

June 2020

India: Bengaluru Metro Rail Project

Phase 2B (Airport Metro Line)

KR Puram to Kempegowda International Airport

NOTES

- (i) The fiscal year (FY) of the Government of India and its agencies ends on 31 March. "FY" before a calendar year denotes the year in which the fiscal year ends, e.g., FY2019 ends on 31 March 2019.
- (ii) In this report, "\$" refers to United States dollars.

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V. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Methodology

215. The methodology of assessing environmental impacts from the project entailed clearly identifying the environmental components that will be impacted, type of impacts, assessment area where the impacts will be felt and defining the criteria for assessing the significance of each type of impact. After defining these aspects, a screening of project impacts during design and pre-construction (D), construction (C) and operation (O) stages of the project was carried out to identify the minor, moderate and major impacts to guide development of mitigation measures and ensure that there are no or minimal residual impacts.

i. Identification of environmental components

216. This includes identifying the valued environmental components (VEC) of the physical, biological, and human environments that are at risk of being impacted by the project. The VECs for this project which are based on the environmental baseline are:

- Physical environment – air quality and greenhouse gas emissions, land and soil, surface water quality and quantity, and groundwater quality and quantity;
- Biological environment – terrestrial and aquatic vegetation, mammals, avifauna, and ecologically important areas;
- Social environment – private land and buildings, public infrastructure including utility structures, noise and vibration levels, cultural/heritage buildings, and occupational health and safety for the construction workers and local community living within the vicinity of the project area.

ii. Type of impact on the VECs

217. The type of impact can be described as:

- **Positive:** Improvement in the quality of the VECs because of the project;
- **Negative:** Degradation or reduction in the quality of the VECs because of the project;
- **Neutral:** No noticeable change in VECs.

iii. Area of impact assessment

218. The area covered for assessing direct project impacts include a of 300m corridor from the centre line of the existing road. In addition, a 10 km radius along the project alignment was studied for indirect impacts.

iv. Significance of impacts

219. The assessment of the significance of the impacts on the VECs requires understanding the (i) sensitivity of each VEC within the project context; (ii) duration of impact; (iii) area of impact and (iv) severity of impact. The following sections elaborate these.

220. (i) Sensitivity of VEC: The sensitivity of a VEC can be determined by the existing conditions of the VEC within the project area and existence of important VEC's within the project areas. Sensitivity of each VEC is described as high, medium or low as described below.

- **Low:** No environmentally important areas (such as protected areas, natural or critical habitat areas, heritage sites, places of worship etc.) are located within the direct and indirect impact zone. The quality of existing conditions of VECs is good or fair;

- **Medium:** There are one or more environmentally important areas within the indirect impact zone of the project area. The quality of existing conditions of VECs is good or fair;
- **High:** There are one or more environmentally important areas within the direct impact zone of the project area. The quality of existing conditions of the VECs is poor or degraded (such as poor air quality, high noise levels, poor water quality).

221. Based on baseline conditions in the project area and sensitivity criteria, the level of sensitivity of each VEC is provided in table 5-1.

Table 5- 1: Sensitivity of VECs in the project area

VEC	Sensitivity level	Remarks
1. Physical environment		
1.1 Air quality	High	The average ambient air quality in the project area is generally poor with PM ₁₀ and PM _{2.5} being the main pollutants.
1.2 GHG emissions	High	Vehicular pollution is expected to be the main source of GHG pollution.
1.3 Surface water quality	High	Water quality of the surface waters in the project area is poor, mainly due to high amounts of organic components and the presence of E.coli.
1.4 Surface water quantity	High	Bengaluru is facing major water shortages.
1.5 Ground water quality	Medium	Water quality of the groundwater in the project area is moderate due to the presence of coliform.
1.6 Ground water quantity	High	Bengaluru is facing major water shortages.
1.7 Land degradation and pollution	Medium	The project alignment is following the median of the Outer Ring Road which passes mainly through residential and industrial areas or is located next to Highway 44 passing agricultural land. Generation of muck due to underground section.
2. Biological environment		
2.1 Trees, terrestrial and aquatic vegetation	Medium	The critical habitat area of Bannerghatta National Park is located at a distance of 15 km from the proposed project alignment with extensive urban development in between. The alignment passes a number of fresh water bodies, however none of these serve as ecological habitat for avian and/or aquatic fauna. Approx 3541 trees have to be removed from the project alignment and the stations and depot areas
2.2 Terrestrial fauna (mammals, birds, insects)	Low	
2.3 Ecologically important areas)	Low	
3. Social environment		
3.1 Private land and buildings	Medium	Approximately 264 families will be affected, approx. 208,000 m ² of private land needs to be acquired.
3.2 Public property/ infrastructure/ utility structures	High	A major gas pipeline has to be shifted from the median of the Outer Ring Road in order to provide space for the metro line.
3.3 Noise	High	The ambient noise levels exceed CPCB limits during daytime as well as night time
3.4 Vibration	High	There are several structures located near the alignment. Regular traffic such as buses and trucks on the Outer Ring Road and NH 44 add to vibration levels

3.5 Occupational health and safety	Medium	The project area already experiences some road safety issues due to the heavy traffic plying on the ORR and the highway
3.6 Public health and safety	Medium	
3.7 Physical cultural resources (PCR)	Medium	There are several religious places located near the alignment

222. (ii) Duration of the impact: Duration means the time dimension of the impact on the VECs. The terms permanent, temporary and short-lived are used to describe the duration of impact:

- **Short-lived:** The impact disappears promptly;
- **Temporary:** The impact is felt during one project activity or, at most, during the construction period of the project;
- **Permanent:** The impacts are felt throughout the life of the infrastructure.

223. (iii) Area of impact: The area of impact entails the spatial scale of impact on one or more of the VECs. The terms regional, local and limited are used to describe the area of impact:

- **Limited:** The impact is felt within the direct impact zone;
- **Local:** The impact is felt within the indirect impact zone;
- **Regional:** The impact is felt beyond the indirect impact zone.

224. (iv) Severity of impact: The severity or seriousness of an impact entails understanding the repercussion or risks posed by the impact. This is a subjective criteria which is defined as high, medium or low as below:

- **High:** The severity of impact is high if grave repercussions are expected as a result of the impact due to any of the following or similar situations: the impact will be felt by a large number of people or receptors; the receptors are highly sensitive; the impacts will cause serious health issues; there is already a history of complaints from the project area and people have raised significant concerns during public consultation; some of the VEC in the project area already severely degraded and maybe further worsened by the project; there will be a significant change in one or more VEC because of the project;
- **Medium:** The severity of impact is medium due to any of the following or similar situations: the impact will be felt by a small number of people; some receptors are affected but they are not sensitive; the impact will not cause serious health issues; some concerns were raised during public consultations, but they were not significant; there will be minor changes in one or more VEC because of the project;
- **Low:** The severity of impact is low due to any of the following or similar situations: the impact will not be felt by anyone; no or limited receptors are affected; no concerns were raised during public consultations; there will be no noticeable changes in one or more VEC because of the project.

225. Based on the sensitivity of the VEC and the rating of duration, area and severity of impact as described above, the overall significance of each impact was classified as major, moderate or minor as demonstrated in table 5-2 below.

Table 5- 2: Criteria for rating the significance of impacts

Significance	VEC Sensitivity	Duration	Area	Severity
Minor	Medium or Low	Short-lived or Temporary	Limited, Local or Regional	Low
	Low	Permanent	Limited	Low
Moderate	High or Medium	Temporary	Limited, Local or Regional	Medium
	Medium	Permanent	Limited	Medium
Major	High	Permanent or Temporary	Limited, Local or Regional	High
	High or Medium	Permanent	Local or Regional	Medium

v. Screening of impacts

226. Based on the rating criteria provided in table 5-2, environmental impacts anticipated during the project design and pre-construction/design stage (D), construction (C) stage and operation (O) stage were screened for their level of significance as demonstrated in Table 5-3 below. The screening was carried out for impacts that are expected without mitigation. Hence, it guided the identification of impacts that need mitigation and clearly point out significant/major negative impacts that need to be prioritized for mitigation.

227. The significance of each environmental impact or project activity is indicated by the colors of the cells in the last column of the table 5-3. Red indicates major negative impact, orange indicates moderate negative impact, yellow indicates minor negative impact and green indicates positive impact. The following section discusses the details of impacts on each of the VECs in line with the identification of major, moderate, and minor impacts in the screening matrix. Major impacts have been given priority for identification of mitigation measures to ensure that there are minimal or no residual impacts.

