CHAPTER 14

ENVIRONMENTAL IMPACT ASSESSMENT

TABLES

CHAPTER 14

ENVIRONMENTAL IMPACT ASSESSMENT

14.0 INTRODUCTION

The Ministry of Environment and Forests (MoEF), Government of India issued notification on 14th September 2006 superseding the earlier notification No.: SO 60(E) dated 27th January 1994 for getting Environmental Clearance. All new projects/expansion and modernization of existing projects or related activities listed in the schedule 1 of the notifications are required to obtain prior environmental clearance from MoEF. The proposed Nagpur Metro rail project does not fall in the schedule requiring the prior environmental clearance. Still, DMRC being an environmental conscious organization has undertaken EIA study to mitigate/reduce the environmental impacts arising from construction and operation of the project.

DMRC appointed M/s Consulting Engineering Services (India) Private Limited for carrying out the EIA study for the proposed Nagpur Metro. The objective of the EIA study is as follows:

- Ascertain positive and negative environmental and social impacts of the project.
- Mitigate negative environmental and social impacts.
- Enhance environmental quality in and around the project area by adopting mitigation and conservation measures.

14.1 BASELINE ENVIRONMENTAL CONDITIONS

The development / compilation of environmental baseline data are essential to assess the impact on environment due to the project. The environment includes water, land, air, ecology, noise, vibration etc. The information presented in this section stems from various sources such as reports, field surveys and monitoring.

Climatologically data was collected from regional meteorological department at Nagpur. This data has been further utilized to assess the incremental impact if any due to the project. Socio-Economic assessment has also been done. Study area

consists of the following two metro alignments for the proposed metro rail project in Nagpur.

- Automotive Square to KHAPRI (North – South Corridor) – 19.658 Km including one depot
- Prajapati Nagar to Lokmanya Nagar (East – West Corridor) – 18.557 Km including one depot.

14.1.1 Physiography

Nagpur district lies on the Deccan Plateau of Indian peninsula and has a mean altitude of 310.5 mean above sea level. It is situated at latitude between 20°35'N and 21°44'N and longitude between 78°15'E and 79°40'E. The district is situated on the eastern part of the State abutting the state of Madhya Pradesh in north and is bounded by Wardha and Amravati districts in the west, Bhandara district in the east and Chandrapur district in the south. The district has a geographical area of 9892 sq. km. Nag River a tributary of Kanhan river flows through the project alignment. The district forms part Godavari Terrain of the project area is plain.

14.1.2 Geology and Soil

The city of Nagpur lies on the basaltic flow known geologically as Deccan Traps. The parent basalt is very dark grey in colour, compact, dense and very hard in nature. It is very difficult to break this rock and it breaks up with sharpconchoidal fractures confirming to be of igneous origin. Nagpur city lies in the neighbourhood of the classical geological areas of India. More than half of the whole district of Nagpur is covered by basaltic and doleritic lava flows known as Deccan Traps. The main soil types present in the region are kali soils, morand soils, khardi soils, bardi soils, kachchar soils and wardi soils.

14.1.3 Hydrology

Nagpur city is located on a basaltic plateau and the topography in and around the city is plain it gently rolling. The north-eastern and eastern parts of Nagpur district are drained by Wainganga river and its tributaries of which Kanhan forms the major .The central and western portion of the district is drained by Wena river which is main tributary of Wardha river.

There are several natural water bodies within the city limits including 12 lakes, two rivers and five nallahs. The lakes (Gorewada, Futala, Ambazari, Sonegaon, Sakkardara, Gandhisagar, LendiTalao, NaikTalao, DobTalao, Pandrabodi, Sanjay Nagar Khadan and Pardi) cover an area of about 3.13 sq. km. The Nag and Pili

Rivers cut across the city and are 15.73 km. and 12.11km. in length, respectively. Besides these, Chamar Nallah, Shakti Nagar Nallah, Hudkeshwar Nallah, Swawalabmi Nagar Nallah and Sahakar Nagar Nallah also flow through the city.

