
- (iii) Powai Midblock (JVLR) Jogeshwari – Vikroli Link Road

AECOM classified vehicles in 14 main categories and commodities in to 12 categories (**Table 3.1**). A total of 7362 samples were collected as a part of this exercise.

Table 3.1: Classification of Vehicles

Sr. No.	Types of Vehicles	Commodity Type
1.	Two Wheelers	Food-grains
2.	Autorickshaw (3 wheelers)	Fruits and vegetables
3.	Maxi Cab (3 wheelers)	Household goods
4.	Taxi	Chemicals and Fertilizers
5.	Car/Jeep/Van (other than Taxi	Petroleum
6.	Bus	Building Materials
7.	LCV	Textile
8.	LCV (3, 4, 6 wheelers)	Ore / Mineral
9.	2, 3- Axle Trucks	Timber
10.	Multi-Axle Truck	Manufactured Goods
11.	Tractor with Trailor	Empty
12.	Tractor without Trailor	Others (specify)
13.	Cycle	
14.	Others (specify)	

Video-graphic Classified Traffic Volume Counts were conducted at 4 locations are shown on the Map of traffic analysis zones as shown in **Figure 3.2** and **Figure 3.3**.

- ∞ Classified Turning Movement was conducted at 1 location
- ∞ Origin-destination surveys along with willingness to pay conducted at 3 locations of SGNP
- ∞ Speed and Delay between both the portal locations in peak and non-peak hours to and fro

3.3.3 Location-1: Dattapada (Magathane Junction)

This location is located on western express highway (WEH) where Dattapada Road (1-9) meets with WEH from west and Jai Maharashtra Road meets from east. 4-way traffic at the junction was considered, which includes the traffic on Dattapada road, Jai Maharashtra Road and service lanes of WEH (1-9), **Zone 6**. Classified Traffic Volume Count (CTVC) was conducted on Dattapada road and turning movement count was carried out at the junction. This location will be act as a starting/ending point for Speed and Delay. The map of Traffic Analysis Zone presented in **Figure 3.2**.

3.3.4 Location for CVC-2 (near Fountain Hotel)

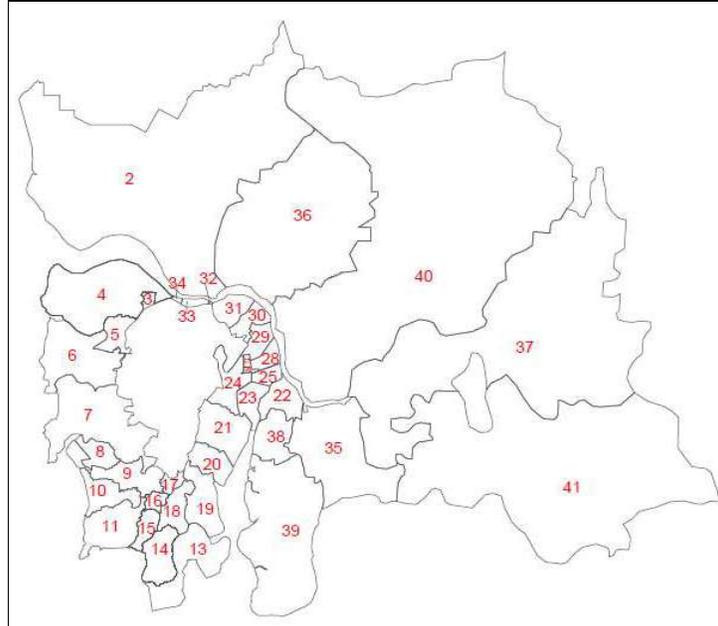
This location is a mid-block located on WEH. Two-way traffic at WEH (1-9) was considered. With reference to the zone map, this location is located in **Zone 3**. Classified Traffic Volume Count was conducted on WEH, O-D and willingness to pay was carried out on this location.

3.3.5 Location for CVC-3 (Kapurhawdi)

This is a mid-block located on Ghodbunder road, Thane. Two-way traffic at Ghodbunder Road (1-11) was considered. With reference to this zone map, this location is located in **Zone 26**. Classified Traffic Volume Count was conducted on WEH. O-D and willingness to pay were carried out on this location. This location will act as a starting/ending point for speed and delay.

3.3.6 Location for CVC-4 JVLR (Powai)

This is a mid-block located on Jogeshwari-Vikroli Link Road (JVLR). Two-way traffic at JVLR (1-12) was considered. With reference to this zone map, this location is in **Zone 17**. Classified Traffic Volume Count was conducted on WEH. O-D and willingness to pay were carried out on this location. This location will act as a starting/ending point for speed and delay.



Source: Feasibility Report, AECOM

Figure 3.2: Map of Traffic Analysis Zones



Source: Feasibility Report, AECOM

Figure 3.3: Traffic Survey at Locations (Dattapada, Fountain, Kapurbawdi)

and JVLR (Powai)

3.4 Data Analysis

The data collected from CVC, TMC, O-D Surveys and Willingness to Pay (WP) was analyzed using Microsoft Excel and QGIS (flow map) software. QGIS is geo-graphic information system based software used for working with maps. It is generally used for creating and using maps, compiling geographic data, analyzing mapped information and mapping geographic information for database sharing. As mentioned earlier, QGIS software was used for preparation of desire line diagram consistent with the methodology adopted for this project.

3.4.1 Traffic Volume Count and Trips Generated

The classified volume count (CVC) data obtained from 24 hours for 7 days is summarized below in **Table 3.2**. The CVC are significant to ascertain the travel behavior of trips corresponding to the respective modes. The percent wise composition of traffic is presented in **Table 3.3**.

Table 3.2: Traffic Volume Count at four mid-blocks for base year (2018)

Location (Mid-Block)	2 Wheeler	3 Wheeler	4 Wheeler	LCV	Truck	Bus	Other	Total Traffic Count (both direction) AADT (Veh/day)
Traffic Volume (AADT) Vehicle/day								
Dattapada	29164	39178	27887	3862	1963	1334	1152	1,04,540
Fountain Hotel	30932	23579	52542	11229	8043	3276	87	1,29,688
Kapurbawdi	49241	29379	72653	9493	10100	7138	250	1,78,254
JVLR (Powai)	50282	36410	74579	7586	2942	6748	171	1,78,718

Source: Feasibility Report, AECOM

Table 3.3: Composition of Traffic in Percent (%)

Location (Mid-Block)	MTW	Bus	Mimibus	LCV	2-Axle	3-Axle	MAV	Bicycle	OSMV	Car	Taxi	AR
	Percent (%)											
Dattapada	28	1	0	4	1	1	0	1	0	22	5	37
Fountain	24	2	0	9	2	3	1	0	0	36	5	18
Kapurbawdi	28	3	1	5	2	1	2	0	0	35	6	17
JVLR (Powai)	28	3	1	4	1	0	0	0	0	30	12	21

Source: Feasibility Report, AECOM

3.4.2 Traffic Volume at Peak Hour

Summary of the total traffic volume during the peak hour for the following 4 locations as shown below:

- (1) Dattapada (Megathane) WEH, (Borivali) – West of SGNP

- (2) Hotel Fountain (Ghodbunder Road, Thane) - North
- (3) Kapurbawdi - East
- (4) Jogeshwari-Vikroli Link Road (JVLR, Powai) – South

The hourly traffic volume of each junction was used for calculating the average daily traffic. Based on IRC 106 the peak hour volume was considered to be 8% of the annual average daily traffic as given in **Table 3.4**.

Table 3.4: Total Traffic Volume at Peak Hour (PCU)

Sr. No.	Junction	Peak Hour Volume (PCU)
1.	Dattapada (Megathane) WEH, (Borivali)	8,685
2.	Hotel Fountain (Godbunder Road, Thane)	10,886
3.	Kapurbawdi	14,015
4.	Jogeshwari-Vikroli Link Road (JVLR, Powai)	14,998
	Total	48,584

Source: Feasibility Report, AECOM

The traffic volumes were converted into trips in PCU's. **Table 3.5** summarizes the average passenger car units as per IRC 106.

Table 3.5: Passenger Car Unit

Mode of Vehicle	2-Wheelers	3-Wheelers	4-Wheelers	LCV	Trucks	MAV
PCU's	0.5	0.75	1	1.5	3	4.6

Source: Feasibility Report, AECOM

3.4.3 O-D Matrix for Existing Scenario

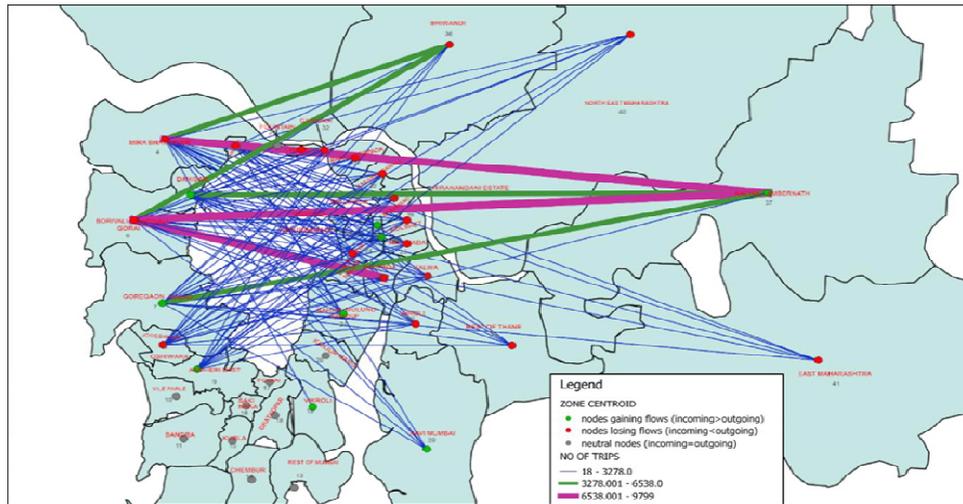
Based on the total vehicles interview during roadside O-D survey, the Origin Destination Matrix for the corresponding trips was prepared using Microsoft Excel. This matrix was converted into an O-D matrix in terms of PCU's using the traffic volume count for 24 hours for 7 days. For collecting the data in O-D survey approximately 10% sample size was maintained.

3.4.4 Desire Line Analysis

The desire line analysis is a tool used for determining the level of interaction between zones. In case of traffic studies, the level of interaction is generally in terms of the number of trips between the traffic analysis zones (TAXs). In this study the desired line analysis was performed to determine the number of trips between the TAZs obtained from the origin and destination survey. A desire line diagram was prepared using the network analysis tool in QGIS software. The steps followed for preparation of desire line diagram were as follows:

- ∞ Flow Mapped Plugin of QGIS
- ∞ Mapping of zones are creation of Shapes file showing zones
- ∞ Using O-D Matrix and Co-ordinate of each zone for creation of desire line

∞ Analyzing values of number of trips to desire line.



Source: Feasibility Report, AECOM

Figure 3.4: Desire Line Diagram for O-D Survey Conducted at Kapurbawdi

Figure 3.4 shows the desire line diagram based on 24-hour trips. It illustrates the trips between the zones of the study area. The centroids of the respective zones are donated as per traffic flow, green nodes donates zone having gaining flow (incoming is greater than outgoing), red nodes denote zone having losing flow (incoming is lesser than outgoing) and grey nodes donate zones having neutral flow (incoming=outgoing). The thickness of the line determines the number of trips between the zones. Magenta lines donate higher number of trips. This above figure indicated desire line diagram which has been developed for O-D survey conducted at Kapurbawdi.

3.4.5 Traffic Projections

Elastic Travel Demand Modeling was undertaken for estimation the future scenario. In this method the growth rate was obtained by considering factor like GSDP, NSDP, Population, PCI by regression analysis. The growth factors based on elasticity of transport demand were calculated by plotting of log NSDP versus log registered vehicle for commercial vehicles and log PCI versus log registered vehicles for passenger vehicles as per IRC standards. Elasticity was calculated with the help of population, registered vehicles and NSDP. Using this method, the growth rates were calculated which are indicated in Table 3.6.

Table 3.6: Proposed Growth Rates (%) of Vehicles in the Study Region

Year	2-Wheelers	Rickshaws	4-Wheelers	Buses	Trucks
	Percent (%)				
2018-2022	9.00	5,50	7,50	7.00	9.00
2023-2026	7.90	6.00	6.80	6.60	8.50
2027-2030	7.00	4.80	5.80	6.40	8.20
2031-2034	6.80	4.20	5.40	6.15	7.90
2035-2038	6.20	3.60	5.00	6.00	7.60
2039-2942	5.50	3.20	4.80	6.90	7.00

Source: Feasibility Report, AECOM

The traffic which diverts to proposed tunnel for the base year (2018) has been calculated on the basis of Willingness to pay under two criteria i.e. without Goregaon - Mulund Link Road (GMLR) and with GMLR. Various toll scenarios were analyzed and following have been summarized (**Table 3.7**) and detailed analysis has been included in Appendix (Traffic Projection)

Table 3.7: Willingness to Pay under GMLR and Without GMLR

Sr. No.	WTP (Rs.)		AADT
	Passengers	Goods	
1	With GMLR (Goregaon – Mulund Link Road)		
1.1	NO TOLL		47462
	With TOLL		
1.2	<50	300-500	26056
1.3	50-100	300-500	8379
	Without GMLR (Goregaon – Mulund Link Road)		
2.1	No TOLL		87057
	With TOLL		
2.2	<50	300-500	47793
2.3	50-100	300-500	15368

Source: Feasibility Report, AECOM

Determination of roadway geometry for proposed road (**Table 3.8**).

Table 3.8: Scenario with Toll and Without Toll under GMLR and without GMLR

With GMLR	Scenario 1.1 (No Toll)	2 lanes are required till 2026 3 lanes will be sufficient till 2032 After 2032 >3 lanes will be required
	Scenario 1.2 : (With Toll) (Goods 300-500 and Passengers <50)	2 lanes are sufficient till 2035 3 lanes will be sufficient till 2042
	Scenario 1.3: (With Toll) (Goods 300-500 and Passengers 50-100)	2 lanes will be sufficient throughout
Without GMLR	Scenario 2.1 (No Toll)	3 lanes are sufficient till 2023 After 2023 >3 lanes will be required
	Scenario 2.2 : (With Toll) (Goods 300-500 and Passengers <50)	2 lanes are sufficient till 2026 3 lanes will be sufficient till 2032 After 2032 >3 lanes will be required
	Scenario 2.3: (With Toll) (Goods 300-500 and Passengers 50-100)	2 lanes will be sufficient throughout

Source: Feasibility Report, AECOM

3.4.6 Finding

It can be seen from Desire Line Diagram that a large number of traffic from central areas like Kalyan, Ambernath, Navpada, Bhivandi., rest of Thane are would go to western areas like Borivali, Kandivali, Goregaon, Mals, Jogeshwari, Andheri, Gorai, Mira, Bhayander.

Similarly considerable traffic is also expected from Kalwa, North East Maharashtra, Nahur, Mulund, Gaimukh, Kolshet, etc. to western area as mentioned above.

- ∞ Areas like Brahmand, Airoli, Vikroli, Majiwada etc. also contribute trips to western areas.
- ∞ In future Goregaon – Mulund Link Road (GMLR) is one of the parallel facilities which are coming up parallel to Tikuji-ni-wadi – Borivali Tunnel Road. Due to this facilities substantial traffic from Navi Mumbai, east Maharashtra areas, Kalyan, Ambernath, Airoli, Kalwa, Navpada etc. would shift to GMLR
- ∞ Passenger traffic is very high as compared to goods traffic and also it is very sensitive to toll as indicated in our Willingness to Pay Toll survey. In view of this traffic projections have been carried out in various toll scenarios.
- ∞ It is proposed to widen the existing Thane – Ghodbunder road by MMRDA, moreover after diversion of traffic to TBHT the level of service on Thane-Ghodbunder road will improve.
- ∞ Hence after studying various toll scenarios, it can be concluded that 2 lanes tolled carriageway for either direction would be an ideal choice.

3.5 Alignment Alternatives

Topo sheet, maps of the area including Google earth and prepared DEM were studied to have possible alternative alignments. The governing factors being availability of land for portals outside the Sanjay Gandhi National Park (SGNP), availability / possibility of access roads to connect the tunnel portals to the eastern and western express ways. From various alternatives options to be considered factors like, disturbance to the existing structures, infrastructure etc. Salient features of the area and local constraints such as habitations, structures etc. were also checked.

Following principles were kept in mind so that the alternative alignment will be feasible:

- ∞ The alignment should be able to take off and join eastern and western express way at the appropriate locations i.e. a proper interchange should be formed so that the entry and exit of vehicle should be possible
- ∞ The alignment should be shorter than the existing alignment and at the same time should be able to achieve the gradient as per IRC norms

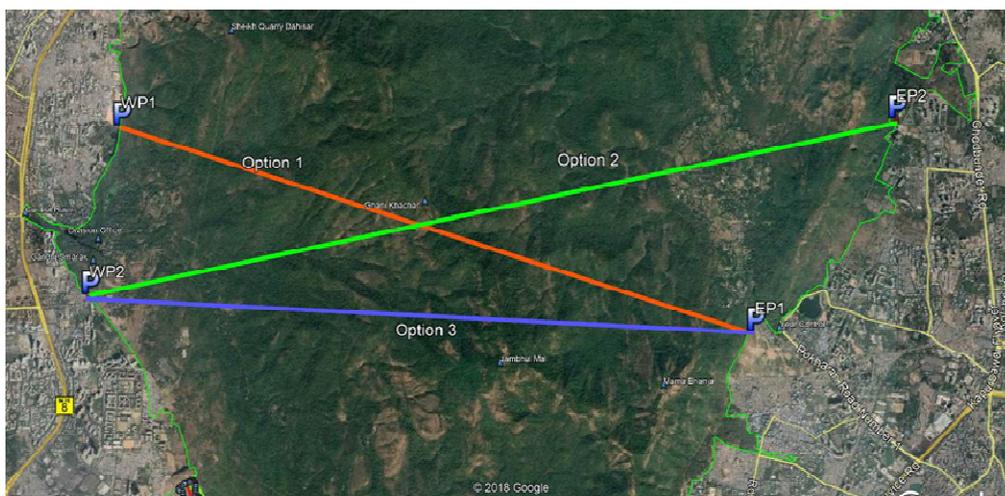
- ∞ The alignment should not fall in the area which will become constraint during the construction i.e. it should avoid villages, major structures, monuments. etc.
- ∞ The alignment should be able to accommodate the geometric design standards in terms of horizontal and vertical curves
- ∞ Portal locations should be such that tunnel construction activities can be taken up
- ∞ Three alignments were conceptualized with variable such as:
 - ∞ Distance of proposed Tunnel
 - ∞ Land Use Pattern
 - ∞ Minimum Number of Structure affected
 - ∞ Cost Criteria

The main constraints for this project are:

- ∞ Biodiversity of Sanjay Gandhi National Park (Protected Forest Area)
- ∞ Large slum areas along the park boundary
- ∞ Difficult road access to the park boundary

3.5.1 Proposed Alignment and Options

The possible alignment options are studied based on available Topo Sheet No. 47A-15, 16 along with updated satellite images available in Google Earth. Besides, each option for individual realignment was also crossed-checked through detailed reconnaissance survey at site. Considering the above parameters 3 options were shortlisted and were studied in details and marked on Google Earth Map as well as the portals locations and available areas shall be used for construction works are shown in **Figure 3.5**.



Source: Feasibility Report, AECOM

Figure 3.5: Three Different Alignment Options and their Portals marked on Google Earth

Table 3.9: Details of Three Alignment Options

Options	Direction	West Portal Coordinates (WP) (approximate)	East Portal Coordinates (EP) (approximate)	Length (km)
1.	WP1 to EP1	19 ^o 14'09.76''N - 72 ^o 87'48.41''E	19 ^o 21'60.76''N - 72 ^o 94'68.01''E	8.18
2.	WP2 to EP2	19 ^o 24'09.76''N - 72 ^o 87'48.41''E	19 ^o 23'09.83''N - 72 ^o 96'12.90''E	10.2
3.	WP3 to EP3	19 ^o 25'49.31''N - 72 ^o 88'25.50''E	19 ^o 21'60.76''N - 72 ^o 94'68.01''E	8.28

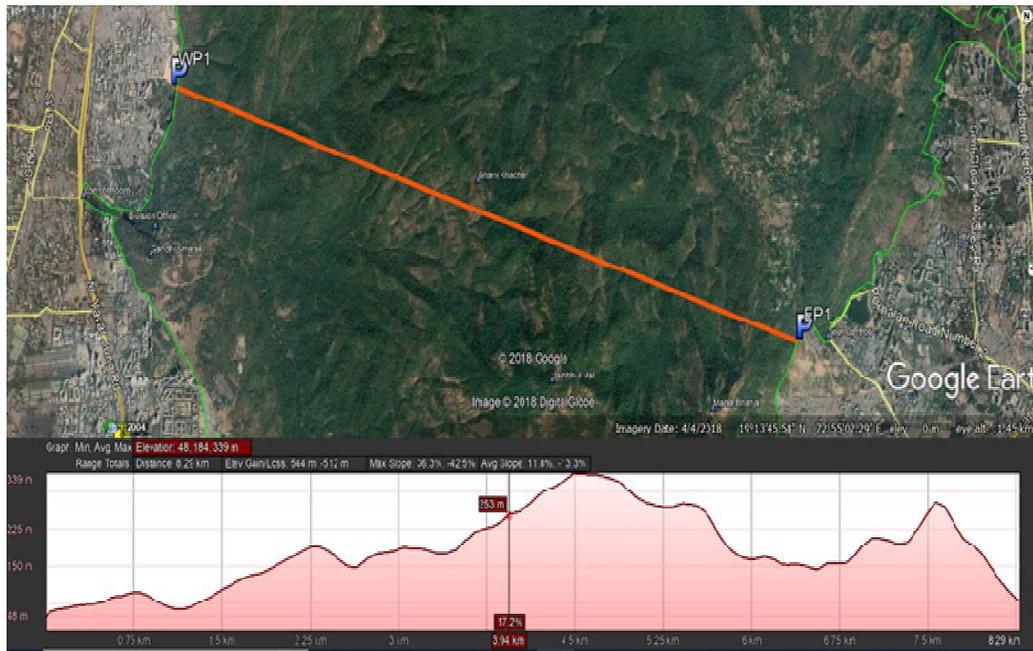
Source: Feasibility Report, AECOM

3.5.2 Comparison of the Alignment Options

The three alignments of the options were comprehensively studied and compared as below:

3.5.2.1 Option-1

Option 1 is starts from the existing stone quarry near Ektanagar on western side (WP1) and ends on Military grounds on eastern side (EP1) as shown in **Figure 3.6**.



Source: Feasibility Report, AECOM

Figure 3.6: L-section of Option-1 showing west Portal (WP1) and East Portal (EP1)

Table 3.10: Site Accessibility Assessment: West Portal (WP1) and East Portal (EP1):

West Portal (WP1): Located at the boundary of LP Shingle Film City besides existing stone quarry near Ektanagar and accessible through S.N. Dube Road.	
Advantages	Disadvantages
Doesn't infringe with the boundary of SGNP	Portal location is in depression to surrounding area
Significant land available for the construction	Large around of project affected persons (PAP)
Land site can be used as Muck disposal and filling	Unavailability of land for (3+3) access road connecting WEH due to densely populated urban area of Dahisar
An elevated approach to NH-8 might be necessary due to densely populated region between portal area and NH-8	
East Portal (EP1): Located at the boundary shared between Military ground near Misal Wadi and SGNP	
Doesn't infringe with the boundary of SGNP	Due to flat surface suitable overburden for tunneling is unavailable
Huge land available for the construction	Approaches to both NH-3 and Ghodbunder road through Pokharan Road No.1 Pokharan Road No. 2 passes through densely developed urban area Existing traffic scenario of these roads are already congested Project implementation will be worsen No scope to widen these roads further
Land site can also be used as Muck disposal and land filling	Land belongs to Defense and it has been utilized as shooting range

Source: Feasibility Report, AECOM

3.5.2.2 Option-2

This alignment starting from Trimurty Nagar and ending at TMC's Nisarg Garden in Thane is studied as Option 2 as shown in **Figure 3.7**. The portal is located at the boundary of SGNP at Trimurti Nagar near Jai Maharashtra Nagar accessible to WEH through Jai Maharashtra Road.

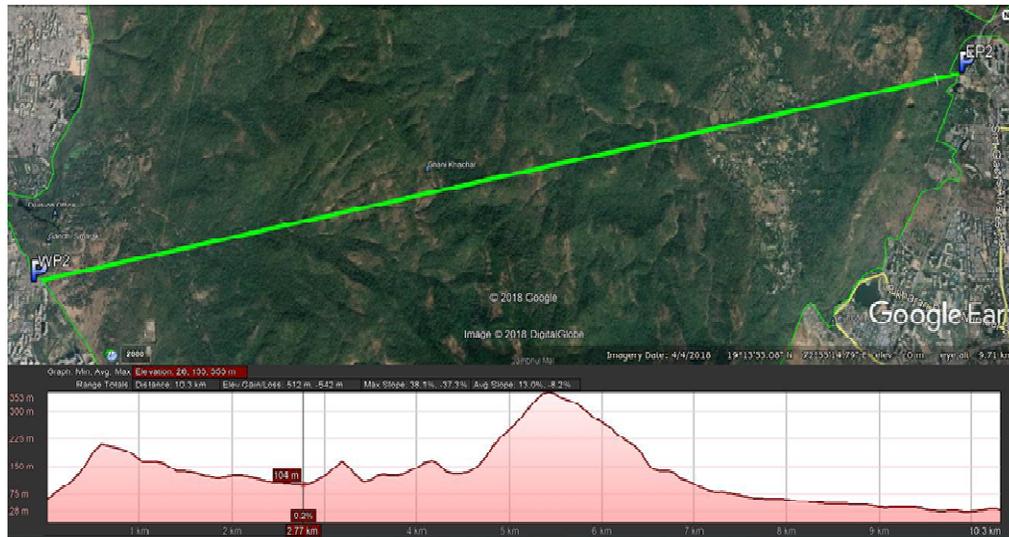


Figure 3.7: L-section of Option-2 showing west Portal (WP2) and East Portal (EP2)

Table 3.11: West Portal (WP2) and East Portal (EP2): Site Accessibility Assessment

West Portal WP2: Located at boundary of SGPN in Trimurti Nagar near Jai Maharashtra Nagar, accessible to WEH through Jai Maharashtra road	
Advantages	Disadvantages
Doesn't infringe with the boundary of SGNP	Moderate amount of PAP's are involved
Land is under SRA scheme can be easily available	Due to initial low overburden area suitable precautions while tunneling needs to be taken
Direct connectivity to WEH at Megathane Junction	
East Portal EP2: Located at the boundary of SGNP near TMC's Nisarg Garden in Manpada, Thane	
Doesn't infringe with the boundary of SGNP	Portal location is surrounded by high rise building on southern side
Sufficient land is available for the construction	
Approach to Ghodbunder road will be through proposed 40m DP road of TMC, Traffic will be distributed to NH-3 and eastern express highway	

Source: Feasibility Report, AECOM

3.5.2.3 Option-3

In this option the tunnel is proposed from WP2 in the boundary of SGNP in Trimurti Nagar to Misal Wadi ending at Military shooting range ground. Both these portals have been shown at WP2 and EP1 (**Figure 3.8**) and the advantages and disadvantages already discussed above and also shown in **Table 3.11**.

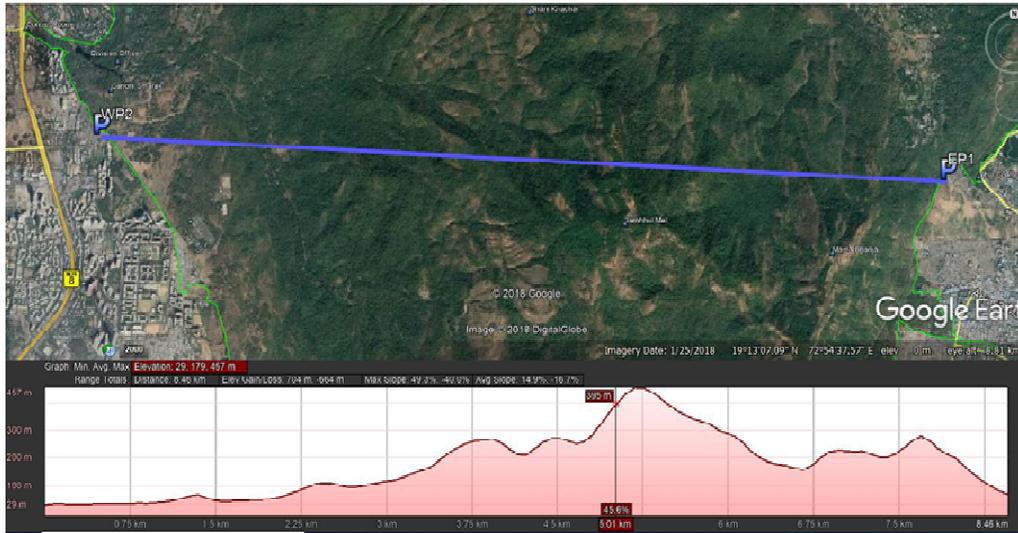


Figure 3.8: Location of Option 3 same as WP2 and EP1

3.5.2.4 Comparison of Options

Below **Table 3.12** gives a comparative study of all these three options on different crucial parameters.

Table 3.12: Salient Features of Various Alternatives for different Alignments

Particulars	Option-1	Option-2	Option-3
Location	From Ektanagar in western side to Shastrinagar junction on Pokharan Road No. 1	From WEH near Megathane DP Road to Tikujiniwadi near Patlipada	From WEH near Megathane DP Road to Shastrinagar junction on Pokharan Road No. 1
Land availability for development of Portal/ Cut-n- cover	Private/Government land on western side and Government (defense) land on eastern side	Private / Government land on both western and eastern side	Private / Government land on western side and Government (defense) land on eastern side
Topography and Land Use	The western end location is on the border of SGPN (North eastern corner). Open land parcel sloping towards eastern direction The topography of the area undulating rocky area sloping towards north-west.	Proposed western end is far away from SGNP boundary and is habituated at present However, there is a redevelopment plan of BMC of the region. Eastern end also lies outside SGNP. Topography is undulating on a hilly terrain under green cover	Proposed western end is far away from SGNP boundary and is habituated at present However, there is a redevelopment plan of BMC of the region. Eastern end also lies outside SGNP in the defense land. Topography is undulating on a hilly terrain under green cover

Particulars	Option-1	Option-2	Option-3
Alignment Length	12.56 km	11.85km	9.68 km
Ground Elevation above (msl)	397 m (maximum)	357 m (maximum)	470 m (maximum)
Proximity to eco-sensitive area	>95% of total proposed alignment is within SGNP. However, no NP land required for construction	>95% of total proposed alignment is within SGNP. However, no NP land required for construction	>95% of total proposed alignment is within SGNP. However, no NP land required for construction
Population Density	No population along the proposed alignment	Significant population of slum area at the western end outside the SGNP at present which is the part of BMC's redevelopment plan Developing residential societies of Patlipada eastern end	Significant population of slum area at the western end at present which is the part of BMC's redevelopment plan. Population along the proposed alignment above Yeoor hills
Direct connectivity to National Highway	Connectivity to NH-8 on western side through elevated structures and Pokharan road on eastern end through access road	Direct connectivity to NH-8 at western end and Thane Godbunder road at eastern end through Cut- n-cover / access roads	Direct connectivity to NH-8 and Pokharan road No.2 at both western and eastern ends respectively through Cut n cover
Proximity to identified water sources and the disturbance to environment	Alignment is crossing one identified stream flowing from south to north in the middle east of the SGNP. However, the alignment is proposed to be underground within the SGNP limits in order not to affect any of the surface water and the habitations	Alignment is crossing one identified stream flowing from south to north in the middle east of the SGNP. However, the alignment is proposed to be underground within the SGNP limits in order not to affect any of the surface water and the habitations	Alignment is crossing one identified stream flowing from south to north in the middle east of the SGNP. However, the alignment is proposed to be underground within the SGNP limits in order not to affect any of the surface water and the habitations
Loss of agricultural land	No agricultural land is involved	No agricultural land is involved	No agricultural land is involved

Particulars	Option-1	Option-2	Option-3
Proximity to ASI sites & religious structure	NIL	NIL	NIL
Actual length	24.8 km	22.1 km	26.14 km
Length saved	11.88 km	9.44 km	8.38 km
Tunnel Length	8.28 km	10.8 km	8.28 km
Access Length	4.5 km	1.6 km	3.1 km
West Portal (WP)	Outside SGNP	Outside SGNP	Outside SGNP
East Portal (EP)	Outside SGNP	Outside SGNP	Outside SGNP
Cover (Min.)	100m	25m	29m
Cover (Max.)	268m	380m	457m
Availability of space for roads at West Portal	Available through Shiv Vailabh Road, (1+1) lane	Available through an open land	Available through Shiv Vailabh road, (1+1) lane
Availability of space for road at East Portal	Available through Khewra Circle Marg and Pokharan Road No. 2	Available 40m DP Road of TMC through Patlipada	Available through Khewra Circle Marg and Pokharan Road No. 2
Remarks	Access to highway 3 + 3 lane not available on western side due to densely populated urban area of Dahisar	Availability of land for both the portal location and construction yard. Direct connectivity to existing DP Road and it is decided to go with Option-2	Unavailability of sufficient overburden on eastern portal. Access road on eastern side passes through dense urban area of Vartak Nagar

Source: Feasibility Report, AECOM

3.6 Proposed Alignment - Option-2

- ∞ Option 1 was discarded due to unavailability of access road.
- ∞ It was decided to go with **Option-2** was finalized for further investigations/studies in consultation with project proponent and submitted the case for forest permissions required to geotechnical investigations and survey.
- ∞ Option 3 was discarded due to unavailability of sufficient overburden disposal site on eastern portal and access road on eastern side passes through dense urban area of Vartak Nagar.

Chapter 4

Description of Environment

4.1 Background

This chapter describes the existing environmental status in the study area. This includes the physical environment comprising air, noise, water, land, biological and socio-economic components. The baseline status of environmental quality in the vicinity of project site serves as the basis for identification, prediction and evaluation of impacts. The baseline environmental quality is assessed through field studies within the impacts zone for various components of the environment.

The environmental study for the project area has been carried out, in accordance with the requirements of the Government of India guidelines for Rail / Road / Highway / Tunnel projects. The Environment assessment process includes an inventory of baseline environmental conditions using data collected from secondary sources and field investigations; the identification of environmental issues / impacts and suggestion for mitigation measures to minimize adverse environmental impacts.

The Environmental Screening and Initial Environmental Examination report is prepared for the identification of major areas of concern of environmental attributes and social aspects, the fixing of the work plan and guidelines for detailed EIA report preparation. Accordingly detailed EIA report will be prepared as a part of DPR in terms of the provision of EIA Notification 2006 and amendments thereto.

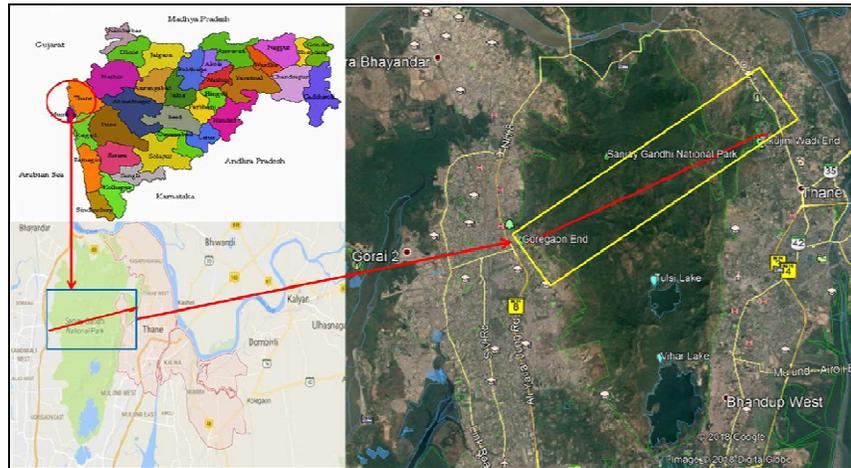
Development of underground highway tunnel projects is generally intended to have low environmental impacts and improve the economic and social welfare of the people. At the same time it may also create adverse impact on the surrounding environment like aquifer recharge, ground and surface water quality and noise and vibration. As tunneling is an essential activity of the project execution across 10.8 km of the core area of Sanjay Gandhi National Park (SGNP), a number of other impacts along with the above ecology and biodiversity impacts have to be taken into account.

The environmental examination of tunnel projects include damage to habitation within the path of tunnel, sensitive eco-systems, soil erosion, changes to drainage pattern and thereby ground water, interference with wildlife movement, disruption of local economic activities, demographic changes and accelerated urbanization around area. Highway development and operation therefore, be planned with careful consideration of the environmental impact after initial examination. To minimize these adverse effects that may be created by the highway tunnel development projects, the screening and initial environmental examination of the project become necessary.

Attributes of the physical environment like air, noise, water, land and biological quality in the surrounding area were assessed primarily through field studies and by undertaking monitoring and analysis of samples collected from the field of the project site. For the purpose of Environment Study a corridor up to 2.5 km on either side of the project tunnel has been studied. The primary monitoring of key

environmental parameters has been collected out by experienced team of Bhojraj Laboratories (MoEFCC Accredited), Pune, during summer season (20th March to 20th June, 2021).

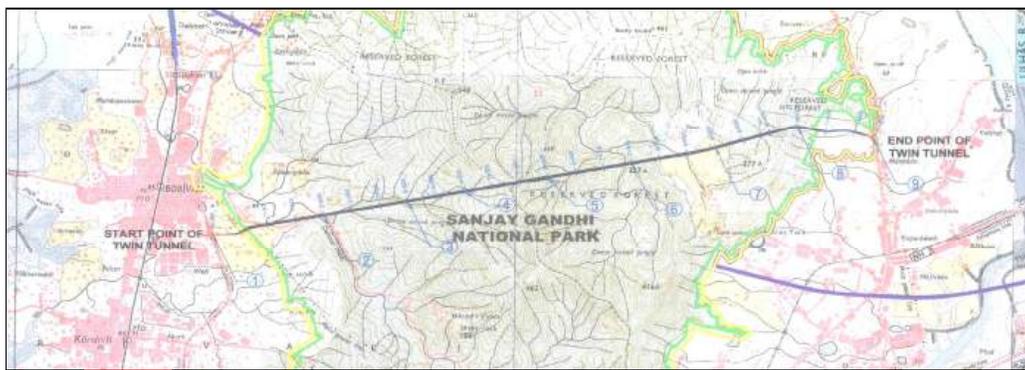
Project Location: The proposed twin tube, 2 Lanes (each side) highway tunnel of about 10.8 km passes through below the SGNP, connecting Western Express Highway (WEH) near Borivali and Ghodbunder road (Thane) Near Tikuji-ni-wadi. The project passes through Magathane village of Borivali, and Yeoor, Chene, Boriwade, Majiwada, and Manpada villages of Thane District. Major arterial roads in this region are Western Express Highway leading to NH-8 and Eastern Express Highway leading to NH-3. The location of the study area from Borivali to Tikuji-ni-wadi (NH-3), Thane is shown in **Figure 4.1.1**.



Source: Feasibility Report, AECOM

Figure 4.1.1: Project Location Tunnel Passes from Borivali to Thane

The proposed alignment of Tunnel passes underground the SGNP starting at chainage 0.200km in Tikuji-ni-wadi and ends at chain-age 10.600 SGNP km in Borivali. The area has unique combinations of rich bio-diversity. The vegetation of this area ranges from littoral forests to western sub-tropical hill forests. The park is home to a number of endangered species of flora and fauna. Large numbers of vertebrate and invertebrate species belonging to various classes and orders are indicators of immense biological diversity of this area. The study area map on Toposheet No. 47A-15, 16 as shown in **Figure 4.1.2**.



Source: **MSRDC**

Figure 4.1.2: Study Area Location Map (Toposheet)

Climate: The climatic condition in the study area is strongly influenced by its geographical conditions. Climatological data recorded at station IMD Mumbai for summer season is presented in **Table 4.1.1**. It is very humid and warm due to coastal region. The humidity ranges from 33% - 83% recorded during study period. On an average, the temperature ranges from 22°C to 36°C. April and May are usually warm period. The project area gets assured rainfall of 2000-2500 mm, from the south-west monsoon during the months of middle of June to September. Generally, the highest rainfall is recorded in the month of July. The cloud cover recorded minimum in the month of March and increases from April to June in the study period.

Table 4.1.1: Climatological Data Station IMD Mumbai (Summer 2021)

Months	Temperature (°C)		Relative Humidity (%)		Winds				Rainfall (mm)	Cloud Cover (%)	
	Min.	Max.	Min.	Max.	Speed (km/hr)		Direction		Monthly	Min.	Max.
					Min.	Max.	-	-			
March	22	36	33	78	3	28	NW	WNW	0.0	0	6
April	24	33	45	74	4	31	NW	WNW	0.0	0	85
May	23	35	50	81	2	48	W	WNW	46.4	0	92
June	25	32	60	83	4	32	SW	WSW	561.1	13	100

Source: IMD, Mubai

Geology: The area comprises of mainly basic lava flows. These are commonly referred to as the Deccan – Trap. They have been dated as between 45 to 60 million years. Another interesting geological feature of the area is the occurrence of thick volcanic agglomerates near Tulsi Lake and Kanheri Caves indicating a possible volcanic focus. It is seen that the rock structure within the park is mostly impermeable and non-porous with the exception of the areas adjoining Tulsi and Vihar Lakes. Though the area receives high rainfall, due to such rock structure there is less seepage of water. The streams and few waterholes start drying up as soon as monsoon is over.

Topography and Terrain: The terrain is largely semi mountainous with only a few patches of level ground. The area has two lakes Tulsi and Vihar, which are main source of the drinking water of Mumbai city. The dominant topographical feature is the peripheral range of hills, both along the eastern and western limits of the park. The hills constitute the outer spur of the Sahyadris. Rising from an elevation of less than about 30m amsl, the terrain culminates in to a series of peaks dispersed through the park; the highest near Kanheri Cave being 484m. Most of the streams in the area are monsoon fed and they dry up in summer season. Amongst 28 nallahs / streams inside park, two major streams are Revat Nallah and Dahisar River. Dahisar River originates near Tulsi Lake and flows across SGNP through Magathane Forest area and joins Manori Creek. The Revat stream starts from Avaghada Hills to the south of the Yeur village, flows towards north through reserved forests of Yeur and Chenna Village and joins Bassein Creek.

Soil: Only a thin mantle of soil covers the volcanic rocks underlying the region particularly on the ridges and other places where years of erosion have steadily worn it away. In some places, fairly large areas of the hard, dry rocks are completely exposed as at Kanheri caves and their vicinity. On the tree clad lower slopes of Vihar and Tulsi Catchment area, a good part of Chenna Private Forest and Nagla Block, the soil is sufficiently deep and fertile.

4.2 Air Environment

Assessment of impacts on air environment due to any developmental activities and feedback for EMP requires information on existing ambient air quality status around the project activities. The studies of existing baseline status for air environment include reconnaissance, identification of specific air pollutants due to proposed developmental activity and measurement of their existing levels along with measurement of conservatives' pollutants in ambient air within the study area prior to implementation of the project. The data required to assess the status can be collected, analyzed and evaluated through a well-designed Ambient Air Quality Monitoring Network (AAQMN) as per CPCB guidelines.

4.2.1 Design of Network for Ambient Air Quality Monitoring

Existing ambient air quality data is collected through a well-designed AAQM network. The following criteria were taken into account while designing the ambient air quality monitoring network (AAQMN).

- ∞ Topography of the study area
- ∞ Representation of the regional background
- ∞ Populated and sensitive area
- ∞ Representation of valid cross-sectional distribution including where maximum incremental GLC is likely to occur downwind direction
- ∞ Screening of maximum ground level concentration (GLC) and distance of their likely concentration as per climatologically normal

4.2.2 Reconnaissance

The proposed twin tube, 2 Lanes (each side) highway tunnel of about 10.8 km passes through below the SGNP, connecting Western Express Highway (WEH) near Borivali and Ghodbunder road (Thane) near Tikuji-ni-wadi. The project passes through 3 villages (Magathane village of Borivali, Yeoor and Manpada villages of Thane District). No public buildings and monuments of national importance exist in the lease hold areas.

4.2.3 Micrometeorology

The study of micro-meteorological conditions of a particular region is of utmost importance to understand the variations in ambient air quality status in that region. The prevailing micrometeorology at project site plays a crucial role in transport and dispersion of air pollutants released from the project activities. The persistence of the predominant wind direction and wind speed at the project site will decide the direction and extent of air pollution impact zone. The micrometeorological data procured from IMD corresponding to nearest available observatory (Mumbai) are appropriately used in this study. The records of wind speed and wind direction of the study period was used for computing the relative percentage frequencies of wind occurrence in various wind directions. The wind rose is presented in **Figure 4.2.1**. The 24-hourly wind roses diagram indicate the predominant winds are West, North and North-West with speed ranging between 1.0 and 3.5 m/s. accordingly the impact

zone will be spread over East, South, and South-East direction during summer season. The calm condition was also recorded in %.

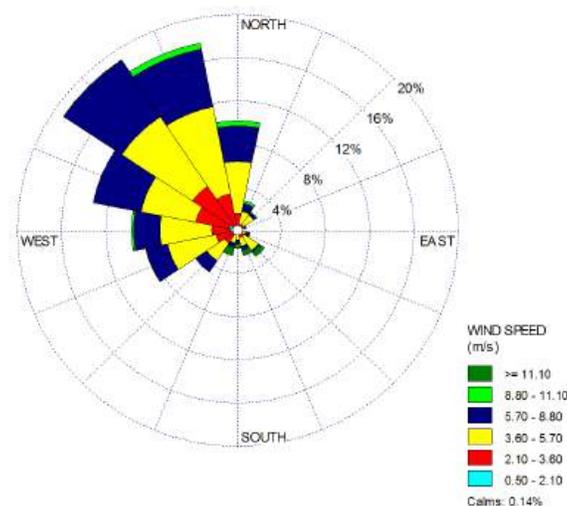


Figure 4.2.1: Wind Roses

4.2.4 Air Environment

The compliance pollutants such as Particulate Matter less than 10 and 2.5 microns size (i.e. PM_{10} and $PM_{2.5}$), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NO_x), and Carbon Monoxide (CO) were identified as significant parameters for air quality monitoring were carried out in the summer season (2021) in the study area. At all the AQM location, the Air quality monitoring samplers were installed for continuous sampling of air on 24 hourly bases. A laboratory set up in the study area at the site and the samples were analyzed on the same day for chemical analysis of representative air samples. The instruments used for analysis are shown in **Table 4.2.1**.

Table 4.2.1: Instruments Used for Analysis

Sr. No.	Instrument Name	Make	Parameters
1.	Spectrophotometer	HACK	SO_2 , NO_x
2.	Electronic Balance	Metler	PM_{10} , $PM_{2.5}$
3.	Gas Chromatograph with FID and ECD	GC-3 VARIAN	CO

The environmental attributes frequency monitoring is depicted in **Table 4.2.2** and techniques of analysis are given in **Table 4.2.3**.

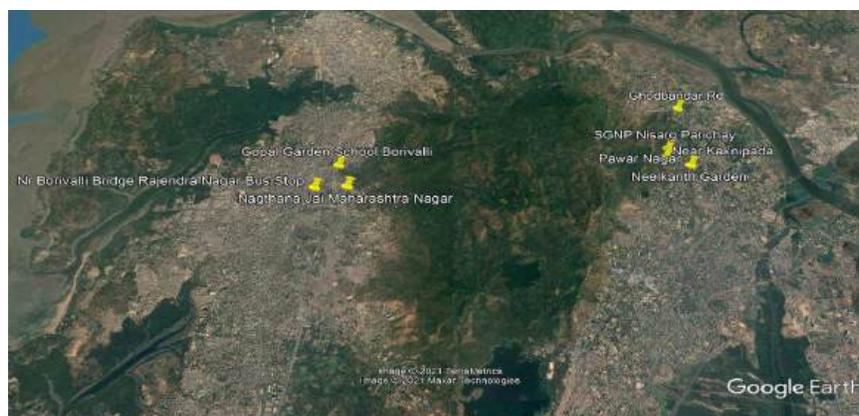
Table 4.2.2: Environmental Attributes and Frequency of Monitoring

Sr. No.	Attribute	Parameters	Sampling Location (No.)	Frequency of Monitoring (Summer Season)
1.	Meteorology	WS, WD, Temp. RH, Rainfall	1	One season data
2.	Ambient Air Quality	PM ₁₀ , PM _{2.5} , SO ₂ , NO _x , CO	8	24 hourly Sampling
3.	Noise levels	Noise levels in dB(A)	8	Hourly observation
4.	Surface Water Quality	Physioco-chemical & Bacteriological	2	Once during study period
5.	Ground Water Quality	Physioco-chemical & Bacteriological	1	Once during study period
6.	Soil (Sub-surface)	Physical and Chemical	3	Once during study period
7.	Land use, Land cover	Different classification	Summer	Using satellite imaging & GIS
8.	Ecology Biodiversity	Existing Flora and Fauna	Summer	Data Secondary source (Once)
9.	Socio-economic	Demographic study & QoL	Summer	Data Secondary source (Once)

Table 4.2.3: Technique Used for Ambient Air Quality Monitoring

Sr. No.	Parameters	Technique/Methods	Technical Protocol (CPCB)	Minimum Limits
1.	PM ₁₀	Gravimetric Method	IS-5182 (Part-23)	3 (ug/m ³)
2.	PM _{2.5}	Gravimetric Method	IS-5182 (Part-23)	3 (ug/m ³)
3.	SO ₂	West and Gaeke Method	IS-5182 (Part-2)	3 (ug/m ³)
4.	NO _x	Jacob & Hochheiser Method	IS-5182 ((Part-6)	3 (ug/m ³)
5.	CO	Gas Chromatograph with FID & ECD Method	IS-5182 ((Part-10)	1 (mg/m ³)

Total eight (8) ambient air quality monitoring (AAQM) locations were selected based on guidelines of network sitting criteria. The study area along with 8 AAQM locations with respect to the proposed site is depicted in **Figure 4.2.2** and details of the locations for PM₁₀, PM_{2.5}, SO₂, NO_x and CO are given in **Table 4.2.4**.



Source: Bioraj Laboratories, Pune

Figure 4.2.2: Study Area Map for Ambient Air Quality Sampling Locations

Table 4.2.4: Air Quality Sampling Location (Summer Season)

Sr. No.	Sampling Location		
(I) Portal East (Thane)			
		Latitude (N)	Longitude (E)
AQ1.	Near Nilkamal Garden	19°237156 N	72°96479E
AQ2.	Near Pawar Nagar	19°233215 N	72 °96311E
AQ3.	Near Koknipada	19 °230341 N	72 °970305E
AQ4.	Near SG Udyan, Manpada (Nisarg Parichay Kendra)	19 °237156 N	72 °96479E
AQ5.	Near Godbunder Road	19 °256123N	72 °970822E
(II) Portal West (Borivali)			
AQ6.	Nr. Gopal Gardan School, Borivali	19 °23023N	72 °864022E
AQ7.	Nr. Megathane, Jai Maharashtra nagar	19 °221318 N	72 °867155E
AQ8.	Nr, Borivali Bridge	19°220927 N	72 °857463E

Source: Bioraj Laboratories, Pune

4.2.5 Air Quality Baseline Status

The project sites are divided into two portals (a) East Poral (Thane) and West Portal (Borivali). The observed ambient air quality data within the study area of the project site is reported in **Table 4.2.5**.

Table 4.2.5: Air Quality Monitoring (Summer 2021)

Sampling Location	PM ₁₀			PM _{2.5}			SO ₂			NO _x			CO		
	(µg/m ³)									(mg/m ³)					
(I) East Portal (Thane)															
Months	April	May	June	April	May	June	April	May	June	April	May	June	April	May	June
AQ1.	53.44	52.7	46.89	29.17	26.8	24.62	7.23	6.21	6.48	14.51	12.7	11.31	0.6	0.5	0.42
AQ2.	59.82	56.27	46.11	29.88	25.21	27.31	7.91	6.98	10.51	15.21	14.72	15.83	0.6	0.6	0.47
AQ3.	57.27	53.18	41.71	28.11	27.33	21.57	7.67	7.11	10.88	15.02	14.25	14.57	0.5	0.5	0.43
AQ4.	55.63	53.19	41.82	27.21	25.12	23.69	6.72	6.16	9.65	14.68	14.17	14.11	0.5	0.5	0.42
AQ5.	63.17	62.77	54.75	31.40	30.83	31.55	11.5	10.73	11.41	21.6	20.82	16.36	0.8	0.8	0.42
(II) West Portal (Borivali)															
AQ6.	60.52	59.66	54.85	29.14	28.32	30.51	8.15	7.92	11.24	14.18	14.22	15.17	0.6	0.6	0.42
AQ7.	59.29	60.26	52.88	30.14	32.33	29.50	7.21	7.84	12.48	14.87	14.16	16.22	0.6	0.6	0.42
AQ8.	62.84	60.93	62.43	31.1	30.44	14.17	12.4	11.92	14.25	21.1	20.31	19.58	0.8	0.8	0.49
Min.	53.44	52.7	41.71	27.21	25.12	14.17	6.72	6.16	6.48	14.18	12.7	11.31	0.5	0.5	0.42
Max.	63.17	62.77	62.43	31.4	32.33	31.55	12.4	11.92	14.25	21.6	20.82	19.58	0.8	0.8	0.49
Mean	59.00	57.37	49.53	29.52	28.30	25.37	8.60	8.11	10.86	16.40	15.67	15.39	0.63	0.61	0.44
98 th Percentile	63.12	62.51	61.52	31.36	32.12	31.40	12.27	11.75	14.00	21.53	20.75	19.13	0.8	0.8	0.49
NAAQS (2009)	100			60			80			80			2		

Source: Bioraj Laboratories, Pune

4.2.6 Background Air Quality Data Interpretation

Particulate Matter (PM₁₀): The 98th percentile values of PM₁₀ ranged between 61.52 - 63.12 µg/m³. The concentrations were observed to be below stipulated standards for NAAQS (24 hourly **PM₁₀=100 µg/m³**).

Particulate Matter (PM_{2.5}): The 98th percentile values of PM_{2.5} ranged between 31.36 - 32.12µg/m³. The PM_{2.5} concentrations for all the locations were observed to be below stipulated standards for NAAQS (24 hourly **PM_{2.5}=60 µg/m³**).

Sulphur Dioxide (SO₂): The 98th percentile value of SO₂ ranged between 11.75 - 14.00µg/m³.

Oxides of Nitrogen (NO_x) The 98th percentile value of NO_x ranged between 19.13 - 21.53µg/m³.

The values of gaseous pollutants were below the stipulated standards of NAAQS (**24 hourly SO₂ and NO_x = 80µg/m³**).

Carbon Monoxide (CO): In order to assess the concentration of Carbon Monoxide (CO) samples were collected in Tedlar bags and analyzed within 24 hours by carbon monoxide analyzer based on the principle of infrared radiation at wavelength near 4.7 microns. The 98th percentile of CO at all the sampling locations varied between 0.49 and 0.8 mg/m³ which are within the permissible limits of NAAQS for the respective designated areas (**CO for 1 hour = 2.0 mg/m³**).

4.3 Noise Environment

4.3.1 Methodology

The objective of the noise pollution survey in the study area was to assess the impact of noise generated by the existing noise sources in the region especially on the human settlement. The baseline status of the environment with respect to noise levels in the study area have been asses in 2.5 km on either side of the project area. Sound Pressure Levels (SPL) was measured using precision sound level meter (Bruel and Kjaer make). Noise levels in the nearby villages as residential zone, and commercial zones were measured.

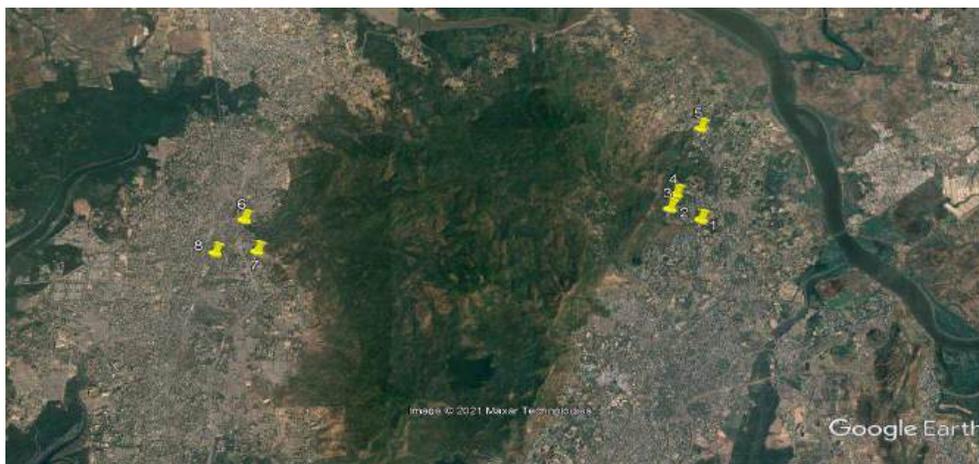
Survey was carried out in the following steps:

- ∞ Reconnaissance survey
- ∞ Measurement of background noise levels
- ∞ Identification and characterization of the noise sources
- ∞ Measurement of prevailing noise levels due to vehicular movements

Reconnaissance: A reconnaissance was conducted with a view to establish the baseline status of the environment with respect to noise levels of the proposed project study area, surrounding villages and other centers of human activities. The proposed highway tunnel will be passing through underground area of SGNP from Tikuji-ni-wadi, Thane to Borivali East covering 11.8km length. An area of 2.5km on either side from the tunnel alignment was considered as the study area for EIA study.

4.3.2 Background Noise Levels Interpretation

Total 8 locations have been monitored on the noise sampling in the region. Monitoring locations are shown in **Figure 4.2.1** and presented in **Table 4.2.1**. Background noise levels were monitored in the villages in the study area, equivalent noise levels were monitored for the residential and commercial zones. In the residential areas noise levels were observed in the range of 50.9 to 54.5 dB(A) in day time and 41.7 to 44.6 dB(A) during night time. In the commercial areas noise levels were observed in the range of 60.2 to 64.4 dB(A) in day time and 45.1 to 57.8 dB(A) during night time. The levels of noise in the study area were compared with noise limits (CPCB, 1998) and observed within the guidelines limits.



Source: Bioraj Laboratories, Pune

Figure 4.3.1: Noise Level Monitoring Locations

Table 4.3.1: Noise Level Monitoring Locations

Sr. No.	Sampling Location	Area/Zone
(I) East Portal Tunnel Area (Thane)		
N1.	Near Nilkamal Garden	Residential
N2.	Near Pawar Nagar	Residential
N3.	Near Koknipada	Residential
N4.	Near SG Udyan, Manpada (Nisarg Parichy Kendra)	Residential
N5.	Near Godbunder Road	Commercial
(II) West Portal Tunnel Area (Borivali)		
N6.	Nr. Gopal Gardan School, Borivali	Commercial
N7.	Nr. Megathane, Jai Maharashtra nagar	Residential
N8.	Nr, Borivali Bridge	Commercial

Table 4.3.2: Baseline Noise Level Monitoring Status (Summer Season)

Sampling Location	Sampling Location	Leq _{day}	Leq _{night}	Leq _{day}	Leq _{night}	Leq _{day}	Leq _{night}
		(dB(A))	(dB(A))	(dB(A))	(dB(A))	(dB(A))	(dB(A))
East Portal Tunnel Area (Thane)		April		May		June	
N1.	Near Nilkamal Garden (Residential)	52.6	42.8	53.1	43.2	53.4	44.6
N2	Near Pawar Nagar (Residential)	52.7	43.8	53.5	42.2	54.5	44.1
N3	Near Koknipada (Residential)	53.8	41.7	54.1	42.8	54.2	42.3
N4	Near SG Udyan, Manpada (Nisarg Parichy Kendra) (Residential)	50.9	43.3	52.2	42.4	54.2	44.9

N5	Near Godbunder Road (Commercial)	62.8	53.6	63.7	57.8	64.4	51.5
West Portal Tunnel Area (Borivali)							
N6.	Nr. Gopal Gardan School, Borivali (Commercial)	61.8	52.2	60.9	52.5	60.2	47.5
7N.	Nr. Megathane, Jai Maharashtra nagar (Residential)	52.9	43.6	53.1	44.3	53.8	44.3
N8.	Nr, Borivali Bridge (Commercial)	63.6	53.6	62.7	54.1	61.9	45.1
CPCB Limits Residential (55-45)		50.9 – 54.5			41.7 – 44.6		
CPCB Limits Commercial (65-55)		60.2 – 64.4			45.1 – 57.8		

Source: Bioraj Laboratories, Pune

CPCB Guidelines Limits in dB(A) Leq (1998)

Sr. No.	Category of Area/Zone	Day Time	Night Time
1.	Industrial Area	75	70
2.	Commercial Area	65	55
3.	Residential Area	55	45
4.	Silence Area	50	40

4.3.3 Traffic Survey

The traffic survey locations were selected to assist in determining the existing traffic volumes and travel patterns operating in the study area corridor network.

Location-1 (Magathane Junction) is located on WEH where Dattapada road, Jai Maharashtra road and service lines of WEH (1-9). This location will act as a starting/ending point of tunnel for speed and delay. With reference to the zone map, this location is located in Zone-6.

Location-2 (Near Fountain Hotel) is a mid-block located on WEH, two ways traffic at WEH (1-10) was considered. This location is located in Zone-3.

Location-3 (Kapurwadi) is a mid block on Ghodbunder road, Thane, two ways traffic at Ghodbunder road (1-11) was considered. This location is located in Zone-26. This location will act as a starting/ending point of tunnel for speed and delay.

Location-4 (Powai) is a mid-block located on Jogeshwari-Vikroli Link Road (JVLR), two ways traffic at JVLR (1-12) was considered. This location is located in Zone-17.

The classified volume count (CVC) data obtained from 24 hours for 7 days summarized in **Table 4.3.3**.

Table 4.3.3: Traffic Volume Count (TVC)

Locations	2-Wheelers	3-Wheelers	4-Wheelers	LCV	Trucks	Bus	Other	TVC (both directions) AADT (Veh/day)
1-Megathane	29164	39178	27887	3862	1963	1334	1152	104540
2-Fountain Hotel	30932	23579	52542	11229	8043	3276	87	129688
3-Kapurwadi	49241	29379	72653	9493	10100	7138	250	178254

4-Powai	50282	36410	74579	7586	2942	6748	171	178718
Total	159619	128546	227661	32170	23048	18496	1660	591200
Percentage (%)	27.00	21.74	38.59	5.44	3.90	3.13	0.28	100

Source: Feasibility Report, AECOM

The total Traffic Volume Counts (TVC) from all 4 locations were computed as 5,91,200 vehicles/day. The 4-wheelers was highest in numbers 2,27,661(38.59%), whereas lowest was bus count 18,496 (3.13%), while the other vehicle counts (0.28%) were not specified and thus not considered for vehicle accounts.

4.3.4 Traffic Noise

The present mode of transportation of proposed project is mainly Godbunder road, Thene EEH (NH-3) and WEH (NH-8) at Magathane. The frequency of the vehicles on these connecting roads was found to be very high. This causes very insignificant increase of noise levels in the region. The number of heavy, medium and light vehicles at check post and monitored noise levels were observed. The observed Leq ranged from 60 dB(A) to 70 dB(A). The details of traffic survey, forecast and assignment is presented in Chapter-3. At present there is no any noise generating activities in the study area. Generally, in process of construction tunnel there will be hardly any stationery noise generating units except drill and blasting, motor drive, loading and hauling overburden etc. which produce noise levels will be in the range of about 78 dB(A) to 94 dB(A).

4.3.5 Vibration

The source of vibration and noise during construction of tunnel is due to operation of Tunnel Boring Machine (TBM). Human response to vibration is subjective and will be different for different people. When the vibration reaches the floors and walls it may results in perceptible vibration depending on the amplitude and frequency of the vibration. People may be more annoyed if they are exposed both noise and vibrations compared to when only vibration is felt. According to the U.S. Department of Transportation (1998) the perception threshold of humans for peak particle velocity (PPV) is about 0.04mm/s. To know the impact of vibration due to TBM operation on wildlife in core area of SGNP due to construction and operation will be studied by National Institute of Rock Mechanics (NIRM) by selecting the most sensitive area falling on the proposed tunnel alignment.

Vibrations were monitored at proposed highway tunnel project area. Vibration can be characterized by various parameters such as Peak Particle Velocity (PPV), Peak Vector Sum (PVS), Peak displacement (Pk Disp.), Peak Acceleration (Pk /accl.), Peak Sound Pressure Level (PSPL) and Zero Crossing (ZC) frequency.

It is observed that all the PPVs monitored within the proposed project area and nearby residential areas are well below permissible limits of BSI standards as presently the site area located in protected area (SGNP) and no project activities being carried out. The impact of vibrations generated from the existing activities and nearby residential areas is expected to be insignificant. When the construction of tunnel work will be start, then only the vibration study taken up and will be beneficial.

Drill and blast construction produces vibration from both the blast, travelling through ground and from pressure of the blast travelling through the air.

Unlike TBM vibration, which is steady, blasting will be felt as quick impulses lasting for several seconds several times a day. Vibration from the blast would be barely perceptible and not enough to damage structure.

Vibration created by blasting underground is less than the surface blasting. As the depth of cover increases, the intensity of the vibration will decrease due to the damping effect of the different mediums (soil/rock) the waves will cross.

The human body can detect magnitudes of vibrations lower than those which would normally cause mechanical or structural problems. The “discomfort” or “annoyance” produced by whole body vibration is a very influential factor and may be one of the limiting parameters in the design of the structure. It can be said that PPV less than 1mm/sec are not detectable for human beings whereas PPV more than 10mm/sec are clearly detectable. The impact of vibrations generated from the existing activities and nearby residential areas is expected to be insignificant.

4.4 Water Environment

Surface Water: The study area is largely mountainous with only a few patches of level ground. The area has two lakes Tulsi and Vihar which are main source of the drinking water of Mumbai city. The Tulasi Lake is about 4.9km away from the proposed tunnel locations. Most of the streams in the area are monsoon fed and they dry up in summer season.

Ground Water (Hydrogeology): The entire area is underlain by basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow Alluvium formation of recent age also occurs as narrow stretch along the major rivers flowing in the area i.e. Hard Rock Area and Deccan Trap Basalt.

The ground water exists in fractures, joints, vesicles and in weathered zone of Basalt. The occurrence and circulation of ground water is controlled by vesicular unit of lava flows and through secondary porosity and permeability developed due to weathering, jointing, fracturing etc. of Basalt. The ground water occurs under phreatic, semi confined and confined conditions. The leaky confined conditions are also observed in deeper aquifers. Generally, the phreatic aquifer ranges down to depth of 10m bgl. The yields of the wells are the functions of the permeability and transmissivity of aquifer encountered. This varies with location, diameter and depth of wells.

There are mainly two types of ground water structures i.e. dug wells and bore wells in the area. The yields of the dug wells varies from 10 to 1000 m³/day, whereas that of bore wells ranges between 50 and 1000 m³/day tapping the promising aquifer in the depth range of 40 to 60 m bgl. Even though the bore wells drilled in the area by both official and private agencies are in large number, no adequate data regarding areal extent of the aquifer is available. The bore wells in low lying area are affected by saline water where as in upland areas the quality is potable. The above description confirms following points:

- ∞ The tunneling is being carried out in the hard rock formations of Kanheri-Tulasi area.
- ∞ The Tunnels being dug out about 20 m bgl
- ∞ There are little chances of having substantial aquifers at that level.

- ∞ The Tulsi lak is 4.9 km away from the Tunnel locations.
- ∞ Tulsi lake is feeding on surface water collected during monsoon and does not have dependence on any aquifers

Considering the above facts, it is very unlikely that the proposed tunnel will have any impacts on the aquifers of Tulsi lake water catchment.

4.4.1 Water Sampling Locations

Physico-chemical and biological parameters have been determined to establish the baseline status of the existing surface and ground water sources. One (1) ground water and two (2) surface water samples were collected during summer season (2021). Sampling location of surface water and ground water quality monitoring are shown in **Figure 4.4.1** and enlisted in **Table 4.4.1**.

Table 4.4.1: Water Sampling Locations (Summer Season)

Sr. No.	Type of Water	Sampling Location
GW1	Ground Water	Near Neelkanth Garden
SW1	Surface Water	Near Neelkanth Garden
SW2	Surface Water (Lake)	Near SG Udyan, Manpada, Nisarg Parichay Kendra

Source: Bioraj Laboratories, Pune

4.4.2 Methodology

The physico-chemical parameters estimated for ascertaining the baseline status of water environment of summer season. All the analysis estimations were carried out as per the procedures described in the 20th Edition of Standard Methods, 1998 (APHA, QWWA and WEF). Heavy metals were determined by ICP using JY-24 Model of Jobin Yvon, France. Sodium and Potassium were also estimated using Systronic 128 Model Flame Photometer.

4.4.3 Baseline Status Interpretation

4.4.3.1 Physical Parameters

The results of physical parameters viz. turbidity, pH, and TDS of ground water are found in the range of 1.0 NTU, 7.12, and 617 mg/l respectively. The surface water quality viz. turbidity, pH and TDS of are found in the range of 1.0-3.0 NTU, 7.10 – 7.89 and 488-1012 mg/l respectively. It indicates that the turbidity and TDS in surface water (SW2) are higher than acceptable limits but lower than permissible limits (**Table 4.4.2**).

Table 4.4.2: Water Quality Analysis: Physical Parameters

Sr. No.	Para-meters	Test Method	Results Water Sampling Locations			Unit	Requirement (Acceptable Limit)	Permissible Limit in absence of alternate sources
			Ground Water (GW1)	Surface Water				
				Neelkanth Garden (SW1)	Lake Water, SG Udyan, Manpada (SW2)			
1.	Colour	IS-3025(P-04)	<5.00	<5.00	<5.00	Hazen Unit	5	15
2.	Odour	IS-3025(P-05)	Agreeable	Agreeable	Agreeable	-	Agreeable	Agreeable
3.	Taste	IS-3025(P-05, P-08)	Agreeable	Agreeable	Agreeable	-	Agreeable	-
4.	Turbidity	IS-3025(P-10)	1.0	1.0	3.0	NTU	1	5
5.	pH Value	IS-3025(P-04)	7.12	7.10	7.89	-	6.5-8.5	-
6.	TDS	IS-3025(P-16)	617	488	1012	mg/l	500	2000

Source: Bioraj Laboratories, Pune

4.4.3.2 Chemical Parameters

Inorganic parameters of ground water viz. total alkalinity, total hardness, chloride (Cl), sulphate (SO₄), and nitrate (NO₃) is found in the range of 190mg/l, 360mg/l, 119.96 mg/l, 52.87mg/l, and 4.28 mg/l respectively. The surface water quality of inorganic parameters in terms of total alkalinity, total hardness, chloride (Cl), sulphate (SO₄), and Nitrate (NO₃) are found in the range of 110-217mg/l, 183-318mg/l, 59.2-96.8 mg/l, 4.1-87.6mg/l, and 2.11-8.12 mg/l respectively. The chemical quality of ground water and surface water were observed to be good when compared with drinking water quality standards except total hardness values are observed higher in (GW1) and surface water (SW2) than the acceptable limits (**Table 4.4.3**).

Table 4.4.3: Water Quality Analysis: Inorganic Parameters (General)

Sr. No.	Parameters	Test Method	Results			Unit	Requirement (Acceptable Limit)	Permissible Limit in absence of alternate sources
			Water Sampling Locations					
			Ground Water (GW1)	Surface Water				
Neelkanth Garden (SW1)	Lake Water, SG Udyan, Manpada (SW2)							
1.	Ammonia (Total)	IS-3025 (P-34)	<0.10	<0.10	<0.10	mg/l	0.5	No Relaxation
2.	Boran (as B)	IS-3025 (P-57)	<0.10	<0.10	<0.10	mg/l	0.5	1.0
3.	Calcium (as Ca)	IS-3025 (P-40)	55.6	24.1	44.1	mg/l	75	200
4.	T. Hardness (as CaCO ₃)	IS-3025 (P-23)	360	183	318	mg/l	200	600
5.	Chloride (as Cl)	IS-3025 (P-32)	119.96	59.2	96.8	mg/l	250	1000
6.	Fluoride (as F)	IS-3025 (P-60)	0.54	0.1	0.5	mg/l	1.0	1.5
7.	Free Residual Chlorine	IS-3025 (P-26)	<0.1	<0.1	<0.1	mg/l	0.2	1.0
8.	Iron (as Fe)	IS-3025 (P-52)	0.12	<0.1	3.92	mg/l	0.3	No Relaxation
9.	Magnesium (as Mg)	IS-3025 (P-46)	21.04	11.4	18.1	mg/l	30	100
10.	Mineral Oil	Clause 6 of IS:3025	<0.50	<0.50	<0.50	mg/l	0.5	No Relaxation
11.	Nitrate (as NO ₃)	IS-3025 (P-34)	4.28	2.11	8.12	mg/l	45	No Relaxation
12.	Sulphate (as SO ₄)	IS-3025 (P-24)	52.87	4.1	87.6	mg/l	200	400
13.	Sulphide (as H ₂ S)	IS-3025 (P-29)	<0.05	<0.50	<0.05	mg/l	0.05	No Relaxation
14.	Alkalinity (as CaCO ₃)	IS-3025 (P-23)	190	110	217	mg/l	200	600
15.	Chloramines (as Cl ₂)	IS-3025 (P-26)	<1.00	<1.00	<1.00	mg/l	4.0	No Relaxation

Source: Bioraj Laboratories, Pune

4.4.3.3 Heavy Metals (Toxic Substances)

The heavy metal of ground water and surface water quality is presented in **Table 4.4.4**. Levels of heavy metals in ground and surface water in terms of copper, Nickel, Chromium, Manganese, Lead, and Zinc found to be less than acceptable limits. The ground and surface water sources in study area showed low concentrations of heavy metals.

Table 4.4.4: Water Quality Analysis: Toxic Substances (Heavy Metals)

Sr. No.	Parameters	Test Method	Results			Unit	Requirement (Acceptable Limit)	Permissible Limit in absence of alternate sources
			Water Sampling Locations					
			Ground Water (GW1)	Surface Water				
			Neelkanth Garden (SW1)	Lake Water, SG Udyan, Manpada (SW2)				
1.	Aluminum (as Al)	IS-3025 (P-55)	<0.01	<0.01	<0.01	mg/l	0.03	0.2
2.	Arsenic (as As)	IS-3025 (P-37)	<0.01	<0.01	<0.01	mg/l	0.01	0.05
3.	Cadmium (as Cd)	IS-3025 (P-41)	<0.001	<0.001	<0.001	mg/l	0.003	No Relaxation
4.	Copper (as Cu)	IS-3025 (P-42)	<0.05	<0.05	<0.05	mg/l	0.05	1.5
5.	Cyanide (as CN)	IS-3025 (P-27)	<0.01	<0.01	<0.01	mg/l	0.05	No Relaxation
6.	Nickel (as Ni)	Annex. J of IS-13428	<0.01	<0.01	<0.01	mg/l	0.02	No Relaxation
7.	Total Chromium (as Cr)	Annex. L of IS-13428	<0.05	<0.05	<0.05	mg/l	0.05	No Relaxation
8.	Manganese (as Mn)	Cluse 35 of IS 3025	<0.01	<0.01	<0.01	mg/l	0.1	0.3
9.	Lead (as Pb)	IS-3025 (P-47)	<0.01	<0.01	<0.01	mg/l	0.01	No Relaxation
10.	Mercury (as Hg)	IS-3025 (P-48)	<0.001	<0.001	<0.001	mg/l	0.001	No Relaxation
11.	Molybdenum (as Mo)	IS-3025 (P-2)	<0.05	<0.05	<0.05	mg/l	0.07	No Relaxation
12.	Silver (as Ag)	Annex. L of IS-13428	<0.05	<0.50	<0.50	mg/l	0.1	No Relaxation
13.	Selenium (as Se)	IS-3025 (P-56)	<0.01	<0.01	<0.01	mg/l	0.01	No Relaxation
14.	Zinc (as Zn)	IS-3025 (P-49)	0.21	0.82	1.83	mg/l	5.0	15

Source: Bioraj Laboratories, Pune

4.4.3.4 Bacteriological Characteristics

Methodology and Analysis: The Coliform group of bacteria is significant as a principal indicator of pollution of water and is also indicative of the sanitary quality. The Coliform group belongs to the family of Enterobacteriaceae and includes all aerobic and facultative anaerobic, gram-positive, nonspore-forming, rod-shaped bacteria that ferment lactose with gas and acid formation within 24 hours at 35°C. For estimation of bacterial counts in water samples, the standard test for the Coliform group was carried out by the Membrane Filter (MF) technique. This technique

involved direct plating for detection and estimation of total Coliform and faecal Coliform densities. The bacteriological quality of surface and ground water quality was assessed by analyzing 3 samples (1 ground water and 2 surface waters). The *E. Coli* and total *Coliform* bacterial density in both ground and surface water was observed to be absent in all the samples analysed required as per IS: 10500:2012 (Table 4.4.5).