Table 5- 3: Screening of environmental impacts

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance
1. Physical environment						
1.1 Air quality (high sensitivity)	More efficient and environmentally friendly movement of people	D	Permanent	Local	High	+ve
	Dust and gaseous emissions	C	Temporary	Limited	High	Major -ve
	Modal shift towards public transport	O	Permanent	Local	High	+ve
1.2 GHG emissions (high sensitivity)	More efficient and environmentally friendly movement of people	D	Permanent	Regional	High	+ve
	Gaseous emissions from construction equipment and vehicles	C	Temporary	Limited	Low	Moderate -ve
	Modal shift towards public transport	O	Permanent	Regional	High	+ve
1.3 Surface water quality (high sensitivity)	Degradation of water quality due to sewage discharge	D	Permanent	Limited	Low	Moderate -ve
	Pollution arising from construction and labor camps and spillages	C	Temporary	Limited	Low	Moderate -ve
	Degradation of water quality due to sewage discharge	O	Permanent	Limited	Low	Moderate -ve
1.4 Surface water quantity (high sensitivity)	None	D				Neutral
	Increased water scarcity due to utilization for construction	C	Temporary	Limited	High	Moderate -ve
	None	O				Neutral
1.5 Ground water quality (medium sensitivity)	None	D				Neutral
	Pollution arising from construction and labor camps and spillages	C	Temporary	Limited	Low	Minor -ve
	Degradation of water quality due to sewage discharge	O	Permanent	Limited	Low	Moderate -ve
1.6 Ground water quantity (high sensitivity)	None	D				Neutral
	Increased water scarcity due to utilization for construction	C	Temporary	Limited	Low	Moderate -ve

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance
	Increased water demand from public water supply	O	Permanent	Limited	Medium	Moderate -ve
1.7 Land degradation/ pollution (medium sensitivity)	Pollution due to poor waste management practices	D	Permanent	Limited	Low	Minor -ve
	Change in topography, excavation, soil erosion, muck and debris generation and disposal, removal of trees, removal of bituminous pavement	C	Temporary	Local	Low	Moderate -ve
	None as long as proper waste management procedures are followed	O				Neutral
2. Biological environment						
2.1 Trees, terrestrial and aquatic vegetation (medium sensitivity)	Removal and transplantation of trees along the alignment	D	Permanent	Limited	Medium	Moderate -ve
	Removal of trees along the alignment	C	Permanent	Limited	Medium	Moderate -ve
	None	O				Neutral
2.2 Terrestrial fauna (mammals, birds, insects) (low sensitivity)	None	D				Neutral
	Disturbance to fauna at construction site	C	Temporary	Limited	Low	Minor -ve
	None	O				Neutral
2.3 Ecologically important areas (low sensitivity)	None	D				Neutral
	Extraction of sand from river beds	C	Permanent	Local	Low	Minor -ve
	None	O				Neutral
3. Social environment						
3.1 Private land and buildings (medium sensitivity)	Land acquisition	D	Permanent	Limited	Medium	Moderate -ve
	Temporary use of land for construction camps and labor camps	C	Temporary	Limited	Medium	Moderate -ve
	Increased accessibility	O	Permanent	Local	High	+ve

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance
3.2 Public property/infrastructure/ utility structures (high sensitivity)	Alignment passes major utility services that have to be shifted	D	Permanent	Limited	Medium	Moderate -ve
	Unforeseen disruptions of utility services and traffic diversions	C	Temporary	Limited	Medium	Moderate -ve
	None	O				Neutral
3.3 Noise (high sensitivity)	Increased noise levels in urban area	D	Permanent	Limited	High	Major -ve
	Noise from construction activities and equipment, hauling of materials, construction camps	C	Temporary	Local	High	Major -ve
	Increased noise levels due to metro operation	O	Permanent	Limited	High	Major -ve
3.4 Vibration (high sensitivity)	Disturbance and damage due to vibrations	D	Permanent	Limited	High	Major -ve
	Disturbance and damage due to vibrations caused by construction equipment and machinery	C	Temporary	Local	High	Major -ve
	Disturbance and damage due to vibrations caused by metro operation	O	Permanent	Limited	High	Major -ve
3.5 Occupational health and safety (medium sensitivity)	Provision of Health and Safety features in stations and trains	D	Permanent	Limited	Medium	Moderate -ve
	Large scale construction activities including handling and transport of large quantities of material and operation of heavy machinery and equipment	C	Short-lived	Limited	High	Moderate -ve
	None as long as SHE features are incorporated in the design	O				Neutral
3.6 Public health and safety (medium sensitivity)	Large scale movement of people	D	Permanent	Local	High	Moderate -ve
	Nuisance due to large scale construction activities in urban area	C	Temporary	Limited	High	Moderate -ve
	None	O				Neutral
3.7 Physical cultural resources (PCR)	Damage to religious and cultural sites next to the alignment	D	Permanent	Local	High	Moderate -ve

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance
(medium sensitivity)	Possible chance find of objects of archeological interest	C	Short-lived	Limited	Low	Minor -ve
	None	O				Neutral

Note: +ve = positive impact; -ve = negative impact; C = construction stage; D = design & pre-construction stage; O = operation stage; VEC = valued environmental component



: positive impact



: minor negative impact



: moderate negative impact



: major negative impact

B. Impacts during Pre-Construction (Design) Phase

i. Change of Land use:

228. The proposed metro project requires acquiring residential, commercial, government and defence lands. The proposed alignment follows one of the busiest traffic corridors in Bengaluru city and finalization of the alignment is much influenced by traffic induced obligatory factors and the connectivity it offers in the region. However, attempts have been made to take the alignment along the median of the outer ring road to minimise the land acquisition and the consequent impact. Major share of land acquisition is required for proposed metro stations. 313,519 Sqm (Government land – 105,500 Sqm and Private land – 208,019 Sqm) of land is acquired for the Phase 2B project. The type of land acquired involves private, government and defence lands. Acquisition of land leads to insignificant change in the land use. The change in land use is insignificant as the proposed metro alignment is following the median of ORR and the available space between main highway and service road along Airport Road. In addition, most of the metro stations are proposed on the vacant land without much impact on the existing structures. Land is also required, for establishing construction camps, casting yards, material storage and labour camps during construction phase.

229. Transfer of land and involuntary resettlement will cause adverse social, economic and cultural impacts on families and communities who are dependent on them. The details of land requirement for different components of the project of Phase 2B metro line is given in table 5-4.

Table 5- 4: Land acquired Phase 2B project

Sl. No.	Land required for	Land acquired in (Sqm)				
		Private	State Government	Central Government	Defence	Total
1	Depot	91,532	-	-	-	91,532
2	Stations and viaduct	116,487	-	105,500	-	221,987
	Total	208,019		105,500		313,519

Source: BMRCL Dec 2019

230. From the data, it could be concluded that out of total permanent land requirement about 66.35 % land to be acquired is from private and 33.65 % from Central Government.

a. Mitigation measures:

- The land acquisition has been avoided and minimized to reduce the impact on owners owning the adjacent properties and lands. Alternative engineering designs have been attempted to avoid or minimize land acquisition. Where land acquisition is unavoidable, resettlement of Project Affected Persons (PAPs) shall be implemented as an integral part of the project.
- All temporary land required for construction establishments and labour camps acquisition will be preferably Government lands and away from Bengaluru city to reduce the impact of these construction establishments. The conditions for locating and management of these establishments and camps are given in EMP.
- The temporarily lands for construction camps, labour camps, batching plants shall be transferred back to the owner after suitable rehabilitation before the completion of construction works.
- Contractor has to conduct baseline monitoring of ambient air, ambient noise, surface and ground water quality from nearby water resources and soil before establishing the construction camps.

C. Impacts during Construction Phase

i. Impact on Land Environment

231. The impact on the topography is limited as most of the alignment is elevated and follows median of existing outer ring road and the space between main highway and service road on airport road that has been allocated for high speed public rail. The impact on topography is limited to metro station locations and the 800 m underground section including ramps near Yelahanka air force station. In addition, there will be significant change in topography at the locations of construction camps, labour camps, material storage yards, gravel & sand quarries.

232. The project may not have significant impact on soil erosion, however, minor impact on soil erosion due to runoff from unprotected excavated areas which may result in soil erosion, especially where the erodibility of soil is high. During monsoon, excavated soil may tend to move from construction site along with surface run-off, in absence of suitable mitigation measures to mitigate the soil erosion.

233. The soil/debris will be generated during foundation excavations for pile construction which needs to be carefully and safely disposed of. Lot of waste slurry is also generated during pile foundation construction which causes soil pollution if it is not disposed properly. However, soil contamination is not considered to be a significant concern in this project as the alignment is following the median of outer ring road which has a median width of 1 to 2 metre and the rest is paved surface. Problems could arise from dumping of construction soils (concrete, bricks), waste materials (from contractor's camp) etc. causing surface and ground water pollution. Maintenance, servicing construction machinery and fuel refilling of transportation vehicles construction machinery at construction camps may lead to soil pollution.

234. Proposed project involves construction of as many as 1120 pile foundations which requires soil to be excavated and disposed of at the pre-identified and approved disposal sites safely. The estimated total earth work excavation from pile drilling, pile cap, cut-and-cover and open foundation activities is about 273,586 Cum and the concrete debris of about 14,096 Cum is generated from Phase 2B project. The details are given in table 5-2.

Table 5- 5: Quantity of Soil Debris and C&D waste generated(Cum)

Package No.	Source of debris (At viaduct and station)	Qty (Cum)
I	A. Earth work excavation	
	a. Pile drilling muck	46911
	b. Pile cap and open foundations	18677
	B. Concrete Debris	4691
II	A. Earth work excavation	
	a. Pile drilling muck	54290
	b. Pile cap and open foundations	33024
	c. Yelahanka underground section	39691
	B. Concrete Debris	5432
III	Earth work excavation	
	a. Pile drilling muck	39711
	b. Pile cap and open foundations	41281
	B. Concrete Debris	3973
Total earth work excavation		273586

Package No.	Source of debris (At viaduct and station)	Qty (Cum)
Total concrete Debris		14096

235. The run off from unprotected excavated areas during construction results in excessive soil erosion. Periods of prolonged rainfall or heavy downpours during construction phase may increase the risk of erosion and subsequent sedimentation of local storm water drains. Similarly, periods of dry and windy weather may increase the potential for soil erosion in the project area.

236. Land clearing for the project will involve removal of trees which have a very important role in binding the soil intact. Stripping of topsoil to level the ground at the construction site will lead to the loss of developed and stable soil. The impact on the soil is not of importance as the land use pattern in project area is urban and uncultivable. However, it is necessary to limit the removal of ground cover, trees or shrubs only to the area needed for permanent works to minimize the impact on soil. Alteration of storm water drainage near the project construction site may lead to soil erosion. The elevated structure of viaduct will have the runoff during monsoon and if this runoff is not drained off properly, may lead to flooding and accelerated soil erosion on the at grade roads.