14.1.4 Land Use Pattern

The land use/land cover pattern of a region is an outcome of natural and socio – economic factors and their utilization by man in time and space. Hence, information on land use / land cover is essential for the selection, planning and implementation of land use which can be further used to meet the increasing demands for basic human needs and welfare. Land use pattern along both the alignment is generally residential and commercial, with some part of the alignment having plantation, Institutions, water bodies etc.

The different categories of land use of the study region are given in the Table 14.1 below:

Table 14.1: Land Use Categories

S. No.	Land Use Category	Area (sq.km)	Area Percentage (%)
1	Agricultural Land	11.34	14.52
2	Built-up Area	38.85	49.75
3	Open Area	7.31	9.36
4	Plantation	8.25	10.56
5	Institute	0.51	0.65
6	Industry	6.79	8.70
7	Lake	1.57	2.01
8	Water body	0.42	0.54
9	Canal	0.23	0.29
10	Ground	0.19	0.24
11	Wasteland	2.63	3.37
Total		78.09	100.00

14.2 Meteorology and Climate

The climate of Nagpur can be broadly divided into three important seasons of summer, winter and monsoon. Almost throughout the summer (March-June), the maximum temperature remains beyond 40 degree Celsius. Sometimes it may be as high as 48 degree Celsius. Monsoons (July-September) take its charge in the month

of June. It showers maximum in the months of July and August. The minimum temperature recorded around 12 degree Celsius in winters (October-January) and sometimes even dips down below that level in the month of February. Nagpur city experiences a low pressure in the end of May month resulting in the wind blowing at a speed of 6 m/s or more and for the rest part of the year; the speed remains 2 to 3 m/s.

14.2.1 Temperature

The temperature generally rises from the beginning of March till June, which is the hottest month of the year with mean minimum and maximum temperatures of 20.3^{o}C and 36.7^{o}C respectively. With the onset of monsoons by the end of June, temperature begins to fall. The drop in day temperature is much more than the drop in night temperature.

The night temperature falls rapidly after the withdrawal of monsoons by mid-September. The month of December is coolest month with the mean maximum and minimum temperatures being 28.3^{o}C and 12.1^{o}C respectively.

Sky is generally clear with light surface winds blow from North or Northeasterly direction. The normal minimum temperature is 12.0°C to 14.0°C with slight rise in the mean daily minimum temperature. The mean maximum temperature is around 29.0°C.

14.2.2 Humidity

Except during monsoon months is generally low throughout the year. During summer season, humidity is lowest (20.7%). During monsoon months, it goes as high as 80-90%. The highest level of humidity (88%) is observed in the month of August.

14.2.3 Rainfall

At Nagpur, the annual rainfall is 1250.7 mm. About 60 to 70 % of the annual rainfall is reviewed in the monsoon months. The rain in Nagpur is heavily dominated by the south-westerly monsoon winds. Precipitation in form of rain is received during monsoon months. The number of rainy days in a year is about 56.9 at Nagpur.

14.2.4 Seismicity

The project area falls in **Zone-II** of Seismic Zoning Map of India. This is a least active zone from seismic point of view. Nagpur has close to zero chances of getting a major earthquake which may cause huge devastation. Recent history also supports the fact

that Nagpur region is relatively very safe as far as earthquakes are concerned. But still, as per the Seismic Zoning Map of India (IS 1893, Part-I, 2002) necessary seismic factors suggested by Indian Meteorology Department (IMD) shall be incorporated suitably while designing the structures to safeguard against earthquake risks.

14.3 Ambient Air Quality

As a part of this study ambient air quality monitoring (AAQM) has been carried out by setting up ambient air quality monitoring stations at four locations. The baseline data pertaining to the existing air quality will help mitigate impact on air quality during construction stage and operation stage of the project. The prominent source of air pollution in urban area is vehicular traffic.

Monitoring was done as per the guidelines for Ambient Air Quality Monitoring, National Ambient Air Quality Series NAAQMS/25/2003-04. The following parameters were measured:

- Respirable Suspended Particulate Matter (RSPM/PM_{10})
- Fine Particulate Matter (FPM/$PM_{2.5}$)
- Sulphur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Carbon Monoxide (CO, 1 hourly)
- Hydrocarbons (HC 1 hourly)

Air quality monitoring results are summarized in the following Table 14.2.