Table 4.4.5: Water Quality Analysis: Bacteriological Parameters

Sr. No.	Parameters	Test Method	Results			Required as per IS 10500: 2012
			Water Sampling Locations			
			Ground Water (GW1)	Surface Water		
Neelkanth Garden (SW1)	Lake Water, SG Udyan, Manpada (SW2)					
1.	Eccherichia Coli	IS-1632	Absent	Absent	Absent	Absent / 100ml
2.	Coliform Bacteria	IS-1632	Absent	Absent	Absent	Absent / 100ml

Source: Bioraj Laboratories, Pune

4.4.4 Status of Surface and Ground Water Exploitation

4.4.4.1 Surface Water

These fresh water lakes (Tulsi and Powai) primarily fulfill the water requirement of the southern part of Mumbai. The tunneling will be carried out in the hard rock formations of Kanheri-Tulasi area. The tunnels will be dugout about 20m below ground level (bgl). There are little chances of having substantial aquifer at this level. The Tulsi Lake is about 4.9 km away from the tunnel locations. Tulsi Lake is feeding on surface water collected during monsoon and does not have any impacts on the aquifers of Tulsi Lake water catchment. Considering the above facts, it is very unlikely that the proposed tunnel will have any impacts on the aquifer of Tulsi Lake water catchment.

4.4.4.2 Ground Water

Even though the bore wells drilled in the area by both official and private agencies are in large numbers, no adequate data regarding aerial extent of the aquifer is available. The bore wells in low lying area are affected by saline water whereas in upland areas the quality is potable. The tunneling will be carried out in the hard rock formations of Kanheri and Tulsi area which are 2.5 km and 4.9 km away respectively from the tunnel locations. The tunnels being dug out about 20 m below bgl. There are little chances of having substantial aquifers at that level. The present utilization of ground water resources for the domestic and irrigation requirements is negligible. Considering the above facts, it is very unlikely that the proposed tunnel construction will have any impacts on the aquifer of Tulsi lake water catchment.

4.5 Land Environment

The impacts of any major developmental projects on land environment generally depend on type /category of proposed development. For example, the grass root / green field development requires land acquisition / procurement, site grading /

construction and operation. In such case the impacts on land environment would be in the form of permanent change in land use patterns as well as direct and indirect impacts on surrounding land due to pollution discharge in the form of gases, fugitive emission, liquid and solid wastes as well as subsequent urbanization. Apart from the above, the importance of impacts on land environment also depend on several factors like the project location, land-use / land-cover in surrounding area, ecological or otherwise sensitivity of the surrounding region etc.

The project under study is related to construction of highway tunnel of 10.8 km long passing through underground SGNP from Tikuji-ni-wadi, Thane to Borivali east, Mumbai. Impact on land environment from underground tunnel construction activities could be mainly attributed change in land use pattern (direct/indirect) as well as pollution impacts due to disposal of solids (overburden), hazardous waste and discharge of wastewater either on land (direct impact) or into surface water resources which are also used as irrigation / plantation of water sources (indirect impacts). Moreover, impacts on vegetation are also expected due to fall out of air pollutants in case of excessive emission beyond certain limits. Accordingly, for impact assessment on land component, it is pertinent to study the existing land-use pattern in the project area, soil characteristics and details of waste generation from the project activities including the resulting impacts on soil with respect to land application / disposal of solid hazardous waste and the behavior of the surrounding terrestrial and aquatic environment. The baseline (pre-project) status of land environment has been assessed through reconnaissance in the project area, characterization of soils through field studies. The pre-project status with respect to soil characteristics (Physical and chemical) in the impact zone around the proposed project site for land environment was studied.

4.5.1 Reconnaissance

The project location identified for proposed twin tube, 3 lanes (each side) highway tunnel of about 10.8km passes through below SGNP, connecting Western Express Highway (WEH) near Borivali and Ghodbunder road (of Thane) near Tikuji-ni-wadi. Total lease area consists of 57.02 ha major area of SGNP and Government land.

4.5.2 Baseline Status

Baseline data was collected to assess land-use/land-cover of different areas of villages within the 1 km on either side of the study area of 11.8km length of tunnel development.

4.5.2.1 Collection of Soil and Analysis - Methodology

Total 3 villages (soil sampling points) were identified for existing soil quality assessment. The soil sampling locations in the study area is given in **Table 4.5.1**. Representative soil samples were collected to the depth of (0-15 cm) from the study area for assessing of the physicochemical characteristics of soil. Air dried and sieved soil samples have been used for determination of physico-chemical characteristics and parameter related to agricultural productivity. Soil sampling was carried out by Bioraj Laboratories, Pune.

Table 4.5.1: Soil Sampling Locations (Summer Season, 2021)

Sr. No.	Sampling Location
S1.	Near Neelkanth Garden
S2.	Near SG Udyan, Manpada, Nisarg Parichay Kendra
S3.	Near Koknipada

Source: Bioraj Laboratories, Pune

Standard method has been used for the analysis of soil sample. The International Pipette Method (Balck, 1964) was adopted for determination of particle size analysis. Physical parameters such as bulk density, porosity and water holding capacity were determined by following KR Box Method (Keen and Raczkowski, 1921).

The chemical characteristics of soil were determined by preparing soil extract in distilled water in the ratio of 1:2 (as per Jackson's procedure, 1967). Organic carbon was determined by Walkley and Black Method (1972). Fertility status of soil in terms of available nitrogen was determined nitrogen by Kjeldahl method, available phosphorus was determined by chlorostannous reduced molybdo phosphorous blue colour (Olsen's method, 1954) and available potassium was determined by Flame Photometer method (Jackson M.L., 1967). Heavy metals in soil were determined by extracting soil with concentration HNO₃ and HClO₄ followed by analysis on ICP / (APHA, 1995).

4.5.3 Soil Baseline Status and Interpretations

The physico-chemical, nutrient and heavy metals characteristic of soil is presented in Table 4.5.2.

Table 4.5.2: Results of Soil Analysis

Sr. No.	Parameters	Unit	Soil Analysis Results			Test Method
			Nilkanth Garden (S1)	SG Udyan, Manpada (S2)	Koknipada (S3)	
Physical Parameters						
1.	Bulk Density	kg/cm ³	1.22	1.27	1.32	NTL/STP/SOIL
2.	Porosity	% by mass	42.00	40.00	37.00	NTL/STP/SOIL
3.	Permeability	cm/hr	1.72	1.84	1.10	NTL/STP/SOIL
4.	Water Holding Capacity	%	49.88	53.81	50.14	NTL/STP/SOIL
Chemical Parameters						
5.	pH	-	7.42	7.18	7.05	IS:272(P-26)R2011
6.	Conductivity	μmhos/cm	341	329	382	IS:14767:2000 R 2016
7.	Calcium (as Ca)	mg/kg	110.00	98.10	110.81	NTL/STP/SOIL
8.	Magnesium (as Mg)	mg/kg	38.9	30.2	38.7	NTL/STP/SOIL
9.	Sodium (as Na)	mg/kg	604.5	301.2	362.7	NTL/STP/SOIL
10.	Potassium (as K)	mg/kg	350.6	281.7	292.5	NTL/STP/SOIL
Nutrient Status						
11.	Organic Matter	%	2.15	2.47	2.14	NTL/STP/SOIL
12.	Available Phosphorous (as P)	mg/kg	29.60	12.18	21.66	NTL/STP/SOIL

Sr. No.	Parameters	Unit	Soil Analysis Results			Test Method
			Nilkanth Garden (S1)	SG Udyan, Manpada (S2)	Koknipada (S3)	
13.	TKN	%	0.01	0.01	0.01	NTL/STP/SOIL
14.	Chlorides	mg/kg	290.9	178.3	118.5	NTL/STP/SOIL
Heavy Metals						
15.	Copper (Cu)	mg/kg	6.55	3.16	4.89	NTL/STP/SOIL
16.	Iron (Fe)	mg/kg	5.57	4.16	6.73	NTL/STP/SOIL
17.	Lead (Pb)	mg/kg	0.63	0.41	0.38	NTL/STP/SOIL
18.	Zinc (Zn)	mg/kg	6.2	5.9	7.9	NTL/STP/SOIL
19.	Total Chromium (Cr)	mg/kg	2.6	2.2	2.9	NTL/STP/SOIL
20.	Cadmium (Cd)	mg/kg	0.03	0.06	0.05	NTL/STP/SOIL
21.	Manganese (Mn)	mg/kg	4.27	3.38	5.17	NTL/STP/SOIL

Source: Bioraj Laboratories, Pune

4.5.3.1 Physical Characteristics

Physical characteristics of soil are delineated through specific parameters viz., particle size distribution, bulk density, porosity and water holding capacity. Regular cultivation practices increases the bulk density of the soil thus inducing compaction. This results in reduction in water percolation rate and penetration of root through soil. The bulk density of soil in the region is ranged between 1.22 kg/cm³ to 1.32kg/cm³ and considered as moderately good soil quality. Soil porosity is a measure of air filled pore spaces and gives information about movement of gaseous, inherent moisture and development of root system and strength of soil. The porosity and water holding capacity of soil is in the range of 37.00 to 42.00% by mass. The soil permeability ranges between 1.10 to 1.84 cm/hr. The water holding capacity in the soil ranges between 49.88% and 53.81%.

4.5.3.2 Chemical Characteristics

The soil samples were analyzed for various chemical properties. The parameters selected were pH, Electrical Conductivity, nutrient status, organic carbon content and heavy metals etc. pH is an important parameter indicative of alkaline or acidic in nature of the soil. It greatly affects the microbial population as well as the solubility of metal ions and regulates nutrient availability. The pH of the soil in the study area is observed to be alkaline in reaction ranged from 7.05 - 7.42. The soluble salt was determined from soil extract (1:2) and the soluble salt is expressed in terms of electrical conductivity (EC). The EC of the soil samples are in the range of 329 – 382 µmhos/cm. The important cations present in the soil are calcium and magnesium. It is observed that both calcium and magnesium concentrations are in the range of 198.10 – 110.81 mg/kg and 30.2 – 38.9 mg/kg whereas sodium and potassium are in the range of 301.2 – 604.5 mg/kg and 281.7 – 350.6 mg/kg respectively.

4.5.3.3 Nutrient Status

Organic matter present in soil influences its physical and chemical properties of soil. It commonly accounts as one third or more of cation exchange capacity of the surface soils and is responsible for stability of soil aggregates. Organic carbon and available phosphorous are found to be in the range of 2.14 – 2.47 % and

12.18 – 29.60 mg/kg respectively. These soils are medium level in organic carbon content while poor in available phosphorous content. Similarly, soils are medium fertility level in available phosphorous and available potassium content.

4.5.3.4 Heavy Metals

Plants require some of the heavy metals at microgram levels for their metabolic activities. These some heavy metals are also called as micro-nutrients. Their deficiency becomes a limiting factor. They are held strongly as complex on the surface of clay, alumina silicates, hydrated oxide and humus. In general adsorption increases with pH, heavy metals pollution is serious because it can persist for many decades. The heavy metals also create problems in the nutrient utilization in plant and also marked reduction in chlorophyll content.

Soil samples were also analyzed for heavy metals such as Calcium (Cu), Iron (Fe), Lead (Pb), Zinc (Zn), Chromium (Cr), Cadmium (Cd), and Manganese (Mn). The presence of heavy metals at proper pH enhances the microbial activity in soil. The concentrations of heavy metals found in the study area are observed normal.

4.5.4 Land-use and Land Cover Pattern

The work on building India's longest (10.8 km) highway twin-tunnel connecting Borivali-Thane and passing underneath the Sanjay Gandhi National Park (SGNP).

The study area covers 1 km radius from the tunnel alignment based on coordinates on satellite imagery and determined the study area for the proposed project. The land use and land cover analysis of study area were carried out for the Borivali - Thane Twin tube Tunnel.

Satellite Data

Sentinel-2 Spatial and Temporal Resolutions: Sentinel-2 has had two launches, Sentinel-2A that was launched on 23rd June 2015 and Sentinel-2B on 7th March 2017. Both Sentinel-2A and Sentinel-2B satellites have on board the exact same Multi-Spectral Instrument (MSI) with bands from the visible to the shortwave infrared: four (4) bands at 10m, the classical broadband visible blue (490 nm), green (560 nm), red (665 nm), and near infrared (842 nm); six (6) bands at 20m, four narrow bands in the vegetation red edge spectral domain (705, 740, 775, and 865 nm), and two longer SWIR bands (1610 and 2190 nm); and three (3) bands at 60m dedicated to atmospheric correction (443 nm for aerosols and 940 nm for water vapor) and to cirrus detection (1380 nm). After the second launch the satellite provides higher temporal resolution with a 5-day global revisit frequency, and up to 2-day revisit in top northern and southern parts of the globe.

The study areas were selected to delineate the present overlay of land use / land cover analysis. The various features in the study area were depicted using the satellite imagery of ESA Sentinel 2A. Satellite data downloaded from <https://earthexplorer.usgs.gov/> Satellite specifications and its band characteristics are given in **Table 4.5.3** and **Table 4.5.4** and satellite image showing in **Figure 4.5.2**.

Table 4.5.3: ESA Sentinel 2A Satellite Specifications

Sr. No.	Satellite Specifications	
1.	Satellite Agency	ESA
2.	Platform	Sentinel – 2A
3.	Date of Pass	2020-12-03
4.	Orbits Number	5
5.	Datum	WGS84
6.	Map Projection	UTM
7.	UTM Zone	43N
8.	Spatial Resolution (Meters)	10, 20, 60
9.	Band Nos. (13)	1,2,3,4,5,6,7,8,8A, 9,10,11,12

Source: FAE-LU

Table 4.5.4: ESA Sentinel 2 A Satellite Bands and resolutions of Multi-Spectral Instrument (MSI)

Sentinel-2 bands	Central Wavelength (μm)	Resolution (m)	Bandwidth (nm)
Band 1 – Coastal aerosol	0.443	60	20
Band 2 – Blue	0.490	10	65
Band 3 – Green	0.560	10	35
Band 4 – Red	0.665	10	30
Band 5 – Vegetation red edge	0.705	20	15
Band 6 – Vegetation red edge	0.740	20	15
Band 7 – Vegetation red edge	0.783	20	20
Band 8 – NIR	0.842	10	115
Band 8A – Vegetation red edge	0.865	20	20
Band 9 – Water vapor	0.945	60	20
Band 10 – SWIR – Cirrus	1.375	60	30
Band 11 – SWIR	1.610	20	90
Band 12 – SWIR	2.190	20	180

Source: FAE-LU

Preparation of land use land cover maps of Study Area

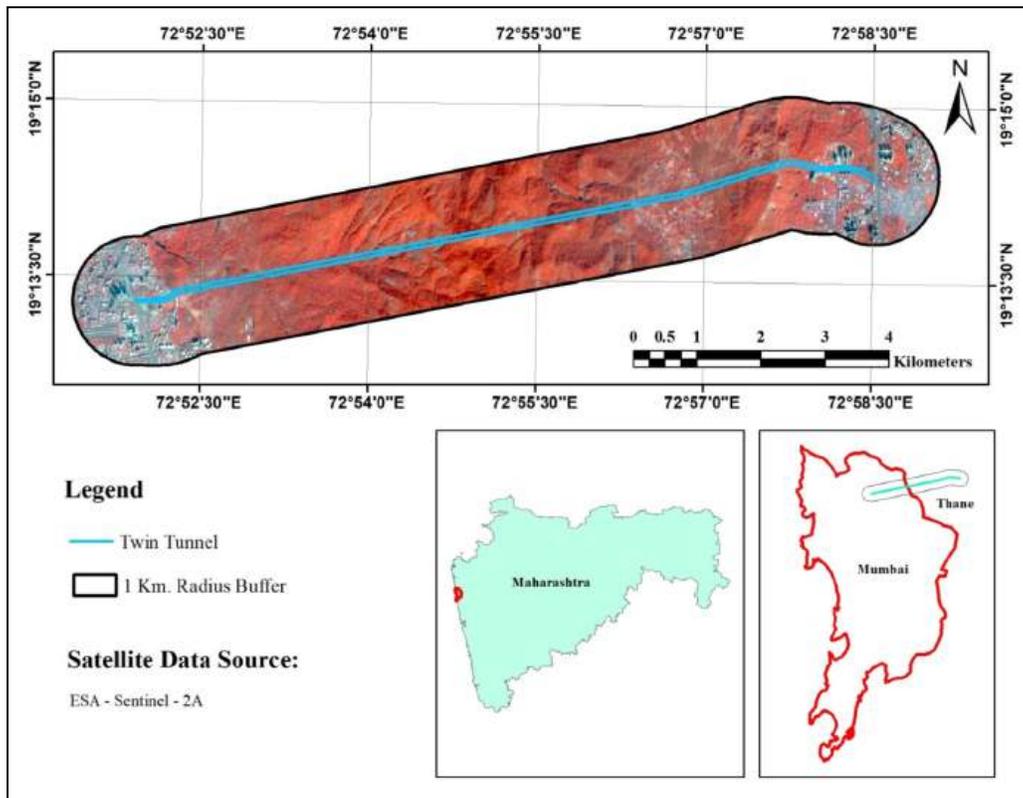
Land use classes can be effectively delineated from the digital remote sensing data. The study revealed that nearly 8.29 km² of the area were covered by built-up area, 9.61 km² of area were covered with open forest, whereas 8.31 km² of area were covered with dense forest, 1.03 km² of the area were covered with waste / barren Land and 0.65 km² of the area were covered with agriculture land. Water body covered with very negligible percent which is 0.01 km².

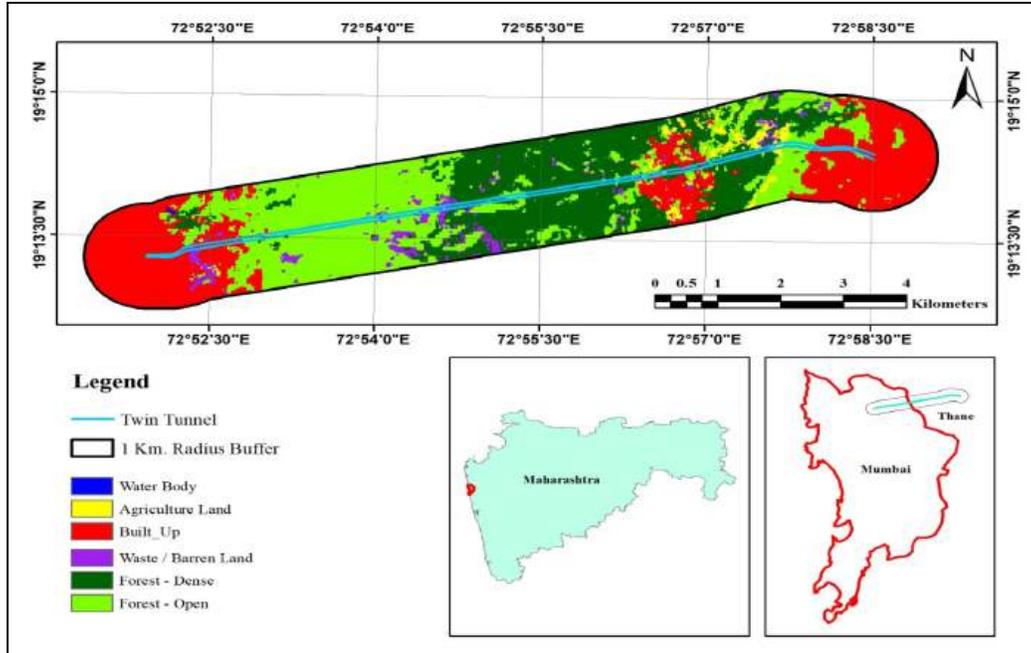
Area under different land use / land covers categories of study area presented in **Table 4.5.5** and shown in **Figure 4.5.3**. The percent land use / land cover category of study area is shown in **Figure 4.5.4**.

Table 4.5.5: Area under different land use/land cover categories of Study Area

Sr. No.	Land Use / Land Cover Classification	Area (ha)	Area (km ²)	Area (%)
1.	Water Body	1.21	0.01	0.043
2.	Agriculture Land	64.51	0.65	2.312
3.	Built Up	828.72	8.29	29.706
4.	Waste / Barren Land	103.36	1.03	3.705
5.	Forest - Dense	830.91	8.31	29.784
6.	Forest - Open	961.04	9.61	34.449
	Total	2789.75	27.90	100

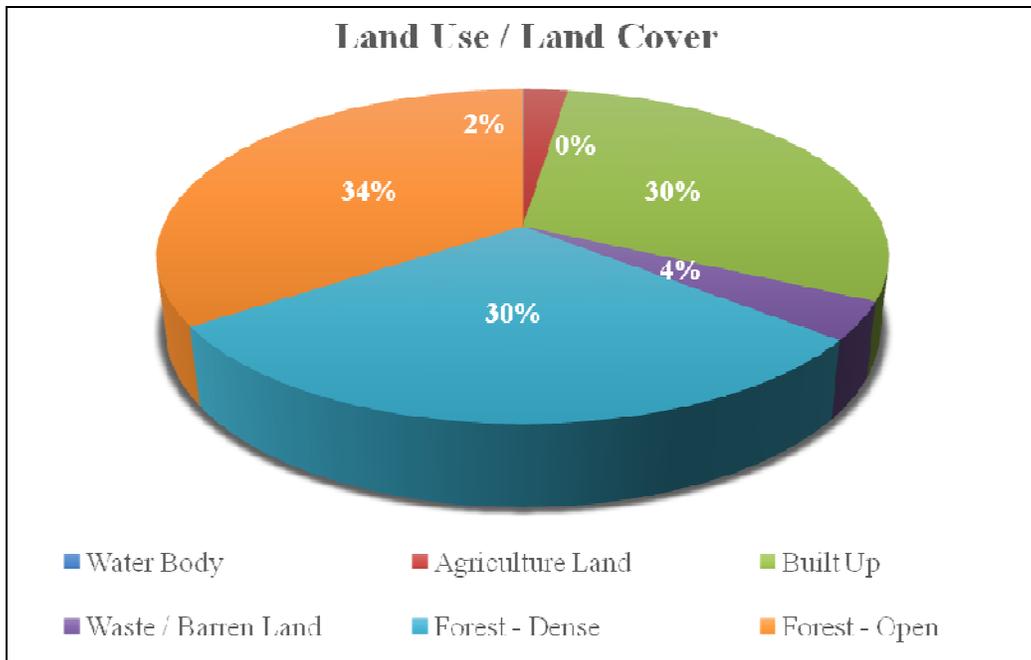
Source: FAE-LU

**Figure 4.5.2: ESA Sentinel 2A Satellite image using for the LU/LC Classification of Study Area**



Source: FAE-LU

Figure 4.5.3: Land Use / Land Cover Classification around 1km Radius Study Area



Source: FAE-LU

Figure 4.5.4: Percent land use/land cover categories of study area

4.6 Biological Environment

Flora basically the plant and fauna the animal life that is present in a particular region or habitat or at a particular time. Flora and fauna forms a major part of biodiversity. In the last few decades we saw a steady increase in the extinction rate of flora and fauna. Therefore, conservation of biological biodiversity is of paramount importance to the survival of man and to preserve the continuity of food chains. Biodiversity sustains human livelihoods and life itself.

Study of biological environment is one of the most important aspects in EIA studies in view of the need for conservation of environmental quality and biodiversity. Biodiversity makes up the structure of the ecosystems and habitats that supports essential living resources, including wildlife, fisheries and forests.

Earlier conservation law comes from India in the 3rd century BC when Emperor Samrat Asoka wrote the fifth pillar edict forbidding the slaughter of certain wildlife in the forest. Around 10% of the country still has forest cover only and 4% is protected within National Parks and similar Reserves. Article 48-A of the constitution of India, specify “The state shall endeavor to protect and improve the environment and to safeguard the forest and wildlife of the country”, whereas Article 51-A (g) state that “It shall be the duty of every citizens of India, to protect and improve the natural environment including forest, lake, river, wildlife and to have compassion for living creatures”. These laws are strengthened by judicial interpretation of Article 21.

The protection of biodiversity and environment is vital for sustainable human development. Classification of flora and fauna has been made as per Schedule given in the Wildlife (Protection) Act, 1972. Today it is a well known fact that climate change, deforestation, drought and other natural calamities are induced by the destruction of natural resources. A change in the composition of biotic communities is reflected by a change in the distribution pattern, density, frequency, dominance and abundance of natural species of flora and fauna existing in the ecosystem. The sensitivity of animals and plant species to the change occurring in their existing ecosystem can therefore be used for monitoring environmental Impact Assessment (EIA) studies of any project or activities. Studies on biological aspects of ecosystems are very important in EIA for the safety of natural flora and fauna. The change in biotic community is studied by the pattern in the distribution, abundance and diversity. In this regard, the baseline condition of the study area needs to be studied for an EIA project.

4.6.1 Objectives of the Ecological and Biodiversity

The main objective of the ecology and biodiversity under environmental biology are as under:

- ∞ To assess the vegetation type, identify the flora and fauna, rare and endangered species (if any) and evaluate the impact of the proposed project activities on these biodiversity.
- ∞ To prepare the list of flora and fauna of the study area along with classification for fauna as per schedule given in the Wildlife (Protection) Act, 1972.

- ∞ To identify the issues/impacts and suggestion for mitigation measures to minimize adverse environmental impacts.
- ∞ To prepare a comprehensive conservation plan for the endangered / economically important biotic species found in the study area.

4.6.2 Study Area

The project area falls within Sanjay Gandhi National Park and its ECO Sensitive Zone. There are other protected areas (Tungareswar National Park and Thane Creek Flamingo Sanctuary), water-bodies, and small lakes located within 15 km boundary from the alignment.

4.6.3 Reconnaissance

An environmental study for the project area has been carried out in accordance with the requirements of the Government of India guidelines for Rail/Road/highway/tunnel projects. For the purpose of environment study a corridor up to 1km on either side of the project road has been studied based on the selection of objectives and guidelines for preliminary environmental examination (PEE). The detailed information about this region was collected from various government offices, project authority, etc. The secondary data related to this region were also obtained from forest department of State Forest Division, Borivali, Mumbai. The biological environment includes mainly terrestrial and aquatic ecosystems. The sensitivity of animal and plant species to the change occurring in their existing ecosystem can therefore be used for EIA studies. The biological sampling locations were made with reference to topography, land use, and vegetation pattern.

4.6.4 Forest and Forest Types of the Study Area

The bio-geographic classification developed by the WII Dehradun has recognized 10 broad bio-geographical zones of India. Within these zones there are 25 biotic provinces. SGNP division belongs to 5 A - Malabar Plains. The present coverage of Malabar plains by protected areas in India is only 0.4 % against the proposed area of 1.1 % by Wildlife Institute of India, Dehradun in 1988. According to the revised classification of forest types of India by Champion and Seth, the forests of SGNP division represent the following four types of Forests:

- ∞ 3 B/C1 Southern moist teak bearing forests
- ∞ 3 B/C2 Southern moist mixed deciduous forests
- ∞ 4 B/TS1 Mangrove scrubs
- ∞ 8 A/C2 Western sub-tropical hill forests

(a) 3 B/C1 Southern Moist Teak Bearing Forests

The moist teak bearing forests constitutes 3-5 % of the total area of National Park. These forests exist where the soil condition is relatively better. Density is generally above 0.4 - 0.7. The forests are mostly concentrated in Yeur and Ghodbander rounds. Earlier Nagla block had vast areas under teak forest but teak has been almost wiped out from this area due to illicit cutting.



3B/C1 Southern Moist Teak Bearing Forests (Yeur)

(b) 3 B/C2 Southern Moist Mixed Deciduous Forest

The Southern moist mixed deciduous forests are profusely found in the study area. Teak is occasionally found in low proportions. The density varies from 0.4 - 0.7. Clumps of Manvel Bamboo (*Dendrocalamus strictus*) and Katas Bamboo (*Bambusa arundinacea*) are found in the area. This forest type covers major part of the division. The semi- evergreen species found in this forest type are Mango, Lokhandi, Shendri, Koshimb and Ashok, though Ashok is mostly localized along the stream courses in Kanheri, Chene and Krishnagiri Upvan Forests. The soil is deep, loamy and generally rich in humus content.



B/C2: Southern Moist Mixed Deciduous Forest

(c) 4B/TS1 Mangrove Scrubs

The coastal line of Maharashtra is about 720 km (NIO-GOA, 1998) and numerous river mouths, creeks, small bays, headlands, cliffs etc indent it. Bassein creek is one of the 37 stations which were surveyed by NIO for the floral and faunal diversity. Bassein creek is the longest creek with 41km length. However, only 23% area i.e. approximately 2000 ha has mangrove coverage. This creek passes through SGNP. The extent of mangrove forests included within the boundaries of this area is now precisely known. *Avicenna marina* is dominating the vegetation. At present SGNP have about 40 ha of mangrove forests.



Mangrove Scrubs

(d) 8A/C2 Western Sub-tropical Hill Forest

These are few remnant patches of natural forests of higher elevations that occur on low lying hills (Bio-diversity of the Western Ghats, 1997). The western sub-tropical hill forests are found in very small patches at high altitude. Density is around 0.6. It is semi-evergreen type of forest with many evergreen species present in the forest area. The floristic includes climbers, orchids and ferns. *Mangifera indica* (Mango), *Pongamia pinnata* (Karanj), *Gardcinia indica* (Kokam), *Syzygium cuminii* (Jambul), *Calophyllum inophyllum* (Undi), *Sideroxylon tomentosum* (Kate-Kumbal), *Ixora* (Lokhandi), *Murraya paniculata* (Pandari). *Garcinia* are located on the way to highest point above Kanheri Forests.



8A/C2 Western Sub-tropical Hill Forest

4.6.5 Sampling Locations

Selection of sampling locations has been made with reference to topography, land-use and vegetation pattern. Total 7 sampling locations were selected for the study on biological survey. Sampling locations selected for biological survey are given in **Table 4.6.1**.

Table 4.6.1. Biological Sampling Location (SGNP)

	Village Name
EB1.	Start Point of Twin Tunnel (Borivali Ea
EB2.	Koknipada
EB3.	Yoor
EB4.	Magathane
EB5.	Manpada
EB6.	Patlipada
EB7.	End point of Tunnel (Tikujiniwadi) Tha

Source: FAE-EB

4.6.6 Survey Methodology

A floral study was conducted in study area in and around the tunnel site. Sampling locations were randomly selected assuming that predominant plants are randomly distributed. The structure and composition of vegetation cover was studied by using phyto-sociological methods to analyze and estimate biodiversity, density, dominance and frequency of different members of plant population. The density and diversity was calculated by using quadrat method. It may be single sample plot or may be divided into several subplots. Quadrat size of 1m x 1m, 5m x 5m and 10m x 10m were taken for herbs, shrubs and trees respectively. The count of individuals of each species and the total count of individuals of all species per plot, the basal area are the major parameters in this study. The derived parameters i.e. frequency, density, abundance, important value Index (IVI), Simpson's Diversity Index (SDI) gives a clear picture of community structure in quantitative terms. The values of a parameter as estimated from the representative samples are the estimate which is close to the real value. The specific parameters in the study of biological environment are biological characteristics through quadrat method (Rau and Wooten, 1980). A formula for analyzing phyto-sociological characteristics of vegetation is presented as below:

$$\text{Density} = \frac{\text{Number of individuals of species A}}{\text{Area Sampled}}$$

$$\text{Relative Density} = \frac{\text{Density of species A}}{\text{Total density of all species}} \times 100$$

$$\text{Dominance} = \frac{\text{Total cover of basal area of species A}}{\text{Area sampled}}$$

$$\text{Relative Dominance} = \frac{\text{Domiance of species A}}{\text{Total density of all species}} \times 100$$

$$\text{Frequency} = \frac{\text{Number of plots in which species A occurs}}{\text{Total Number of Plots Sampled}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency value of species A}}{\text{Total frequency values of all species}} \times 100$$

$$\text{Importance Value Index} = \frac{\text{R.Density} + \text{R.Domiance} + \text{R.Frequency}}{3}$$

$$\text{Simpson's Diversity Index} = \frac{1}{\sum_{i=1}^n \frac{ni(ni-1)}{n(n-1)}}$$

Where;

ni - is the number of individuals of the *i*th species in the sample and

n - is the total number of individuals in the sample Ranges of SDI plant diversity

<0.060: very good biodiversity; 0.060 - 0.100: good biodiversity;

0.110 – 0.200: medium biodiversity; > 0.200 – 1.0: low biodiversity

4.6.7 Floral Biodiversity

To characterize vegetation in the study area, the primary data was collected and analyzed for describing the characteristics of vegetation with reference to species composition and structural attributes. The diversity measurement reflect as to how many diverse species are present, the density measurement indicate number of individuals of a species.

The proposed project site is located in Sanjay Gandhi National Park (SGNP), between Thane and Borivali (Mumbai) and land located within dense forest area. There is large number of natural vegetation in the study area. The Sanjay Gandhi National Park is said to be the lungs of the city as it purifies much of the air pollution of the city. The list of plant species recorded along with IUCN category from Forest Working Plan of Borivali, Mumbai depicted in **Table 4.6.2**.

Table 4.6.2: List of Plant Species (Flora) in the Study Area (SGNP)

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
(A)	Trees			
1.	<i>Acacia arabica</i>	Babul	Mimosaceae	EN
2.	<i>Acacia catechu</i>	Khair	Fabaceae	-
3.	<i>Acacia suma</i>	Shenkhair	Fabaceae	-
4.	<i>Acacia ferruginea</i>	Pandhra Khair	Fabaceae	VU
5.	<i>Adansonia digitata</i>	Gorakh Chinch	Malvaceae	EN
6.	<i>Adina cardifolia</i>	Haldu	Rubiaceae	-
7.	<i>Aegle marmelos</i>	Bel	Rutaceae	-
8.	<i>Aflantia racemosa</i>	Ranilimbu	Rutaceae	-
9.	<i>Albizia procera</i>	Kinhai, Silk plant	Fabaceae	LC
10.	<i>Albizia lebbek</i>	Siris, Sankesar	Fabaceae	LC
11.	<i>Albezzia odoratissima</i>	Chinchona, Kali Siris	Fabaceae	LC
12.	<i>Albizzia chinensis</i>	Pharadi	Fabaceae	LC
13.	<i>Annona squamosa</i>	Sitaphal	Annonacea	-
14.	<i>Annona raticulata</i>	Ramphal	Annonacea	-
15.	<i>Anocardium occidentale</i>	Kaju/Cashew nuts	Anacardiaceae	-
16.	<i>Anogiessus latifolia</i>	Dhawada	Combretaceae	-
17.	<i>Azadirachata indica</i>	Kaduneem	Meliaceae	-

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
18.	<i>Borassus flabellifer</i>	Tad	Arecaeae	-
19.	<i>Barringtonia acutanguta</i>	Nivar/ Samudra phal	Lecythidaceae	-
20.	<i>Bauhanania lanzam</i>	Charoli/Char	Anacardiaceae	-
21.	<i>Bauhinia racemosa</i>	Apta	Rubiaceae	-
22.	<i>Bauhinia malabarica</i>	Ambotha	Caesalpiniaceae	-
23.	<i>Bauhinia variegata</i>	Kanchan	Fabaceae	-
24.	<i>Bombax malabaricum</i>	Sewar, Kateshevry	Malvaceae	-
25.	<i>Bridelia retusa</i>	Asana, katak	Phyllanthaceae	VU
26.	<i>Bridelia vahlii</i>	Mahul	Phyllanthaceae	LC
27.	<i>Butea monosperma</i>	Palas	Fabaceae	CR
28.	<i>Calophyllum inophyllum</i>	Undi	Calophyllaceae	LC
29.	<i>Careya arborea</i>	Kumbha	Lycethidaceae	VU
30.	<i>Casuerina equisetifolia</i>	Suru	Casuarinaceae	VU
31.	<i>Cassia fistula</i>	Bahuwa/Amaltas	Fabaceae	-
32.	<i>Cordia myxa</i>	Bhokar	Boraginaceae	-
33.	<i>Cordia macleodii</i>	Dharwas (Dahivel)	Boraginaceae	VU
34.	<i>Cocos nucifera</i>	Naral	Arecaeae	-
35.	<i>Cyperus spp.</i>	Motha	Cyperaceae	LC
36.	<i>Dalbergia latifolia</i>	Shisam	Fabaceae	VU
37.	<i>Dalbergia paniculata</i>	Dhobin	Fabaceae	-
38.	<i>Dalbergia Sisoo</i>	Shisoo	Fabaceae	LC
39.	<i>Delonix regia</i>	Gulmohar	Fabaceae	LC
40.	<i>Diospyros malanoxylon</i>	Tendu	Ebenaceae	-
41.	<i>Dillenia pentagyna</i>	Karambel	Dilleniaceae	-
42.	<i>Dolichandrone falcata</i>	Medsingi	Boraginaceae	-
43.	<i>Erythrina india</i>	Pangara	Fabaceae	-
44.	<i>Ehretia laevis</i>	Daterang	Boraginaceae	-
45.	<i>Euphorbia parviflora</i>	Newali, Thor	Euphorbiaceae	-
46.	<i>Excoecaria agallocha</i>	Phungoli	Euphorbiaceae	-
47.	<i>Emblica officinalis</i>	Awala	Phyllanthaceae	-
48.	<i>Elaeodendron glaucum</i>	Jamrasi	Celastraceae	-
49.	<i>Fiscus arnottiana</i>	Payer	Moraceae	-
50.	<i>Ficus tsiela</i>	Piper	Moraceae	-
51.	<i>Ficus bengalensis</i>	Wad	Moraceae	-
52.	<i>Ficus mysorensis</i>	Bhurwad	Moraceae	-
53.	<i>Ficus religiosa</i>	Pimpal	Moraceae	-
54.	<i>Ficus elastic</i>	Indian Caoutchuc tree	Moraceae	-
55.	<i>Ficus hispida</i>	Kala Umber	Moraceae	-
56.	<i>Ficus glornerata</i>	Ubber	Moraceae	-
57.	<i>Ficus asperrima</i>	Kharwat	Moraceae	-
58.	<i>Ficus retusa</i>	Nandruk	Moraceae	-

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
59.	<i>Ficus heterophylla</i>	Datir	Moraceae	-
60.	<i>Flacourtia montana</i>	Attak, Champer	Salicaceae	-
61.	<i>Feronia elephantum</i>	Kawath	Rutaceae	-
62.	<i>Garcinia indica</i>	Kokarn	Clusiaceae	VU
63.	<i>Garuga pinnata</i>	Kakad	Burseraceae	-
64.	<i>Grewia colimnaria Columaris</i>	Kala Dhaman	Tiliaceae	-
65.	<i>Grewia tiliaefolia</i>	Dhaman	Tiliaceae	-
66.	<i>Gardenia latifolia</i>	Ghogari	Rubiaceae	EN
67.	<i>Gmelina arborea</i>	Shivan	Lamiaceae	-
68.	<i>Glycosmis pentaphylla</i>	Kirmira	Rutaceae	-
69.	<i>Heterophragma quadriloculare</i>	Warus, Panlag	Bignoniaceae	-
70.	<i>Holoptelea integrifolia</i>	Vavla, Papra	Ulmaceae	-
71.	<i>Holarrhena antidysenterica</i>	Kutaja	Apocynaceae	-
72.	<i>Hymenodictyon excelsum</i>	Potur	Rubiaceae	-
73.	<i>Ixora arborea</i>	Kotagandhal	Rubiaceae	-
74.	<i>Ixora nigricans</i>	Lokhandi	Rubiaceae	-
75.	<i>Ixora Parviflora</i>	Lokhandi	Rubiaceae	-
76.	<i>Jatropha curcas</i>	Mogli, Erandi	Euphorbiaceae	-
77.	<i>Kydia calycina</i>	Arango	Malvaceae	-
78.	<i>Lannea grandis</i>	Shemat	Anacardiaceae	-
79.	<i>Lagerstroemia parviflora</i>	Bondara	Lythraceae	-
80.	<i>Lagerstroemia Lanceota</i>	Lanci	Lythraceae	-
81.	<i>Macaranga peltata</i>	Chandodo	Euphorbiaceae	-
82.	<i>Madhuca indica</i>	Mohwa	Sapotaceae	-
83.	<i>Mallotus Phillipensis</i>	Kamela, Kunku	Euphorbiaceae	-
84.	<i>Mamecyclon edule</i>	Anjani	Melastomataceae	-
85.	<i>Mangifera indica</i>	Amba	Anacardiaceae	-
86.	<i>Manilkara hexandra</i>	Ahmedabadi hewa	Sapotaceae	-
87.	<i>Melia dubia</i>	Bakan	Meliaceae	-
88.	<i>Mimusops elengi</i>	Bakul	Sapotaceae	-
89.	<i>Manilkara hexandra</i>	Bakul	Sapotaceae	-
90.	<i>Murraya koenigli</i>	Kadulimb	Rutaceae	-
91.	<i>Mitragyna parvifolia</i>	Kalam	Rubiaceae	-
92.	<i>Morinda tinctoria</i>	Shevga	Rubiaceae	VU
93.	<i>Murraya exotica</i>	Pandhari	Rutaceae	-
94.	<i>Nyctanthes arbortristis</i>	Parijatak	Oleaceae	-
95.	<i>Ochrocarpus longifolius</i>	Surangi	Calophyllaceae	-
96.	<i>Olea dioica</i>	Par-jambhul	Oleaceae	-
97.	<i>Oroxylum indicum</i>	Tetav	Bignoniaceae	-
98.	<i>Ougenia oojainensis dalbergioides</i>	Tiwas	Fabaceae	-

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
99.	<i>Parkinsonia acutangula</i>	Vedi-Bhabul	Fabaceae	-
100.	<i>Phoenixsylvestris</i>	Shindi	Arecaceae	-
101.	<i>Pongamia Pinnata</i>	Karanj	Fabaceae	-
102.	<i>Ptrocarpus marsupium</i>	Bibla	Fabaceae	EN
103.	<i>Pterospermum suberifolium</i>	Konak Champha	Malvaceae	-
104.	<i>Randia dumetorum</i>	Gela	Rubiaceae	-
105.	<i>Ricinuscommunis</i>	Erandi	Euphorbiaceae	-
106.	<i>Saccopetalum tomentosum</i>	Humb	Annonaceae	-
107.	<i>Salvadora persica</i>	Khokan	Salvadoraceae	-
108.	<i>Sapindus trifoliatus</i>	Ritha	Sapindaceae	-
109.	<i>Schleichera oleosa</i>	Kusum	Sapindaceae	LC
110.	<i>Semecarpus anacardium</i>	Biba	Anacardiaceae	-
111.	<i>Sideroxylon tomentosum</i>	KateKumbhal	Sapotaceae	-
112.	<i>Spondias magnifera</i>	Ambada	Anacardiaceae	-
113.	<i>Streblus asper</i>	Kharota	Moraceae	-
114.	<i>Sterculia colorata</i>	Khovas	Malvaceae	-
115.	<i>Sterculia urens urens</i>	Kadhari	Malvaceae	-
116.	<i>Sterculia guttata</i>	kukeri	Malvaceae	-
117.	<i>Stereospermum personatum</i>	Padal	Bignoniaceae	-
118.	<i>Syzygium cumini</i>	Jambhul	Myrtaceae	-
119.	<i>Sesbania grandiflora</i>	Agasta	Fabaceae	-
120.	<i>Tamarindus indica</i>	Chinch	Fabaceae	-
121.	<i>Tectona grandis</i>	Sagwan	Lamiaceae	-
122.	<i>Terminalia bellerica</i>	Behada	Combretaceae	-
123.	<i>Terminalia chebula</i>	Hirda	Combretaceae	-
124.	<i>Terminalia tomentosa</i>	Ain, Sadada	Combretaceae	-
125.	<i>Terminalia arjuna</i>	Arjun	Combretaceae	-
126.	<i>Thespesia populnea</i>	Ran-bhendi	Malvaceae	-
127.	<i>Trawia Polycarpa</i>	Petari	Euphorbiaceae	-
128.	<i>Trema orientalis</i>	Ran-ambada, Korgol	Cannabaceae	-
129.	<i>Vengueria spinosa</i>	Alu	Rubiaceae	-
130.	<i>Wrightia tinctoria</i>	Dudhi	Apocynaceae	-
131.	<i>Xylia xylocarpa dolabriformis</i>	Jambu	Fabaceae	-
132.	<i>Ziziphus jujuba</i>	Bor	Rhamnaceae	-
133.	<i>Ziziphus xylopyrus</i>	Ghatbor	Rhamnaceae	-
(B)	Shrubs			
134.	<i>Acacia Pinnata</i>	Shambati	Fabaceae	-
135.	<i>Acacia concinna</i>	Shikekai	Fabaceae	DD
136.	<i>Adhatoda vasica</i>	Adulsa	Acanthaceae	-
137.	<i>Asparagus recemosus</i>	Shatawari	Asparagaceae	-

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
138.	<i>Amorphophallus campanulatus</i>	Elephant Yam	Araceae	LC
139.	<i>Bambusa arundinacea</i>	Bamboo	Poaceae	-
140.	<i>Barleria prionitis</i>	Koranti	Acanthaceae	-
141.	<i>Capparis spinosa</i>	Waghata	Capparaceae	-
142.	<i>Capparis zeylanica</i>	Waghata	Capparaceae	-
143.	<i>Calotropis gigantea</i>	Rui	Apocyanaceae	-
144.	<i>Calycopteris floribunda</i>	Ukshi	Combretaceae	-
145.	<i>Carissa carandas</i>	Karwand	Apocyanaceae	-
146.	<i>Clerodendron inermis</i>	Koyanel	Lamiaceae	EN
147.	<i>Crotalaria retusa</i>	Ghogali	Fabaceae	-
148.	<i>Erythropsis calorata</i>	Khavas	Malvaceae	-
149.	<i>Euphorbia nerifolia</i>	Nivdung	Euphorbiaceae	-
150.	<i>Helicteres isora</i>	Murudsheng	Malvaceae	VU
151.	<i>Ixora parviflora</i>	Bokars	Rubiaceae	-
152.	<i>Jasminum pubescens</i>	Ranmogra, Ranjai	Oleaceae	-
153.	<i>Jatropha curcus</i>	Chandrajyot	Euphorbiaceae	-
154.	<i>Kirganolis reticulata</i>	Pavan	Euphorbiaceae	-
155.	<i>Leea edgeworthii</i>	Dina	Vitaceae	-
156.	<i>Lawsonia inermis</i>	Mendi	Lythraceae	-
157.	<i>Lepidagathis cristata</i>	Kumbhi	Acanthaceae	-
158.	<i>Lantana camera</i>	Ghaneri	verbenaceae	-
159.	<i>Lantana alba</i>	Gultora	verbenaceae	-
160.	<i>Microcos paniculata</i>	Shetali	Malvaceae	-
161.	<i>Mayenia arecta</i>	Alu	Acanthaceae	-
162.	<i>Moghania strobelifera</i>	Konfuti	Fabaceae	-
163.	<i>Nerium indicum</i>	Ran Kanher	Apocyanaceae	LC
164.	<i>Opuntia dillenii</i>	Nivdung	Cactaceae	-
165.	<i>Ocimum canum</i>	Ran-Tulas	Lamiaceae	-
166.	<i>Pogostemon bengalensis</i>	Pangali		-
167.	<i>Strobilanthes callosus</i>	Karvi	Acanthaceae	-
168.	<i>Solanum indicum</i>	Bhui, Ringani	Solanaceae	-
169.	<i>Vitex negundo</i>	Nirgudi	Lamiaceae	-
170.	<i>Woodfordia floribunda</i>	Dhayati	Lythraceae	LC
171.	<i>Zizyphus cenoplia</i>	Makor	Rhamnaceae	-
(C)	Herbs			
172.	<i>Agave americana</i>	Ghaypat	Asparagaceae	-
173.	<i>Argemone maxicana</i>	Pivla Dhotra	Papaveraceae	-
174.	<i>Abutilon indicum</i>	Mudra	Malvaceae	-
175.	<i>Aeschynomene indica</i>	Silar	Fabaceae	LC
176.	<i>Alysi carpus rugosus</i>	Boker	Fabaceae	-
177.	<i>Ammania beccifera</i>	Bhar Jambhul	Lythraceae	LC
178.	<i>Ammania multiflora</i>	-	Lythraceae	LC

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
179.	<i>Anosomeles indica</i>	-	Lamiaceae	-
180.	<i>Achyranthes aspera</i>	Aghada	Amaranthaceae	LC
181.	<i>Alternanthera sessilis</i>	Kanchari	Amaranthaceae	LC
182.	<i>Amaranthus spinosus</i>	Kate-math	Amaranthaceae	-
183.	<i>Biophytam sensitivam</i>		Oxalidaceae	-
184.	<i>Begonia crenota</i>		Begoniaceae	-
185.	<i>Bidens biternata</i>		Asteraceae	-
186.	<i>Blumea laciniata</i>	Burada	Asteraceae	-
187.	<i>Blepharis asperrima</i>		Acanthaceae	-
188.	<i>Carchorus capsularis</i>		Malvaceae	-
189.	<i>Carchorus aestuans</i>		Tilaceae	-
190.	<i>Carchorus olitorius</i>	Jute	Malvaceae	-
191.	<i>Cardiospermum helicacabum</i>	Capsihodi	Sapindaceae	-
192.	<i>Cassia tora</i>	Tarota, Takla	Fabaceae	-
193.	<i>Caesulia axillaris</i>	Maka	Asteraceae	LC
194.	<i>Centalla asiatica</i>		Apiaceae	-
195.	<i>Centratherum anthelminticum</i>	Kali Jeeri	Asteraceae	-
196.	<i>Centarium centauroides</i>		Gentianaceae	-
197.	<i>Coldenia procumbens</i>		Boraginaceae	-
198.	<i>Commelina benghalensis</i>	Kena	Commelinaceae	-
199.	<i>Commelina obliqua</i>	Kena	Commelinaceae	-
200.	<i>Crotalaria juncea</i>	Taag	Fabaceae	-
201.	<i>Curcuma aromatic</i>	Jungli Halad	Zingiberaceae	EN
202.	<i>Desmodium triflorum</i>	Ran-Methi	Fabaceae	-
203.	<i>Dinebra retroflexa</i>	Kardi	Poaceae	-
204.	<i>Datura Kutal</i>	Dhotra	Solanaideae	-
205.	<i>Digera muricata</i>	Tondullira	Amaranthaceae	-
206.	<i>Dioscorea bulbifera</i>		Dioscoreaceae	-
207.	<i>Dioscorea pentaphylla</i>	Babra	Dioscoreaceae	-
208.	<i>Eclipta alba</i>	Maka	Asteraceae	-
209.	<i>Elephantopus scaber</i>		Asteraceae	-
210.	<i>Evolvulus alsinoides</i>	Shankavali	Convolvulaceae	-
211.	<i>Euphorbia nuda</i>	Dudhi	Orchidaceae	NT
212.	<i>Grangea maderaspatana</i>		Asteraceae	LC
213.	<i>Haplanthus tentaculatus</i>		Acanthaceae	-
214.	<i>Helianthus Spp.</i>	Suryaphul	Asteraceae	-
215.	<i>Hemidesmus indicus</i>	Anant-Mul	Apocynaceae	-
216.	<i>Hemigraphis latebrosa</i>		Acanthanaceae	-
217.	<i>Hoppes dichotoma</i>		Gentianaceae	-
218.	<i>Holiotropium indicum</i>	Bhurundi	Boraginaceae	LC
119.	<i>Hygrophila serpyllum</i>	Ran tewar	Acanthaceae	-
220.	<i>Indigofera astragalina</i>	Ranmethi, Phulizadi	Fabaceae	-

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
221.	<i>Impatiens balsamina</i>	Terdi	Balsaminaceae	-
222.	<i>Jussiaea suffruticosa</i>	Ban (Jangli) Lavang	Onagraceae	-
223.	<i>Justicia simplex</i>	Sokamble Zara	Acanthaceae	-
224.	<i>Leea macrophylla</i>	Dindi	Vitaceae	-
225.	<i>Leucas aspera</i>		Lamiaceae	-
226.	<i>Limnophila indica</i>		Plantaginaceae	-
227.	<i>Lindernia ciliate</i>		Linderniaceae	-
228.	<i>Malachara rotundifolia</i>	Ran Bhendi	Malvaceae	-
229.	<i>Melochia corchorifolia</i>	Methuri	Malvaceae	-
230.	<i>Mollugo pentaphylla</i>	Jharasi	Molluginaceae	-
231.	<i>Musa rosacea</i>	Jungli-kela	Musaceae	EN
232.	<i>Oxalis latifolia</i>	<i>Khatta Zara</i>	Oxalidaceae	-
233.	<i>Oldenlandia corymbosa</i>	Bit Popda	Rubiaceae	-
234.	<i>Pavetta indica</i>	Papadi	Rubiaceae	-
235.	<i>Peristrophe bicalyculata</i>		Acanthaceae	-
236.	<i>Phaseolus radiates</i>	Mug, Moong	Fabaceae	-
237.	<i>Phaseolus trilobus</i>		Fabaceae	-
238.	<i>Phyla nodiflora</i>		Verbenaceae	LC
239.	<i>Phyllanthus niruri</i>	Ran-Aoli	Phyllanthaceae	-
240.	<i>Physalis minirna</i>	Ran Popti	Phyllanthaceae	-
241.	<i>Plumbago zeylanica</i>	Shritrak	Plumbaginaceae	-
242.	<i>Polygonum glabrum</i>	Dongra	Polygonaceae	-
243.	<i>Portulaca oleracea</i>	Ghala	Polygonaceae	-
244.	<i>Sida acuta</i>	Jungli Methi	Malvaceae	-
245.	<i>Sida retusa</i>	Atibala	Malvaceae	-
246.	<i>Smithia (Smithea) hirsuta</i>		Fabaceae	-
247.	<i>Smithia (Smithea) sensitive</i>		Fabaceae	-
248.	<i>Sphaeranthus indicus</i>	Gorkmundi	Asteraceae	-
249.	<i>Solanum xanthocarpum</i>	Bhuivangani	Solanaceae	-
250.	<i>Sesamum indicum</i>	Til	Solanaceae	-
251.	<i>Stachytarpheta indica</i>	Tulsi Zara	Verbenaceae	-
252.	<i>Strychnos nuxvomica</i>	Kuchla	Loganiaceae	-
253.	<i>Scilla indica</i>		Asparagaceae	-
254.	<i>Tephrosia purpurea</i>	Sai-pMukhc	Fabaceae	-
255.	<i>Trichodesma indicum</i>	Ghotakalpa	Boraginoideae	-
256.	<i>Tridax procumbens</i>	Degadipola	Asteraceae	-
257.	<i>Triumfetta annua angulata</i>		Malvaceae	-
258.	<i>Triumfetta pilosa</i>		Malvaceae	-
259.	<i>Urena lobata</i>	Jai-Jaitang	Malvaceae	-
260.	<i>Vernonia cineria (cinerea)</i>	Sahadevi	Asteraceae	NT
261.	<i>Waltheria indica</i>	Hierba de	Malvaceae	LC

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
		soldado		
262.	<i>Woodfordia floribunda</i>	Dhaiti	Lythraceae	LC
263	<i>Xanthium Strumarium</i>	Ghokhru	Asteraceae	
(D)	Grasses			
264	<i>Andropogon triticus</i>	<i>Bhale Kusa</i>	Poaceae	LC
265	<i>Andropogon monticola</i>	Dongari Gavat	Poaceae	LC
266	<i>Andropogon pertusus</i>	Ghanya Marvel	Poaceae	LC
267.	<i>Andropogon pumilus</i> (<i>pumilis</i>)	Gondval	Poaceae	LC
268.	<i>Andropogon halepensis</i>	Boru	Poaceae	LC
269.	<i>Andropogon contortus</i>	Kusali	Poaceae	LC
270.	<i>Andropogon annulatus</i>	Marvel	Poaceae	LC
271.	<i>Andropogon schoenanthus</i>	Rosha	Poaceae	LC
272.	<i>Arundinella ciliata</i>		Poaceae	LC
273.	<i>Arundinella intricata</i>		Poaceae	LC
274.	<i>Arundinella minila mutica</i>		Poaceae	LC
275.	<i>Apluda mutica</i>	Pochati, Full-Zara	Poaceae	LC
276.	<i>Anthistria ciliata</i>	Bhongrut	Poaceae	LC
277.	<i>Aristida paniculata</i> (<i>funiculate</i>)	<i>Bhuri</i>	Poaceae	LC
278.	<i>Brachiaria eruciformis</i>	Sheprut	Poaceae	LC
279.	<i>Coix aquatica</i>	Ran-Jondhola	Poaceae	LC
280.	<i>Cynodon dactylon</i>	Hereli, Durwa	Poaceae	LC
281.	<i>Eleusine caracana</i>	Nachni, Nagli	Poaceae	LC
282.	<i>Eragrostis spp.</i>	Darbha, Kusha	Poaceae	LC
283.	<i>Imperata cylindrical</i> <i>aryndinaka</i>		Poaceae	LC
284.	<i>Ischaemum indicum</i>	Ber	Poaceae	LC
285.	<i>Ophismenus compositus</i>	Hirvi Bangadi	Poaceae	LC
286.	<i>Panicum Paspalidium</i> <i>flavidum</i>		Poaceae	LC
287.	<i>Panicum glabrum</i>	<i>Varai</i>	Poaceae	LC
288.	<i>Paspalum disticum</i>		Poaceae	LC
289.	<i>Spodiopogon rhizophorus</i>	Math-Zara	Poaceae	LC
290.	<i>Sporobolus indicus</i>		Poaceae	LC
291.	<i>Themeda triandra</i>	Gondel	Poaceae	LC
(E)	Bamboos			
292.	<i>Bambusa arundinacea</i>	Kotas	Poaceae	LC
293.	<i>Dendrocalarnus strictus</i>	Manvel	Poaceae	LC
(F)	Climbers			
294	<i>Ampelocissus latifolia</i>	Kandvel, Rudrakshi	Vitaceae	VU
295.	<i>Abrus precatorius</i>	Gunj	Fabaceae	VU
296.	<i>Argyreia nervosa</i>	Samudra-Ashok	Convolvulaceae	-

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
297.	<i>Argyreia sericea</i>	Sambarveli	Convolvulaceae	-
298.	<i>Butea superba</i>	Palasvel	Fabaceae	EN
299.	<i>Capparis horride</i>	Taroti	Capparaceae	-
300.	<i>Clematis clematius triloba</i>	Ranjai	Ranunculoideae	-
301.	<i>Cocculus coccelus villosus</i>	Parvel	Menispermaceae	-
302.	<i>Cissus rapanda</i>	Arbatvel	Vitaceae	-
303.	<i>Cissus auriculata</i>	Kalivel	Vitaceae	-
304.	<i>Cylista scariosa</i>	Ran-Ghewada	Fabaceae	-
305.	<i>Coccinia indica</i>	Tondli	Cucurbitaleae	-
306.	<i>Caesalpinia sepiaria</i>	Chillori	Fabaceae	-
307.	<i>Celastrus paniculata</i>	Malkangni, Pingvel	Menispormaceae	VU
308.	<i>Capparis sepiaria</i>		Capparaceae	NT
309.	<i>Combretum ovalifolium</i>	Madhel	Comberetaceae	-
310.	<i>Derris trifolia</i>	Karanjvel	Leguminosae	-
311.	<i>Entda scandena</i>		Fabaceae	EN
312.	<i>Gloriosa superba</i>	Bachmag	Lilliacae	EN
313.	<i>Hemidesmus indicus</i>	Anantvel	Apocynaceae	-
314.	<i>Ipomea digitata</i>	Bhuikohala	Convolvulaceae	-
315.	<i>Jasminum malbaricum</i>	Jai	Oleaceae	-
316.	<i>Luffa acutangula</i>	Shirali	Cucurbitaceae	-
317.	<i>Mucuna prutita (pruriens)</i>	Khajlikayli	Fabaceae	EN
318.	<i>Momordica dioica</i>	Kartoli	Cucurbitaceae	-
319.	<i>Marsdenia volubilis</i>	Green milkweed	Apocynaceae	VU
320.	<i>Parsonsia spiralis</i>	Nagalkoda	Apocynaceae	-
321.	<i>Smilax zeylanica</i>	Ghotvel	Smilacaceae	-
322.	<i>Tinospora cordifolia</i>	Gulvel	Menispermaceae	EN
323.	<i>Teramnus labialis</i>	Ranudid	Fabaceae	-
324.	<i>Trichosanthes palmata</i>	Padvel	Cucurbitaceae	VU
325.	<i>Zizyphus rugosa</i>	Torai	Rhamnaceae	-
(F)	Epiphytes/Parasite			
326.	<i>Cuscuta reflexa</i>	Amarvel	Convolvulaceae	LC
327.	<i>Dendrophthoe falcata</i>	Bandgul	Loranthaceae	NE
328.	<i>Viscum nephalensis</i>	Banda	Santalaceae	-
329.	<i>Vanda tessellata</i>	Aitkel	Orchidaceae	-
(G)	Aquatic Plants			
330.	<i>Asteracantha longifolia</i>	Kolshinda, Talimkhan	Acanthaceae	-
331.	<i>Ceriops tagal</i>	Churi	Rhizophoraceae	LC
332.	<i>Ipomoea aquatica</i>		Convolvulaceae	LC
333.	<i>Limnanthemum indicum</i>	Kumud	Menyanthaceae	-
334.	<i>Murdannia nudiflora</i>		Commelinales	-
335.	<i>Pistia Pistacia stratiotes</i>	Gondal	Araceae	-

Sr. No.	Scientific Name	Local Name	Family	IUCN Category
336.	<i>Utricularia orbiculata</i>		Lentibulariaceae	-
(H) Halophytes				
337.	<i>Aegiceras corniculata</i>	Kunjala	Myrsinaceae	LC
338.	<i>Acanthus ilicifolius</i>	Marandi (seahally)	Acanthaceae	LC
339.	<i>Avicennia officinalis</i>	Tivar	Acanthaceae	-
340.	<i>Avicennia marina</i>	Tivar	Acanthaceae	LC
341.	<i>Pandanus tactorius</i>	Kevada	Pandanaceae	-
342.	<i>Sonneratia apetala</i>	Tivar	Lythraceae	-
(I) Orchids				
343.	<i>Platanthera spp.</i>	White Orchids	Orchidaceae	EN
344.	<i>Habenaria spp.</i>		Orchidaceae	-

EN=Endangered, VU= Vulnerablr, CR=Critical, NT= Near Threatened, DD=Data Deficit, NE= Not Evaluated, LC=Least Concerned

Source: FAE-EB

Kadamba, Teak, Karanj, Shisham and species of Acacia, Ziziphus, Euphorbia, Flame of the forest, Red Silk Cotton and a number of other varieties of flowers. Karvi or Karvy, a flowering plant that blossoms once in eight years, can be found in the SGNP. Karvi flower a shrub (*Strobilanthes callosus*) in a mass flowering covering the forest floor in lavender blush. It grows in abundance in the Western Ghats hills near Mumbai and throughout the park. In the park Karvi flowers last blooming were occurred in 2016 and it is scheduled to bloom here again in August–October 2024.

The principal types of flora are; *Tectona grandis* (Teak), *Terminalia tomentosa* (Ain), *Bombax malabaricum* (red silk cotton), *Garuga pinnata* (Kakad), *Mimusops hexandra* (Rinjan), *Lanea grandis* (Shemat), *Schleichera oleosa* (Koshimb), *Adina cordifolia* (Kadamba), *Dendrocalamus strictus* (Bamboo), *Butea monosperma* (flame of the forest), *Pongamia pinnata* (Karanj), *Gardcinia indica* (Kokam), *Calophyllum inophyllum* (Undi), *Sideroxylon tomentosum* (Kate-Kumbal), *Adina cordifolia* (Hed), *Pterocarpus marsupium* (Bija), *Bombax malabaricum* (Sawar), *Pterocarpus marsupium* (Bibla), *Mangifera indica* (Amba), *Aegle marmelos* (Bel), *Cassia fistula* (Bahawa), *Ficus bengalensis* (wad) and other Trees like *Acacia catechu* (Khair), *Azadirachta indica* (Kaduneem), *Ailanthus excelsa* and *Syzygium cumini* (Jambul). Important shrubs include *Carissa carandus* (Karvand), *Helicteres isora* (Murudsheng), *Adhatoda vasica* (Adulsa) and *Thespesia lampas* (Ranbhendi). The climbers are *Abrus precatorius* (Gunj), *Climatis triloba* (Ranjai), *Zizyphus rugosa* (Toria). Bamboo species found in the forests are *Dendrocalamus strictus* (Manvel), *Bambusa arundinacea* (Katas). Important grass species are *Cynodon dactylon* (Harali), *Dicanthium annulatum* (Ranbangdi), *Coix gigantea* (Ranjondhala), *Eragrostis spp.* (Darbha) and *Panicum glabrum* (Varai) all these indicates medium to good biodiversity in the protected study area. The floristic includes climbers, orchids and ferns.

At present SGNP have about 40 ha of mangrove forests. *Avicenna marina* is dominating the vegetation. *Bruguiera gymnorhiza* and *Lumnitzera racemosa* have almost vanished from the estuaries of Bassein Creek, while species like *Sonneratia alba*, *Rhizophora apiculata*, *Acrosticham sureum* are absent from this region.

4.6.8 Fauna (Wildlife)

The surrounding area of the proposed project is found to be natural vegetations as well as hilly region of dense forest area. It was observed that the populations of wildlife animals are good in number due to protected forest area. Photograph of a spotted Deer in Sanjay Gandhi National Park given in **Figure 4.6.2**.



Figure 4.6.2: Spotted Deer in Sanjay Gandhi National Park

A list of total 335 wildlife species (Mammals 43 species, Reptiles 38, Amphibia 7 and Avifauna/birds 247 species) were recorded and listed as per their Schedule of Wildlife (Protection) Act, 1972 and IUCN category is shown in **Table 4.6.3**.

Table 4.6.3: List of Fauna in the Study Area (SGNP)

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act,1972
(A)	Mammals			
1.	<i>Suncus murinus</i>	House screw/Gray musk Shrew	LC	-
2.	<i>Rousettus leschnaulti</i>	Fulvous Fruit Bat	LC	V
3.	<i>Pteropus giganteus</i>	Indian flying fox	LC	V
4.	<i>Cynopterus sphix</i>	Short-nosed Fruit Bat	LC	V
5.	<i>Taphozous melanopogon</i>	Black-beared Tomb Bat	LC	V
6.	<i>Taphozous soccolaimus</i>	Pouch bearing Bat	-	-
7.	<i>Megaderma iyra</i>	Indian false Vampire	LC	I
8.	<i>Megaderma spasma</i>	Indian false Vampire	LC	V
9.	<i>Rhinolophus rouxii</i>	Roux's Horseshoe Bat	LC	V
10.	<i>Hipposideros bicolor</i>	Bicoloured-leaf-nosed Bat	LC	V
11.	<i>Hipposideros speoris</i>	Schenider's leaf-nosed Bat	LC	V
12.	<i>Hipposideros galeritus</i>	Cantor's Leaf-nosed Bat	LC	V
13.	<i>Pipistrellus coromandra</i>	Indian Pipistrelle	LC	V
14.	<i>Pipistrellus minus</i>	Indian Pigmy Pipistrelle	LC	V
15.	<i>Pipistrellus dormeri</i>	Domer's Bat	LC	V
16.	<i>Hesperoptenus tickelli</i>	Indian Tickell's Bat	LC	V
17.	<i>Scotophilus heathi</i>	Common Yellow Bat	LC	V
18.	<i>Kerivoula picta</i>	Painted Bat	UC	IV
19.	<i>Macaca radiata</i>	Bonnet Macaque	LC	II

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act,1972
20.	<i>Macaca Mulata</i>	Rhesus Macaque	LC	II
21.	<i>Presbytis entellus</i>	Common Langur	LC	IV
22.	<i>Canis aureus</i>	The Golden Jackal	LC	III
23.	<i>Viverricula indica</i>	Small Indian Civet	LC	II
24.	<i>Paradoxurus hermaphrodites</i>	Toddy Cat or small Indian Civet	LC	II
25.	<i>Herpestes edwardsi</i>	Indian Grey Mongoose	LC	II
26.	<i>Hyaena hyaena</i>	Striped hyena	NT	III
27.	<i>Felis chaus</i>	Jungle Cat	LC	II
28.	<i>Felis rubiginosus</i>	Rusty spotted Cat	NT	I
29.	<i>Panthera Pardus</i>	Leopard	LC	I
30.	<i>Sus scrota</i>	Wild Boar	C	III
31.	<i>Tragulus meminna</i>	Mouse Deer/spotted Chevrotain	LC	I
32.	<i>Axix axis</i>	Spotted Dear	LC	III
33.	<i>Cervus unicolor</i>	Sambar	VU	III
34.	<i>Muntiacus muntjak</i>	Barking Dear or Muntjac	LC	III
35.	<i>Tetracerus quadricornis</i>	Four-horned Antelope	VU	I
36.	<i>Lepus nigricollis</i>	Indian Black Naped Hare	C	IV
37.	<i>Funambulus palmarum</i>	Three strioed Palm Squirrel	LC	II
38.	<i>Funambulus pennatii</i>	Five Striped Palm Squirrel	LC	II
39.	<i>Hystrix indica</i>	Indian Crested Porcupine	LC	IV
40.	<i>Rattus blanfordi</i>	White tailed Wood Rat/Blanford's Rat	LC	IV
41.	<i>Rattus rattus</i>	House Rat	C	IV
42.	<i>Mus musculus</i>	House Mouse	C	Iv
43.	<i>Bandicota Bengalensis</i>	Indian Mouse, Lesser Bandicoot	LC	IV
(B) Reptiles				
1.	<i>Crocodylus palustris</i>	Indian Magar	VU	I
2.	<i>Geomyda trijuga</i>	Pond Tortoise	NT	-
3.	<i>Testudo elegans</i>	Star Tortoise	VU	IV
4.	<i>Trionix labthi</i>	-	-	-
5.	<i>Hemidactylus maculatus</i>	Rock Gecko	LC	-
6.	<i>Hemidactylus brookii</i>	Brok's Gecko	LC	-
7.	<i>Hemidactylus leschenaultii</i>	Bark Gacko	-	-
8.	<i>Hemidactylus triedrus</i>	Termite Hill Gacko	-	-
9.	<i>Eublepharis macularius</i>	Fat tailed Gacko	-	-
10.	<i>Calotes versicolor</i>	Garden Lizard/Blood sucker	-	-
11.	<i>Calotes rouxi</i>	Forest Calotes	LC	-
12.	<i>Psmmophilus blanfordanus</i>	Rock Lizard	LC	IV
13.	<i>Chamaeleon zeylanicus</i>	Indian Chamaeleon	LC	-
14.	<i>Mabuya carinata</i>	Common Brahminv Skink	LC	-

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act,1972
15.	<i>Varanus monitor</i>	Common Monitor	-	I
16.	<i>Typhlina brahmia</i>	Blind Snake/common Worm	-	-
17.	<i>Python moluxu</i>	Indian Python	NT	I
18.	<i>Eryx conicus</i>	Russel's Sand Boa	T	IV
19.	<i>Eryx johnii</i>	Jhon's Sand Boa	NT	-
20.	<i>Acrochordus granulatus</i>	Wart Snake	LC	-
21.	<i>Elephe Helena</i>	Trinket Snake	-	-
22.	<i>Ptyas mucosus</i>	Dhaman/common Rat Snake	E	II
23.	<i>Argypogena fasciolatus</i>	Rat Snake/Banded Snake	-	II
24.	<i>Agrypogena ventromaculata</i>	Gray's Rat Snake/Glossy Bellied Racer	E	II
25.	<i>Oligoden arnensis</i>	Common Kukri Snake	T	-
26.	<i>Lycodon aulicus</i>	Common Wolf Snake	NE	II
27.	<i>Lycodon travancoricus</i>	Travancore Wolf Snake	LC	-
28.	<i>Dendrelaphis tristis</i>	Common Indian Bronzeback/Tree Snake	LC	IV
29.	<i>Xynochrophis piscator</i>	Checked Keelback	NE	II
30.	<i>Amphiesma stolata</i>	Buffstriped Keelback	-	IV
31.	<i>Macropisthodon plumbicolor</i>	Green Keelback	C	IV
32.	<i>Boiga trigonta</i>	Indian Gamma /Cat Snake	LC	IV
33.	<i>Ahactulla nasutus</i>	Common Green Whip Snake	-	-
34.	<i>Bungarus caeruleus</i>	Common Indian Krait	LC	-
35.	<i>Callopiis melanurus</i>	Slender Coral Snake	-	-
36.	<i>Naja naja</i>	Indian Cobra	VU	-
37.	<i>Vipera russelli</i>	Russell's Viper	-	-
38.	<i>Trimeresurus malabaricus</i>	Malbar Pit Viper	LC	-
(C)	Amphibia			
1.	<i>Bufo melanostictus</i> Schn.	Common Indian Toad		-
2.	<i>Ramanella montana</i>	-		-
3.	<i>Rana cyanophlyctis</i>	Skipper frog		-
4.	<i>Rana tigerina</i>	Indian Bull frog		-
5.	<i>Rana limnocharis</i>	Indian Cricket frog		-
6.	<i>Rana breviceps</i>	Indian Burrowing Frog		-
7.	<i>Blypedates maculatus</i>	Common tree frog		-
(D)	Birds (Avifauna)			
1.	<i>Pediceps ruficollis capensis</i>	Little Grebe/Dabchick	-	-
2.	<i>Phalacrocorax niger</i>	Little of Pigmy cormorant	LC	-
3.	<i>Anhinga ruta melanogaster</i>	Oriental Dartar	NT	-
4.	<i>Ardeola gray</i>	Pond Heron / Paddy Bird	EN	-

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act, 1972
5.	<i>Bulbulcus ibis coromandus</i>	Cattle Egret	LC	IV
6.	<i>Egretta alba modesta</i>	Large Egret	LC	-
7.	<i>Ardea intermedia</i>	Median /smaller Egret	LC	-
8.	<i>Egrettaca garzetta</i>	Little Egret	LC	Appendices I, II & III
9.	<i>Ncticorax ncticorax</i>	Black crowned night Heron	LC	-
10.	<i>Ixobrychus cinnamomeus</i>	Chestnut Bitters	LC	-
11.	<i>Anastomus ositanas</i>	Open Bill Stork	LC	-
12.	<i>Ciconia episcopus</i>	White necked Stork	VU	-
13.	<i>Dendrocygna javanica</i>	Lesser Whistling Teal	LC	-
14.	<i>Anas acuta</i>	Pintail	LC	-
15.	<i>Anas crecca</i>	Common Teal	LC	IV
16.	<i>Anas poecilorchyncha</i>	Spot-billed Duck	LC	IV
17.	<i>Anas querqedula</i>	Gazaney /Blue Winged Teal	LC	-
18.	<i>Aythya ferina</i>	Red-necked Pochard	VU	Appendix II
19.	<i>Aythya nyroca</i>	White Eyed Pochard	NT	Annex I
20.	<i>Aythya fuligula</i>	Tuffed Duck	LC	-
21.	<i>Nettapus coromandelianus</i>	Cotton Teal	LC	-
22.	<i>Elanus caeruleus vociferus</i>	Black winged Kite	LC	-
23.	<i>Pernis ptilorhyncus rufficollis</i>	Crested Honey Buzzard	LC	Appendix II
24.	<i>Milvus migrans govinda</i>	Pariah Kite	LC	Appendix II
25.	<i>Haliastur Indus Indus</i>	Brahminy Kite	LC	Appendix II
26.	<i>Accipiter badius dussumieri</i>	Indian Shikra	LC	Appendix II
27.	<i>Accipiter trivirgatus</i>	Crested Goshawk	LC	Appendix II
28.	<i>Accipiter nisus melaschistus</i>	Sparrow Hawk	LC	-
29.	<i>Butastur teesa</i>	White Eyed Buzzard	LC	Appendix II
30.	<i>Aquila rapax vindhina</i>	Ta Wny Eagle	CR	-
31.	<i>Ictinactus malayensis perniger</i>	Black Eagle	CR	-
32.	<i>Haliaeetus leuccgaster</i>	White Bellied Sea Eagle	CR	I
33.	<i>Gyps indicus</i>	Indian Longbilled Vulture	LC	I
34.	<i>Gyps bengalensis</i>	Indian Whitebacked Vulture	NT	I
35.	<i>Neophron perenopterus</i>	indian Scavenger Vulture	LC	I
36.	<i>Circus pygarus</i>	Montagus Harrier	LC	-
37.	<i>Circus maacrourus</i>	Pale Harrier	LC	-
38.	<i>Spilornis cheela melanotis</i>	Crested Serpent Eagle	LC	Appendix II