237. Removal of existing bituminous pavement at grade for preparatory works of pile foundation and indiscriminate disposal would cause soil pollution. These wastes could be managed well, by careful handling, storing and disposal.

a. Mitigation measures:

- Unplanned disposal of the soil from the pile foundation excavation from the proposed metro stations sites will cause the loss of productive top soil and erosion of soil. In such locations where soil is susceptible for erosion due to exposed surface area shall be limited to minimum and construction shall be scheduled immediately after completing land clearing.
- Soil erosion can be effectively controlled by careful planning, timing of cut and fill operations and safe disposal of excess excavated unserviceable soil, especially during monsoon season.
- The soil erosion can best be mitigated by removing vegetative cover only from the specific site on which construction is to take place and by disturbing the vegetation in adjacent areas as little as possible.
- Removal of bituminous wastes from the existing roads should not be disposed nearby water bodies, open spaces and parks and wastes should not be left unmanaged on the road sides. Bituminous material should be examined for PAH to establish if it can be recycled. If not, the scarified bitumen shall be treated as hazardous and disposed of in clay lined bitumen disposal pits.
- The excavated soil from the pile foundations shall be stockpiled and covered such that the soil is not eroded away and it should be transported securely to the approved disposal sites.
- The top soil from all areas of cutting, shall be stripped to a specified depth of 150 mm and stored in stockpiles of heights not exceeding 2 m. The stored topsoil shall be spread back to maintain the original characteristics of the soil.
- Adopting waste minimization technologies would minimize the generation of waste materials to be disposed and thereby the cost incurred for transportation and handling will be reduced.

- Refilling and servicing areas in construction camps shall be properly lined such that the oils and lubricants should not contaminate the soil. The washings from this area shall be provided with proper drainage with oil interceptors to prevent oil waste entering main drainage.
- As far as possible, demolition and construction waste should be segregated and recycled. The unserviceable waste left after recycling should be dumped in pre-identified and approved pits, as per Construction & Demolition Waste Management Rules.
- The unserviceable debris generated from project shall be disposed of in a scientific and sustainable manner in the listed BBMP approved locations located in and around Bengaluru city. All required permissions shall be obtained from the concerned authorities before disposing the debris.

ii. Impact on Air Quality

238. Dust generation and gaseous emissions from construction machinery are the main air quality issue associated with the construction of metro project. Primary sources of dust during construction phase include activities like site preparatory earthworks; demolition of existing structures; foundation excavation works; loading and unloading soil and construction materials and material handling; etc. Operation of heavy equipment & construction machinery; transporting vehicles, traffic diversion, etc. release gaseous emissions to the air. In addition, dust and gaseous emissions are released from the batching plants, hot mix plant and diesel generators; stone crushing unit operations in the stone quarries. Main pollutants released during construction are particulate matter and obnoxious gaseous pollutants like Carbon Monoxide, Oxides of Nitrogen, Sulphur Dioxide deteriorating quality of ambient air along the project corridor and at construction establishments.

239. As the project construction sites are located along one of the major and congested roads, dust may be a nuisance to the community living near to the proposed alignment. However, the degree of dust nuisance would depend on the nature of works at the particular section, duration of construction time and the local meteorology (like humidity, wind speed and wind direction).

240. In addition to dust, it is also expected that the project activities release air pollutants like SO₂, NO_x, CO, Lead, etc. Air pollutants adversely impact on human health, vegetation and materials. Human beings exposed to air pollutants will have higher incidence of cough, shortness of breath, bronchitis, chronic fibrosis, emphysema, bronchopneumonia, colds of long duration and fatigue. Pollutants such as SO₂ and NO_x in the atmosphere are converted to acid, thereby making rain water acidic. Air pollution has damaging effect on vegetation depending upon their chemical nature, level of concentration and duration of exposure. Air pollutants cause physical and chemical change in materials and results in damage and their destruction. The most destructive air pollutants to materials are smoke, grit, dust and oxides of sulphur.

241. Inhabited stretches along the proposed metro alignment such as commercial zones, schools, hostels, hospitals, office occupancies, place of public worship, etc. are considered as Air Sensitive Receptors (ASRs). The temporary impact of air pollution will be on the adjacent inhabited areas along the project alignment, metro stations, metro depots and associated construction establishment areas under the project. There are 54 ASRs considered to be affected by the air pollution and noise generated from construction activities of the project.

242. DG sets will be used at construction sites for various construction activities and construction camps. Particulate and gaseous emissions are expected from DG sets. The impacts will be of short term and limited in nature. Proper site selection, appropriate location of plant and regular maintenance and monitoring of DGs will minimize such impacts. However suitable mitigation measures such as using chimneys of required height will be ensured as

per the KSPCB norms. The details of air sensitive receptors along the metro alignment is given in table 5-3.

**Table 5- 6: Details of Air Sensitive Receptors (ASRs)
along the proposed Metro corridor**

Sl. No.	Name of Schools & Colleges	Chainage (Km)	LHS/ RHS	Distance from Center Line (M)
1	Primary School, Benniganahalli	0+250	LHS	145
2	Shemrock Happy Hearts - Play school	0+850	LHS	90
3	Zamindar Microsurgical Centre - Eye Care Clinic	1+200	LHS	175
4	Presidency School	1+330	LHS	170
5	New Horizon College	1+400	LHS	180
6	Asha Nursing Home	2+210	LHS	210
7	Sri Sai Sathyanarayana PU College	2+250	LHS	145
8	EITA Training Academy – University	3+230	RHS	95
9	PB Academy – University	3+400	RHS	130
10	Cloud nine Hospital – HRBR	3+560	RHS	56
11	Motherhood Hospital	3+700	LHS	30
12	Banasawadi Medical Centre	3+770	LHS	30
13	Future Ray Play and Learn School	3+950	RHS	80
14	Leviosa Business School – University	4+120	RHS	60
15	Chethana Super Speciality Child Clinic	4+240	LHS	75
16	International School of Business	4+300	LHS	40
17	Parankushachar Institute of Vedic Studies - Research institute	4+590	RHS	75
18	Bangalore Nethralaya	4+620	RHS	90
19	Royal Concorde International School	4+850	RHS	75
20	VJR High School	4+990	RHS	100
21	Spandana Hospital & Diagnostic Centre	5+000	LHS	85
22	Bangalore City College – College	5+090	RHS	250
23	Susruta Nursing Home	5+200	RHS	99
24	The Princeton School	5+250	LHS	165
25	Sneha College of Nursing	5+480	RHS	85
26	Indo Asian Academy Group of Institutions	5+550	RHS	50
27	SERRA International Pre-School	5+750	LHS	110
28	Florence College of Nursing and Physiotherapy	5+900	LHS	30
29	Chris Super Specialty Hospital	6+000	RHS	65
30	New Life College	6+230	RHS	40
31	VBR PU College	6+725	RHS	100
32	Navashakthi Nethralaya	7+100	RHS	50
33	Government Kannada Model Primary School Nagavara	7+500	LHS	155
34	Art of Living Yoga & Meditation Center	7+580	RHS	45
35	JMJ Hospital	7+670	LHS	125
36	Little Gladys English High School	8+800	LHS	185
37	Columbia Asia Hospital Hebbal	12+100	RHS	35
38	Aster CMI Hospital, Hebbal & Sankara Nethralaya	12+100	RHS	40
39	North Side Hospital	12+460	LHS	190
40	Green Country Public School (B)	12+940	LHS	105
41	Government Primary School	13+010	RHS	90
42	Prolife Hospital	13+500	LHS	300
43	Cytecure Cancer Hospital,	13+650	RHS	25
44	Government Flying Training School - Flight school	13+870	RHS	30
45	University of Agricultural Sciences Library	14+900	RHS	30
46	Vidya Prakash high School	15+650	RHS	30
47	Vidyashilp Academy	15+700	RHS	130
48	Shree Nava Chaitanya Association for Special – School	16+250	RHS	165

Sl. No.	Name of Schools & Colleges	Chainage (Km)	LHS/ RHS	Distance from Center Line (M)
49	Bhuvan Group of Institution – College	17+100	RHS	200
50	Vinayaka Public School	19+070	RHS	30
51	Astra Zenica Pharmaceuticals	19+900	LHS	90
52	Kendriya Vidyalaya Airforce Station	20+200	RHS	110
53	ECHS Polyclinic Yelahanka	20+900	RHS	140
54	Academy of Aviation and Engineering	21+400	RHS	190

a. Mitigation measures:

243. During construction, the following mitigation measures will be implemented in order to minimise the impact on air quality.