Table 14.2: Summary of Air Quality Monitoring Results

Parameter.	Proposed Kadbi Chawk Station (Residential/Commercial area)	Near proposed Mayuresh Station (Residential/Commercial area)	Ambedkar Chawk (Residential/Commercial area)	Near Proposed Subhash Nagar Station (Residential/Commercial area)
$PM_{2.5}$ µg/m^3				
No. of Samples	8	8	8	8
Range	28-52	32-51	29-64	27-40
Mean	42.8	36.3	41.8	33
98 percentile	49.6	40.7	61.3	39.5
PM_{10} µg/m^3				
No. of Samples	8	8	8	8
Range	29-86	23-37	70-83	29-33
Mean	55.3	30.9	77.0	30.7
98 percentile	85.6	36.4	82.1	33.1

NO_2 µg/m^3				
No. of Samples	8	8	8	8
Range	37-49	29-49	29-44	29-49
Mean	42.4	36.6	35.9	41.6
98 percentile	47.6	48.6	42.9	48.5
SO_2 µg/m^3				
No. of Samples	8	8	8	8
Range	9-23	11-26	9-26	10-24
Mean	16.3	17 .8	17.4	17.9
98 percentile	22.0	24.8	25	23.5
CO mg/m^3				
No. of Samples	8	8	8	8
Range	1.1-1.17	1.12-1.31	1.13-1.34	1.15-1.23
Mean	1.13	1.24	1.21	1.20
98 percentile	1.17	1.3	1.31	1.23
Hydrocarbons (µg/m3)				
No. of Samples	8	8	8	8
Concentration	<1.0	<1.0	<1.0	<1.0

The maximum value of $PM_{2.5}$ found at Kadbi Chawk station (42.8 µg/$m^{3)}$ followed by Ambedkar Chawk (41.8 µg/$m^{3)}$, Mayuresh Station (36.3 µg/$m^{3)}$ and Subhash Nagar Station (33 µg/$m^{3)}$.

The mean Nitrogen Dioxide concentrations were measured as 42.4 µg/$m^{3,}$ $^{36.6}$ µg/$m^{3,}$ $^{35.9}$ µg/m^{3} ^{and} 41.6 µg/m^3 at Kadbi Chawk, Mayuresh station, Ambedkar Chawk and Subhash Nagar station. These concentrations are well within the standards i.e. 80 µg/m^3 as prescribed by National Ambient Air Quality Standards. The low level of the Nitrogen Dioxide concentration may be attributed to better traffic management.

The average concentration of Sulphur Dioxide generated at various monitoring stations were recorded 16-18 µg/m^3 ^{and}. The values are also well within the specified limit i.e.80 µg/m^3 at all the monitoring stations

The mean Carbon Monoxide values at all four monitoring sites were recorded as 1.13 mg/m^3, 1.24 mg/m^3, 1.21 mg/m^3 and 1.20 mg/m^3 at Kadbi Chawk station, Mayuresh Station, Ambedkar Chawk and Subhash nagar station which is well within the National Ambient Air Quality Standards of 2mg/m^3.

As per the quantitative analysis of Hydrocarbons in air samples it may be concluded that hydrocarbons are present in minimum concentration (<1.0 µg/m^3) in the air environment of the study area. The concentration of Hydrocarbons measured at all four stations throughout the winter season was very well below the limit of 5 µg/m^3.

14.4 Ambient Noise Quality

Noise levels are measured at different places (16 locations) in Nagpur along the corridor at building lines away from source as per standard practice. Noise monitoring locations are presented in following Table 14.3 below:

Statistical indicators worked out for establishing the baseline conditions along the project corridor is presented in Table 14.3 below:

Table 14.3: Statistical Indicators for Noise Quality

Sl. No.	Station Id	L_{eqDay}	$L_{eqNight}$	Leq	L_{10}	L_{50}	L_{98}
1	Automotive Square	70.00	61.40	67.55	70.05	65.05	63.65
2	Sri Guru Govind Singh Educational Institute	73.00	60.00	70.20	74.70	68.35	65.50
3	Z.P.School Patawardhan Technical High School & College	64.00	53.20	61.34	64.09	59.44	55.64
4	Bank of Maharashtra near proposed Sitaburdi station (Munje Chawk)	70.00	58.00	67.26	72.06	64.36	63.06
5	NEERI Campus	71.50	63.80	69.17	74.57	65.67	65.45
6	Mayuresh Apartmnt (at proposed mayuresh station)	62.80	48.60	59.95	63.25	56.95	54.75
7	Existing Terminal Building	71.50	43.70	68.50	70.0	67.0	63.2
8	Open land of MIHAN SEZ	55.00	34.28	52.03	55.38	49.03	46.53
9	Saboo Hospital	70.80	62.70	68.42	72.31	65.22	63.47
10	Ashish Tower	68.50	55.00	65.68	70.08	63.88	60.48
11	Mayo Hospital	70.00	62.00	67.63	71.03	66.68	64.43
12	Ram Mandir	73.50	67.40	71.44	75.09	69.14	66.34
13	Govardhan Das Rawal High School	67.00	52.80	64.15	67.00	63.15	58.75
14	Salpeker's Brother's Petrol Pump	74.00	65.70	71.59	75.44	69.84	66.09
15	Dharampeth Polytechnic & Scienc College	69.00	48.90	66.03	71.23	63.03	61.83
16	St. Xevieviers High School	68.00	52.30	65.11	69.91	62.36	62.11

Highest value of Leq $_{day}$ has been obtained at NQ 13 (74 dB A) and minimum value has been obtained at NQ 7 (67 dB A) along the East – West corridor. Whereas, maximum day time L_{eq} has been obtained at NQ2 (73 dB A) and minimum value is obtained at NQ5 (62.5 dB A) along the North South corridor.

14.5 Water Quality

It is reported that five rivers are intercepting the project road. The other hydrological features are irrigation canal which intercepted the project road at five locations. The ponds are existing along either side of the project road provide requirements to village communities. The flow of river in the project site is seasonal and remains dry throughout the year. The underground water is the only important source for catering to needs of water demand for village's communities falling along the project road.

Water quality monitoring was carried out at four location covering two surface water sources and two groundwater sources. The results of the groundwater analysis obtained are presented below in Table 14.4:

Table 14.4: Water quality monitoring results

Parameter and unit	Station code			Limits as per IS:10500
	Gandhi Bagh Garden (GW1)	Automotive Square (GW2)	Mayuresh Station (GW3)	
Colour (Hazen units)	<5	<5	<5	5
Taste	Agreeable	Non-Agreeable	Non-Agreeable	Agreeable
Temperature (°C)	28	28.6	27.6	-
Ph	8.6	8	8.9	5-8.5
Conductivity (µS/cm)	950	835.2	605.2	-
TDS (mg/L)	31.5	30.5	14.9	500
TSS (mg/L)	2	3	1	-
Total hardness(mg/l)	329.4	313.2	199.8	300
Total alkalinity(mg/l)	152.63	50.88	101.75	200
Chloride (mg/l)	67.10	72.07	77.04	250
Sulphate (mg/l)	7.28	4.28	5.06	200
Nitrate (mg/l)	0.011	BDL	BDL	45
Fluoride (mg/l)	0.76	BDL	BDL	1
Calcium (mg/l)	70.2	270	81	75
Magnesium (mg/l)	62.99	10.50	28.87	30
Sodium (mg/l)	697	477	432	-
Potassium (mg/l)	168	155	266	-

Parameter and unit	Station code			Limits as per IS:10500
	Gandhi Bagh Garden (GW1)	Automotive Square (GW2)	Mayuresh Station (GW3)	
Phosphate (mg/l)	0.04	0.32	2.47	-
Silica (mg/l)	0.19	0.70	0.11	-
Arsenic (mg/l)	<0.01	<0.01	<0.01	0.01
Lead (mg/l)	<0.05	<0.05	<0.05	0.05

14.5.1 Physical Parameters

The quality of the ground water is showing alkaline trend as the pH value ranges from 8-8.9 which is not within the desirable limit for Automotive Square and Mayuresh Station persisting non-agreeable taste used for drinking purpose. The water contains no color, turbidity free and is odourless serving the most important source for drinking. Electrical Conductivity is a useful tool to evaluate the purity of water. The groundwater is fresh and potable with electrical conductivity ranging between 605.2µS/cm to 950µS/cm at 25°C

Total dissolved solids (TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro granular suspended form. The limit of 500mg/l for potable water is based primarily on the taste threshold. TDS ranges between 14.9mg/L to 31.5mg/L which is well in the permissible limit.