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act, 1972
39.	<i>Pandion haliaetus haliaetus</i>	Osprey	LC	-
40.	<i>Falco tinnunculus</i>	European Kestrel	LC	Appendix II
41.	<i>Francolinus pictus</i>	Painted Partridge	LC	IV
42.	<i>Coturnix coromandelica</i>	Black Breasted / Rain Quail	LC	IV
43.	<i>Coturnix coturnix</i>	Common Grey Quail	LC	IV
44.	<i>Perdica asiatica</i>	Jungle Bush Quail	LC	IV
45.	<i>Galloperdix spadicea</i>	Red Spur fowl	LC	IV
46.	<i>Gallus gallus</i>	Red Jungle Fowl	LC	IV
47.	<i>Gallus sonneratti</i>	Gray jungle Fowl	LC	IV
48.	<i>Pavo cristatus</i>	Common Peafowl	LC	I
49.	<i>Turnix sylvaticus dussumier</i>	Little Bustard Quail	LC	II
50.	<i>Turnix suscitator taigoor</i>	Common Busteded Quail	LC	-
51.	<i>Rallus stviatus albiventer</i>	Blur Busteded Banded Rail	LC	IV
52.	<i>Porzana pusilla</i>	Baillon's Grake	LC	-
53.	<i>Amaurornis fuscus zeylanicus</i>	Ruddy Crake	LC	-
54.	<i>Amaurornis phoenicurus</i>	White Breasted Waterhen	LC	-
55.	<i>Porzana porzana</i>	Spotted Crake	LC	-
56.	<i>Gallixrex cinerea</i>	Water Cock/ Kora	LC	-
57.	<i>Gallinula chloropus</i>	Common Moorhen	LC	-
58.	<i>Porphyrio porphyrio</i>	Purple Moorhen	-	-
59.	<i>Fulica atra</i>	Coot	LC	IV
60.	<i>Hydropha cianus chirurgus</i>	Pheasant Tailed Jacana	LC	-
61.	<i>Metopidicus</i>	Bronzewinged Jacana	LC	-
62.	<i>Haematopus ostralegus</i>	Oyster catcher	E	-
63.	<i>Vanellus indicus</i>	Red Watted Lapwing	LC	-
64.	<i>Vanellus malabaricus</i>	Yellow Wattled Lapwing	LC	-
65.	<i>Numenius arquata</i>	Curlew	NT	-
66.	<i>Numenius phaeopus</i>	Whimbrel	LC	-
67.	<i>Tringa tetanus eurhinus</i>	Common Redshank	LC	-
68.	<i>Tringa stagnatilis</i>	Marsh Sandpiper	LC	IV
69.	<i>Tringa nebularia</i>	Green Shank	LC	-
70.	<i>Tringa ochropus</i>	Green Sand piper	LC	-
71.	<i>Tringa hypeloucco</i>	Common Sand Piper	LC	IV
72.	<i>Gallinago stenura</i>	Pintail Spine	LC	IV
73.	<i>Gallinago gallinago</i>	Common Snipe	LC	-
74.	<i>Gappela miphima</i>	Jack Shipe	LC	-
75.	<i>Calidris minuta</i>	Little Stint	LC	-
76.	<i>Calidris temminckii</i>	Temminck's Stint	LC	-
77.	<i>Phiomachus pugnax</i>	Ruff	LC	-
78.	<i>Rostratula benghalensis</i>	Greater Painted Shipe	LC	-
79.	<i>Himantopus himantopus</i>	Black-winged Stilt	LC	-

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act,1972
80.	<i>Burhinus ocdicnemus</i>	Eurasia thick-knee	LC	-
81.	<i>Cursorius coromandelicus</i>	Indian Courser	LC	-
82.	<i>Larus brunnicephalus</i>	Brown headed Gull	LC	-
83.	<i>Childonias nybrida</i>	Whiskrred Tern	LC	-
84.	<i>Gelochelidon nitotica</i>	Gulibilled Tern	LC	-
85.	<i>Sterna aurantica</i>	Indian River Tern	NT	IV
86.	<i>Sterna acuticauda</i>	Black-bellied Tern	NT	-
87.	<i>Sterna albifons</i>	Little Tern	LC	-
88.	<i>Petrocles exustus</i>	Indian Sandgrouse	LC	-
89.	<i>Treron pompadora affinis</i>	Grey Fronted Green Pigeon	LC	-
90.	<i>Treron pheonicoptera chlorigaster</i>	Yellow-legged Green Pigeon	LC	-
91.	<i>Columba livia intermedia</i>	Blue Rock Pigeon	LC	IV
92.	<i>Streptopelia decaocto</i>	Indian Ring Dove	LC	IV
93.	<i>Streptopelia tranque baraca</i>	Red Turtle Dove	LC	IV
94.	<i>Streptopelia chinensis surantemsis</i>	Spotted Dove	LC	IV
95.	<i>Streptopellia senegalensis cambaynesis</i>	Little Brown Dove	LC	IV
96.	<i>Chalcophas indica</i>	Emerald Dove	LC	-
97.	<i>Psittacula eupatria</i>	Large Alexandrine Parakeet	NT	-
98.	<i>Psittacula kremeri manillensis</i>	Rose-ringed Parakeet	LC	-
99.	<i>Psittacula cyanocephala</i>	Blossomheaded Parakeet	LC	-
100.	<i>Loriculus vernalis</i>	Indian Lorikeet	LC	-
101.	<i>Clamator coromandus</i>	Red-winged Crested	LC	-
102.	<i>Clamator jacobinus</i>	Pied Crested Cuckoo	LC	-
103.	<i>Cuculus varius</i>	Common Hawk Cuckoo	LC	-
104.	<i>Cuculus micropterus</i>	Indian Cuckoo	LC	-
105.	<i>Cuculus canorus</i>	Cuckoo	LC	-
106.	<i>Cacomantis sonneratti</i>	Indian Baybanded Cuckoo	LC	-
107.	<i>Cacomantis passerinus</i>	Indian Plantive Cuckoo	LC	-
108.	<i>Surniculus lugubris dicruoides</i>	Square Tailed Drongo Cuckoo	LC	-
109.	<i>Taccocua leschenaultii</i>	Sirkar Cuckoo	LC	-
110.	<i>Eudynamys scolopacea</i>	Koel	LC	-
111.	<i>Centropus sinensis parroti</i>	Pheasant Cuckoo	LC	-
112.	<i>Tytoalba stertens</i>	Barn Owl	LC	-
113.	<i>Otus scops</i>	Scops Owl	LC	-
114.	<i>Bubo Bub</i>	Great Horned Owl / Eagle Owl	LC	-
115.	<i>Bubo zeyionensis</i>	Brown Fish Owl	LC	-

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act,1972
116.	<i>Glaucidium radiatum</i>	Barred Jungla Owlet	LC	-
117.	<i>Athene brama</i>	Spotted Owlet	LC	-
118.	<i>Asio flammeus</i>	Shorteared Owl	LC	-
119.	<i>Caprimulgus indicus</i>	Indian Jungle Nightjar	LC	-
120.	<i>Caprimulgus asiaticus</i>	Indian Jungle Nightjar	LC	-
121.	<i>Apus affinis affinis</i>	House Swift	LC	-
122.	<i>Cypsiurus parvus batasiensis</i>	Palm Swift	LC	-
123.	<i>Harpactes fasciatus legerli</i>	Indian Trogon/Malabar Trogon	LC	-
124.	<i>Ceryle rudis</i>	Lesser Pied Kingfisher	LC	IV
125.	<i>Alcedo atthis taprobana</i>	Small Blue Kingfisher	LC	IV
126.	<i>Ceyx erithaca</i>	Three Toed Kingfisher	LC	IV
127.	<i>Halcyon smyrnesis</i>	White Breasted Kingfisher	LC	IV
128.	<i>Halcyon pileata</i>	Black Capped Kingfisher	LC	IV
129.	<i>Merops philippinus</i>	Blue tailed Bee-eater	LC	-
130.	<i>Merops orientalis orientalis</i>	Green Bee-eater	LC	-
131.	<i>Coracias benghalensis indica</i>	Indian Poller / Blue Jay	LC	-
132.	<i>Upupa epops</i>	Hoopae	LC	-
133.	<i>Tockus griseus</i>	Malabar Indian Grey Hornbill	LC	-
134.	<i>Megalaima zeylanica inornata</i>	Large Green Barbet	LC	-
135.	<i>Magalaima haemacephala indica</i>	Crimson breasted Barbet/copper smith	LC	-
136.	<i>Jynx torquilla torquilla</i>	Wryeck	LC	-
137.	<i>Micropternus brachyurus jerdoni</i>	Rufous Wood Pecker	LC	IV
138.	<i>Dinopium benghalensis</i>	Lesser Gold Backed Wood Packer	LC	IV
139.	<i>Dinopium javanense</i>	Indian Golden-pecker, 3 toed wood pecker	LC	IV
140.	<i>Dryocopus javensis</i>	Indian Great Black wood Pecker	LC	IV
141.	<i>Picoides maharaitensis maharaitensis</i>	Yellow fronted Pied/Maratha woodpecker	LC	IV
142.	<i>Picoides hunus hardwickii</i>	Brown arounded Pygmy Woodpecker	LC	IV
143.	<i>Hemicircus canente</i>	Heart spotted Woodpecker	LC	IV
144.	<i>Chrysocolaptes jucidus</i>	Large Golden backed Woodpecker	LC	IV
145.	<i>Chrysocolaptes fistivus</i>	Black Backed Woodpecker	LC	IV
146.	<i>Pitta brachyuran brachyrura</i>	Indian Pitta	LC	IV
147.	<i>Mirafraga erythroptera</i>	Redwinged Bush Lark	LC	-
148.	<i>Eremopterix grisea</i>	Ashycrowned Finch-Lark	LC	-

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act,1972
149.	<i>Ammomanes phoenicurus</i>	Rufoustailed Finch-Lark	LC	-
150.	<i>Galerida malabarica</i>	Malbar Gested Lark	LC	IV
151.	<i>Aluuda gulgula gulgula</i>	Small / Eastern Skylark	LC	-
152.	<i>Hirundo concolor</i>	Dusky Carg Martin	LC	-
153.	<i>Hirundo rustica</i>	Swallow	LC	-
154.	<i>Hirundo srnithii filifera</i>	Wiretailed Swallow	LC	-
155.	<i>Hirundo daurica nipalensis</i>	Straited Swallow	LC	-
156.	<i>Hirundo dawrica erythropygia</i>	Redrumped Swallow	LC	-
157.	<i>Lanius schach erythronotus</i>	Refous backed Shrika	LC	-
158.	<i>Oriolus oeirole</i>	Golden Oriode	LC	-
159.	<i>Oriolus xanthornus</i>	Blackheaded Onde	LC	-
160.	<i>Dicrurus adsimilies macrocercus</i>	Black Drongo / King Crow	LC	IV
161.	<i>Dicrurus aeneus aeneus</i>	Bronze Drongo	LC	IV
162.	<i>Dicrucrus paradiseus paradiseus</i>	Large Recket Tailed Drongo	LC	IV
163.	<i>Dirucrus leucophaues longicaudatus</i>	Grey / Ashy Drongo	LC	IV
164.	<i>Dicrurus hottentottus</i>	Haircrested Drongo	LC	IV
165.	<i>Artamus fuscus</i>	Ashy Swallow Shrike	LC	-
166.	<i>Sturnus malabaricus malabaricus</i>	Grey headed Myna	LC	IV
167.	<i>Sturnus pogodurum</i>	Black-headed/Byahmnya Myna	LC	IV
168.	<i>Sturnus contra contra</i>	Pied Myna	LC	IV
169.	<i>Sturnus roseus</i>	Rosy Pastor /osy starling	LC	IV
170.	<i>Acridotheres tristis</i>	Common Myna	LC	IV
171.	<i>Acridotheres fuscus</i>	maharattensis Jungle Myna	LC	IV
172.	<i>Gracula religiosa</i>	Grackle/Hill Myna	LC	IV
173.	<i>Dendrocitta vagabunda</i>	Indian Tree Pie	LC	IV
174.	<i>Corvus splendens</i>	House Crow	LC	IV
175.	<i>Corvus macrorhynahos culminatus</i>	Jungle Crow	LC	IV
176.	<i>Tephrodornis pondicerianus</i>	Common Wood Shrike	LC	-
177.	<i>Coracina novachollandiae mecei</i>	Large cuchoshrike	LC	-
178.	<i>Coracina melanoptera Sykesi</i>	Blackheaded cuckooshrike	LC	-
179.	<i>Pericrocotus flammeus</i>	Scarlet minivet	LC	-
180.	<i>Pericrocotus cinnamomeus</i>	Small minivet	LC	-
181.	<i>Aegithina tipha multicolor</i>	Common Lora	LC	-

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act,1972
182.	<i>Chloropsis aurifrons frontalis</i>	Gold Fronted Chloropsis	LC	-
183.	<i>Chloropsis cochinchinensi jerdoni</i>	Jordon/Goldmeentled chlopasis	LC	-
184.	<i>Pycononofus fuscicaudatus</i>	Redwhiskered Bulbul	LC	IV
185.	<i>Pycononofus leucogenys leucotis</i>	White eared Bulbul	LC	IV
186.	<i>Pycononofus cafer cafer</i>	Redvented Bulbul	LC	IV
187.	<i>Pycononofus luteolus luteolus</i>	White Brownd Bulbul	LC	IV
188.	<i>Pellornerum ruticeps ruticeps</i>	Spotted Babbler	LC	-
189.	<i>Pomatorhinus schisticeps horsfieldii</i>	Slaty heded scimitar Babbler	LC	-
190.	<i>Dumetia hypezythra</i>	Tawny billed Babbler	LC	-
191.	<i>Chrysomma sinense Sinense</i>	Yelloweyed Babbler	LC	-
192.	<i>Turdoides caudatus</i>	Common Babbler	LC	-
193.	<i>Turdoides rnalcolmi</i>	Large Grey Babbler	LC	-
194.	<i>Turdoides strlatus</i>	Jungle Babbler	LC	-
195.	<i>Alcippe poioicephala brucei</i>	Quakar Babbler	LC	-
196.	<i>Musciacapa pazva Parva</i>	Western Red breasted flycatcher	LC	-
197.	<i>Musciacapa thickelliae</i>	Tickell's Blue Flycatcher	LC	-
198.	<i>Musciacapa thalassina</i>	Verditer Flycatsher	LC	-
199.	<i>Musciacapa latirostvs</i>	Brown Flycatcher	LC	-
200.	<i>Culicicapa ceylonensis</i>	Grey headed Flycacher	LC	-
201.	<i>Rhipidura albicollis albogularis</i>	White spotted fantail	LC	-
202.	<i>Terpsiphorie paradisi</i>	Paradese Flycatcher	LC	-
203.	<i>Monarch azurea stayni</i>	Black-naped Monarch	LC	-
204.	<i>Cisticola juncidis cursitans</i>	Stveaked fantail Warbler	LC	-
205.	<i>Prinia hodgsonii</i>	Franklin's Wren Warbler	LC	-
206.	<i>Prinia subflava inarnata</i>	Plain Wren Warbler	LC	-
207.	<i>Prinia socialis</i>	Ashy Wren Warbler	LC	-
208.	<i>Prinia sylvatica</i>	Jungle Wren Warbler	LC	-
209.	<i>Orthotornus sutorius gusuratus</i>	Tailor Bird	LC	-
210.	<i>Acrocephalus stentoreus brunnescens</i>	Indian Great Reed Warbler	LC	-
211.	<i>Acrocaphalus dumetorum</i>	Blyth's Reed Warbler	LC	-
212.	<i>Acrocephalus agricola</i>	Paddyfield Warbler	LC	-

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act, 1972
213.	<i>Hippolais calligata caligata</i>	Booted Tree Warbler	LC	-
214.	<i>Sylvia curruca blythi</i>	Lasser Whitethroat	LC	-
215.	<i>Phylloscopus collybita</i>	Common Chiffchaff	LC	-
216.	<i>Phylloscopus tyleri</i>	Tyler's Leaf Warbler	NT	-
217.	<i>Phylloscopus inornatus</i>	Yellow Browed Leaf Warbler	LC	-
218.	<i>Phylloscopus trochiloides</i>	Dull Green Leaf Warbler	LC	-
219.	<i>Luscinia svecica</i>	Blue Throat	LC	-
220.	<i>Copsychus saularis saularis</i>	Magpie Robin	LC	-
221.	<i>Copsychus malabaricus</i>	White-rumped shama	LC	-
222.	<i>Saxicoloides fulicata intermedia</i>	Indian Robin	LC	-
223.	<i>Monticola cinclorhynchus</i>	Blue capped Rock Thrush	LC	-
224.	<i>Monticola solitarius Pandoo</i>	Blue Rock Thrush	LC	-
225.	<i>Myiophonus horsfieldii</i>	Malabar Whistling Thrush	LC	-
226.	<i>Zoothera citrine</i>	Orange Headed Thrush	LC	-
227.	<i>Turdus smilimus</i>	Indian Blackbird	LC	-
228.	<i>Anthus trivialis</i>	Tree Pipit	LC	-
229.	<i>Anthus godlewskii</i>	Blythe Pipit	LC	-
230.	<i>Motacilla citreola citreola</i>	Yellow headed Wagtail	LC	-
231.	<i>Motacilla alba dukhunensis</i>	White / Pide Wagtail	LC	-
232.	<i>Dicaeum ezythortynchos</i>	Tickell's Flower	LC	-
233.	<i>Dicaeum agile</i>	Thickbilled Flower Pecker	LC	-
234.	<i>Nectarinia zeylonica sola</i>	Purplerumped Sunbird	LC	-
235.	<i>Nectarinia lotenia hindustanica</i>	Lotn's Sunbird	LC	IV
236.	<i>Nectarinia asiatica asiatica</i>	Purple Sunbird	LC	IV
237.	<i>Aethopyga siparaja vigorsii</i>	Yellow Backed Sunbird	LC	IV
238.	<i>Passer domesticus indicus</i>	House Sparrow	LC	IV
239.	<i>Petonia xanthocilis xanthocilis</i>	Yellow throated Sparrow	LC	IV
240.	<i>Ploceus philippinus</i>	Baya / Weaver Bird	LC	IV
241.	<i>Estrilda amandawa</i>	Red Munia / Avadavat	LC	IV
242.	<i>Lonchura striata</i>	White Backed Munia	LC	IV
243.	<i>Lanchura malabarica</i>	White Throated Munia	LC	IV
244.	<i>Lonchura Punctulata</i>	Spotted Munia	LC	IV

Sr. No.	Scientific Name	Common Name	IUCN Category	Scheduled of WL (Protection) Act,1972
245.	<i>Lonchura malacca</i>	Blackheaded Munia	LC	IV
246.	<i>Carpodacus erythrurus roseatus</i>	Common Rosefinch/Scarlet Grosbeak	LC	-
247.	<i>Emberiza melanoc eahala</i>	Blackheaded Bunting	LC	-

Source: FAE-EB

4.6.9 Fishes Diversity

The major sources of water in the park are Tulsi and Vihar lakes, Dahisar and Rewat Rivers. Numerous small tributaries join these rivers during their course through the park. Marine water from Bassin Creeks is also passing through the park.

Fisheries are the indicators of status of aquatic body related with aquatic pollution. Fishes have been recognized as suitable for biological assessment due to its identification and economic value. Fish has been widely used as ecological monitors to determine the level of degradation of water bodies. Total 30 species of fishes (18 freshwater and 12 marine species) were recorded from the fresh water Lakes, Rivers and Marine water in the Park. As the rivers are of a short length, indigenous fish fauna includes rather small sized varieties like Puntius, Rasbora, and Garra etc. A hill stream Cyprinid, *Parapsilorhynchus tentaculatus* was found in seasonal streams flowing down the Kanheri caves from an altitude of about 486 MSL. Marine fish are also found in the Bassin Creek as *Ilisa toil*, *Arius caelatus*, *Katbala axillaris*, *Glossogobios gioris gioris*, etc (Table 4.6.4) .

Table 4.6.4: List of Fishes in the Study Area (SGNP)

Sr. No.	Scientific Name	Family	Conservation Status
(A)	Fresh Water Fishes		
1.	<i>Salmostoma clupeioides</i>	Cyprinidab	LC
2.	<i>Danio aequipin</i>	Cyprinidab	LC
3.	<i>Rasbora daniconius</i>	Cyprinidab	LC
4.	<i>Puntius ticto or rasbora</i>	Cyprinidab	LC
5.	<i>Catla catla</i>	Cyprinidab	VU
6.	<i>Cirrbinus mrigala</i>	Cyprinidab	LC
7.	<i>Labeo calbasu</i>	Cyprinidab	LC
8.	<i>Labeo rohita</i>	Cyprinidab	LC
9.	<i>Parapsilorhynchus tentaculatus</i>	Cyprinidab	-
10.	<i>Garra mullya</i>	Cyprinidab	LC
11.	<i>Aorichthys aor</i>	Bagridab	LC
12.	<i>Mystus menoda tracbacantbus</i>	Bagridab	LC
13.	<i>Heteropneustes fossilis</i>	Hbteropnustidab	LC
14.	<i>Aplocheilus lineatus</i>	Cyprinodontidae	-
15.	<i>Channa punctatos</i>	Channidae	LC

Sr. No.	Scientific Name	Family	Conservation Status
16,	<i>Tilapia mossambica</i>	Cichlidab	VU
17,	<i>Auabas testodiuus</i>	Anabantidab	Excess
18.	<i>Glossogobios gioris gioris</i>	Gobiidab	LC
(B)	Prominent Marine Water Fishes (Bassein Creek)		
19.	<i>Ilisa toli</i>	Clupeidae	LC
20.	<i>Coilia dossumieri</i>	Engraulidae	-
21.	<i>Arius caelatus</i>	Ariidab	-
22.	<i>Arius sona</i>	Ariidab	-
23.	<i>Harpadon nehereus</i>	Harpadontidae	-
24.	<i>Terapon jarbua</i>	Teraponidab	LC
25.	<i>Johnius belangerii</i>	Sciabnidab	-
26.	<i>Johnius elongatus</i>	Sciabnidab	-
27.	<i>Katbala axillaris</i>	Sciabnidab	-
28.	<i>Valamugil spiegleri</i>	Mugilidae	-
29.	<i>Boleophthalmus boddarti</i>	Gobiidae	-
30.	<i>Boleophthalmus dussumieri</i>	Gobiidae	-

Source: FAE-EB

4.6.10 Data Interpretation

4.6.10.1 Rare, Endangered and Threatened Plant Species

India has approximately 15,000 flowering plants and in the early 1990's an estimated 27% of plant species were endangered. SGNP is a stunning example of why the Western Ghats have been chosen as a global biodiversity hotspot. National threatened plant species are those found only in small numbers or those very near to extinction in the country. India has a list of threatened species at the all India level, published by the Botanical Survey of India entitled "Red Data Book" by N.P. Nayar and A. P. K. Sastry, B.S.I., 1988). In the study area, out of total 344 plant species, 133 species are trees, 38 shrubs, 92 herbs, 28 grasses, 2 bamboos, 32 climbers, 4 epiphytes/parasites, 7 aquatic plants, 6 holophytes and 2 species of orchids. Out of these plants species, there are 13 species of endangered (EN), 1 species is not evaluated (NE), 13 vulnerable (VU), 1 with data deficient (DD), 1 critical (CR), 3 near threatened (NT) and 60 species were least concerned (LC).

Table 4.6.5: Total Endangered (EN) Plant Species are 13 Nos.

Trees	Shrubs	Herbs	Climbers	White Orchids
(1) <i>Acacia arobica</i>	(1) <i>Clerodendron inermis</i>	(1) <i>Curcuma aromatic</i>	(1) <i>Butea superba</i>	(1) <i>Platanthera spp.</i>
(2) <i>Adangonia digitata</i>		(2) <i>Musa rosasicea</i>	(2) <i>Entda scandena</i>	
(3) <i>Gardenia latifolia</i>			(3) <i>Gloriasa superba</i>	
(4) <i>Ptrocarpus marsupium</i>			(4) <i>Mucona Pratita</i>	
			(5) <i>Tinospora cardifolia</i>	

Source: FAE-EB

However, there is intense anthropogenic pressure on flora and forest resources under SGNP area, which are observed to be dwindling because of the national park area is located within a metropolis limit of Mumbai.

4.6.10.2 Conservation of Endangered and Vulnerable Animals (Schedule I)

A comprehensive Central Legislation namely Wildlife (Protection) Act was enforced in 1972. This law provides protection to wildlife animals and for matters related to their ancillary or incidental deaths are categorized under Scheduled-I. Conservation status of 5 species of mammals, 3 reptiles and 5 species of birds are reported from study area under fall under Schedule-I of Wildlife (Protection) Act (1972) as endangered and vulnerable animals as presented as below:

Table 4.6.6: Total Endangered (EN) Animal Species are 13 Nos: Schedule-I

Mammals	Reptiles	Birds
<i>Megaderma iyra</i> (Indian false Vampire)	<i>Crocodilus palustris</i> (Indian Magar)	<i>Haliaeetus leuccgaster</i> (White Bellied Sea Eagle): Critical (CR)
<i>Leopards pardus</i> (Leopard)	<i>Python morulus</i> (Indian Python)	<i>Gyps indicus</i> (Indian longbilled Vulture) (LC)
<i>Felis rubiginosa</i> (Rusty spotted Cat)	<i>Varanus monitor</i> (common Monitor)	<i>Gyps bengalensis</i> (Indian Whitebacked Vulture) (NT)
<i>Tetracerus quadricornis</i> (four horned Antelope)		<i>Neophron perenopterus</i> (Indian Scavenger Vulture) (LC)
<i>Trangulus meminna</i> (Mouse Deer)		<i>Pavo cristatus</i> (Common Peafowl) (LC)

Source: FAE-EB

4.6.10.3 Conservation of Endangered and Vulnerable Fishes

Out of 30 species of freshwater and marine fishes in the study area, following two species are reported as Vulnerable (VU) and no endangered aquatic fishes observed in the area.

- (1) *Catla catla* (Vulnerable -VU)
- (2) *Tilapia mossambica* (Vulnerable -VU)

Therefore, conservation for these wildlife animals is required under protected area of SGNP. Other faunal species reported from the study area have been categorized under Schedule-II, Schedule-III, and Schedule-IV respectively. The scope and duration of the study was limited and detailed survey of the study area may suggest presence or occurrence of further avifauna species protected under Schedule-I of Wildlife (Protection) Act (1972).

4.6.11 Habitat Management for Wildlife

- ∞ The existing road infrastructure around the national park experiences heavy traffic movement round the year and the traffic volume has been increasing day by day.
- ∞ Besides traffic, there has been heavy human habitation and activities around the national park causing pressure on the protected area i.e. flora and fauna.

- ∞ The increasing traffic volume and frequent jams on the road stretch has been adding to heavy carbon emission that affects negatively to Sanjay Gandhi National Park (SGNP).
- ∞ This proposed tunnel provides a vital connectivity between WEH and EEH highways, and reduces traffic substantially within Mumbai Suburban.
- ∞ The proposed tunnel will further help reducing traffic to Mumbai-Suburban and on the existing roads which would work as a breather for the present carbon-footprint situation.
- ∞ The proposed tunnel avoids requirements of forest land on ground from the national park as it is said to be the lungs of the city, it purifies much of the air pollution of the city.
- ∞ Both regulatory (for human actions) and habitat management practices including engineering devices need be utilized for managing and improving habitats for wildlife.
- ∞ For good governance in the interest of wildlife conservation and sustainable economic development, the following regulatory measures need be practiced equitably in case of common citizens, authorities and very important persons:
 - Wildlife (Protection) Act 1972 and amendments
 - The Forest Conservation Act 1980
 - The (Prevention and Control of Air Pollution) Act 1981
 - The (Prevention and Control of Water Pollution) Act 1974
 - The Environment (Protection) Act 1986
 - The Biodiversity Act, 2002
 - Discharge of effluents as per EPA, 1986
 - Noise Pollution and Control Rules, 2000
 - Construction and Demolition of Waste Management Rules, 2016
 - Solid Waste Management Rules, 2016
 - Plastic Waste Management Following Plastic Waste Management Rules, 2016

4.7 Socio-economic Environment

Major developmental activities in industrial sector are required for economical development as well as creation of employment opportunities (direct / indirect) and to meet the basic / modern needs of the society, which ultimately results in overall improvement of quality of life through economical, health, education, nutrition status in the project region, state as well as the country. The highway tunnel projects are also expected to generate / discharge different types of pollutants in the surrounding environment. They may cause natural resources degradation, ecological and human health risks, unless the development is planned properly and implemented

in an environmentally sustainable manner through implementation of pollution prevention, mitigation and control measures. In this manner all developmental projects have direct as well as indirect relationship with socio-economic aspects, which include public acceptability for new developmental projects. Thus, the study of socio-economic component incorporating various facets related to improving social and cultural conditions and economic status of the project region is an important part of EIA study.

The study of socio-economic component incorporating various facts related to socio-economic condition in the area is an integral part of EIA process. This includes demographic structure, population dynamics, infrastructure resources, health status of the community and socio-economic attributes refers to employment, industrial development and sustainability of the project in view of financial terms.

4.7.1 Description of the Project

MMRDA is proposing to construct twin tube, 3 lanes (each side) highway tunnel of about 11.8 km, which passes through below the SGNP connecting WEH near Borivali and Ghodbunder road, Thane near Tikuji-ni-wadi. The proposed tunnel will start from Tikuji-ni-wadi near Manpada/Patilpada in Thane – Ghodbunder road and ends at the Western Express Highway end near Magathane Bus Depot with twin tube tunnel. The proposed tunnel option will explore the possibility of shorter and economical alignment to connectivity of two National Highways NH-3 and NH-8 which will not only save the time but will also help in reducing the traffic congestion from current route. At present, motorists have to travel 25km in order to reach the Thane Tikuji-ni-wadi area from Borivali via the Western Express Highway (WEH) and Thane-Ghodbunder road. Thane and Borivali will be connected within 10 minutes by this proposed tunnel.

The feasibility of tunnel boring boring mschine (TBM) were explored for doing the tunnel work as it causes very low vibrations and will have minium impacts on the surface environment. The tunnel may be connected by central 3 m wide baby tunnel; the vertical clearance in each tunnel is proposed to be minimum 5.50m. The two twin tunnel would be about 2D apart in base and each tunnel will consist of the unidirectional lanes. Approximate project cost would be about INR 3000 Crores only.

4.7.2 Reconnaissance

The villages that are under direct impact of the proposed alignment are called as ‘project village area’ in this section of the report. The demographic profile and detailed analysis of the project village area is detailed out in this EIA report. The following are the list of villages that are impacted due to the proposed project presented in **Table 4.7.1**.

Table 4.7.1: List of Villages in the Study Area

Sr. No.	District	Taluka	Villages
1.	Thane	Talasari	Patilpada
2.			Manpada
3.		Thane	Yoor
4.	Mumbai Suburban	Borivali	Magathane

Source: Census 2011 Thane and Mumbai Suburban District, State Maharashtra

4.7.3 Baseline Status

Baseline information is collected after delineation of the baseline study area in order to study the socio-economic profile of the project affected area. The process related to baseline database analysis includes:

- ∞ Demographic Structure
- ∞ Infrastructure Base
- ∞ Economic Structure
- ∞ Health Status
- ∞ Cultural Attributes
- ∞ Salient Observations
- ∞ Public Awareness and their concerns regarding the proposed project
- ∞ Socio-economic status in relation with 'Quality of Life'

4.7.4 Demographic Structure

The proposed project passes through Magathane village of Borivali, and Yeoor, Chene, Boriwade, Majiwade, and Manpada villages of Thane. These affected villages have different demographic profiles. The demographic structure of the study area was derived primarily from data of Census Record of Thane and Mumbai Suburban district covering three tehsil and 4 villages. This section of demographic profiling of project village area included population count, sex ratio, literacy, working population and marginal worker shares. This data shall provide information regarding the social profile of the villages and helps to identify the vulnerable groups.

The demographic structures of each village in the study area as per Census 2011 are presented in **Table 4.7.2**. Summary of demographic structure is presented in **Table 4.7.3** and worker pattern, main worker employment pattern are presented in **Table 4.7.4** and **Table 4.7.5**.

Table 4.7.2: Demographic Structure of Village in the Study Area

Sr. No.	Villages	Total Population				0-6 Child Population			Scheduled Cast			Scheduled Tribes		
		Household	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
District: Mumbai Suburban														
1.	Magathane	139924	598881	327878	271003	58398	30701	27697	30462	15835	14627	8983	4772	4211
District: Thane Tehsil: Talasari														
2.	Patilpada	602	3000	1423	1577	559	275	284	0	0	0	2974	1412	1562
3.	Manpada	188	949	439	510	152	71	81	1	1	0	944	434	510
District: Thane Tehsil: Thane														
4.	Yeoor	-	3010	1190	1820	-	-	-	200	-	-	2800	-	-
Subtotal		790	6959	3,052	3907	711	346	365	201	1	0	6718	1846	2072
Total		1,40,714	6,05840	3,30930	274910	59109	31047	28062	30663	15836	14627	15701	6618	6283

Source: Census 2011, Thane and Mumbai Suburban District, State Maharashtra

Table 4.7.3: Summary of Demographic Structure in Study Area

Demographic Parameters	Details
No. of States	1
No. of District	2
No. of Tehsil	3
No. of Villages	4
No. of Villages Surveyed	4
Total No. of Households	1,40,714
Total Population	6,05,840
Sex ratio (No. of female \ 1000 males)	831
Scheduled Castes	30,663 (5.06%)
Scheduled Tribes	15,701(2.59%)
Literate	4,91,888 (81.19%)
Total Worker	2,50,098 (41.28%)
Main Worker	2,34,280 (38.67%)
Marginal Worker	15,818(2.61%)
Non Worker	3,54,622 (58.72%)

Source: Census 2011 Thane & Mumbai Subran District, State Maharashtra

Salient Features of Demographic Structures are given below:

Population

As per census 2011, the following enlisted the population data are of the directly affected villages. Out of the affected villages, larger impacts will be seen on villages having high populations

- ∞ The study area covers two districts which are Thane and Mumbai Suburban in Maharashtra State.
- ∞ Socio-economic survey was conducted in the 4 villages in the study area.
- ∞ Total population in the study region (Census 2011) worked out to be 6,05,840, out of which 3,31,030 (54.62%) male and 2,74,910 (45.38%) female (**Figure 4.7.2**).
- ∞ Total number of households recorded was 1,40,714 with average occupancy of 4 persons per household.

Scheduled Caste and Scheduled Tribes

- ∞ Out of the total population, SC and ST are 30,663 (0.06%) and 15,701 (2.59%) respectively.
- ∞ As regards vulnerability, it would be safe to say that poverty is actually a reason for making a section of the population quite vulnerable.
- ∞ It would be safe to say that the families belongs to SC and ST are observed vulnerable

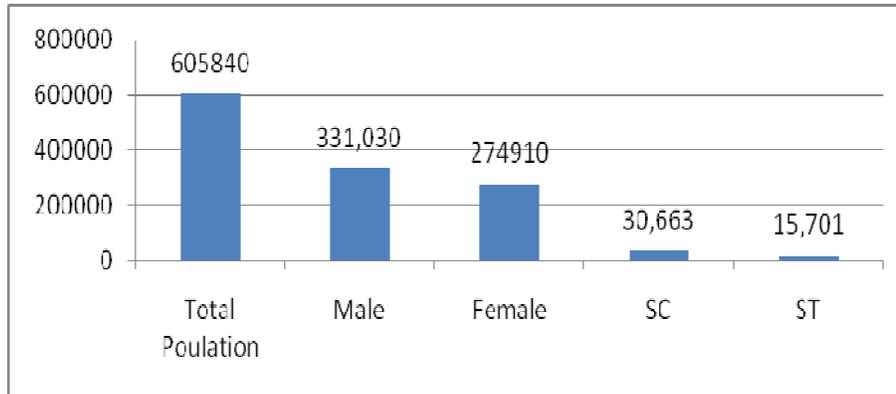


Figure 4.7.2: Population Details in the Study Area

Literacy and Illiteracy Rates

- ∞ The literacy rate of the total population is worked out to be 4,91,888 (81.19%). Male literacy 27,8769 (46.10%) and female literacy is 2,11,559 (35.09%)
- ∞ The Illiteracy rate of the total population is worked out to be 1,12,502 (18.81%) male Illiteracy 50,971 (8.46%) and female Illiteracy is 61,531 (10.21%)
- ∞ The male and female literacy rate and the graph of literacy are shown in **(Figure 4.7.3)**
- ∞ The villages that show high high literacy rates imply the villages have better skills and education, thus ensuring better prospects for employment
- ∞ Villages with low literacy rates will become vulnerable.
- ∞ Also, social evils like poverty, child marriage, child labour, all types of blind beliefs and superstitions are also some of the consequences of illiteracy.
- ∞ The villages with low literacy rates these villages may show relatively more economic and social vulnerability.

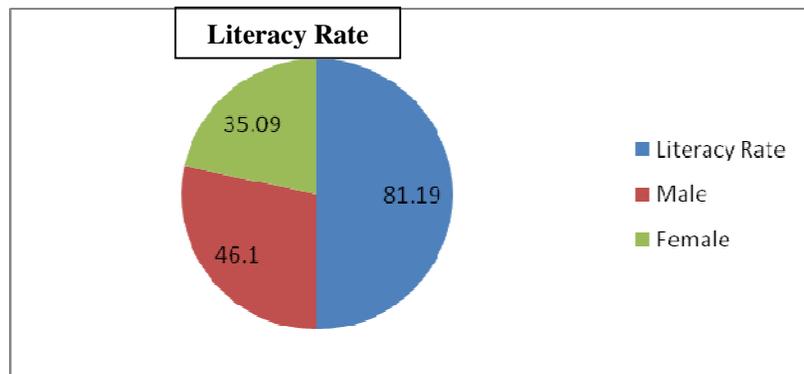


Figure 4.7.3: Literacy Rates

Worker and Employment Pattern

- ∞ The total population of main worker, marginal worker and non-worker category are 2,34,280 (38.67%), 15,818 (2.61%) and 3,54,622(58.72%) respectively.
- ∞ The majority of the main worker are cultivator worker 844 (0.36%) and agricultural workers 1,513 (0.65%).
- ∞ There are 6,606 (2.83%) household worker and 2,24,237 (96.16%) as other workers (**Figure 4.7.4**).

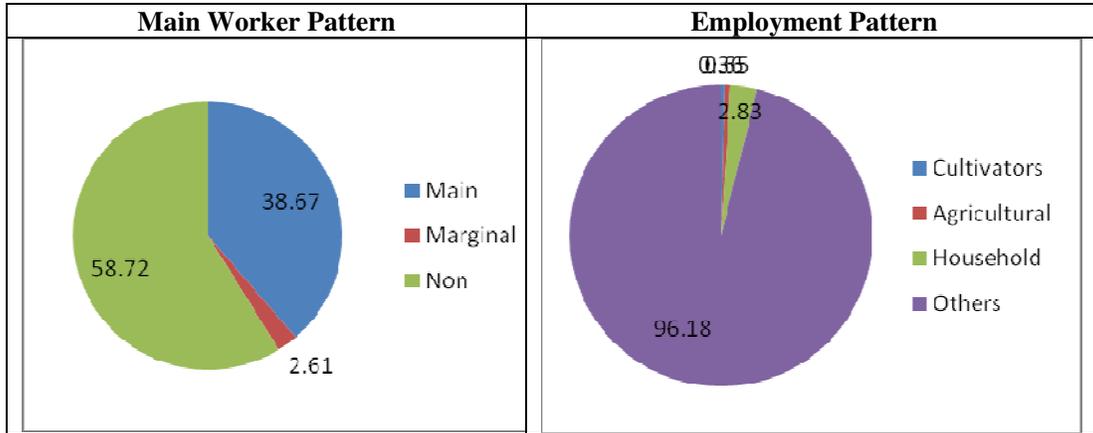


Figure 4.7.4: Worker and Employment Pattern

Sex Ratio

- ∞ Sex ratio (number of females per thousand of males) in the region is recorded as 831 indicating male population in the region is marginally higher than the female population.
- ∞ The sex ratio of Maharashtra state as per Census 2011 is 929. It is observed that the villages under study shows the sex ratio is less (831) as compared to Maharashtra state.
- ∞ Total child population in the study region is worked out as 59,109 (9.81%) out of which 31,047 (5.15%) are boys and 28,062(4.66%) girls (**Figure 4.7.5**).

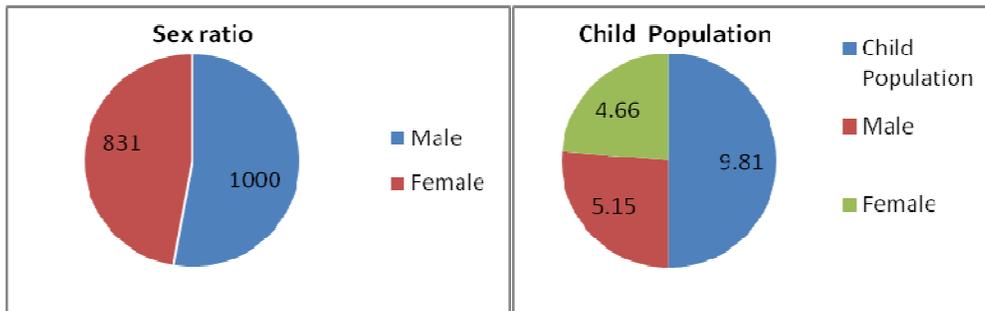


Figure 4.7.5: Details of Sex Ratio and Child Population

4.7.5 Economic Attributes

The classification of workers is based on their occupation. Economic resource based on any region mainly depends upon its economically active group i.e. the working population involved in productive work. Work may be defined as participation in any economically productive activity. Such participation may be physical or mental in nature. Work involves not actual work but also effective supervision and direction of work. It also includes unpaid work on farm or in family enterprise. There are different types of workers that may be classified as under with main workers employment pattern given in **Table 4.7.4** and **Table 4.7.5**.

Table 4.7.4: Worker Pattern in the Study Area

Sr. No.	Villages	Worker Pattern			Employment Pattern		
		Total	Male	Female	Main	Marginal	Non-workers
District-Mumbai Subran							
1.	Magathane	2,46,627	1,94,343	52284	232353	14274	352254
District-Thane							
2.	Boriwade	1170	716	454	614	556	1830
3.	Manpada	411	229	182	233	178	538
4.	Yeoor	1890	-	-	1080	810	-
Subtotal		3471	945	636	1927	1544	2368
Total		2,50,098	1,95,288	52,920	2,34,280	15,818	3,54,622

Source: Primary Census Abstract 2011, District Thane & Mumbai Suburban, Maharashtra

Table 4.7.5: Worker Employment Pattern

Sr. No.	Villages	Cultivators	Agriculture	Household	Others
District-Mumbai Subran					
1.	Magathane	562	1339	6601	2,23,851
District- Thane					
2.	Boriwade	210	125	1	278
3.	Manpada	72	49	4	108
4.	Yeoor	-	-	-	-
Sub Total		282	174	5	386
Total		844	1513	6606	224237

Source: Primary Census Abstract 2011, District Thane & Mumbai Subran, Maharashtra

- ∞ Villages with low working population rates make them susceptible to many economic and social vulnerable.
- ∞ Providing employment opportunity or creating multiple platforms for economic development shall reduce risks of such villages
- ∞ As per census definition, the working population is divided into two categories - main workers and marginal workers. As per the figure below, amongst the working population, the percentage of main workers is 38.67% in the villages.

4.7.6 Infrastructure Resources

The infrastructure resources base of the eleven study areas with reference to education, medical facility, water supply, post and telegraph, transportation,

communication facility, power supply etc. according to the Village Directory Census CD 2011 supply is given in **Table 4.7.6.**

Table 4.7.6: Infrastructure Resource Base of the Study Area

Sr. No.	Village	Education	Medical	Water	Sanitation	Communication	Transportation	Road	Bank	Power	SHG
1.	Boriade	GPPS (3), GPS(2), GMS(2), GSS	VH	TWT, UW, HP, TW/B	OD, OPD U	PO, P&TO, TP, PCO, MPC	GBS, A/MA, T, V, NH	BTPR, GKR, AWR, WBM, F	ACS	PSAU	SHG
2.	Manpada	GPPS (2), GPS	NA	UW, HP, T/P/L	ND	TP, MPC	GBS	BTPR, GKR, AWR, WBM, F	NA	PSAU	SHG
3.	Yeoor	-	-	-	-	-	-	-	-	-	-

Source: District Census Handbook 2011, District-Thane

Abbreviations:

Education	Medical facility	Drinking Water	Transportation	Sanitation	Communication	Road
AC: Anganwadi Center	PHC: Primary Health Centre	TWT: Tap Water Treated	GBS: Govt. Bus Service	Open Drainage	PO: Post Office	BTPR: Black Topped Road
GPPS: Govt. Pre - Primary School	VH: Veterinary Hospital	CW; Covered Well	A/MA: Auto/Modified Autos	Open Pucca Drainage Covered	P&TO: Post & Telegraph office	GKR: Gravel (kuchha) Road
GPS: Govt. Primary School	SHG: Self Help Group	UW: Uncovered Well	V: Van	Open Pucca Drainage Uncovered	TP: Telephone	WBM: Water Bounded Macadam
GMS: Govt. Middle School	NA: Not Applicable	HP; Hand Pump	T: Taxi	No Drainage	PCO: Public Call Office	AWR: All Weather Road
GSS: Govt. Secondary School	BANK	T/P/L: Tank/Pond/Lake	NH: National Highway	Open Kuccha Drainage	MPC: Mobile Phone Coverage	F: Footpath
	ACS: Agriculture Credit Society	TW: Tube Wells/Borehole	POWER PSAU: Power Supply For All Users			

Observations on Infrastructure Resources

The salient observations recorded during socio-economic survey in the study area are:

(a) **Education Facilities:** In the study area, education is available from Primary School to Secondary School. Higher education facilities were available in the range of about 10 km. Colleges and other diploma courses are available at Thane and Mumbai city about 10-20 km away from the project site.

(b) **Medical Facilities:** There is one healthcare facility available within the study area at Village Magathane. However; two villages namely Patilpada and Manpada in the study areas were lacking in medical facilities. Hospitals and other better medical facilities were available at Mumbai and Thane.

(c) **Drinking Water:** The main water supply in the surveyed villages is through well, tap water, hand pump, and tube well is the main sources of drinking water in the region.

(d) **Power Supply:** All villages are availing electricity facility for all purpose.

(e) **Transportation:** For transportation purpose Auto, Taxi and Public Bus services are available in the study area. Transportation facilities were frequently available in the region. Some of the People Private vehicles like Cycles and Motorcycles were used by for transportation purpose.

(f) **Communication Facilities:** For communication purpose mainly Post Office, Telephone, Mobile phones and newspaper are available in most of the villages.

(g) **Grampanchayat:** Most of the villages have Grampanchayat looks after the activities of villages in the study area.

(h) **Agriculture:** Few of the respondents are engaged in labor work, agriculture and livestock activities. Business is the main occupation; a few respondents service in government sectors. Most of the respondents are labors and others are trying to migrate towards Thane and Mumbai city.

(i) **Houses:** Most of the houses are pakka and Semi pakka with good construction in the study area.

(j) **Employment:** main occupations of the people in the study area are agriculture and labor work. The labors were getting daily wage in the range of Rs. 500-600, depending on the type of work involved.

(k) **Fuel:** The primary source of cooking fuel is LPG and wood. Kerosene is also been used as per the requirement

(l) **Main Crops:** paddy is the main crop grown in the study area, major producer of oilseeds. Groundnut, sunflower, soybean are major oil seed crops. Important cash crops grown are cotton, sugarcane, turmeric and vegetables. Average crop productivity of paddy is 8-10quintal per acre.

(m) **Language:** Official language and mother tongue is Marathi. Most of the people follow Marathi and Hindi too.

(n) **Migration:** During survey it was found that local population were migrating maximum towards the Mumbai city as a purpose of employment.

(o) **Sanitation:** Toilet facility is one of the most basic requirements in a house. Most of the households are having toilet facilities in their houses. The villages having proper drainage line, soak-pit facilities were observed in some of the surveyed village. The overall condition of cleanliness is satisfactory in the villages of study area.

(p) **Road Connectivity:** Most of the roads are made of asphalt and cement and connect the villages. Both asphalt and cement roads were commonly seen in villages.

(q) **Market Facility:** Study area is predominantly urban type. In villages, small shops are available for daily needs. Daily market facilities were available in all villages. Wholesale markets are available at town place. Mumbai is major hub for all type of facilities in the area.

(r) **Recreation:** Temples, Samaj Bhawan, Television and Radio are the main recreation facilities in the study area. Newspaper/Magazine are also used by the villagers

4.6.7 Health Status

Diarrhea / Cholera, Malaria, Cough, Cough; viral fever, eye disease, skin disease and unhygienic are the general health problems which are attributed due to improper sanitation, mosquito nuisance and water logging. Malaria is one of the most frequently occurring diseases and also respiratory infection in the region.

4.7.8 Socio-Economic Survey - Sampling Methodology

The purposive sampling technique, also called judgment sampling. Purposive sampling method were used for choosing respondents of various sections in the society i.e. Sarpanch, adult males / females, teachers, medical practitioners, businessmen, agriculture labourers and unemployed group etc. Judgmental or purposive sampling method includes right cases from the total population that helps in fulfilling the purpose of study needs. The discussions were made in the locality with the villagers in the study area as shown below:

Data Collection Method

In order to assess and evaluate the likely impacts arising out of any developmental projects on socio-economic environment, it is necessary to gauge the apprehensions of the people in project area. For the process of data collection through primary and secondary sources certain methods are used as given below:

Field Survey and Observation

Field survey and observations is made at each sampling villages and the quality of life of that region is studied. Visits are made to hospitals, primary health centres to know the health status of the region. Various governmental organizations such as statistical department, department of census operations are visited to collect the population details of that region.

Interview Method

Structured interview method is used to collect data regarding the awareness and opinion of sample selected from various socio-economic sections of the community. Structured interviews involve the use of predetermined set of questions that includes fixed and alternative questions. The questionnaire mainly highlights the parameters such as income, employment and working conditions, housing, food, clothing, water supply, sanitation, health, energy, transportation, communication, education, environment and pollution to assess the quality of life of that particular region, general awareness and opinion of the respondents about the project. Interview method helps to collect error free and accurate information to the interviewer during the field survey. The respondents were asked for their awareness / opinion about the project and also the impacts of the project which is an important aspect of socio-economic environment, viz. job opportunities, education, health care, transportation facility and economic status.

Focus Group Discussion

A focus group discussion is a small, but demographically diverse group of people. It is a form of qualitative research consisting of interviews in which a group of people are asked about their perceptions, opinions, beliefs, and attitudes towards an employment, income, transport, education, medical facilities, sanitation, housing, health, agriculture, pollution etc. Questions are asked in an interactive group setting where participants are free to talk with other group members. During this process, the researcher either takes notes.

Through the focus group discussion of all these factors, the proposed project helps in evaluating socio-economic conditions in the study area.

The study was carried out with a participatory approach by involving the stakeholders, particularly the project beneficiaries and probable affected persons through a series of consultative process. The population groups consulted include beneficiary group of people shopkeepers, farmers, school teachers, gram panchayat sarpanch / members, village leaders, etc.

4.7.9 Awareness and Opinion of People about the Project

- ∞ An attempt has been made to know the awareness and opinion of the people about the proposed Tunnel Project.
- ∞ The respondents were happy to know about the proposed tunnel project and they responded positively because any developmental activity would definitely contribute towards development and improvement of local as well as regional economy.
- ∞ Villagers also added that due to non-availability of technical education most of the local educated youth are not offered jobs in the company. So they would prefer professional educational and training facilities in the region under proposed project activities.

4.7.10 Cultural and Aesthetic Environment

- ∞ There are no cultural and heritage sites that could be affected due to the proposed and construction along or in close proximity to the study area.
- ∞ The Khaneri caves is located in the SGNP but quite away (2.5km) from the project site

4.7.11 Quality of Life Assessment (QoL)

QoL is a term which indicates overall status of socio-economic environment in a given area.

- ∞ The quality of life for this study area is leaning satisfactory level due to economic status like income, employment, education, medical facility and also availability of basic needs viz. food, clothing and housing.
- ∞ The area lacking with employment and social security, beside's lack of sanitation, which are not observed much satisfactory.

4.6.12 Rehabilitation and Resettlement Plan (R & R Plan)

- ∞ As there is no existing settlement on the proposed project area, there are no issues of resettlement or rehabilitation.

4.6.13 Expected Socio-economic Benefits of the Project

- ∞ By improving the existing road connectivity, the project will substantially reduce the existing the transport bottleneck to trade and will foster economic cooperation
- ∞ The entire regional connectivity with the important destinations will be promoted from the project improving the project road will reduce transport cost
- ∞ The distance between Thane and Borivali is also expected to reduce by over 10km
- ∞ Travel time saving 20 to 25 minutes and no disturbance to existing townships

This will also results in avoidance of traffic jams and saving fossil fuel and protecting environment due to reduced vehicular emissions.

Chapter 5

Anticipated Environmental Impacts and Mitigation Measures

5.1 Identification of Impacts

The identification, assessment and cumulative of impacts over various environmental attributes in the study area due to proposed tunnel project have been discussed and evaluated and presented in this chapter.

Various techniques are available for identification of impacts in the present case for the activities related to the proposed highway tunnel from Borivali to Thane passing below SGNP by adopting of Network Method which involves understanding of cause-condition-effect relationship between an activity and environmental parameters for identification of impacts has been found to be most appropriate methodology.

5.2 Prediction of Impacts

Prediction of impacts is the most important component in environmental impact assessment process. Several mathematical / statistical techniques and methodologies are available for predicting impacts due to developmental activities on physico-ecological and socio-economic environment. The results obtained from predictions are superimposed over the baseline (pre-project) status of environmental quality to derive the ultimate scenario of environmental conditions. The quantitative prediction of impact is also essential to delineate pragmatic environmental management plan (pollution control measures) for implementation during and after the commissioning of the proposed activities for minimizing the adverse impacts on environmental quality.

Mathematical models are the best tools to quantitatively describe cause-condition-effect relationships between sources of pollution and different components of environment. In case, mathematical models are either not available, it is not possible to identify / validate models for a particular situation; predications are arrived at through available scientific knowledge and judgments. In case of water, land, biological and socio-economic environments, the prediction have been made based on the available scientific expertise and judgments. The impacts are also analyzed with to pre-construction, construction and operation phases and were categorized in terms of magnitude and significance as given below:

5.3 Pre-construction Phase

The primary aim of the environment management plan is to eliminate environmental impacts during designing wherever possible or minimize the risks through best engineering controls. The tunnel route has been selected in such a manner to avoid the possibility of geo-hazards such as faults and landslides that can cause damage to tunnel. The environmental pollution during construction phase is purely temporary and localized except permanent change in local land-use and landscape at the proposed tunnel at both the ends only. Environmental pollution in construction phase will be mainly due to site preparation, civil works, transportation, storage and handling of different kinds of materials including hazardous materials, construction workers' sanitation etc. The environmental impacts during construction period are considerably less and of shorter duration. However, they require due consideration and importance during project execution, and also wherever applicable detailed protocol / procedures shall be implemented to prevent / mitigate adverse impacts / occupational hazards. Alternative alignments assessment is carried out for environmental feasible option of Tunnel construction. Also the tunnel construction methodology is studied owing to the environmental sensitivity of the project area. The details of the studies are given below:

5.3.1 Natural Hazards and Vulnerability

Seismic Profile of the Area: In peninsula India the state of Maharashtra, has suffered from frequent earthquakes, both deadly and damaging, although not located on or near any plate boundaries. All the earthquakes here, as in all of peninsula India, are interpolating events. The seismic hazard map of India was updated in 2000(5) by the Bureau of Indian Standards (BIS). Apart from the merging of Zones I and II into Zone II in the latest map, there are no major changes from the BIS 1984 map. Zone III stretches across the length of southern borders of Gujarat, Dadra and Nagar Haveli and western parts of Maharashtra state, which includes the areas of Mumbai, Thane, Kalyan etc., where the maximum expected intensity is IV.

According to 2014 seismic zoning map of India, the western parts of the state of Maharashtra falls in Zone III and IV on the basis seismic hazard as shown in **Figure 5.1**. However, the entire project area in Borivali (Mumbai) and Thane districts in Maharashtra state falls in Zone III (Moderate Seismic Zone) where intensity zone IV earthquakes can be expected due to high earthquakes. This zone is classified as moderate damage risk zone which is liable to MSK IV.

Based on frequency and intensity of the expected earthquakes in different areas, these have been categorized in different seismic zones on the seismic zoning map of India. Higher the zone the seismic hazard risk is more. Mumbai region falls in Zone IV on this seismic zoning map dividing India in to II to V different zones.



Figure 5.1: Seismic Zone Map of India

Faults and Seismo-tectonics: At least one known mapped fault is crossed between Thane and Panvel region away from the proposed tunnel alignment and preliminary indication from the literature suggest that may continue to be active. **Figure 5.2** shows the potential faults traced between Thane and Panvel near Mumbai as shown in Seismo-tectonic Map of the project area. This fault should be investigated prior to detailed design, following location of the exact position and predicted seismically induced displacement. Fault activity may be assessed by field trenching and age dating. Some of the faults may ultimately be discounted as inactive at a later stage, prior to construction. The tunnel route will be designed in accordance with the Indian seismic design code IS 1893 (Indian standard criteria for earthquake resistance design of structures). The designs for tunnel and other structures shall consider the corresponding seismic zone factor.

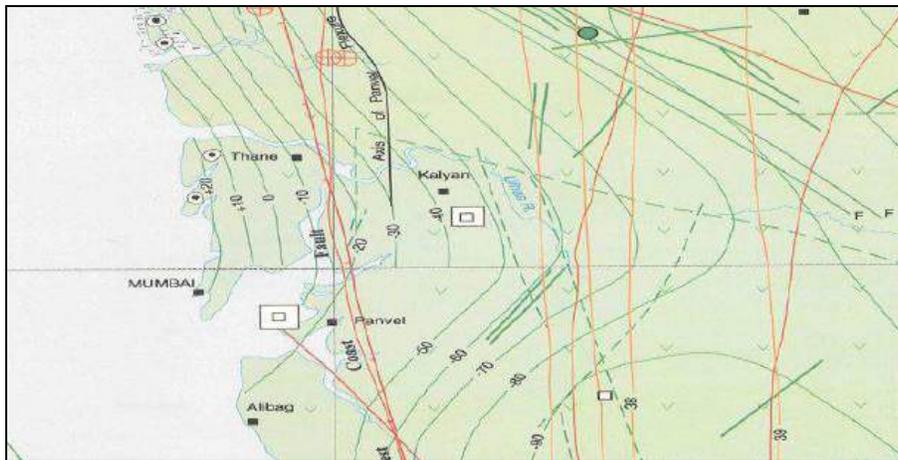


Figure 5.2: Seismo-tectonic Map of the Project Area

In order to understand the potential of seismic and geo-hazards along the tunnel alignment and to ensure minimization of environmental impacts and life safety risks to acceptable levels, Project proponent has conducted a study and mapped the seismic zones due to earth quake shaking etc. It should be emphasized that the tunnel passing through active seismic zone are possible and may be engineered to reduce any risk of rapture to an absolute minimum value. Due consideration may be given to these aspects during the design of tunnel route and other structure. The following measures are envisaged to mitigate the seismic and geo-hazards risks:

- ∞ Selection of ground amplification factors depending upon soil classification along different sections of the tunnel alignment
- ∞ Assessment of probabilistic seismic hazard analysis etc.

5.3.2 Land Use Land Cover

Figure 5.3 below shows the least area of land use and land cover is water bodies (0.043%) and height area covered by forest-dense and forest-open are (29.784%) and (34.449%) respectively. It indicates that the proposed tunnel is passing below SGNP and thus impact on land use and land cover is found insignificant.

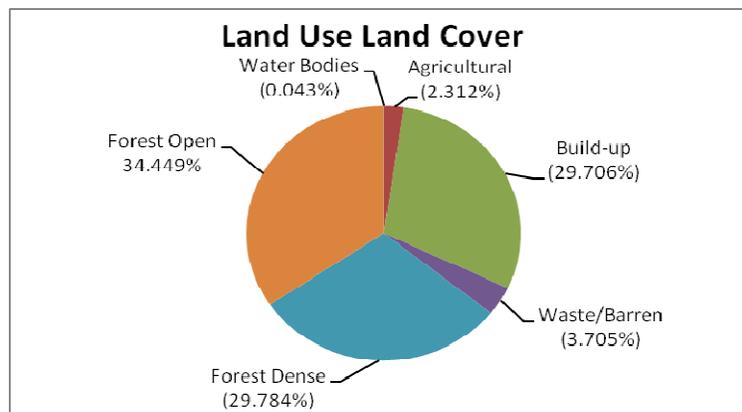


Figure 5.3: Land Use Land Cover of the Study Area

5.3.3 Analysis of Alternatives

The alternative locations / routes analyzed during the survey so as to leave least impact on the environment. The tentative options as identified during the preliminary assessment. Three portals on either end were identified and respective alignments were evaluated. Many possible alignments due to involvement of forest and defense land in large extent were rejected. Other possible alignments (Option-1, Option-2 and Option-3) are studied and discussed subsequently. The three alignments of the options were comprehensively studied and compared as shown below:

- ∞ Option 1 was discarded due to unavailability of access road.
- ∞ It was decided to go with Option-2 as it is causing minimal disturbance to forest, wildlife, and the surrounding environment. Hence the same was persuaded and finalized for further investigations/studies in consultation with MMRDA.

- ∞ Option 3 was discarded due to unavailability of sufficient overburden disposal site and access road on eastern portal side passes through dense urban area of Vartak Nagar.

5.3.4 Site Preparation

The soil investigations such as bearing capacity, resistivity, temperature, etc., will be undertaken during / before commencement of construction work of tunnel route.

The following measures shall be taken for site preparation activities:

- ∞ Ensure natural drainage channels are avoided or rerouted to ensure unhindered flow of rain / flood water where necessary adequate erosion control measures will be provided
- ∞ Located in manner to avoid / minimum cutting/felling of trees
- ∞ Maximum care will be taken to avoid other sensitive plant life
- ∞ Consultation with local authorities regarding preferred tunnel routings
- ∞ Plan routing to minimize subsequent disturbances to natural resources
- ∞ Use hand cutting to clear vegetation initially as necessary to be selective in using machinery and identify sensitive flora for re-plantation
- ∞ Where vegetation and soil are removed ensure proper separation and storage / collect seed, rootstock, brush for subsequent re-vegetation
- ∞ Incorporate drainage and minimize disturbance to natural drainage pattern, engineer slopes and drainages to minimize erosion. Design for storm water drain
- ∞ Minimize vegetation loss and disturbances.
- ∞ Do not burn brush and uprooted materials
- ∞ Since construction activity is for a short-term, the overall impact on the air, water and soil environment during construction phase is likely to be local, temporary and insignificant
- ∞ General tunnel construction standards would be established to minimize surface disturbance, provide soil stability and presence reclamation potential
- ∞ The project site shall be secured by fencing and controlled entry points during construction and operation.

5.3.5 Tunnel Construction Technology

TBM method can be adopted for the proposed project construction according to the assessment of best technology. Bored tunneling by using a Tunnel Boring Machine (TBM) is often used for excavation long tunnels. An effective TBM method requires the selection of appropriate equipment for different rock mass and geological conditions. The TBM may be suitable for excavating tunnels which contain

competent rocks that can provide adequate geological stability for boring a long section tunnel without structural support. The process for bored tunneling involves all or some of the following operations:

Probe Drilling (when needed)	Transportation of musk
Grouting (when needed)	Lining or coating/sealing
Excavation	Draining
Supporting	Ventilation

TBM is a best method for excavation of shallow tunnel irrespective of shape for cut and tunneling commonly used for construction of stations. Drilling and blasting, bored and tunneling and sequential excavation methodology will be used.

5.3.6 Hydrology

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

- ∞ Hard Rock Areas
- ∞ Deccan Trap Basalt

There are mainly two types of ground water structures i.e. dug wells and bore wells in the area. The yields of the dug wells varies from 10 to 1000 m³/day, whereas that of bore wells ranges between 50 and 1000 m³/day tapping the promising aquifer in the depth range of 40 to 60m bgl. The above description confirms following points:

- ∞ The tunneling is being carried out in the hard rock formations of Kanheri - Tulsi area
- ∞ The Tunnels being dugout about 20 m below ground level (bgl)
- ∞ There are little chances of having substantial aquifers at that level
- ∞ The Tulsi Lake is 4.9 km away from the tunnel locations.
- ∞ It is feeding on surface water collected during monsoon and does not have dependence on any aquifers

Considering the above facts, it is very unlikely that the proposed tunnel will have any impacts on the aquifers of Tulsi Lake water catchment.

5.4 Construction Phase

5.4.1 Air Environment

(a) Prediction of Impacts: The impact of ambient air quality within the project site and nearby areas may be significant during the construction phases. The ambient air quality in the proposed tunnel project alignment is generally good and well within the National Ambient Air Quality Standards, (NAAQS, 2009). Some important observations in the ambient air quality are:

- ∞ The emissions of individual vehicles, their monitoring and regular checks are important. The fuel composition, maintenance of engines, and engine temperature must be properly regulated for improved scenario.
- ∞ As there is no structure of archaeological importance (Kanheri Caves- 2.5 km away) going to be affected due to proposed alignment, the impact does not need an assessment from this point of view. Sensitive areas will be taken care of especially in this regard.
- ∞ By and large the pollution level with regard to Particulate Matters (PM_{2.5}) and (PM₁₀) at all study areas were within the standard prescribed limits.
- ∞ The other gaseous parameters of air quality measurements, namely, Oxides of Nitrogen (NO_x), Sulphur Dioxide (SO₂) and Carbon Monoxide (CO) at all selected sites were also recorded to be within the standard prescribed limits.
- ∞ Particulate matter will be the main pollutant at the project site due to the tunnel boring machine, excavations, handling and transport of earth and construction material etc.
- ∞ The other pollutants will be NO_x due to the construction activities like operation of construction equipment and traffic movement.
- ∞ Since the construction activities is a temporary activity and hence the increase in particulate matter and NO_x will be for short duration and its impact will be felt close to the tunnel construction site only.
- ∞ Outside the boundary of project activities, the impacts would be marginal or insignificant.
- ∞ Generation of exhaust gases is likely due to movement of heavy machinery for clearance of the proposed RoW for construction.
- ∞ Although the impact will be much localized, it can spread downwind direction depending upon the wind speeds.
- ∞ The health effects of inhaling particulate matter have been widely studied in humans and animals and include asthma; lung cancer, cardiovascular issues, and premature death.
- ∞ Raising of dust from construction areas by wind, vehicle movements and other activities
- ∞ Spill of construction material during transportation, loading, unloading, material transfer
- ∞ Haulage roads used for transportation of material and for disposal of debris generated
- ∞ Dust is not only a threat to lungs and eyes, but may contribute to poor visibility

- ∞ Fugitive emissions from construction machinery / vehicles involved in construction
- ∞ Exhaust from stationary combustion sources, including generators, heaters
- ∞ Exhaust from tunnel boring machines, either directly, in the case of diesel powered tunnel boring machines or indirectly, in the case of electric tunnel boring machines powered by diesel generators etc.

(b) Mitigation Measures: The contractor will be responsible for putting in place a comprehensive dust management strategy and typical components of such a strategy will include:

- ∞ The mitigate measures suggested include the policies, regulation and enforcement programs covering vehicle standards and maintenance requirement, fuel quality and technology, management of traffic efficiency and removing the high-pollution vehicles besides plantation of tall, leafy, and dense vegetation to filter and adsorb some pollutants.
- ∞ Demolition activities will be performed using appropriate dust controls such as consideration of meteorological conditions, use of water sprays and ensuring proper covering of materials transported from the one site and to other site
- ∞ Trucks transporting excavated material will be washed down and covered with tarpaulin prior to exit from the worksites to prevent windblown dust during transport
- ∞ The place where muck generated due to the construction will be collected shall be kept covered from all the sides, so that soil / rock particles are not carried by wind.
- ∞ Water will be sprinkled regularly twice a day on haulage roads.
- ∞ Provision of water sprays on unsealed trafficked areas in the worksites and newly established stockpiles at the dumpsites.
- ∞ All vehicles / construction machineries involved in the construction will adhere to the emission norms as specified by the SPCB.
- ∞ Bathing plants will be sited away from the congested locations and human settlements.
- ∞ Management measures of diesel exhaust emission will include:
 - ∞ Avoiding queuing of the construction traffic vehicle fleet on the roads adjacent to the sites to minimize the exhaust emissions generated during construction work
 - ∞ Wherever possible exhaust emissions from mobile and stationary plant will be directed away from the ground
 - ∞ Vehicles and machinery will be fitted with appropriate emission control equipment and maintained adequately to meet manufacturer's specification

Specific Mitigation Measures: Not to use road construction machines as well as self-propelled machines with damaged engines.

- ∞ Excavation at the tunnel portals will be performed within the enclosed work sheds constructed prior to the commencement of works.
- ∞ Tunnel ventilation air during construction will be treated by passing through particulate filter prior to the exit from work sheds to meet the required standards.
- ∞ Storage areas should be located downwind of the habitation area.
- ∞ Mask and other PPE shall be provided to the all construction workers.
- ∞ Road transportation vehicles should not be loaded with bulk materials beyond the safe-clearance and should be covered during transportation.
- ∞ Disposal of waste, not subject of frequent loading-unloading activity, to be protected from the wind by covers; practice speed restrictions.
- ∞ Burning of wastes generated at the construction sites, work camps and other project-related activities shall be strictly prohibited.
- ∞ Keep stockpiles moist and cover vehicles with tarpaulin sheets to minimize dust emission and prevent spillage of materials (soil, cement, stone, sand, aggregates, etc.).
- ∞ Artificial ventilation of underground excavations should be applied at all stages of tunnel and installation and construction works
- ∞ All operating diesel, petrol construction machines should be equipped with the systems of neutralization of exhaust gases of engines.
- ∞ The amount of air necessary for airing of the constructed underground excavations, should be chosen basing on the condition of non-exceeding the content of harmful and poisonous gases, as well as dust of maximum permissible concentration.
- ∞ Air quality monitoring should be carried out during construction phase. If monitored parameters are above the prescribed limit, suitable control measures shall be taken.

To control fugitive emissions during construction following measures are recommended:

- ∞ The storage and handling of soil, sub-soils, top-soils etc. will be carefully managed to minimize the risk of windblown material and dust, by using of cover sheets like tarpaulin
- ∞ Fugitive dust emissions shall be controlled by application of water sprinkling
- ∞ Trucks hauling dirt, rock or other granular or particulate material to construction site should have their loads limited, trimmed or wetted and covered to prevent material from being spilled / scattered or wind blown over public streets.
- ∞ Nose masks or earmuff should be provided to construction workers, while carrying out operations that may entail potential for dust inhalation.
- ∞ Engines and exhaust systems of all vehicle and equipment will be maintained so that exhaust emissions do not breach statutory limits by

CPCB and that all vehicles and equipment are maintained in accordance with manufactures guidance

- ∞ The air pollution impacts during construction phase would be temporary and contained within the project boundary.

5.4.2 Noise Environment

Noise Due to Stationary Sources: Tunnel Boring Machine (TBM) and diesel generators at construction site can be considered as stationary sources though they may be stationed at a particular site for few weeks. The cumulative noise levels from the above temporary and permanent sources during construction and operation phases have been estimated at various distances using Mathematical Noise Model, as described below:

A singular consolidated noise source at project site was first calculated using the equation ...(1).

During day and night time, a singular consolidated noise source having Leq equal to 103.7 dB(A) is used for calculating noise levels over various distances using equation ...(2).

$$L_n = 10 \log_{10} (10^{L_1/10} + 10^{L_2/10} + 10^{L_3/10} + \dots + 10^{L_n/10}) \dots\dots\dots(1)$$

$$L_2 = L_1 - 20 \log_{10} (R_2/R_1) \dots\dots\dots(2)$$

Where,

LndB(A) = Resultant noise level of combination of sources

L₁dB(A) = Noise level at a distance R₁(m)

L₂dB(A) = Noise level at a distance R₂ (m)

Prediction of Noise Levels: During construction phase the major noise generating sources are Tunnel Boring Machine (TBM), DG sets, Crusher, Excavators, Crane, Concrete mixer, Workshops, Earth moving equipment and Vehicles etc. The major sources of noise pollution during construction are movement of vehicles for transportation of construction materials, waste material from the construction site. At present, there is no noise generating sources along the tunnel alignment. These activities at the site are likely to increase the background noise levels by 1-2 dBA at a distance of 0.2 km. The noise contour Isopleths for construction phase is presented in **Figure 5.4.**

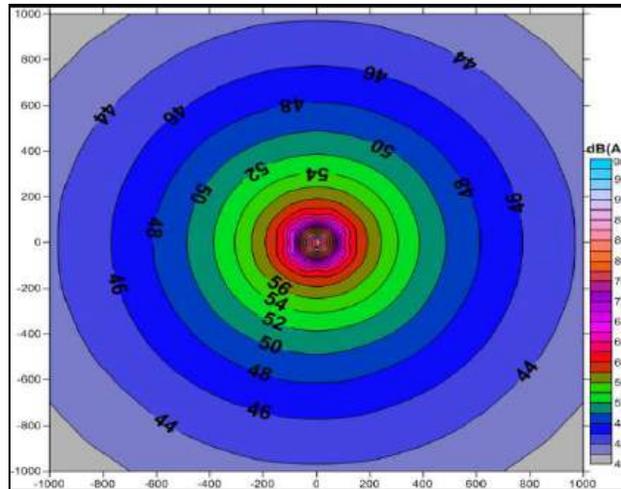


Figure 5.4: Isoleths Showing the Cumulative Noise Levels due to Construction Activity

The results of mathematical calculation of predicted noise levels are presented in **Table 5.1**. Resultant noise levels were calculated at various distances from project site.

Table 5.1: Predicted Noise Levels with Distance

Distance (m)	Source Noise Level (dBA)	Calculated Noise Levels at Receptor (dBA)
100	103.7	64.5
200	103.7	58.4
300	103.7	54.9
400	103.7	52.6
500	103.7	50.7
600	103.7	49.2
700	103.7	47.9
800	103.7	46.8
900	103.7	45.7
1000	103.7	44.9

Interpretation of the Results: DG sets are likely to be used during power failure. Predictions have been made taking into account even DG set in operation and thus reflecting the worst case scenario. The maximum predicted noise level within the tunnel alignment (0.2 km radius) is predicted as 58.4 dB(A). The sound pressure level generated by noise sources, decreases with increasing distance from the source due to wave divergence.

Typical predicted maximum cumulative noise levels of construction equipment are shown in **Table 5.2**.

Table 5.2: Typical Reference Noise Generating Sources of Equipment

Description	Noise Levels dB(A) at 1 m from Source
Earth Movers	
Excavator	90-95
Crane	90-95

Trucks (10t and 16t)	84-88
Dozer	85-90
Dumpers	87-91
Wheel loader	89-94
Tractors	76-96
Scrapers, Graders	80-93
Pavers	86-88
Trucks	82-94
Material Handlers	
Concrete mixers	75-88
Cranes (movable)	75-86
Impact Based Equipment	
Pneumatic Wrenches	83-88
Cranes (derrick)	86-88
Stationary Equipment at storage terminals	
Pumps	69-71
Generators	71-82
Compressors	74-86

Noise Impacts on Community: Day and night sound pressure levels are often used to describe the community exposure. The nearest settlement is near S G Udyan, Manpada Nisarg Parichay Kendra is 0.67 km away from Portal East (Thane) and resultant noise levels at this village is 57.7 dB(A) and 49.7 dB(A) during day time and night time respectively. The nearest settlement near Magathane Jai Maharashtra Nagar Borivali is 0.5 km away from Portal West (Borivali) and resultant noise level at this village are 59.0 dB(A) and 55.4 dB(A) during day time and night time respectively (**Table 5.3**).

Table 5.3: Predicted Noise Levels at Noise Monitoring Locations

Sl. No	Location	Distance (m)	Source Noise Level (dBA)	Calculated Noise Levels at Receptor (dBA)	Baseline L(Day) (dBA)	Baseline L(Night) (dBA)	Resultant Noise Level (dBA) Day Time	Resultant Noise Level (dBA) Night Time
Portal East (Thane)								
N1	Near Neelkanth Garden	2300	103.7	37.3	56.9	44.6	56.9	45.3
N2	Near Pawar Nagar	2000	103.7	38.5	57.5	45.1	57.6	46.0
N3	Near Kokanipada	1000	103.7	44.5	54.2	42.3	54.6	46.5
N4	Near S G Udyan, Manpada	670	103.7	48.0	57.2	44.9	57.7	49.7
N5	Near Godhbandar Road	3300	103.7	30.0	64.4	51.5	64.4	51.5
Portal West (Borivali)								
N6	Near Gopal Garden School	1000	103.7	44.5	60.2	47.5	60.3	49.3
N7	Near Magathane (Borivali)	500	103.7	55.0	56.8	45.3	59.0	55.4
N8	Near Borivalli Bridge	1800	103.7	39.4	61.9	50.1	61.9	50.5

∞ From the above table, it can be seen that the ambient noise levels (day time and night time) at all the locations will remain within permissible limits of CPCB.

- ∞ It can be further concluded that in actual conditions due to presence of various topographical features in the path of sound propagation the noise levels will be further attenuated.

Noise Impacts on Occupational Health: Equivalent sound pressure level (Leq) averaged over 8 hours is used to describe noise exposure in work place environment. The damage risk criteria for hearing as enforced by CPCB and OSHA (Occupational Safety and Health Administration), stipulates that noise level up to 90 dB(A) are acceptable for 8 hrs exposure (working shift) per day. The tunnel route and portals are adequately away from the villages. There will be no direct significant impact due to proposed construction on the nearby villages. However, marginal increase of 1-2 dBA at background noise level would be prevalent during construction phase. Hence, the noise level may not be of much concern from an occupational health point of view.

Noise Impact due to Transportation: The noise impact due to transportation will occur during the construction phase when transporting construction material and machinery to construction site. It is expected that a maximum of 100 vehicles per day will be playing at construction site. This may not be continuous operation but it may last for few weeks at a particular site.