- Water spraying is needed to compact the soil properly and prevent dust. All construction sites, material haulage roads (unpaved) and the traffic diversion routes should be sprayed with water two to three times a day.
- The materials transported to and from the construction site will should be properly covered with tarpaulin;
- Unnecessary idling of construction equipment and transportation vehicles should be avoided as much as possible.
- Temporary stockpiles of soil or other material should be covered or sprayed with water on a regular basis, particularly during dry or windy conditions;
- All stockpiles should be located far from residences and businesses where possible, prevent placing dusty material storage piles near ASRs;
- All construction equipment should be operated and maintained to specifications to minimize emissions of gaseous pollutants. Construction vehicles used for the construction shall be serviced regularly to ensure that the air pollutants emissions are not exceeding the norms prescribed by CPCB and shall obtain the Pollution Under Control Certificate.
- Siting of all construction establishments such as batching plant, crusher plant, construction camps, hot mix plants and offices shall ensure compliance to all legal requirements and strictly adhered to conditions stipulated in the consent.
- Batching plants, Hot (asphalt) mix plants, crushers, etc. should be located at least 500 m down windward of human settlements. These establishments should be compulsorily fitted with dust suppression units including all the general and specific conditions of the consent.
- Ambient air quality monitoring shall be done regularly at all the representative sensitive locations to ensure that all the emissions from construction activities are within the National Ambient Air Quality Standards by CPCB and implement required mitigation measures if any of the air pollutant exceeds the limit. If any of the air quality parameter exceeds the prescribed NAAQS standards, more stringent measures such as use of construction machineries complying to emission norms; timing of construction activities; stopping unnecessary idling of construction equipment; use of proper PPEs by construction labours; etc. shall be implemented.

iii. Traffic Diversions

244. During construction, complete or partial traffic diversions will be required. Traffic shall have to be diverted into service roads and other alternate roads. The traffic diversions will create traffic nuisance in addition to inconvenience of exposure to emission of dust, pollutant

gases, increased noise levels to the inhabitants living adjacent to the proposed project corridor.

245. As the metro alignment follows median of ORR, the construction activities are limited to the central part of ORR which has four lane divided carriage way with service roads on either side. Along airport road, the metro alignment follows the space between main highway and the service road. Hence, it is not necessary to completely block either the ORR or airport road. A clear passage shall be maintained on both sides of ORR road, for smooth operation of through traffic and local vehicular movements. The traffic along Airport road will not be significantly affected as the metro alignment is between the main highway and the service road. Local traffic using the service road will get impacted during construction. Traffic diversions should be planned well ahead of schedule of construction activities and information on traffic diversions shall be disseminated to local public and commuters in advance.

246. Traffic diversion arrangements are required to be done at all major junctions and project stretches without alternative roads to avoid traffic chaos. Details of major junctions and project stretches without service roads are given in the table 5-4. where traffic control and diversion will be a challenging task.

Table 5- 7: Major Junctions along the proposed project

Sl. No.	Junction Name	Chainage (km)
1	TIN Factory Junction	0+000
2	Ramamurthy Nagar Main Road Crossing	2+200
3	Horamaavu Junction	3+300
4	Kalyan Nagar Junction	4+700
5	Kammanahalli main Road Junction	5+450
6	Hennur Junction	5+950
7	Nagawara Junction	7+600
8	Manyata Tech Park Junction	8+200
9	Veerannapalya Cross	8+850
10	Hebbala Junction	11+100
11	Kempapura Main Road Junction	11+900
12	Kodigehalli gate Junction	12+800
13	Sahakara Nagar Junction	13+400
14	Jakkur Main Road Junction	14+600
15	Yelahanka Junction	15+500
16	Kogilu Cross Junction	18+050
17	Bagalur Main Road Junction	20+350
18	Yelahanka Airforce Station Junction	21+500
19	Sadahalli Gate Junction	29+050

iv. Impact on Noise

247. The community living adjacent to the proposed project corridor and workers involved in construction of project will be adversely affected by increase in ambient noise levels due to construction activities. Various construction activities such as demolition of structures along the proposed alignment and station locations; grading, excavation and drilling operations for pile foundations; construction of viaduct structures, stations and facilities; movement of heavy construction vehicles, equipment & machineries to construction site; loading, transportation and unloading of construction materials and transportation of unserviceable materials from construction site to disposal sites; etc. Further, activities such as blasting at stone quarry sites, crushing plants, asphalt production plants, produce significant noise during the construction phase. Traffic diversions during construction also contribute to the increase in noise. Poor maintenance of equipment; faulty or damaged mufflers; loose engine parts; rattling screws, bolts or metal plates contribute to increased noise. Improper handling and operation of equipment also increase noise levels. The values for noise and vibrations monitored along the

proposed alignment is being put to model to predict the impact of construction activities on the baseline noise will be annexed with this report and forms part of this report.

248. Table 5-5 summarizes the noise generated from different construction equipment which are used in project construction. Equipment and operation noise levels are expressed in terms of L_{Max} noise levels

Table 5- 8: Average noise levels generated from equipment used in construction¹⁰

Sr. No.	Equipment	Noise Level in dB(A) (L_{max} @ 50 feet (DBA, slow))
1	Batching Plant	83
2	Concrete Pump Truck	82
3	Dumpers	84
4	Cranes	85
5	Dozer	85
6	Generators	82
7	Excavator	85
8	Trailer	84
9	Jackhammer	85
10	Hydraulic Hammer	90
11	Compactor (ground)	83
12	Compressor (air)	78
13	Impact Pile Driver	95
14	Vibratory Concrete Mixer	80
15	Auger Drill Rig	85

249. Increase of noise around 90 dB (A) creates fatigue of the hearing organs. Prolonged stay in an area with noise pollution gradually induces deafness. Increased noise may induce various types of temporary physiological changes, such as hypertension, change of the rate of heart-beat, high respiratory rates, excessive perspiration, vomiting tendency, vertigo, exhaustion and disturbs sleep. If the noise is intolerable, it can tend people to shift to far off places.

250. The impact of noise from the project activities are insignificant as the recorded noise levels in the project area monitored are more than the norms prescribed for the nature of commercial land use adjacent to project corridor. All the identified inhabited stretches are prone to increased noise. Further, noise sensitive receptors like schools, hostels, hospitals, libraries are largely impacted from project activities both during construction and operation phase. The noise sensitive receptors along the proposed metro corridor are tabulated in the table 5-6 below.

Table 5- 9: Noise sensitive receptors along the proposed metro corridor

Sl. No.	Name of Schools & Colleges	Chainage (Km)	LHS/ RHS	Distance from Center Line (M)
1	Primary School, Bennigana Halli	0+250	LHS	145
2	Shemrock Happy Hearts - Play school	0+850	LHS	90
3	Zamindar Microsurgical Centre - Eye Care Clinic	1+200	LHS	175
4	Presidency School	1+330	LHS	170
5	New Horizon College	1+400	LHS	180
6	Asha Nursing Home	2+210	LHS	210
7	Sri Sai Sathyanarayana PU College	2+250	LHS	145
8	EITA Training Academy – University	3+230	RHS	95
9	PB Academy – University	3+400	RHS	130
10	Cloud nine Hospital – HRBR	3+560	RHS	56
11	Motherhood Hospital	3+700	LHS	30

¹⁰These values represent the default values for use in the Roadway Construction Noise Model (RCNM), Federal Highway Administration's (FHWA), national model for the prediction of construction noise.

Sl. No.	Name of Schools & Colleges	Chainage (Km)	LHS/ RHS	Distance from Center Line (M)
12	Banasawadi Medical Centre	3+770	LHS	30
13	Future Ray Play and Learn School	3+950	RHS	80
14	Leviosa Business School – University	4+120	RHS	60
15	Chethana Super Speciality Child Clinic	4+240	LHS	75
16	International School of Business	4+300	LHS	40
17	Parankushachar Institute of Vedic Studies - Research institute	4+590	RHS	75
18	Bangalore Nethralaya	4+620	RHS	90
19	Royal Concorde International School	4+850	RHS	75
20	VJR High School	4+990	RHS	100
21	Spandana Hospital & Diagnostic Centre	5+000	LHS	85
22	Bangalore City College – College	5+090	RHS	250
23	Susruta Nursing Home	5+200	RHS	99
24	The Princeton School	5+250	LHS	165
25	Sneha College of Nursing	5+480	RHS	85
26	Indo Asian Academy Group of Institutions	5+550	RHS	50
27	SERRA International Pre-School	5+750	LHS	110
28	Florence College of Nursing and Physiotherapy	5+900	LHS	30
29	Chris Super Specialty Hospital	6+000	RHS	65
30	New Life College	6+230	RHS	40
31	VBR PU College	6+725	RHS	100
32	Navashakthi Nethralaya	7+100	RHS	50
33	Government Kannada Model Primary School Nagavara	7+500	LHS	155
34	Art of Living Yoga & Meditation Center	7+580	RHS	45
35	JMJ Hospital	7+670	LHS	125
36	Little Gladys English High School	8+800	LHS	185
37	Columbia Asia Hospital Hebbal / Embassy Lake Terraces	12+100	RHS	35
38	Aster CMI Hospital, Hebbal & Sankara Nethralaya	12+100	RHS	40
39	North Side Hospital	12+460	LHS	190
40	Green Country Public School (B)	12+940	LHS	105
41	Government Primary School	13+010	RHS	90
42	Prolife Hospital	13+500	LHS	300
43	Cytecure Cancer Hospital,	13+650	RHS	25
44	Government Flying Training School - Flight school	13+870	RHS	30
45	University of Agricultural Sciences Library	14+900	RHS	30
46	Vidya Prakash high School	15+650	RHS	30
47	Vidyashilp Academy	15+700	RHS	130
48	Shree Nava Chaitanya Association for Special – School	16+250	RHS	165
49	Bhuvan Group of Institution – College	17+100	RHS	200
50	Vinayaka Public School	19+070	RHS	30
51	Astra Zenica Pharmaceuticals	19+900	LHS	90
52	Kendriya Vidyalaya Airforce Station	20+200	RHS	110
53	ECHS Polyclinic Yelahanka	20+900	RHS	140
54	Academy of Aviation and Engineering	21+400	RHS	190

251. Construction workers are affected by the construction noise. The intermittent and impulse noises are less dangerous than continuous noise due to the short exposure duration except under the situation when the level exceeds 115 dB (A). The exposure to a noise level >115 dB (A) is not permitted under the Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Central Rules, 1998.

a. Mitigation measures:

252. The effective control of construction noise can be achieved by using a three-part approach consisting of control of the noise at the source, path and at the receptor. The following mitigation measures should be employed in order to minimise the impact of increased noise levels during the construction of metro project.