TSS varies from 1mg/L to 3 mg/L while Total Hardness in the ground water samples vary from 199.8mg/L to 329.4mg/L as $CaCO_3$.All the ground water samples were found to be moderately hard. Maximum Total hardness is reported in Gandhi Bagh Garden whereas minimum total hardness is reported in Mayuresh Station. Though hard water has no harmful effects on health but it restricts its use for other purposes

14.5.2 Chemical Parameters

Chloride content in the water samples was low in the winter season. The concentration of chloride in the groundwater is found in the range of 67.1mg/L to 77.04 mg/L which is within the limit at all groundwater stations

The sulphate content varies between 4.28mg/l to 7.28mg/l and the fluoride content is 0.76mg/l at Gandhi Bagh Garden which is within the desirable limit of 1mg/l. Maximum Sulphate concentration is observed in Gandhi Bagh Garden but very well below the desirable limit.

Total Alkalinity in terms of $CaCO_3$ varies from 50.88mg/l to 152.63mg/l which is within the desirable limit of 200mg/l as prescribed by Indian Standards of Drinking Water.

Nitrate is well within the limits of IS: 10500 at all the stations. Its concentration at Gandhi Bagh Garden is 0.011mg/l while it is below detection limit at other sites which is within the permissible limit of 45mg/l

Fluoride content at Gandhi Bagh garden is 0.76mg/l which is well below the desirable limit 1.0mg/l

Calcium is a major cation found in ground water. Its concentration varies between 70.2mg/l to 270 mg/l. The concentration of calcium at Automotive Square and Mayuresh Station exceeds the limit of 75mg/l.

Magnesium concentration in the groundwater is high ranging between 10.5mg/l to 62.99mg/l Mayuresh Station exceeds the permissible limit of 30mg/l

14.5.3 Heavy metals

Arsenic and lead concentration at all the GW stations is below the desirable limit of 0.01mg/l and 0.05mg/l respectively.

14.5.4 Microbiological parameters

Total coliform and fecal coliform are absent in the groundwater samples.

The results of the surface water sample analysis obtained are presented below in Table 14.5:

Table 14.5: Surface water sample analysis results

Parameter and unit	Station code	Limits as per IS:2296
	Ambajhari lake (SW1)	Class D
Colour (Hazen units)	>5	-
Taste	Non-Agreeable	-
Temperature (°C)	28	-
Ph	8.2	8.5
Conductivity (µS/cm)	1966.1	1000
TDS (mg/L)	88.8	-
TSS (mg/L)	20	-
Dissolved Oxygen (mg/l)	5.6	4
Total hardness(mg/L)	286.2	-
Total alkalinity(mg/L)	254.38	-
Chloride (mg/L)	206.26	-
Sulphate (mg/L)	33.84	-
Nitrate (mg/L)	0.023	-
Fluoride (mg/L)	0.94	-
Calcium (mg/L)	17.28	-
Magnesium (mg/L)	59.049	-

Parameter and unit	Station code	Limits as per IS:2296
	Ambajhari lake (SW1)	Class D
Sodium (mg/L)	1456	-
Potassium (mg/L)	187	-
Phosphate (mg/L)	0.02	-
Silica (mg/L)	0.86	-
Nitrite mg/l	BDL	-
COD	12	-
BOD mg/ml	5.0	-
Oil & Grease mg/l	6	0.1
Arsenic (mg/L)	<0.01	-
Lead (mg/L)	<0.05	-
Total Coliform (MPN/100ml)	110	-

14.5.5 Physical Parameters

The pH value of SW1 is 8.2. The alkaline pH in lake water might be due to presence of alkalinity minerals in water. Higher values of pH also reduce germicidal potential of chloride. The electrical conductivity of the surface water is 1966.1 µS/cm. Electrical conductivity at the site was found to exceed the limit of 1000µS/cm. High value of conductivity recorded at SW1 (Ambajhari Lake) indicates a high concentration of soluble salts in water. The water contains color, therefore do not serves the drinking purpose of the local population dwelling in the area.