The equivalent noise levels due to traffic are estimated using FHWA (Federal Highway Administration) Traffic noise model, as follows:

$$Leq(h)_i = L_{oe} + 10 \log (n_i/S_i T_i) + 10 \log (15/D)^{(1+A)} + S_o - 13$$

Where,

$Leq(h)_i$ = Leq at hour h for i^{th} vehicle type

L_{oe} = Reference mean energy level for i^{th} vehicle type

N_i = Number of i^{th} type vehicle passing during time T

S_i = Average speed for the i^{th} vehicle type (km/hr)

T = Duration for which Leq is desired

D = Perpendicular distance in meters from centerline of the traffic lane to the location

A = Factor relating to absorption characteristics of ground cover between the roadway and observer

S_o = Shielding factor

Noise levels for light, medium and heavy vehicles on the roads are calculated using the above model and cumulative effect is computed using the following model:

$$Leq(Total) = 10 \log (10^{LeqL/10} + 10^{LeqM/10} + 10^{LeqH/10})$$

Where, $LeqL$, $LeqM$, $LeqH$ are equivalent noise levels for light, medium and heavy vehicles respectively

It is predicted that maximum contribution of vehicles during construction period at 10m and 20m from the edge of the road will be about 60 dB(A) and 56 dB(A) respectively. Considering background noise levels 60 dB(A) along the roads, the incremental increase in noise levels will be 2-3 dB(A). There will be an increase

in noise levels in residential areas situated close to the road due to movement of trucks. However, the impact of truck movements on noise levels in residential areas situated at 100 m and beyond will be insignificant and will be below the stipulated standard of CPCB i.e. 55 dB(A) during day time.

Vibration

(a) Impact due to Ground Vibration: The source of the vibration and noise during construction of tunnel is due to operation of Tunnel Boring Machine (TBM). Human response to vibration is subjective and will be different for different people. When the vibrations reach the floors and walls it may result in perceptible vibration depending on the amplitude and frequency of the vibrations. People may be more annoyed if they are exposed to both noise and vibration compared to when only vibration is felt. According to the U.S. Department of Transportation (1998) the perception threshold of humans for peak particle velocity is about 0.04 mm/s (65VdB with reference 1e-6 inch/sec). To know the impact of vibration due to TBM operation on wildlife in Core area of SGNP due to construction and operation will be studied by National Institute of Rock Mechanics (NIRM) by selecting the most sensitive area falling on the proposed tunnel alignment.

No ground vibration impacts are expected on property and human beings due to proposed project due to absence of any major vibration source during construction and operation phases. However, the vibration impact will be temporary in nature similar to noise impacts. Full body vibration and hand-arm vibration impacts will be felt by operators sitting in heavy machineries and operating vibrating devices, respectively. Necessary precautions in workplace environment shall be exercised to reduce work place vibration impacts.

(b) Mitigation Measures: The noise levels are considered to have insignificant impact on community. However, the following noise mitigation measures shall be followed:

- ∞ Earth movers and construction machinery with low noise levels should be used
- ∞ Transport of construction material from the site should be restricted during daytime
- ∞ Use of personal protective devices such as ear-muffs, ear-plugs etc. should be enforced
- ∞ Either acoustic barriers / shelters shall be developed in noisy work places or acoustic enclosures shall be provided for the high noise generating equipment.
- ∞ Noise suppression equipment and baffling should be employed on ventilating machinery, compressors and generators especially when they are operated in silence zone.
- ∞ Periodic maintenance of construction machinery and transportation vehicles should be undertaken to reduce the noise impact
- ∞ To limit the impact of noise in residential areas in according with national legislation, construction activities will be coordinated with local residents, restriction on idling time for machines and equipment, servicing and regular maintenance of construction vehicles

- ∞ To travel on predetermined routes and approaches to strictly comply with the permissible speed when crossing settlements, limiting working hours in time zones designated by local authorities, in the case of acoustic emission in a specific direction to use acoustic barriers to break the line of impact from noise source to noise receiver.
- ∞ To reduce noise level in the tunnel and constructions adjacent to the tunnel it is necessary to use the sound-proofing and sound-absorbing barriers.
- ∞ To installation of noise suppressors at inducing and exhaust in ventilation systems.
- ∞ The contractor shall develop and adopt effective measures both in terms of management and the technologies applied to minimize noise levels, particularly near settlements.
- ∞ Overall, the impact of generated noise on the environment is likely to be insignificant, reversible and localized in nature and mainly continued to the day hours as sufficient noise control measures would be undertaken
- ∞ Equipment should be standard, good working condition, properly lubricated and maintained to keep noise within permissible limits.
- ∞ Tall trees with heavy foliage shall be planted along the boundary / project site / plantation area, which will act as a natural barrier to propagating noise.
- ∞ If required silent DG sets shall be used at project site otherwise mainly use electricity for working of equipments
- ∞ Use of horns / sirens shall be prohibited
- ∞ Regular noise monitoring shall be carried at construction camp / project site to check compliance with prevailing rules.

5.4.3 Water Environment

Water Requirement: The minimum water requirement during construction phase of proposed tunnel project is for civil work of tunnel and drinking water at construction camps. Water requirement during construction phase (at peak) is approximately estimated as 500m³/day will be sourced from nearby surface water locations. The water requirement during construction phase only, the impact will be temporary. The sewage generated from construction camps will be treated in septic tanks followed by soak pits. The magnitude of impact on water environment during construction will be minor in nature as the requirement is meager and temporary in nature. Special precautions will be taken to minimize sediment run-off during rainy season by avoiding certain activities. There will be no requirement of water during operation period. From the above, it can be concluded that the construction may slightly affect the water quality and will be insignificant in terms of impact.

(a) Impact Assessment

Impact on Surface water: With regards to surface water, contamination of water by digging soil is possible during construction activity in case of accidental oil spills during construction. In the period of construction, a change in the quality of

surface water is expected to be minimal. With the purpose to protect and prevent surface and underground water contamination to ensure sanitary control in compliance with the construction norms that will exclude the possibility of contaminated water flow into underground waters and open surface water bodies. Water consumption and water disposal systems which are planned to be used during construction of the tunnel will exclude potential contamination of surface and underground waters. The Contractor shall comply with the requirements of current legislation in the field of water protection in regards to ensuring all necessary permits (for use of water and wastewater discharge) and take over administrative and criminal responsibility.

(b) Mitigation Measures

- ∞ The measures that are proposed to mitigate / restrict the pollution impact on surface water are related to restricting disposal of excavated earth, grease, oil, etc. in existing water sources, rivers, streams, irrigation canals, etc.
- ∞ To protect surface water from oil and oil products penetration, proper working equipment and machinery shall be used.
- ∞ Drip boards and other protection must be considered for all specific places on the structure, for preventing water and humidity penetration.
- ∞ During the whole construction period, the Contractor shall guarantee that all river beds and drainages in and around the construction site will be maintained in good condition and no excavation material or other particles originated by works will fall in them.

The Contractor shall submit an Action Plan for incidents involving spills of hazardous substances before the actual rehabilitation works may commence.

- ∞ The designs of the proposed works will include adequate measures for water drainage.
- ∞ Water from excavation at tunneling to ascent should be drained in the duct by gravity.
- ∞ Diversion of the polluted superficial drain from the territory of construction site should be carried out through special treatment facilities.

Impact on Ground Water: Ground water conditions are indicative that the rocks are massive and joints are few and not connected. The water table in the drill holes has not been encountered till the formation level suggesting no water ingress. During tunneling in situations where the water table is higher than the project road level water may drip from the roof and also enter from the sidewalls of the tunnel. Detailed hydro-geological studies are to be conducted to understand the ground water regime.

Impact on Hydrogeology: The entire area is underlain by basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow Alluvium formation of recent age also occurs as narrow stretch along the major rivers flowing in the area.

There are mainly two types of ground water structures i.e. dug wells and bore wells in the area. The yields of the dug wells varies from 10 to 1000 m³/day, whereas that of bore wells ranges between 50 and 1000 m³/day tapping the promising aquifer in the depth range of 40 to 60m bgl. Even though the bore wells drilled in the area by both official and private agencies are in large number, no adequate data regarding areal extent of the aquifer is available. The bore wells in low lying area are affected by saline water whereas in upland areas the quality is potable. The above description confirms following points:

- ∞ The tunneling is being carried out in the hard rock formations of Kanheri-Tulasi area.
- ∞ The Tunnels being dug out about 20m below ground level (bgl)
- ∞ There are little chances of having substantial aquifers at that level.
- ∞ The Tulsi Lake is 4.9 km away from the Tunnel locations.
- ∞ Tulsi Lake is feeding on surface water collected during monsoon and does not have dependence on any aquifers

Considering the above facts, it is very unlikely that the proposed tunnel will have any impacts on the aquifers of Tulsi Lake water catchment.

Mitigation Measures

Mitigation measures to avoid degradation of the groundwater quality will included as below:

- ∞ Development of a comprehensive erosion and sediment control plan prior to earth-moving
- ∞ Construct settling ponds where silt-laden water can settle before being discharged into natural water courses;
- ∞ Application of erosion and sediment control practices to prevent onsite damage;
- ∞ Apply perimeter control practices to protect the disturbed areas from onsite runoff and to prevent sediment damage to areas below the construction site
- ∞ Keeping run-off velocities low and trying to retain much of the run-off on the site
- ∞ Stabilization of the disturbed areas as soon as the final grade has been attained.
- ∞ Use of oil / water separators to extract floating oils.
- ∞ Proper storage of contaminated liquids and disposal after treatment to bring such liquids within prescribed permissible limits.
- ∞ Restricting construction activities near water courses as far as practicable during the dry season.

- ∞ On site fuelling area of vehicles and equipment will be selected away from water bodies and should be protected by a beam to prevent runoff from leaving the area.
- ∞ A construction material handling protocol (e.g. storage away from water sources and provision of retention areas to contain accidental spills of such toxic, hazardous and harmful construction materials like asphalt, oil and petroleum products) will be prepared and applied.

Specific Mitigation Measures

- ∞ Installation of a water proofing system between the initial ground support system and the final concrete lining. This will consist of a PVC membrane with protection layers made from geo-textile material
- ∞ Collection of roadway water in a dedicated drainage system to separate it out from the clean water drainage system. As the tunnel will be open for vehicular traffic carrying dangerous goods, the drainage system will consist of a slotted gutter. This will be connected to the principal longitudinal drains by gully pits containing a siphon system.
- ∞ Drinking water requirements during the construction phase will be met from local sources and packaged water. Construction laborers should be provided with adequate quantity of drinking water of potable quality.
- ∞ Impact on water quality during construction period may be due to non-point discharge of sewage generated from the construction work force stations at the project camp site.
- ∞ Therefore, the water requirement and wastewater generation will be very small quantity.
- ∞ Proper sanitation facilities will be provided by the contractor for the construction workers.
- ∞ Sanitation facilities (soak pits / septic tanks) will be made available for disposal of sewage generated by the workers as per SPCB norms.
- ∞ Sufficient and appropriate sanitary facilities should be provided in order to maintain hygienic conditions in the camps of construction laborers.
- ∞ Ends of the Tunnel shall be located away from the sources of drinking water supply.
- ∞ It should be ensured during construction that depression is not formed while reinstating land which otherwise could lead to water logging
- ∞ Depending upon the quantity of wastewater generated, the wastewater treatments will be either solar evaporated or disposed off into a suitable places.
- ∞ Water collection basins will be put at each end of the portals where drainage water will be collected

5.4.4 Land Environment

(i) Impact on Geology

Tunnel excavation will require extraction of geological resources consisting of conglomerates and metamorphic i.e. basalts and andesine. Such extraction / removal are not likely to result in loss of mineral resources as no mineralized zone is present along the axis of the tunnel. Excavation activity from tunnels may have some impact on the fossil finds in the sedimentary. The blasting operations will lead to rock movement, minor fragmentations and vibrations. Likely impact on the geological resources will occur from the extraction of materials (borrow of earth, stone metals, granular sub- base and aggregates for base courses and concrete.

Mitigation Measures

- ∞ In case of finding of mineralized zones along the tunnel alignment during excavation, it will be brought to the notice of the Department of Geology and Mining of the State Government for directions from their end.
- ∞ Appropriate blasting design will be adopted which will consider safety, blast geometry, free faces, burden, spacing, initiation pattern and angled holes etc.

(ii) Impact on Land

The tunnel alignment will be passing through below Sanjay Gandhi National Park. The land required for the tunnel project at the end of tunnel will be obtained on Right of Use (RoU) basis. Physico-chemical changes in soil quality may occur during construction phase mainly due to clearing of vegetative cover by causing temporary soil erosion. There will be temporary disturbance of land during construction phase. The tunnel alignment will be 20m below the ground level hence impact on land-use pattern will be marginal. As a result of construction activity of tunnel, the vegetative cover is likely not affected in an alignment through SGNP. However, the construction of tunnel impact will be temporary in nature during construction.

The implementation of the project will cause permanent changes in land-use and loss of property and other assets caused by occupation of land for the new road and tunnel, temporary changes in land uses caused by short term occupation of land for construction and changes in accessibility to existing land uses resulting from the temporary or permanent presence of the project. As a part of project proceedings huge amount of solid waste will be generated in the form tunnel excavations, muck etc. Disposal of these excavated materials without any proper management may pose a problem to environment. Movement of construction machinery, vehicles during construction especially haul road. Reuse of excavated material after testing their suitability will minimize requirement surface areas for dumping. Roads will lead to physical disruption of soil.

Mitigation Measures

The execution from tunnel site, following measures are recommended to mitigate adverse impacts of land during construction phase:

- ∞ The tunnel excavation can be used in production of aggregates for road making.
- ∞ Hard rock formations can be used in construction of breast and retaining walls as well as gabion walls.
- ∞ Standard construction procedures will be implemented to ensure that the impact on surface drainage pattern and soil erosion is kept minimal. This will necessarily include avoiding blockage of natural surface drainage and developing appropriate drainage system in areas where it is unavoidable.
- ∞ Reuse of excavated material after testing their suitability will minimize requirement surface area for dumping.
- ∞ Security of especially protected natural territories and valuable objects of environment.
- ∞ Maximum decrease in volumes and intensity of emissions (discharges) of polluting substances in the territory of construction site and adjacent lands
- ∞ Rational use of lands during the discharge of construction wastes, placement of dumps and solid waste landfills
- ∞ After completion of the tunnel construction, it is necessary to restore soil and vegetation cover, to fix and ramp the formed slopes, worked-out quarries and dumps
- ∞ Every precaution should be taken to avoid spillage on soils to protect groundwater quality and soil microbiology in the project area
- ∞ Construction activities should not be done during the rainy season to avoid soil erosion
- ∞ Excavated top soil should be preserved near the site and reused for plantation.
- ∞ Land should be reinstated after laying the tunnel using the preserved soil
- ∞ Temporary drainage channels should be provided to minimize soil erosion by adopting erosion control measures such as raising of shrubs and grasses
- ∞ A record with respect to quantity, quality and treatment / management of solid / hazardous waste shall be maintained.
- ∞ Security of especially protected natural territories and valuable objects of environment
- ∞ Timely re-cultivation of lands broken at construction and operation of the object;
- ∞ Removal and use of soil layer for broken lands re-cultivation or fertilizing of low yield farmlands with rich soil.

- ∞ After completion of the tunnel construction it is necessary to restore soil and vegetation cover, to fix and ramp the formed slopes, worked-out quarries and dumps

(iii) Waste Management

Waste discharged during the construction phase will consist of wash water from the equipment maintenance shops and sanitary wastewater effluent from the work camps. The oily wash water will be passed through an oil separator prior to discharge. Waste will be generated both during construction and operation periods and will be stored in and transported to places specialized for that purpose. If construction camps are large (e.g., population over 300), liquid wastes, prior to their discharge to a natural watercourse will receive primary-equivalent treatment in an anaerobic pond preceded by a bar screen. Septic tanks will be used for sanitary wastewater disposal in smaller camps. There will be no direct discharge of untreated sanitary waste to surface water bodies.

Solid waste generated during construction will consist of:

- ∞ Domestic waste and construction waste from work camps
- ∞ Hazardous waste from work sites
- ∞ Spoil and muck from the cuts and tunnels.

Disposal of domestic waste and construction waste will occur regularly to approved disposal site. There will be no on-site development of landfills. Hazardous waste will be collected and stored on-site in approved facilities according to relevant standards. Hazardous waste will then be removed from site to approved hazardous waste disposal facilities. The spoil from the cuts and tunnel will be used, where possible, for embankment fill. Excess spoil will be placed in storage areas with containment walls.

Mitigation Measures

- ∞ Re-use / recycle the materials and proper disposal of waste in accordance with permit.
- ∞ Wastes generated at construction and operation of the tunnel is subject to the obligatory registration and assessment.
- ∞ Wastewater removed from the tunnel in case of their discharge in reservoirs or the system of rain sewerage which does not have treatment facilities in the distance from discharge point to reservoir should be preliminary treated. For these purpose grids for manual treatment, mud settlers, petrol and oil collectors, filters settlers and other means of water treatment from pollution should be installed in the cameras of dewatering plants before the entrance to water chamber sumps.
- ∞ Waste generated during the whole construction period will be systematically collected, stored and disposed in the corresponding specialized sites in accordance with regulatory requirements in the field of waste management.

- ∞ The Contractor shall develop a program for waste management before works start as required under the regulations on waste management system.
- ∞ Centralized waste management facility is recommended to collect all wastes
- ∞ On completion of construction works all temporary structures, surplus materials and wastes will be completely removed to avoid future land use incompatibility. Dumping of construction waste on agricultural land will be prohibited and stockpiles will be provided with gentle slopes.
- ∞ The impact on soil due to land disposal of solid work as construction debris, composite garbage and discarded top soil may impact surrounding soil quality. However, the impact is likely to be insignificant as the project authorities will take adequate measures to ensure that all waste generated at the construction site and at the labor camp are collected and disposed off in an appropriate manner in a dump site or recycled or reused where feasible
- ∞ Standard construction procedures will be implemented to ensure that the impact on surface drainage pattern and soil erosion is kept minimal. This will necessarily include avoiding blockage of natural surface drainage and developing appropriate drainage system in areas where it is unavoidable.
- ∞ The current topography and land usages of the project area will not be adversely affected due to limited constructional activities for the project
- ∞ Large quantity of quarry material will be required for the construction of project infrastructure. The quarry activities will not therefore result in construction of the land mass. The current topography and land usages of the project area will not be adversely affected due to limited constructional activities for the project.
- ∞ Waste will be generated both during construction periods and will be stored in and transported to places specialized for that purpose.

5.4.5 Biological Environment

(a) Prediction of Impact on Flora and Fauna

Predictions of impact on biological environment are arriving through available scientific knowledge and judgments of ecology and biodiversity. The construction work would be related to the construction of proposed tunnel and infrastructural facilities at the proposed site. Besides traffic, there has been heavy human habitation and activities around the Sanjay Gandhi National Park (SGNP) at Thane and Borivali causing pressure on the protected area. The construction phase will be required about 3 years; this activity will be effect on air, noise, water, soil quality and socio-economic trends etc. The proposed construction of tunnel passing below the Sanjay Gandhi Nation Park, therefore there will be no danger of wildlife. Impact on flora and fauna will be temporary, will not cause any long term impacts. Impact on flora and fauna would be negligible due to this underground tunnel activity.

Openings at two end of the tunnels, construction activities will be open, which involves number of workers in construction phase is found to be low in number, hence impact at the project site will be negligible. The local people will not be affected as the nearest residential area is quite away from the project site. There may be negligible disturbance to wildlife especially burrowing animal during the construction of the tunnel since the minimum depth of the tunnel from the ground level will be about 20m. The proposed tunnel avoids requirement of forest land as it will be passing below ground from the SGNP. During construction a short-term impact on ecology is likely to occur in and around the quarry sites, material stockpiling areas and worksites due to vegetation clearance.

Flora degradation is expected to occur marginally as a result of tunnel construction. Construction and operation of the project will have only a minimal effect on existing flora and fauna. The work will directly cause minor degradation of the local ecology through the clearance of areas of vegetation (ground cover) at major work sites and ancillary sites. A permanent but relatively minor impact on ecology is likely to occur due to the alignment of any unstable section. Vegetative cover stripped from these locations will be kept for landslide and slope protection. Potential impacts from construction worker camps include poaching of edible animals and birds in the locality, despite prohibitions.

Mitigation Measures

The following mitigation measures recommended mitigating adverse impacts on flora and fauna during tunnel construction activities:

- ∞ Plantation and wildlife are the backbone of the biotic environment in protected areas
- ∞ Precaution should be taken to minimize the damage of plants at construction sites
- ∞ Minimum number of tree should be cut while construction
- ∞ Plants acts as wind breakers to mitigate impact due to fugitive emission
- ∞ Plants creates an aesthetic environment and restore the water balance
- ∞ Plants creates complex bio-diverse ecosystem
- ∞ Plants needs for prevention of soil erosion and surface run off
- ∞ Already a good green covers are around the project area as dense forest of SGNP
- ∞ Due to proposed greenbelt, air, noise and water pollution will be reduced significantly
- ∞ There will be no disturbance to wildlife movement after construction of the tunnel is over.
- ∞ Flora and fauna should not be disturbed; deforestation and cutting down of bushes, change of hydrological mode of water bodies, deterioration of ways of animals migration, reduction of the sizes of plantation, extinction of species are in admissible.

- ∞ Contractors will be responsible for putting new vegetation in removal sites suitably.
- ∞ Construction vehicles should use temporary roads to minimize damage to wildlife
- ∞ Where local roads are used, they will be repaired after the completion of project work.
- ∞ The contractor's environmental health and safety manager will be responsible for providing adequate knowledge to workers regarding the protection of fauna.
- ∞ Workers will be trained regarding nature, protection and to avoid cutting down trees
- ∞ The plantation of diverse local plants will be developed as greenbelt which will increase the biodiversity of plants in this study area
- ∞ This will further enhanced and extended to the proposed greenbelt
- ∞ Flora degradation is expected to occur marginally as a result of tunnel construction.
- ∞ Construction of project will have a minimal effect on flora and fauna.
- ∞ The work will directly cause minor degradation of the local ecology through the clearance of areas of vegetation (ground cover) at major work sites and ancillary sites.
- ∞ A permanent but relatively minor impact on ecology is likely to occur due to the alignment of any unstable section.
- ∞ Vegetative cover stripped from these locations will be kept for landslide and slope protection.
- ∞ Contractors will be responsible for supplying appropriate fuel (gas cylinders) in the work camps to prevent fuel wood collection for cooking.

Reduction in Biotic Pressure

- ∞ Precaution should be taken to minimize the damage to native plants on the periphery of construction area at the ends of the tunnels and along the route.
- ∞ Special care should be taken that any endangered plants should not be cut down and their conservation measure should be adopted.
- ∞ Fencing should be made at both ends of tunnel area to prevent the entry of wild animals.
- ∞ Good environmental practice of dust suppression by using water sprinklers in the site

Reclamation and Regeneration

- ∞ Abandoned waste dump areas should be suitably reclaimed by removing accumulated hazardous waste, leveling of land and development of plantations over the area. This will reduce the desertification process, wind erosion of soil and pollution of land.
- ∞ Double the number of native trees should be planted under compensatory a-forestation.
- ∞ Regeneration should commence simultaneously at the time when site clearing is being undertaken.

(b) Wildlife Conservation Plan

(i) Conservation of Flora

- ∞ The floral conservation plan is mainly focused on regeneration of good forest cover to the scattered patches of barren land present at the proposed project site.
- ∞ Strict implementation of forest conservation Act, 1980 (as amended) is needed to protect forest cover in the healthy state for the protection of wildlife.
- ∞ Development and maintenance of permanent water bodies like water harvesting impounding construction of pickups, anicuts should be undertaken.
- ∞ Small earthen bund tanks, seepage springs, check dams, game tanks may also be developed in the critical areas.
- ∞ Development of ecological corridors through a-forestation should be provided.
- ∞ Fire control should be carried out for proper forest management measures. Fire as management tools is required for forest conservation.
- ∞ Motivation and awareness of local people through incentives and active participation in conservation program such as control of forest fire, environmental awareness campaign and control of illegal practice should be provided.
- ∞ The factors affecting will be given special consideration because saving the forest ultimately conservation of wildlife are protection of fire, poaching, restriction of grazing, man-animal conflict, illegal cutting, encroachment, drought, soil erosion and environmental awareness etc.
- ∞ The project area should be planted to minimize the air and noise pollution. This not only helps in controlling problem of pollution but also protects the wild animals
- ∞ Proper fencing arrangements should be made available to prevent the entry of wildlife
- ∞ MMRDA should tie up with Forest Department for developing vegetation in the region

- ∞ The local people should be educated to understand the importance of wildlife conservation and plantation program, should be encouraged to take active part in social forestry program with the leading role played by the MMRDA and Forest Department

(ii) Conservation of Fauna

Many of us do not know that the extinction of the species not only cause disturbance in the ecological system of the world but loosing the ecological balance. Extinction of a single species has its negative effect on the whole ecological system because every individual is an important constituent of food chain and food web. Under the proposed project area there are few wild animals reported under Schedule-I as per the Wildlife (Protection) Act, 1972 is given below:

Mammal: Indian false Vampire, Leopard, Rusty spotted Cat, four horned Antelope and Mouse Deer

Reptiles: Indian Magar, Indian Python and common Monitor

Birds: White Bellied Sea Eagle, Indian long-billed Vulture, Indian White-backed Vulture, Indian Scavenger Vulture and common Peafowl.

The proposed project area of 11.8 km highway tunnel alignment passing through underground of SGNP a highly protected area of the reserved forest and therefore need not required a separate wildlife conservation plan for these above mentioned animals as they are already protected in National Park (SGNP).

5.4.6 Socio-economic Environment

(a) Impacts on Socio-economic

- ∞ The impact of the proposed development and construction activities are likely to be at a minimum as the tunnel passing below ground level of the SGNP.
- ∞ It is expected that the impact due to loss of land structure would be minimum.
- ∞ No potential negative social impacts are anticipated during the course of the construction works of the tunnel project.
- ∞ Since the nearest village from the tunnel is situated within 0.5 km of tunnels location.
- ∞ There will not be major changes of land-use pattern.
- ∞ Increased traffic in the area due to construction activities may create air and noise pollution which may create related health hazards.

(b) Mitigation Measures

- ∞ A prior information about the project should be given to local project affected people
- ∞ Caution should be exercised to avoid disturbance to existing infrastructure along tunnel

- ∞ Preference shall be given for employment of the local people during project activities
- ∞ Requirement of drinking water during the construction phase will be met from packaged water or water transported through tankers from excess available areas. The impact on socio-economic will be insignificant as water requirement being meager.
- ∞ Adequate measures for dust suppression should be maintained
- ∞ Separate agreements shall be made at the construction camps for water, sanitation, power supply and fuel to ensure that there are no pressure on the local resources
- ∞ Proposed construction of highway tunnel activities in general have beneficial impact on socio-economic front both locally and regionally through improved connectivity
- ∞ Within the course of construction works part of the reinforced concrete shall be removed
- ∞ The proposed construction of project shall also not entail any displacement of people.
- ∞ Residential / buildup land will not be acquired for the purpose of the project; hence R and R plan will not be associated with the project activities.
- ∞ There will not be any adverse impact on transportation during construction phase as the existing roads will be used for construction related activities.
- ∞ Interaction of local laborers without labor force during construction phase may lead to transference of communicable diseases if left uncontrolled and unchecked
- ∞ The proposed project activities do not involved loss / disturbance to the cultural heritage
- ∞ The construction debris shall be taken out of the tunnel and temporarily stored at the designated areas and promptly taken to disposal with prior investigation and permission from local authority.

5.4.7 Protection of Health and Labor Safety

- ∞ Regarding the basic working requirements for safe working conditions shall be met.
- ∞ The Contractor shall develop a plan for health and safety at work, including: risk assessment of workplace; measures and requirements for safety and health performance of construction works, risk factors, personal protective equipment, safe work instructions, plans for fire prevention and fire fighting, emergency and evacuation plans for workers and occupants of the site, on-site contractor coordinator of

health and safety and other requirements arising from legislation on labor protection.

- ∞ Migration of workers and establishments of construction camps which may lead to problems of sanitation. This might also lead to transmission of communicable diseases.
- ∞ Uncontrolled digging of borrow areas will result in water accumulation and thus breeding of vector diseases.
- ∞ Psychological impacts on project affected people in the area.
- ∞ Discomforts arising out of air and noise pollution especially due to blasting activities etc.

The spread of Corona-virus (Covid-19) can increase, if workers do make maximum direct contact with others and do not keeping safe distance.

Mitigation Measures

- ∞ The measures for ensuring the work safety will be determined and performed by documenting in logbooks, assignments of duties, etc. according to specified templates.
- ∞ Electric installation works will be performed using electric protection equipment which will avoid electric power injuries, the electric arc effect and the products of its burning as well as the impact of an electro-magnetic field.
- ∞ All electric installation works must be performed by qualified personnel who will have had passed training on health and safety labor conditions
- ∞ Conduct orientation for all workers on safety and environmental hygiene.
- ∞ Provide first aid facilities that are readily accessible by workers.
- ∞ Safety conditions for personnel also need to be managed (hygiene and sanitation facilities / toilets with sufficient water supply for removal of domestic waste, supply of drinking water, facilities for storing materials, etc).
- ∞ Provide appropriate personnel safety equipment such as safety boots, helmets, gloves, protective clothes, breathing mask, goggles and ear protection devices, etc.
- ∞ Provide sufficient lighting such as the tunnel areas, excavation sites as well as in other construction areas as appropriate to enable safe equipment operation. Provide emergency lighting system of adequate intensity that is automatically activated upon failure of the principal artificial light source to ensure safe equipment operation, safe shut-down, evacuation, etc.
- ∞ Ensure that sufficient fresh air is supplied at confined work spaces such as the tunnel and excavation sites. Re-circulation of contaminated air is not acceptable. Air inlet filters shall be kept clean and free from dust and microorganisms.
- ∞ Confined spaces (tunnel) shall be provided with safety measures for venting, monitoring and rescue operations to the extent possible.
- ∞ Design of works connected with the use of explosive materials should be carried out according to the requirements of uniform safety rules during the blasting works.
- ∞ Plan of accident elimination should be developed and approved
- ∞ Content of toxic substances in ventilation emissions should not exceed the maximum permissible values for each ingredient according to the norms established by sanitary and epidemiological bodies.
- ∞ Content of harmful substances in the air of underground excavations and drainage waters should not exceed maximum permissible concentration

- ∞ Tunneling, construction, load-lifting, transport vehicles, mechanisms and equipment should conform to the state requirements, the rules for installation and safe operation as well as to the manuals of manufacturers.
- ∞ Protection of people in the tunnel from influence of products of burning (smoke) it should be ensured by timely evacuation outside through portals or safe zone (in the next tunnel) through evacuation passes (linkage), thus operation of the smoke protection system, if available, should be considered.
- ∞ Limiting face-to-face contact, keeping a safe distance with others, frequent hand washing / sanitizer and using masks are the best way to reduce the spread of (Covid 19) Corona-virus during construction.
- ∞ Protection of people and property against the impact of dangerous factors of the fire and (or) limitation of consequences of their impact in the tunnel should be provided with one or several of the following ways:
 - ∞ Application of space-planning decisions and means providing limitation of distribution of the fire out of the center limits;
 - ∞ Evacuation ways meeting the requirements of safe evacuation of people at fire
 - ∞ Installation of fire detection systems (fire alarm devices) for warning of the people and evacuation management at fire;
 - ∞ Use of systems of collective protection (including smoke protection);
 - ∞ Application of emergency and automatic installations of firefighting equipment;
 - ∞ Organization of activity of fire protection divisions.
 - ∞ Fencing of construction sites to restrict public access.
 - ∞ Prior to excavation work, provide fencing on all the areas to restrict public access.
 - ∞ Provide warning signs at the periphery of the construction site.
 - ∞ Strictly impose speed limits on construction vehicles along residential areas and where other sensitive receptors such as schools, hospitals, and other populated areas are located.
 - ∞ Educate drivers on safe driving practices to minimize accidents and to prevent spill of hazardous substances and other construction materials during transportation

5.5 Impacts during Operation Phase

5.5.1 Air Environment

Air Dispersion Model: The air quality impact of a source or group of sources is evaluated by the use of mathematical models. The widely accepted interpretation models simulate the relationships between air pollutant emissions and its impact on air quality. For the present study, this model is used for the prediction of maximum ground level concentrations (GLCs).

Assessment of air pollution was carried out for line source. The AERMOD from Lakes Environment is an hour-by-hour steady state Gaussian Plume Model. This model is widely recognized as predictive tool in impact assessment for air environment.

Meteorological Data: Minimum one day hourly meteorological data required for the modeling studies. Data consider for 1st March 2021 for summer season (Figure 5.5).

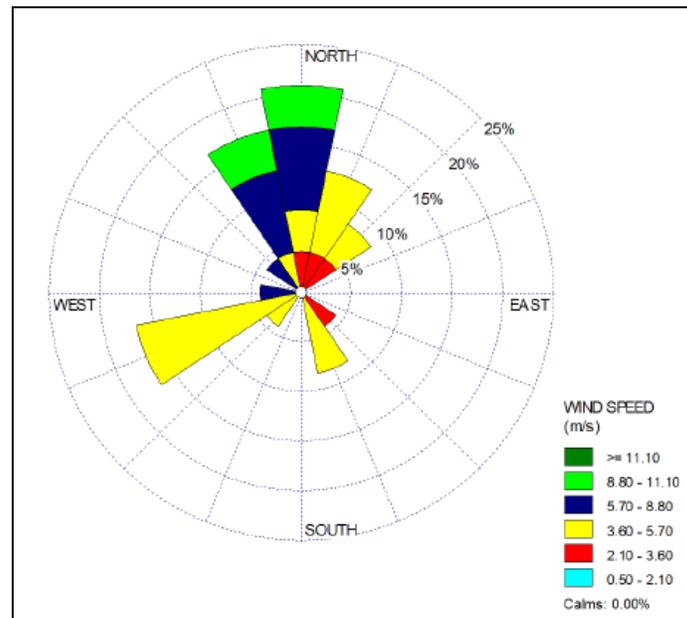


Figure 5.5: Wind Rose Diagram

Traffic volume count vehicle per day is presented in Table 5.4.

Table 5.4: Total Traffic Count (Veh/day)

Location (Mid-Block)	4 Wheeler	LCV	Truck	Bus	Other	Total Traffic Count (both direction) AADT (Veh/day)
Dattapada	27887	3862	1963	1334	1152	36,198
Fountain Hotel	52542	11229	8043	3276	87	75,177
Kapurbawdi	72653	9493	10100	7138	250	99,634
JVLR (Powai)	74579	7586	2942	6748	171	92,026

The emission of CO, HC, NO_x and PM from Heavy Diesel vehicles has been calculated for the proposed project, based on the emission factor in gm/km-hr

and gm/kw-hr of Trucks / Trailer / Bus / 4 wheeler (Source: Central Pollution Control Board) (Table 5.5 and Table 5.6).

Table 5.5: Emission Factors

Mode	CO (gm/km-hr)	HC (gm/km-hr)	NO _x (gm/km-hr)	PM (gm/km-hr)
Emission norms for Heavy Diesel vehicles (Trucks / Trailer Bus/4wheeler)	4.5	1.1	8.0	0.36

Source: Central Pollution Control Board

Table 5.6: Daily Emission

Location (Mid-Block)	Total No. of vehicles/day	CO (gm/km-sec)	HC (gm/km-sec)	NO _x (gm/km-sec)	PM (gm/km-sec)
Dattapada	36,198	45.25	11.06	80.44	3.62
Fountain Hotel	75,177	93.97	22.97	167.06	7.52
Kapurbawdi	99,634	124.54	30.44	221.41	9.96
JVLR (Powai)	92,026	115.03	28.12	204.50	9.20

Resultant Concentrations

The simulations were made to evaluate CO, HC, NO_x and PM incremental rise due to proposed project. These results are based on considering the emissions due to traffic density. In the short-term simulations, the incremental concentrations were observed to obtain an optimum description of variations in concentrations within the study area.

The maximum incremental ground level concentrations (GLCs) for CO, HC, NO_x and PM due to proposed developmental activities were carried out. The predicted 24 hourly maximum concentrations for CO, HC, NO_x and PM are found to be 244 µg/m³, 49.11 µg/m³, 15.9 µg/m³ and 358 µg/m³ respectively. The short term modeling results are presented in Table 5.7. The isopleths of CO, HC, NO_x and PM are shown in Figures 5.6 to Figure 5.9 respectively.

Table 5.7: Short Term Modelling Results

Pollutants	Incremental Concentration (αg/m ³)	At UTM	Direction	Conclusion (Limits)
CO	244	276088.88 m E 2126705.70 m N	S/SSE	4000 αg/m ³
HC	49.11			-
NO _x	15.9			80 αg/m ³
PM	358			500 αg/m ³

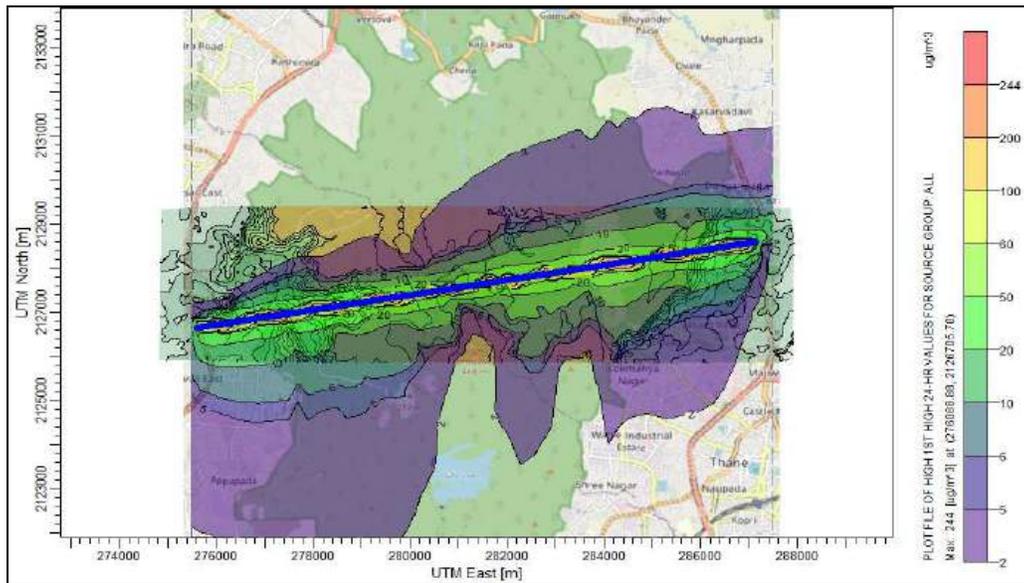


Figure 5.6: Incremental Rise of CO (Google View)

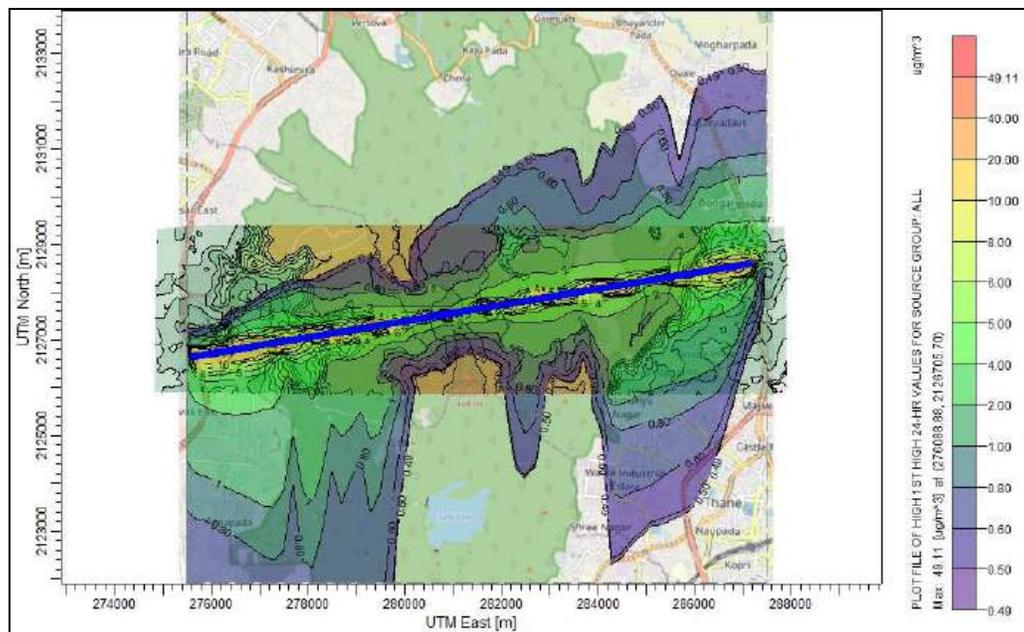


Figure 5.7: Incremental Rise of HC (Google View)

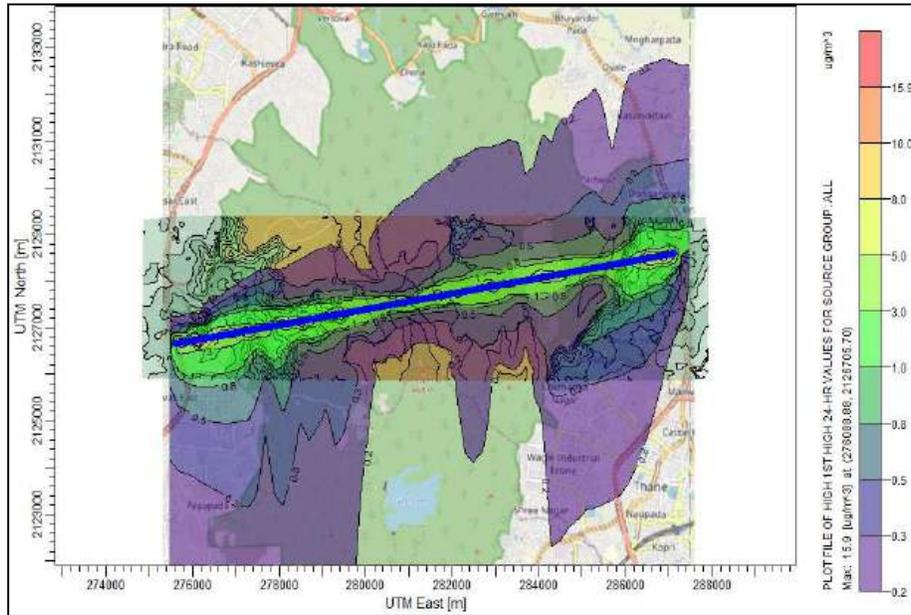


Figure 5.8: Incremental Rise of NO_x (Google View)

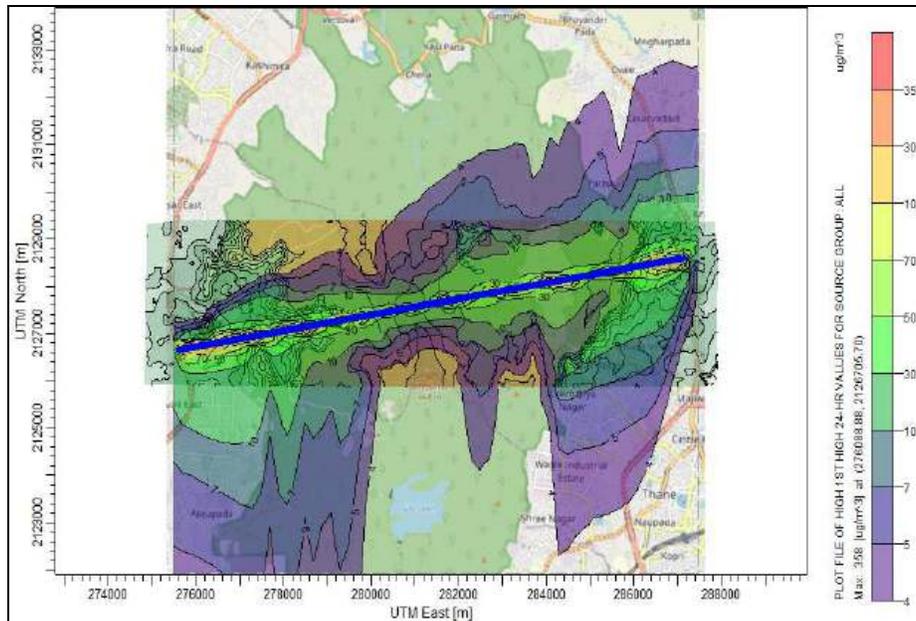


Figure 5.9: Incremental Rise of PM (Google View)

Interpretation of Data

- ∞ This quantum of pollutants spread over the whole day at maximum traffic movement is considered.
- ∞ There will be particulate matter (PM) emission impact predicted as $358 \mu\text{g}/\text{m}^3$ on the surrounding environment due to 55,687 vehicles per day.
- ∞ Impact due to the emission of other pollutants (CO, NO_x and HC) will be insignificant.

Impacts of Air Quality on Traffic

This construction of proposed tunnel highway will naturally increase the traffic load on it after the construction is over and as predicted the traffic load will be increased. The hourly traffic volume of each junction was used for calculating the average daily traffic. Based on IRC 106 the peak hour volume was considered to be 8% of the annual average daily traffic as given in **Table 5.8** and **Table 5.9**.

Table 5.8: Total Traffic Volume at Peak Hour (PCU)

Sr. No.	Junction	Peak Hour Volume (PCU)
1.	Dattapada (Megathane) WEH, (Borivali)	8,685
2.	Hotel Fountain (Godbunder Road, Thane)	10,886
3.	Kapurbawdi	14,015
4.	Jogeshwari-Vikroli Link Road (JVLR, Powai)	14,998
	Total	48,584

Source: Feasibility Report, AECOM

Table 5.9: Proposed Growth Rates (%) of Vehicles in the Study Region

Year	2-Wheelers	Rickshaws	4-Wheelers	Buses	Trucks
	Percent (%)				
2018-2022	9.00	5.50	7.50	7.00	9.00
2023-2026	7.90	6.00	6.80	6.60	8.50
2027-2030	7.00	4.80	5.80	6.40	8.20
2031-2034	6.80	4.20	5.40	6.15	7.90
2035-2038	6.20	3.60	5.00	6.00	7.60
2039-2942	5.50	3.20	4.80	6.90	7.00

Source: Feasibility Report, AECOM

Prediction of Impact on Ambient Air Quality

To assess the impact on air quality of the project area during operation phase, air pollution dispersion modeling was carried out using future traffic projections. The modeling was carried out using CALINE-4, line source model developed by the California Transport Department. Carbon monoxide (CO) is the main component of the vehicular pollution. So, prediction of CO concentration is representative of the impacts of air pollution due to traffic movement.

CALINE - 4 Model

The air dispersion model used is CL4 (A Graphical User Interface for CALINE-4) developed by the California Department of Transportation (Caltrans) for predicting air pollutant concentrations near roadways. CALINE-4 is a simple line source Gaussian plume dispersion model.

CALINE-4 is a model based on the Gaussian diffusion equation and employs a mixing zone concept to characterize pollutant dispersion over the proposed tunnel roadway. The purpose of the model is to assess air quality impacts near transportation facilities. Given source strength, meteorology and site geometry, the model can predict pollutant concentrations for receptors located within 500m of the tunnel roadway. It also has special options for modeling air quality near intersections, street canyons and parking facilities.

CALINE-4 divides individual highway sections into a series of elements from which incremental concentrations are computed and then summed to form a total concentration estimate for a particular receptor location. Downwind concentrations from the element are modeled using the crosswind FLS (Finite Line Source) Gaussian formulation, but σ_y and σ_z are modified to consider the mechanical turbulence created by moving vehicles and the thermal turbulence created by hot vehicle exhaust in the region directly over the tunnel highway, region considered as a zone of uniform emissions and turbulence.

Input Data Requirement:

Emissions The emissions are provided by traffic volume (vehicles/h) and emission factor (gr/mile/vehicle) for each section

Meteorology Wind speed, Wind direction, Wind direction standard deviation, Atmospheric stability Class Mixing Height, Ambient Temperature.

The details of input parameters considered for the modeling exercises are presented in the following paragraphs.

Traffic Data

The traffic surveys have been carried out along the corridor to establish base year traffic with reference to traffic movements. Average hourly traffic data has been considered for the present modeling exercises.

Meteorological Data

“Worst case wind angle” run type was considered to predict the worst-case scenario. The met inputs entered were:

Wind speed	-	1.0m/s
Stability class	-	F
Mixing height	-	50m
Standard deviation	-	5 ⁰
Ambient Air Temperature	-	25 ⁰ C

Interpretation of Results

For one-hour simulations, the concentrations were estimated around 3 receptors to obtain an optimum description of variations in concentrations over the distance of 30m, 50m and 100m downwind from the centerline for the worst angles as identified by the model. Based on the observed traffic flows and reconnaissance surveys, the proposed project (Tunnel) roadway has been divided into two homogenous traffic sections. The nearest receptor was considered to be at 30m from the centerline of Homogenous Sections.

The predicted 1hour maximum concentration of CO after construction of the proposed project is found to be within 4 mg/m³ prescribed by National Ambient Air Quality Standards, 2009 for residential, rural and other areas even in 2038.

Air modeling results of all the homogenous sections i.e. Ghodbunder Road Thane (PE-1) has been presented in **Table 5.10**.

Table 5.10: Air Modeling Result for Ghodbunder Road (Thane) (PE-1): Predicted Concentration of CO)

Predicated Maximum 1 hour concentration of CO (ppm)					
Receptor Distance from Centerline	2018	2023	2028	2033	2038
At 30	0.1	0.1	0.2	0.4	0.9
At 50	0.0	0.1	0.2	0.4	0.7
At 100	0.0	0.1	0.1	0.3	0.6
Predicated Maximum 1 hour concentration of CO (mg/m ³)					
At 30	0.115	0.115	0.230	0.460	1.035
At 50	0.00	0.115	0.230	0.460	0.805
At 100	0.00	0.115	0.115	0.345	0.690

Mitigation Measures

- ∞ All underground excavation works shall be properly and adequately, ventilated by system of pipes and fans as required by relevant codes and to the satisfaction of the engineer
- ∞ Adequate artificial means of ventilation shall be deployed and shall be in operation at all times when people are working underground
- ∞ Adequate ventilation shall be provided at all the working cavities and drifts etc
- ∞ After breakthrough of the tunnel excavation from both ends, mechanical ventilation system will still be necessary in the tunnel till its final handing over to the relevant authorities
- ∞ In case of mechanical ventilation, it is proposed to provide Jet Fans units at 200 m distance in ceiling of tunnel.
- ∞ These fans are reversible in action, can be operated in both directions. These fans are controlled from the central control room.
- ∞ The sensors fitted in tunnel gives the information about CO₂ levels and based on which the fans are operated.

- ∞ Greenbelt development shall be implemented to mitigate impacts from fugitive emissions. About 33% of the total area of tunnels will be developed for greenbelt with local vegetations
- ∞ All vehicular tunnels need ventilation. It is created by natural means or by mechanical means. The ventilation measures carried out for tunnel in construction and operation phase. Construction phase will follow IS 5878: 1971 (Part II, Section 2) Underground Excavation in Rock, Section 2, Ventilation, Lighting, Mucking and Dewatering.

5.5.2 Noise Environment

Prediction of noise levels during operational phase: During the operation phase, the main source of noise will be from running of transport vehicles. Noise radiated from vehicle operations and road structures generally constitute the major noise sources. In operation phase of the project there will be significant increase of vehicles due to the highway tunnel project site. The total Traffic Volume Counts (TVC) from all 4 locations were computed as 5,91,200 vehicles/day. The 4-wheelers was highest in numbers 2,27,661(38.59%), whereas lowest was bus count 18,496 (3.13%), while the other vehicle counts (0.28%) were not specified and thus not considered for vehicle accounts.

A noise propagation modeling study has been conducted to find out the impact from the noise generated because of the estimated total traffic flow as well as the significance of these impacts. The noise modeling has been done taking into account the design speed at various stretches and the stretches with restricted speeds have also been considered. DhvaniPRO is a computer program developed to undertake construction, traffic noise propagation studies for noise assessment. Different operative speeds have been used for various horizon years in the design life to get a realistic picture of the noise levels. DhvaniPRO is used for noise modeling. **Table 5.11** present the results.

Table 5.11: Noise level predictions for the receptors at the homogenous intersections

Sr. No.	Locations	2018	2023	2028	2033	2038
1.	NQ1	60	62	64	66	68
2.	NQ2	58	60	62	64	66
3.	NQ3	54	56	58	60	62
4.	NQ4	57	59	61	63	65
5.	NQ5	64	66	68	70	72
6.	NQ6	60	62	64	66	68
7.	NQ7	57	59	61	63	65
8.	NQ8	62	64	66	68	70

Interpretation of the Noise Modeling Results:

The predicted noise levels during both day and night time are within limit but in 2038 year exceeding the stipulated limits at some locations up to the end of design life of the project for all the land uses i.e. commercial, residential / rural and sensitive.

Mitigation Measures

- ∞ **Wheel Noise:** Due to wheel roughness
- ∞ **Propulsion Equipment:** Fraction motors, cooling fans for TM, reduction gears etc.
- ∞ **Auxiliary Equipment:** Compressors, motor generators, brakes, ventilation systems, other car mounted equipment
- ∞ Periodic maintenance of transport machinery and vehicles should be undertaken to reduce the noise impact
- ∞ Use of personal protective devices such as ear-muffs, ear-plugs etc. should be enforced wherever necessary
- ∞ Implementation of greenbelt development, landscaping, horticulture etc. are expected to reduce noise impacts within the project premises
- ∞ The opening ends of the Tunnel shall be surrounded by some forest area with trees, shrubs etc., which act as natural attenuators.
- ∞ Thus there will be an incremental noise level of 1-2 dB(A) over the baseline at distance of 500 m from the proposed highway tunnel.
- ∞ As no major settlement is located within 0.5 km from the tunnel alignment, no noise impact on the community is envisaged.

5.5.3 Water Environment

- ∞ No surface water bodies occur within the tunnel section.
- ∞ No adverse impacts are anticipated during operation phase on surface/ground water.
- ∞ During operation period, no significant surface water pollution is expected.
- ∞ No liquid effluent is envisaged as part of the project during operations.

5.5.4 Tunnel Safety

Structural and technical safety installations will comply with National and International recommendations, regulations or standards. These safety installations will be effective only when they are well operated with combination of an efficient emergency service. Appropriate behavior of the tunnel users in emergency situations may also contribute significantly to tunnel safety during operation. Main impacts characteristic of the operational period are: noise, ambient air and storm sewage. The first two ones have special importance for the settled areas, but settled areas are located far enough from the tunnel alignment. The sewage collecting system has nothing in common with the situation outside the tunnel. Only serious concern is related with the safety and emergency response in case of accidents or fire and respective measures are envisaged to take care of in its operations. To achieve optimal level of safety in tunnels, the primary objective has been kept at prevention and the secondary objective will be reduction of consequences. To deal with situations as accidents and fires, the objective has been to create ideal conditions for.

Mitigation Measures

- ∞ People involved in accidents to rescue themselves
- ∞ Immediate intervention of road users to prevent greater consequences
- ∞ The tunnel fires can be extinguished immediately after it breaks out but after a few minutes, there are chances of development of full blaze involving loss of life and tunnel damage etc.
- ∞ Ensure appropriate and timely response by emergency services.
- ∞ Protection of the environment and limiting material damage
- ∞ Maintenance required depends on where the tunnel is located, the type and volume of traffic it is required to handle, quality of ventilation, size and grade of the tunnel itself.
- ∞ Luminary units should be sealed so as to prevent entry of water from sprays, dust and smoke.
- ∞ Luminaries have to be cleaned frequently to clear dust and soot, may collect on their outer surface.
- ∞ Proper routine maintenance program should be conceived and implemented.
- ∞ Instead of waiting for the luminaries to fail before replacement, systematic replacement and renewal program should be conceived and implemented.

Chapter 6

Environmental Monitoring Plan

6.1 Environmental Monitoring Plan (EMP)

Environmental monitoring is an essential tool sustainable development and assuring effective implementation of mitigation measures. It is essential to keep updating the environmental management system for effective conservation of environment along with ongoing project activities / operations. It provides exact idea for mitigation measures to be implemented as it is linked with actual distraction of environmental quality due to project activities. Hence, monitoring of critical parameters of environmental quality is very essential in the routine activity scheduled for the following major activities:

- ∞ Assessment of the changes in environmental changes, if any, during project activities
- ∞ Monitoring the effectiveness of environmental management plan
- ∞ Implementation of mitigation measures as planned
- ∞ Identification of any significant adverse transformation in environmental condition to plan additional mitigation measures

6.2 Environment Management Cell (EMC)

With a view of successful fulfillment of the environmental requirement determined in the EIA and EMP, it is necessary that the project proponent (i.e. Project Implementation Unit (PIU), the contractor (CTRC), and the Contactor Supervisor Engineer (CSE) to have appropriate institutional potential that shall ensure correspondence of the construction works with the environmental requirements.

Apart from having an EMP, it is necessary to have a permanent organizational set up charged with the task of proposed project will create a departmental consisting officers from various disciplines to co-ordinate the activities concerned with the management and implementation of the environmental control measures.

MMRDA will have the Environmental Management Cell (EMC) for tunnel project environmental management and administration and their roles and responsibilities are given in **Figure 6.1**.

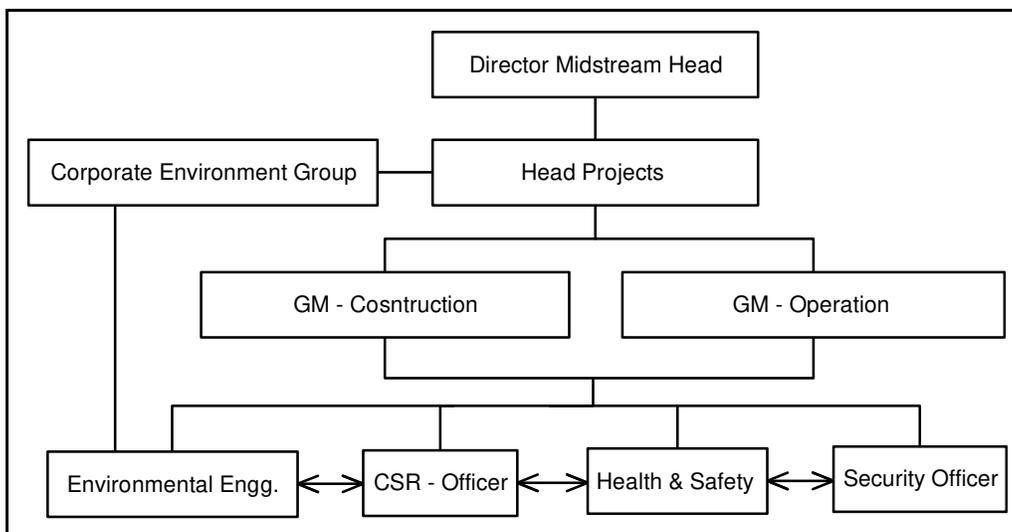


Figure 6.1: Organization Chart of Environmental Cell of Tunnel Project

6.3 Monitoring Points / Locations and Components

The environmental monitoring points shall be decided considering the environmental impacts likely to occur due to construction and operation of the proposed project as the main scope of the monitoring program is to track, timely and regularly, the changes in environmental conditions and to take timely action for protection of environment. The monitoring points / locations of components of significance shall be as per **Table 6.1**.

Table 6.1: Environmental Monitoring Program

Sr. No.	Environmental Components	Monitoring Points/Location
1.	Ambient Air Quality Monitoring	Minimum 5 locations: 2 locations at each tunnel portal, 1 location at nearest village in upwind direction, 2 locations at downwind directions
2.	Water Quality (Ground and Surface Water)	Ground water quality at minimum 5 locations within the tunnel surrounding locations areas. Surface water will be studied on the available locations within the tunnel location areas
3.	Emission	At sources of emission from TBM/DG sets as per CPCB guidelines
4.	Noise Levels	At all noise sources points and outside the tunnel area
5.	Greenbelt / Vegetation cover	The existing site of proposed tunnel has already thick green cover of SGNP. The proposed tunnel portal area will be provided greenbelt as per the CPCB guidelines
6.	Soil Quality Monitoring	At least 5 locations from both the tunnel portal areas

6.4 Monitoring Parameters and Frequency

Monitoring of environmental samples shall be done as per the guidelines provided by MoEF&CC/CPCB/SPCB. The method followed shall be recommended/ approved as per in Standard Methods.

The monitoring parameters and frequency of environmental monitoring shall be as per **Table 6.2**.

Table 6.2: Parameters and Frequency for Post Project Environmental Monitoring

Sr. No.	Attributes	Parameters	Frequency
	Meteorology	WS (km/h), WD, Temp.(⁰ C), RH(%), RF (mm)	Continuous & Seasonal
1.	Ambient Air Quality	PM ₁₀ , PM _{2.5} , SO ₂ , NO _x , CO, VOC and HC	Once in a month
	Indoor Air Quality	CO, CO ₂	Once in a month
2.	Process Emission	Fugitive gaseous pollutant Expected	Monthly
3.	Noise Level	Equivalent noise level dB(A)	Once in a month
	Vibration Studies	Construction and Vehicular Movement	Once in a month in 1km radius
4.	Soil, Solid wastes	Physico-chemical properties	Once in a month
5.	Greenbelt	No. of plantation (unit), No. of Survival plants/trees, No. of poor plant/trees	Ongoing round the year
6.	Environmental Audit	As per direction of ISO 14001 MoEF&CC /CPCB	Once in a year

6.5 Monitoring and Documentation

- ∞ The records of the monitoring program shall be kept on regular basis for all aspects of the monitoring. Separate records for water, wastewater, solid waste, air emission, soil and solid wastes shall be prepared and preserved regularly.
- ∞ Immediately upon the completion of monitoring as per the plan scheduled, report shall be prepared and necessary documents shall be forwarded to the concerned person.
- ∞ Methodology of monitoring (sampling and analysis) shall be prepared as separate documents as Standard Operating Procedure (SOP) wherever required.
- ∞ Their records showing results / outcome of the monitoring programs shall be prepared as per the requirement of the scheduled mentioned

above. Regularly, these documents and records shall be reviewed for necessary improvement of the monitoring plan / mitigation Measures / environmental technologies as well as for necessary actions of Environmental Management Cell (EMC).

6.6 Budget and Procurement Schedule

On regular basis, Environment Management Cell shall inspect the necessity and availability of the materials, technologies, services and maintenance works. The EMC shall make appropriate budget for the monitoring purpose. Regular record review for any change in financial requirement of the environment management shall be done and appropriate budgetary provisions shall made. Along with other budgets, budget for environmental management shall be prepared and revised regularly as per requirement.

The budget shall include provision for the followings:

- ∞ Environmental Monitoring Program
- ∞ Operation and maintenance of environmental technologies / equipments
- ∞ Laboratory work for environmental management activities
- ∞ Emergency purchase of necessary materials, equipments, tools, services etc.
- ∞ Greenbelt development
- ∞ Social and environmental welfare and awareness program / training (CSR)
- ∞ Annual environmental audit

6.7 Environmental Monitoring Cost

The environmental monitoring cost is estimated on the basis of the length and existing environmental scenario of the proposed project. Environmental monitoring cost of Rs. 57.84,000/- has been allocated for construction and operation stages. The details have been presented in **Table 6.3**.

Table 6.3: Environmental Monitoring Cost

Sr. No.	Parameter Components	Particulars	Guidelines	Unit Cost per Sample (Rs.)	Total Cost (Rs.)	Total Cost (Lakhs)
1	Ambient Air Monitoring: At construction Stage: At 3 locations, once in month for a year years	AAQ Monitoring at Construction sites	PM _{2.5} and Respirable dust samplers to be used and located 50 m from the construction site	9,000	5,40,000	5.40
2	At Operation Stage: At 3 locations, once in a month for a year	Ambient Air Quality Monitoring	PM _{2.5} and Resiprable dust samplers to be used and located 50 m from the operation site	9,000	3,24,000	3.24
3.	Ground Water Monitoring: At Construction Stage: At 5 locations for three season in a year	Ground water bodies	Analyze as per the standard methods for examination of water and waste water	6,000	3,60,000	3.60
4.	At Operation Stage: At 3 locations for three season for a year	Ground water bodies	Analyze as per the standard methods for examination of water and waste water	6000	2,16,000	2.16
5.	Surface Water Sampling At Construction Stage: At 3 locations for three season in a year	Surface water resources	Analyze as per the standard methods for examination of water and waste water	6000	2,16,000	2.16
6.	At Operation Stage: At 2 locations for three season for a year	Surface water resources	Analyze as per the standard methods for examination of water and waste water	6000	1,44,000	1.44

Sr. No.	Parameter Components	Particulars	Guidelines	Unit Cost per Sample (Rs.)	Total Cost (Rs.)	Total Cost (Lakhs)
7.	Noise Monitoring: At Construction Stage: At 4 locations for three season in a year	At equipment yards / construction sites identified by IC	Using an integrated noise level meter kept at a distance of 15 m from the construction site	3000	1,44,000	1.44
8.	Noise Monitoring: At Operation stage At 3 locations for three season for a year	As directed by the Engineer	Using an integrated noise level meter kept at a distance of 15 m from the construction site	3000	1,08,000	1.08
9.	Soil Monitoring: At Construction Stage: At 5 locations for three season in a year	At productive agricultural land	-	7000	4,20,000	4.20
10.	At Operation Stage: At 3 locations where for three season for a year	At productive agricultural land	-	7000	2,52,000	2.52
11.	Development of greenbelt at 3 location twice a month for three season for a year	Both the end of portal side and tunnel area	-	2000	1,20,000	1.20
12.	Social and environmental welfare and awareness program/training (CSR)	Medical, Hospital, School, Water, Transport	-	1,00,000 monthly	12,00,000	12.00
	Staff Salary	Minimum 6 No.	-	2,45,000 pm	29,40,000	29.40
Total Monitoring Cost		Rs. 57,84,000				69.84 Lakh

Chapter 7

Risk Assessment

7.1 Background

The proposed tunnel project having additional activities and thus exposed to various hazardous activity. To combat emergency situation arising out of disasters, the Tunnel adopts and promulgates the emergency preparedness and response procedures.

Proposed tunnel construction project from Tikuji-ni-wadi, Thane to Ektanagar, Borivali (Mumbai) about 10.8km length of MMRDA is passing through below Sanjay Gandhi National Park will be connected NH-3 and NH-8, toposheet 47A-15, 16.

Longitude 72°52'18.15" E to 72°56'55.90" E

Latitude 19°13' 19.36" N to 19°14'15.29" N

Topographically the terrain is hilly area with dense protected forest Sanjay Gandhi National Park (SGNP).

7.2 Salient Features of Safety Policy

MMRDA is committed to:

- ∞ For safety of its employees and the persons associated and connected with corporation.
- ∞ For setting safety target, ensuring and fixing of responsibility for implementation of safety and by providing resources for implementation of safety programme for enforcing safety efforts in a continual and well fed manner.

Guideline Principals:

- ∞ MMRDA believes that accidents can be prevented
- ∞ All employees are responsible for following the established safety standards.
- ∞ To introduce safety standards in all work procedures
- ∞ The basic element of our safety programme will be developing safety consciousness by safety training and following safe work procedures
- ∞ Making collective effort for progress of safety-by-safety committees and other forums
- ∞ Carrying all operations only as per statues
- ∞ Throughout documentation's of safety performance will be necessary part of our safety programme

- ∞ Continual improvement in implementation of safety is necessary for our success

7.3 Emergency Planning

Disaster management plan for an activity unit of the project is necessary a combination of various actions which are to be taken in a very short time but in a present sequence to deal effectively and efficiently with any disaster, emergency or major accident with an aim to keep the loss of men, material, machinery etc. to the minimum. The main function of the Disaster Management Cell is to prepare a detailed Disaster Management Plan, which includes the followings:

- ∞ Identification of various types of expected disaster depending upon the type of the activity of the unit
- ∞ Identification of various groups, agencies, departments etc. necessary for dealing with a specific disaster effectively
- ∞ Preparation by intensive training of relevant teams / groups within the organization to deal with a specific disaster and keep them in readiness
- ∞ Establishment of an early detection system for the disaster
- ∞ Development of a reliable instant information / communication system
- ∞ Organization and mobilization of all the concerned departments / organizations / groups and agencies instantly when needed
- ∞ A major disaster that can be expected due to fire in the proposed project

7.4 Emergency Planning for Disaster due to Fire

Cable rooms, transformer unit, auxiliary transformers, oil tanks etc. within the project site are the likely areas for which disaster management plan is to be made to deal with any eventuality of fire, stores, workshops, canteen, and administrative building will be included.

Classification of Fire

- Class (A) : Fire involving combustible like wood, paper, cloths etc.
- Class (B) : Fire due to inflammables materials like oil, diesel, petroleum products etc.
- Class (C) : Fires involving domestic and industrial gases like butane and propane etc.
- Class (D) : Metals fires
- Class(E) : Electrical fires due to short circuiting etc.
- ∞ All the equipment shall be maintained as per the guidelines of the manufacturer with a preventive maintenance schedule.
- ∞ It shall be ensured that there is no leakage of HSD / hydraulic oil from the equipment during its operation.

- ∞ Sparking due to short-circuit of wiring shall be prevented through regular checking
- ∞ All the equipments shall be provided with auto-fire detection and suppression system
- ∞ All the operators shall be trained on fire fighting

Establishing a Fire Fighting Group

A small spark of fire may results into loss of machine and the damage by fire may high economic losses. These types of losses can be avoided by preventing and controlling the fire instantly for which fire-fighting group need to be established. Establishing such group which would house and keep in readiness, the following types of equipments and arrangements are:

CO ₂ Extinguishers	Foam extinguishers	Fire Brigade	Dry powder chemical extinguishers
80mm Spray hoses	Fire hydrant	Protocol (chemical to combat oil fires)	

In order to avoid fires in cable galleries, all the power and control cables of FRLS type (Fire resistant low smoke) will be used.

Inspection

- ∞ Fire alarm panel (electrical) will cover the entire unit. The inspection group will periodically inspect fire extinguishers in the fire stations and machines and other places
- ∞ The group will display emergency telephone number boards at vital points
- ∞ The group will regularly carry out general inspection for fire

7.4.1 Procedure for Extinguishing Fire

The following steps will be taken during a fire accident in the system

- ∞ As soon as the message is received about fire, one of the systems will be diverted to the place of the fire accident along with a staff members
- ∞ Simultaneously, plant fire station will be informed by phone walkie-talkie for the fire brigades and fire stations of nearby area
- ∞ Meanwhile, the pipe system will be operated to obtain maximum pressure on output
- ∞ In case cables are within the reach of fire, power supply will be tripped and the cables shall be shifted

7.4.2 Fire Fighting with Water

Adequate and reliable arrangement is required for fighting the fire with water such as:

- ∞ Provision for fire brigade and fire hydrant

- ∞ Arrangement of pipelines along and around all vulnerable areas
- ∞ Provision of valves at appropriate points to enable supply of water at the required place / area or divert the same to another direction / pipelines
- ∞ Provision of overhead tanks which will be providing with the water during power failure and it would work by the gravitational force
- ∞ Sources of Water for Fire Fighting
 - Overhead Tank
 - Raw Water Reservoir

7.4.3 Fire Fighting with Fire Extinguishers

To deal with fire – other than carbonaceous fires, which can be deal with by water – suitable fire extinguishers are required to do the job efficiently. It is therefore, necessary to keep adequate number of extinguisher in readiness at easily approachable places. Adequate number of fire stations would be:

- ∞ Further, other spray groups from the system will be diverted to the spot
- ∞ In case of fire in the belt, belt will be cut near the burning portion to save the remaining parts
- ∞ After extinguishing the fire, the area will be well prepared for reuse
- ∞ Foam system for firefighting will be provided to control fire from the LDO storage tank
- ∞ The foam thus produced will suppress fire by separating the fuel from the air (oxygen) and hence avoiding the fire and explosion to occur in the tank. Foam would blanket the fuel surface smothering the fire. The fuel will also be cooled by the water content of the foam
- ∞ The foam blanket suppresses the release of flammable vapors that can mix with air
- ∞ All the equipment shall be maintained as per the guidelines of the manufacturer with a preventive maintenance schedule.
- ∞ It shall be ensured that there is no leakage of HSD / hydraulic oil from the equipment during its operation.
- ∞ Sparking due to short-circuit of electrical wiring shall be prevented through regular checking
- ∞ All the equipments shall be provided with auto-fire detection and suppression system
- ∞ All the operators shall be trained on fire fighting

7.5 On-Site Emergency Plan

The views of the possible hazards that can arise out of the daily construction and operation of the highway tunnel, various measures are adopted to prevent the occurrence of the major accident. This comprises of:

- ∞ Built and safety measures, alarm, trips and interlocks etc.
- ∞ Standard safe operating and maintenance procedures permit system etc.
- ∞ Training of all the involved staff in normal and emergency operating procedures
- ∞ Training of all employees in safety, firefighting and first aid

However, in spite of these precautions, it is required to foresee situation of major accident and plan for taking timely action to minimize the effects of such incident on the safety and health of persons working in the construction and operation as well as those living around the premises.

7.5.1 Preparation of Plan

7.5.2 Alarm System

A siren shall be provided under the control of Security Office in the project premises to give the warning in case of emergencies this will be used on the instructions to Shift-in-Charge that is positioned round the clock. The warning signal for emergency shall be follows:

Emergency Siren: waxing and waning sound for three minutes

All Clear Signal: Continuous siren for one minute

7.5.3 Communication

Walkies and talkies are located at strategic locations; internal telephone system EPBX with external P & T telephones would be provided

Fire Protection System/Fire Fighting System

The fire protection and firefighting system for the unit is to provide for early detection, air containment and suppression of fires. The fire detection and protection system has been planned to meet the above objective.

The complete fire protection system will comprise of the followings:

Fire Brigade: Automatic / manual fire detection and alarm system

Fire Hydrant: It will be provided at all around in the unit as per TAC norms

Portable Fire Extinguishers: Various areas of the unit will have one or more of the above system depending upon the particular nature of risk involved in that area

Potable Chemical Fire Extinguishers: These are intended as a first line of defense and hence will be stationed at strategic locations in different project area and

also outdoor facilities. Portable fire extinguisher will be foam type; carbon dioxide type and multipurpose dry chemical (MPDC) type.

Fire Detection and Alarm System: Fire detection and alarm system an effective means of detection, visual indication of fire location and audible alarm of any fire at its incipient stage. This system will comprises fire alarm panels, automatic fire detectors, manual call points and fire siren (hooter).

- ∞ The main fire alarm panel will provide both visual and audible alarm of the fire in any protected areas of the unit
- ∞ Manual break glass type fire alarms will be provided at strategic locations where high hazard exits
- ∞ Automatic fire detectors will be provided in the unit areas such as control rooms, switchgear rooms, cable galleries etc.

7.5.4 First Aid

- ∞ A first aid centre with adequate facilities shall be provided
- ∞ It shall be maintained round the clock by a Compounder-cum-dresser and a Doctor
- ∞ An ambulance shall also be provided at site to carry affected people to hospital

7.5.5 Security

- ∞ The security requirements of the company premises shall be taken care of by CSO assisted by a Fire-in-Charge
- ∞ The team, apart from the normal security functions will manage the role required during a disaster management operation as a part of the crises control team

7.5.6 Safety

- ∞ The safety wing led by a Safety Manager will meet the requirement of emergencies round the clock
- ∞ The required safety appliances shall be distributed at different locations of the unit to meet any eventualities
- ∞ Poster / playcards reflecting safety awareness will be placed at different locations in the unit area

7.5.7 Evacuation Procedure (Emergency Control Centre-ECC)

- ∞ As the major hazard is only due to fire, which has more or less localized impact no mass
- ∞ Evacuation would involved only the people working very close to the fire area

7.5.8 Emergency Control Center

- ∞ Provision is made to establish an Emergency Control Centre (ECC) from which emergency operations are directed and coordinated. This centre is activated as soon as on-site emergency is declared
- ∞ The ECC consists of one room located in an area that offers minimal risk being directly exposed to possible accident
- ∞ During an emergency, the emergency management staff including the site controller will gather in the ECC
- ∞ Therefore, the ECC is equipped with adequate communication systems in the form of telephones and other equipments to allow unhampered organizations and other nearby facility personnel
- ∞ The ECC provides shelter to its occupants against the most common accidents; in addition, the ECC's communication systems are protected from possible shutdown
- ∞ The ECC has its own emergency lighting arrangement and electric communication system operation
- ∞ Only a limited and prearranged number of people are admitted to the ECC, when in use. This eliminates unnecessary interference and reduce confusion
- ∞ The ECC is always ready for operation and provided with the equipment and supplies necessary during the emergency such as:
 - Updated copies of the on-site Disaster Management Plan
 - Emergency Telephone Numbers
 - The names, phone numbers and address of external agencies, response organizations and neighboring facilities
 - The adequate number of telephones (more than two)
 - Emergency lights, clocks, personnel protective equipments (PPE)
 - List of fire extinguishers with their type number and location, capacity etc.
 - Safety helmets, list of quantity and locations
 - Material safety data sheets for chemical handled at the facility
 - Status boards / message boards
 - Several maps of the facility including drainage system for surrounding area showing as:
 - Area where hazardous materials are stored
 - Plot plans of storage tanks, routes of tunnel alignment, all water permanent lines etc.
 - The locations where personal protective equipment are stored

- The position of pumping stations and other water sources
- Road and tunnel entrances
- Assembly areas and layout of hydrant lines

7.5 9 Communication Equipments and Alarm System

- ∞ This kind of equipment is absolutely vital for notifying accident; make the emergency both inside and outside of the facility and coordinating the response actions among the various groups involved in response operations
- ∞ In particular, this equipment is used to communicate within the facility; communicate between the facility and outside organizations and inform the public
- ∞ Different communications systems can vary in effectiveness, depending on the task. The most common types installed in the unit are listed below:

7.5.10 Sirens

- ∞ These are alarm systems commonly used in facilities
- ∞ In case of any emergency siren will be operated short intermittently for 1.5 minutes
- ∞ As alarm does more than just emergency warning
- ∞ It also instructs people to carry out specific assignments, such as reach to assembly point for further instructions and actions or carry out protective measures; this can be achieved only if the people are familiar with the alarm systems and are trained to respond to it.