- Properly maintained equipment & machinery, designed with in-built silencers, mufflers and enclosures and shock absorbing pads shall be used in the construction. This would reduce the noise by 5 to 10 dB (A).
- Noise producing stationary equipment should be located away from noise sensitive receptors to decrease the impact of noise.
- Construction establishments such as batching plants, casting yards, construction camps, hot mix plants shall be sited away from the human habitations.
- Enclosures should be installed around the construction establishments to obstruct the noise transmission.
- The plant and equipment used in construction shall strictly conform to CPCB noise standards. Noise standards for motor vehicles are notified under Central Motor Vehicle Rules, 1989 and amendments. Every motor vehicle shall be constructed and maintained so as to conform to noise standards specified in the Environment (Protection) Rules, 1986.
- Proposed project involves construction of as many as 800 pile foundations. Generally, piling is driven using an impact hammer which often produces excessive noise. This noise can be reduced by various dampening and shielding methods. Alternative method such as vibration or hydraulic insertion can be used. Drilled holes for cast in place piles are another alternative that may produce noise levels significantly lower than the traditional driving methods.
- Considerable noise is produced by intake and exhaust parts of the engine. In such cases mufflers can be used for controlling the noise. Muffler requirements shall be made as per contract specifications.
- Poor maintenance of equipment; faulty or damaged mufflers; loose engine parts; rattling screws, bolts or metal plates contribute to increased noise. Improper handling and operation of equipment also increase noise levels. Specifications / instructions shall be included to the Contract to ensure all equipment are regularly inspected for faulty or damaged mufflers; loose engine parts; rattling screws, bolts or metal plates contributing to increased noise.
- Noise levels may be regulated by stopping the noise generating construction works at night time near the inhabited localities. Noisier construction and demolition activities to be restricted around 6 AM and 10 PM to reduce construction noise impacts during night hours.
- Turning off construction equipment during the prolonged periods of non-use eliminates the noise from construction equipment. Continuous loud noises around noise sensitive receptors such as schools, hospitals, etc., shall be avoided. Restriction of construction activity to limited time periods can be effective in reducing noise induced impacts.
- Construction equipment and vehicles carrying castings, spoils, concrete or other materials can be routed through streets that could cause least disturbance to residents. The contractor shall propose and get the approval for such proposed hauling routes prior to the construction.

- Dissemination of information to the public and adjacent property owners of upcoming noise generating construction activities in order to allow residents to plan their activities accordingly.
- Efforts shall be made to reduce truck trips by increasing load size, decreasing fill requirements, or combining trips would help to reduce noise levels.
- Ensure proper personal protective devices as per Occupational Safety and Health Administration standards to all the persons working in high noise zones.
- Regular monitoring of noise levels shall be done at noise sensitive locations near the construction sites and construction establishments to monitor and have a control over increase in noise. If noise levels exceed the prescribed Leq, suitable mitigation measures like using additional silencers in noise generating equipment; erecting additional noise barriers; use of proper PPEs by the receptors can be recommended.
- Increased noise and its transmission to sensitive receptors from the construction sites can be controlled and regulated by providing suitable noise barriers. These noise barriers are erected to suit the acoustic requirements and aesthetic considerations.
- Suitable sign boards to restrict use of horns and speed limit shall be erected at all the noise sensitive receptors.

v. Impact from Vibrations

253. Vibrations are expected to be generated due to construction activities of proposed project and operation metro trains which has the potential to cause some damage to the building and properties. Therefore, various mitigation measures are to be adopted during design phase to prevent any such damage.

254. Pile driving for piers generates vibrations. Vibration is pronounced in hard rock sections. Transmission of vibrations depends on several parameters such as type of pile rigs used in piling; type of rocks at construction site; distance of receptor from the construction site; age and condition of the buildings adjacent to the alignment; etc. Because of the limited workspace at the underground section near Yelahanka air force station and the depth of the construction some form of retaining wall has to be installed. Installing a temporary sheet pile wall may cause vibrations, when using in-situ techniques like diaphragm walls the possibility of impacts due to vibration is minimalized.

255. Further, vibrations monitored along the proposed alignment is being put to model to predict the impact of construction activities on the baseline vibrations which will be annexed with this report and forms part of this report.

a. Mitigation measures:

- Vibration during construction depends on the type of equipment and the piling method used in construction. Vibrations generated will be very small in diaphragm wall method and cast-in-situ piling method.
- The vibrations from pile driving activity could be reduced by deep barriers (in excess of 10 m). In-ground barriers such as trenches, either open or filled trench with a material such as bentonite or concrete will significantly reduce the transmission of vibrations to the surrounding area.
- The vibration level limits for work sites adjacent to the alignment shall conform to the permitted values of peak p velocity as given in project SHE Manual & EMP.

- Vibrations can be reduced by improving track geometry, providing elastic fastenings, and separation of rail seat assembly from the concrete plinth with insertion of resilient and shock absorbing pad.
- Installation of elastomeric bearings, separating the track desk and the pier, resilient rail fasteners (Spring clip, rail pad, elastic pad and compression spring) and continuously welded rails, etc. are known to reduce induced vibrations on the surrounding buildings.
- Quality of the track and the rolling stock is very important in controlling induced vibrations in the nearby structures. Vibration emanates from rail - wheel interaction and the same can be reduced by minimizing surface irregularities of wheel and rail. Both the wheel and the rail should be free from surface wear/ irregularities (corrugation/ flat etc.) and the defective units of the rolling stock should be removed from the operation.
- In vibration sensitive areas, track on floating slab can be provided so as to avoid propagation of noise to adjacent structures.
- As per RDSO (Research Designs and Standards Organization) Guidelines 2015, baseline and vibration monitoring studies have to be conducted along the project corridors to determine the extent of impacts. If significant impacts are expected, mitigation measures have to be implemented and building condition survey have to be conducted before and during construction.

vi. Impact on Water Quality, Drainage and Hydrology

256. There are a few important water bodies along the proposed metro alignment which may be impacted from construction activities. Water bodies adjacent to the alignment are shown in table 5-7.

Table 5- 10: Details of water bodies adjacent to proposed metro corridor

Sl. No.	Water bodies / Lakes	Chainage (Km)	LHS / RHS	Distance from Metro alignment (m)
1	Beninganahalli Lake	0+000 to 0+800	RHS	30
2	Chalkere Lake	4+500 to 4+750	RHS	170
3	Pond	7+000 to 7+200	LHS	30
4	Nagavara Lake	9+000 to 10+100	RHS	50
5	Drain	10+300	both sides	25
6	Hebbal Lake	11+500 to 11+700	LHS	140
7	Pond	16+500 to 16+750	LHS	100
8	Hunasemaranahalli Lake	22+300 to 22+800	LHS	65
9	Pond	25+200 to 25+400	LHS	80
10	Lake near Chikkajala	26+600 to 26+700	LHS	70

257. There are a few major water bodies like Benniganahalli Lake, Chalkere Lake, Nagawara Lake, Hebbala Lake, Hunasemaranahalli Lake and Lake near Chikkajala along the proposed metro corridor. These water bodies may get affected by the construction activities during construction phase, if proper precautions are not taken.

258. Construction of metro project requires water. Water required for construction shall not be sourced from public water resources and supplies. Contractor shall procure water from approved sources only. All necessary permissions are obtained from concerned authorities before extracting water for construction works. Water is also required for curing purposes. Water will be contaminated from the washings and the surplus water from curing activities.

259. Establishment of temporary construction camps and labour camps during the construction of project will require water and cause water pollution due to disposal of untreated

sewage and garbage. If these wastes are let into the water bodies without proper treatment, will lead to water pollution increasing the risk of outbreak of communicable diseases.

260. If disposed without proper treatment, the waste water from toilets of metro stations and washings and oil spills from metro depots will pollute the nearby waterbodies. Precaution shall be taken to treat and dispose the wastes in a proper manner to prevent and minimize the impact of oil spills from construction equipment.

261. Construction of metro project requires water. Water required for construction shall not be sourced from public water resources and supplies. Contractor shall procure water from approved sources only. All necessary permissions are obtained from concerned authorities before extracting water for construction works.

262. Construction of the project corridor and the associated activities may impact on the water bodies. The debris generated from the demolition of structures and excavation for pile foundation could potentially find its way to the nearby water bodies adjacent to the project corridor. This will not only silt up the lakes but also impact the aquatic life in these waterbodies.

263. There is no significant impact on either ground water or water table by the project activities. The metro alignment is proposed along the existing paved roads which are not making significant impact on the ground water percolation and ground water potential.

a. Mitigation measures:

- Arrangement for water used in construction shall be made by the contractor, in such a way that the water availability and supply to nearby communities remains unaffected. If a new tube-well is to be bored, proper sanction and approval from local authorities and Central Ground Water Board should be obtained.
- Careful planning shall be adopted to avoid the spillage of soil and debris into the water body during transportation and disposal. Construction works close to water bodies and streams shall be avoided, especially during the monsoon period.
- Construction establishments such as construction camps, labour camps, stone crushing units should be located away from the water bodies. Domestic and sewage wastes from labour camps shall be treated to the standards specified by CPCB before disposal.
- The excavated earth, stones or any other construction material, shall be properly handled, stacked and disposed of so as not to choke the nearby drainage system and block the flow of water. All required precautions shall be taken up to ensure no silt, soil, construction material reaches and silt up the adjacent waterbodies by constructing suitable retaining barricades.
- The water used for curing structures shall be passed through desilting chambers before it is disposed of outside the construction site. Muck shall not be allowed to confluence with any water course.
- Sustainable methods of curing such as curing by sprinkling, reuse of water shall be adopted for curing. Contractor may source the treated water from local Sewage Treatment Plants to use in the construction and curing purpose.
- Proper treatment methods such as oil interceptors for oil wastes from depots and treatment plants to treat the toilet wastes shall be established to ensure proper treatment before disposing to sewer or surface water bodies.
- Fuel storage and refilling sites for construction vehicles and equipment shall be kept away from cross drainage structures and water bodies. Fuel tanks shall be stored

in a catch basin large enough to hold the entire contents of the tank and additional ten percent.