The value of TDS 88.8 mg/L. TSS is found in natural surface water. TSS value of water sample is 20 mg/l.

The value of DO is 5.6 mg/l indicating low levels of organic matter in the water. The principal natural physical factors affecting the concentration of oxygen in the marine environment are temperature and salinity. DO concentrations decrease with increasing temperature and salinity.

14.5.6 Chemical Parameters

Total Hardness in the surface water sample is 286.2mg/L as $CaCO_3$. Sulphate is present in the surface water within the permissible limit. Its concentration is 33.84mg/l.

Total Alkalinity in terms of $CaCO_3$ of the water sample is 254.38mg/l indicating high concentration of carbon based molecules suspended in that water Chloride is an important anion present in the water. Its concentration is 206.6mg/L showing high chloride content. Elevated levels may also harm aquatic life.

Nitrates are used as indicators of nutrient levels and as a guide for the algal blooms and hence eutrophication. Its concentration beyond permissible limit leads to methaemoglobinemia, which is blue baby disease. Its concentration in the surface water samples is 0.023 mg/l. Fluoride content is 0.94mg/l

Calcium is a major cation found in water. Its concentration in the water sample is 17.28 mg/l.

Chemical Oxygen Demand value is 12 mg/l in the water sample which indicates that the Lake water is unpolluted. Low Total Phosphate content of the water sample is 0.02mg/l indicates there is no phosphorus loss from agricultural sites entering lakes.

BOD concentration in the water sample is 5.0mg/l. The BOD value indicates less quantity of organic waste in the Lake water making it moderately clean.

14.5.7 Heavy metals

Arsenic and Lead concentration in the water sample is <0.01mg/l and <0.05 mg/l respectively.

Coliform analysis can indicate the degree of possible contamination by human sewage, and possible presence of other pathogens, present in the water. Total Coliform in SW1 is 110 MPN/100ml.

14.6 Soil quality

Soil samples were collected from selected locations to establish the baseline soil conditions in the study area. Representative soil samples from depth (15cm) were collected for estimation of physic-chemical characteristics of soil.

14.6.1 Physical properties

Results indicate that the clay content is 22% at SQ1, 29% at SQ2, 19% at SQ3 and 54% at SQ4. The sand content varies from 34-52% while silt content is varying from 12-39%. The porosity is ranging from 7.4% by mass to 10.5% by mass. Lower values of bulk density varying from 1.17 to 1.24gm/cc. indicate good soil structure.

Texture of SQ1(Automotive Square) is classified as Sandy Clay Loam, SQ2 as Medium Loam, SQ3 as Sandy Loam and SQ4 as Clayey. The soils varied in moisture content from dry through moist to wet types. Moisture content varies from 3.7% to 31.3%.

14.6.2 Chemical Properties

The collected soil samples were analyzed for various chemical properties. The parameters selected were pH, electrical conductivity, Organic Matter, Nitrogen,

Exchangeable Potassium, Phosphorus, Sulphate and Sodium. pH is an important factor which indicates the alkaline and acidic nature of soil and gives the idea of nutrient availability, microbial activity and physical condition of the soil. The soil in the study area is alkaline in nature as the pH value is varying from 7.75 to 8.58. Conductivity is ranging from 80 to 175µS/cm. The total Nitrogen in the soil samples in the study area varies from 728mg/100g to 1784mg/100g.The substantial amount of the nitrogen in the soils of the study area is contributed by nitrogen fixing bacteria of the genus *Rhizobium* associated with the leguminous plants of the area which constitute an appreciable proportion of the plant species.

Organic matter is an important soil health indicator as it contributes to the biological, chemical, and physical properties of the soil. Organic matter serves as a reservoir of nutrients and water in the soil, aids in reducing compaction and surface crusting, and increases water infiltration into the soil. The organic matter in the soil samples is ranging from 1.5% to 2.6%. It is also responsible for the stability of soil aggregates.

The phosphorus concentrations ranged from 33mg/100g to 94mg/100g. The total content of the basic chemicals like K, gives the extent of leaching of the soil where the concentration of exchangeable Potassium varies from 77.1mg/1000g to 251.9mg/1000g.