7.5.11 Personal Protective Equipment (PPE)

- ∞ This instrument is used mainly for three reasons; to protect personnel from a hazard while performing rescue / accident control operations, to do maintenance and repair works under hazardous conditions and for escape purposes
- ∞ The list of PPE provide at the facility and their locations are available in ECC
- ∞ Effective command and control accomplish these functions necessitates personal trained in this On-site Disaster Management Plan with adequate facilities and equipments and to carry out their duties and functions.

7.5.12 Procedure for Testing and Updating the Plan

- ∞ Simulated emergency preparedness exercises and mock fire fighting exercises including mutual aid scheme resources and in conservation with district emergency authority to be carried out time to time.

7.5.13 Disclosure of Information to workers and Public Awareness System in Existence and Anticipated

- ∞ Safety awareness among workers by conserving various training programs and seminars, competitions, slogans etc.
- ∞ Practical exercise
- ∞ Distribution and practices of safety instructions
- ∞ Safety Quiz contests
- ∞ Display of safety posters and safety slogans
- ∞ Developing safety instructions for every job and ensuring these instructions / booklets or manuals by the workers

7.6 Off-Site Emergency Preparedness Plan

- ∞ The task of preparing the off-site emergency plan lies with the District Collector
- ∞ However, the off-site plan will be prepared with the help of the local district authorities
- ∞ The proposed plan will be based on the following guidelines

7.6.1 Guidelines of Proposed Plan

- ∞ Off-site emergency plan follows the on-site emergency plan. When the consequences of an emergency situation go beyond the project boundaries, it becomes an off-site emergency is essentially the responsibility of the public administration. However, the project management will provide the public administration with the technical information relating to the nature, quantum and probable consequences on the neighboring population.
- ∞ The off-site plan in detail will be based on those events which are most likely to occur, but other less likely events which have severe consequence will also be considered. Incidents which are very severe consequences yet have a small probability of occurrence will also be considered during the preparation of the plan. However, the key feature of the good off-site emergency plan is flexibility in its application to emergencies other than those specifically included in the formation of the plan.
- ∞ The role of the various parties who will be involved in the implementation of an off-site emergency plan are described below:
- ∞ Depending on the local arrangements, the responsibility for the off-site plan will be either rest with the works management or with the local authority. Either way, the plan will identify an emergency coordinating officer, who would take the overall command of the off-site activities. As with the on-site plan, an emergency control center will be setup within which the emergency coordinating office can operate.

- ∞ An early decision will be required in many cases on the advice to be given to people living “within range” of the accident – in particular whether they should be evacuated or told to go indoors. In the latter case, the decision can regularly be reviewed in the event of an escalation of the incident. Consideration of evacuation may include the following factors:
- ∞ In the case of major fire but without explosion risk (i.e. an storage tank), only houses close to the fire are likely to need evacuation, although a severe smoke hazard may require this to be reviewed periodically.
- ∞ If a fire is escalating and in turn threatening a store of hazardous materials, it might be necessary to evacuate people nearby, but only if there is time; if insufficient time exists, people should be advised to stay indoors and shield them from the fire

Aspects to be considered in the Off-site Emergency Plan

The main aspects, which will be included in the emergency plans, are:

7.6.2 Organization

- ∞ Details of command structure, warning systems, implementation procedures, emergency control centers
- ∞ Names and appointments of incident controller, the main controller, their deputies and other key personnel

7.6.3 Communication

- ∞ Identification of personnel involved, communication center, call signs, lists of telephone numbers

7.6.4 Specialized Knowledge

- ∞ Details of specialist bodies, firms and people upon whom it may be necessary to call i.e. those with specialized chemical knowledge, laboratories etc.

7.6.5 Voluntary Organization

- ∞ Details of organizers, telephone numbers, resources etc.

7.6.6 Chemical Information

- ∞ Details of the hazardous substances stored or procedure on each side and a summary of the risk associated with them

7.6.7 Meteorological Information

- ∞ Arrangement for obtaining details of weather conditions prevailing at the time and weather forecasts

7.6.8 Humanitarian Arrangements

- ∞ Transport, evacuation centers, emergency feeding, treatment of injured. First aid, ambulances, temporary mortuaries

7.6.9 Public Information

- ∞ Arrangements for dealing with the media press office, informing relatives, etc.

7.6.10 Assessment

- ∞ Arrangements for:
 - Collecting information on the causes of the emergency
 - Reviewing the efficiency and effectiveness of all aspects of the emergency plan

7.6.11 Role of Controlling Officer

- ∞ The various emergency services will be coordinated by an emergency coordinating officer (ECO), who will be designated by the District Collector
- ∞ The ECO will liaise closely with the site main controller
- ∞ Again depending on local arrangements, the external control will be passed to a senior local authority administrator or even an administrator appointed by the central or state government

7.6.12 Role of the Local Authority

- ∞ The duty to prepare the off-site plan with the local authorities. The Emergency Planning Officer (EPO) appointed will carry out his duty in preparing for a whole range of different emergencies within the local authority area. The EPO will liaise with the works, to obtain the information to provide the basis for the plan. This liaison will ensure that the plan is continuously up-to-date.
- ∞ It will be responsibility of the EPO to ensure that all those organizations which will be involved off-site in handling the emergency, know of their role and are able to accept it by having for example, sufficient staff and appropriate equipments to cover their particular responsibilities. Rehearsals for off-site plans will be organized by the EPO.

7.6.13 Role of Police

- ∞ Formal duties of the police during an emergency include protecting life, property and controlling traffic movements
- ∞ Their functions will include controlling by standards evacuating the public, identifying the dead and dealing with casualties and informing relatives of death or injury, if any.

7.6.14 Role of Fire Authorities

- ∞ The control of a fire will be normally the responsibility of the senior fire Brigade Officer who would take over the handling of the fire from the site incident controller on arrival at the site.
- ∞ The senior fire Brigade Officer will also have a similar responsibility for other events, such as explosions
- ∞ Fire authorities in the region will be apprised about the location of all stores of flammable materials, water and foam supply points and fire fighting equipments
- ∞ They will be involved in on-site emergency rehearsal both as a participant and on occasions, as observes of exercises involving only site personnel.

7.6.15 Role of Health Authorities

- ∞ Health authorities, including Doctors, Surgeons, Hospitals, Ambulances, and so on, will have a vital part to play following a major accident and they will form an integral part of emergency plan
- ∞ For major fires, injuries will be the results of the effects of thermal radiation to a varying degree and the knowledge and experience to handle this in all but extreme cases may be generally available in most hospitals
- ∞ Major off-site incidents are likely to require medical equipments and facilities additional to those available locally and a medical “mutual aid” scheme should exist to enable the assistance of neighboring authorities to be obtained in the event of an emergency.

7.6.16 Role of Government Safety Authorities

- ∞ Project inspectors of the region may like to satisfy themselves that the organization responsible for producing the off-site plan has made adequate arrangements for handling emergencies of all types including major emergencies.
- ∞ They may wish to see well documented procedures and evidence of exercise undertaken to test the plan.
- ∞ In the event of an accident, local arrangements regarding the role of the project inspector will apply
- ∞ These may vary from keeping a watching brief to a close involvement in advising on operations

7.6.17 Occupational Health and Safety

- ∞ Large projects, in general, and chemical plant in particular where multifarious activities are involved during construction, erection, testing, commissioning, operation and maintenance, the men, materials are the basic inputs.

- ∞ Along with the boons, the industrialization generally brings several problems like occupational health and safety
- ∞ Occupational health needs attention both during construction and erection as well as operation and maintenance phases. However, the problem varies both in magnitude and variety in the phases mentioned above
- ∞ The occupational health problems envisaged at this stage can mainly be due to constructional accident and noise
- ∞ To overcome these hazards, in addition to arrangements to reduce it within TLV's personal protective devices should also be supplied to workers

7.6.18 Operation and Maintenance

- ∞ The problem of occupational health, in the operation and maintenance phase is due to reparable dust and noise
- ∞ With suitable engineering controls the exposures can be reduced to less than TLV limits and proper personnel protective devices should be given to the employees
- ∞ The working personnel should be given the following appropriate personnel protective devices (**Table 7.1**).

Table 7.1: Appropriate Personnel Protective Devices

Industrial Safety helmet	Canister Gas Mass
Crash Helmet	Dust Masks
Zero power plain goggles with cut type filters on both ends	Self-contained breathing apparatus
Zero power goggles with cut type filters on both sides and blue color glasses	Leather apron
Chemical goggles	Boiler Suit
Welder equipments for eyes and face protection	Aluminized fiber glass fix proximity suit with hood and gloves
Cylindrical type earplug and ear muffs	Safety Belt / Lime man's safety belt
Leather hand gloves	Asbestos hand gloves
Acid/Alkali proof rubberized hand gloves	Canvas cum leather hand gloves with leather palm
Lead hand gloves	Electrically tested electrical resistance hand gloves
Industrial safety shoes with steel toe	Rubber Boots (alkali resistant)
Electrical safety shoes without steel toe and gum boots	

- ∞ Fully fledged hospital facilities should be made available round the clock for attending emergency arising out of accident, if any
- ∞ All working personnel should be medically examined at least once in every year and at the end of his term of employment
- ∞ This is in addition to the pre employment medical examination

7.6.19 Safety Plan

- ∞ Safety of both men and materials during construction / operation phases is of concern
- ∞ The preparedness of a project for the occurrence of possible disaster is known as emergency plan
- ∞ The disaster in the project unit is possible due to leakage of hazardous chemicals, collapse of structures and fire / explosion etc.
- ∞ Keeping in view the safety requirement during construction, operation and maintenance phases, proposed project has formulated safety policy with the following regulations:
- ∞ To allow sufficient resources to maintain safe and healthy conditions at work
- ∞ To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of the project machinery and equipment
- ∞ To ensure that adequate safety instruction are given to all employees
- ∞ To provide wherever necessary protective equipment, safety appliances and clothing and to ensure their proper use
- ∞ To inform employees about material equipment, or process used in their work which is known to be potentially hazardous to health or safety
- ∞ To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and up to date knowledge
- ∞ To provide appropriate facilities for first aid and prompt treatment of injuries and illness at work
- ∞ To provide appropriate instruction, training, retraining and supervision to employee in health and safety, first aid to ensure that adequate publicity is given to these matters
- ∞ To ensure proper implementation of the fire prevention methods and an appropriate firefighting service together with training facilities for personnel involved in this service
- ∞ To organize collection, analysis and presentation of data on accident, sickness and incident involving personnel injury or injury to health with a view to taking corrective, remedial and preventive measures

- ∞ To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees
- ∞ To publish / notify regulations, instruction and notices in the common language of employees
- ∞ To prepare separate safety rules for such types of occupation / process involved in a project
- ∞ To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations

7.7 Safety Organization

Construction Phase

- ∞ A qualified and experienced safety officer will be appointed
- ∞ The responsibility of the safety officers include identification of the hazardous conditions and unsafe acts of workers and advice on corrective actions, conduct safety audit, organize training programs and provide professional experts advice on various issues related to occupational safety and health
- ∞ He is also responsible to ensure compliance of works safety rules / statutory provisions
- ∞ In addition to employment of safety officer by the tunnel construction every contractor, who employees more than 70 workers should also employ one safety officer to ensure safety of the workers, in accordance with the condition of contract

Operation and Maintenance Phase

- ∞ When the construction is completed the posting of safety officers should be in accordance with the requirement of Factories Act and their duties and responsibilities should be as defined thereof.

Safety Circle

- ∞ In order to fully develop the capabilities of the employees in identification of hazardous processes and improving safety and health, safety circles would be constituted to each area of the work
- ∞ The circle would consists of 5-6 employees from that area
- ∞ The circle normally should meet for about an hour every week

Safety Training

- ∞ A fully fledged training center will be set up
- ∞ Safety training will be provided by the safety officer with the assistance of faculty members called from Corporate Center, Professional Safety Institutions and Universities

- ∞ To regular employees, limited contractor labors are also provided safety training
- ∞ To create safety awareness safety films will be shown to workers and leaflets etc, will be distributed
- ∞ Some precautions and remedial measures proposed to be adopted to prevent fires are:
 - Compartmentation of cable galleries, use of proper sealing techniques of cable passages and crevices in all directions would help in localizing and identifying the area of occurrence of fire as well as ensure effective automatic and manual firefighting operations
 - Spread of fires in horizontal direction system with proper zoning and interlocks for alarms are effective protection methods for conveyor galleries
 - Housekeeping of high standards helps in eliminating the causes of fire and regular fire watching system strengthens fire prevention and fire fighting
 - Proper fire watching by all concerned would be ensured

7.8 Health of Employees

- ∞ Proper health checkup will be done on regular basis
- ∞ Each employee health data will be maintained
- ∞ In every six month health checkup will be done
- ∞ Adequate fund per year will be allocated under occupational health and safety plan. Worker's health will be evaluated by pre-designed format, chest x rays, eudiometry, Spirometry, Vision testing (far and near vision, color vision and any other ocular defect), ECG, during pre-placement and periodical examinations etc.

7.9 Public Consultation

“Public consultation” refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project are ascertained with a view to taking into account all the material concerned in the project design as appropriate.

Public consultation is a part of MMRDA's business process and has been outlined in MMRDA's CSR policy. The policy stresses on importance of respecting local culture factors and emphasizes on contributing to socio-economic development in the regions where it undertakes business activities. MMRDA has developed mechanisms for public consultation and responding to concerns in all the assets where it has had its presence for a substantial period of time like Maharashtra. Various initiatives are taken for improving local socio-economic, education, and community health conditions.

As per MoEF&CC highway project activity is under 7(f), Category 'A' and Category 'B' should be New National Highway or State Highway respectively, if it is greater than 30km in length, involving additional right of way (RoW) greater than 20km with general condition, if any, shall be apply. However, the proposed highway tunnel project is of 11.8km in length only. The project proponent (PP) had submitted an application to the concerned authority for the grant of ToR under highway project Category 7(f) B1 as per EIA Notification 2006. Based on the application draft ToR, MoEF&CC has returned application of ToR stating that the proposed project is not admissible under EIA Notification and will not require Environmental Clearance (EC) from Government of Maharashtra. Thus, no ToR is approved by the concerned authority, and therefore no public consultation is recommended under this process of public consultation.

Chapter 8

Project Benefits

8.1 Demand of Connectivity between Western and Eastern of Mumbai

Mumbai has been witnessing rapid urban and industrial growth in the past 2-3 decades and with the country's current liberalization policy this growth is expected to accelerate in future. MMRDA is therefore, proposing to construct twin tube, 2 lanes (each side) highway tunnel of about 11.8 km which passes through below Sanjay Gandhi National Park connecting Western Express Highway near Borivali and Ghodbunder road (Thane) near Tikuji-ni-wadi. In view of increasing traffic load on Thane Ghodbunder road, it is necessary to look for an alternative. Therefore, road tunnel passing below Sanjay Gandhi National Park is being proposed which will provide fast and smooth movement of traffic from Thane to Borivali. The distance between Thane and Borivali is also expected to reduce by over 10 km. This will also result in avoidance of traffic jams and saving fossil fuel and protecting environment due to reduced vehicular emissions. This is an important East-West links and carries heavy commercial traffic between NH-3 and NH-8. This road faces massive traffic congestion at various spots during peak traffic time in Mumbai. Congestion of traffic causes undesired burning of automobile fuels, which is a national loss in addition to the contribution of pollution, which could be contributing factor for air quality in the adjacent Sanjay Gandhi National Park (SGNP) keeping in view, these factors in addition to reducing travel time and easy access between Thane and western sub-rubs of Borivali, Mumbai.

Road tunnels were adopted in past only where other practicable means of road were not possible mostly for the highways in hilly terrains. Urban road tunnels were often discouraged due to an expensive option. However, it is increasingly difficult to provide the additional road space that may be required. Construction costs are used to compare alternative transportation routes and in case other factors are considered, then tunneling would become a viable option. Currently the local community has to bear these costs as they are not recognized or accounted for in the normal evaluation of alternatives.

During socio-economic survey, it was observed that the proposed tunnel project would create certain improvement on the socio-economic environment. Proposed tunnel developmental project will result in considerable growth of service sector and will also generate new industrial and business opportunities in the area. Small and medium scale industries may be developed as consequence. The major benefits of the proposed commercial developments of Thane and Borivali project areas will reduced the impact on environment as well as helps in reducing the time saving by 20-25 minutes and distance saving 10 km. The presence of tunnel in the project area will substantially improves the socio-economic conditions in the region.

By providing the existing road connectivity, the proposed project will substantially reduce the existing transport bottleneck to trade and will foster regional economic cooperation. The entire regional connectivity with the important destinations will be promoted from the project improving the project road will reduce transport cost.

In view of increasing traffic load on Thane Ghodbunder road, it is necessary to look for an alternative. Therefore road tunnel passing below SGNP is being proposed which will provide fast and smooth movement of traffic from Thane to Borivali.

The salient features of the project are given below:

- ∞ The tunnel alignment will pass through below Sanjay Gandhi National Park
- ∞ Therefore, environmental and forest zone won't be disturbed.
- ∞ A project safety plan (PSP) is to be formulated during construction and after construction considering the relevant acts and IS: 4756-1978
- ∞ Adequate ventilation shall be created by natural / mechanical means to ventilate tunnel.
- ∞ Well illuminated retro reflective / led light sign boards shall be installed at entrance and inside the tunnel at appropriate location
- ∞ Distance between the Thane to Borivali will be reduced/saved by 10km
- ∞ Reduction of tunnel time by 20 - 25 minutes
- ∞ Smooth traffic movement and reduction in traffic congestions
- ∞ Substantial reduction in pollution caused from vehicular congestion
- ∞ No disturbance to existing townships of Thane and Mumbai
- ∞ Fire extinguishers / water hoses, smoke detectors shall be provided at intervals of tunnels.
- ∞ Avoidance of massive traffic jams and thus saving fossil fuel
- ∞ Congestion of traffic causes undesired burning of automobile fuels, which is a national loss in addition to the contribution of pollution
- ∞ Protecting environment due to reduced vehicular emissions
- ∞ Effect on community health, air noise pollution, make tunneling viable option
- ∞ The project will generate temporary and permanent employment to the skilled / un-skilled workers offering employment opportunity to local population
- ∞ Tunnels reduce noise, air pollution, community disharmony and are visually attractive unlike surface roads.
- ∞ The intangible costs, such as effect on community health, air pollution and noise level, make tunneling viable, if they are assessed.

8.2 Improvement in the Physical Infrastructure

- ∞ The construction of the project would form an important part of the evolving road network in the area, provides high economic returns to the society and has a number of other up-quantifiable benefits as noted above
- ∞ The beneficial impact of proposed tunnel construction on the civic amenities will be substantial after the commencement of project activities.
- ∞ The community development interventions based on the community needs will be contribute to the improvement in health, educational facilities to the community
- ∞ Improvement in medical facilities around the tunnel development organized by project authority and the local government as well as local people
- ∞ The construction of new roads in the project area will enhance the transportation facilities. With improved transportation facilities there is always a scope for development
- ∞ The tunnel project activity would generate additional employment such as transportations, raw material supply, auxiliary ancillary work etc.
- ∞ The project helps in improving the socio-economic conditions of the region by employment generation, communication, education etc.
- ∞ The easy availability of infrastructure, manpower, raw materials will reduce the production cost as well as demand supply gap. The same will bring revenue to the state exchanger by way of duties and taxes.
- ∞ The project will have long run benefits for the Thane-Mumbai district
- ∞ The development of green belt around the tunnel and its terminals will improve on the aesthetics value of the area. Moreover, it will help in reducing the noise levels
- ∞ Overall improvement of the peripheral human habitat in the project area

8.3 Improvement in the Social Infrastructure

- ∞ The works associated with construction of the tunnel would give employment to the people living in the corridor. In addition, it will boost the economic activity and the improvement of socio-economic conditions
- ∞ The project will create opportunities for direct and indirect employment.
- ∞ The proposed project will categories local economic growth and thereby the potential to enhance quality of life of the communities around tunnel corridor

- ∞ The project will not disturb the existing pattern of the demographic structure
- ∞ No R & R Plan is required as there is no project affected people including home ousters, land ousters and landless labors. Also the tunnel project is passing below the SGNP, already procured permission from the concerned authority of the forest department
- ∞ The project will further enhance with diversification and the Panchayat will have a continued benefits of taxes and cess
- ∞ By the development of this project, local transporters will have business
- ∞ Overall growth of the neighboring area viz.;
 - Health and family welfare
 - Infrastructure development
 - Local population may get benefited due to increased business activated. viz. market, trade and commerce
 - Positive impact to local economy during the project construction phase
 - The proposed highway tunnel project activity will increased further development in the regions

8.4 Employment Potential

- ∞ The project period for construction phase is expected to complete within a period of about three years.
- ∞ About 200 - 300 labors of different categories on an average basis will be engaged on daily basis. Apart from that many local people will be getting indirect employment
- ∞ The tunnel project activities will provide employment to persons of different skills and trades.
- ∞ The local population will be given preference to employment of different categories.
- ∞ During construction of the project will provide temporary employment to unskilled and semi-skilled laborers.
- ∞ During operational phase, plans to develop and train local community members for providing services such as security, house-keeping, maintenance etc as per requirement will be implemented.

8.5 Other Tangible Benefits

The proposed tunnel project shall create both tangible and non-tangible benefits and many of those as described below:

- ∞ The project will provide a vital infrastructure link from Thane to Borivali, Mumbai districts. This will add impacts to the economic growth of this region of Mumbai
- ∞ The proposed project shall enhance the prospects of local economic growth and direct and indirect employment of the local communities
- ∞ The project construction and operation phase will influence in a positive manner the improvement in the basic amenities viz. roads, transportation, electricity, proper sanitation, educational institutions, medical facilities, etc.
- ∞ Soil erosion control by nalla training terracing and bonding
- ∞ Time saving by quicker transport by this tunnel project area like Mumbai
- ∞ Developed economy strengthens demographic set up in the area that will bring weight-age to secure better health institute

8.6 Corporate Social Responsibility (CSR) Policy of MMRDA

Corporate Social Responsibilities is the commitment of business to contribute to sustainable economic development by working with the employees, their families, local community and society at large to improve their lives in the ways that are good for business as well as overall development. CSR in fact is about business giving back to the society. The CSR cell will be headed by GM, Planning and Marketing Department and he will be responsible for guiding and steering the CSR activities. The head would be assisted by Technical Support Team. The CSR activities to be undertaken by MMRDA are listed as below:

- ∞ Conduct road safety campaigns
- ∞ Set up Counseling Centers like alcohol rehabilitation and de-addiction
- ∞ Providing health care check up services
- ∞ Providing safe drinking water to passengers (by Water Vending Machine)
- ∞ Setting up battery charging units for the benefit of passengers
- ∞ Build community toilets facility to the passengers specially women
- ∞ Skill development / up gradation training programs
- ∞ Providing vocational training courses
- ∞ Providing ICT based learning infrastructure for social awareness
- ∞ Providing Community Development Scheme
- ∞ Adopting Model Villages (for potable water, hygienic toilets and urinals)
- ∞ Installation of solar lights for passengers

- ∞ Tree plantation initiatives for greenery
- ∞ “Swachh Bharat Abhiyan” to spread awareness
- ∞ Water conservation initiatives (to save, reduce wastage, recycle of water)
- ∞ Providing scholarships to meritorious children of MSRDC staff
- ∞ Use of Public Private Partnerships (PPP) wherever possible

About 2.5% of the capital cost of the project will be earmarked for CSR activity for infrastructural and health program development etc.

Chapter 9

Environmental Cost Benefit Analysis

This chapter is beyond the scope of this report as the “Proposed Twin Tube (2 lanes Each) Highway Tunnel from Tikuji-Ni-Wadi in Thane District to Borivali in Mumbai Suburban District in the State of Maharashtra” does not require prior Environmental Clearance under EIA notifications 2006 and subsequent amendments.

Chapter 10

Environmental Management Plan (EMP)

10.1 Environmental Management Plan (EMP)

The Environmental Management Plan (EMP) consists of the set of mitigation measures, monitoring program, management, and institutional arrangement to be taken during the design, construction and operation phases of the project to eliminate adverse environmental impacts or reduce or offset them to acceptable levels. The plan also includes the actions needed for the implementation of these measures. The EMP addresses the components of environment affected.

The EMP is divided into two sections corresponding to the stage of project development: during, and post construction. During construction the contractors are given details on how to mitigate identified significant adverse impacts from tunneling, cut and cover, spoil disposal, ground water extraction, temporary disruption of services, occupational and community health and safety and decommissioning. During tunnel operation, mitigation measures to be implemented by MMRDA are recommended to control noise, vibration, and depletion of groundwater.

10.2 Corporate Environmental Policy

- ∞ MMRDA reaffirms its commitments to contributes towards a clean and sustainable environment and continually enhances its environmental performance as an integral power of its business philosophy and values
- ∞ Overall conservation of environment
- ∞ Minimization of waste generation and pollution
- ∞ Judicious use of natural resources and water
- ∞ Safety, welfare and good health of the work force and populace
- ∞ Ensure effective operation of all control measures
- ∞ Vigilance against probable disasters and accidents
- ∞ Monitoring of cumulative and long time impacts
- ∞ Progressively adopt cleaner and energy efficient technology
- ∞ Minimize waste generation and promote recovery, recycle and reused of wastes
- ∞ Increase greenery in and around the project boundary

- ∞ Enhance environmental awareness among employees working on behalf of project
- ∞ Annual review of the entire system and various environment management as well as process control and monitoring systems shall be done to collect the data on air, noise, water, soil etc and duly recorded

Environmental management plan which shall be implemented in detailed under the following heads:

- ∞ Pollution control system
- ∞ Water minimization and resources conservation
- ∞ Occupational health and safety
- ∞ Socio-economic development
- ∞ Greenbelt development plan

10.3 Objectives

The main objective of the Environmental Management Plan (EMP) is to ensure that the various adverse impacts associated with the project are properly mitigated. The objective of the EMP at various stages of the project planning and implementation are as follows:

(a) Construction Phase

- ∞ To prevent and reduce the negative environmental impacts of the project by implementation of techno-economically feasible mitigation measures;
- ∞ To ensure that the provisions of the EMP are strictly followed and implemented;
- ∞ Establish the roles and responsibilities of all parties involved in environmental management;
- ∞ Ensure implementation of recommended actions aimed at EMP and its enhancement;
- ∞ Ensure that the environment and its surrounding areas are protected and developed to meet the needs of the local communities including other stakeholders to safeguard and the interests of the common people

(b) Operation Phase

- ∞ To prevent deterioration of environmental components viz. air, water, soil, noise etc.
- ∞ To improve the safety of the highway users and road side communities.

10.4 Administrative Aspects for EMP

10.4.1 Operational Philosophy

The basis of the operational philosophy of MMRDA operations in Maharashtra is that the activities proposed in highway processing (tunnel) shall be operated in complete compliance with all applicable Laws, Regulations, Standards and Permits along with MMRDA policies, procedures, specifications, rules, standards and guidelines etc.

In order to achieve this, MMRDA will establish a resource base for the management of health, safety, environmental and social issues during construction and operation of twin tunnel, 2 lanes (each side) of 10.8 km length project from Borivali to Thane below the Sanjay Gandhi National Park. Technically qualified and experienced staff will be deployed. Detailed procedures and plans will be developed for each activity prior to operations start up. All persons on this project work will be experienced crew with valid qualifications.

The Health Safety Environment (HSE) Management System Process which will be developed for use as part of the implementation of the operations philosophy will be followed, together with the commitments contained within the MMRDA corporate Health, Safety and Environment (HSE) Policy. MMRDA is committed to being accredited with ISO 14001 standards. The system also contains adequate security measures that are designed to protect people and property. The HSE objectives for the project are simply stated as:

- ∞ No accidents,
- ∞ No harm to people and
- ∞ No damage to the environment.

10.4.2 HSE Management during Design, Construction and Operations

During the design phase, office occupational health and safety will be monitored by a series of HSE and social audits conducted by the project team and co-ordinated by HSE Manager, together with representatives of the Detailed Design Contractor.

All construction contractors will work in accordance with the requirements set out in project Contractors' Safety Requirements. This document requires contractors to implement HSE management systems that meet the requirements of international standards and to follow a risk-based approach to identify and manage hazards. The Contractors' Safety Requirements would be consistent with the MMRDA Process developed to guide the project team in setting out the appropriate safety programs and procedures to manage the construction hazards. The contents of this guideline should be regarded as the minimum acceptable safety requirements for the Midstream Facilities Development Project. This covers areas like are the followings:

- ∞ Appraising project safety status

- ∞ Identifying resource
- ∞ Managing project safety issues
- ∞ Measuring project safety performance
- ∞ Improving communication
- ∞ Capturing, incorporating and sharing lessons learned

In addition to specifying the HSE requirements for the construction sites and fabrication facilities, the “Contractors’ Safety Requirements” shall include the requirements to ensure the occupational health and safety of the workforce is protected, including their fitness to work and general welfare.

Following the pressurization or energisation of systems, a “Permit to Work” system will be implemented with appropriate levels of authorization required prior to work commencing. All project personnel will receive HSE training appropriate for their needs, as identified through formal competency assessments and by their departmental heads in consultation with Project HSE Manager.

The selection of materials during both construction and operations will be based on those that are safe to use and cause the minimum environmental impact. Handling will be in accordance with the manufacturer’s instructions. Proper personal protective equipment (PPE) and training in the potential hazards will be provided.

10.4.3 Contractors HSE Plan

Reputed highway tunnel contractor(s) will be engaged for the construction of tunnel and associated activities / facilities based on competitive bidding basis. The competency of the contractor HSE systems will be one of the main considerations for selection criteria. The construction shall be managed by a dedicated construction team interacting with the contractors’ construction personnel and ensuring all QHSE aspects of the project. During construction phase of tunnel project, the HSE management systems developed by the construction contractor aimed at managing the environmental and social management plans will be implemented.

Each contractor shall develop procedures for waste management including handling and management of chemicals, hazardous wastes, spill control measures, used oil, emission control, wastewater treatment, etc. Contractors shall comply with all applicable government regulations governing storage, disposal and transportation of wastes.

All waste streams shall be identified and appropriate waste storage and removal procedures shall be in place. Measures shall be taken to prevent the pollution of soil and ground water. Personnel shall be trained and instructed for proper handling and spill prevention. The waste shall be storage in proper place or containers and located at pre-defined and protected locations. Waste quantities shall be properly reordered and documented. The waste transport and disposal vendors engaged by contractor shall be reviewed and approved by MMRDA.

10.5 Health Safety and Environment

10.5.1 Health

Systems equipment and tunnel alignment/layout should be designed to ergonomic principles to help facilitate both operation and maintenance of the tunnel and equipment. Health and safety of all personnel will be a consideration in design to ensure that the risks to those personnel are minimized. This should include a human factor study of the design which will address issues such as exposure to noise, heat, cold, stress, lighting, control room design, control desk, layout, field accommodation and recreation facilities, transportation etc.

A pre-mobilization, company approved minimum level of medical fitness including all applicable regional vaccinations will be required for all persons working in the field and along the tunnel route. This will apply to all company and contract employees and will continue throughout the life of the project and into the operations phase.

Due to the remote location of the field, high quality medical facilities and staff are required and will be in place for first aid and initial life survival capabilities with an efficient response network capable of transferring sick or injured persons to medical facilities outside the field. The area near to the starting point at Borivali east will have an adjacent helipad for use in medical emergencies. Such medical facilities should also be provided at other end point at Tikuji-ni-wadi, Thane. An approved exposure monitoring and health surveillance program will be in place throughout the construction, commissioning and operations phases.

10.5.2 Safety

10.5.2.1 Emergency Response

There will be emergency response teams shall be provided in the starting and ending points of the tunnel route. These teams will be made up from operations personnel, who can be called upon 24 hours a day, supported by an Incident Management Centre (IMC) manned by operations senior management field personnel as and when required. Both the tunnel ends will also have a dedicated fire and emergency team to carry out with the routine operations personnel. The fire and emergency response teams will receive specific training for their roles and exercised on a regular basis, as described in the Site Emergency Response Plan.

10.5.2.2 Safety Case (COMAH)

MMRDA will adopt COMAH (Control of Major Accidents Hazards) principles for the basis of safety management and reporting. The Safety Report will be a document prepared by MMRDA will provide information that will demonstrate that all measures necessary for the prevention and mitigation of major accidents have been taken.

Hazard management will identify hazard and consequences, assess and optimize risks and provide tools for managing each risk. All personnel working at sites will be expected to fully conform at all times to the appropriate MMRDA

requirements for PPE (Personal Protective Equipment) for the area in which they work.

Safety rules will be developed and adhered to by all employees and contractors whilst involved in MMRDA activities. Key areas such as Permit to Work (PTW), energy isolation and hazard identification / risk assessment shall be fundamental to the development of these rules. These rules shall also be in compliance with relevant laws, company policy and established international practices.

Different phases of the project will be monitored through the methods of raising, recording and reviewing safety actions and the implementation of the resulting actions. A procedure for the management of safety actions will form part of the project management system.

Various reviews, studies and audits shall be used to ensure the technical safety of the design. These include the followings:

- ∞ Environment Impact Assessment (EIA)
- ∞ Project Health, Safety and Environment Reviews (PHSER)
- ∞ Hazard Identification (HAZID)
- ∞ Layout Review
- ∞ Design Review
- ∞ Hazard and Operability Studies (HAZOP)
- ∞ Fire Protection Review
- ∞ Quantitative Risk Analysis (QRA)
- ∞ Safety Audits and Inspections
- ∞ COMAH Documentation

10.6 Environment Monitoring Plan (EMoP)

The environment monitoring plan (EMoP) is an important component of environmental management aspects relevant to the proposed works. To ensure the effective implementation of the EMP, it is essential that an effective monitoring program be designed and carried out. The broad objectives are:

- ∞ Verification of the estimated expected impacts based on selective parameters and determine scale of impacts, as well as registration of unforeseen effects
- ∞ To evaluates the performance of the mitigation measures proposed in the EMP
- ∞ To evaluates the adequacy of Environmental Impact Assessment
- ∞ To suggests improvement in management plan, if required
- ∞ To enhance environmental quality
- ∞ To satisfies the legal and community obligations

- ∞ The monitoring plan will be used for performance monitoring of the project

The Environmental and Corporate Social Responsibility Management issues of the proposed tunnel development project has been widely recognized within MMRDA as a key challenge that need to be managed appropriately and effectively to obtain and maintain the 'Social License to Operate'. The environmental control measures being put in place will be aligned with ISO 14001.

The Environmental Impact Assessment (EIA) and Risk Assessment (RA) will provide guidance on what particular areas should be monitored; these will typically include chemical consumption, emissions to air, liquid discharges and waste disposal. The waste management will be designed into the facilities to allow and encourage safe and efficient waste reduction, recycling, segregation and disposal. The operation will be designed to first minimize waste and then effectively deal with that waste which is generated.

10.6.1 Greenbelt Development Plan

Greenbelt development planning will be done with ecological perspectives of the proposed highway tunnel project from Thane to Borivali taking into consideration the nature of pollutants, availability of space and dominant wind directions. Trees form the important part of the biosphere in the eco-system management. This will help in reducing the concentrations of pollutants and will also be effective in attenuating noise levels and providing thick green cover to suppress fugitive emission and also to provide aesthetic beauty.

Objectives of Greenbelt Development

- ∞ A greenbelt of appropriate width should be developed in and around the proposed tunnel site and its east and west portals
- ∞ Development of greenbelt with carefully selected native plant species is of prime importance due to their capacity to reduce noise and air pollution impacts by attenuation / assimilation and for providing food and habitat for local macro and micro fauna. This is not only overcomes the problem but also enhances the beauty of the area that will attract birds and butterfly species and by this way ecology of the area will be maintained to a great extent.
- ∞ For developing greenbelt in and around the proposed tunnel sites and their portals, care need to be taken to plant the evergreen species. The planting of evergreen species may have certain advantages that may reduce the environmental pollution.
- ∞ The proposed greenbelt development plan by MMRDA should be provide a suitable width along the highway tunnel, tunnel portals areas including the space between the highway within the portals, along the roads, the waste disposal facilities etc.
- ∞ A greenbelt or tree plantation along the sides of tunnel and tunnel portals that shall help to arrest the effects of particulate matter and

gaseous pollutants in the area besides playing a major role in environmental conservation efforts.

- ∞ The greenbelt would be consisting of trees, shrubs, avenue trees, revenue plants etc.
- ∞ For effective control of air pollutants in and around the proposed tunnel project, a suitable greenbelt will be developed taking in to consideration the following criteria:
 - To mitigate gaseous emissions
 - Have sufficient capability to arrest accidental release of pollutants
 - Effective in wastewater reuse
 - Maintain the ecological balance
 - Control noise pollution to a considerable extent
 - Prevent soil erosion
 - Improve the aesthetics value

Recommendation on Greenbelt Development

- ∞ Trees and shrubs vegetation will be grown along the proposed tunnel portals and also by the side of tunnel highway which acts as dust filters and sink to the fumes coming from heavy machinery and vehicles
- ∞ Greenbelt will be developed making use of diverse local trees species, fruit trees and grass species of fodder importance
- ∞ The plantation with greenbelt would provide habitat for birds and arboreal animals as well as natural environment for wildlife and may not scare away due to aesthetic environment

The plant species suitable for greenbelt development will be selected based on the following criteria:

- ∞ Diverse fast growing local plants
- ∞ Selected plant species should have thick canopy cover
- ∞ They should be perennial and evergreen
- ∞ They should have high sink potential for pollutants
- ∞ They should be efficient in absorbing pollutants without significantly affecting their growth
- ∞ Preparation of greenbelt plan keeping in view the selected plant species:
- ∞ The development of greenbelt is an effective way to check the dispersion of pollutants to the environment
- ∞ The degree of pollution attenuation by a greenbelt depends on its height, width, foliage, surface area, density of leaf etc.
- ∞ Greenbelt will be done to improve the aesthetic value of the project area as well as to reduce the air pollutants

- ∞ Out of the total project area, 33% land will be utilized for greenbelt development and plantation will be done as per Central Pollution Control Board (CPCB) norms / guidelines
- ∞ Local plant species would be preferred.
- ∞ A land measuring around 57.02 ha is available for locating the tunnel length of 11.8 Km
- ∞ Project proponent committed to develop greenbelt in approximately 33% (18.48 ha) of total land area
- ∞ Therefore, total plantation will be around 36,960 numbers (@ 2000 plantation/ha).

Guidelines for Plantation

Plant species identified for greenbelt should be planted using pitting technique. The pit size should be either 45cm x 45cm x 45cm or 60cm x 60cm x 60cm. Bigger pit size is prepared on marginal and poor quality of soil. Soil used for filling the pit should be mixed with well decomposed farm yard manure or sewage sludge at the rate of 2.5 kg (on dry weight basis) and 3.5 kg (on wet weight basis) for 45cm x 45cm x 45cm and 60cm x 60cm x 60cm size pit respectively. The filling of soil should be completed at least 5-10 days before actual plantation. Highly sapling of identified species should be planted in each pit.

Tunnel (Roadside) Plantation

Tunnel or roadside plantation plays a very important role for greening the area, increasing the shady area, increasing aesthetic value and for eco-development of the area. The approach roads to the project site should be planted with the suitable flowering trees. MMRDA should encourage plantation outside the boundary of tunnel portals and overburden disposal sites. Adequate care should be taken to encourage greenbelt development on the tunnel/road side, however to uplift the park ecosystem of the area by greenbelt development. All the voluntary organizations should take initiative to encourage massive plantation along the roadside and tunnel sides. Tree should be planted to increase aesthetic value as well as shady area along the tunnel portals. A list of selected native plants for development of greenbelt at the tunnel site presented in **Table 10.1** and time frame for greenbelt development plant is provided in **Table 10.2**.

Table 10.1: List of Plant Species Suggested for Greenbelt Development

Sr. No.	Name of the Plant Species	Height (m)
Trees		
1.	<i>Acacia auriculoformis</i>	16
2.	<i>Acacia nilotica</i>	08
3.	<i>Achras sapota</i>	10
4.	<i>Aegle marmelos</i>	12
5.	<i>Annona squamosa</i>	10
6.	<i>Annona reticulate</i>	10
7.	<i>Albizia lebbeck</i>	20
8.	<i>Azdirachta indica</i>	20

Sr. No.	Name of the Plant Species	Height (m)
9.	<i>Cassia siamea</i>	12
10.	<i>Casuarina equisetifolia</i>	10
11.	<i>Dalbergia sissoo</i>	10
12.	<i>Derris indica</i>	10
13.	<i>Ficus bengalensis</i>	20
14.	<i>Ficus religiosa</i>	20
15.	<i>Mangifera indica</i>	15
16.	<i>Mimusops elengi</i>	10
17.	<i>Peltophorum pterocarpum</i>	10
18.	<i>Pithecellobium dulce</i>	08
19.	<i>Psidium guayava</i>	15
20.	<i>Saraca asoka</i>	05
21.	<i>Syzygium cumini</i>	20
22.	<i>Tamarindus indica</i>	20
23.	<i>Zyzyphus mauritiana</i>	10
Shrubs		
24.	<i>Bougainvillea spectabilis</i>	08
25.	<i>Citrus lemon</i>	03
26.	<i>Lawsonia inermis</i>	05
27.	<i>Nerium indicum</i>	05
28.	<i>Sesbania sesban</i>	06
29.	<i>Thevetia peruviana</i>	06

Table 10.2: Time Frame and Greenbelt Development Plan

Project Implementation	Time Frame	No. of Plantation
Construction Phase	1 st Year	5000
	2 nd Year	5000
	3 rd Year	5000
Operation Phase	4 th Year	10,000
	5 th Year	10,000

10.7 Security

MMRDA's Security Policy commits the company to provide security to everybody involved with these project activities, the people who come into contact with our operations and the physical and natural environments in which we work. To achieve this, MMRDA seeks to provide a secure working environment and adopt appropriate international standards to protect employees and contractors, physical assets and operations against risks of injury, loss, damage or impairment from criminal, hostile or malicious acts.

To achieve this, a strong security presence / surveillance are required along the tunnel in order to manage the security concerns of the facility and infrastructure. Each of the tunnel ending stations will have security guards, supervisors and patrol crew for 24-hours a day, 365 days a year. It is envisaged that the security personnel

will be working a two-shift work schedule. In addition there will be security personnel for patrolling and working as supervisors / area in-charge.

10.8 Corporate Social Responsibility (CSR)

Proactive management of our interface with society and the local communities impacted by our activities is one of the key issues to be managed in the construction of tunnel development project.

In accordance with MMRDA's Corporate Social Responsibility (CSR) Policy, a Community Development Plan / Strategy shall be prepared for implementation.

10.9 Environmental Organization

To facilitate the implementation of the Environmental Management Systems, one of the most important aspects related to the organization and personnel are given below:

MMRDA has a well defined organization for Environment Management System. Both the highways and tunnel operating assets in Maharashtra are certified with ISO 14001 (2004) system and maintains the international standards in respect to safety and environment. All individual departments are accountable for the environment in and around them and individual departments take prompt action in dealing with environmental issues.

The HSE department is the nodal agency to coordinate and provide necessary services on environmental issues during construction and operation of this project. The department consists of officers from various disciplines to co-ordinate the activities concerned with the management and implementation of the environmental control measures.

Basically, this department will supervise the monitoring of environmental pollution levels viz. ambient air quality, water and wastewater effluent quality, noise level either departmentally or by appointing external agencies wherever necessary.

In case the monitored results of environmental pollution found to exceed the allowable limits, the Environmental Management Cell will suggest remedial action and get these suggestions implemented through the concerned authorities.

10.10 Staff Requirement for Environmental Management

The Environment Management Cell at the tunnel project should be headed by a senior executive who reports to the environment engineer at site. The environment cell consists of environment professionals with experience in various aspects of environment management ranging from 5 years to 20 years. This cell will be set up during the construction of the tunnel itself and will have adequate expertise and competency in handling and implementing the environment management systems and practices. The Environment Management Cell monitors and measures the environmental performance of the tunnel. There will be a laboratory set up for monitoring of environmental parameters as per CPCB guidelines and norms. This cell is qualified and experienced chemists, environmental scientists who support the head of environmental cell at site.

Third party Environmental Audits are also coordinated by the cell on a regular basis. Members of the Environment Cell also participate in National Task Forces under CREP (Charter for Corporate Responsibility for Environmental Protection) and in committees for reviewing National Standards for the highway tunnel project.

A dedicated HSE set-up exists in the corporate level to oversee the environmental management and pollution control aspects and headed by Director (Business Services) and constitutes Deputy General Manager, Environmental manager, Environmental Safety Engineers, Health Officer, etc. This environmental group is responsible for implementation of environmental management plan at asset level, interaction with the environmental regulatory agencies, reviewing draft policy and planning, etc. This department interacts with MoEF&CC, Central Pollution Control Board (CPCB), SPCB and other environment regulatory agencies. The department shall also interact with operational and local people to understand their problems and to formulate appropriate plans.

A monitoring plan defining all parameters to be monitored, with tentative location, project strategies for measurements, implementations and institutional responsibilities for differential components is prepared for all the stages of the project presented in **Table 10.3**.

Table 10.3: Environmental Management Plan (EMP)

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
(I) Construction Stages or Work				
Tunnel Construction		<ul style="list-style-type: none"> ∞ To the extent possible reuse spoils as embankment /Sub-grade or other facilities ∞ Consultation with local government and community as to reuse spoils for urban or community infrastructure construction ∞ Proper disposal of remain spoils in the identified spoils sites. ∞ Geological advanced probe boring and prediction will be adopted. Grouting will used to seal the leakage, and Water discharge will limit. ∞ Tunnel liner will be timely and properly installed. ∞ Sedimentation and filtration ponds will be adopted at tunnel construction sites to treat wastewater before discharged to nearby irrigation ditches 	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		<ul style="list-style-type: none"> ∞ Strictly follow operation and safety codes. ∞ Prior notice will be announcement to local community ∞ Prior safety inspection of nearby buildings for determination of blasting method and dosage. ∞ Strengthening and relocation of buildings if necessary. ∞ TBM technique will be used for tunnels in sensitive areas to minimize blasting impact on wildlife. ∞ Work will be arranged in daytime to minimize disturbance on wildlife. 		
Tunnel excavation TBM Operations Extraction of materials	Disturbance of rock formations, rock movements and fragmentations	∞ Procurement of boulders from authorized suppliers	Contractor	Environmental Expert or PIU
Earth-stone excavation, borrowing	Loss of vegetation Soil erosion issues	<ul style="list-style-type: none"> ∞ No tree cutting through route of the tunnel portion ∞ Only few trees in forest land outside SGNP with prior permission ∞ Top soil to be reserved for future reclamation ∞ Temporary drainage system will be built during dumping operation. ∞ Cutting/filling slopes wherever required will be timely protected with engineering or green belt plantation 	Contractor	Environmental Expert or PIU
Crushers and Batching Plants Location	Impact on Air, Noise disturbance including vibrations	<ul style="list-style-type: none"> ∞ Crushers and batching plants should be sited sufficiently away from settlements and agricultural operations or any commercial establishments. ∞ Such plants will be located at least 1000 m away from the 	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		<p>nearest village/settlement preferably in the downwind direction.</p> <ul style="list-style-type: none"> ∞ The contractor shall submit a detailed lay-out plan for all such sites and approval of environmental expert of CSE shall be necessary prior to their establishment. ∞ Arrangements to control dust pollution through provision of windscreens, sprinklers and dust encapsulation will have to be provided at all such sites. ∞ Specifications of crushers and batching plants will comply with the requirements of the relevant current emission control legislations for all such plants shall be submitted to the CSE and PIU. ∞ The contractor shall not initiate plants operation till the required legal clearances are obtained and submitted. 		
Works near Watercourses	Impairment of water quality, potential erosion of river embankment	<ul style="list-style-type: none"> ∞ Submit a method statement or plan for the execution of works near watercourses including measures that will be undertaken to address adverse environmental impacts such as erosion of river embankment and siltation of watercourses that may result from such activities. ∞ Discharge of sediment-laden construction water (e.g., from areas containing dredged spoil) directly into surface watercourses will be forbidden. Sediment laden construction water will be discharged into settling lagoons or tanks prior to final discharge 	Contractor	Environmental Expert or PIU
Drainage and Flood Control	Block the flow of water of any water course and	<ul style="list-style-type: none"> ∞ Contractor will ensure that no construction materials like earth, stone, ash or appendage disposed off so as not to block 		

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
	cross drainage channels	<p>the flow of water of any water course and cross drainage channels.</p> <ul style="list-style-type: none"> ∞ Contractor will take all necessary measures to prevent the blockage of water flow. In addition to the design requirements, the contractor will take all required measures as directed by the environmental expert of CSE to prevent temporary or permanent flooding of the site or any adjacent area. 		
Access Road	Loss of surface vegetation, Soil erosion, Local traffic disturbance and community safety concern	<ul style="list-style-type: none"> ∞ Access road will utilized existing rural roads as much as possible. ∞ Access road plan will fully consider the road development of local communities. ∞ Access road shall meet specifications with adequate erosion control and safety measures. ∞ Warning and safety signs used near communities. ∞ Accessibility of local community must be ensured. ∞ Periodic water spraying during dry season near local communities. ∞ Access roads will be well rehabilitated to return to local government, or in other cases, restored with plantation. 	Contractor	Environmental Expert or PIU
Construction sites, Material hauling	Noise impact on nearby communities	<ul style="list-style-type: none"> ∞ Construction vehicles slow down when going through towns and residential areas. ∞ Use of low noise construction machinery. ∞ Noise monitoring will be conducted for sensitive sites during construction ∞ Avoid transport night (22:00~6:00) where there are residents' concentration sites on the both sides of 	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		<p>construction access road, within 30 m.</p> <ul style="list-style-type: none"> ∞ In case night-time construction is needed: Prior consultation with nearby community shall be conducted. ∞ Approval from local authorities shall be obtained ∞ Public notice shall be posted to inform nearby communities. ∞ Noise monitoring shall be conducted 		
(II) Pollution				
General Construction Activities	Air Quality	<ul style="list-style-type: none"> ∞ Demolition debris shall be kept in controlled area and sprayed with water mist to reduce debris dust ∞ During pneumatic drilling/wall destruction dust shall be suppressed by ongoing water spraying and/or installing dust screen enclosures at site ∞ The surrounding environment (sidewalks, roads) shall be kept free of debris to minimize dust ∞ There will be no open burning of construction/ waste material at the site ∞ There will be no excessive idling of construction vehicles at sites ∞ Vehicles delivering fine materials like sand and fine aggregate shall be covered to reduce spills on roads. ∞ Do not use machines road construction machines as well as self-propelled machines with damaged engines; there shall also not have a prolonged idle running. ∞ It shall be ensured that the dust emissions from the crusher and vibrating screen at the stone quarries are within the emission standards. 	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
	Noise disturbance including vibrations	<ul style="list-style-type: none"> ∞ Construction noise will be limited to restricted times agreed to in the permit ∞ During operations the engine covers of generators, air compressors and other powered mechanical equipment shall be closed and equipment placed as far away from residential areas as possible ∞ The construction equipment will strictly conform to national noise standards; Vehicles and equipments used shall be fitted with exhaust silencers and shall be checked regularly. In residential areas, construction activity in that part of the tunnel near the locality will be in a good organization primarily during any period, the technique is not idling, servicing heavy construction vehicles to travel on predetermined routes and approaches to comply strictly permissible speed when crossing the settlements, limiting working hours in time zones designated by local authorities, in the case of acoustic emission in a specific direction to use acoustic barriers (barriers) to break the line of impact from the noise source to receiver. ∞ Workers shall be provided with earplugs; suitable noise barriers or double-glazing of windows will be provided to the noise receptors. 	Contractor	Environmental Expert or PIU
	Water Quality	<ul style="list-style-type: none"> ∞ The site will establish appropriate erosion and sediment control measures such as silt fences to prevent sediment from moving off site and causing excessive turbidity 	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		<p>in nearby streams and rivers.</p> <ul style="list-style-type: none"> ∞ All the existing flowing water bodies (rivers, streams, canals including irrigation canals) hazard is provided with culverts to maintain the natural drainage of the area. 		
(III) Waste Management				
Toxic Materials	Toxic / hazardous waste management	<ul style="list-style-type: none"> ∞ Temporarily storage on site of all hazardous or toxic substances will be in safe containers labeled with details of composition, properties and handling information ∞ The containers of hazardous substances shall be placed in an leak proof container to prevent spillage and leaching ∞ The wastes shall be transported by specially licensed carriers and disposed in a licensed facility. ∞ Paints with toxic ingredients or solvents or lead based paints will not be used. 	Contractor	Environmental Expert or PIU
(IV) Safety				
Work site operation / Operation of equipment maintenance and fuel storage areas	Worker's health and soil / water pollution	<ul style="list-style-type: none"> ∞ Prior to the commencement of works, the work site personnel shall be instructed about safety rules for the handling and storage of hazardous substances (fuel, oil, lubricants, bitumen, paint etc.) and also the cleaning of the equipment. ∞ In preparation of this the contractor shall establish a short list of materials to be used (by quality and quantity) and provide a rough concept explaining the training / briefing that shall be provided for the construction personnel. ∞ Locate storage facilities for fuels and chemicals away from watercourses. Such facilities will be bounded and provided 	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		with impermeable lining to contain spillage and prevent soil and water contamination. ∞ Store and dispose waste/used oil consistent with environmental legal requirements. ∞ Mentioning all workers wearing hardhats at all time ∞ Contractors shall put information stands at appropriate places at all construction sites, with necessary safety information, basic rules etc. etc. in languages understandable by workers. ∞ Work site restoration: After completion of construction works the contractor shall execute all works necessary to restore the sites to their original state (removal and proper disposal of all materials, wastes, installations, surface modeling if necessary, spreading and leveling of stored top soil).		
Traffic and Pedestrian Safety	Direct or indirect hazards to public traffic and pedestrians by construction activities	∞ In compliance with national regulations the contractor will insure that the construction site is properly secured and construction related traffic regulated. This includes but is not limited to ∞ Signposting, warning signs, barriers and traffic diversions: site will be clearly visible and the public warned of all potential hazards ∞ Traffic management system and staff training, especially for site access and near-site heavy traffic. Provision of safe passages and crossings for pedestrians where construction traffic interferes	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		<ul style="list-style-type: none"> ∞ Adjustment of working hours to local traffic patterns, e.g. avoiding major transport activities during rush hours or times of livestock movement ∞ Active traffic management by trained and visible staff at the site, if required for safe and convenient passage for the public. ∞ Ensuring safe and continuous access to office facilities, shops and residences during renovation activities, if the buildings stay open for the public. 		
Personal Safety Measures for Labor		<ul style="list-style-type: none"> ∞ Contractor will provide: ∞ Protective footwear and protective goggles to all workers employed on mixing asphalt materials, cement, lime mortars, concrete etc. ∞ Welder's protective eye-shields to workers who are engaged in welding works ∞ Earplugs to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation. ∞ Adequate safety measures for workers during handlings of materials at site are taken up. ∞ The contractor will comply with all regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress 	Contractor	Environmental Expert or PIU
Risk Force Measures		<ul style="list-style-type: none"> ∞ The contractor will take all reasonable precautions to prevent danger to the workers and public from fire, etc. resulting due to construction activities. 	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		<ul style="list-style-type: none"> ∞ The contractor will make required arrangements so that in case of any mishap all necessary steps can be taken for prompt first aid treatment. ∞ Construction Safety Plan prepared by the contractor will identify necessary actions in the event of an emergency 		
First Aids		<ul style="list-style-type: none"> ∞ The contractor will arrange for – A readily available first aid unit including an adequate supply of sterilized dressing materials and appliances in every work zone ∞ Availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital 	Contractor	Environmental Expert or PIU
Blasting		<ul style="list-style-type: none"> ∞ Explosives will be stored, handled and used as per applicable laws. Controlled and slow blasting will be carried out to minimize the damage. Areas near the blasting site will be given prior information of TBM work; Flagmen will be stationed near the site 	Contractor	Environmental Expert or PIU
(V) Labor Camp Management				
Camp and Workers	Heath, culture and local custom	<ul style="list-style-type: none"> ∞ Contractor will set up construction camps in coordination with local governments and public ∞ Adequate sanitary facility will be provided in camp sites ∞ Utilities will be properly maintained or timely restored ∞ Safety education for the nearby residents will be done in advance, including prevention and control of diseases transmission (e.g. HIV/AIDS) ∞ Local labors will be hired to increase the income of local people. 	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		<ul style="list-style-type: none"> ∞ Provide safety instructions and protective clothing, safe organization of temporary routes, safety will be determined and performed by documenting in logbooks, assignments of duties, etc. according to specified templates 		
Potable Water		<ul style="list-style-type: none"> ∞ The contractor will construct and maintain all labor accommodation in such a fashion that uncontaminated water is available for drinking, cooking and washing ∞ The contractor will also provide potable water facilities within the precinct of every workplace in an accessible place. ∞ The contractor will also guarantee the following: ∞ Supply of sufficient quantity of potable water in every workplace / labor camp site at suitable and easily accessible places and regular maintenance of such facilities ∞ If any water storage tank is provided that will be kept such that the bottom of the tank at least 1m from the surrounding ground level 	Contractor	Environmental Expert or PIU
Sanitation and Sewage System		<ul style="list-style-type: none"> ∞ The Contractor will ensure that –he sewage system for the camp are designed, built and operated in such a fashion that no health hazards occurs and no pollution to the air, ground water or adjacent water courses take place; ∞ Separate toilets/bathrooms, wherever required, screened from those from men (marked in vernacular) are to be provided for women 	Contractor	Environmental Expert or PIU

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		<ul style="list-style-type: none"> ∞ Adequate water supply is to be provided in all toilets and urinals ∞ All toilets in workplaces are with dry-earth system (receptacles) which are to be cleaned and kept in a strict sanitary condition 		
(VI) Flora and Fauna				
Flora and Fauna		<ul style="list-style-type: none"> ∞ The contractor will take reasonable precaution to prevent his workmen or any other persons from removing and damaging any flora (plant/vegetation) and fauna (animal) including fishing in any water body and hunting of any animal. ∞ If any wild animal is found near the construction site at any point of time, the contractor will immediately upon discovery thereof acquaint the Environmental ∞ Expert of CSE and carry out the CSE's instructions for dealing with the same. ∞ The Environmental Expert of CSE will report to the nearby forest office (range office or divisional office) and will take appropriate steps / measures, if required in consultation with the forest officials. 	Contractor	Environmental Expert or PIU
Damaged Drainage	Harmful environmental impacts resulting from damaged drainage or uncontrolled erosion.	∞ Routine monitoring of drainage system and erosion control at least twice a year	MMRDA	MSRDC
Pollution Monitoring		∞ The periodic monitoring of the indoor / ambient air quality, noise level, water (both ground and surface water) quality, soil	MSRDC	MSRDC

Activities	Potential Environmental Impacts	Mitigation Measures	Institutional Responsibility	
			Implement	Monitor
		pollution/contamination in the selected locations as suggested in pollution monitoring plan will be responsibility of MSRDC		
Noise Level and Vibration		<ul style="list-style-type: none"> ∞ Noise pollution and vibration will be monitored as per monitoring plan at sensitive locations. ∞ Noise control programs are to be enforced strictly. ∞ Monitoring the effectiveness of the pollution attenuation barriers, if there is any, will be taken up thrice in the operation period. ∞ Tunnel ventilation systems shall have suitable noise control measures incorporated into their design to reduce mechanical noise to acceptable levels in the surrounding community. ∞ Depending on the results of noise monitoring, installation of acoustical treatment to the first few meters (i.e. <15 m) of the tunnel portal shall be implemented as necessary 	MSRDC	MSRDC

MMRDA will be responsible for the implantation and monitoring of Environmental Monitoring Plan. Potential environmental impacts and safety of people can easily be avoided or mitigated by adopting good engineering practices. The contractors that will carry out the works will also follow the requirements of National Legislation and the current environmental management plan. MSRDC will assign some monitoring activities during construction and operation of the investments under the project to a supervision engineering consultant.

10.11 Construction Stage: Development of Site

To minimize the adverse impact during excavation of material following measures are need to be undertaken:

- ∞ Adequate drainage system shall be provided to prevent the flooding of the excavated area
- ∞ At the stockpiling locations, the contractor shall construct sediment barriers to prevent the erosion of excavated material due to runoff

- ∞ Construction of offices, laboratory, workshop and rest places shall be done in the up-wind of the tunnel to minimize the adverse impact due to dust and noise.
- ∞ The access road to the tunnel shall be constructed taking into consideration the location of units and also slope of the ground to regulate the vehicle movement within the project area.
- ∞ In-case of storage of blasting material, all precautions shall be taken as per The Explosive Rules, 1983.

10.12 Tunnel Operations Including Safety

- ∞ Overburden shall be removed and disposed on designated site
- ∞ During excavation, slopes shall be flatter than 200 to prevent their sliding.
- ∞ In-cases where quarry strata are good and where chances of sliding are less this restriction can be ignored.
- ∞ The contractor shall ensure that all workers related safety measures shall be done as per guidelines for workers and safety.
- ∞ The Contractor shall ensure maintenance of crushers regularly as per manufacturer's recommendation.
- ∞ Topsoil will be excavated and preserved during transportation of the material.
- ∞ Measures shall be taken to minimize the generation of dust and prevent accidents.

10.13 Institutional Framework for EMP Implementation

With the view of successful fulfillment of the environmental requirements determined in the EIA and the management plans, it is necessary that the project proponent (i.e. Project Implementation Unit (PIU), the Contractor (CRTG) and the Construction Supervision Engineer (CSE) to have appropriate institutional potential that shall ensure correspondence of the construction works with the environmental requirements.

MSRDC will have the Environmental Management Cell (EMC) for the project environmental supervision and administration and their roles and responsibilities are:

- ∞ Supervise the implementation of EMP
- ∞ Enforce applicable laws, regulations and standards
- ∞ Coordinate the environmental protection effort between departments
- ∞ Check and supervise the construction, completion and operation of environmental facilities

The main beneficial impacts are drawn from the initial environmental examination process are as follows:

- ∞ No plant cover within construction site will be destroyed
- ∞ No rivers/streams will be affected by the proposed project
- ∞ Proper treatment of the wastewater generated from the construction camps
- ∞ Proper disposal of the solid waste from the construction camps
- ∞ This project will significantly improve the local transportation condition
- ∞ It will bring substantial benefits to the local people economy and income
- ∞ As a result, life quality of the local residents will be improved and property alleviated
- ∞ As the negative impacts to the environment will be minimized and mitigated
- ∞ This project will receive strong supports from local people and governments
- ∞ The EMP has found this project environmentally acceptable and well implemented
- ∞ No change in the macro-climatic setting (precipitation, temperature and wind) is envisaged
- ∞ Negative impacts during construction stage like removal of topsoil, vegetation clearing, earth borrowing operations and possible decrease in surface water due to extra consumption of water during construction etc. are not going to be substantial
- ∞ The proposed project is not likely to have any significant impacts on the existing geology and soil pattern
- ∞ Net environmental impacts to the biophysical and socioeconomic environment, will be insignificant and of short term in nature by observing proposed mitigation measures.

Chapter 11

Summary and Conclusion

11.1 Introduction

M/s MMRDA has been appointed as the implementing agency by the Government of Maharashtra for the “Proposed Twin Tube (2 lanes Each) Highway Tunnel from Tikuji-ni-wadi in Thane District to Borivali in Mumbai Suburban District in the state of Maharashtra”. The project does not require prior environmental clearance (EC) from the Central or State Level Authority. The project needs only Forest Clearance from Forest Department and Wildlife Clearance from NBWL, which are under process. Dr. N.C. Kankal, retired senior principal Scientist from NEERI, Nagpur has prepared the EIA report for this project. Alignment survey has been carried out for fixing alignment location and topographical survey prepared around surrounding right of way (RoW). Topographical surveys make it possible to measure the steepness of slopes as well as detailed terrain. The alignment has been finalized in such a way that there will be zero disturbances to the ecosystem of the SGNP especially the flora and fauna found in the rich biodiversity of the National Park.

Environmental Setting and Magnitude of Operation

Sr. No.	Particulars	Details
1.	Project Location	
	Geographical Location (Coordinate)	Latitude: 19°10'19.36" N to 19°14'29.43"N Longitude: 72°52'18.15" E to 72°58'07.54" E
	Toposheet No.	47A-15,16
2.	Area Details	
	Total Area of Land Acquisition	42.46 ha of forest area of SGNP underground tunnel
	Right of Way	41 m land width for taking tunnel alignment
3.	Environmental Setting and Sensitivity	
	No. of affected villages by Land acquisition	Magathane village of Borivali, Mumbai; Yeoor, Chene, Majiwade, and Manpada of Thane district.
	Nearest major settlement	Tikuji-ni-wadi, Thane and Ektanagar, Borivali East
	Nearest Road	Ghodbunder Road (NH-3) East and Western Express Highway (NH-8) West
	Nearest Rly Stations	Thane and Borivali Railway Stations
	Nearest Air Port	Mumbai Air Port
	National Parks/Wildlife Sanctuary/Biosphere Reserve / RF/PF	Sanjay Gandhi National Park (SGNP) The proposed tunnel passing below the SGNP
	Archaeological Site	Kanheri caves locate within the National Park 2.5 km away from project alignment
Nearest Water Bodies	Tulasi Lake (south), 4.9km	

Sr. No.	Particulars	Details
	Terrain	Largely semi mountainous with only few patches of level land. Highest near Kanheri caves being 486 m
	Seismic Zone	Zone IV
	Climate	Temperature: 17. 5 ⁰ C – 33 ⁰ C, Humidity: 50% - 80%, Rainfall 2500-3000mm
5.	Project Design Criteria	
	Design Speed	100 -120km/hr
	Tunnel Connected	With Cross Passages
	Vertical Clearance in the tunnel	5.50m and width 13.1m
	Distance of two twin tunnels	50m apart in base
	Tunnel Methodology	Tunnel Boring Machine (TBM)
	Construction Period	About 3 Years
	Proposed Toll Plazas	As applicable decision taken by the authority
6.	Safety Measures	
	Ventilation	Quality of tunnel ventilation, traffic control system, safety walks, fire/life safety system etc. Structural and technical safety installation will comply with National and International regulations and standards.
	Lighting	Regular lighting throughout the day and year
7.	Environmental Management Plan	
	R & R Plan:	No R & R Plan is required
	Green Belt Development (Total plantation and area)	As per IRC SP 21:2009 /MoRTH Code/Guidelines About 14 ha (33%) of total area of 42.46ha Plantation about 28000@ 2000/ha
8.	Total Project Cost	3000 Cr

Site Selection Criteria

Three alternative routes / options were analyzed. Many possible alignments due to involvement of forest and defense land extent were rejected. Other possible alignments (Option 1, Option 2 and Option 3) are discussed subsequently. Out of three options, option 2 was finalized for further studies in consultation with MMRDA.

Salient Features of the Project

- ∞ Tunnel will be connected with cross passages
- ∞ Vertical Clearance in the tunnel will be 5.50m and width 13.1m
- ∞ Two twin tunnels are at about 50m apart in base
- ∞ Each tunnel will consists of unidirectional three lanes (total six lines)
- ∞ Gradient proposed in tunnel is +2.5% (1 in 40) in 500m stretch
- ∞ Tunnel passing below SGNP, thus environment and forest zones won't be disturbed

- ∞ The tunnel will be bored by Tunnel Boring Machine (TBM)
- ∞ The expected construction period will be about 3 years
- ∞ Fire extinguishers/water hoses, smoke detectors shall be provided at intervals
- ∞ A project safety plan (PSP) is considering the relevant acts and IS: 4756-1978
- ∞ Adequate ventilation shall be created by natural or mechanical means
- ∞ Illuminated retro-reflective light sign boards shall be installed at suitable locations.

11.2 Type of Project

- ∞ The proposed project of construction of new state highway tunnel is less than 30km in length will not categorize as 7(f) ‘A’ or ‘B’ of the schedule as per the MOEF&CC Notification dated September 14, 2006 and its subsequent amendments.
- ∞ Therefore, environmental clearance (EC) from the State Expert Appraisal Committee (SEAC), will not be required for this type of highway tunnel.

Need of Project

Over a period of 16 years (2005-21), it is estimated that, the private vehicles (two wheeler and cars) model share will increase from 12.8% to around 21.5%. Therefore, considering the potential increase in demand and limited available connectivity strength of existing roads have been proposed by removing bottlenecks and additional connectivity is proposed as per the following background:

- ∞ Thane Ghodbunder road is a major link road connecting Mumbai-Ahmadabad (NH-8))
- ∞ This is an important east-west link, carries heavy traffic between NH-3 and NH-8
- ∞ Existing Thane and Borivali via Ghodbunder road having length of 23km
- ∞ Therefore, it is proposed to explore the possibility of another shorter route as a tunnel from Thane to Borivali in Mumbai
- ∞ The two ends of the proposed tunnel have been separated by a chain of hills of SGNP
- ∞ There will be zero disturbances to the ecosystem of the SGNP having rich biodiversity
- ∞ The project will cut down traffic jam, pollution, fuel and save travel time by 20-25 min.
- ∞ The travel distance will be saved by 13km and no disturbance to existing township

- ∞ There will be fast and smooth movement of traffic and environmental friendly.

Technology and Process Description: Tunnel Construction Methodology

Keeping in view the present ground conditions, length of the tunnel and time frame there is a possibility of considering following two technology and processes:

(i) New Austrian Tunneling Method (NATM)

This method is known as New Austrian Tunneling Method (NATM), more than method is a philosophy of excavating tunnels, in which using the rock mass strength as structure to support the excavation. Drilling rigs are used to bore blast holes on the proposed tunnel surface to a designated depth for blasting. Explosive and timed detonators are then placed in the blast holes. Once blasting is carried out, waste rocks and soils are transported out of the tunnel before further blasting.

(ii) Tunnel Boring Machine (TBM)

In TBM excavation normally have a circular section launched in June 2015. Recently rectangular sections are also possible with specialized machine. These are more expensive than circular ones. The merit of such machine is that the excavated area is optimally utilized. The rectangular TBMs in the past have been manufactured by German, Chinese and Japanese manufacturers. The existing machines have multiple cutter heads and cut an almost rectangular face. The overlapping cutter heads of rectangular shield have only been soft ground cutter heads with scrapers but not disk cutters. Considering present scenario rectangular TBM seems not suitable for the proposed project.

Process by TBM Technology

Probe Drilling (when needed)	Transportation of muck
Grouting (when needed)	Lining or coating/sealing
Excavation (or blasting)	Draining
Supporting	Ventilation

Disturbance in the National Park (SGNP)

Vibration due to Blasting and TBM mining

- ∞ Blasting method never received any complaint about vibration disturbing the animals (dog)
- ∞ So, it is assume and indicate that the animals were not bothered by blasting vibration
- ∞ Vibration from blasts would be barely perceptible and not enough to damage structure
- ∞ This does not address the issue relating to animal sensitivity
- ∞ But it does not indicate that vibration created by blasting underground is less than surface

- ∞ As the depth of cover increases, the intensity of vibration will be decreases due to the damping effect of the different mediums (soil/rocks) the waves will cross.

Human Body Perception and Response

- ∞ Human body can detect magnitudes of vibration lower than those which would normally cause mechanical or structural problems.
- ∞ The “discomfort” or ‘annoyance” produce by whole body vibration is a very influential factor and may be one of the limiting parameters in the design of the structure.
- ∞ Data on human exposure to vibration has been incorporated into IS 2670:
- ∞ Evaluation of human exposure to whole-body vibration.
- ∞ Vibration exposure limits are given as a function of:
 - Direction of motion either horizontal or vertical
 - Frequency of vibrations and exposure of time
 - In most sensitive cases the allowable vibration is 3mm/sec.
 - Also it can be said that Peak Particle Velocity (PPV) <1 mm/sec are not detectable for human beings whereas PPV >10 mm/sec are clearly detectable.

Cost of Construction

- ∞ The maximum excavation area in NATM is 123.3m² whereas in TBM it is 132 m².
- ∞ Thus, the cost of construction of tunnel by NATM and TBM methods are computed as 1591 Cr. and 2287 Cr. respectively.
- ∞ The total cost of construction for twin tubes by TBM shall be expensive by about 696 Cr.

Options of Methodology

- ∞ It is concluded from the above, it indicates the total cost of construction for twin tubes by TBM shall be more expensive 696 Cr (14.37%).
- ∞ TBM requires limited skilled team to operate and after launching gives a high production.
- ∞ NATM equipment required is common and readily available, but more manpower
- ∞ The musk from either TBM single shield or double shield open machine and from drill and blast can be recycled as construction materials.
- ∞ The vibration in TBM is low and constant whereas in NATM it is intermittent and high.
- ∞ In both the methodology vibration can be controlled to the desired levels.

- ∞ Both these options are technically feasible
- ∞ Project Proponent has decided to use NATM option for construction.

Adoption of Technology

- ∞ TBM method can be adopted for construction according to the best technology.
- ∞ Bored tunneling by using a TBM is often used for excavation long tunnels.
- ∞ TBM may be suitable for excavating tunnels which contain competent rocks that can provide adequate geological stability for boring a long tunnel without structural support.

Requirement of Construction Materials

Use of Natural Resources

- ∞ Borrow areas for locating suitable soils for use in embankment and sub-grade.
- ∞ Quarries for locating hard stone/granular materials for use in sub bases, and concrete works
- ∞ Source of fine aggregate for use in DBM/BC layers and cement concrete works.

Borrow Area

- ∞ The survey of soil from borrows areas for use in embankment and sub-grade layer will be conducted along the proposed alignment.
- ∞ The location of borrow areas with their distances from the proposed alignment and the quantities available will be carried out during their actual requirement, if any.

Requirement of Borrow Area Soil (Overburden)

- ∞ Extensive survey will be conducted to locate the potential sources of borrow area soils (overburden) required for the construction of embankment and sub-grade within project area.
- ∞ Total volume of soil/rocks will be generated from the tunnel excavation is worked out amounting about 13,78,080m³.
- ∞ As per the requirements, this soil from the overburden may be used as construction materials and remaining can be disposed off at a suitable site which will be provided during construction.

Archaeological Values

- ∞ Kanheri Caves, located within the park, form a major point of interest
- ∞ These caves located about 2.5 km from the project alignment which will not impacted by the constructions activities.

Other Infrastructure

- ∞ As this is proposed tunnel construction facilities in the area, no major infrastructure facility is provided.
- ∞ Regular maintenance of trucks, drill, excavators and other equipments will be required
- ∞ These activities will require a bigger workshop for overhauling of major components of equipments and skilled manpower.
- ∞ Offices of the engineers, store for keeping regular maintenance, spares have also been envisaged.
- ∞ Equipment washing bay along with air compressors has also been envisaged.
- ∞ The total maintenance activity will be done by the contractor

Rehabilitation and Resettlement (R & R Plan)

- ∞ Project Proponent will implement the R & R policy for the project affected persons, if any.

Project Implementation

- ∞ All the activities envisaged for the highway tunnel will be on contractual basis.
- ∞ The total time required for construction of tunnel will be by TBM method shall be about 4.8 years (56 months) from the date of construction approval of the project
- ∞ Whereas with NATM the time taken for construction will be about 5.6 years (66 months).

11.3 Technology Alternatives

Keeping in view the alignment, technology, overburden for the proposed project for the parallel highway tunnel construction using drill and blast / New Austrian Tunneling Method (NATM) or Bored Tunnel Method using Tunnel Boring Machine (TBM) is an established construction practice technology worldwide.

Proposed Alignment Option

- ∞ Option 1 was discarded due to unavailability of access road
- ∞ **Option-2** was finalized for further investigations/studies in consultation with project proponent and forest department because of minimal disturbance to forest and wildlife.
- ∞ Option 3 was discarded due to unavailability of sufficient overburden disposal site on eastern portal and access road on eastern side passes through dense urban area of Vartak Nagar.