- The vehicles and equipment shall be properly maintained and repaired to avoid contamination from fuel and lubricants. Oil interceptors shall be installed at the construction camps, vehicle service areas (Depots), to ensure oils and oil-based product do not pollute the soil or reach nearby waterbodies.
- Rain water harvesting and recharge pits shall be proposed all along the median. Rain water collected on the via duct structures shall be suitably guided through chute pipes and made to recharge the ground water after passing through oil interceptors to ensure that the oil traces do not enter the recharge pits.

vii. Impact on Biological Environment

a. Impact on wildlife

264. The proposed project is within Bengaluru city and does not pass through any forests and eco-sensitive zones. Bannerghatta National Wildlife Sanctuary is at a distance of approximately 19 km which is the nearest wildlife sensitive protected area. The list of birds and reptiles commonly found around Bengaluru is given in annexure – 3. As brought out in baseline environment chapter, water bodies located adjacent to the proposed alignment do not have significant aquatic fauna because of sewage inflow from adjacent residential layouts and are not attracting the birds because of presence of high-rise buildings around these waterbodies. When it comes to green spaces (neighbourhood parks) like in Bengaluru city, are small green patches which vary in size and scattered in nature are mainly catering to the recreational purposes and do not support large number of birds. The trees which are impacted by the project are mainly on the median of ORR are small and are in the middle of busy road do not serve as shelter to avian community. Hence, there are no perceivable impacts on the wildlife by the proposed metro project.

b. Impact on Trees

265. Trees are major source of air purification in urban areas making cities environmentally more sustainable. Trees clean air by absorbing CO₂ from atmosphere during photosynthesis and play an important role in climate amelioration. In addition, trees will help to control temperature and keeps the air cool, thus reducing the urban heat island effect. The impact on the trees is unavoidable as the alignment of the metro corridor is taken almost along the median of existing Outer Ring Road. There will be significant impact on trees located in the median. Not all the trees along the alignment are to be cut. Small trees along the alignment can be transplanted to suitable locations.

266. Removal of trees will impact the quality of air. Total of 3541 trees located on the alignment, station and at depots locations which are getting affected along Phase 2B. The breakup of trees impacted along the alignment, stations and depot locations are given in table 5-8 below.

Table 5- 11: Details of trees impacted along the metro project corridor

Sl. No.	Type of Ownership	No. of trees impacted				Total
		Package 1	Package 2	Package 3	Depot	
1	Government	2091	503	52	170	2816
2	Private	45	105	575	-	725
	Total	2136	608	627	170	3541

Table 5- 12: Details of trees impacted along the metro project corridor

Phase No.	No. of trees to be transplanted				Total
	Package 1	Package 2	Package 3	Depot	
2B	1472	294	42	50	1853

Most of the trees which are being affected by the project are transplanted to a suitable location.

c. Mitigation measures:

- Trees cutting and felling shall be done only after the confirming that the tree comes in the way of construction. No damage shall be caused to the trees during construction activities other than the trees marked for felling.
- Trees cleared shall be replaced with minimum of 10 tree saplings per tree cut or according to conditions specified by Tree Committee or Forest Department. The saplings will be monitored for their survival for three years. Replantation shall be taken up every year with new saplings where sapling fail to survive. Compensatory plantation will help the city to increase the green cover.
- No paint thinner, paint, plaster or other liquid or solid excess or waste construction materials or wastewater shall be dumped near the tree or base of the tree or anywhere else.
- Wherever excavations are made in the ground near the roots of trees, appropriate measures shall be taken to prevent exposed soil from drying out and causing damage to tree roots.
- All possible efforts shall be made to transplant trees to a suitable and preapproved location. Transplanting of tree depends on general health, form and structure of the tree; size and quality of root system; size of trees, species and conservation status of a tree; availability and suitability of a receptor site, time for preparation, cost effectiveness, etc.
- Two rows of suitable ornamental plants shall be planted in medians of at grade roads all along the proposed metro alignment.

viii. Impact on Socio – economic environment

a. Structures Affected

267. During pre-construction stage, the proposed metro project requires land to be acquired and structures to be demolished. Total land required for Phase 2B project 3,14,212.516 Sqm (Government land – 11,976.180 Sqm and Private land – 1,94,444.336 Sqm). Survey covered major structures like residential, commercial and government.

268. The project affected families are limited in number (only 123 owners, 137 tenants and 4 non-title holders) as the land being acquired for construction of viaduct is very less and the land required for construction of proposed metro stations is minimum as 12 metro stations out of 17 metro stations are located on the vacant government lands. Approximately 93 structures are affected by the proposed metro project, especially at the proposed metro station locations. The type of structures impacted includes both residential and commercial. The details of structures affected are given in table 5-10. Further details of different types of buildings and land ownerships along with rehabilitation and resettlement details of displaced families are addressed in Social Impact Assessment (SIA) report and Resettlement Plan (RP).

Table 5- 13: Details of Structures Impacted and Open lands (Nos.)

Phase No.	Residential Structures	Commercial Structures	Religious Structures	Vacant lands
2B	10	32	01	15

269. There are no notified archaeological structures present along the proposed metro alignment. However, there is one ancient Chikkajala fort at chainage 22+600 km on RHS of the alignment which is already in dilapidated condition during widening of National Highway 44. Construction of metro project near the Chikkajala fort does not require special clearance but care should be taken not to damage the existing structure.

b. Mitigation measures:

- Project-affected persons, families and households shall be compensated before the start of project as per the statutory provisions before the commencement of project. The impacts shall be addressed as per the KIADB Act with compensation at par with Land Acquisition, Rehabilitation and Resettlement Act, 2013 and Safeguard Policy Statement, 2009 of ADB.
- Construction of metro stations shall be planned in such a way that impact on the adjacent structures is minimized. Alternative engineering designs shall be attempted to avoid or minimize land acquisition.
- If valuable or invaluable articles such as fabrics, coins, artefacts, structures or other geographic or archaeological rarities are discovered, the excavation should be stopped and the archaeological department to be contacted.

ix. Impact on Livelihood, Public services, Health and Safety of Community and Laborer

270. There will be inconveniences and nuisance to the public temporarily during construction of the project. Inconveniences will be mainly due to utility shifting, excavations, unplanned stacking of excavated earth and traffic diversions in the vicinity of project corridor. The construction of proposed metro project may impact on utility services such as electricity, telephone, optical cables, storm water drains, UGD, water supply, etc. during the construction stage.

271. Movement of pedestrians through constricted space may cause potential health & safety issues especially during erecting elevated structures like viaduct components. Fine dust of cement / silt / sand could cause problem to respiratory system of pedestrians nearby. Use of cranes and launchers during construction of elevated structures are a major safety concern not only for the labours involved in construction but also to the pedestrians who are around construction site. The movement of trucks to and from construction areas will increase the traffic risk of the commuters.

272. Construction activities causes disturbance to traffic along the proposed alignment resulting congestion, traffic diversions, dust generation, emission of air pollutants, etc. The commercial activities along the proposed alignment will be affected incurring loss to the retailers and businessmen. Increase in noise along the corridor will impact inhabitants particularly old age people, school children and the patients. In addition to the above concerns, there may be regional labour issues; safety of children and the elders; possibility of spread of communicable disease; etc. These impacts are temporary in nature but, it needs planning, coordination and management to reduce the intensity of the impact and sustainable completion of the project.

273. Encountering unexpected polluted soil during construction works may be a safety risk for workers and environment, if not handled properly. Sufficient quantity of PPEs like masks,

hand gloves and gum boots should be kept ready. Plan for storage and safe disposal of polluted soil should be ready as a part of mitigation measures.

a. Mitigation measures:

- All the utilities shall be shifted to proper and pre-approved locations before the start of construction to avoid or reduce the impact on public.
- Contractor shall prepare traffic management plan to address the traffic issues in the project corridor alignment and get the approval of engineer concerned before start of construction.
- As much as possible semi-skilled and unskilled labourers would be recruited from nearby areas to create some employment opportunities and sense of well-being among local people. This will also reduce social tension of migration and the necessity establishing labour camps within the city thus alleviating impacts associated with establishment of labour camps.
- All the labourers engaged in the construction works are provided with proper camp facilities including sanitation, drinking water supply, washing facilities, cooking facilities and primary health facilities as per the Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996.
- The issues related to safety shall be addressed by properly locating the labour camps and construction establishments sufficiently away from thickly populated areas to avoid the pressure on the local resources and facilities. Construction zone should be separated such that public cannot access the construction area by providing appropriate barricading, providing personal protective equipment (PPE) to labourers, educating and training the labourers and local community, and establishing labour camps far from the inhabited areas.
- Community nearby construction sites shall be given safety education; impose fines for violating safety requirements; ensure adequate traffic flow around construction areas; provide adequate signage, barriers and flag persons for safety precautions and communicate the public through radio, television & newspaper announcements regarding the construction activities and timeframe of projects and expected disruptions or access restrictions.
- Operation of launchers and cranes should be done under the strict supervision of a qualified engineer and a safety supervisor. Only qualified & trained crane/ launcher operators should be allowed to operate. Regular examination and servicing of crane, launchers should be taken up before commencement of work.
- The routes, timing and logistics of the haul truck movements should be planned ahead to minimize impacts on the safety and inconveniences to commuters.
- Construction workers are ensured adequate safety measures complying as per the occupational safety requirements to prevent accidents and hazards. Safety of workers during construction should be ensured by providing them with helmets, masks, safety goggles etc. as per The Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996.
- The workplace shall have proper medical facilities approval by the local medical health or municipal authorities. At every work place, a readily available first aid unit, including an adequate supply of dressing materials, a mode of transport (ambulance), nursing staff and an attending doctor, to be provided as per the provisions of the Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996.
- To ensure safe construction, the temporary accesses during construction, lighting devices and safety signals shall be installed and traffic rules and regulations to be

strictly followed. The electrical equipment should be checked regularly to avoid risks to workers.

x. Impact on Economy

274. During metro construction phase, local people involving in construction activities earn their livelihood in the form of wages and salaries. Local retail shops get their business by construction workers, making everyday purchases. This is likely to give a short-lived stimulus to daily commercial activities till the completion of project. Broader, flow-on economic impacts will be experienced in other sectors of economy as a result of purchase of construction materials.