The analytical results of the soil samples are presented in the Table 14.6.

Table 14.6: Soil samples analysis results

Parameter & unit	Monitoring location			
	SQ1 Automotive Square	**SQ2** New Airport Area	**SQ3** Between Prajapati Nagar and Vaishno Devi Chawk	**SQ4** Between Subhash Nagar & Rachana Ring Road
pH	7.75	7.84	8.58	8.02
Electrical Conductivity (µS/cm)	175	58	80	86
Sand (%)	52	48	42	34
Silt (%)	26	23	39	12
Clay (%)	22	29	19	54
Moisture Content (%)	31.3	6.2	3.7	8.9
Infiltration rate (mm/hr)	14.5	10.3	11.2	8.6
Bulk Density (gm/cc)	1.24	1.19	1.21	1.17

Parameter & unit	Monitoring location			
	SQ1 Automotive Square	**SQ2** New Airport Area	**SQ3** Between Prajapati Nagar and Vaishno Devi Chawk	**SQ4** Between Subhash Nagar & Rachana Ring Road
Porosity (%)	9.2	9	10.5	7.4
Organic Matter (%)	1.7	2.1	2.6	1.5
Nitrogen (mg/100 g)	1784	1024	1429	728
Exchangeable Potassium (mg/1000g)	203.3	177.8	251.9	77.1
Phosphrous (mg/100 g)	94	57	72	33
Sulphate (as SO_4) (mg/kg)	298	7.6	51.9	16.2
Sodium as (Na) (mg/kg)	257	54.1	149.2	45

14.6.3 Biological Environment

The main impact on biological environment will be from the tree felling. Data pertaining to the field survey indicates that total 41 species will be felled due to the project. Primary survey of the terrestrial ecology indicates that no rare endangered species listed in the IUCN are getting affected due to the project. The main species are given in Table 14.7.

Table 14.7: Summary of Trees

Corridor	Location	Length	Trees to be felled
Corridor – 1 (North – South)	Automotive Square to Depot at KHAPRI	19.658 Km	85 Nos.
Corridor – 2 (East – West)	Prajapati Nagar to Lokmanya Nagar	18.557 Km	74 Nos.

Hence, a total of 159 trees are likely to be felled for the project construction.

14.7 POSITIVE IMPACTS DUE TO THE PROJECT

The metro rail will not only offer commuters a more secure and comfortable travel experience that comes with world class facilities, but it will also reduce the time of travelling and rush hour commuting. Its wide network coverage and connections will provide a very positive impact on daily commute of the people of Nagpur city. Some of the positive environmental impacts are as follows:

- Employment opportunities

- Enhancement of Economy
- Less fuel consumption
- Traffic congestion reduction
- Less GHG emissions
- Reduction in Air pollutant emission

The different components of benefits include:

- Vehicles off the Road due to Metro
- Vehicle KM Saved by Metro passengers
- Amount of travel time saved by Metro Passengers and by the Remaining Road Passengers (due to reduced congestion and increased speed on the road)
- Fuel consumption saved due to shifting to Metro
- Reduction in vehicular emissions in tonnes and the reduction in related emission cost
- Reduction in total and fatal accidents and savings in Accident Costs
- Reduction in Vehicle maintenance and operation Cost.
- Travel time savings to remaining road users due to release of road space, reduced congestion and improved speeds.

14.8 ANTICIPATED IMPACTS AND MITIGATION MEASURES

The environmental impact assessment of the project is based on the Baseline Environmental Status of the Area. The proposed project will have impacts on the environmental attributes in construction and operation phase. During construction phase which may be regarded as temporary or short-term; and the operation phase impacts may have long term effects. The environmental impacts due to construction phase and operation phase are discussed in the following subsections.

14.8.1 Impacts during Construction Phase

Potential sources of the construction phase environmental impacts are earthwork, bituminous work, concreting, setting up of labour camps etc. However, the construction phase impacts will be short-term and localized and can be mitigated by adopting appropriate mitigation measures.