11.4 Baseline Environmental Status

(a) Air Environment

Results of AAQ in the study area and compared with NAAQS are shown below:

Sr. No.	Parameters	(98 th Percentile)	NAAQS
1.	Particulate Matter (PM ₁₀)	61.52 - 63.12 (µg/m ³)	100
2.	Particulate Matter (PM _{2.5})	31.36 - 32.12 (µg/m ³)	60
3.	Sulphur Dioxide (SO ₂)	11.75 - 14.00 (µg/m ³)	80
4.	Oxides of Nitrogen (NO _x)	19.13 - 21.53 (µg/m ³)	80
5.	Carbon Monoxide (CO)	0.49 - 0.8 (mg/m ³)	2

Interpretation: All ambient air quality parameters are within the permissible limits of NAAQM

(b) Noise Environment: Interpretation

- ∞ In the residential areas noise levels were observed in the range of 50.9 to 54.5 dB(A) in day time and 41.7 to 44.6 dB(A) during night time.
- ∞ In the commercial areas noise levels were observed in the range of 60.2 to 64.4 dB(A) in day time and 45.1 to 57.8 dB(A) during night time.
- ∞ The levels of noise in the study area were compared with noise standards (CPCB, 1998) and observed within the prescribed limits.
- ∞ The impact of vibrations generated from the existing activities and nearby residential areas is expected to be insignificant

(c) **Water Environment**

Results of Ground water and Surface water parameters in the study area:

Sr. No.	Parameters Physico-chemical	Ground Water	Surface Water	Standard Limits (IS 10500: 2012)		Interpretation Range
				Acceptable	Permissible	
1.	pH	7.12	7.10 – 7.89	6.5 -8.5	-	Within range
2.	Turbidity (NTU)	1.0	1.0 - 3.0	1	5	Permissible
3.	TDS (mg/l)	617	488 - 1012	500	2000	Permissible
4.	Total Alkalinity	190	110 - 217	200	600	Within range
5.	Total Hardness	360	183 - 318	200	600	Within range
6.	Chloride	119.96	59.2 – 96.8	250	1000	Within range
7.	Sulphate	52.87	4.1 – 87.6	200	400	Within range
8.	Nitrate (NO ₃)	4.28	2.11 – 8.12	45	No Relaxation	Within range
9.	Heavy Metals	Low Conce.	Low Conce.	Low Conce.	Within	Within range
10.	<i>Eccherichia Coli</i>	Absent	Absent	Absent	Absent	Absent/100ml
11.	<i>Coliform Bacteria</i>	Absent	Absent	Absent	Absent	Absent/100ml

Interpretation: Most of the results are observed within the range of the standard limits

Surface and Ground Water Exploitation

- ∞ The Tulsi Lake is about 4.9 km away from the tunnel locations. Considering the above facts, it is very unlikely that the proposed tunnel will have any impacts on the aquifer of Tulsi Lake water catchment.
- ∞ The tunnels being dug out about 20 m blow bgl. There are little chances of having substantial aquifers at that level. The present utilization of ground water resources for the domestic and irrigation requirements will be found negligible.

(d) **Land Environment (Baseline data): Interpretation**

- ∞ The bulk density of soil in the region is ranged between 1.22 kg/cm³ to 1.32kg/cm³ and considered as moderately good soil quality.
- ∞ The porosity of soil is in the range of 37.00 to 42.00% by mass.
- ∞ The soil permeability ranges between 1.10 to 1.84 cm/hr.
- ∞ The water holding capacity in the soil ranges between 49.88% to 53.81%.
- ∞ The pH of the soil in the study area is observed to be alkaline in reaction ranged from 7.05 - 7.42.
- ∞ The EC of the soil samples are in the range of 329 – 382 μmhos/cm.
- ∞ Ca and Mg concentrations are in the range of 198.10 –110.81 mg/kg and 30.2 – 38.9 mg/kg respectively
- ∞ Na and K are in the range of 301.2 – 604.5 mg/kg and 281.7 – 350.6 mg/kg respectively.
- ∞ Organic carbon are found to be in the range of 2.14 – 2.47 %

- ∞ Available phosphorous 12.18 – 29.60 mg/kg
- ∞ The concentration of heavy metals found in the study area is normal.

(e) Biological Environment

(i) Conservation Status of Flora: Interpretation

In the study area, out of total 344 plant species, 133 species are trees, 38 shrubs, 92 herbs, 28 grasses, 2 bamboos, 32 climbers, 4 epiphytes/parasites, 7 aquatic plants, 6 halophytes and 2 species of orchids. Out of these plants species, there are 13 species of endangered (EN), 1 species is not evaluated (NE), 13 vulnerable (VU), 1 with data deficient (DD), 1 critical (CR), 3 near threatened (NT) and 60 species were least concerned (LC).

However, there is intense anthropogenic pressure on flora and forest resources under SGNP area, which are observed to be dwindling because of the national park area is located within a metropolis limit of Mumbai.

(ii) Conservation Status of Fauna (13 Nos.): Scheduled-I

Conservation status of 5 species of mammals, 3 reptiles and 5 species of birds are reported from study area which is under Schedule-I of Wildlife (Protection) Act (1972) as endangered animals. These endangered animals are already protected area under Sanjay Gandhi National Park. No need of conservation of these animals.

(f) Socio-economic Environment

Summary of Demographic Structure in Study Area

Demographic Parameters	Details
No. of States	1
No. of District	2
No. of Tehsil	3
No. of Villages	4
No. of Villages Surveyed	4
Total No. of Households	1,40,714
Total Population	6,05,840
Sex ratio (No. of female \ 1000 males)	831
Scheduled Castes	30,663 (5.06%)
Scheduled Tribes	15,701(2.59%)
Literate	4,91,888 (81.19%)
Total Worker	2,50,098 (41.28%)
Main Worker	2,34,280 (38.67%)
Marginal Worker	15,818(2.61%)
Non Worker	3,54,622 (58.72%)

Interpretations:

- ∞ Poverty is actually a reason for making a section of the population quite vulnerable
- ∞ Families belongs to SC and ST are observed vulnerable
- ∞ Villages with low literacy rates will become vulnerable

- ∞ The villages with low literacy rates may show relatively more economic and social vulnerability
- ∞ Villages with low working population, make them susceptible to economic and social vulnerable

11.5 Anticipated Environmental Impact Assessment

(A) Pre-construction Phase

- ∞ The primary aim of the environment management plan is to eliminate environmental impacts during designing or minimize the risks through best engineering controls
- ∞ The tunnel route has been selected in such a manner to avoid the possibility of geo-hazards such as faults and landslides that can cause damage to tunnel.
- ∞ Also the tunnel construction methodology is studied owing to the environmental sensitivity of the project area.

(B) Construction Phase

(I) Air Environment

Impacts of Air Quality: During construction stage air quality is to be impacted of dust generation and construction vehicle emissions. The potential for air quality impacts from construction activities will arise from:

- ∞ Raising of dust from open construction areas by wind, vehicle movements etc.
- ∞ Spill of construction material during transportation, loading, unloading and transfer
- ∞ Haulage roads used for transportation of material and for disposal of debris generated
- ∞ Dust is not only a threat to lungs and eyes, but may contribute to poor visibility
- ∞ Fugitive emissions from construction machinery / vehicles involved in construction.
- ∞ Stone crushers may contribute in deterioration of air quality due to generation of dust.
- ∞ Diesel exhaust emission from mobile sources, earth-moving equipment and trucks;
- ∞ Exhaust from stationary combustion sources, including generators, heaters and possibly off-site construction and fabrication
- ∞ Exhaust from tunnel boring machines: in the case of diesel powered tunnel boring machines or in the case of electric tunnel boring machines powered by DG set

Mitigation Measures

- ∞ Demolition activities will be performed using appropriate dust controls methods
- ∞ Trucks transporting excavated material will be washed down and covered with tarpaulin
- ∞ Muck generated due to the construction will be collected, kept covered
- ∞ Water will be sprinkled regularly twice a day on haulage roads.
- ∞ All vehicles/construction machineries will adhere to the emission as per CPCB norms
- ∞ Avoiding queuing of the construction traffic vehicle fleet on the roads to minimize the exhaust emissions generated during construction work
- ∞ Vehicles, and machinery will be fitted with appropriate emission control equipment
- ∞ Maintained adequately to meet manufacturer's specification of vehicle and machinery
- ∞ Not to use road construction and self-propelled machines with damaged engines
- ∞ Excavation at the tunnel portals will be performed within the enclosed work sheds.
- ∞ Ventilation air during tunnel construction will be treated, passing through particulate filter
- ∞ Mask and other PPE shall be provided to the all construction workers.
- ∞ Road transportation vehicles should not be loaded with bulk materials
- ∞ Disposal of waste to be protected from the wind by covers; practice speed restrictions.
- ∞ Prohibition of burning of wastes generated at the construction sites, work camps etc.
- ∞ Stockpiles moist and cover vehicles with tarpaulin sheets to minimize dust emission
- ∞ Artificial ventilation of underground excavations should be applied at all stages of tunnel
- ∞ All construction machines should be equipped with neutralization of exhaust gases
- ∞ Air quality monitoring should be carried out during construction phase.
- ∞ The storage and handling of soil, sub-soils, top-soils etc. will be covered tarpaulin.
- ∞ Fugitive dust emissions shall be controlled by application of water sprinkling

- ∞ Noise masks or earmuff should be provided to construction workers,
- ∞ Engines and exhaust systems of all vehicle and equipment will be maintained
- ∞ Air pollution impacts during construction would be temporary/within project boundary.

(II) Noise Environment

Impacts of Noise to Stationary Sources

- ∞ The equipment and diesel generators at construction site can be considered as stationary sources though they may be stationed at a particular site for few weeks.
- ∞ During construction phase the major noise generating sources are DG sets, crusher, excavators, crane concrete mixer etc.
- ∞ At present, there is no noise generating sources along the tunnel route.
- ∞ These activities at the site are likely to increase the background noise levels by 1-2 dBA at a distance of 0.5 km.

Impact of Noise due to Transportation

- ∞ The noise impact due to transportation will occur during the construction phase when transporting construction material and machinery to construction site.
- ∞ It is expected that a maximum of 100 vehicles per day will be plying to construction site.
- ∞ This may not be a continuous operation but it may last for few weeks at a particular site.

Impact of Noise on Occupational and Community Health

- ∞ There will be no direct noise impact due to proposed construction on the nearby villages.
- ∞ However, marginal increase of 1-2 dBA at background noise level would be prevalent during construction phase.
- ∞ The noise level will increase temporarily in the close vicinity of various construction activities, maintenance workshops, vehicles and earthmoving equipment.

Impact of Vibration on surrounding region (SGNP)

- ∞ The source of the vibration and noise during construction of tunnel is due to operation of Tunnel Boring Machine (TBM)
- ∞ Human response to vibration is subjective and will be different for different people
- ∞ When the vibrations reach the floors and walls it may result in perceptible vibration depending on the amplitude and frequency of the vibrations

- ∞ People may be more annoyed if they are exposed to both noise and vibration
- ∞ According to the U.S. Department of Transportation, (1998) the perception threshold of humans for peak particle velocity is about 0.04 mm/s (65VdB with reference 1-6 inch/sec).

Mitigation Measures

From the noise modeling, it has been predicted that the peak noise levels from construction activities will be as high as 65 dB(A) at distance of 500 m from the construction site. Since, the populated areas are located at more than 1 km away from the project areas, the noise levels are considered to have insignificant impact on community. However, the following noise mitigation measures shall be followed:

- ∞ Earth movers and construction machinery with low noise levels should be used
- ∞ Transport of construction material from the site should be restricted day daytime
- ∞ Use of personal protective devices such as ear-muffs, ear-plugs etc.
- ∞ Acoustic enclosures shall be provided for the high noise generating equipment.
- ∞ Noise suppression equipment and baffling should be employed on ventilating machinery, compressors and generators
- ∞ Periodic maintenance of construction machinery and transportation vehicles should be undertaken to reduce the noise impact
- ∞ To limit the impact of noise in residential areas in according with national legislation
- ∞ To reduce noise level in the tunnel and constructions adjacent to the tunnel it is necessary to use the sound-proofing and sound-absorbing barriers.
- ∞ Overall, the impact of generated noise on the environment is likely to be insignificant, reversible and localized in nature and mainly continued to the day hours as sufficient noise control measures would be undertaken

(III) Water Environment

(a) Impact on Surface water

- ∞ With regards to surface water, contamination of water by digging soil is possible during construction activity in case of accidental oil spills
- ∞ During period of construction, a change in the surface water quality may expected minimal.

Impact on Ground Water (Hydrology)

- ∞ The tunneling is being carried out in the hard rock formations of Kanheri-Tulasi area.

- ∞ The Tunnels being dug out about 20m below ground level (bgl)
- ∞ There are little chances of having substantial aquifers at that level.
- ∞ The Tulasi Lake is 4.9 km away from the Tunnel locations.
- ∞ It is very unlikely that the proposed tunnel will have any impacts on the aquifers of Tulasi lake water catchment.

(b) Mitigation Measures

- ∞ Restricting disposal of excavated earth, grease, oil, etc. in existing surface water.
- ∞ No excavation material or other particles originated by works will fall in surface water.
- ∞ Contractor shall submit an Action Plan for involving spills of hazardous substances.
- ∞ The designs of the proposed works will include adequate measures for water drainage.
- ∞ Water from excavation at tunneling to ascent should be drained in the duct by gravity.
- ∞ A comprehensive erosion and sediment control plan prior to earth-moving
- ∞ Construct settling ponds where silt-laden water can settle before being discharged
- ∞ Keeping run-off velocities low and trying to retain much of the run-off on the site
- ∞ Stabilization of the disturbed areas as soon as the final grade has been attained.
- ∞ Use of oil / water separators to extract floating oils.
- ∞ Proper storage of contaminated liquids and disposal after treatment
- ∞ Restricting construction activities near water courses during the dry season.
- ∞ On site fuelling area of vehicles and equipment will be selected away from water bodies
- ∞ Collection of roadway water in a dedicated drainage system
- ∞ Laborers should be provided with adequate quantity of drinking water of potable quality.
- ∞ The water requirement and wastewater generation will be very small quantity.
- ∞ Sanitation facilities (soak pits / septic tanks) will be provided as per SPCB norms

- ∞ Proper maintenance of hygienic conditions in the camps of construction laborers.
- ∞ Ends of the tunnel shall be located away from the sources of drinking water supply.
- ∞ Depression should not be formed on land, otherwise its lead to water logging
- ∞ Wastewater treatments will be either solar evaporated or disposed in a suitable places.
- ∞ Water collection basins will be put at each end of the portals where drainage water will be collected

(IV) Land Environment

Impact on Geology

- ∞ No mineralized zone is present along the axis of the tunnel.
- ∞ Likely impact on the geological resources will occur from the extraction of materials (borrow of earth, stone metals, granular sub-base and aggregates for base courses and concrete.

Impact on Land

- ∞ The tunnel alignment will be passing through below Sanjay Gandhi National Park.
- ∞ Land required for tunnel project at both ends of tunnel will be obtained on Right of Use (RoU) basis.
- ∞ There will be temporary disturbance of land during construction phase.
- ∞ The tunnel alignment will be 20m below the ground level hence impact on land-use pattern will be marginal.
- ∞ As a result of construction activity of tunnel, the vegetative cover is likely not affected
- ∞ However, the construction of tunnel impact will be temporary in nature.
- ∞ As a part of project proceedings huge amount of solid waste will be generated in the form tunnel excavations, muck etc.
- ∞ Disposal of these excavated materials without any proper management may pose a problem to environment.
- ∞ Reuse of excavated material after testing their suitability will minimize requirement surface areas for dumping.
- ∞ Roads will lead to physical disruption of soil.

Waste Management

Solid waste generated during construction will consist of:

- ∞ Domestic waste and construction waste from work camps
- ∞ Hazardous waste from work sites

- ∞ Spoil and muck from the cuts and tunnels.
- ∞ Disposal of domestic / construction waste will occur regularly to approved disposal site.
- ∞ There will be no on-site development of landfills.
- ∞ Hazardous waste will be collected and stored on-site in approved facilities
- ∞ Hazardous waste will be removed from site to approved waste disposal facilities.
- ∞ The spoil from the cuts and tunnel will be used, where possible, for embankment fill.
- ∞ Excess spoil will be placed in storage areas with containment walls.

Mitigation Measures

- ∞ The tunnel excavation can be used in production of aggregates for road making.
- ∞ Hard rock formations can be used in construction of breast, retaining and gabion walls.
- ∞ Implementation of standard construction procedures to ensure that the impact on surface drainage pattern and soil erosion is kept minimal.
- ∞ Reuse of excavated material after testing their suitability will minimize requirement surface area for dumping.
- ∞ Rational use of lands during the discharge of construction wastes, placement of dumps and solid waste landfills
- ∞ Precautions should be taken to avoid spillage on soils to protect groundwater quality
- ∞ Construction activities should not be done during rainy season to avoid soil erosion
- ∞ Excavated top soil should be preserved near the site and reused for plantation.
- ∞ Land should be reinstated after laying the tunnel using the preserved soil
- ∞ Temporary drainage channels should be provided to minimize soil erosion by adopting erosion control measures such as raising of shrubs and grasses
- ∞ After completion of the tunnel construction it is necessary to restore soil and vegetation cover, to fix and ramp the formed slopes, worked-out quarries and dumps
- ∞ Reuse and recycle the materials and proper disposal of waste as per the permit.

- ∞ Waste generated during the whole construction period will be systematically collected, stored and disposed in the corresponding specialized sites
- ∞ Centralized waste management facility is recommended to collect all wastes during construction phase.
- ∞ All waste generated at the construction site and at the labor camp are collected and disposed off in an appropriate manner in a dump site or recycled or reused where feasible
- ∞ Standard construction procedures will be implemented to ensure that the impact on surface drainage pattern and soil erosion is kept minimal.
- ∞ The large quantity of quarry material will be required for the construction of project infrastructure.

(V) Biological Environment

(a) Impact on Biodiversity

- ∞ The proposed construction of tunnel passing below the Sanjay Gandhi Nation Park, therefore there will be no danger of wildlife.
- ∞ Impact on flora and fauna will be temporary, will not cause any long term impacts.
- ∞ Impact on flora and fauna would be negligible due to this underground tunnel activity.
- ∞ The local people will not be affected as the nearest residential area is quite away from the tunnel alignment
- ∞ There may be negligible disturbance to wildlife especially burrowing animal during the construction of the tunnel since the minimum depth of the tunnel from the ground level will be about 20m bgl.
- ∞ During construction a short-term impact on ecology is likely to occur in and around the quarry sites, material stockpiling areas and worksites due to vegetation clearance.
- ∞ Flora degradation is expected to occur marginally as a result of tunnel construction.
- ∞ Potential impacts from construction worker camps include poaching of edible animals and birds in the locality, despite prohibitions.

(b) Mitigation Measures

- ∞ Plantation and wildlife are the backbone of the biotic environment in protected areas
- ∞ Precaution should be taken to minimize the damage of plants at construction sites
- ∞ Minimum number of tree should be cut while construction
- ∞ Plants acts as wind breakers to mitigate impact due to fugitive emission

- ∞ Plants creates an aesthetic environment and restore the water balance
- ∞ Plants creates complex bio-diverse ecosystem
- ∞ Plants needs for prevention of soil erosion and surface run off
- ∞ Due to proposed greenbelt, air, noise and water pollution will be reduced significantly
- ∞ There will be no disturbance to wildlife movement after construction of the tunnel is over.
- ∞ Contractors will be responsible for putting new vegetation in removal sites suitably.
- ∞ Construction vehicles should use temporary roads to minimize damage to wildlife
- ∞ Workers will be trained regarding nature, protection and to avoid cutting down trees
- ∞ Plantation of diverse local plants will be developed as greenbelt
- ∞ Flora degradation is expected to occur marginally as a result of tunnel construction.
- ∞ Construction of project will have a minimal effect on flora and fauna.
- ∞ Precaution should be taken to minimize the damage to native plants
- ∞ Endangered plants should not be cut down, conservation measure should be adopted.
- ∞ Fencing should be made at both ends of tunnel area to prevent the entry of wild animals.
- ∞ Abandoned waste dump areas should be suitably reclaimed by suitable plantation
- ∞ This will reduce the desertification process, wind erosion of soil and pollution of land.
- ∞ Double the number of native trees should be planted under compensatory a-forestation.
- ∞ Strict implementation of forest conservation Act, 1980 (as amended) is needed to protect forest cover in the healthy state for the protection of wildlife.
- ∞ The factors affecting will be given special consideration because saving the forest ultimately conservation of wildlife are protection of fire, poaching, restriction of grazing, man-animal conflict, illegal cutting, encroachment, drought, soil erosion and environmental awareness etc.

(VI) Socio-economic Environment**(a) Impact on Socio-economic**

- ∞ The impact of the proposed development and construction activities are likely to be at a minimum as the tunnel passing below ground level of the Sanjay Gandhi National Park.
- ∞ It is expected that the impact due to loss of land structure would be minimum.
- ∞ No potential negative social impacts are anticipated during construction
- ∞ There will not be major changes of land-use pattern.
- ∞ Increased traffic due to construction activities may create air and noise pollution which may create related health hazards.
- ∞ However, noise and vibration studies will be carried out during impact assessment and construction phases.

Protection of Health and Labor Safety

- ∞ The basic requirements for safe working conditions shall be met.
- ∞ The Contractor shall develop a plan for health and safety at work, including:
 - Risk assessment of workplace;
 - Safety and health performance of construction works,
 - Risk factors, personal protective equipment, safe work instructions,
 - Plans for fire prevention and fire fighting,
 - Emergency and evacuation plans for workers and occupants of the site,
 - On-site contractor coordinator of health and safety
 - Other requirements arising from legislation on labor protection.
 - Migration of workers and establishments of construction camps which may lead to problems of sanitation.
 - This might also lead to transmission of communicable diseases.
 - Uncontrolled digging of borrow areas will result in water accumulation and thus breeding of vector diseases.
 - Psychological impacts on project affected people in the area.
 - Discomforts arising out of air and noise pollution especially due to blasting activities etc.
 - In the prevalent Covid-19 pandemic situation, the chances of spread of covid-19 increases if workers do not avoid direct contact with others and do not keep safe distance.

(b) Mitigation Measures

- ∞ A prior information about the project should be given to local project affected people
- ∞ Caution should be exercised to avoid existing infrastructure along the tunnel
- ∞ Preference shall be given for employment of the local people during project activities
- ∞ The impact on socio-economic will be insignificant as water requirement being meager.
- ∞ Adequate measures for dust suppression should be maintained
- ∞ Proposed construction of highway tunnel activities in general have beneficial impact on socio-economic front both locally and regionally through improved connectivity
- ∞ The proposed construction shall also not entail any displacement of people.
- ∞ R and R plan will not be associated with the project activities.
- ∞ The proposed project activities do not involved loss / disturbance to the cultural heritage
- ∞ The measures for ensuring the work safety will be determined and performed by documenting in logbooks, assignments of duties, etc. according to specified templates.
- ∞ Electric installation works will be performed by a qualified personnel using electric protection equipment which will avoid electric power injuries
- ∞ Conduct orientation for all workers on safety and environmental hygiene.
- ∞ Provide first aid facilities that are readily accessible by workers.
- ∞ Safety conditions for personnel also need to be managed (hygiene and sanitation facilities / toilets with sufficient water supply for removal of domestic waste, supply of drinking water, facilities for storing materials, etc).
- ∞ Provide appropriate personnel safety equipment such as safety boots, helmets, gloves, protective clothes, breathing mask, goggles and ear protection devices, etc
- ∞ Provide sufficient lighting such as the tunnel areas, excavation sites as well as in other construction areas as appropriate to enable safe equipment operation.
- ∞ Ensure that sufficient fresh air is supplied at confined work spaces such as the tunnel and excavation sites.

- ∞ Limiting face-to-face contact, keeping a safe distance with others frequent hand washing / sanitizer and using masks is the best way to reduce the spread of Corona-virus (Covid 19).
- ∞ Plan of accident elimination should be developed and approved:
 - Evacuation ways meeting the requirements of safe evacuation of people at fire
 - Installation of fire detection systems (fire alarm devices) for warning of the people and evacuation management at fire;
 - Application of emergency and automatic installations of firefighting equipment;
 - Organization of activity of fire protection divisions;
 - Fencing of construction sites to restrict public access;
 - Provide warning signs at the periphery of the construction site;
 - Strictly impose speed limits on construction vehicles along residential areas;
 - Educate drivers on safe driving practices to minimize accidents and to prevent spill of hazardous substances and other construction materials during transport.

(B) Impacts during Operation Phase

(i) Impact on Air Environment

- ∞ All vehicular tunnels need ventilation
- ∞ It is created by natural means or by mechanical means
- ∞ The ventilation measures carried out for tunnel in construction and operation phase
- ∞ Construction phase will follow IS 5878: 1971 (Part II, Section 2) Underground Excavation in Rock, Section 2, Ventilation, Lighting, Mucking and Dewatering.

(ii) Mitigation Measures

- ∞ All underground excavation works shall be properly and adequately, ventilated by system of pipes and fans as required by relevant codes and to the satisfaction of the engineer
- ∞ Adequate artificial means of ventilation shall be deployed and shall be in operation at all times when people are working underground
- ∞ Adequate ventilation shall be provided at all the working cavities and drifts etc.
- ∞ After breakthrough of the tunnel excavation from both ends, mechanical ventilation system will still be necessary in the tunnel till its final handing over to the relevant authorities

- ∞ In case of mechanical ventilation, it is proposed to provide Jet Fans units at 200 m distance in ceiling of tunnel.
- ∞ These fans are reversible in action, can be operated in both directions. These fans are controlled from the central control room.
- ∞ The sensors fitted in tunnel gives the information about CO₂ levels and based on which the fans are operated.
- ∞ Greenbelt development shall be implemented to mitigate impacts from fugitive emissions. About 33% of the total area of tunnels terminals will be developed for greenbelt with local vegetations

(iii) Impact on Noise during operation

- ∞ The main source of noise will be from running of transports during operation phase
- ∞ Expected noise level will be within the permissible limits and will meet the relevant requirements of the national legislation
- ∞ Noise radiated from vehicle operations generally constitute the major noise sources
- ∞ Airborne noise is radiated from at-grade and elevated structures
- ∞ While ground-borne noise and vibration of primary concern in underground operations
- ∞ The opening ends of the tunnel shall be surrounded by some forest area with trees
- ∞ The cumulative noise levels due to the combined operation of vehicular traffic (Trucks/Tractors) are predicted to be 82-94 dBA at a distance of 250m
- ∞ Thus there will be an incremental noise level of 1-2 dB(A) over baseline at 500m
- ∞ As no major settlement is in 1km from the tunnel, no noise impact is envisaged.

(iv) Mitigation Measures

- ∞ **Wheel Noise:** Due to wheel roughness
- ∞ **Propulsion Equipment:** Fraction motors, cooling fans for TM, reduction gears etc.
- ∞ **Auxiliary Equipment:** Compressors, motor generators, brakes, ventilation systems, other car mounted equipment
- ∞ Periodic maintenance of transport / vehicles should be undertaken to reduce noise impact
- ∞ Enforced personal protective devices (ear-muffs, ear-plugs) wherever necessary
- ∞ Implementation of greenbelt development, landscaping, horticulture etc. are expected to reduce noise impacts within the project premises

(v) Impact on Water during Operation

- ∞ No surface water bodies occur within the tunnel section.
- ∞ No adverse impact is anticipated during operation phase on surface and ground water.
- ∞ During the operation period, no significant surface water pollution is expected.
- ∞ No liquid effluent is envisaged as part of the project during operations.
- ∞ Structural and technical safety installations will comply with National and International recommendations, regulations or standards.
- ∞ Appropriate behavior of the tunnel users in emergency situations may also contribute significantly to tunnel safety during operation.
- ∞ Main impacts characteristic of the operational period are: noise, ambient air and storm sewage.
- ∞ The sewage collecting system has nothing in common with the situation outside the tunnel.

(vi) Mitigation Measures

- ∞ Ensure appropriate and timely response by emergency services.
- ∞ Luminary units should be sealed to prevent entry of water from sprays, dust and smoke
- ∞ Luminaries cleaned frequently to clear dust and soot may collect on their outer surface.
- ∞ Proper routine maintenance program should be conceived and implemented.
- ∞ Instead of waiting for the luminaries to fail before replacement, systematic replacement and renewal program should be conceived and implemented

Natural Hazards and Vulnerability of the sub-project area**Seismic Profile of the Area**

- ∞ The proposed highway tunnel project is situated between Tikuji-niwadi, Thane and Borivali in Maharashtra state.
- ∞ The project area is located approximately between the Latitude 19°10' to 19°19' and Longitude 72°45' to 72°73'.
- ∞ The proposed tunnel is 10.8km long. The main physical features of the land are coastal plains and the hilly tracks to the east.
- ∞ In peninsula India the state of Maharashtra, has suffered from frequent earthquakes, both deadly and damaging, although not located on or near any plate boundaries.
- ∞ All the earthquakes here, as in all of peninsula India, are interpolating events.

- ∞ The seismic hazard map of India was updated in 2000(5) by the Bureau of Indian Standards (BIS).
- ∞ Apart from the merging of Zones I and II into Zone II in the latest map, there are no major changes from the BIS 1984 map.
- ∞ Zone III stretches across the length of southern borders of Gujarat, Dadra and Nagar Haveli and western parts of Maharashtra state, which includes the areas of Mumbai, Thane, and Kalyan etc., where the maximum expected intensity is IV.
- ∞ According to 2014 seismic zoning map of India, the western parts of the state of Maharashtra falls in Zone III and IV on the basis seismic hazard
- ∞ However, the entire project area in Borivali (Mumbai) and Thane districts in Maharashtra state falls in Zone III (Moderate Seismic Zone) where intensity zone IV earthquakes can be expected due to high earthquakes.
- ∞ This zone is classified as moderate damage risk zone which is liable to MSK IV.
- ∞ Mumbai region falls in Zone IV on this seismic zoning map dividing India in to II to V different zones.
- ∞ At least one known mapped fault is crossed between Thane and Panvel region away from the proposed tunnel alignment and preliminary indication from the literature suggest that may continue to be active.
- ∞ The tunnel route will be designed in accordance with the Indian seismic design code IS 1893 (Indian standard criteria for earth quake resistance design of structures).
- ∞ The designs for tunnel and other structures shall consider the corresponding seismic zone factor.

11.6 Environmental Monitoring

Sr. No.	Attributes	Parameters	Frequency
1.	Air Quality	PM ₁₀ , PM _{2.5} , SO ₂ , NO _x , CO, VOC and HC	Once in a month
2.	Indoor Air Quality	CO, CO ₂	Once in a month
3.	Process Emission	Fugitive gaseous pollutant expected	Monthly
3.	Noise Level	Equivalent noise level dB(A)	Once in a month
4.	Vibration Studies	Construction and Vehicular Movement	Once in a month
5.	Soil, Solid wastes	Physico-chemical properties	Once in a month
5.	Greenbelt	No. of plantation (unit), No. of Survival plants/trees, and No. of poor plant/trees	Ongoing round the year
6.	Environmental Audit	As per direction of ISO 14001, MoEF&CC /CPCB	Once in a year

11.7 Safety Policy

MMRDA is committed to:

- ∞ For safety of its employees, persons associated and connected with corporation
- ∞ For setting safety target, ensuring and fixing of irresponsibility for implementation
- ∞ Enforcing safety efforts in a continual and well fed manner
- ∞ MMRDA believes that accidents can be prevented
- ∞ All employees are responsible for following the established safety standards
- ∞ To introduce safety standards in all work procedures
- ∞ Developing safety consciousness by safety training and safe work procedures
- ∞ Making collective effort for progress of safety-by-safety committees
- ∞ Carrying all operations only as per statues
- ∞ Continual improvement in implementation of safety is necessary for our success

11.8 Project Benefits

- ∞ Proposed tunnel project would create certain improvement on the socio-economic
- ∞ Growth of service sector and will also generate new business opportunities
- ∞ Small and medium scale industries may be developed as consequence
- ∞ Project areas will reduced the impact on environment
- ∞ Time saving by 20-25 minutes and distance saving 10 km
- ∞ The project improving the project road will reduce transport cost
- ∞ Project provides fast and smooth movement of traffic from Thane to Borivali.
- ∞ Smooth traffic movement and reduction in traffic congestions
- ∞ Avoidance of massive traffic jams and thus saving fossil fuel
- ∞ The project will generate temporary and permanent employments
- ∞ It provides high economic returns to the society
- ∞ The project area will enhance the transportation facilities
- ∞ The project will bring revenue to the state exchanger by way of duties and taxes

- ∞ Project enhance quality of life of the communities around tunnel corridor
- ∞ Panchayat will have a continued benefits of taxes and cess
- ∞ CSR in fact is about business giving back to the society
- ∞ CSR providing community development scheme
- ∞ Tree plantation initiatives for greenery
- ∞ About 2.5% of the capital cost of the project will be earmarked for CSR activity

11.9 Environmental Management Plan (EMP)

The EMP consists of the set of the followings;

- ∞ Mitigation Measures
- ∞ Monitoring Program
- ∞ Environmental Management
- ∞ Institutional arrangement to be taken during design, construction and operation
- ∞ To eliminate adverse environmental impacts or reduce / offset to acceptable levels.

Chapter 12

Disclosure of Consultants Engaged

Dr. N. C. Kankal, has been engaged as an independent Environmental Consultant for preparation of Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) Report for the “Proposed Twin Tunnel (2 lanes Each) Highway Tunnel from Tikuji-ni-wadi in Thane District to Borivali in Mumbai Suburban District in the state of Maharashtra”.

Dr. N.C. Kankal is an approved EIA Coordinator by QCI-NABET for 4, 7, and 37 sectors and FAE for Ecology and Biodiversity. He is a retired Senior Principal Scientist from CSIR-NEERI, Nagpur. He has over 40 years of experience in the field of Ecology, Biodiversity, and Environmental Science, He has worked on many projects involving Central and State Level Appraisal Committees of different sectors during his services till date. He has contributed as independent EIA Coordinator and as a FAE for Ecology and Biodiversity for this project. He also has provided the detailed impacts, mitigation measures and designed an effective Environmental Management Plan (MP) for this project. He has guided the FAEs during field visits, sampling, analysis, and compilation of data and EIA report preparation.

The following EIA reports has been prepared so far by Dr. Kankal

Sr. No.	Sectors	No.
1.	Thermal Power Plants (Maharashtra & Rajasthan)	8
2.	Distillery (Maharashtra, Tamil Nadu and Madhya Pradesh)	6
3.	Metallurgical Industry (Maharashtra, Andhra Pradesh)	5
4.	Common Municipal Solid Waste Management (Rajasthan and Gujarat)	5
5.	Crude Oil Pipeline (Rajasthan, Gujarat and Karnataka)	4
6.	Mines (Maharashtra and Chatishgarh)	4
7.	Refineries (Gujarat)	3
8.	Sugar Industry (Maharashtra)	3
9.	Oil and Gas Exploratory Drilling (Andhra Pradesh)	1
10.	Sea ports (Karnataka)	1
	Total	40



महाराष्ट्र शासन

महसुल व वन विभाग

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O/o Principal Chief Conservator of Forests (HoFF), Maharashtra State



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पत्र-ईमेल क्रमांक:-कक्ष-२३(२)/वजी/सर्व्हे/प्र.क्र.१८९/२१९८/२०२३-२४, दिनांक:-२३/१०/२०२३

प्रति,

कार्यकारी अभियंता,
मुंबई महानगर प्रदेश विकास प्राधिकरण,
वार्डे, मुंबई.

विषय :- ठाणे जिल्ह्यातील टिकुजीनीवाडी ते मुंबई उपनगर जिल्ह्यातील बोरीवली पर्यंत प्रत्येक बाजूला बोगदा २ लेन

तयार करण्यासाठी वन्यजीव मान्यतेचा प्रस्ताव.
(संजय गांधी राष्ट्रीय उद्यान व त्याचे पर्यावरण संवेदनशील क्षेत्र)

संदर्भ - १. या कार्यालयाचे पत्र क्रमांक कक्ष-२३(२)/वजी/सर्व्हे/प्र.क्र.१८९/२१९८-अ, दि १५/१०/२०२३
२. दि. १६/१०/२०२३ रोजी संपन्न झालेली राज्य वन्यजीव मंडळाची २२ वी बैठक.
३. शासनाकडून दि.१९/१०/२०२३ रोजी दुरध्वनीवर प्राप्त झालेल्या सुचना.

संदर्भात पत्र १ अन्वये विषयांकित प्रकरणीचा प्रस्ताव राज्य वन्यजीव मंडळाचे निर्णयार्थ ठेवण्यासाठी राज्य शासनास सादर करण्यात आलेला होता. राज्य वन्यजीव मंडळाची २२ वी बैठक दिनांक १६/१०/२०२३ रोजी संपन्न झाली. सदर बैठकीमध्ये प्रस्तुत प्रस्तावावर मंडळाने चर्चा करून, प्रस्तुत प्रस्तावाचे अनुषंगाने, मंडळाने मुख्य वन्यजीव रक्षक, महाराष्ट्र राज्य यांनी घालून दिलेल्या अटी व शर्तीच्या अधिन राहून सदर प्रस्ताव राष्ट्रीय वन्यजीव मंडळाकडे सादर करण्याची मंडळाने शिफारस केलेली आहे. सदर प्रस्तावाच्या अटी खालीलप्रमाणे आहेत.

१. वापरकर्ता एजन्सी वन (संवर्धन) च्या तरतुदीनुसार वनजमीन वळवण्यासाठी आवश्यक परवानगी घेईल.
२. संजय गांधी राष्ट्रीय उद्यानातील वन्यजीव संवर्धन उपक्रमांसाठी प्रकल्प खर्चाच्या २% रक्कम उपलब्ध करून देण्यात येईल.
३. संजय गांधी राष्ट्रीय उद्यानाच्या पर्यावरणीय, भूगर्भशास्त्रीय, जलविज्ञान आणि भूकंपशास्त्रीय बाबींचा भूमिगत बोगद्याच्या बांधकामाच्या परिणामाचा एकत्रित अभ्यास प्रकल्प सुरू होण्यापूर्वी वापरकर्ता

एजन्सीद्वारे भारतीय वन्यजीव संस्थान, डेहराडून द्वारे करणे आवश्यक आहे. त्यानुसार, वरील अभ्यासानुसार सुचविलेल्या आवश्यक खबरदारी आणि सुरक्षा उपायांचा प्रकल्पात समावेश केला जाईल. तसेच, अभ्यास अहवालाची एक प्रत संजय गांधी राष्ट्रीय उद्यान प्राधिकरणांना सादर केली जाईल.

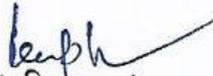
४. वापरकर्ता एजन्सी यांनी सदर सुरंगमध्ये कोणतेही वन्यप्राणी शिरणार नाही यासाठी संजय गांधी राष्ट्रीय उद्यान प्राधिकरणाच्या निर्देशानुसार पुरेशा आकाराची सिमेंट काँक्रीटची भिंत बांधेल व इतर कायम स्वरूपी व्यवस्था करेल.
५. वापरकर्ता एजन्सी SGNP प्राधिकरणांद्वारे प्रदान केलेल्या Specification नूसार सुरंगाच्या प्रवेशाच्या आणि बाहेर पडायच्या ठिकाणी दोन मोठे होर्डिंग्ज स्थापित करेल. वन्यजीव संबंधित शिक्षण सामग्री/सूचना संदेश प्रदर्शित करण्यासाठी ते SGNP अधिकाऱ्यांकडे सोपवावे लागेल.
६. वापरकर्ता एजन्सी हे सुनिश्चित करेल की अंमलबजावणी आणि ऑपरेशनल टप्प्यांमध्ये वन्य प्राण्यांचे अपघातांपासून संरक्षण केले जाईल. भविष्यात वन्यप्राण्यांचे अपघात टाळण्यासाठी हा प्रकल्प सुरक्षित करण्यात यावा.
७. प्रकल्पाच्या कामात गुंतलेले प्रकल्प कर्मचारी सध्याच्या कायदेशीर तरतुदी, विशेषतः पर्यावरण (संरक्षण) कायदा १९८६, वन्यजीव (संरक्षण) कायदा १९७२, वन कायदा १९२७ आणि इतर लागू कायद्यांच्या तरतुदींचे पालन करतील.
८. वापरकर्ता एजन्सी प्रकल्पाच्या परिसरातील वनस्पती आणि प्राणी यांचे संवर्धन आणि संरक्षणासाठी सर्व आवश्यक उपाययोजना करेल. कोणतीही मानवी आणि वन्यजीव दुर्घटना टाळण्यासाठी वापरकर्ता एजन्सीद्वारे कार्याच्या ठिकाणी योग्य बॅरिकेडिंगची तरतूद केली जाईल.
९. ध्वनी, वायू आणि जलप्रदूषणाचे नियम काटेकोरपणे पाळावेत. ध्वनी, वायू आणि जलप्रदूषण कमी करण्यासाठी उपायांचा अवलंब वापरकर्ता एजन्सीने करणे आवश्यक आहे.
१०. प्रकल्प क्षेत्रात तसेच संजय गांधी राष्ट्रीय उद्यानाच्या आजूबाजूच्या परिसरात भविष्यातील भूखलन थांबवण्यासाठी स्ट्रक्चरल इंजिनीअरिंग डिझायनिंगच्या स्वरूपात आवश्यक खबरदारी या प्रकल्पामध्ये समाविष्ट केली जाईल.
११. वापरकर्त्याद्वारे वनक्षेत्रावर कोणत्याही प्रकारचा ढिगारा टाकू नये.
१२. वापरकर्ता एजन्सी हे सुनिश्चित करेल की संजय गांधी राष्ट्रीय उद्यानामधील वन्यजीव आणि त्यांच्या अधिवासाला अंमलबजावणी आणि ऑपरेशनल टप्प्यात कोणतेही नुकसान किंवा त्रास होणार नाही.

१३. वन्यजीवांना त्रास टाळण्यासाठी सूर्यास्तापासून सूर्योदयापर्यंत कोणतीही कामे केली जाऊ नयेत.
१४. विविध वैधानिक प्राधिकरणांकडून इतर सर्व आवश्यक परवानग्या प्रकल्प सुरू होण्यापूर्वी वापरकर्ता एजन्सीद्वारे प्राप्त केल्या जातील.
१५. प्रकल्प संजय गांधी राष्ट्रीय उद्यानातून जात असल्याने आणि महाराष्ट्र वन विभागातील क्षेत्रीय कर्मचारी आणि प्रशासकीय कर्मचा-यांसाठी वर्षभर गस्त घालण्यासाठी हा महत्त्वाचा प्रवेश मार्ग आहे. म्हणून, वापरकर्ता एजन्सीद्वारे या प्रस्तावित बोगद्याद्वारे सर्व वन कर्मचा-यांना विनामूल्य प्रवेश प्रदान केला जाईल.
१६. प्रकल्प कार्यान्वित करताना ब्लास्टिंग होणार नाही. याव्यतिरिक्त, उत्खननाच्या टप्प्यात, संजय गांधी राष्ट्रीय उद्यानामधील वनस्पती आणि जीवजंतूंचे संरक्षण करण्यासाठी वापरकर्ता एजन्सीद्वारे सर्व आवश्यक सावधगिरीचे पालन केले जाईल.

वरील बाबीचे अनुषंगाने अट क्रमांक १ आणि ३ ते १६ बाबत मुद्रांकावर (Stamp Paper) लिखित हमीपत्र उलट टपाली सादर करावे. तसेच अट क्र. २ नुसार, २% रक्कम रु. ३७९.५१४ कोटी रक्कमेचा भरणा महाराष्ट्र राज्यातील वन्यजीव अभयारण्याच्या संवर्धन आणि संरक्षणासाठी वनसंरक्षक तथा संचालक, संजय गांधी राष्ट्रीय उद्यान, बोलीवली यांचेकडे त्वरीत जमा करावे.

सदरहू प्रस्ताव हा राष्ट्रीय वन्यजीव मंडळाचे निर्णयासाठी तात्काळ सादर करावयाचा आहे. त्यामुळे अट क्र. २ नुसार २% रक्कम रु. ३७९.५१४ कोटी त्वरीत भरणा करून उर्वरित १ आणि ३ ते १६ अटीबाबत लिखित हमीपत्र उलट- टपाली सादर करावे.

वरील प्रमाणे अहवाल प्राप्त झालेनंतर, सदर प्रस्ताव केंद्र शासनास सादर करण्याबाबत, राज्य शासनास या स्तरावरून विनंती करण्यात येईल.


(महिप गुप्ता)

मुख्य वन्यजीव रक्षक तथा
प्रधान मुख्य वनसंरक्षक (वन्यजीव)
महाराष्ट्र राज्य

प्रतिलिपी :- प्रधान सचिव (वने), महसुल व वनविभाग, मंत्रालय मुंबई यांना माहितीस सादर.

प्रतिलिपी :- अपर प्रधान मुख्य वनसंरक्षक तथा केंद्रस्थ अधिकारी यांना माहिती व योग्य त्या कार्यवाहीस अग्रेषित.

प्रतिलिपी :- अपर प्रधान मुख्य वनसंरक्षक (वन्यजीव) पश्चिम, मुंबई यांना माहितीस व आवश्यक कार्यवाहीस अग्रेषित.

प्रतिलिपी :- वनसंरक्षक व संचालक, संजय गांधी राष्ट्रीय उद्यान, बोरीवली यांना माहितीस व आवश्यक कार्यवाहीस अग्रेषित.

Government of Maharashtra
Revenue and Forest Department
Office of the Principal Chief Conservator of Forests (Head of Forest
Force), Maharashtra State, Nagpur
O/o Principal Chief Conservator of Forests) HoFF(, Maharashtra State)

Phone - 0712-2549563 **Principal Chief Conservator of**
Forests (Wildlife), Maharashtra State

E-mail - pccfwlqp@mahaforest.gov.in **Principal Cheif Conservator of**
Forest (wildlife), Maharashtra State

Website - www.mahaforest.gov.in **"Van Bhavan"3rd Floor, Ramgiri**
Road, Civil Lines, Nagpur 440 001

Letter-Email No.:-Room-23(2)/Vaji/Survey/P.No.189/2349/2023-24, Date:- 23/10/2023

To,

Executive Engineer,

Mumbai Metropolitan Region Development Authority,

Vadre. Mumbai.

Subject:- Tunnel 2 lanes on each side from Tikujiniwadi in Thane district to
Borivali in Mumbai Suburban district

Proposal for wildlife recognition for creation.

(Sanjay Gandhi National Park and its eco-sensitive areas)

Reference - 1. Letter of this Office No.Room 23(2)/VG/Survey/Pr.No.189/2198-
A, dated 15/10/23

2. The. 22nd Meeting of State Wildlife Board held on 16/10/23

3. Government of India. Notice received by telephone on 19/10/23

The proposal on the subject matter under reference letter 1 was submitted to
the State Government for the decision of the State Wildlife Board

The 22nd meeting of the State Wildlife Board was held on 16/10/2023. In the said meeting, the Board discussed the proposal presented and in accordance with the presented proposal, the Board has recommended that the said proposal be submitted to the National Wildlife Board subject to the terms and conditions laid down by the Chief Wildlife Warden, Maharashtra State

The terms of the said proposal are as follows.

1. The user shall obtain necessary permission for diversion of forest land as per the provisions of the Agency Forest (Conservation).
2. 2% of the project cost will be made available for wildlife conservation activities in Sanjay Gandhi National Park.
3. A comprehensive study of the impact of the construction of the underground tunnel on the ecological, geological, hydrological and seismological aspects of the Sanjay Gandhi National Park will be conducted before the project is started.

The agency is required to do this through Wildlife Institute of India, Dehradun. Accordingly, necessary precautions and safety measures suggested as per the above study will be incorporated in the project. Also, a copy of the study report will be submitted to the Sanjay Gandhi National Park Authorities.

4. The user agency shall construct a cement concrete wall of adequate size and make other permanent arrangements as per the directions of the Sanjay Gandhi National Park Authority to ensure that no wildlife enters the said tunnel.
5. The user agency shall install two large hoardings at the entrance and exit points of the Noosa Tunnel as per the specification provided by the SGNP authorities. The same shall be handed over to the SGNP authorities for displaying wildlife related educational materials/information messages.

6. The user agency will ensure that wildlife is protected from accidents during the implementation and operational phases. The project should be secured to prevent future wildlife accidents.
7. Project personnel engaged in the project work will comply with the existing legal provisions, particularly the provisions of the Environment (Protection) Act 1986, the Wildlife (Protection) Act 1972, the Forest Act 1927 and other applicable laws.
8. The user agency will take all necessary measures for the conservation and protection of flora and fauna in the project area. Proper barricading will be provided at the work site by the user agency to avoid any human and wildlife accidents.
9. Noise, air and water pollution regulations should be strictly followed. Measures to reduce noise, air and water pollution must be adopted by the user agency.
10. The project will incorporate necessary precautions in the form of structural engineering design to prevent future landslides in the project area as well as in the surrounding areas of Sanjay Gandhi National Park.
11. Users should not throw any kind of debris on the forest area.
12. The user agency will ensure that there is no harm or disturbance to wildlife and their habitats in the Sanjay Gandhi National Park during the implementation and operational phases.
13. To avoid disturbing wildlife, no work should be done from sunset to sunrise.
14. All other necessary permissions from various statutory authorities shall be obtained by the user agency before the commencement of the project.
15. Since the project passes through Sanjay Gandhi National Park and is an important access route for field staff and administrative staff of Maharashtra Forest Department for patrolling throughout the year, free

access will be provided to all forest staff through this proposed tunnel by the user agency.

16. No blasting will be done during the execution of the project. In addition, during the excavation phase, all necessary precautions will be taken by the user agency to protect the flora and fauna of the Sanjay Gandhi National Park.

In accordance with the above, a written undertaking in respect of conditions 1 and 3 to 16 should be submitted on Stamp Paper by post. Also, as per condition no. 2, a deposit of 2% of the amount of Rs. 379.514 crore should be deposited immediately with the Conservator of Forests and Director, Sanjay Gandhi National Park, Borivali for the conservation and protection of wildlife sanctuaries in the State of Maharashtra.

The said proposal is to be submitted immediately for the decision of the National Wildlife Board.

Therefore, as per condition no. 2, a written undertaking in respect of the remaining conditions 1 and 3 to 16 should be submitted by post. After receiving the report as above, the State Government will be requested at this level to submit the said proposal to the Central Government.

(Mahip Gupta)

Chief Wildlife Warden and

Principal Chief Conservator of
Forests (Wildlife)

State of Maharashtra

Copy:- Submitted to Principal Secretary (Forests), Revenue and Forest Department, Mantralaya, Mumbai for information.

Copy:- Forwarded to Additional Principal Chief Conservator of Forests and Central Officers for information and appropriate action

Copy:- Forwarded to Conservator of Forests and Director, Sanjay Gandhi National Park, Borivali for information and necessary action.

F.No.WL-6/16/2024-WL

Government of India
Ministry of Environment, Forests and Climate Change
(Wildlife Division)

2nd Floor, Vayu Wing,
Indira Paryavaran Bhawan,
Jor Bagh Road, New Delhi 110003.

Date: 7th Feb, 2024

To,

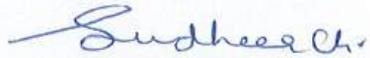
All Members
Standing Committee of NBWL

Sub: Minutes of 77th Meeting of the Standing Committee of National Board for Wild Life-reg.

Sir/Madam,

Kindly find enclosed copy of the Minutes of 77th Meeting of the Standing Committee of National Board for Wild Life held on 30th January, 2024 under the Chairmanship of Hon'ble Minister of Environment, Forest and Climate Change, Government of India.

Yours faithfully,


(Dr. Sudheer Chintalapati)
Scientist 'E'
Email: adwl-mefcc@gov.in

Encl: As above

Distribution:

1. Secretary, MoEF & CC
2. DGF&SS, MoEF&CC
3. ADGF (WL), MoEF&CC
4. ADGF (FC), MoEF&CC
5. Member Secretary, NTCA
6. Director/IGF, PE Division, MoEF&CC
7. Director, WII, Dehradun
8. Director, GEER Foundation, Gandhinagar
9. Dr. R. Sukumar, Member, NBWL
10. Dr. H.S. Singh, Member, NBWL
11. Secretary, Environment, Forest, Science and Technology Department, Govt. of Andhra Pradesh.

Copy to:

1. PS to Hon'ble MoEF&CC
 2. PS to Hon'ble MoS, EF&CC
 3. PPS to Secretary, MoEF & CC
 4. PPS to DGF&SS, MoEF&CC
 5. PSO to Addl. DGF (WI)/PPS to IGF (WI)
 6. **The Additional Chief Secretary/Principal Secretary/Secretary Forest Department,** Assam/Andhra Pradesh /Gujarat /Karnataka/ Maharashtra /Manipur /Tamil Nadu/Uttarakhand /Uttar Pradesh /UT of Ladakh/Kerala /West Bengal/Rajasthan/Goa/Madhya Pradesh./Haryana /Arunachal Pradesh / Himachal Pradesh/Telangana /Meghalaya
 7. **The Chief Wild Life Warden,** Assam/Andhra Pradesh /Gujarat /Karnataka/ Maharashtra /Manipur /Tamil Nadu/Uttarakhand /Uttar Pradesh /UT of Ladakh/Kerala /West Bengal/Rajasthan/Goa/Madhya Pradesh./Haryana /Arunachal Pradesh / Himachal Pradesh/Telangana /Meghalaya
 8. **The PCCF and HoFF,** Government of Assam/Andhra Pradesh /Gujarat /Karnataka/ Maharashtra /Manipur /Tamil Nadu/Uttarakhand /Uttar Pradesh /UT of Ladakh/Kerala /West Bengal/Rajasthan/Goa/Madhya Pradesh./Haryana /Arunachal Pradesh / Himachal Pradesh/Telangana /Meghalaya
- Copy also to:** Sr. Technical Director, NIC with a request to upload the minutes of the meeting on PARIVESH Portal.


 (Dr. Sudheer Chintalapati)
 Scientist 'E'
 Email: adwl-mefcc@gov.in

The Chief Wild Warden mentioned that both the notifications would be issued simultaneously.

Decision taken: After discussions, the Standing Committee decided to recommend the proposal submitted by the State Government of Madhya Pradesh for denotification of 304.350 ha from the Sailana Sanctuary and addition of 490.39 ha to the sanctuary subject to the condition that the State Government shall publish the notification for addition of areas to sanctuary prior to or simultaneously with the notification for exclusion of the areas from the sanctuary. The State Government shall accordingly submit proposal for declaration of Eco-sensitive Zone around the sanctuary.

77.5.46 Proposal for use of 35.5644 ha forest land (25.2239) ha from Sanjay Gandhi National Park and 10.3405 ha from its Eco-sensitive Zone) for construction of underground Twin Tube Tunnel 2 Lanes Each from Tikuji Ni Wadi in Thane District to Borivali in Mumbai Suburban District in the State of Maharashtra.

WL/MH/ROAD/428426/2023

The Standing Committee was informed that the proposal for use of 35.5644 ha forest land (25.2239) ha from Sanjay Gandhi National Park and 10.3405 ha from its Eco-sensitive Zone) for construction of underground Twin Tube Tunnel 2 Lanes Each from Tikuji Ni Wadi in Thane District to Borivali in Mumbai Suburban District in the State of Maharashtra.

The proposal has been recommended by Chief Wild Life Warden, the State Board for Wild Life and the State Government.

Decision Taken: After discussions, the Standing Committee decided to recommend the proposal subject to the following conditions:

1. The user agency shall take the necessary permission for diversion of forest land under the provisions of the Forest (Conservation) Act 1980.
2. 2% amount of project cost be made available for wildlife conservation activities in the Sanjay Gandhi National Park.
3. A cumulative study on the effect of construction of underground tunnel the ecological, geological, hydrological and seismological aspects of the Sanjay Gandhi National Park from WII needs to be undertaken by the user agency before commencement of the project. Accordingly, the

necessary precautions and safety measures as suggested by above studies shall be incorporated in the project. Also, a copy of the study report shall be submitted to the Sanjay Gandhi National Park Authorities.

4. The user agency shall construct the cement concrete wall of adequate size as directed by the Sanjay Gandhi National Park authorities, along the project where wildlife is liable to cross over the project area and to prevent straying of wildlife out of the Sanjay Gandhi National Park.
5. The user agency shall install two big billboards/hoardings at the entry and exit of the project as per the specifications provided by the SGNP Authorities. After complete installation of billboards/hoardings, it has to be handed over to SGNP authorities for displaying wildlife related education contents/alert messages.
6. The user agency shall ensure that wild animals are protected from the accidents both during the execution and operational phases. This project be made safe to avoid wildlife accidents in future.
7. The project personnel engaged in the project work shall observe the provisions of the existing legal provisions, especially the Environment (Protection) Act, 1986, the Wild Life (Protection) Act, 1972, the Indian Forest Act, 1927 and other applicable laws.
8. The user agency shall take all necessary measures for conservation and protection of flora and fauna in the vicinity of the project.
9. There shall be no blasting during execution of the project. In addition, during excavation phase, all necessary precautions shall be followed by the user agency to protect the flora and fauna of the SGNP. Provision of proper barricading of the work site shall be done by the user agency during execution phase to avoid any human and wildlife mishaps.
10. Norms of noise, air and water pollution be strictly followed. The adoption of measures for reducing noise, air and water pollution need to be undertaken by the user agency.
11. Necessary precautions in the form of structural engineering designing shall be incorporated in the project to stop any future landslides in the project area as well as in the surrounding areas of the Sanjay Gandhi National Park.
12. There shall be dumping of any type of debris on the forest area by the user agency.
13. The user agency shall ensure that no damage or disturbance is caused to the wildlife and its habitat in SGNP during execution and operational phases.

14. No works shall be carried out from sunset to sunrise to avoid disturbances to wildlife.
15. All other necessary permissions from the different statutory authorities shall be obtained by the user agency prior to commencement of the project.
16. As the project passes through the Sanjay Gandhi National Park and is an important access route for the field and administrative staff of Maharashtra Forest department for patrolling round the year, free access to all forest personnel shall be provided through this proposed tunnel by the user agency.
17. An annual compliance certificate on the stipulated conditions shall be submitted by the User Agency to the State Chief Wild Life Warden and an annual compliance certificate shall be submitted by the State Chief Wild Life Warden to Government of India.

77.5.47 Proposal for use of 3.46 ha of land (0.28 ha of forest land and 3.18 ha of non-forest land) from buffer & ESZ of Melghat Tiger Reserve for laying of drinking pipeline on Telhara 69 villages Regional Rural Water Supply Scheme Under JJM, Akola district.

WL/MH/Pipeline/442397/2023

The Standing Committee was informed that the proposal for use of 3.46 ha of land (0.28 ha of forest land and 3.18 ha of non-forest land) from buffer & ESZ of Melghat Tiger Reserve for laying of drinking pipeline on Telhara 69 villages Regional Rural Water Supply Scheme Under JJM, Akola district.

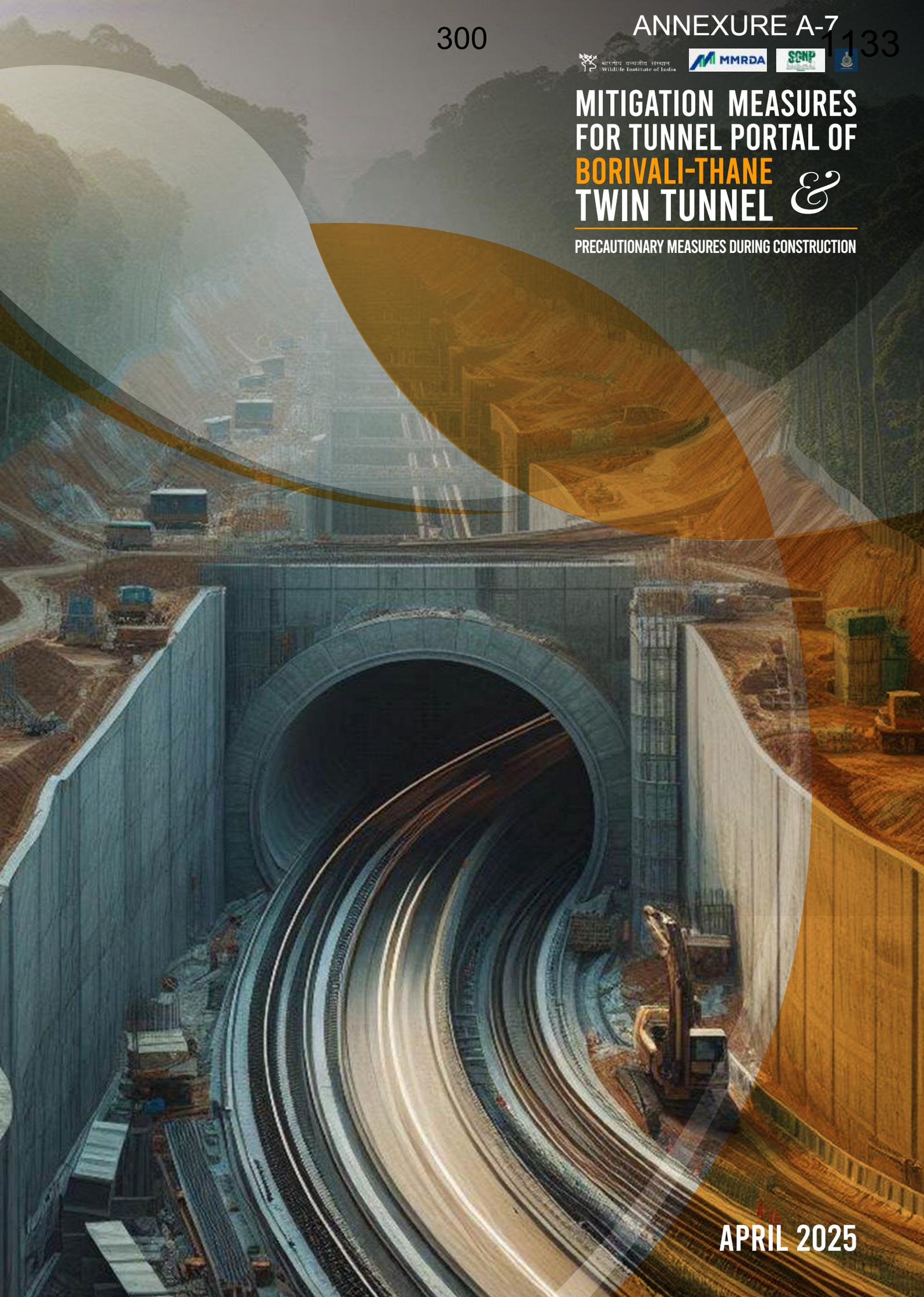
The proposal has been recommended by Chief Wild Life Warden, the State Board for Wild Life and the State Government. The NTCA has also recommended the project proposal.

Decision Taken: After discussions, the Standing Committee decided to approve the proposal subject to the following conditions:

1. Project proponent authority shall deposit 2% of the project cost falling in Buffer/ ESZ of Melghat Tiger Reserve area with Chief Conservator of Forest & Field Director, Melghat Tiger Reserve, Amaravati for conservation and protection of wildlife sanctuary.
2. Modern technology should be used while construction activity to reduce sound pollution and to minimize disturbance to the wildlife habitat inside the buffer zone of MTR.

MITIGATION MEASURES FOR TUNNEL PORTAL OF **BORIVALI-THANE** TWIN TUNNEL &

PRECAUTIONARY MEASURES DURING CONSTRUCTION



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**Wildlife Institute of India,
Ministry of Environment, Forest and Climate
Change, Government of India.**

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Graphics, Illustrations & Design

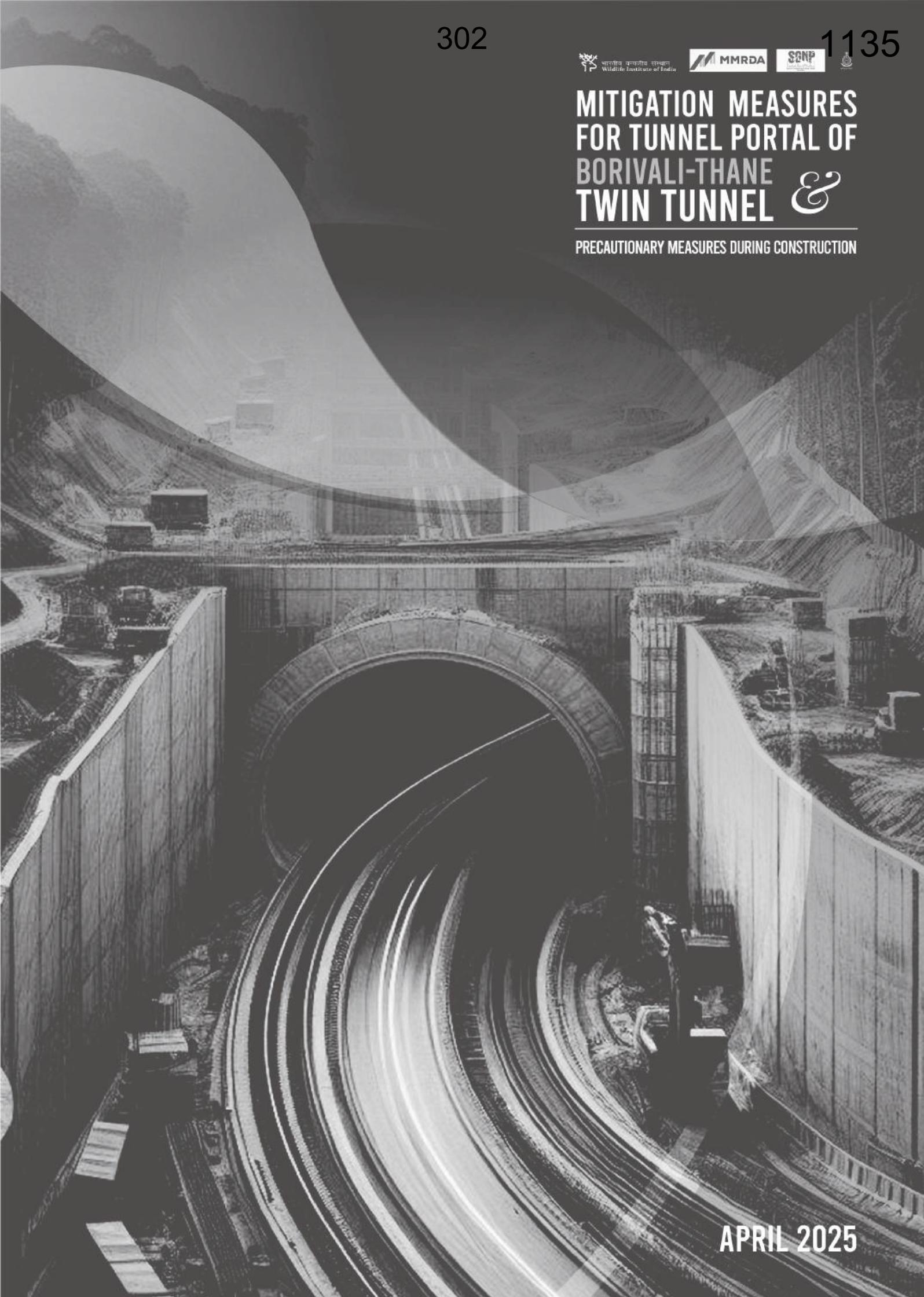
Kashish Sherdia

Citation:

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MITIGATION MEASURES FOR TUNNEL PORTAL OF BORIVALI-THANE TWIN TUNNEL &

PRECAUTIONARY MEASURES DURING CONSTRUCTION



Report Title

Mitigation measures for tunnel portal of Borivali-Thane Twin Tunnel and precautionary measures during construction

Project

Integrated Study of the Effects of Construction of the Twin Tunnel on Wildlife of Sanjay Gandhi National Park, Mumbai, Maharashtra

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Funding Support

Mumbai Metropolitan Region Development Authority





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Background

The Mumbai Metropolitan Region Development Authority (MMRDA) proposed the construction of a Twin tube tunnel (2 lanes each) from Tikuji-ni-wadi, Thane to Magathane bus depot, Borivali to reduce traffic congestion on the Thane-Ghodbunder Road (SH 42). As the tunnel passes through the subterranean area of Sanjay Gandhi National Park (SGNP), MMRDA sought the Wildlife Institute of India (WII) to study the impacts of pre-construction, during, and post-construction on wildlife and to propose/recommend mitigation for minimisation of the impact in letter no. ED/MMRDA/TBTT/Wildlife clearance/1450/2023; dated: 29-12-2023 to the Director, Wildlife Institute of India. In order to assess the impact on the wildlife of the Sanjay Gandhi National Park, the Wildlife Institute of India has developed a comprehensive project proposal titled “Integrated study of the effects of construction of twin tunnel on wildlife of Sanjay Gandhi National Park”. The proposed study will evaluate the habitat use and movement pattern of herbivores (Chital and Sambar), Carnivores (Leopard), Burrowing Mammals (Rodents), and Herpetofauna present within the limits of the National Park. MMRDA further requested WII to recommend/propose precautionary measures to be followed during the tunnel’s construction and suitable mitigation at the tunnel openings (henceforth portal) in the eco-sensitive zone (ESZ) of SGNP.

To understand the presence of wildlife and evaluate the mitigation requirement at the portals, WII conducted a site visit at the portal construction site along with a field survey in a zone of influence. The study recommends measures for avoiding human-animal conflict at the tunnel portal and damage to vegetation through:

1. Adopting precautionary measures to reduce human-animal interaction during construction.
2. Utilizing measures to reduce damage to animals and plants in the zone of influence during construction.
3. Providing mitigation measures to reduce the impact on wildlife during the operation of the tunnel.



Introduction

Roads are important in infrastructure development as they facilitate transportation and economic growth. However, their presence in natural environments negatively impacts wildlife and ecosystem functioning (Forman, 2000; Trombulak & Frissell, 2000). As road networks expand, their ecological footprint intensifies. Roads cutting through wildlife habitats significantly impact biodiversity and natural processes (Forman, 2000). The majority of the roads connect densely populated areas, leading to increasing traffic and demanding more roads.

Impact of roads on the environment

Barrier Effects: Roads fragment habitats, restricting the movement of wildlife. This leads to genetic isolation, reduced access to resources, and increased inbreeding, which can impact species survival (Jaeger et al., 2005; Fahrig & Rytwinski, 2009).

Traffic-Induced Mortality: Wildlife-vehicle collisions are a leading cause of mortality, particularly for slow-moving species and those that use roads for resources (Luell et al., 2003). Endangered species with small populations are especially vulnerable.

Habitat Loss and Degradation: The physical footprint of roads results in habitat destruction, altering ecosystem processes, and reducing available space for wildlife (Baskaran & Boominathan, 2010; Daigle, 2010; Ree et al., 2015).

Disturbance and Pollution: Noise, light, and chemical pollution from roads disrupt animal behavior, alter migration patterns, and degrade local ecosystems (Ree et al., 2011). Anthropogenic noise has showcased several consequences on animal behavior and physiology because of disruption in communication by acoustic masking as well as distraction in signal receiving in highly acoustic groups of animals (Barber et al., 2010; Senzaki et al., 2018). In addition to fragmentation of habitat, traffic noise or seismic disturbance displace mammals away from noise sources, creating a permanent barrier (Ree et al., 2011). Change in foraging behavior is known in many species of ungulates, burrowing mammals, and even bats due to prolonged exposure to anthropogenic noise and seismic activities, primarily due to shifts in vigilance behavior (Shannon et al., 2016; Erbe et al., 2022). Studies have found disruption in typical mate selection in anurans that call within the frequency of traffic noise (1-3 kHz), which directly affects their reproductive success. Although these effects are limited with many species showcasing coping mechanisms to airborne noise, ground-borne vibrations impact the call rate and reduce the overall calling activity of many terrestrial fauna (Caorsi et al., 2019). Birds are known to be affected by low-frequency (<3 kHz) anthropogenic noise, and long-term exposure can lead to a decrease in species diversity and breeding densities in an area (Goodwin & Shriver, 2011; Reijnen & Foppen, 2006). Although most of the auditory communication in reptiles depends on substrate-borne vibrations, limited literature suggests similar effects as on birds. Responses of reduced call rates are primarily triggered by the entire spectrum of anthropogenic vibrations, rather than its peak frequency alone, which also affects their spectral threshold (Caorsi et al., 2019; Schou et al., 2021). Figure 1 demonstrates variations in amplitude spectrum (above a, c, e, g) and waveform (below b, d, f, h) of the road traffic and wind turbine seismic vibrations recorded and synthetic stimuli (adopted from Caorsi et al., 2019, Fig. 1)

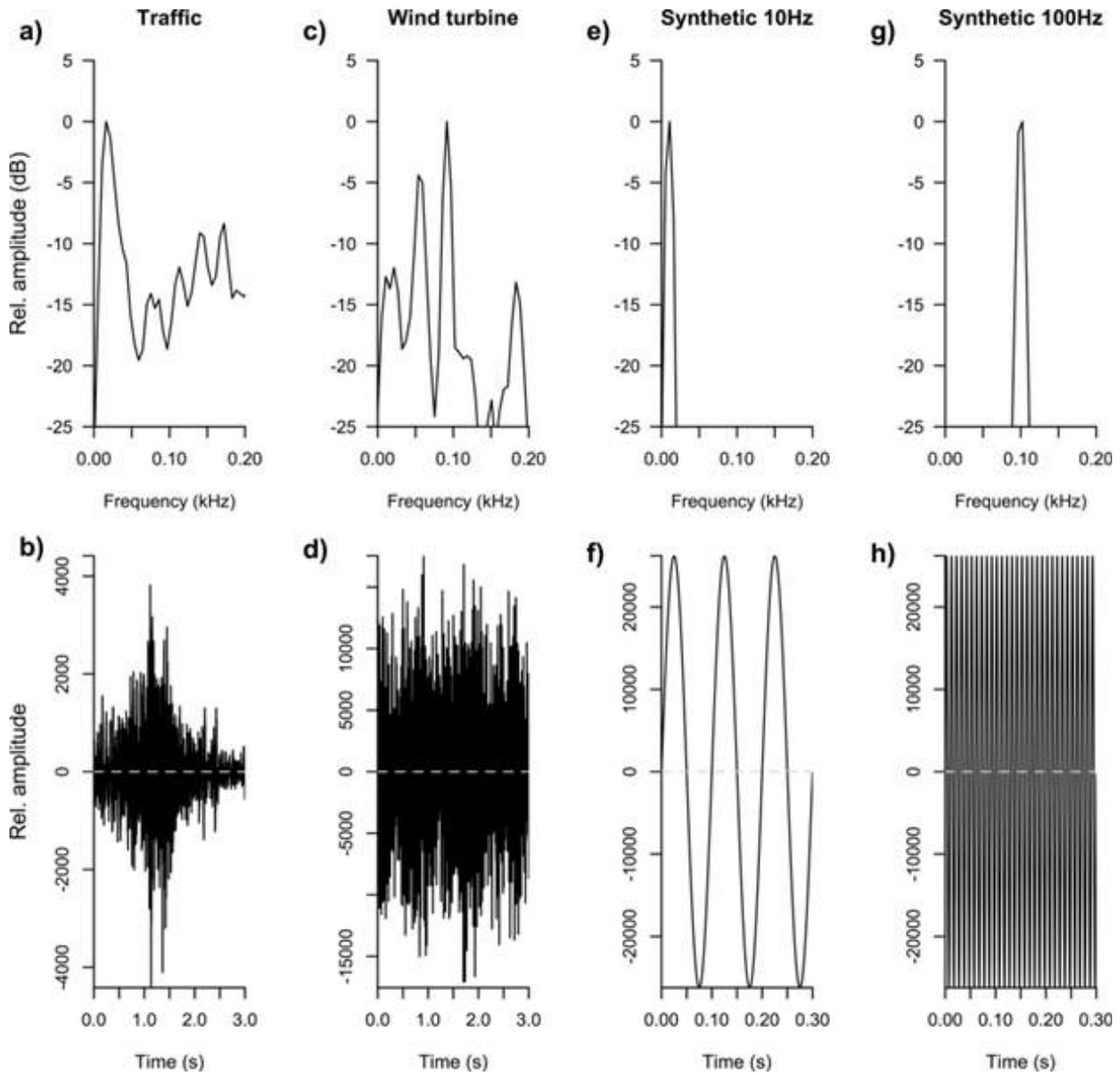


Figure 1: Variations in amplitude spectrum (above) and waveform (below) of the road traffic and wind turbine seismic vibrations recorded and synthetic stimuli generated to represent dominant frequency of road traffic (10kHz) and wind turbines (100 kHz). Adopted from Caorsi et al. 2019

In this context, tunnels have emerged as a viable alternative for urban road construction, offering a solution that minimises environmental impact while preserving the limited forested areas within cities. By directing traffic underground, tunnels reduce the need for extensive land clearing, thereby protecting green spaces and wildlife habitats, preserving the integrity of wildlife corridors, reducing habitat fragmentation, decreasing surface-level pollution and noise, and maintain overall ecosystem integrity. Additionally, they help alleviate surface-level congestion and improve urban aesthetics, making them a sustainable option for city infrastructure development (Forman et al., 2003).

Tunneling as a measure

Road tunnels have been opted for in recent years to address the increasing road traffic. They offer several environmental advantages over traditional surface roads, particularly in terms of reducing habitat disruption and minimizing noise pollution.

However, several concerns with regard to the influence of wildlife still prevail. Although this influence is understudied, literature on the mortality of mammals at tunnel openings is available (Ree et al., 2011). Also, the concentration of pollutants outside a tunnel due to accumulation can be harmful to the environment (Jacques & Possoz, 1996).

Materials and Methods

Study area

The proposed Thane Borivali Twin Tunnel (TBTT) project is a 10.06 km tunnel project connecting Tikuji-ni-wadi on Thane-Ghodbunder Road and the Western Express highway near Magathane bus depot in Borivali. The tunnel passes under the SGNP, a 104 sq. km protected area (PA) located in the suburban Mumbai and Thane districts. With a hilly terrain from the northern region of the Western Ghats biodiversity hotspot and dominated by moist deciduous vegetation (Champion & Seth, 1968), it is one of the few PAs located within the limits of a metropolis. Studies have previously documented the presence of around 40 species of mammals (Yazdani et al., 1993), with the leopard being the apex carnivore in the park.