D. Impacts during Operation Phase

275. There are no significant adverse impacts on the physical and biological environment envisaged during operation phase. However, the project may cause the following negative impacts to the social environment during operation phase:

- Noise from operating metro trains and track structures is of concern, especially for noise sensitive receptors and residential areas. A separate noise and vibration study is being conducted to capture the baseline conditions along the proposed metro corridors to model and predict the impact on noise and vibrations both during construction and operation phase of the project. The details of the study will be a part of the final EIA report. Preliminary results show that 1 noise sensitive receptor, the Embassy Lake Terraces development located at chainage km 12+100, might be impacted by noise during operation phase of the metro. Detailed additional monitoring at this specific location will be carried out to determine the necessity and extent of mitigation measures. Construction of the metro will be in such a way that additional measures, such as transparent walls to be placed on top of the parapet walls, can be added when proven necessary.
- The cut-and-cover underground section near Yelahanka Airforce station potentially poses a risk of flooding during extreme rainfall. Proper water proofing on outer surface of the RCC box will be ensured to avoid any leakage of water into cut and cover section. Protection against the flood water entering into the cut and cover section will be provided by constructing parapet / curtain walls for sufficient height. There is a possibility of rain water entering into cut and cover from open ramps and same will be collected in sump on either end by providing side drains on either side of tracks. The leakage if any, within the cut and cover in spite of water proofing treatment will be directed towards the sump through side drains with proper gradient. Water collected in the sump at either end of the cut and cover will be dewatered by using suitable pumping system.
- For elevated corridors, ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations. In addition, baffle wall as parapets will be constructed up to the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc.
- Vibrations from operating trains caused from rail-wheel interaction, particularly at curves which will be taken care by use of resilient mounting and dampers etc. In addition, this can be reduced by minimizing surface irregularities on the wheel and rail. The vibration shock absorbing pad will be provided. Impact of vibration to the passengers will be reduced by maintaining the distance between rail seat assembly and concrete plinth. Preliminary results of the vibration study show that minimal impacts are possibly to be expected when buildings are within 12.2 meters from the alignment at sections where metro is travelling with a speed of 60 km/h (Yelahanka Station to KIA Terminals).

- Noise and air pollution are expected from DG sets used during power disruption. However, this is insignificant as the impact will be only for short period of power interruption.
- Elevated structures of metro project would impact the light transmission below the structure thus reducing the visibility to drivers using at-grade roads. This may impact the safety of vehicle users, particularly during evenings in absence of proper lighting arrangement. However, looking at the location of elevated structure along the outer ring road which is wider enough and the built-up structures are away from the metro alignment, the impact is not significant.
- Elevated structures of metro after completion of construction will also affect the aesthetics of area by blocking the view. Aesthetics can be improved by taking up painting on the pier structures and landscaping beneath the elevated structures.
- Increase in the number of passengers and trains at the stations will require more water for drinking, toilet, cleaning and also for other purpose like AC, chiller and other purposes. The trash from station includes garbage, rubbish, and floor sweepings.
- First and last mile connectivity including poor access to stations; lack of parking facilities; and absence of dedicated space for buses, cabs and autorickshaws, etc. are apparently costing the Metro at least one lakh daily ridership. BMRCL has the dedicated team comprising of six to seven officials led by an executive director to explore ways to address connectivity issues.

i. Positive Impacts of Metro Project

276. Construction of metro project in a city like Bengaluru will yield many tangible benefits such as better accessibility; reduction in atmospheric air pollution; less travel time; more comfort and improved quality of life. Some of the positive impacts have been listed and discussed below.

- GHG emission reduction - Based on the ridership numbers in table 2-1, a build-up period of 3 years, a 4% increase in ridership per year and a design life of the project of 25 years there will be an estimated net emission reduction of about 365,000 tons of CO₂. Other pollutants that will be reduced include PM, NO_x, HC, and CO.
- Employment Opportunities - The project is expected to generate employment for unskilled labourers during construction phase and the large number of skilled work force is required to operate and maintain the system during operation phase. During the construction phase, there will be requirements.
- Safety – Metro trains are largely safer, efficient and faster compared to other modes and means of transportation. Also, operation of metro trains reduces traffic congestion and chaos on at-grade roads making the roads safer and reduces the incidence of accidents.
- Reduction in Traffic Congestion and resulting Air pollution and Noise pollution – Proposed metro connectivity provides quick access to commuters thus attracting public to use metro thus reducing the traffic congestion significantly on the main roads. The reduction in traffic congestion reduces the fuel consumption and helps to conserve fuel and reduce air pollution and noise pollution on the roads.
- Increase in Green Cover – Compensatory plantation at the rate of 10 trees for each tree being cut due to the project, will increase the green cover and improves the weather.
- Benefits to Economy - The project will facilitate movement of people from one part to other. This safe and easy movement yields benefit to growth of economic activity due to better accessibility, savings in fuel consumption, reduction on investment on

road infrastructure, reduction in vehicle operating costs, savings in travel time, improvement in safety and quality of life and reduction in loss of productivity due to health disorders resulting from pollution.

VI. INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

277. Consultation and inclusion of various stakeholders is an integral part of environment and social impact assessment and ADB SPS 2009. The stakeholders of the project include project affected communities and other stakeholders. Consultations at micro-level (along the alignment) and macro-level (e.g. city level institutional consultations) help planners integrate the short term and long-term requirements of the local and regional planning goals.

278. The consultations were conducted during the field visits based on informal unstructured interviews and focus group discussions. The objective of the consultation was to disseminate the project information and obtain stakeholder's views on probable environmental and social impacts that may arise during the implementation of the proposed project. Consultations at project level were conducted at pre-identified, accessible locations along the alignment. The project affected families are limited in number (only 123 owners, 137 tenants and 4 non-title holders) as the land being acquired for construction of viaduct is very less and the land required for construction of proposed metro stations is minimum as 12 metro stations out of 17 metro stations are located on the vacant government lands. The informal consultations were organized with individuals and nearby people, in order to present the project features and collect their views on the perceived positive and negative impacts on the environment on account of this new development. More public consultations will be conducted to ensure that the public are properly heard during various stage of implementation of project.

279. A walk-through informal group consultation was conducted during site visits in June 2019 along the alignment stations and at affected locations of proposed metro project. During discussion, the project proposals (alignment and proposed stations); benefits of the project; impact and resettlement benefits; grievance redressal details and role of administration; etc. were explained to get their opinion and wider public input from among the general public and affected public. The details of these informal consultations are as below.

- Public at Benniganahalli had several issues with respect to their properties being lost for the project. Hence, they wanted to know the contact details and the concerned person so that they get clarification on the exact area of land being impacted.
- Public of Benniganahalli area were worried that most of them who are living in the area will be displaced. This confusion was mainly due to different Phases of metro projects and the flyovers being planned and implemented in this location. The project proposals were explained to the public with the help of drawings. It was clarified to them on the structures being impacted due to project.
- There was also a request from the public to give them more time for relocation. It was assured to them that sufficient time is given to them after disbursement of rehabilitation benefits.



- People at Kogilu Cross were very curious to know the alignment and the proposed stations to know the accessibility and distance from their settlements. Most of the public were happy to learn that the proposed metro project is passing near their settlements. They assured their support to the project as it helps them to commute quickly to other parts of the city.
- The participants were very keen to know the impact caused by the metro project on the land and structures. They were also eager to know the policy framework on the rehabilitation benefits extended for affected families. There were also requests for employing project affected people in Metro project/BMRCL.
- Some of the public requested to shift the metro station to avoid impact. It was explained to them that the station is proposed on other side of the airport road on the vacant land and the access to the station is being provided to their settlement.



280. Two other public consultation meetings for Phase 2B section were held at Muthu Mariamma Temple, Jyothinagara, Outer Ring Road, KR Puram on 12 December 2019 and Kogilu Cross, Airport Road on 28 February 2020. Stakeholders and project affected people were among the people who attended the meetings. The details on gender disaggregated ratio are given in social impact assessment and resettlement plans prepared for the project. The main concerns raised by the stakeholders was on the how compensation will be decided, when compensation will be paid to them and when they have to vacate their houses. The key findings of the meeting are given in Tables 6.1 and 6.2 and the photographs are given in Figures 6-1 and 6.2.

Table 6-1: Major findings of Public Consultation, Muthu Mariyamma Temple, ORR

Sl. No.	Name of Stakeholder / Project Affected Public	Grievance / Request	BMRCL's Response
1	Govardhan	When will the compensation be issued to property owners and when should they vacate the houses and shops?	Sufficient time of 15 days will be given to property owners to vacate and shift their articles after the publication of Notification.
2	Shankar	I am a commercial tenant. My shop is being affected. How much will I get for shifting my shop.	You will get Rs. 35,000 as shifting charges depending on the area of your shop and the GST being paid by you. Shifting allowance of Rs. 1,70,000 for 1000 sq ft and Rs. 4,00,000 for 1500 sqft will be given. Further, if the building is bigger, shifting allowance will be paid at the rate of Rs. 540 /sqft.
3	Rangamma	I have 5 children, I am leading my life by daily wage. I have one handicap daughter in my house. Please let me know the compensation for me.	You will be given compensation under the project as a special consideration
4	Govardhan	How do you pay for shifting houses with sheet roof and mold roof?	Rs. 1,00,000 of shifting allowance will be given for shifting of both type of houses with sheet roof or mold roof.
5	Sagar	My plot has a length of 15 m out of which only 10.5 m is being acquired by BMRCL. Can BMRCL take whole of my land and pay me the compensation. I have taken bank loan on the land being acquired. Please give me information.	Please submit your request to BMRCL Office which will be examined and suitable action will be taken.
6	Harish Reddy	Please let me know what is the compensation for converted land and the revenue land having survey number? You had acquired my land for which NGT had not allowed for land conversion. But now NGT has allowed conversion for my land. Please give more information on how BMRCL considers this and gives compensation.	Requested him to submit the request along with details and records on his land to BMRCL, so that BMRCL will take suitable action.
7	Radha	Time given for shifting to different place is not sufficient as I have children going to nearby school. Request BMRCL to give time till the annual examinations are over.	BMRCL will consider children going to school.

Sl. No.	Name of Stakeholder / Project Affected Public	Grievance / Request	BMRCL's Response
8	Prabhu	Please give alternative government land for us to shift.	Government land is not available and you are requested to shift to suitable places on your own.
9	Indrani / Vijayalakshmi	My granddaughter is handicapped, please help me.	Please share more information to BMRCL officials so that appropriate action will be taken.
10	Tenants	There are about 40 tenants being affected. Please give us government plots.	Tenants can be paid shifting allowance only. BMRCL cannot give either the cost of house or the plot. BMRCL can send a request to government on behalf of tenants.

Figure 6- 1: Public Consultation Meeting Photos, Muthu Mariyam Temple, ORR



Table 6-2: Major findings of Public Consultation, Kogilu Cross, Airport Road

Sl. No.	Name of Stakeholder / Project Affected Public	Grievance / Request	BMRCL's Response
1	Subramani	Survey number 75 has many houses in a single plot with a space left for access road within the plot. Request was made to consider this space and give compensation.	BMRCL asked to submit the request along with relevant documents of ownership for claiming the compensation
2	Sarojamma	She requested to give more time for shifting after paying the compensation as they have to either look for new accommodation to purchase and it requires time.	Six months will be too long a time to consider. Time as per the provisions of Policy framework will be given.
3	Venkatesh	My land has already been acquired for National Highway by NHAI and the compensation given is not sufficient.	Compensation for NHAI acquired land cannot be paid by BMRCL.
4	Hemaraju	The compensation given is less than the market value	BMRCL has released amount to NHAI but NHAI has not yet released the compensation.
5	Srinivas, Raghavendra Condiments (tenant)	The shifting allowance is not sufficient as we have spent more for the furniture in the shop	Business loss allowance and shifting allowance will be paid to tenants based on the area of the shop
6	Raju Gowda	We don't know the amount of compensation being disbursed by BMRCL	BMRCL will communicate the amount of compensation to be released within 15 – 20 days, depending on individual loss.
7	Y M Gopal, Hotel owner	I don't know the extent of building being demolished. Please let me know.	BMRCL will let you know about the exact extent of building to be demolished after finalizing the drawings of proposed station at Kogilu cross.
8	Muniraj, Udupi Garden & Vandana Hotel	My land has been acquired several times by various agencies like NHAI, BBMP & BMRCL. The compensation given during previous acquisition is not sufficient.	BMRCL cannot help for previous acquisition and compensation but will give the compensation as per the latest market value with 100 % solatium for the land being acquired by BMRCL.
9	Naushad, Tenant, Mobile shop	Requested to give compensation for the furniture in the shop	There is no provision to pay for the furniture in the shop. They have to be shifted on their own.
10	Ramamurthy	I am losing underground water sump of size 14'X14'X14' and request you to consider for compensation	It will be considered
11	Syed Abdul Subhan, Famous Chicken Center	Do you pay for the employees in my shop	BMRCL does not pay for employees in shops
12	Abhishek Gowda & Kempamma tenant	Requested for alternate job as a compensation	There is no provision of this in BMRCL compensation policy

13	Ammayamma	She is not getting the rent after taking the notice from BMRCL. Will that be compensated?	Business and rental income loss will be considered based on the BMRCL compensation policy. It was informed that a notice will be served to the tenants also.
14	Jayamma	She has five daughters and distributed all the property to them. I require some livelihood assistance	BMRCL will look into the matter.
15	Mubharak, Real Estate Office	I have five employees, Will there be any assistance to them?	BMRCL does not pay for employees in shops
16	Manjunath B N (& Susheelamma B N)	I am handicap and dependent on rental income. Can I get employment in the metro?	The matter will be examined. Loss of rental income will be compensated as per BMRCL compensation policy.

Figure 6- 2: Public Consultation Meeting Photos, Kogilu Cross Airport Road



281. Consultations have also been organised for stakeholders at the regional level to collect the opinion / views on the proposed metro project. Consultation was organized with officers of concerned government department and non-government organizations (NGOs) in the city.

282. Information disclosure will follow the procedure for ADB Category A projects disclosure requirements. It is the policy of the ADB to have environmental and social assessment reports made available/accessible to the general public.

283. The project EA will be responsible for the disclosure of this EIA in compliance to ADB's Communication Policy 2011 and ADB's SPS 2009. The draft Environmental Impact Assessment Report will be disclosed in the English language in the office of BMRCL. The report will also be made available to interested parties on request from the office of the BMRCL. Since this is Category A subproject, the draft EIA report will be disclosed to the public through the ADB website, 120 days before the approval of the project by ADB Board. The draft EIA report will also be made available to all stakeholders as part of the consultation process required under the SPS 2009. The final report will also be disclosed on ADB website.

A. Grievance Redressal Mechanism

284. A grievance redress mechanism (GRM) is in place to hear grievances and suggestions from stakeholders and affected people on issues related to the construction of metro project; R & R issues and implementation of EMP. Public Relation Officer (PRO) will be nodal officer to interact, co-ordinate and resolve the grievances. Provision is made to submit the concerns / grievances at Construction sites, Land Acquisition Office and BMRCL Head Quarters. The PRO with the help of respective department heads (Social, Environment, Technical, etc) is responsible to suitably address the issues from stakeholders and project affected people through acknowledgement, evaluation, action and response approach. Grievance redress mechanism framed by BMRCL and contact details (with name) of PRO will be displayed in the BMRCL website, project offices head office and at the project construction site prior to commencement of construction works.

285. The grievances are screened for genuineness and validity after registering in the grievance register and logbook. The genuine and valid grievances will be acknowledged, evaluated, redressed, implemented and communicated in a timely manner to the complainant by the grievance redressal mechanism with the help of Grievance Redress Committee (GRC) constituted at BMRCL. The small and local grievances will be dealt and resolved by the Contractor or Site Engineer in-charge or Tahsildar. The grievances from public or stakeholders related to project; response to parliamentary questions; public representations; court cases and right to information (RTI) applications on social and environmental issues and any other matters will be dealt by forwarding to respective department heads. Matters related to social issues and resettlement benefits are forwarded to Deputy General Manager (DGM) or General Manager (GM) Land Acquisition Department for resolution. Issues related to environment and EMP implementation are directed to the Environment Officer (EO). Both Land Acquisition Department and Environment Department constitute to form Social and Environment Management Unit (SEMU). All the other technical issues are referred to respective Deputy Chief Engineer (DCE) or Chief Engineer (CE). A copy of grievance shall be parallelly communicated to Designated Engineer (DE) for information and required action. The grievance which could not be resolved at SEMU or Technical Section level, will be referred to Grievance Redressal Committee (GRC) headed by Director (Projects and Planning) who acts as Chairman of GRC. The grievances and enquiries beyond the purview of GRC requiring to be cleared through judiciary will be referred and resolved through legal cell of BMRCL. The GRM flowchart is shown in the figure below.

286. The GRC comprises of following members under the Chairmanship of Director (Projects and Planning).

- a. Director (Projects and Planning), Chairman
- b. General Manager (LA & E), Convener
- d. General Manager (F & A), Member
- e. Chief Public Relation Officer, Member
- f. Chief Engineer (respective Reach), Member
- g. Manager (Transportation), Member
- h. Tahsildar (Respective Reach)

287. The main responsibilities of the GRC are:

- (i) To provide support to stakeholders and Project Affected Persons (PAPs) on resettlement and rehabilitation benefits provided and problems and complaints arising out of land acquisition, relocation of utilities and project implementation.
- (ii) To record the grievance and resolve them within stipulated time frame.
- (iii) To report to the aggrieved parties about the development regarding their grievances and decision of BMRCL.
- (iv) To meet regularly on a prefixed date during implementation of project.

288. The flow chart of grievances redressal mechanism is indicated in Figure 6-3.

Figure 6- 3: The GRM Framework, BMRCL