Field visit

The portal construction site was inspected for the status of work (Borivali & Thane) in the ESZ along with consultant engineers on the 25th of January 2025 and 30th of January 2025 respectively. Site design and construction schedule were discussed with the engineers. Further, a 2 km zone of influence inside the PA was surveyed intensively for animal signs and plant density between 1st February to 20th February 2025. The survey was focused on intensive sampling of vegetation within 80 m asl, which could showcase prominent change due to construction work below the surface (Hiller & Crabb, 2000). A thorough literature review for previous records of leopards and ungulates in and around the zone of influence outside SGNP was also conducted.

Results

Status of Pre-Construction Activities and Mitigation Measures

The pre-construction preparations at the Borivali portal are yet to be initiated due to a delay in the relocation of residents to the site. The TBM launching site lies within the ESZ and about 60 m from the PA boundary. The preparations at the Thane portal have been initiated, which include the construction of an approach road, reinforcing with shotcrete, grouting, and rock anchoring. A 13 m high noise barrier is installed at the construction site, only facing north (towards TMC garden). A 3 m high wall is constructed around the site (excluding service roads) but has gaps in multiple places.

Presence of wildlife

In a 2 km buffer zone of the portal, we could assess the presence of leopard, sambar, chital, bonnet macaque, rhesus macaque and Mustelidae species, from direct sightings, animal droppings, and other indirect signs. Records of leopard movement were also noted previously outside the protected area on both the Borivali and the Thane side, within ~2 km distance from the national park boundary.

We detected high signs of chital (3.25 signs/km) and leopard (1.5 signs/km) in the Borivali area. The terrain within the 2 km buffer from the Borivali portal (Figure 2) is predominantly flat (29-97 m asl), facilitating vehicle traffic and tourist activities of SGNP. The availability of food waste in this area has caused the habituation of the chital population to human and livestock presence. This was evident from their lower flight initiation distance (distance from which an animal moves away from a threat) of an average of 9.45 m (n = 15) as compared to the individuals in the undisturbed forest areas of an average 54.45 m (n = 4). Such facilitation attracts herbivores and their prey to new resources, increasing the human-animal interface.

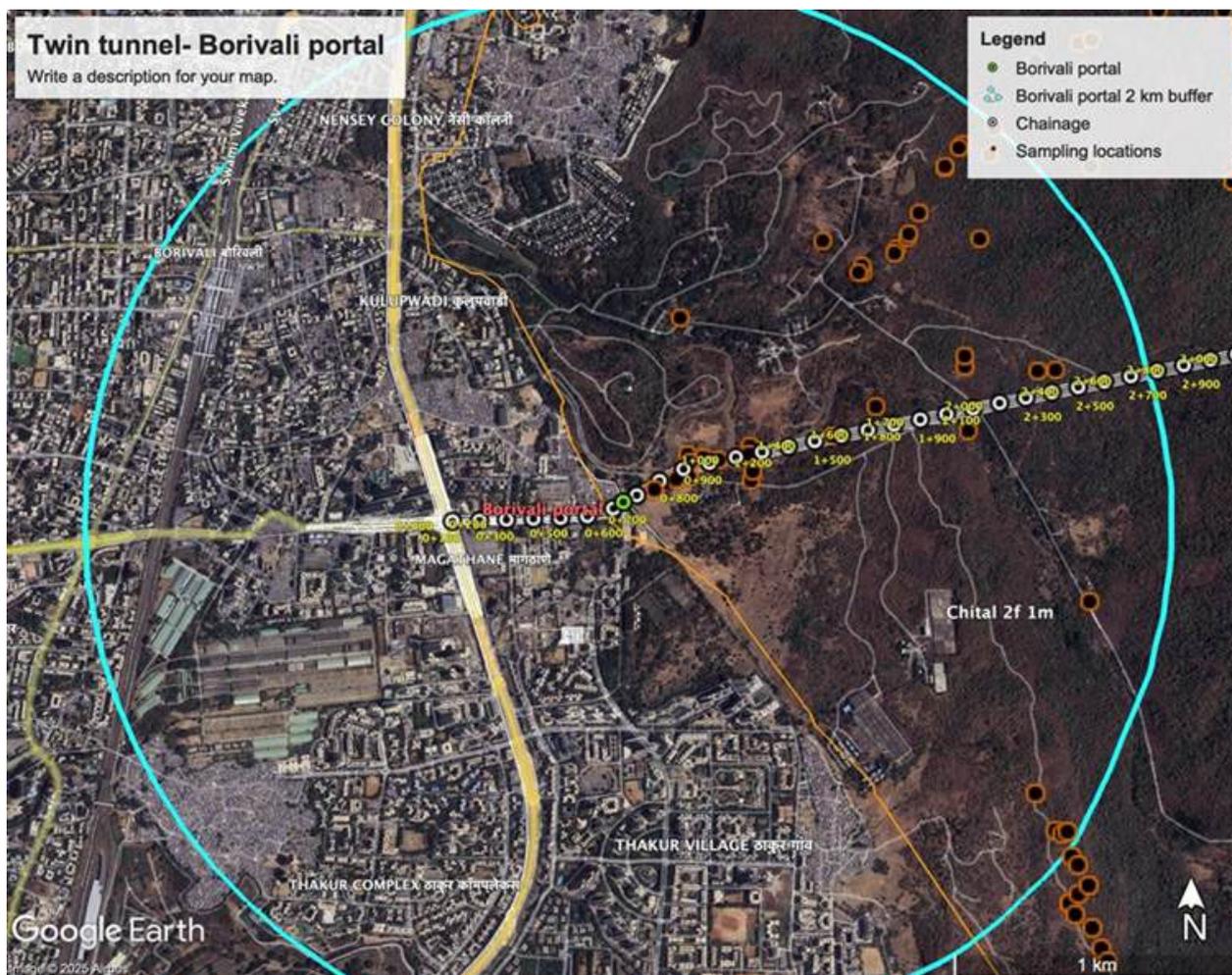


Figure 2: Sampling locations for vegetation and animal signs in 2 sq. km buffer zone around the tunnel portal near Magathane bus depot, Borivali

The terrain within the 2 km buffer of Thane portal (Figure 3) has highly undulating terrain (37- 284 m asl), with very low human footfall inside the national park. Given that, we identified the presence of leopard, sambar, chital, bonnet macaque and Mustelidae species as well in the area. The detection of chital signs was 0.25 signs/km and leopard signs were 1 sign/km in the Thane side. The area in the ESZ has comparatively more canopy coverage, which could increase the chances of leopards straying out near the construction site.

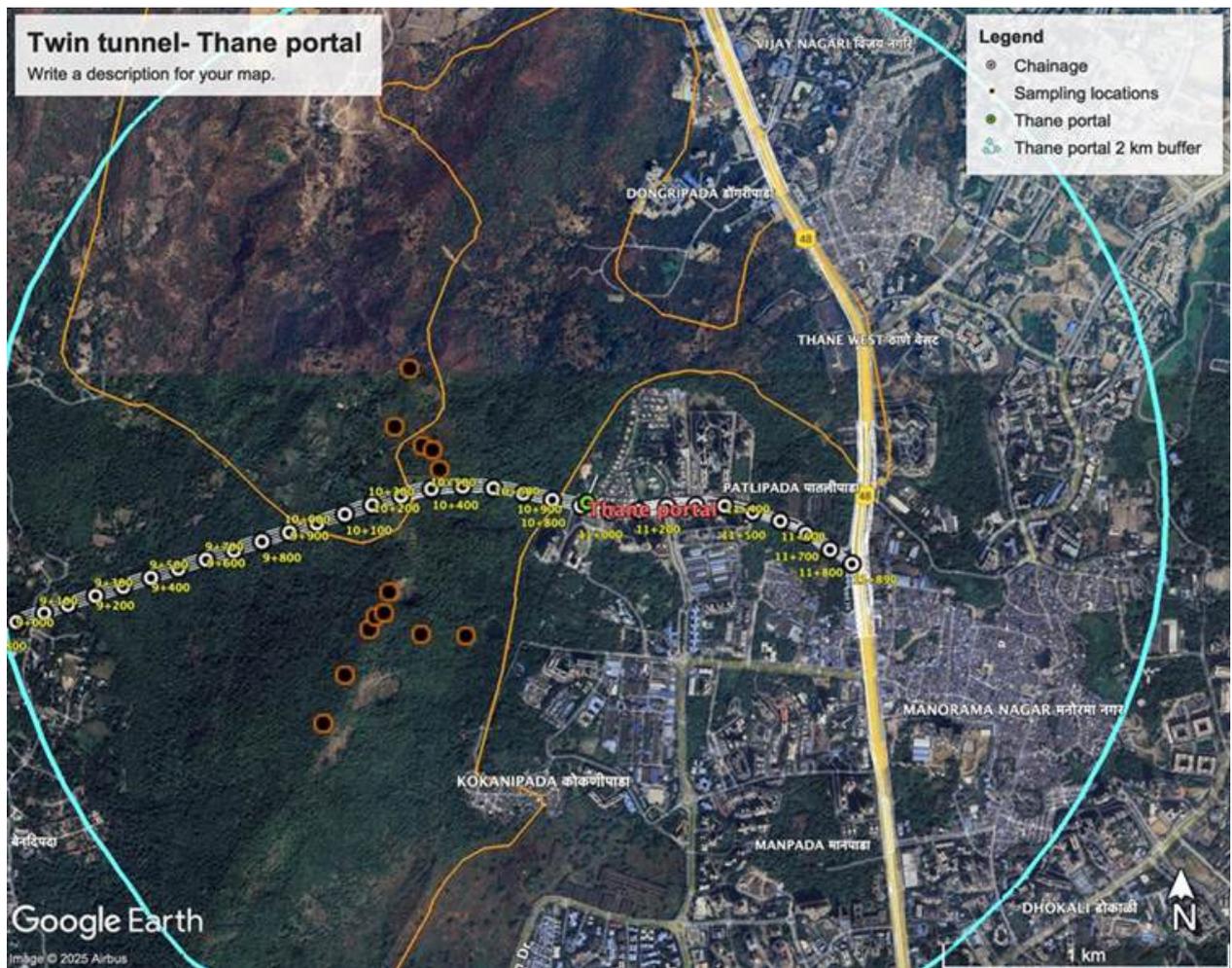


Figure 3: Sampling locations for vegetation and animal signs in 2 km² buffer zone around the tunnel portal near Tikuji-ni-wadi, Thane

Vegetation within a 2 km buffer

In the 2 km buffer from the portal within SGNP, both sides (i.e. Borivali and Thane) have a high human foot-fall because of tourism and human settlements. In the Borivali area, the canopy coverage, i.e., the area with trees above 5 m in height, was 56.10% resulting in most of the area as open habitats with sparse vegetation. Whereas the Thane area had canopy coverage (>5 m) of 56.59% along with undulating terrain with a mosaic of agriculture and moist deciduous vegetation. In the sampled area of this buffer (Figure 4).

Although the canopy cover is currently lower, the proposed alignment passes just 23.83-25.56 m below the surface for a significant distance from the Borivali portal, where the continuous dredging work might impact the trees in the area. Hiller & Crabb (2000) suggest the influence of ground-borne vibrations from construction work like tunneling up to 45 m from the source.

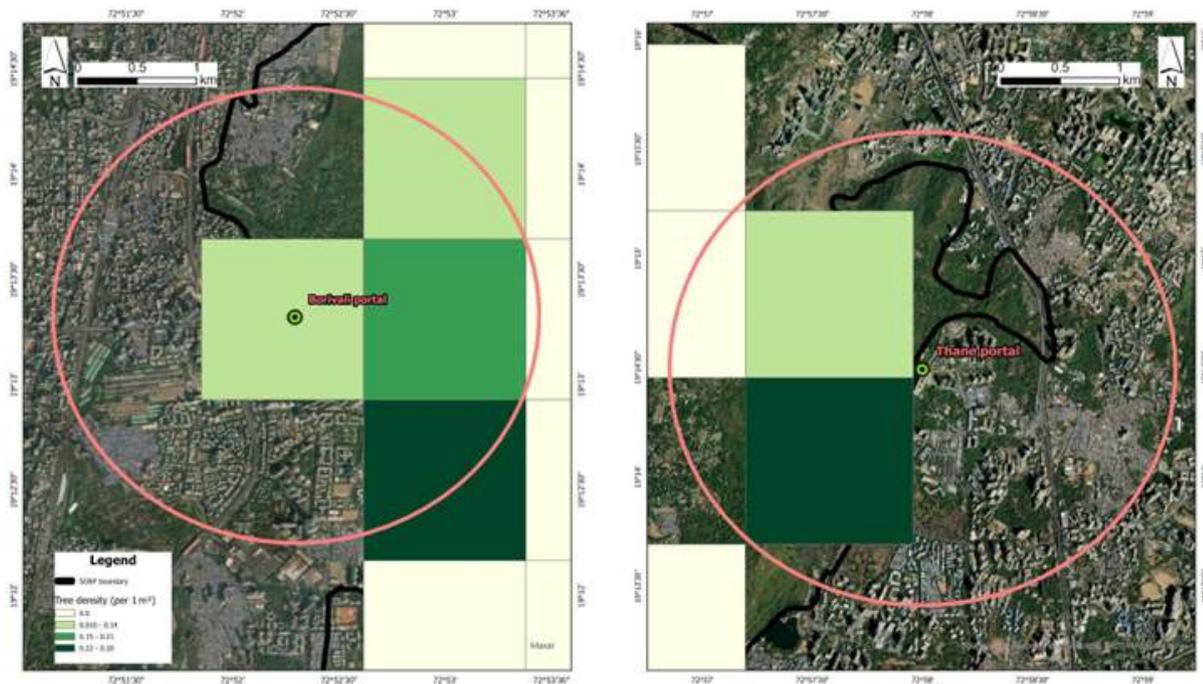


Figure 4: Gridwise plant density within the 2 km buffer area of the TBTT portals

Recommendations to minimize impact of tunnel construction at Thane and Borivali portals

Precautionary measures during the construction phase

Barricades

Small to medium-sized animals can get attracted or stray into the construction area due to resources. So, the site should be properly barricaded with at least 3-5 m tall walls. The Borivali portal, especially, requires proper complete barricading as the area is frequented by chital deer.

Sound and light barrier

TBM launching, dredging and constraint noise of construction machinery will cause disturbance to the mammals and the birds nesting in the vicinity of the site. So, sound absorbents need to be placed on 3 sides facing the forest area. During the visit, sound absorbents were only observed on one side of the construction site. Additionally, high-intensity construction lights scattering into the forest will deter these animals. So, we recommend using warm-coloured LED lights with directional lighting that will prevent spillage of light into the forest (Schofield et al., 2023; Habib et al., 2024).

Management of stray dogs

Previous studies have recorded the presence of leopards in human-dominated regions around SGNP and their dependency on domestic animals like dogs, cats and livestock (Edgaonkar & Chellam, 2002; Athreya et al., 2013; Surve et al., 2022). Hence, there is a need to manage the free-ranging dog population around the construction site.

Waste management

The wet and solid waste generated at the construction site should be strictly managed in designated bins and cleared. This will prevent animals from straying into the area for food, and reduce disease transmission, and human-animal interaction. No construction waste should be dumped around the site, which could leachate into the surrounding water bodies. Along with this, open defecation should be strictly avoided (Figure 5).

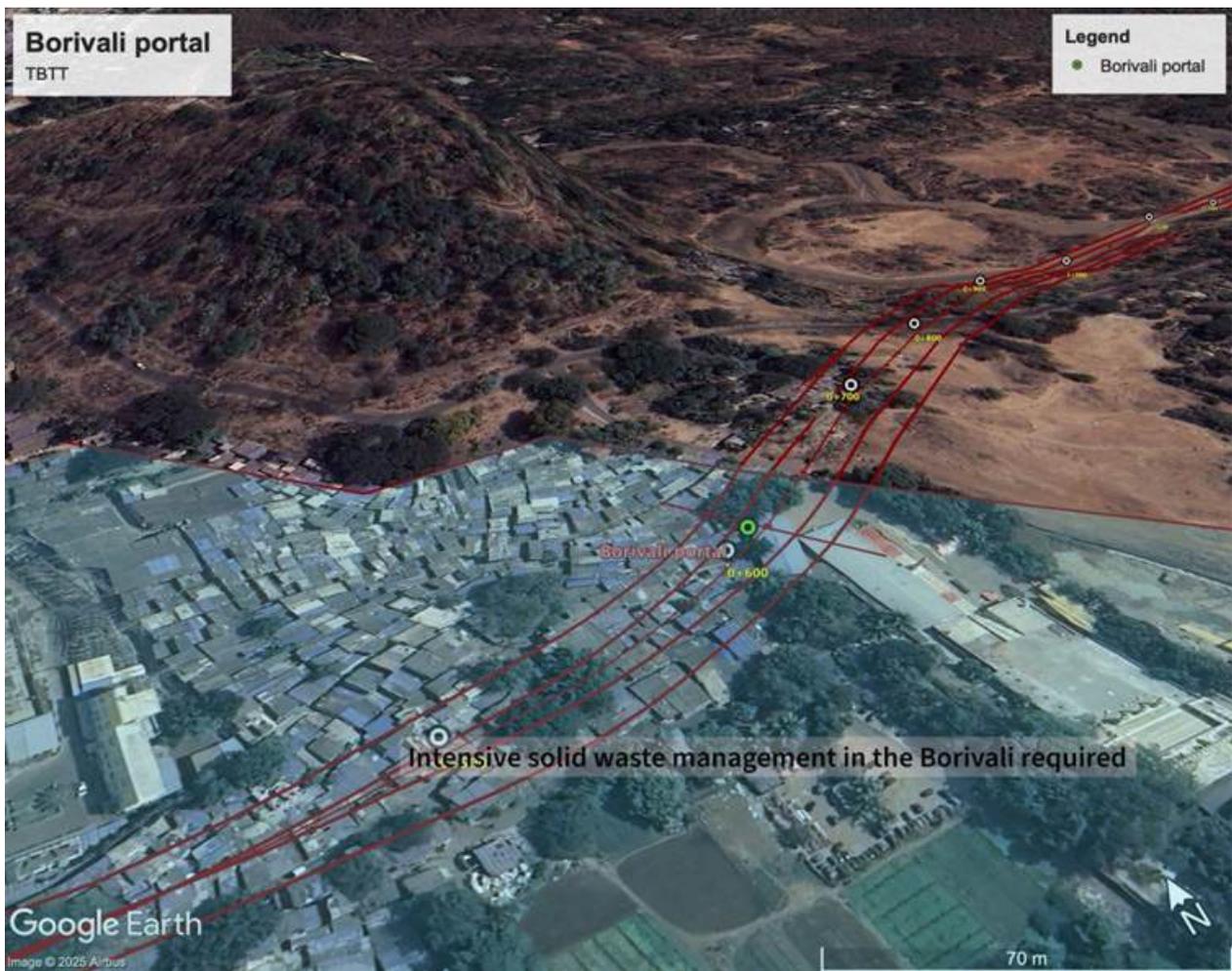


Figure 5: Blue shaded zone will require intensive waste management in the Borivali portal area.

Additional precautions:

Wild animals should not be fed near the site to avoid any confrontation with the animals.

Burrowing animals encountered during the construction of the tunnel need to be properly rescued with the help of SGNP forest officials.

Animal rescue and emergency contacts should be displayed at the construction site to prevent retaliatory harm to any animal.

The following measures should also be displayed at the construction site for the information of the workers.

Operation-phase mitigation

Barricades

Systematic walls need to be placed at the portal and approach roads to prevent entrance to mammals, amphibians and reptiles. Any openings in the wall should be barricaded to prevent access. A tunnel approach road (cut and cover) of about 290 m is planned at both portals, where suitable animal exit ramps need to be built to provide an emergency exit in case of intrusion of any mammals above the approach road (Figure 6).

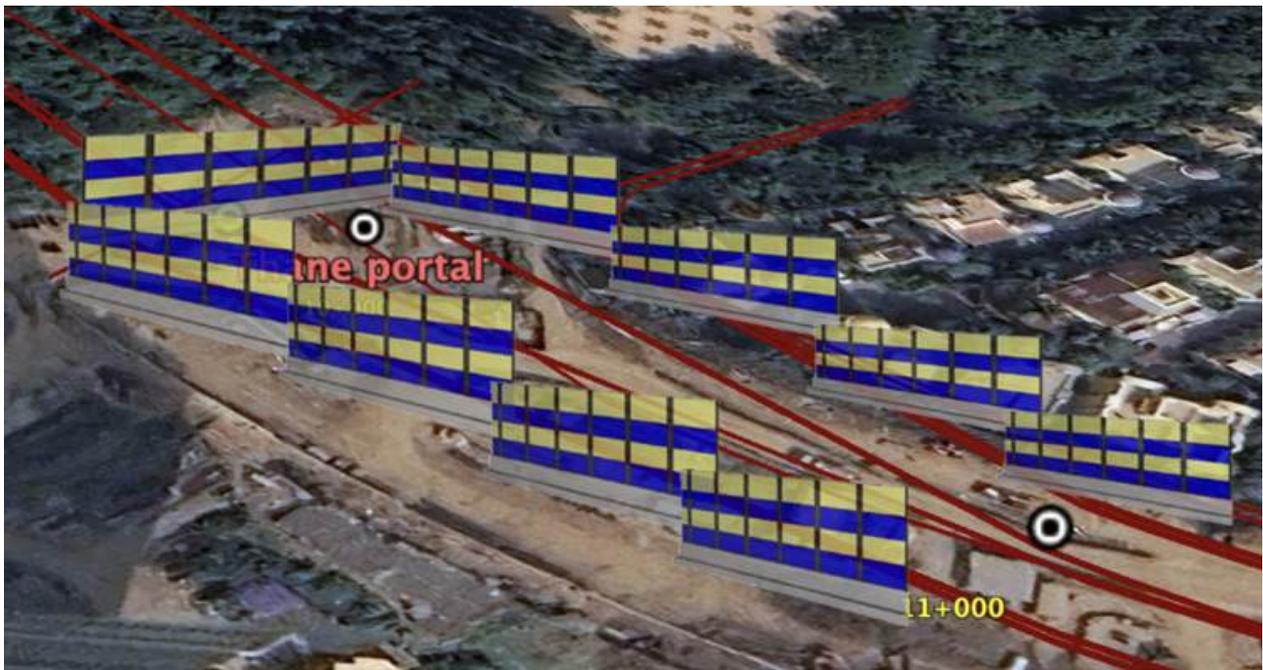


Figure 7: Representation of sound and light barrier along the portal opening. Example: Thane portal. (Only for representation)

Ventilation system management

High concentrations of air pollutants (such as CO and NO_x) can influence plant productivity in the long term in the surroundings of the ventilation system. So, the system at the openings should be redirected away from the vegetation, especially at the Thane portal where a steep hill covers the portal. We also recommend exploring solutions to reduce air pollution such as (i) Diluting tunnel air with fresh air before releasing (ii) cleaning pollutants by off-line precipitating and filter systems, or (iii) designing pipeline geometry that favours dispersion of pollutants (Henning & Berge, 1995; Jacques & Possoz, 1996).

Drainage and amphibian tunnels

A proper drainage system needs to be implemented at the Thane portal construction site to prevent the accumulation of water. Also, small amphibian passages need to be incorporated into the design to allow amphibians and reptiles to cross the approach road and service road site.

References

1. Athreya, V., Odden, M., Linnell, J. D. C., Krishnaswamy, J., & Karanth, U. (2013). Big Cats in Our Backyards: Persistence of Large Carnivores in a Human Dominated Landscape in India. *PLOS ONE*, 8(3), e57872. <https://doi.org/10.1371/journal.pone.0057872>
2. Barber J.R., Crooks K.R., Fristrup K.M. (2010). The costs of chronic noise exposure for terrestrial organisms. *Trends Ecol Evol* 25, 180–189. <https://doi.org/10.1016/j.tree.2009.08.002>
3. Baskaran, N., & Boominathan, D. (2010). Road kill of animals by highway traffic in the tropical forests of Mudumalai Tiger Reserve, southern India. *Journal of Threatened Taxa*, 2(3), 753-759.
4. Caorsi, V., Guerra, V., Furtado, R., Llusia, D., Miron, L.R., Borges-Martins, M., Both, C., Narins, P.M., Meenderink, S.W. & Márquez, R. (2019). Anthropogenic substrate-borne vibrations impact anuran calling. *Scientific reports*, 9(1), 19456.
5. Champion, H. G., & Seth, S. K. (1968). A revised survey of the forest types of India. Manager of publications.
6. Daigle, P. (2010). A summary of the environmental impacts of roads, management responses, and research gaps: A literature review. *Journal of Ecosystems and Management*, 10(3).
7. Edgaonkar, A., & Chellam, R. (2002). Food habit of the leopard, *Panthera pardus*, in the Sanjay Gandhi National Park, Maharashtra, India. *Mamm*, 66(3), 353–360. <https://doi.org/10.1515/mamm.2002.66.3.353>
8. Erbe, C. et al. (2022). The Effects of Noise on Animals. In: Erbe, C., Thomas, J.A. (eds) *Exploring Animal Behavior Through Sound: Volume 1*. Springer, Cham. https://doi.org/10.1007/978-3-030-97540-1_13
9. Fahrig, L., & Rytwinski, T. (2009). Effects of roads on animal abundance: an empirical review and synthesis. *Ecology and society*, 14(1).
10. Forman, R. T. (2000). Estimate of the area affected ecologically by the road system in the United States. *Conservation biology*, 14(1), 31-35.
11. Forman, R. T., Reineking, B., & Hersperger, A. M. (2002). Road traffic and nearby grassland bird patterns in a suburbanizing landscape. *Environmental management*, 29(6), 782–800. <https://doi.org/10.1007/s00267-001-0065-4>
12. Forman, R.T., Sperling, D., Bissonette, J.A., Clevenger, A.P., Cutshall, C.D., Dale, V.H., Fahrig, L., France, R., Goldman, C.R., Heanue, K. & Jones, J.A. (2003). Road ecology. *Science and solutions*, 482.
13. Goodwin, S. E., & Shriver, W. G. (2011). Effects of traffic noise on occupancy patterns of forest birds. *Conservation Biology*, 25(2), 406-411.
14. Habib, B., Nath, A., Goyal, S. P., Parab, T., Madhusudanan, A., Kadam, R. (2024). Recommendations for directional lighting on Wildlife Crossing structures; Proposal for monitoring of underpasses on Delhi-Dehradun highway (NH-307), Ganeshpur to Asharori. Pp. 134
15. Henning, J.E., & Berge, K.O. (1995). Ventilation et traitement de l'air dans les tunnels routiers (Ventilation and air treatment in road tunnels). PIARC, XX World Road Congress, Communications individuelles des Comités et Groupes de Travail, Montreal, Canada, pp.180-186.
16. Hiller, D. M., & Crabb, G. I. (2000). Groundborne Vibration Caused by Mechanised Construction Works. Transport Research Laboratory.
17. Iuell, B., G. J. Bekker, R. Cuperus, J. Dufek, G. Fry, C. Hicks, V. Hlaváč, V. Keller, B. Rosell, T. Sangwine, N. Tørsløv & B. I. M. Wandall (Eds). (2003). COST 341—Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. KNNV Publishers, Brussels.
18. Jacques, E. J., & Possoz, L. (1996). Road tunnels and the environment. In *Proceedings of a workshop on Measurement Techniques in Energy Systems and Processes*, pp. 83-108.

19. Jaeger, J. A. G., J. Bowman, J. Brennan, L. Fahrig, D. Bert, J. Bouchard, N. Charbonneau, K. Frank, B. Gruber & K. T. von Toschanowitz. (2005). Predicting when animal populations are at risk from roads: an interactive model of road avoidance behavior. *Ecological Modelling* 185, 329–348.
20. Reijnen R., Foppen R. (2006). Impact of road traffic on breeding bird populations. In: Davenport J, Davenport JL (eds) *The ecology of transportation: managing mobility for the environment*. Springer, Netherlands, Dordrecht, pp. 255–274. https://doi.org/10.1007/1-4020-4504-2_12
21. Schofield, J., Hogsden, K., Greenwood, M., Smith, B., & Harding, J. (2023). The colour temperature and placement of LED lighting near rivers can reduce attraction of flying adult caddisflies. *Freshwater Biology*. <https://doi.org/10.1111/fwb.14177>.
22. Schou, C. P., Levengood, A. L., & Potvin, D. A. (2021). Limited effects of traffic noise on behavioural responses to conspecific mating calls in the eastern sedge frog *Litoria fallax*. *Acta ethologica* 24, 217-226.
23. Senzaki, M., Kadoya, T., Francis, C. D., Ishiyama, N., & Nakamura, F. (2018). Suffering in receivers: negative effects of noise persist regardless of experience in female anurans. *Functional Ecology*, 32(8), 2054-2064.
24. Shannon G., Crooks K.R., Wittemyer G., Fristrup K.M., Angeloni L.M. (2016). Road noise causes earlier predator detection and flight response in a free-ranging mammal. *Behav Ecol* 27(5), 1370–1375. <https://doi.org/10.1093/beheco/arw058>
25. Surve, N. S., Sathyakumar, S., Sankar, K., Jathanna, D., Gupta, V., & Athreya, V. (2022). Leopards in the City: The Tale of Sanjay Gandhi National Park and Tungareashwar Wildlife Sanctuary, Two Protected Areas in and Adjacent to Mumbai, India. *Frontiers in Conservation Science*, 3. <https://doi.org/10.3389/fco-sc.2022.787031>
26. Trombulak, S. C., & Frissell, C. A. (2000). Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation biology*, 14(1), 18-30.
27. van der Ree, R., J. A. G. Jaeger, E. A. van der Grift & A. P. Clevenger. (2011). Effects of roads and traffic on wildlife populations and landscape function: road ecology is moving toward larger scales. *Ecology and Society* 16, 1–9.
28. Van Der Ree, R., Smith, D. J., & Grilo, C. (2015). The ecological effects of linear infrastructure and traffic: challenges and opportunities of rapid global growth. *Handbook of road ecology*, 1-9.
29. Yazdani, G. M., Pradhan, M. S., & Singh, D. F. (1993). Fauna of Conservation Areas: Fauna of Sanjay Gandhi National Park, Bombay (Vertebrates). *Records of the Zoological Survey of India*, 225–251. <https://doi.org/10.26515/rzsi/v116/i1-4/1993/160898>

Annexure

Photographs of the Thane portal area as surveyed on 30/01/2025.







Photograph of Right of way (ROW 46) of the Borivali portal area as surveyed on 25/01/2025.





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Ref: MEIL/TBTRP2/3281/25-26/884

Date: 24-07-2025

To,
The Engineer,
HILL — TCE (JV) — General Consultant
1301 & 1302/ 13th Floor, Mahavir Business Park, L.B.S. Road,
Teen Hath Naka, Thane (West) 400604,
Maharashtra — India

Kind Attention: Mr. J. Srinivas Rao – Deputy Project Director

Project: Package-2: Design & Construction of 6.09 km (Ch. 5+750 to Ch.11+840- Thane side) long twin tube road tunnel, approaches and other civil works between Thane and Borivali in the state of Maharashtra.

Subject: Compliance of mitigation measures suggested by WII Dehradun- Reg.

- Ref:**
1. LOA Ref: MMRDA/Twin tunnel/PKG2/LOA/484/2023 Dated 08th May 2023
 2. Contract Agreement Dated 19th May 2023
 3. FP/MH/ROAD/428417/2023/12832 dated 09 February 2024 from AIGF (Central) to The Principal Secretary Forests, Revenue & Forest Department, Govt. of Maharashtra.
 4. Working Permission Letter No. Dek 3/Land/FCA/C.R. 149/555/2024-25 dated 26 June 2024 from APCCF, Wildlife West, Gorai
 5. NBWL Permission accorded in 77th meeting of National Wildlife Board (NBWL) on 30th Jan 2024
 6. Site Visit conducted by WII team on 25/01/2025 and 30/01/2025
 7. TBTT/TBP02/HILL-TCE/MEIL/LTR/2025/0603 dated 07.04.2025

Dear Sir,

1.0 The Contractor refers to the Engineer's letter (7) cited above on the captioned subject and in response, the Contractor would like to submit that mitigation measures as recommended by Wildlife Institute of India - WII Dehradun during their site visit are duly complied with at the Thane Portal of Package-02.

Sr No	Recommendations by WII	Compliance by Contractor
1	Precautionary measures during the construction phase Barricades Small to medium-sized animals can get attracted or stray into the construction area due to resources. So, the site should be properly barricaded with at least 3-5 m tall walls. The Borivali portal, especially, requires proper complete barricading as the area is frequented by chital deer.	5.0 m high barricade (3.0 m concrete wall + 2.0 m green net) has been installed around the project boundary.
2	Sound and light barrier TBM launching, dredging and constraint noise of construction machinery will cause disturbance to the mammals and the birds nesting in the vicinity of the site. So, sound absorbents need to be placed	i. Sound absorbent barriers have been installed on the north side. Subsequently, the barricade height was increased to 5.0 m by adding

	<p>on 3 sides facing the forest area. During the visit, sound absorbents were only observed on one side of the construction site. Additionally, high-intensity construction lights scattering into the forest will deter these animals. So, we recommend using warm-coloured LED lights with directional lighting that will prevent spillage of light into the forest (Schofield et al., 2023; Habib et al., 2024).</p>	<p>a 2.0 m green net above the 3.0 m concrete wall.</p> <p>ii. Construction lighting is now focused exclusively within the project boundary using directional beams.</p>
3	<p>Management of stray dogs Previous studies have recorded the presence of leopards in human-dominated regions around SGNP and their dependency on domestic animals like dogs, cats and livestock (Edgaonkar & Chellam, 2002; Athreya et al., 2013; Surve et al., 2022). Hence, there is a need to manage the free-ranging dog population around the construction site.</p>	<p>The project activities are confined within the barricaded area and do not impact stray animal populations.</p>
4	<p>Waste management the wet and solid waste generated at the construction site should be strictly managed in designated bins and cleared. This will prevent animals from straying into the area for food, and reduce disease transmission, and human-animal interaction. No construction waste should be dumped around the site, which could leachate into the surrounding water bodies. Along with this, open defecation should be strictly avoided (Figure 5)</p>	<p>i. Wet and dry waste are segregated daily and handed over to the Thane Municipal Corporation (TMC) collection vehicles.</p> <p>ii. All waste is stored in containers with lid within a covered shed to maintain hygiene.</p> <p>iii. Deodorizers are applied regularly to control odour around the garbage area.</p> <p>iv. Disposal permission for Construction & Demolition (C&D) waste is currently under process.</p> <p>v. Adequate toilet facilities have been provided to maintain proper sanitation.</p>
5	<p>Additional precautions: Wild animals should not be fed near the site to avoid any confrontation with the animals. Burrowing animals encountered during the construction of the tunnel need to be properly rescued with the help of SGNP forest officials. Animal rescue and emergency contacts should be displayed at the construction site to prevent retaliatory harm to any animal.</p>	<p>Noted.</p> <p>Contact numbers of relevant SGNP officials and emergency responders are displayed at the site's main gate.</p>

The compliance report for the Thane side is enclosed herewith for the Engineer's perusal please.

Yours faithfully,
For Megha Engineering & Infrastructures Limited



Dhirendra Kumar Singh
Authorised Signatory

Encl: Compliance Report

CC: 1. Engineer in Chief (I/C), MMRDA (Mr. Vinay Surve)
 2. Superintending Engineer, MMRDA (Mr. Digvijay Patil)
 3. Executive Engineer, MMRDA (Mr. Shekhar Badane)

326
Portal-PKG-02

Sr. No	Recommendations	Compliance
1	<p>Precautionary measures during the construction phase Barricades Small to medium-sized animals can get attracted or stray into the construction area due to resources. So, the site should be properly barricaded with at least 3-5 m tall walls. The Borivali portal, especially, requires proper complete barricading as the area is frequented by chital deer.</p>	<p>A 5.0 m high barricade (3.0 m concrete wall + 2.0 m green net) has been installed around the project boundary. Photographs attached as Annexure-1</p>
2	<p>Sound and light barrier TBM launching, dredging and constraint noise of construction machinery will cause disturbance to the mammals and the birds nesting in the vicinity of the site. So, sound absorbents need to be placed on 3 sides facing the forest area. During the visit, sound absorbents were only observed on one side of the construction site. Additionally, high-intensity construction lights scattering into the forest will deter these animals. So, we recommend using warm-coloured LED lights with directional lighting that will prevent spillage of light into the forest (Schofield et al., 2023; Habib et al., 2024).</p>	<p>Sound absorbent barriers have been installed on the north side. Subsequently, the barricade height was increased to 5.0 m by adding a 2.0 m green net above the 3.0 m concrete wall.</p> <p>Construction lighting is now focused exclusively within the project boundary using directional beams. Photographs attached as an Annexure-2</p>
3	<p>Management of stray dogs Previous studies have recorded the presence of leopards in human-dominated regions around SGNP and their dependency on domestic animals like dogs, cats and livestock (Edgaonkar & Chellam, 2002; Athreya et al., 2013; Surve et al., 2022). Hence, there is a need to manage the free-ranging dog population around the construction site.</p>	<p>The project activities are confined within a barricaded area and do not impact stray animal populations.</p>

4	<p>Waste management The wet and solid waste generated at the construction site should be strictly managed in designated bins and cleared. This will prevent animals from straying into the area for food, and reduce disease transmission, and human-animal interaction. No construction waste should be dumped around the site, which could leachate into the surrounding water bodies. Along with this, open defecation should be strictly avoided (Figure 5)</p>	<ul style="list-style-type: none"> i. Wet and dry waste are segregated daily and handed over to the Thane Municipal Corporation (TMC) collection vehicles. ii. All waste is stored in lidded containers within a covered shed to maintain hygiene. iii. Deodorizers are applied regularly to control odour around the garbage area. iv. Disposal permission for Construction & Demolition (C&D) waste is currently under process. v. Adequate toilet facilities have been provided to maintain proper sanitation. Photographs attached as an Annexure-3 	
5	<p>Additional precautions: Wild animals should not be fed near the site to avoid any confrontation with the animals. Burrowing animals encountered during the construction of the tunnel need to be properly rescued with the help of SGNP forest officials. Animal rescue and emergency contacts should be displayed at the construction site to prevent retaliatory harm to any animal.</p>	<p>Noted. Contact numbers of relevant SGNP officials and emergency responders are displayed at the site's main gate.</p>	

Proper fencing to prevent Light & Noise



iQOO Z7s
popz Jul 22, 2025, 18:52



iQOO Z7s
popz Jul 22, 2025, 16:52









भारत सरकार
GOVERNMENT OF INDIA
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
MINISTRY OF ENVIRONMENT, FORESTS & CLIMATE CHANGE
Regional Office, Ground Floor, East Wing,
New Secretariat Building Civil Lines,
Nagpur – 440001,
apccfcetral-ngp-mef@gov.in



Proposal No: FP/MH/ROAD/428417/2023/12832 Date: 09.02.2024

To,

The Principal Secretary (Forests),
Revenue and Forest Department,
Hutatma Rajguru Chowk
Madam Cama Marg, Mantralaya, Mumbai – 400032.

Sub: Diversion of 35.5644 ha of forest land in favour of (MMRDA), Thane for construction of Twin Tube Tunnel 2 Lanes each side from Tikujini wadi in Thane District to Borivali in Mumbai Suburban District which passes below the Sanjay Gandhi National Park (SGNP) in Thane District in the State of Maharashtra.- FP/MH/ROAD/428417/2023- in principle approval - regarding.

Sir,

Please refer to the Government of Maharashtra letter no. FLD-1123/C.R.294/F-10 dated 13.10.2023 and online application No **FP/MH/ROAD/428417/2023** seeking prior approval of the Central Government under Section-2 (1) of the Van (Sanrakshan Evam Samvardhan) Adhiniyam, 1980.

After careful consideration of the proposal submitted by the State Government and with the approval of the Regional Empowered Committee (REC), I am directed to convey the Central Government's **In-principle** approval under **Section '2' (1) of Van (Sanrakshan Evam Samvardhan) Adhiniyam, 1980** for diversion of **35.5644** ha of forest land in favour of (MMRDA), Thane for construction of Twin Tube Tunnel 2 Lanes each side from Tikujini wadi in Thane District to Borivali in Mumbai Suburban District which passes below the Sanjay Gandhi National Park (SGNP) in Thane District in the State of Maharashtra, subject to the fulfilment of the following conditions:-

1. The legal status of forest land shall remain unchanged;
2. The demarcation of the proposed forest area shall be carried out at suitable places as per the direction of the DCF concerned at the cost of the User Agency;
3. The State Government shall; carry out compensatory afforestation and its maintenance in the identified non forest area over an extent of **35.5644 ha**. Non-Forest Land in Gut no. 495, at Village-Umravati, Taluka-Phulambri, District- Aurangabad at the cost of the User Agency. The identified non forest area shall be transferred and mutated in favour of forest department and the State Government shall notify such mutated area in to RF/PF before final approval and copy of such notification shall be submitted along with the compliance report;
4. CA scheme shall be implemented as per the provision of under SI No 4 of the Schedule II of the Van (Samrakshan Evam Samvardhan) Rules 2023;
5. The State Government shall charge the Net Present Value of the diverted forest land measuring **35.5644 ha** from the User Agency as per the orders of the Hon'ble Supreme Court

dated 28.03.2008 and 09.05.2008 in IA Nos.826 in 566 with related IA's in Writ Petition (Civil) No.202/1995 and Ministry's guideline.

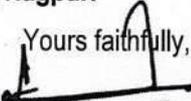
6. Additional amount of the Net Present Value (NPV) of the diverted forest land if any, becoming due after revision of the same by the Hon'ble Supreme Court of India in future, shall be charged by the State Government from the User Agency. The User Agency shall furnish an undertaking to this effect;
7. All the funds received from the User Agency under the project shall be transferred/ deposited to CAMPA fund only through e-portal (<https://parivesh.nic.in/>);
8. **All conditions recommended by the SC NBWL and the Regional Empowered Committee REC) shall be strictly complied with and implemented at the cost of the project;**
9. **No vertical /surface vents / shafts / other vertical openings are permitted inside the SGNP national park and no exhaust pollution will be released in to SGNP;**
10. Proper muck disposal plan shall be implemented and in any way muck disposal shall not be done in the forest area;
11. Work shall be carried out only as per the timings that may be prescribed by the CWLW;
12. No Labour camps/ office etc shall be built in the forest area;
13. The UA shall ensure proper drainage system to flush out wastage throughout the tunnel and any way such waste / garbage shall not be disposed inside the tunnel area;
14. The UA at the project cost shall restore the area and compensate for the damage for the flora & fauna of the SGNP in case of any adverse impact (s) occurs during construction & operation phase throughout the project life due to construction of proposed tunnel;
15. Tree felling shall be carried out wherever necessary under the strict supervision of the Forest Department
16. All mitigation measures as suggested in the reports submitted by the State Government shall be implemented by the concerned agency at the project cost.
17. The UA shall prepare and implement disaster management plan as per the relevant rules/ regulation to that extant, if required for such tunnel projects.
18. The State / UA shall ensure all other approvals / permission under relevant rules / regulation, if any required prior to commencement of the project work.
19. Proper labour camps shall be constructed in the non-forest area and in any case, labour camp shall not be made within the RF area;
20. **After ensuring settlement of rights under the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (2 of 2007) and compliance to all such conditions, the State Government shall issue order for working permission and diversion as the case may be;**
21. User Agency shall obtain Environmental Clearance as per the provisions of the Environmental (Protection) Act, 1986, if applicable;
22. Sufficient firewood, preferably the alternate fuel, shall be provided by the User Agency to the labourers after purchasing the same from the State Forest Department or the Forest Development Corporation or any other legal source of alternate fuel;



23. No additional or new path will be constructed inside the forest area for the transportation of construction materials for execution of the project work;
24. The forest land proposed to be diverted shall under no circumstances be transferred or sublet to any other agencies, department or person without prior approval of Govt. of India;
25. The total forest area utilized for the project shall not exceed **35.5644 ha** and the forest area diverted shall not be used for any purpose other than those shown in the diversion proposal. **The User Agency shall furnish an undertaking to this effect;**
26. The User Agency and the State Government shall ensure compliance to the all acts, rules, regulation and guidelines of the Ministry, for the time being in force, as applicable to the subject project;
27. Any other condition that the Regional Office, Nagpur may impose from time to time in the interest of afforestation, conservation and management of flora and fauna in the area shall be complied by the User Agency;
28. In the event of failure to comply with any of the above conditions the User Agency is liable for penal action as per the rules / guidelines issued under **Van(Sanrakshan Evam Samvardhan) Adhiniyam, 1980;**
29. The State Government shall process and submit compliance report on the above conditions through online (<https://parivesh.nic.in/>).

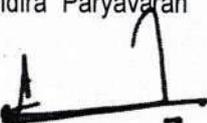
After receipt of the Compliance report on the above conditions, the proposal will be considered to accord final approval. The in-principle approval shall be valid for a period of **2 years** from the date of issue of the same. In the event of non-compliance of the above conditions within the stipulated period, this in-principle approval **shall be deemed to be null and void;**

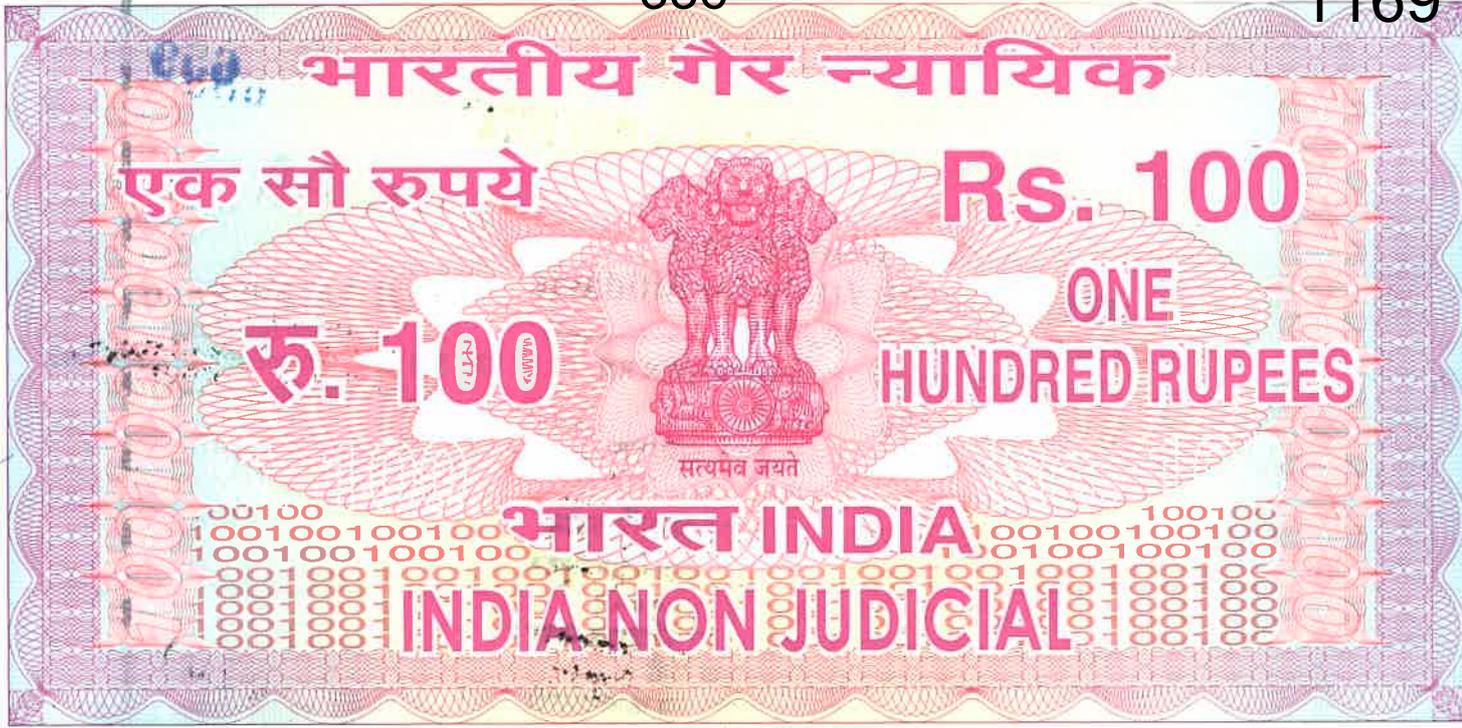
This issues with the approval of DDGF (Central), Regional Office, MoEF & CC, Nagpur.

Yours faithfully,

(C.B. Tashildar)
 AIGF (Central)

Copy to:

- i. The IGF (RoHQ), Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhawan, Jorbagh Road, Aliganj, New Delhi- 110003 **for information please**
- ii. The PCCF (HoFF), Government of Maharashtra, Nagpur.
- iii. User agency.
- iv. Guard file.


(C.B. Tashildar)
 AIGF (Central)



महाराष्ट्र MAHARASHTRA

2024

01AB 991582

प्रधान मुद्रांक कार्यालय, मुंबई
प.मु.वि.क्र. ८००००९६
- 7 MAR 2024
सक्षम अधिकारी

Undertaking

श्री. सुषमा चव्हाण

Sub: Diversion of 35.5644 ha of forest land for the proposed Thane Borivali Twin Tube Tunnel- MMRDA

As per the 112th REC meeting, the In principal approval has been issued subject to the below conditions:-

1. The legal status of forest land shall remain unchanged;
2. The demarcation of the proposed forest area shall be carried out at suitable places as per the direction of the DCF concerned at the cost of the User Agency;
3. The State Government shall, carry out compensatory afforestation and its maintenance in the identified non forest area over an extent of **35.5644 ha**. Non-Forest Land in Gut no. 495, at Village- Umravati, Taluka-Phulambri, District-Aurangabad at the cost of the User Agency. The identified non forest area shall be transferred and mutated in favour of forest department and the State Government shall notify such mutated area in to RF/PF before final approval and copy of such notification shall be submitted along with the compliance report
4. CA scheme shall be Implemented as per the provision of under SI No 4 of the Schedule II of the Van (Samrakshan Evam Samvardhan) Rules 2023.

15 MAR 2024

MMRAA

अनुसूची-१/Annexure-1

फाइल प्रतिज्ञापत्रासाठी /Only For Affidavit

१) मुद्रांक दिवशी गोंधळी जयु. क्र./दिनांक.....

२) मुद्रांक विभाग घेण्याचे पंच, रहिवासाचा पत्ता व सही

३) पत्रव्यवस्थापक मुद्रांक विभागाचे सही

ज्याच्यावर या पत्राचा संबंध मुद्रांक विभागाचे ठिकाण/पत्ता
एरवळ, मुंबई ४००००२ येथे

मुद्रांक विभागाचे ठिकाण/पत्ता घेण्या वर असोसिएशन
घरव्यवस्थापक, रावळदास रॉयल भवन, ब्रॉड मेट्रोपोलिटन
रोड, मुंबई, पत्रांक विभाग, मुंबई-४०००५१
याच्यावर या पत्राचा संबंध/वाचतासंबंध प्रतिज्ञापत्र सादर
करण्याची मुद्रांक विभागाची आवश्यकता नाही
मुद्रांक क्र. १०१७७/२००४ नुसार) ज्या कारणासाठी
ज्यांनी मुद्रांक विभागास त्यांनी त्यांचे कारणासाठी मुद्रांक
घरणी केल्यावरून व महिन्यात वापरणे बंधनकारक

V. K. RAJBHAR B.A.L.L.B.

Advocate High Court,

124, Pali Naka, Pereira House Compound,
Bandra (W), Mumbai - 400 050

श्री. राजेश गोपाळ

5. The State Government shall charge the Net Present Value of the diverted forest land measuring **35.5644 ha** from the User Agency as per the orders of the Hon'ble Supreme Court dated 28.03.2008 and 09.05.2008 in IA Nos.825 in 566 with related IA's in Writ Petition (Civil) No.202/1995 and Ministry's guideline.
6. Additional amount of the Net Present Value (NPV) of the diverted forest land if any, becoming due after revision of the same by the Hon'ble Supreme Court of India in future, shall be charged by the State Government from the User Agency. The User Agency shall furnish an undertaking to this effect;
7. All the funds received from the User Agency under the project shall be transferred/deposited to CAMPA fund only through e-portal (<https://parivesh.nic.in/>):
- 8. All conditions recommended by the SC NBWL and the Regional Empowered Committee REC) shall be strictly complied with and implemented at the cost of the project;**
- 9. No vertical /surface vents/shafts / other vertical openings are permitted inside the SGNP national park and no exhaust pollution will be released in to SGNP;**
10. Proper muck disposal plan shall be implemented and in any way muck disposal shall not be done in the forest area
11. Work shall be carried out only as per the timings that may be prescribed by the CWLW
12. No Labour camps/office etc shall be built in the forest area;
13. The UA shall ensure proper drainage system to flush out wastage throughout the tunnel and any way such waste/garbage shall not be disposed inside the tunnel area;
14. The UA at the project cost shall restore the area and compensate for the damage for the flora & fauna of the SGNP in case of any adverse impact (s) occurs during construction & operation phase throughout the project life due to construction of proposed tunnel,
15. Tree felling shall be carried out wherever necessary under the strict supervision of the Forest Department
16. All mitigation measures as suggested in the reports submitted by the State Government shall be implemented by the concerned agency at the project cost.
17. The UA shall prepare and implement disaster management plan as per the relevant rules/ regulation to that extant, if required for such tunnel projects.

18. The State/UA shall ensure all other approvals/permission under relevant rules/regulation, if any required prior to commencement of the project work.
19. Proper labour camps shall be constructed in the non-forest area and in any case, labour camp shall not be made within the RF area;
- 20. After ensuring settlement of rights under the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (2 of 2007) and compliance to all such conditions, the State Government shall issue order for working permission and diversion as the case may be;**
21. User Agency shall obtain Environmental Clearance as per the provisions of the Environmental (Protection) Act, 1986, if applicable,
22. Sufficient firewood, preferably the alternate fuel, shall be provided by the User Agency to the labourers after purchasing the same from the State Forest Department or the Forest Development Corporation or any other legal source of alternate fuel;
23. No additional or new path will be constructed inside the forest area for the transportation of construction materials for execution of the project work.
24. The forest land proposed to be diverted shall under no circumstances be transferred or sublet to any other agencies, department or person without prior approval of Govt. of India;
- 25. The total forest area utilized for the project shall not exceed 35.5644 ha and the forest area diverted shall not be used for any purpose other than those shown in the diversion proposal. **The User Agency shall furnish an undertaking to this effect:****
26. The User Agency and the State Government shall ensure compliance to the all acts, rules, regulation and guidelines of the Ministry, for the time being in force, as applicable to the subject project;
27. Any other condition that the Regional Office, Nagpur may impose from time to time in the interest of afforestation, conservation and management of flora and fauna in the area shall be complied by the User Agency;
- 28. In the event of failure to comply with any of the above conditions the User Agency is liable for penal action as per the rules / guidelines issued under Van Sanrakshan Evam Samvardhan) Adhiniyam, 1980;**



(M.P. Singh)
Executive Engineer
MMRDA

Annexure - 1

Undertaking for Legal status of Forest Land

MMRDA hereby submits an undertaking that the legal status of forest land shall remain unchanged.

Date: 04 / 03 / 2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

Undertaking for demarcation

MMRDA hereby submits an undertaking that the demarcation of the proposed forest area shall be carried out at suitable places as per the direction of the DCF concerned at the cost of the User Agency.

Date: 04/03/2021

Place: Mumbai



(M.P. Singh)
Executive Engineer
MMRDA, Bandra
Mumbai

No. ED/MMRDA/TBTT/ Forest/244 /2024

Date: 04.03.2024

To,
The Conservator of Forest & Director
Sanjay Gandhi National Park, Borivali
Mumbai - Maharashtra.

Subject: Diversion of 35.5644 ha Forest land in favor of (MMRDA), Thane for the construction of Twin Tube Tunnel 2 lanes each side from Tikujini wadi in Thane District to Borivali in Mumbai Suburban District which passes below the Sanjay Gandhi National Park (SGNP) in Thane District in the State of Maharashtra - **Forest Clearance Proposal No.:** FP/MH/ROAD/428417/2023 – in – principle approval - regarding – Payment details

Reference:

1. Forest Clearance Proposal No.: FP/MH/ROAD/428417/2023
2. Your office Letter No. Desk-2/Land/1797/2023-24 dated 09th February, 2024
3. Ministry of Environment, Forest & Climate Change, Regional Office, Nagpur's letter Proposal No. FP/MH/ROAD/428417/2023/2832 dated 09.02.2024

Sir,

This is for your information that MMRDA has completed the due process of payment of compensatory levies to CAMPA E – Portal and the details of payment NEFT/RTGS are furnished below:

Sr. No	Item	Condition as mentioned in the in-principle approval	Amount in Rs.
1	Cost towards compensatory afforestation	Condition No.3 & 4 of letter under reference (35.5644 ha X Rs.804884)	2,86,25,217/-
2	Net Present Value	Condition No.5	41,90,19,985/-
Total			44,76,45,202/-

Payment (RTGS) is made in favour of –

Account Name - CAMPA MAHARASHTRA
Account No. - 150787284
IFSC Code - UBIN0996335
UTR No. MAHBH24061147686, dt.01.03.2024

Yours faithfully,

(M.P.Singh)

Executive Engineer
MMRDA

लिपिक
04/02/2024

आवक जा.दक

वनसंरक्षक व संचालक

संजय गांधी राष्ट्रीय उद्यान

बोरीवली

मुंबई महानगर प्रदेश विकास प्राधिकरण

वांद्रे-कुर्ला संकुल, वांद्रे (पूर्व), मुंबई ४०००५९

ईपीएबीएक्स +९१ २२ २६५९ ०००९/४०००

<https://mmrda.maharashtra.gov.in>

ANNEXURE A-14

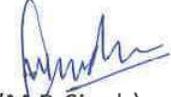
Annexure – 4
(Condition No.-7)

Undertaking for deposit to CAMPA fund

MMRDA hereby submits an undertaking that all the funds received from the User Agency under the project shall be transferred/ deposited to CAMPA fund only through e-portal (<https://parivesh.nic.in/>).

Date: 04 / 03 / 2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-15

Annexure – 5
(Condition No. – 8)

Undertaking for compliance of NBWL & REC conditions

MMRDA hereby submits an undertaking that all conditions recommended by the SC NBWL and the Regional Empowered Committee (REC) shall be strictly complied with and implemented at the cost of the project.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-16

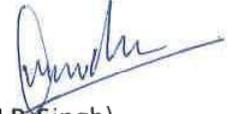
Annexure – 6
(Condition No. – 9)

Undertaking for No Vertical Openings inside SGNP

MMRDA hereby submits an undertaking that No vertical /surface vents / shafts / other vertical openings are permitted inside the SGNP national park and no exhaust pollution will be released in to SGNP.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-17

No. MMRDA/SGNP/TBTT/Forest/rev. Muck disposal plan/153/04-2025 Date: 04/04/2025

To,

The Chief Conservator of Forests & Director

Sanjay Gandhi National Park

Borivali, Mumbai.

Project:- Construction of Thane-Borivali Twin Tunnel Project (TBTT)

Sub:- Submission of Revised Muck Disposal Plan for TBTT Project.

Ref:-

1. Letter No. FP/MH/ROAD/428417/2023/12832 dated 09 February, 2024 from AIGF (Central) to The Principal Secretary Forests, Revenue & Forest Department, Govt. of Maharashtra.
2. Working Permission Letter No. Dek 3/ Land/ FCA/ C.R. 149/ 555/ 2024-25 dated 26 June, 2024 from APCCF, Wildlife West, Gorai.
3. MMRDA's letter no. MMRDA/ ED/ TBTT/ Compliance/ Forest/ 42/ 2024 dated 14.08.2024.
4. MMRDA's letter no. MMRDA/TBTT/SGNP/2024/111 dated 06.01.2025.
5. M/s. MEIL's letter no. MEIL/TBTRP2/3281/25-26/627 dated 25.03.2025.
6. M/s. Hill-TCE JV's letter no. TBTT/ HILL-TCE/ MMRDA/ LTR/ 2025/ 0054 dated 27.03.2025.

Dear Madam,

Thane Borivali Twin Tunnel project is being implemented by MMRDA to establish a direct connectivity between Thane and Borivali thereby decongesting the Ghodbandar road and Western Express Highway. This project is an important public utility project and being considered as a Vital project for public transportation by Govt of Maharashtra Vide GR dated 14th Oct 2024. The stone laying of the project was held with the auspicious hands of Hon'ble Prime minister of India in July 2024.

MMRDA has received all required statutory approvals from REC , SBWL, NBWL, ESZ Committee and MOEF&CC. Moreover, all stage-1 compliances have been completed and statutory payments have been made and confirmed vide letter under reference at Sr. No. 4 above.

In line with stipulated condition No. 10 of stage-1 clearance under reference at Sr. No. 1, please find enclosed herewith Muck Disposal Plan as submitted and to be implemented by the Contractor showing location of dumping ground for your kind perusal and necessary action. The Muck Disposal Plan has been verified by the General Consultant.

मुंबई महानगर प्रदेश विकास प्राधिकरण

वांद्रे-कुर्ला संकुल, वांद्रे (पूर्व), मुंबई ४०००५१.

ईपीएनईक्स +९१ २२ २६५९ ०००९/ ४०००

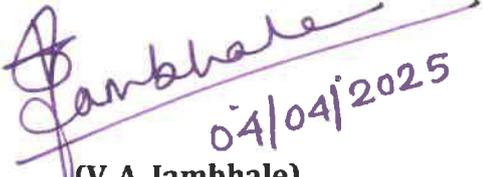
<https://mmrda.maharashtra.gov.in>

You are therefore requested to kindly expedite the process for approving the Muck Disposal Plan. Your cooperation and timely approval for this large scale infrastructure public project is highly appreciated.

Thanking you.

Encl.: As Above

Yours faithfully,


04/04/2025
(V. A. Jambhale)
Chief Engineer (I/c)

Copy to: The Additional Principal Chief Conservator of Forests (West), Gorai, Mumbai
for kind perusal.

Megha Engineering & Infrastructures Ltd.**An ISO 9001-2008 Company**

S-2, Technocrat Indl. Estate, Balanagar, Hyderabad - 500037, Telangana, INDIA

Tel: +91-40-44336700, 44609100 Fax: +91-40-44336800

E-Mail: info@meil.in, Visit us : www.meil.in**Ref: MEIL/TBTRP2/3281/25-26/627****Date: 25-03-2025****To****The Engineer****Hill International – Tata Consulting Engineers JV****708/709 7th floor, R square,****Mulund (west), Mumbai-400080****Maharashtra, India****Kind Attention:** Mr. Tanachard Rinsarnkitjaroen – Project Director**Project:** Package-1: Design & Construction of 5.75 km (Ch. 0+00 to Ch.5+750- Borivali side) long twin tube road tunnel, approaches and other civil works between Thane and Borivali in the state of Maharashtra

Package-2: Design & Construction of 6.09 km (Ch. 5+750 to Ch.11+840- Thane side) long twin tube road tunnel, approaches and other civil works between Thane and Borivali in the state of Maharashtra

Subject: Submission of Muck Disposal Plan for PKG-01 & PKG02 of Thane Borivali Rad Tunnel Project.

- Ref:**
1. LOA Ref: MMRDA/Twin tunnel/PKG2/LOA/484/2023 Dated 08th May 2023
 2. Contract Agreement ref. MH004084786202324E dated 19th May 2023
 3. AECOM Letter No. AECOM/pending subm./MMRDA/Mum/TBTT /2024/96 dated 03.10.2024
 4. MEIL/TBTRP2/3281/24-25/290 dated 12.08.2024
 5. MEIL/TBTRP2/3281/24-25/292 dated 13.08.2024
 6. MEIL/TBTRP2/3281/25-26/621 dated 21.03.2025

Dear Sir,

With reference to the subject and letters cited at Ref. 4 & 5, we hereby submit the Muck Disposal Plan. Please find the attached for your information and reference.

Thanking you and assuring you of our best services always.

Yours faithfully,

For Megha Engineering & Infrastructures Limited**Dharendra Kumar Singh****Authorised Signatory****Encl:** 1. Muck Disposal Plan for PKG-01 & 02

- CC:**
1. Engineer in Chief (I/C), MMRDA (Mr. Vishal Jambhale)
 2. Executive Engineer, MMRDA (Mr. Shekhar Badane)



MUCK DISPOSAL PLAN

Thane – Borivali Twin Road Tunnel

FOR PACKAGE 1 & PACKAGE 2

Package-1: Design & Construction of 5.75 km (Ch. 0+00 to Ch.5+750- Borivali side) long twin tube road tunnel, approaches and other civil works between Thane and Borivali in the state of Maharashtra

Package-2: Design & Construction of 6.09 km (Ch. 5+750 to Ch.11+840- Thane side) long twin tube road tunnel, approaches and other civil works between Thane and Borivali in the state of Maharashtra



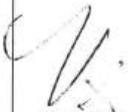
MUCK DISPOSAL PLAN



MUCK DISPOSAL PLAN



Thane – Borivali Twin Road Tunnel

Prepared by	Review by	Review by	Review by	Checked by	Approved by
 Pravin Thakre (Sr.Engineer Planning)	 Prashant Sabde (Planning Manager)	 Tej Bahadur Sinha (Sr. Environment Manager)	 MLV Apparao (Chief Safety Manager)	 Rajiv Sharma (Construction Manager- Tunnel)	 D K Singh (Project Manager)

MUCK DISPOSAL PLAN

Thane – Borivali Twin Road Tunnel

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Annexure- 1 Muck disposal area (Google image) for all two locations along with land documents.



MUCK DISPOSAL PLAN



Thane – Borivali Twin Road Tunnel

1. Purpose:

The purpose of Muck disposal Plan is to provide a clear overview of Contractor's basic work outline along with method that will be adopted to handle and dispose the muck generated during execution of the project.

2. Scope:

Design & Construction of 12 km [PKG-1 (5.75 kms, Ch. 0+000 to Ch.5+750) - Borivali side & Pkg-2 (Ch. 5+750 to Ch.11+840)] long twin tube road tunnel, approaches and other civil works between Thane and Borivali in the state of Maharashtra.

Evolution of Muck Disposal plan - As the project proceeds, changes in either external or internal environment may give rise to the need of modifying the project Muck Disposal plan. From time to time major changes and deviation in plan will be notified to Engineer.

3. Reference Documents:

References are made to the design and construct contract outline design criteria, outline construction specification, employer's requirements: -

- MMRDA Contract Conditions : Employer's requirement (General Specifications)
- MMRDA Contract Conditions : Employer's requirement (Outline Design Specification)
- MMRDA Contract Conditions : Employer's requirement (Outline Construction Specifications)
- Project Health & Safety Plan : MMRDA-PKG-2-MEIL-HSEP-001

4. Responsibility:

- Action may be delegated but responsibility shall not be delegated.

4.1 Project Manager

- The approval of this Muck Disposal plan
- Overall scope of work.
- Co-ordination of personnel and equipment to ensure continuous program of the work during the execution period.
- Receiving daily progress report and distributing to Engineer's representative and MEIL Management, and ensuring prompt action to any matter highlighted in the same.

MUCK DISPOSAL PLAN

Thane – Borivali Twin Road Tunnel

4.2 Construction Manager

- Implementation of the Muck Disposal Plan.
- Safety to the personnel, incident reporting and implementation of the safety management plan and safety management system.
- Ensuring the works shall be carried out according to approved permit and method statement. Ensure all personnel are fully aware of their duties and responsibilities.
- Liaising with Engineer's representatives during the operation and during the method statement change, contingency operation or mitigation plan.

4.3 QA/QC Manager

- Organizing and conducting Quality audits with co-ordination of all concerned.
- Ensure preparation and incorporation of all the Work Methods as required by the contract and corresponding Inspection & Test Plans and Formats.
- Assist Site Management in effective implementation of approved quality plans and QC procedures
- Identify material sources, and conduct material tests and ensure conformity with specifications & standards.
- Conduct Routine Tests on materials & workmanship as per ITP for conformance and maintain records.
- Identify, Calibrate and maintain Master List of Testing and Measuring Equipment.
- Statistical analysis for product quality material (cube, plants, etc).

4.4 Site Engineer

- Implementation of this Muck Disposal plan.
- Ensuring that the works are carried out in accordance with approved permits.
- Ensuring that all personnel are fully aware of their duties and responsibilities.
- Liaising with Engineer's representative during the operations and during contingency operations or mitigation works.

4.5 Site Supervisor

- Ensuring that the handling and disposal of muck as per muck disposal plan.
- Responsible for managing all machinery, tools & labors used
- Maintaining records of Muck disposal challans and to report the site engineer.
- The Slips at the disposal location shall be received by the security guard/site supervisor and signed with time at delivery location and returned to the driver for submission to site supervisor.



MUCK DISPOSAL PLAN



Thane – Borivali Twin Road Tunnel

4.6 Surveyor

- Shall Report to Project Manager.
- Shall be responsible for providing the required co-ordinates of muck disposal site and other survey to quantify the muck disposal capacity of area identified.
- Regular survey of fill areas and excavated area.

4.7 Chief SHE Officer

- Disseminate and Communicate Project SHE Policy, H&S Management System requirements to site personnel.
- Provide necessary advice, information, and support in the effective implementation of the H&S Management System requirements and this SHE plan.
- Advise the execution team in safe operation procedures and to bring out the unsafe conditions to the notice of the in charge.
- At any given point if the activity is not being carried out as mentioned in the method statement, it is to be brought to the notice of the project manager.

4.8 Safety Officer

- Advise the execution team for safe operation procedures and to bring out the unsafe conditions to the notice of the Engineer in charge.
- Defensive driving training shall be given to the drivers prior to start of activity.
- Alcohol test of all the drivers and other staff shall be carried out routinely.
- Reverse horn of all the dumpers to be ensured.
- Regular Maintenance of vehicles to be ensured.
- At any given point if the activity is not being carried out as mentioned in the method statement, it is to be brought to the notice of the Project Manager.

4.9 Environmental Manager:

- Ensure effective implementation of Plans at site level.
- Coordinating and monitoring environmental management at sites.
- Coordinating /conducting site inspections at regular intervals.
- Complying with Clients and Engineers observations & issues related to the site.
- Conducting training on environmental aspect and modules as a part of training program.
- Keeping records of site inspections records, monitoring reports at regular intervals
- Reviewing the inspection reports, observation reports etc. by authorities and complying points.

MUCK DISPOSAL PLAN

Thane – Borivali Twin Road Tunnel

5.0 Method and Measures for Muck Disposal:

5.1 Introduction:

- A large quantity of muck is to be generated as a result of construction of Tunnel Boring Machine mechanical work activities which are majorly mentioned table mentioned below:

Sr. No	Description	UoM	Compacted Volume	Loose Volume (considering 30% Void)
1	TBM Tunnel	cum	28,66,544	37,26,507
	Total	cum	28,66,544	37,26,507

Note: the quantities are approximate with reference to tender drawing and may vary marginal with definitive drawing approvals.

- Muck Disposal areas initial identified are casting yard land finalized by contractor and the supply to the quarries located around semi-urban areas.
- Other Location details will be confirmed after the finalization other sub-contractor of Excavation and Muck disposal.

5.2 Transportation of Muck and of Classified Material:

- Muck dumpers which are exiting from the sites are to go through Wheel wash bay where the wheels/ tyres of the dumpers are cleaned with water.
- Muck dumpers shall be covered/ closed with tarpaulin which helps in prevention of spillages while transporting from station to disposal site.
- Limited quantity of muck i.e. not more than 15 cum (bulk measure) is permitted in the dumper.
- Proper maintenance of the dumpers shall be made in order to keep exhaust gases as clean as possible.
- The driving speed on the given route shall be limited (over speed may result in spillage).
- Honking in residential areas shall be limited in order to avoid disturbances to public.
- Vehicle body shall be modified with liners to avoid percolation of water during transportation from the vehicle body.
- The Vehicle speed on unpaved road shall be restricted to 25KMPH.
- Dumpers body shall be cleaned at wheel wash location to avoid spillage on the road prior to leaving the site.

MUCK DISPOSAL PLAN

Thane – Borivali Twin Road Tunnel

5.3 Record Maintenance:

- Proper record of muck generated in the site will be maintained.
- Muck vehicles will be controlled by the Site in charge.
- A gate pass (with seal & Initial/signature) shall be issued once the muck dumper is allowed to exit from the site and a security team present in the disposal site shall be inspected the gate pass (with seal & Initial/signature). Thus a single trip is completed. This is repeated process.
- The muck disposal record shall be maintained in the station and in the disposal site for further inspection.

5.4 Environmental Impacts & Mitigation:

- Relevant permits and check lists shall be maintained at the time of muck transportation.
- The generated muck shall be carried in dumper trucks covered with heavy duty tarpaulin properly tied to the vehicle.
- Once the Disposal site is finalized a detailed route maps shall be given to the dumper drivers which they have to follow without disturbing public at night times.
- Wheel wash bay shall be located at each site and disposal site at the exit areas of the site. Muck dumpers leaving from site (entering to public roads) shall go through this for cleaning of tyres / wheels with water.
- Proper maintenance of the dumpers shall be made in order to keep exhaust gases as clean as possible and noise in control limits.
- Route maps shall be prepared in such matter that the number of residential areas is less and honring shall be limited in residential areas in order to avoid miscellaneous in residential areas.
- All dumpers shall be well maintained so that loose soil could be protected well during the transportation.
- Dumping shall be avoided during the high speed wind, so that suspended particulate matters (SPM) levels could be maintained.
- Capacity / Volume of the muck disposal sites shall be more than the volume of muck generated.
- Periodical sprinkling shall be done in site regularly in order to control the SPM levels in the site. Excavated/chipping areas were barricaded with green net to prevent dust emission into the roads.
- Bentonite (if used) spillages/muck spillages were controlled by a separate housekeeping team. A bund shall be constructed
- The top surface of the muck shall be levelled and compacted in order to control soil erosion.
- All measures shall be adopted to ensure that the dumping of muck does not cause any injury or inconvenience to the public/property.
- Noise monitoring in sites shall be carried on two shifts and the records will be maintained in site for inspections.
- Noise monitoring shall be carried in the muck transport routes fortnightly and records shall be maintained in the site.
- In case of high levels of noise are monitored, noise mitigation measures shall be taken as per Site Environmental plan.

MUCK DISPOSAL PLAN

Thane – Borivali Twin Road Tunnel

5.5 Permits, legal and contractual requirements:

- All required permits and statutory permissions will be arranged by Contractor and produce from time to time to Engineer.

5.6 Control of Spillages:

- Muck to be transported should not be wet, so that there is no risk of muck spilling on the roads. During monsoon season this should be of even higher importance.
- Housekeeping is one of the first laws of environment and will be of primary concern to all line Managers, Engineers, Supervisors and all workers.
- Each section of work site including muck disposal site will maintain the site reasonably clean, keep free from obstruction and proper storage of construction muck in planned way.
- Proper Housekeeping team shall be present in the site in case of any spillages (bentonite, muck etc.) were cleaned immediately.
- Bunds shall be constructed nearby to the drains in order to prevent mixing of muck in drains or drains will be diverted.
- Muck dumper tyres were cleaned in wheel wash bay to ensure no spillage shall be there on site.
- Muck loaded dumpers shall be closed with tarpaulin in order to control spillages while transporting from site to disposal site.

5.7 Muck Disposal areas: (Selection criteria & strategy of disposal)

Criteria for Selection Location for Muck Disposal:

- Relevant sub-surface geology and geotechnical characteristics.
- Structure of the base and sub-base including ability to protect groundwater and susceptibility to dissolution from rainwater or materials held in the stockpile. .Topography of the land and climatic conditions.
- The site is free from any landslides or creep and care has been taken that the sites do not have a possibility of toe erosion and slope instability.
- No muck disposal shall be located near any surface water body.
- The location of stockpile shall not obstruct any natural drainage system.
- All stockpiles are located at a minimum distance of 200 m from nearest habitation.
- The dumping sites have been selected as close as possible to the project area to avoid long distance transport of muck.
- There is no active channel or stream flowing through the dumping sites.

MUCK DISPOSAL PLAN

Thane – Borivali Twin Road Tunnel

Contractor Strategy for Muck Disposal

- **Muck Disposal on land available with sub-contractors** – Contractor has identified subcontractors for muck disposal works who have authorized area for muck disposal. The preliminary source of disposal are mentioned below:
 - **Location Near Kashidkopar –**
 - i. with lead of around approx. 39.5-42 kms from Thane Site
 - ii. with lead of around approx. 39.5-42 kms from Borivali Site
 - **Location Near Shirsad –**
 - i. with lead of around approx. 40-42 kms from Thane Site
 - ii. with lead of around approx. 36-38 kms from Borivali Site
- The above arrangement are in discussion with sub-contractors, on finalization, the route maps and land survey will be shared with Engineer.



MUCK DISPOSAL PLAN

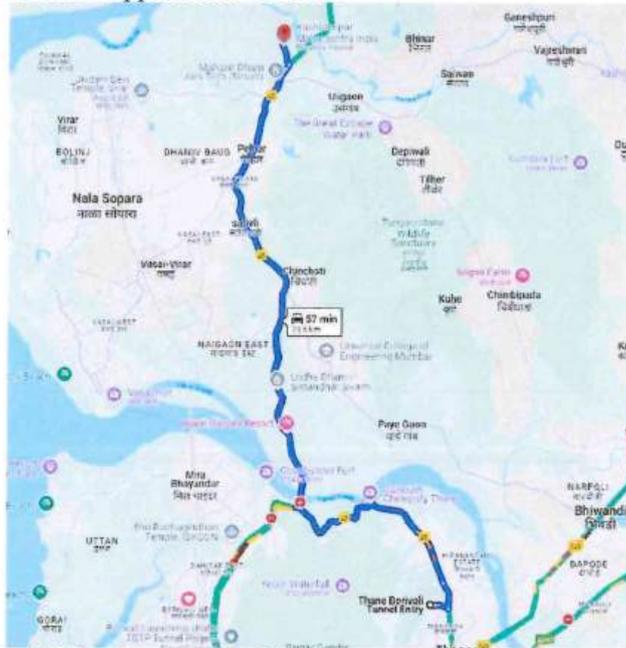


Thane – Borivali Twin Road Tunnel

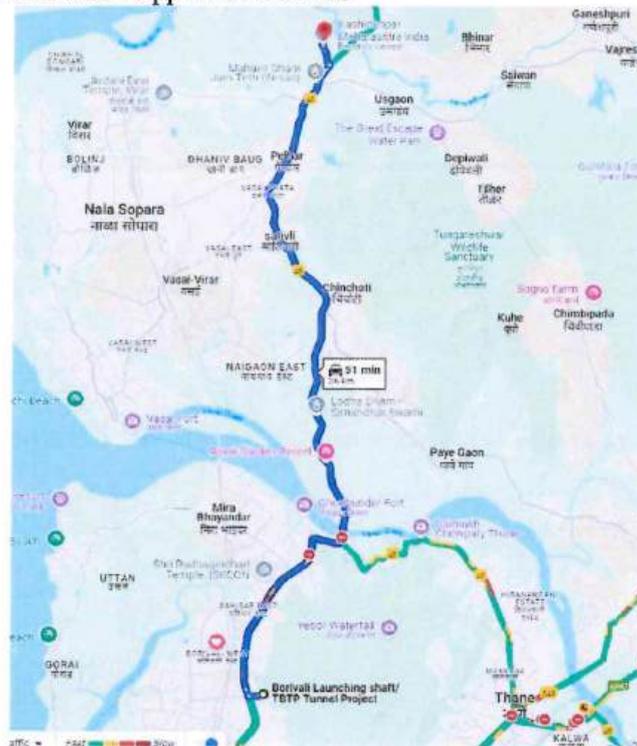
Annexure -1 Muck Disposal area (Google Image) for all three locations

1. Location 1: Kashidkopar

A. Distance from Thane Site= Approx 39.5-42 Kms



B. Distance from Borivali Site= Approx 36-38 Kms





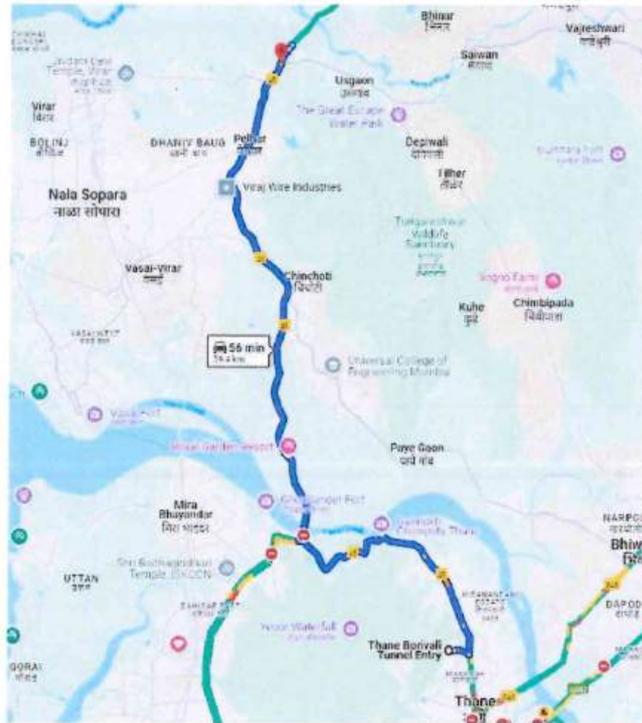
MUCK DISPOSAL PLAN



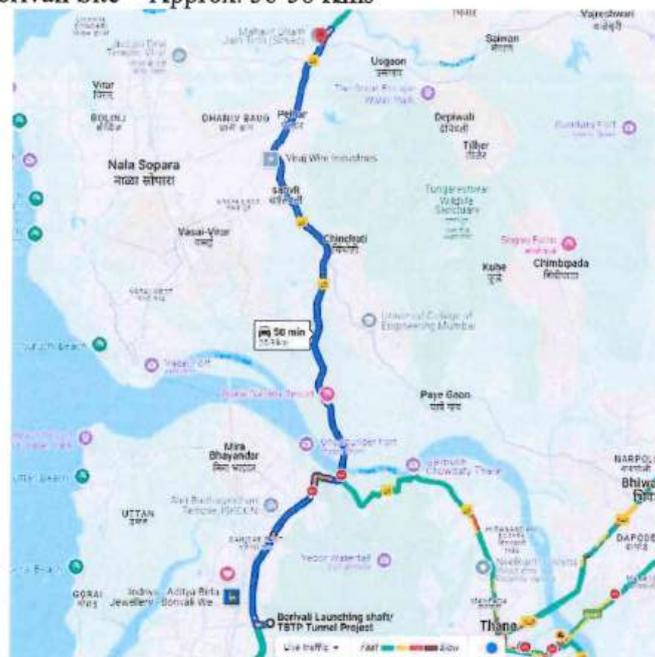
Thane – Borivali Twin Road Tunnel

2. Location-2: Shirsad

A. Distance from Thane Site : Approx. 40 to 42 Kms



B. Distance from Borivali Site = Approx. 36-38 Kms



Land Survey Numbers for Muck Disposal	
Village : Kashidkopar	
Taluka - Vasai, Dist - Palghar	
(Near Mumbai Ahemdabad National Highway)	
Sr. No.	Survey No.
1	39/1/3
2	45/1
3	45/3
4	46/1/B
5	46/3
6	47
7	50/4
8	162/1
9	162/4
10	162/6
11	162/7
12	162/18
13	162/19
14	162/22
15	70/3/1
16	70/2
17	72/3
18	72/4
19	72/7
20	73/1/B

Note: This Land is Private Land and does not fall under Non Eco Zone CRZ, ESA, WetLand and Non Adivasi land.

LAND PROPOSAL FOR MUCK DISPOSAL

Kashidkopar Village Land For Pkg 01 Borivali - Thane Twin Tunnel Project								
Tal: Vasai , Dist: Palghar								
				10000	10.764	4046.85		
Sr. No.	Survey No.	Area as per 7/12 in Hectares	Area for calculation Purpose	Area in Sq. Mtrs.	Area in Sq. fts.	Area In acres	Remarks	
1	9/6	0.14.20	0.1420	1,420	15284.88	0.35	Owner Catagory 1 Kashidkopar	
2	10/3	0.59.70	0.5970	5,970	64261.08	1.48	Owner Catagory 1 Kashidkopar	
3	39/1/3	0.50.20	0.5020	5,020	54035.28	1.24	Owner Catagory 1 Kashidkopar	
4	42/3/4/B/5/A	0.40.50	0.4050	4,050	43594.20	1.00	Owner Catagory 1 Shirsad	
5	45/1	0.44.00	0.4400	4,400	47361.60	1.09	Owner Catagory 1 Kashidkopar	
6	45/3	0.74.40	0.7440	7,440	80085.24	1.84	Owner Catagory 1 Kashidkopar	
7	46/1/B	0.05.60	0.0560	560	6027.84	0.14	Owner Catagory 1 Kashidkopar	
8	46/3	0.61.90	0.6190	6,190	66629.16	1.53	Owner Catagory 1 Kashidkopar	
9	47	0.56.40	0.5640	5,640	60708.96	1.39	Owner Catagory 1 Kashidkopar	
10	50/4	0.43.00	0.4300	4,300	46285.20	1.06	Owner Catagory 1 Kashidkopar	
11	51/3/2	0.43.90	0.4390	4,390	47253.96	1.08	Owner Catagory 1 Kashidkopar	
12	66/2	0.09.10	0.0910	910	9795.24	0.22	Owner Catagory 1 Kashidkopar	
13	70/2	0.21.70	0.2170	2,170	23357.88	0.54	Owner Catagory 1 Kashidkopar	
14	70/3/1	0.44.90	0.4490	4,490	48330.36	1.11	Owner Catagory 1 Kashidkopar	
15	72/3	0.15.90	0.1590	1,590	17114.76	0.39	Owner Catagory 1 Kashidkopar	
16	72/4	0.21.20	0.2120	2,120	22819.68	0.52	Owner Catagory 1 Kashidkopar	
17	72/7	0.22.80	0.2280	2,280	24541.92	0.56	Owner Catagory 1 Kashidkopar	
18	73/1/B	0.13.10	0.1310	1,310	14100.84	0.32	Owner Catagory 1 Kashidkopar	
19	97/B	0.67.80	0.6780	6,780	72979.92	1.68	Owner Catagory 1 Shirsad	
20	162/1	0.37.40	0.3740	3,740	40257.36	0.92	Owner Catagory 1 Kashidkopar	
21	162/4	0.09.10	0.0910	910	9795.24	0.22	Owner Catagory 1 Kashidkopar	
22	162/6	0.16.20	0.1620	1,620	17437.68	0.40	Owner Catagory 1 Kashidkopar	
23	162/7	0.17.20	0.1720	1,720	18514.08	0.43	Owner Catagory 1 Kashidkopar	
24	162/18	0.19.20	0.1920	1,920	20666.88	0.47	Owner Catagory 1 Kashidkopar	
25	162/19	0.12.10	0.1210	1,210	13024.44	0.30	Owner Catagory 1 Kashidkopar	
26	162/22	0.39.60	0.3960	3,960	42625.44	0.98	Owner Catagory 1 Kashidkopar	
		Total	8.6110	86,110	926889.12	21.28		

Note

1. This land is Private Ownership land and is free from Forest, ECO Zone, Wetland and CRZ restrictions.
2. The Distance from Borivali Magathane to KashidKopar is 37 KM.
3. The Land is Near Mumbai Ahemdabad National Highway.



Annexure A-18



456

Annexure – 7
(Condition No. – 10)

Undertaking for Muck Disposal

MMRDA hereby submits an undertaking that Proper muck disposal plan shall be implemented and in any way muck disposal shall not be done in the forest area.

Date: 04/05/2024

Place: Mumbai

(M.P. Singh)
Executive Engineer
MMRDA, Bandra
Mumbai

मुंबई महानगर प्रदेश विकास प्राधिकरण

वांद्रे-कुर्ला संकुल, वांद्रे (पूर्व), मुंबई ४०००५९.

ईपीएबीएक्स +९१ २२ २६५९ ०००९/ ४०००

<https://mmrda.maharashtra.gov.in>

ANNEXURE A-19

Annexure – 8
(Condition No. – 11)

Undertaking for Work Timings

MMRDA hereby submits an undertaking that Work shall be carried out only as per the timings that may be prescribed by the CWLW.

Date: 04/08/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-20

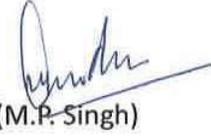
Annexure – 9
(Condition No. – 12)

Undertaking for Labour camps/office

MMRDA hereby submits an undertaking that No Labour camps/ office etc shall be built in the forest area.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

- Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-21

Annexure – 10
(Condition No. – 13)

Undertaking for Disposal of Waste/ Garbage

MMRDA hereby submits an undertaking that the UA shall ensure proper drainage system to flush out wastage throughout the tunnel and any way such waste / garbage shall not be disposed inside the tunnel area.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-22

Annexure – 11
(Condition No. – 14)

Undertaking for Restoration/Compensation

MMRDA hereby submits an undertaking that the UA at the project cost shall restore the area and compensate for the damage for the flora & fauna of the SGNP in case of any adverse impact (s) occurs during construction & operation phase throughout the project life due to construction of proposed tunnel.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

Undertaking for tree felling

MMRDA hereby submits an undertaking that tree felling shall be carried out wherever necessary under the strict supervision of the Forest Department.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-24

Annexure – 13
(Condition No. – 16)

Undertaking for Mitigation Measures

MMRDA hereby submits an undertaking that all mitigation measures as suggested in the reports submitted by the State Government shall be implemented by the agency at the project cost.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

TRANSMITTAL SHEET									
									
To: Hill International – Tata Consulting Engineers JV 708/709 7th floor, R square, Mulund (west), Mumbai-400080 Maharashtra, India									
Attention :- Mr. Tanachard Rinsarnkitjaroen – Project Director									
Project: Thane - Borivali Road Tunnel Project(3280)					Transmittal Number TBRTPI-MEIL-GC-TRN-2025-000090			Sheet No: 1 of 1	
Componet: Tunnel/Cut & Cover/Ramp/Viaduct/Road					Day	17			
					Month	3			
					Year	25			
Subject:-Submission of Disaster Management Plan (R1)									
S-No	Document - Drawing No-	Description	Revision						
REPORT									
1	MEIL/MMRDA/PKG-1(3280)/OHSE/DMP/003	Disaster Management Plan	R0	R1					
Medium of Drawing			Size	Number of Copies					
<input checked="" type="checkbox"/>	Printed Paper	<input type="checkbox"/>	Tracing	A1					
				A3					
<input type="checkbox"/>	Elect- Copy	<input type="checkbox"/>	Photo Copy	A4	√				
<i>Purpose of Issuance</i>									
FI-For Information FA - For Approval FR - For Record									
FT - For Tender FC - For Construction p - Preliminary					FA				
FR - For Review AB - As Built R - Replacement									
Remarks:- As per Contract Specifications Volume 3 Employer's Requirement.									
Issued Dt:- 17-03-2025					Received Dt:-				
  Mr. Vishnuvardhan Reddy Authorised Signatory									
Cc: MMRDA - Engineer in Chief									
Gc-1 hard Copy + 1 soft Copy									
Encl:- 1 hard Copy + 1 Soft Copy									



Mumbai Metropolitan Region Development Authority
COMMENT RESOLUTION SHEET(CRS) - COMMENT SHEET

CRS No: GC-TBT-TBPO1-CRS-051, Rev A
 Project Name: Design & Construction of 5.75 km (Ch. 0+00 to Ch.5+750 - Borivali side) long twin tube road tunnel, approaches and other civil works between Thane and Borivali in the state of Maharashtra Package-1
 Contract/LOA No: MMRDA/TWINTUNNEL/PKG-01/LOA/483/2023
 Reference of Letter/Transmittal: TBTP1-MEIL-GC-TRN-2024-000011
 Reception date of Letter/Transmittal: 21-08-2024
 Discipline: Environment
 Assessor: Sathik Baicha / Karishma Chitnis
 Dy.Project Director: Srinivas Rao Jalam
 Project Director: Authorized Signatory

DEFINITIONS

• **Area of Deficiency (1)**

- 1: Design not complying with functions; 2: Detail incomplete;
- 3 : Detail not submitted; 4: Undesirable design feature;
- 5: Conflicting data; 6: Other (Specify)

• **Status of Comments (2)**

- A. Notice of No Objection ; B. Proceed subject to amendments as noted
- C. Resubmit subject to amendments as noted; D. Rejected; E. For information only

• **Comment Status (3)**

P = Pending H = On Hold C = Closed

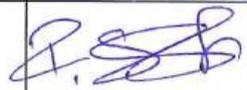
Assessment Code (2)	D	Rejected
Subject :	Submission of Disaster Management Plan	

No	C/S Document References		Engineer's Comments	Issue		Area of Deficiency (1)	Status (2)	Contractor/Suppliers Answers	Comment Status (3)		Closure Date
	Ref./Code	Rev.		Page No.	Format				Fundamental	Contractor	
1		R0	3		✓	3	D	Project Details Revised	Completed		
2	MEILMMRDA/P	R0	5		✓	2	D	Incorporated	Completed		
3	01/CHSE/DMP/	R0	13		✓	2	D	Revised	Completed		
4	003	R0	7		✓	2	D	Added	Completed		
5		R0	7		✓	3	D	Added	Completed		

DISASTER MANAGEMENT PLAN

Design & Construction of 11.842 kms (Ch. 0+000 to Ch.11+842 -) long twin tube road tunnel, approaches and other civil works between Thane and Borivali in the state of Maharashtra. The Permanent and Temporary works shall comprise the Design and Construction of all Works and services necessary to complete the package 1 & 2 of Thane - Borivali road tunnel project as per contract outline design and construction specifications and the Employer requirements from chainage Ch. 5+750 to Ch.11.842, Using 2 Tunnel Boring Machine Package 1&2 Civil - Starts from Thane Side and ends at halfway of the tunnel i.e. from Ch. 5+750 to Ch.11.842.

**Review & Approval:**

	Name	Position	Date	Signature
Prepared by	P Sureshababu	Environment Manager	17.03.2025	
Reviewed by	Mr. Shashidhara Dhamudia	Chief Safety manager	17.03.2025	
Approved by	Mr. Vishnuvardhan Reddy	Project Manager	17.03.2025	

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1. ABBREVIATIONS

ESZ-	Eco Sensitive Zone.
BMC-	Brihanmumbai Municipal Corporation.
UNDP-	United Nations Development Programme.
GOI-	Government of India.
PWD-	Public Work Department.

1.1 PROJECT DETAILS:

Design & Construction of 11.842 kms (Ch. 0+000 to Ch.11+842 -) long twin tube road tunnel, approaches and other civil works between Thane and Borivali in the state of Maharashtra. The Permanent and Temporary works shall comprise the Design and Construction of all Works and services necessary to complete the package 1& 2 of Thane - Borivali road tunnel project as per contract outline design and construction specifications and the Employer requirements from chainage Ch. 5+750 to Ch.11.842, Using 2 Tunnel Boring Machine Package 1&2 Civil - Starts from Thane Side and ends at halfway of the tunnel i.e. from Ch. 5+750 to Ch.11.842.

Table 1: Project Details

1	Package	Contract No: MMRDA/20/IV-051/2021 dated 13-01-2022
2	Employer	MMRDA
3	Contractor	MEIL Infrastructure Limited
4	Date of LOA	13.01.2022
5	Date of Commencement	13 July 2025
6	Stipulated Completion of Work	23 July 2025
7	Total Months	42

1. LIST OF CIVIL WORKS TO BE CARRIED OUT

S. No.	Activity	S. No.	Activity
1.	Batching Plant Erection	8.	NATM
2.	Casting Yard Erection	9.	Cross Passage
3.	Segment Casting	10.	Excavation Activity
4.	CB/Secant Pile	11.	Equipment lowering
5.	D-wall, Guide wall	12.	Block work
6.	RCC wall	13.	OTE Ducts
7.	Base slab, Concourse slab, Roof slab etc.	14.	Utility Shifting

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2. DISASTER MANAGEMENT PLAN:

2.1 Introduction:

Natural disasters can neither be predicted nor prevented. The problem before us is how to cope with them, minimizing their impact. Tamil Nadu has witnessed havoc caused by cyclones and storm surge in the coastal regions, earthquakes, monsoon floods, landslides, and recently the Tsunami. Increase in urban population coupled with the construction of man-made structures often poorly built and maintained subject cities to greater levels of risk to life and property in the event of earthquakes and other natural hazards. One of the main objectives is to reduce the risk of loss of human life and property and to reduce costs to the society. We have to recognize that in such cases of natural disasters, we deal with phenomena of enormous magnitude that cannot be controlled by any direct means of human intervention. But what we try to do is to reduce the impact on human beings and property.

In general, disaster management is a continuous process that aims to manage and minimize hazards. Under disaster response, there are a variety of actions to take like evacuation quarantine, mass decontamination, and the like. Disaster management has its own advantages. Some of these are:

- Reduces the effects of a disaster's aftermath.
- Gives the chance to survive, no matter what kind of a disaster occurs and irrespective of when it occurs.
- Gives you peace of mind from the uncertainties of close encounters to unexpected and dangerous natural events.

The Plan has two components as depicted in the figure 1.1:

- Hazard identification/Safety covers the following
 - Structural Assessment – comprises the set of physical laws and mathematics required to study and predicts the behavior of structures
 - Non-Structural Assessment – deals with the seismic vulnerability assessment of the building
 - Resource Inventory – refers to the resources available within and around the ward to tackle any hazard or to inventories the resources available within the ward or around the ward.
- Response Plan covers the following:
 - Formation of Disaster Management Committee
 - Preparation of Building Emergency Plan, along with Training Procedure to occupants
 - Mitigation of hazards identified along with Evacuation Plan

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- Special Provisions for Handicapped

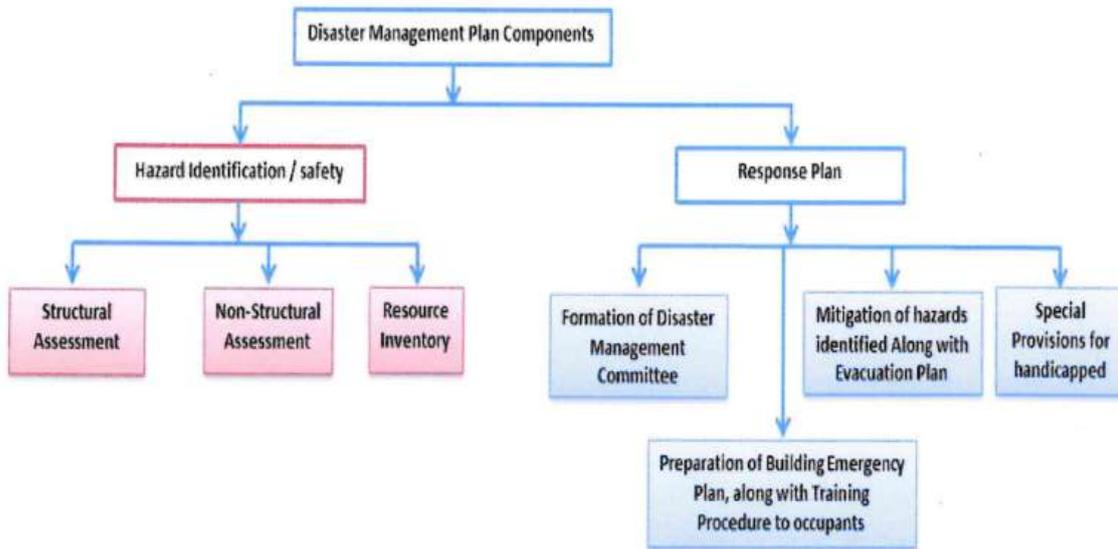


Fig. 1.1: Disaster Management Plan Components

2.2. Formation of the Disaster Management Committee & Groups:

The Disaster Management Committee will be formed by the Contractor/Site members. The Project In-charge/Safety In-charge will be competent enough to handle various disasters, and will be In-charge to look after the complete process of DMC (Disaster Management Committee). DMC will be divided into three groups namely: Co-ordination group, Disaster Awareness group, and Disaster Response group. The Roles and responsibilities of various groups are defined in subsequent paragraphs. The given figure 1.2 demonstrates the structure of types of Disaster Management Plan.

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2.2.1 Types of Hazards Related to Tunnel Project:

Primarily disasters are triggered by natural hazards or human-induced, or result from a combination of both. In particular, human-induced factors can greatly aggravate the adverse impacts of a natural disaster. Even at a larger scale, globally, the UN Inter-Governmental Panel on Climate Change (IPCC) has shown that human-induced climate change has significantly increased both the frequency and intensity of extreme weather events. While heavy rains, cyclones, or earthquakes are all natural, the impacts may, and are usually, worsened by many factors related to human activity. The extensive industrialization and urbanization increases both the probability of human-induced disasters, and the extent of potential damage to life and property from both natural and human-induced disasters. The human society is also vulnerable to Chemical, Biological, Radiological, and Nuclear (CBRN) disasters.

2.2.1.1 Natural Hazards

The widely accepted classification system used by the Disaster Information Management System of Des Inventar classifies disasters arising from natural hazards into five major categories (DesInventar2016):

- 1) **Geophysical:** Geological process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Hydro-meteorological factors are important contributors to some of these processes. Tsunamis are difficult to categorize; although they are triggered by undersea earthquakes, and other geological events, they are essentially an oceanic process that is manifested as a coastal water-related hazard.
- 2) **Hydrological:** Events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up
- 3) **Meteorological:** Events caused by short-lived/small to meso-scale atmospheric processes (in the spectrum from minutes to days)
- 4) **Climatological:** Events caused by long-lived meso- to macro-scale processes (in the spectrum from intra-seasonal to multi-decadal climate variability)
- 5) **Biological:** Process or phenomenon of organic origin or conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

A brief description of these five major categories of the disasters arising from natural factors with the sub-categories is given in Table 1-3. The below classification is not a water tight one. In real life situations, many disasters are a combination of different types of disasters. In addition, secondary disasters may occur after a disaster has occurred.

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	Family	Main Event	Short Description/ Secondary Disaster
1	Geophysical	Earthquake/Mass movement of earth materials	<ul style="list-style-type: none"> • Landslide following earthquake; • Urban fires triggered by earthquakes; • Liquefaction - the transformation of (partially) water-saturated soil from a solid state to a liquid state caused by an earthquake • Mass movement of earth materials, usually down slopes • Surface displacement of earthen materials due to ground shaking triggered by earthquakes
2	Hydrological	<ul style="list-style-type: none"> • Flood • Landslides • Wave Action 	<ul style="list-style-type: none"> • Flood Hydrological - A general term for the overflow of water from a stream channel onto normally dry land in the floodplain (riverine flooding), higher-than normal levels along the coast and in lakes or reservoirs (coastal flooding) as well as ponding of water at or near the point where the rain fell (flash floods)
3	Meteorological	Hazard caused by short-lived, micro- to meso- scale extreme weather and atmospheric conditions that may last for minutes to days	<ul style="list-style-type: none"> • Cyclone, Storm Surge, Tornado, Convective Storm, Extratropical Storm, Wind Lightning, Heavy Rain
4	Climatological	Unusual, extreme weather conditions related to long-lived, meso- to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal (long-term) climate variability	<ul style="list-style-type: none"> • Extreme hot/cold conditions • Subsidence
5	Biological	Exposure to germs and toxic substances	<ul style="list-style-type: none"> • Epidemics: viral, bacterial, parasitic, fungal, or prion infections • Insect infestations

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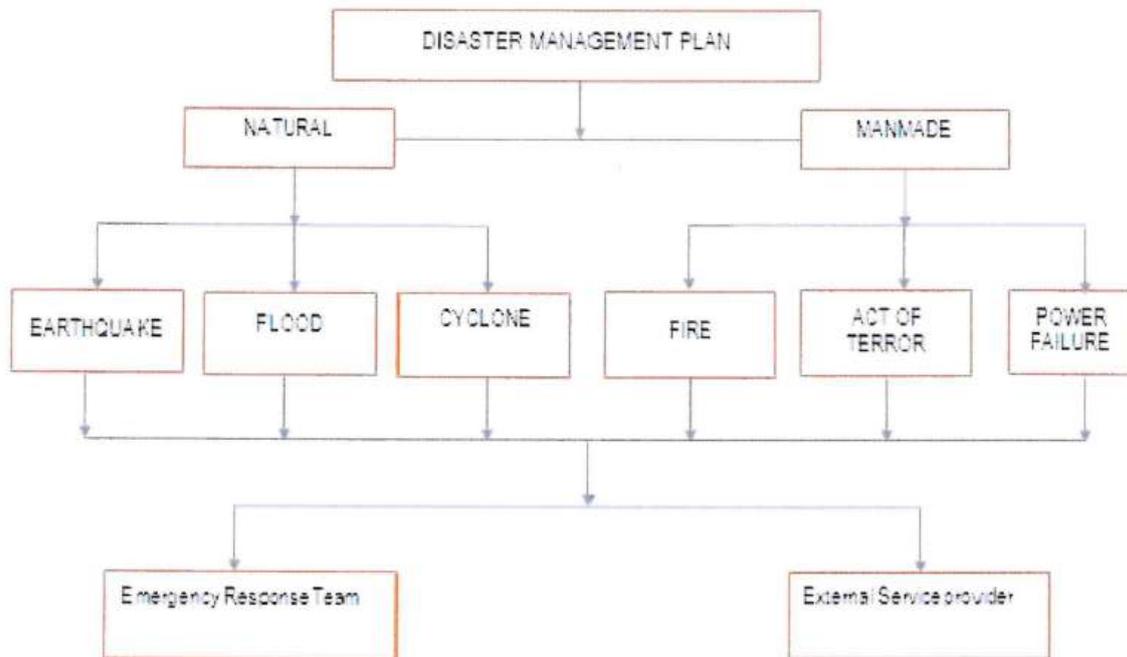


Fig. 1.2: Types of Disaster Management Plan

2.3. Current Scenario:

Details of hazard-prone areas in Mumbai Metropolitan Area are given below:

(i) Earth Quake-Prone Areas:

Mumbai Metropolitan Area falls under Seismic Zone – III. The whole of Mumbai Metropolitan Area falls in this zone.

(ii) Cyclone-Prone Areas:

In Mumbai Metropolitan Area, it extends to a distance of 20 km. from the coast. In these areas, the risk is due to (a) cyclonic wind velocities combined with heavy storm, (b) flooding by seawater due to high waves and flouting due to heavy storm.

(iii) Flood-Prone areas:

From the flood hazard map of India (mapped by meteorological department, New Delhi), it is seen that no area in Mumbai falls in the risk zone. But within a local body area, particularly With reference

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to an area's proximity to a major drainage system like rivers, canals, and also water bodies like lakes, and further with reference to contour levels/low-lying areas, flood prone area mapping has to be done. In Mumbai Metropolitan Area, there are a few areas along the rivers and canals and low-lying areas, which are susceptible to flooding/inundation during heavy storms. Map showing the floodable areas [macro level] identified in the Mumbai Metro Flood Relief / Storm Water Drainage Master plan is annexed. Existence of macro and micro drainage networks in Mumbai Metropolitan Area facilitates draining of these areas within a reasonable time. Developments in such low lying areas are allowed only when a proposed development conforms to standards and after getting clearance from PWD on the measures to be taken to make it free from inundation.

Disaster Management Policy: Mumbai has been having a Disaster Management policy since 2004-05. The thrust of this policy is more on pre-disaster activities of preparedness, prevention and mitigation than on post-disaster measures of relief, rehabilitation and reconstruction.

The key components of this policy are the following:

- (i) Convergence of disaster management and development planning.
- (ii) Formulation of disaster management plans at all levels taking into account the local conditions.
- (iii) Focusing on the reduction of vulnerability of communities instead of mere disaster relief.
- (iv) Fostering a culture of prevention among the community and various organs of Government through training and awareness campaigns.
- (v) Involving the community at all stages in disaster management activities and creating a trained and committed volunteer force on the line of home guards for disaster management.

2.4. Strategies:

Development Control Rules for BMC provide for regulating the

Constructions with reference to zone, location, height, number of floors, size of Height Structure, setback spaces to be left around, and the use of the building and land.

Building rules under the Local Bodies Acts provide for regulation of location of Height Structure, foundations, plinths, superstructures-walls, floors, and rooms, licensing of surveyors and inspection of municipal engineers at various stages of constructions, regulations on dead and superimposed loads, wind load/pressure, reinforced cement Concrete and framed structures, construction materials, etc. Structural safety and soundness are regulated under the building rules under the Local Body Acts. Hence early action should be taken to include Special Rules for Hazard Prone Areas in the Building Rules of the Local Bodies and effectively enforce the same.

Most of the components of the GOI-UNDP Urban Earthquake Vulnerability Reduction Programme is also applicable to other natural disasters viz. cyclones, landslides, floods and Tsunami. Hence the awareness generation, development of techno-legal regime, earthquake preparedness and response

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plans, training and capacity building should be done covering these natural hazards also and the State Nodal Agency may take appropriate action on these.

Even after the GOI-UNDP programme period, the State Nodal Agency should continue these measures. Pre-disaster preparedness and pre-disaster management plans should be periodically reviewed and up dated.

A. Action Plans:

- (i) Early action to amend the building bye-laws of local bodies should be taken to include special provisions for hazard prone areas and enforce the same since the whole of Mumbai Metropolitan Area falls in Seismic Zone-III now and it also includes cyclone-prone areas to a major extent.
- (ii) The elected representatives of local bodies and Government functionaries should be trained to promote community based disaster risk management (CBDRM) and to integrate vulnerability and risk reduction components into all development programmes.
- (iii) A volunteer force for every ward / village should be raised and they should be given all encouragement to take up disaster preparedness and mitigation activities.
- (iv) Disaster management teams at wards/panchayats level from out of the volunteer force may be created and they may be trained in specific areas like early warning, immediate rescue, first-aid, food management, shelter management, water supply and sanitation, damage assessment, etc.
- (v) Conducting regular skill up-gradation, strengthening of local coping mechanism and conducting mock drills should be important components of preparedness strategy.

2.4.1. Power Failures during the Construction Activity:

Failure of electrical power to building will have a serious impact on its operations, particularly if the failure occurs during normal operating hours when the building is fully occupied. A power failure may be a brownout (a partial reduction in service) or a total blackout.

Power failure can be caused either by man-made or natural events. Man- made causes may include drivers who collide with utility poles or power transformers, human error in operating equipment within the building or outside it (such as at the utility company supplying the power), or malicious tampering. Natural events include storms, floods, and earthquakes.

Power failures also can cause computer memory loss and equipment damage. If the power loss is anticipated, computers and computer systems can be shut down before it occurs. If no prior notice is received, the equipment should still be turned off as quickly as possible to avoid potential serious damage to the electrical system from the sudden surge of power when it is first restored. Computer systems, particularly mainframes, often are equipped with an uninterruptible power supply (UPS) and DG; and personal computers often are equipped with surge protectors to reduce the chance of damage when power fluctuates, surges, or is lost.

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Height Structure have emergency and standby power systems to provide safety and comfort to building occupants during interruptions in their normal power supply. These systems also provide power to operate building communication systems and to provide a minimum number of elevator functions. Both functions are critical to Height Structure during power failures.

➤ **Technologies to be installed: Power failure backup**

Emergency power systems are a type of system, which may include lighting, generators, fuel cells and other apparatus, to provide backup power resources in a crisis or when regular systems fail. They find uses in a wide variety of settings from residential homes to hospitals, scientific laboratories, data centers, telecommunication equipment and modern naval ships. Emergency power systems can rely on generators, deep cycle batteries, and flywheel energy storage or hydrogen fuel cells.

A diesel generator is the combination of a diesel engine with an electrical generator (often called an alternator) to generate electric energy. Diesel generating sets are used in places without connection to the power grid or as emergency power-supply if the grid fails. The packaged combination of a diesel engine, a generator and various ancillary devices (such as base, canopy, sound attenuation, control systems, circuit breakers, jacket water heaters and starting system) is referred to as a generating set or a genset for short.



Fig. 1.3: Diesel Generator

➤ **Diesel Generators**

Diesel generate of capacity will be available at site. Will be provided at site. The diesel generator will backup common area lighting, lobbies, staircase & lifts etc.

➤ **Emergency Power Backup:**

- Emergency backup for the (Common loads) Essential load will be provided.
- The generating capacity to be installed will provide Essential power requirements of all systems/services. Auto Mains Failure (AMF) scheme is proposed for DG Sets.

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Notes:

- Ratings of D.G. sets will be reviewed after finalization of all designs and before inviting tenders.
- It is proposed to install emergency backup only for Essential loads using Diesel Generating Sets for supply of power when mains power is not available. Running of D.G sets in parallel with supply or parallel operation of D.G. sets / USS is not proposed.

➤ **Uninterruptible power supply (UPS)**

An uninterruptible power supply, also uninterruptible power source, UPS or battery/flywheel backup is an electrical apparatus that provides emergency power to a load when the input power source, typically the utility mains, fails. A UPS differs from an auxiliary or emergency power system or standby generator in that it will provide instantaneous or near-instantaneous protection from input. This will be used to backup important server and computer system.

2.4.2. Aircraft Collisions at Tunnel Construction Area Premises:

A Site Building & High portal, viaduct Area is vulnerable to the remote possibility that an aircraft flying off-course could collide with it. Obviously, the additional height, as compared with other structures, makes them more susceptible.

➤ **Observations & Findings**

Several Site building & high portal, viaduct design features have been identified as key to the Height Structure ' ability to remain standing as long as they did and to allow the evacuation of most building occupants. These included the following: Similarly, several design features have been identified that may have played a role in allowing the Height Structure to collapse in the manner that they did and in the inability of victims at and above the impact floors to safely exit. These features should not be regarded either as design deficiencies or as features that should be prohibited in future building codes. Rather, these are features that should be subjected to more detailed evaluation, in order to understand their contribution to the performance of these Height Structure and how they may perform in other Height Structure. These include the following:

- The type of steel floor truss system present in these Height Structure and their structural robustness and redundancy when compared with other structural systems
- Use of impact-resistant enclosures around egress paths
- Grouping emergency egress stairways in the site & High portal, viaduct core, as opposed to dispersing them throughout the structure.
- Structural framing systems need redundancy and/or robustness, so that alternative paths or additional capacity are available for transmitting loads when building damage occurs.
- Fireproofing needs to adhere under impact and fire conditions that deform steel members, so that the coatings remain on the steel and provide the intended protection.
- One oft-mentioned issue is whether a separate, more rigorous set of codes and standards should apply to extremely tall Height Structure.

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- Connection performance under impact loads and during fire loads needs to be analytically understood and quantified for improved design capabilities and performance as critical components in structural frames.
- Fire protection ratings that include the use of sprinklers in Height Structure require a reliable and redundant water supply. If the water supply is interrupted, the assumed fire protection is greatly reduced.
- Egress systems currently in use should be evaluated for redundancy and robustness in providing egress when building damage occurs, including the issues of transfer floors, stair spacing and locations, and stairwell enclosure impact resistance.
- Fire protection ratings and safety factors for structural transfer systems should be evaluated for their adequacy relative to the role of transfer systems in building stability.

Mitigation Plan

> Aircraft Warning Lights

Aircraft warning lights are high-intensity lighting devices that are attached to tall structures that are used as collision avoidance measures. Such devices make structures more visible to passing aircraft

2.4.5. Earthquake at Site Location:

Seismic Environment & Precautions

As per the Seismic Zoning Map of India, Mumbai region falls under Seismic Zone-III. The structural design shall be certified as per IS code 875 and IS- 1893-2002 for Seismic Zone – III of Mumbai.

Earthquake Mitigation Strategies

> Roles & Responsibility:

Project In-charge/Security Officer/Safety/Site team Responsibilities

Site Project In-charge/Security Officer/Safety/Site Team and alternate Facility In-charge responsibilities includes:

- Contacting emergencies rescue centers and explain the emergencies to them.
- Determining and co-coordinating emergency response actions for a particular floor or portion of a floor;
- Ensuring that all occupants, including those with disabilities, are completely out of unsafe areas;
- Keeping evacuated or relocated persons at the safe refuge area until Height Structure and Carne management or the fire department authorizes them to return to their workstations.

> Earthquake Preparedness

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Earthquake preparedness can be approached in three distinct phases—before, during, and after the earthquake, for the occupants and the Site in-charge.

➤ **Before the Earthquake**

Modern Site areas subject to earthquake activity are to be constructed in accordance with strict Building codes. Older Height Structure and Carne s erected before seismic design considerations were mandated may be required to perform structural retrofits to bring the structures up to code.

➤ **During the Earthquake**

An earthquake usually occurs without any warning other than possibly a roaring sound like a fast-approaching locomotive or airplane. Thus occupants and Height Structure and Carne staff alike have only a few moments to act. During an earthquake, most actions of those inside a high-rise Height Structure are geared toward self- preservation, particularly on upper floors where the swaying may be the most extreme. The following are basic guidelines for these moments:

- Do not panic (easier said than done).
- If on an upper floor, do not attempt to rush for stairwells. If on the ground or street level, do not run outside. Occupants running out of Height Structure and Carne s may be hit by falling glass and other materials or by vehicles. If outside the Height Structure and Carne, do not attempt to re-enter the Height Structure and Carne but move, if possible, to an open area that is a safe distance away from the Height Structure and Carne, utility poles, fallen electrical power lines, street light fixtures, trees, and objects that may be a hazard.
- If inside an elevator, remember that in earthquake-susceptible areas most Height Structure and Carne, elevators are equipped with the seismic devices described in the previous section on "Elevator Malfunctions and Entrapments," which will take you to the nearest floor in the direction you were traveling, stop, and automatically open the doors. If the elevator stalls, do not attempt to force open the doors. Summon assistance by pushing the emergency call, emergency alarm, or emergency only button on the elevator car's floor selection panel. Then carry out the instructions of responding staff. Remember that power failures are commonly associated with severe earthquakes, and there may be some delay in freeing all passengers trapped in Height Structure and Carne elevators.
- If inside an Height Structure and Carne area, move away from exterior glass windows, interior temporary or glass partitions, hanging objects, freestanding bookcases or cabinets, and other objects that may fall. Get under a strong table or desk and hold onto it—it may move during a severe shaker.
- If in Height Structure and Carne corridors or lobbies, move to an interior wall away from light fixtures, tuck your head to your knees, and cover your head with your arms to protect against falling objects such as ceiling tiles. Do not attempt to use elevators.
- If inside a restroom, remain there and cover your head with your arms to protect yourself from falling objects.
- If in the parking area and it is safe to remain, tuck your head to your knees, and cover your head with your arms. In a severe earthquake, there may be out- of-control vehicles.
- Stay in your protective position, unless it becomes unsafe to do so, until the shaking has ceased and it appears safe to move.

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- Do not smoke or use a lighter or matches; if the Height Structure and Carne has gas lines, there may be leaks.

During this time, listen for announcements and instructions over the PA communication system if it is still operational. Follow the directions of Site staff members, Facility In-charge, and responding public agencies. You could also listen to portable radios for public safety messages. Do not pass on anything to others that could be misinformation. Remain on your floor and do not use elevators until you are authorized to do so. Above all, be prepared for aftershocks. Depending on the severity of the event, Site management will notify occupants if it is safe to return to work, if evacuation of the Height Structure and Camp or relocation within the Safe is required, or if occupants are to remain on their Camp & floor and await further instructions.

Soil liquefaction, landslides, and fires are common results of major earth quakes. Liquefaction occurs in areas where loose soils with a high water table are present. If the earthquake is a major one, public firefighting capabilities will be severely strained because of extraordinary demands for service, difficulties in transporting equipment along damaged or blocked roadways and freeways, and possible disruption of the public water supply.

An earthquake may cause such serious damage to a Site & Camp, Heavy equipment that for a time tenants cannot enter it at all, or can enter only under certain conditions. The Site Team should be secured and a recorded message informing tenants of the situation placed on Site management's voice-mail system or on a special toll- free number. Tenants should be aware that such communications are provided for them to obtain information about Site operations, particularly during emergency situations.

Mitigation Plan

Design and choice of Site materials have a major impact on a Site earthquake safety. Less rigidity in Height Structure and Carne s and a combination of flexing and tensile strength allows for more resistance to earthquakes. Lightness of the Site material reduces likelihood of injuries or of people becoming trapped if the Site building and structures does collapse.

2.5 Tunnel Collapse:

A "tunnel collapse" refers to the sudden failure or caving in of a tunnel structure, often due to geological instability, construction issues, or other factors, leading to potential dangers and disruptions.

Types of Tunnel Collapse:

Tunnel collapses can manifest in several ways, broadly categorized as surface collapse, stratum-layer collapse, and tunnel collapse itself, with the potential for simultaneous occurrences.

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Here's a more detailed breakdown:

Surface Collapse:

This involves the collapse of the ground above the tunnel, often triggered by issues with the overlying soil or inadequate support systems.

Stratum-Layer Collapse:

This refers to the failure of the rock or soil layers surrounding the tunnel, potentially leading to instability and further collapse.

Tunnel Collapse:

This is the direct failure of the tunnel structure itself, which can be caused by various factors including lining issues, hydraulic erosion, or unstable soil conditions.

Other failure modes:

Wedge failure: A section of the tunnel roof or sidewall collapses in a wedge shape.

Chimney type failure:

A vertical column of material collapses, creating a chimney-like opening.

Ravelling ground:

Gradual disintegration of the surrounding rock or soil.

Shear failures:

The tunnel lining or surrounding rock mass fails along a shear plane.

Squeezing ground:

The surrounding ground mass squeezes inward, deforming the tunnel.

Causes of tunnel collapse:

Post-lining cavity:

The formation of voids or pockets behind the tunnel lining.

Lining crack expansion:

Cracks in the tunnel lining that widen and lead to structural failure.

Hydraulic erosion:

Water flowing through the tunnel or surrounding ground, eroding the soil or rock.

Unstable soil:

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The presence of weak or unstable soil or rock formations.

Fire: Fires within the tunnel can weaken the structure and lead to collapse.

Inadequate support:

Insufficient or poorly designed support systems for the tunnel.

Coupling of multiple factors:

The probability of collapse increases when multiple factors combine.

Mitigation measures:

To mitigate tunnel collapses, a multi-pronged approach is crucial, including thorough geological investigations, advanced monitoring systems, pre-excavation support, controlled blasting techniques

Here's a more detailed breakdown of key mitigation measures:

Pre-Construction Planning and Investigation:

Geological and Geotechnical Investigations:

Conduct comprehensive studies to understand the ground conditions, including rock type, stability, and potential hazards like faults and groundwater.

Modeling and Risk Assessment:

Develop models to predict potential instability and assess the risks associated with different excavation methods.

Exploratory Audits and Boreholes:

Drill exploratory audits and boreholes to gain a better understanding of the subsurface conditions.

Seismography:

Use seismography to identify potential geological weaknesses and unstable areas.

2. Excavation and Construction Techniques:

Controlled Blasting:

Implement precise blasting techniques to minimize damage to the surrounding rock mass and prevent instability.

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Multiple Rift or Ring Cutting Methods:

Use multiple rift or ring cutting methods to reduce stress concentration and improve stability.

Scaling of Rock Surfaces:

Regularly scale rock surfaces to remove loose or unstable material.

Advance Long Drilling:

Conduct advance long drilling to investigate any anomalous geology and water sources.

Pre-Excavation Support:

Install pre-excavation support systems like fore-polling and long polling in areas with a high risk of collapse.

Groundwater Control:

Implement effective drainage systems to control groundwater levels and prevent pressure buildup.

Consolidation and Plugging:

Use grouting techniques to consolidate and plug loose and water-bearing strata.

Tunnel Lining and Support Systems:**Lining Systems:**

Install robust lining systems, such as shotcrete, steel ribs, or precast concrete segments, to provide structural support and prevent collapse.

Rock Bolts and Wire Mesh:

Use rock bolts and wire mesh to reinforce the rock mass and prevent rock falls.

Steel Arches:

Install steel arches to provide additional support, especially in areas with high stress.

Shotcrete:

Apply shotcrete to the tunnel walls and roof to create a strong and durable lining.

Monitoring and Maintenance:

Regular Monitoring: Implement regular monitoring systems to track tunnel stability and identify potential problems early on.

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Peripheral Mapping: Prepare peripheral mapping of each advance along the tunnel alignment.

Monitoring of Tunnel Face: Regularly monitor the tunnel face for signs of instability.

Experienced Workforce: Assign experienced and skilled workers to tunnel construction and maintenance tasks.

- **Fire in the Tunnel:**

Fires in tunnel are a serious risk and the probability of such incidence is based on likelihood of a serious accident occurring inside the proposed tunnel and the vehicle involved catching fire. Tunnel alignment have been maintained as straight alignment with maximum grade of 4% allowing high visibility distance. **It is proposed to prohibit all vehicles carrying flammable and dangerous goods on entire Twin Tunnel Project.** This is to eliminate risk of such vehicle entering in to tunnels and getting involved in to an accident. Such type of vehicles may cause fires of up to 100MW having disastrous effect on tunnel structure. Based on present traffic volumes the HGV percentage is likely to be less than 5% of overall traffic volume. Hence a 50MW fire (BD 78/99 table 8.2) is adopted for design of ventilation to bring the impact to an acceptable level.

- **Accidents:**

Probability of occurrence of accident in an uni-directional tunnel is very unlikely. To reduce the probability of same to extremely unlikely event, alignment of the tunnels has been designed as straights with maximum grade of 4%. This will ensure high visibility to stopping vehicle/ debris on road. It is also proposed to restrict the vehicle speeds to 80Kmph for entire coastal road and enforce the same through speed detection cameras.

- **Breakdown and debris on road:**

Risk of occurrence of such event is similar to accidents. Automatic incident detection system shall be implemented to reduce the impact of such event.

Non Vehicle related incidences

- **Vandalism:**

Vandalism: considering that this is an urban tunnel, it is necessary to provide for securitization of likely entry points to the tunnels by pedestrians. Such a vandalism event may have very high impact on tunnel services. Therefore control room shall be provided with automatic incident detection system to report stoppage of vehicles and presence of pedestrian inside tunnel. Control rooms shall be manned 24x7 to register and act on such incidence. However to eliminate risk of this high impact event,

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Terrorist Attack during the Tunnel Operation:

Impact of such event on tunnel operation would be disastrous and would require immediate action by local police who would be informed by the personnel manning the Emergency Control Centers. The method of reducing risk of such event shall be discussed with the Authority.

System will be provided so that the information will be intimated to the Police within a short period of time.

- **Traffic Queues:**

Risk of occurrence of traffic queues is unlikely considering adequate number of lanes has been proposed with adequate distances from tunnel entry/ exit points from proposed interchanges. However, event of traffic queuing is unlikely to impact on tunnel services. Environmental monitoring sensors are proposed to adjust level of tunnel services such as lighting

2.5.1 Flood Mitigation Strategies:

Report on flood mitigation measures already obtained & propose to implement.

- Data Collection and Analysis
- Vulnerability Reduction

b. Preparation for Floods

- Prediction
- Emergency Preparedness (including monitoring, alerts)
- Education, Training and Awareness
- De-watering from the Tunnel.

Post-flood Mitigation Measures:

- Rescue and evacuation
- Relief, Rehabilitation and Reconstruction

Occupant Action

➤ Flood Preparedness

The guide lists simple things one can do to stay safe and protect one from floods.

- Know the route to the nearest safe shelters that your area aware off.
- Keep the First Aid Kit ready with extra medication for snake bite and diarrhea
- Strong ropes for tying things
- A radio, torch and spare batteries

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- Stocks of fresh water, dry food, candles, matchbox, kerosene etc.
- Umbrellas and bamboo sticks (to protect from snakes)
- Higher ground where people and animals can take shelter
- **When you hear a flood warning**
- Tune in to your radio or watch for warning and advice
- De-watering Pump.
- Keep vigil of flood warning given by local authorities
- Keep dry food and drinking water and warm clothes ready
- Check your emergency kit
- **If you need to evacuate**
- Pack clothing, essential medication, valuables, personal papers etc. in water proof bags to be taken to the safe shelter.
- Raise furniture, appliances on beds and tables
- Put sandbags in the toilet bowl and cover all drain holes to prevent sewage backflow.
- Do not get into water of unknown depth and current
- Lock your house and take the recommended or known evacuation routes for your area of safe shelter.

Technologies to be installed

➤ **Sump pump(Tunnel)**

A sump pump is a pump used to remove water that has accumulated in water collecting sump pit in tunnel, commonly found in the Site. Sump pumps are used where flooding happens regularly and to remedy dampness where the water table is above the foundation of a camp. Sump pumps send water away from a Site place where it is no longer problematic, such as a municipal storm drain or a dry well.

➤ **Personal flotation device**

A personal flotation device (abbreviated as PFD; also referred to as, life jacket, life preserver, life vest, life saver, cork jacket, life belt, flotation suit, etc.) is a device designed to assist a wearer, either conscious or unconscious, to keep afloat with his or her mouth and nose (airway) of his or her head's face

Above the water surface when in or on water. It is suggested to have PFD jackets for the Rescue (Disaster Management team).

Other Safety Measure:

➤ **Bombs & Other Terrorist Activities:**

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Bombs can be constructed to look like almost anything and can be placed or delivered in any number of ways. The probability of finding a stereotypical- looking bomb is almost nonexistent. The only common denominator among bombs is that they are designed to explode. Most bombs are homemade. Only the imagination of and the resources available to the bomber limit their design. When searching for a bomb, suspect anything that looks unusual. Let the trained technician determine what is or is not a bomb. Follow the checklist given below:

Addressee unfamiliar with name and address of sender

- Package/letter has no return address
- Addressee is not expecting package/letter, or expects different size package
- Improper or incorrect title, address, or spelling of name of addressee
- Addressee title but no name given
- Wrong title with name
- Handwritten or poorly typed address
- Misspelling of common words
- Return address and postmark are not from same area
- Excessive postage or unusual stamps used versus metered postage
- Special handling instructions on package (special delivery, to be opened by addressee only, foreign mail, and air mail, etc.)
- Restrictive markings (personal, confidential, etc.)
- Excessive securing material such as wrapping, tape, or string
- Oddly shaped or unevenly weighted packages
- Bulky, lumpy, or rigid envelopes
- Lopsided or uneven envelopes
- Oily stains or discoloration
- Strange odors
- Protruding wires or metal
- Visual distractions (drawings, statements, etc.)
- Mail arrives before or after a telephone call from an unknown person who asks whether the recipient has opened it or who requests that he or she opens it this is only a general checklist. When an item is in question, the best protection is to make personal contact with the sender of the package or letter but not to open it.

B. Monitoring and review:

Committee may be constituted under the Chairmanship of the Mayor of Mumbai Corporation with representatives from other local bodies, representatives of community based organization and Non-Governmental organizations, officials, etc. to monitor implementation of plans relating to disaster preparedness and mitigation.

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3. Emergency Response Plan:

Environmental Emergency Response Plan describes how MEIL effectively manages and responds to environmental emergencies should they occur during the construction activities. The objective of this emergency plan is

- Safety of personnel
- Minimise impact on the environment
- Minimise impact on property and assets

This Plan applies to all project areas that may be involved in an emergency and is intended to ensure that the project team is adequately prepared to respond to any emergency during the works being carried out on the project. Project team will implement this site-specific emergency preparedness plan which is relevant to the nature and complexity of the project or service.

This shall cover a range of emergencies such as or chemical spill that are relevant to the project or service. No less than once each year or at a higher frequency if EHS risks changes, project shall conduct an exercise to simulate an emergency. The purpose of the exercise is to test the suitability of the plan and to train people to respond correctly. It is expected that improvement programmes shall be implemented to address opportunities identified during the exercise.

4. Emergency Situation and Severity

The following is a list of anticipated emergency situations (environmental) that the project may come across during execution of construction work.

1. Spills of fuel oil, shuttering oil, grease, hydraulic oil etc.
2. Spillage of chemicals used in day-to-day life activity
3. Fire
4. Discovery of potentially contaminated land
5. Accidental Discharge of waste water or other pollutants into a drain, watercourse, or land
6. Natural Calamities (Like Tsunami, Flood, Earthquake, storm etc.)

The following Table show the classification of different emergency situations based on the severity of their impacts.

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Table 1.4: Incident Severity

Low Severity	Moderate Severity	High Severity
<p>Pollution or degradation which has low severity impacts on the community and/or environment in the short-term and is fully reversible with no residual impacts.</p> <ul style="list-style-type: none"> • No residual contamination of land; • Spill contained to defined area(s) within site or workplace; • No significant clean-up required other than removal of contaminated material to land farm or approved waste area; • Release of low eco-toxicity substances (refer MSDS). • Oil spill escapes into offsite storm water system where it is contained and does not enter a flowing watercourse. 	<p>Pollution or degradation which has moderate severity impacts on the community and/or environment but is fully reversible with no residual impacts.</p> <ul style="list-style-type: none"> • Oil or Sewerage spill escapes into offsite flowing watercourse. • Dangerous road surface has potential to result in an accident. • Warning letter or investigation by Local Government or State Government Agency. 	<p>Pollution or degradation which has high severity impacts on the community and/or environment and may have irreversible residual.</p> <ul style="list-style-type: none"> • Extensive contamination / pollution of waterways or catchment areas. • Local Government or State Government Agency restricts access/egress to site, significantly affecting program. • Dangerous road surface has potential to result in an accident. • Explosion or leak of hazardous gas. • Possible or actual evacuation of local vicinity.

5. Emergency Response Team

The following Table shows the site-specific emergency team that will be formed with specific emergency roles and responsibilities.

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Table 1.5: Emergency Contact (Package-1)

Name and Designation	Role	Contact Number
DK Singh (Project Manager)	Project Emergency controller	8470810288
Appa Rao (Chief SHE Manager)	Environmental Emergency controller/Team Leader	8923236667
Tej Bahadur Sinha (Sr. Environment manager)	Environmental Emergency Response Coordinator	8104577194
Store In charge	Response Logistics provider	8897696821
Foreman	Response Team Member	
Charge hand	Response Team Member	
Workmen	Response Team Members	
First Aider(s)	Provide First Aid cover	
Fire Attendant	Fire fighter	
External Emergency Contacts		
Ambulance		102/108
Police		100
MPCB		022 2401043

Emergency Contact (Package-2)

Name and Designation	Role	Contact Number
B Vishnuvardhan Reddy (Project Manager)	Project Emergency controller	8470810288
Mr. Shashidhara Dhamudia (Chief SHE Manager)	Emergency controller/Team Leader	7058281247
P Sureshbabu (Environment manager)	Environmental Emergency Response Coordinator	8608947085
Mr. Prasath	Response Logistics provider	8310219299
Mr. Sumanth	Response Team Member	9065060599
Mr. Hirthik	Response Team Member	9967801681

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First Aider(s)	Provide First Aid cover	8608947085
Mr.Kiran Kumar	Fire fighter	8787660897
Mr.KP.Singh	Provide First Aid cover	7569897399
External Emergency Contacts		
Ambulance		102/108
Police		100
Sunshine Hospital		022 2801 1258
SGNP Control Room		022-28866449

- Separate Emergency response team shall be formulated in Tunnel and Casting yard areas to tackle the situation.

6. Responsibilities:

Project Manager

The overall responsibility for the implementation of the Emergency Response Plan is with the Project Manager, who can delegate his responsibility, but is accountable to all actions of this procedure. Only Project Manager authorized to declare the situation as Emergency & the normality of the situation can also be declared by Project Manager.

Environmental Manager

The Environmental Manager shall assist the Project Manager in implementation of the plan.

Emergency Response Coordinator

The Emergency Response coordinator is to collect all relevant data of an emergency incident and relay the information to the relevant entities. This position is manned 24/7.

Emergency Response Team Leader

The Emergency Response Team Leader is responsible for managing the environmental emergency teammembers, provide training and to attend and take charge of any incident that the ERT are called out to.

Emergency Response Team

The Emergency Response Team is to be on call 24/7 and respond to any incident call out as required. This team will be organized and developed within the Project Managements Team, EHS representatives, and nominated workmen to be manned 24/7 during the duration of the project.

All Employees and Contractors

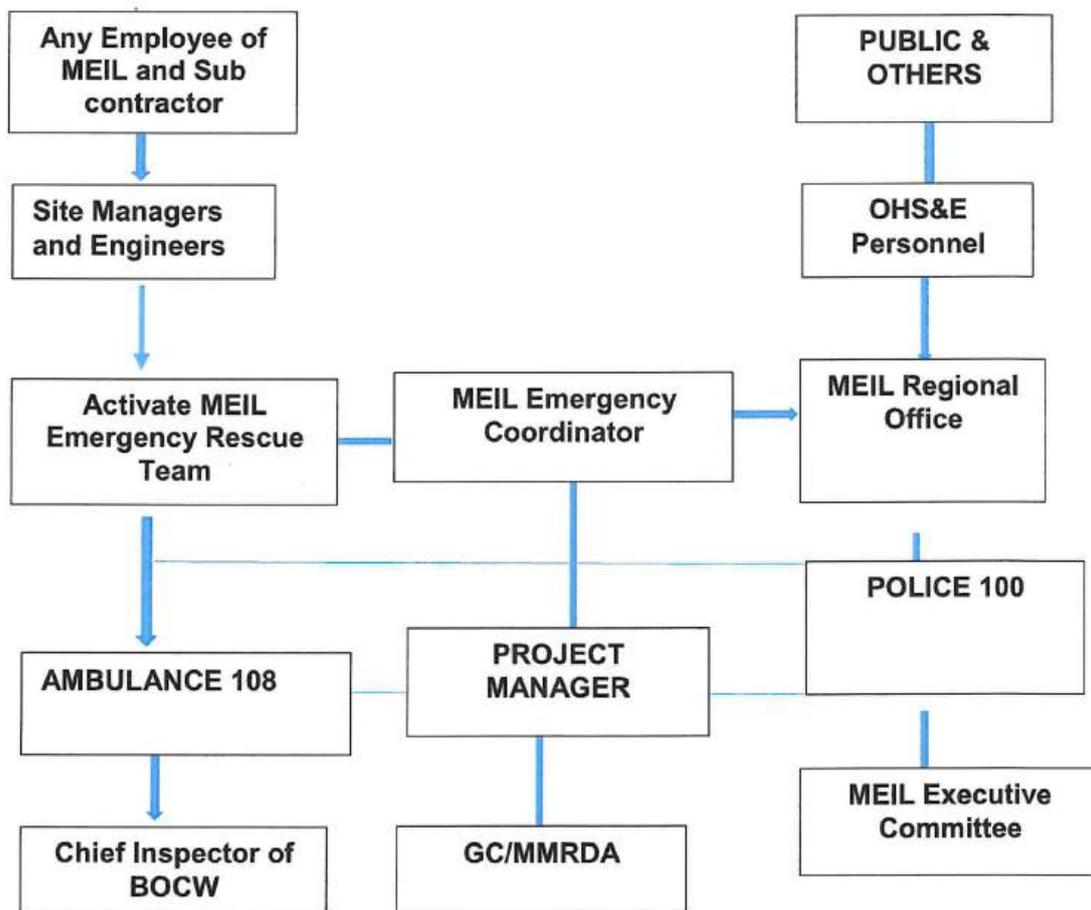
To follow the emergency response plan as indicated in the respective work environment.

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7. Emergency Response Flow Chart

The following flow diagram represents the steps or unit operation that will be followed during an environmental emergency.

EMERGENCY PREPAREDNESS FLOW CHART:



Note: - After the work sites are set up, a layout of emergency evacuation will be installed at prominent locations

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8. Emergency Action Plan

Incidents	Actions to be taken
Spills of diesel or other liquids including chemicals	Locate the spill and try to stop it. Contain the spill – use spill kits materials (absorbent granules / booms), sand or drip tray. Check the spill has not reached any drains or watercourse. Report to Management – Details required are: <ul style="list-style-type: none"> • Location • What was spilled • Has it entered drains /watercourse? Clear up using spill kits. Dispose of used spill kits as special waste.
Fire	Stop works immediately Follow the Emergency Fire Plan.
Discovery of potentially contaminated land	Stop excavation / piling / groundbreaking works, immediately. Report to Management. Fence area off. Contact environmental representative and EHS in charge. Environmental representative will contact a specialist to inspect the material.
Discharge of wastewater or other pollutants into a drain, watercourse, or land	Stop works immediately Stop pumps Report to Project Management Contain the discharge – build a bund Install a control system
All incidents must be recorded and reported on the preliminary incident report and incident investigation Report. A copy of the report is to be forwarded to the MMRDA Environment division.	

9.0 Emergency Response Equipment and Materials:

- Alarm systems – Air horn for site works, Manual alarm system for site offices
- Emergency lighting and power – temporary generators
- Spill Kits – Fuel Storage Areas, chemical storage and handling chemical areas.
- Proper PPE to handling chemicals.
- Warning tape/post to secure the area
- Bucket and shovel

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10. Training on Emergency Preparedness:

Training will be provided to the emergency response team members through mock drills or scenario-based exercise to perform their duty properly during emergency situations. Environmental representative will provide the training to the response team members. Format is attached Annexure-1

11. Emergency Preparedness and Drill:

Emergency drills and or scenario based mock events will be conducted on the Site. These drills will be held every 6 months and will be recorded with lesson learnt. Mockdrill Format Annexure-2.

12. Hazards:

12. Risk Assessment And Analysis:

Risk Analysis Matrix for Proposed Twin Tunnel Project:

Sr. No.	Perceived Risks	Occurrence	Risk Mitigation Methods	
1.0	Environmental			
1.1	Area prone to flooding	Once a Year	a	All entry points to be covered from above to prevent rain water from directly falling on the ramps;
			b	Provide efficient drainage system with collection
			c	Provide Sumps to trap any water coming within the tunnel;
			d	Provide pumps to transfer any such water to external drains;
			e	Install systems to prevent entry of traffic into the tunnel in case of any eventuality;
			f	Install emergency communication methods for traffic to organize and evacuate themselves;
			g	Install quick evacuation methods for vehicles;
			h	Install dedicated emergency communication Systems at every 100 meters.

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1.2	Earthquake	Once in 20 Years	a	Install systems to prevent entry of traffic into the tunnel in case of any eventuality;
			b	Install emergency communication methods for traffic to organize and evacuate themselves;
			c	Install quick evacuation methods for vehicles;
			d	Install dedicated emergency communication systems at every 100 meters.
1.3	Internal Air Quality (IAQ)	Daily	a	Install CO ₂ and CO sensors at every 15 meters;
			b	Provide sufficient fresh air supply fans;
			c	Provide effective exhaust fans.

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2.0	User Related Risks			
	Perceived Risks	Occurrence		Risk Mitigation Methods
2.1	Accidents	Weekly	a	Install cameras at every 30-50meters;
			b	Install incident reporting systems with ability to recognize stoppage in traffic flow, reverse traffic flow etc. in lanes;
			c	Identify methods to enable emergency services to access accident sites quickly;
			d	Install systems to prevent entry of traffic into the tunnel in case of any eventuality;
			e	Install emergency communication methods for traffic to organize and evacuate themselves;
			f	Install quick evacuation methods for vehicles;
			g	Install dedicated emergency communication system at every 100 meters.
2.2	Congestion/Breakdown/	Daily	a	Install variable message system
	Stoppage/ Lane Changing/		b	Install fixed sign system
	Drunk/ Rash Driving/		c	Install cameras at every 30~50meters;
	Over Speeding		d	Install incident reporting systems with ability to recognize stoppage in traffic flow, reverse traffic flow etc. in lanes;
			e	Identify methods to enable emergency services to access accident sites quickly;
			f	Install systems to prevent entry of traffic into the tunnel in case of any eventuality;
			g	Install emergency communication methods for traffic to organize and evacuate themselves;
			h	Install quick evacuation methods for vehicles;
			i	Install pedestrian exit routes at every 500 meters;
			j	Install dedicated emergency communication systems at every 100 meters.

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2.3	Hazardous/ Poisonous Gases	Rare	a	Prevent entry of tankers, articulated long trucks and oversized vehicle into the tunnel;
			b	Provide margin for vehicular rejection at least 50 meters before tunnel entry to divert these vehicles to other lanes
			c	Install sign boards outside the tunnel for vehicles to Organize themselves and Move to other lanes.
			d	Provide sufficient fresh air supply fans;
			e	Provide effective exhaust fans.

Operational/Maintenance Risks			
Perceived Risks	Occurrence	Si.no	Risk Mitigation Methods
Fire	Once a Year	a	Ensure only 'Plug and Play' equipment's are installed;
		b	Install quick response fire detection systems in the tunnel;
		c	Install cameras with ability to recognize fire hazards every 30 – 50 m;
		d	Install Fixed Fire Fighting (FFF) and automatically Systems within the tunnel;
		e	Install smoke evacuation systems;
		f	Identify methods to enable emergency services to access accident sites quickly;
		g	Install systems to prevent entry of traffic into the tunnel in case of any eventuality;
		h	Install emergency communication methods for traffic to organize and evacuate
		i	themselves;
		j	Identify quick evacuation methods for vehicles;
		k	Identify quick evacuation methods for pedestrians;
Power Outage in Tunnels	Once in 6 Months	a	Provide UPS supply to all emergency equipment and at least 1/3 rd of the lights;
		b	Provide secondary source of power supply like DG sets;
		c	Install spare HT cables to transformers for Redundancy.
Equipment Failure	Monthly	a	Install SCADA systems for monitoring all Equipment installed in the tunnels;

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		b	Ensure only 'Plug and Play' equipment's are installed;
		c	Ensure adequate spare parts/ replacements to Minimize equipment downtime.
Security Risks			
Terrorist Attacks	Once in 2 Years	a	Install cameras at every 30~50meters;
		b	Install incident reporting systems with ability to recognize stoppage in traffic flow, reverse traffic flow etc. in lanes;
		c	Install systems to prevent entry of traffic into the tunnel in case of any eventuality;
		d	Install emergency communication methods for traffic to organize and evacuate themselves;
		e	Identify quick evacuation methods for vehicles;
		f	Identify quick evacuation methods for pedestrians;
		g	Install dedicated emergency communication Systems at every 100 meters.

Risk Assessment for Tunnel:

Risk assessment is essential part of tunnel services and structural design. This has been considered in related to various incident scenarios which may occur during operation of the proposed tunnels. Risk analysis is based on risk rating of various incidents and their impact on the proposed tunnel structure and users.

Structural measures	Emergency walkways are mandatory where no emergency lane is provided	Provision of emergency walkway is proposed
	Emergency exits every 500m are mandatory	Cross connections proposed at every 500m
	Mandatory cross-connections for emergency services at least every 1 500 m	Cross connections proposed at every 500m
	Crossing of the central reserve outside each portal (mandatory requirement)	It is proposed to provide continuous cut section to adopt the same
	Drainage for flammable and toxic liquids is mandatory where such goods vehicles are allowed	Although such inflammable and toxic goods carrying vehicles will be rejected. Drainage provisions have been made underneath the pavement
	Fire resistance of structures is mandatory where local collapse of structure may have disastrous effect	Complied by making such provisions

	ENVIRONMENT MANAGEMENT PLAN	
	Document No. - MEIL/MMRDA/PKG-1(3280)/OHSE/DMP/003	
THANE BOROVALI TWIN TUNNEL PROJECT-PKG-1		

Lighting	Normal Lighting	Proposed as per CIE 88, 2004
	Safety lighting	Proposed as per CIE 88, 2004
	Evacuation lighting	Provided over footways
Ventilation	Mechanical ventilation	Proposed longitudinal ventilation by providing jet fans
	Mandatory semi transverse ventilation for tunnels of more than 3000m length	Provisions made through supply ducts and ventilation shafts.
Emergency stations	Mandatory provision of emergency stations at 150m equipped with telephone and two fire extinguishers necessary	Provision to be made at every 150m.
Water supply	At every 250m	Water supply pipe attached to water tank to be provided with supply point at every 150m to match location of emergency station.
Road signs	Mandatory	Provided with road signs

  	Thane-Borivali Twin Road Tunnel Project	
	DISASTER MANAGEMENT PLAN	
	MEIL/MMRDA/OHSE/DMP/003	

Control center	Surveillance of several tunnels may be centralized into a single control centre.	Two control centers shall be provided first near Thane and second Borivali to cover two tunnel sections. The Control Centers are located at start of tunnel as well as center of East and West section of Twin Tunnel.
Monitoring systems	Video	CCTV cameras shall be provided along tunnels as well as along Coastal Road
	Automatic incident detection and/or fire detection	CCTV equipped with automatic incident detection system and response is proposed.
Equipment to close tunnel	Traffic signals before the entrances	The mandatory provision is to be complied by provision of gate controlled from Control center
	Traffic signals inside the tunnel	It is proposed to provide traffic signals at every 500m before every cross connection to enable traffic diversion to parallel tunnel in case of incident.
Communications system	Radio re-broadcasting for emergency services	Wired Telephone communication system will be provided for each 50 Meters.
	Emergency radio messages for tunnel users	Waki Taki/Telephone communication.
	Loudspeakers in shelters and exits	Siren and loudspeakers.
Emergency power supply	Mandatory	It is proposed to equip control center with necessary capacity of standby generators with necessary fuel storage
Fire resistance of equipment	Mandatory	All tunnel fixtures and fitting shall be fire resistance compliant.
Additional Provisions	Drainage	It is proposed to provide sump and pumping arrangement to collect seepage/ storm water at lowest point of tunnels and dispose the same to sea.
	Leaky feeder cable	It is proposed to provide leaky feeder cable to enable use of mobile services within tunnels.

  	Thane-Borivali Twin Road Tunnel Project	
	DISASTER MANAGEMENT PLAN	
	MEIL/MMRDA/OHSE/DMP/003	

Environmental monitoring sensors

It is proposed to provide environmental monitoring sensors to monitor visibility levels, air quality and smoke detection to the operational phase.

Event Probability:

Description	Scenario	Probability
Highly likely	Very frequent occurrence	Over 85%
Likely	More than even chance	51-85%
Fairly likely	Occurs quite often	21-50%
Unlikely	Could happen but not very often	1-20%
Very unlikely	Occurrence is not expected to happen	Less than 1-0.01%
Extremely unlikely	Just possible but very surprising	Less than 0.01%

	Thane-Borivali Twin Road Tunnel Project	
	DISASTER MANAGEMENT PLAN	
	MEIL/MMRDA/OHSE/DMP/003	

Event Impact:

Description	Scenario Examples
Disastrous	Tunnel operation could not be sustained
Severe	Serious threat to tunnel operations
Substantial	Increases operational costs/difficulties substantially
Marginal	Small effect on operational cost /difficulty
Negligible	Trivial effect

Risk response strategies:

Vehicle related incidents: Tunnels are designed to carry traffic loading and there are events of varying probability which may affect safe operation of the tunnel.

Risk Action Required	Possible Response
Elimination	Change provision such as that risk cannot occur.
Avoidance	Modify provision so that risk greatly reduced.
Transfer	Not likely to be able to do this for safety aspects.
Mitigation	Measures taken to reduce impact of risk if it were to occur
Acceptance	It is an accepted risk and it is negligible or there are no cost effective solutions available.

ANNEXURE A-26

Annexure – 14
(Condition No. – 17)

Undertaking for Disaster Management Plan

MMRDA hereby submits an undertaking that the UA shall prepare and implement disaster management plan as per the relevant rules/regulation to that extent, if required for such tunnel projects.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-27

Annexure – 17
(Condition No. – 20)

Undertaking for FRA Certificate

MMRDA has already submitted the application for FRA certificate to the respective Collectors of Thane & Mumbai Suburban districts. FRA Certificate application is being processed. MMRDA hereby submits an undertaking that after due process completion and FRA Certificate will be submitted.

As per the above undertaking (and also ensuring settlement of rights under the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (2 of 2007) and compliance to all such conditions), we request that the State Government shall issue order for working permission and diversion as the case may be.

Date: 04/08/2024

Place: Mumbai



(M.P. Singh)
Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-28

Annexure – 18
(Condition No. – 21)

Undertaking for Environmental Clearance

MMRDA hereby submits an undertaking that user Agency shall obtain Environmental Clearance as per the provisions of the Environmental (Protection) Act, 1986, if applicable.

Environmental Clearance is not applicable (SEIAA document enclosed)

Date: 04/03/2024

Place: Mumbai

(M.P. Singh)
Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-29

Annexure – 19
(Condition No. – 22)

Undertaking for Firewood to Labourers

MMRDA hereby submits an undertaking that Sufficient firewood, preferably the alternate fuel, shall be provided by the User Agency to the labourers after purchasing the same from the State Forest Department or the Forest Development Corporation or any other legal source of alternate fuel.

Date: 04 / 03 / 2024

Place: Mumbai



(M.P. Singh)
Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-30

Annexure – 20
(Condition No. – 23)

Undertaking for No additional/new Path

MMRDA hereby submits an undertaking that no additional or new path will be constructed inside the forest area for the transportation of construction materials for execution of the project work.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-31

Annexure – 21
(Condition No. – 24)

Undertaking for No subletting of diverted Forest Land

MMRDA hereby submits an undertaking that the forest land proposed to be diverted shall under no circumstances be transferred or sublet to any other agencies, department or person without prior approval of Govt. of India

Date: 04 / 03 / 2024

Place: Mumbai



(M.P. Singh)
Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-32

Annexure – 22
(Condition No. – 25)

Undertaking for project area not exceeding 35.5644 ha

MMRDA hereby submits an undertaking that the total forest area utilized for the project shall not exceed 35.5644 ha and the forest area diverted shall not be used for any purpose other than those shown in the diversion proposal.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)
Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-33

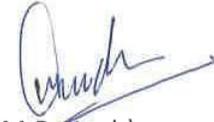
Annexure – 23
(Condition No. – 26)

Undertaking for compliance to the all acts, rules, regulation and guidelines

MMRDA hereby submits an undertaking that MMRDA and the State Government shall ensure compliance to the all acts, rules, regulation and guidelines of the Ministry, for the time being in force, as applicable to the subject project.

Date: 04 / 03 / 2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-34

Annexure – 24
(Condition No. – 27)

Undertaking for Other Conditions imposed by Regional Office, Nagpur

MMRDA hereby submits an undertaking that any other condition that the Regional Office, Nagpur may impose from time to time in the interest of afforestation, conservation and management of flora and fauna in the area shall be complied by the User Agency.

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-35

Annexure – 25
(Condition No. – 28)

Undertaking for penal action as per rules

MMRDA hereby submits an undertaking that in the event of failure to comply with any of the above conditions the User Agency is liable for penal action as per the rules / guidelines issued under Van (Sanrakshan Evam Samvardhan) Adhinyam, 1980;

Date: 04/03/2024

Place: Mumbai



(M.P. Singh)
Executive Engineer
MMRDA, Bandra
Mumbai

ANNEXURE A-36

Annexure – 26

(Condition No. – 29)

Undertaking for compliance report on conditions

MMRDA hereby submits an undertaking that submit compliance report on the above conditions through online or offline (as physibile)

Date: 04/08/2024

Place: Mumbai



(M.P. Singh)

Executive Engineer

MMRDA, Bandra

Mumbai