14.8.2 Traffic Diversion and Risks to Existing Buildings

During construction, traffic diversions on roads will be essentially required. As most of the construction activities will be confined to centre of the road and most of the roads are four lanes, it will be appropriate that the side lanes may also be utilised for traffic

and also for smooth progress of construction activities. Advance information/signboards/warning signs will be an advantage to users of any particular road. As most of the proposed sections are elevated and located in the middle of the road with deck width being much less than the existing road width, hence risk to the existing buildings all along the route will be practically negligible. In underground portion, weather by cut and cover or by tunnelling, the building line is considerably away from the proposed cut and cover and tunnels. Hence no risk is foreseen to adjacent buildings. Some of the measures are as follows:

- At the points where traffic is to deviate from its normal path (whether on temporary diversion or part width of the carriageway) the channel for traffic will be clearly marked with the aid of pavement markings, painted drums or a similar device to the directions of the Engineer in Charge.
- One-way traffic operation will be established whenever the traffic is to be passed over part of the carriageway inadequate for two-lane traffic. This will be done with the help of temporary traffic signals or flagmen kept positioned on opposite sides during all hours.
- For regulation of traffic, the flagmen will be equipped with red and green flags and lanterns/lights.
- On both sides, suitable regulatory/warning signs as approved by the Engineer will be installed for the guidance of road users. On each approach, at least two signs will be put up, one close to the point where transition of carriageway begins and the other 120 m away. The signs will be of approved design and of reflectory type, or as directed by the Engineer.

14.8.3 Air Quality

Potential impacts on existing air quality during the construction phase would be due to dust generated during excavation, earth work, vehicles movement, loading and unloading of the construction materials.

Fugitive emissions generated due to vehicular movement are not expected to travel beyond a distance of 50 to 100 m from the point of their origin. Since, there is no habitation within 200 to 300m of the project site the impact on air environment during the construction phase is not expected to be significant as far as air pollution is concerned. Combustion of diesel in different construction equipment could be one of the possible sources of incremental air pollution during the construction phase.

Mitigation measures for minimizing impact on air quality during construction phase shall comprise:

- Vehicles with an open load carrying shall not be used for moving potentially dust-producing materials. Vehicles shall have properly fitting side and tailboards.
- Materials having the potential to generate dust shall not be loaded to a level higher than the side and tail boards, and shall be carried in vehicles fitted with cover lids / tarpaulin cover
- Excavated materials shall be placed in the designated dumping/disposal areas.
- Material shall be stabilized during summer season, each day, by watering at every two hours interval.
- The heights from which materials are dropped shall be limited to 1.5 m. to restrict fugitive dust generation.
- Water shall be sprayed at construction sites once every hour for period of two minutes to suppress dust, during handling of excavated dry soil or debris.
- Water sprays shall be used during the delivery and handling of all raw sand, and aggregate and other similar materials, when dust is likely to be created and to dampen all stored materials during dry and windy weather.
- All motorised vehicles on katcha roads on the Site shall be allowed a maximum speed of 15 -20 kilometers per hour.
- Concrete batching plant sites and ancillary areas shall be cleaned frequently and water shall be sprayed to minimise any dust emissions. Tentative sites for locating the construction camps have been identified at the following locations:
  - Lokmanya Nagar (proposed metro depot) – Government Land
  - KHAPRI Depot Land – Government Land
  - Automotive Square – Private Land
- Barriers/hoarding shall be provided securely around all construction work sites during the main construction activity, when reasonably practicable, to contain dust within the site area and also to reduce air turbulence caused by wind or passing traffic.

Workers working in dust generating areas shall use nose masks. Placards advising workers to use nose masks shall be displayed.

14.8.4 Noise Quality

During the construction phase, noise will be generated due to movement of vehicles, and operation of light & heavy construction machineries including pneumatic tools (dozers, tippers, loaders, excavators, graders, roller, concrete mixer, generators,

concreting pumps, vibrators, cranes, compressors etc.). The construction activities are expected to produce noise levels in the range of 75 – 95 dB (A).

The construction works will be carried out during the day time in residential areas. The impact of noise produced during the construction will, however, be limited to a distance of about 75 meters at which the noise level of various equipment will come down below 55 dB(A). It could therefore be concluded that the construction activities would not have a significant impact on existing ambient noise levels.

Workers working at noisy areas may be affected (if they do not use ear muffs/plugs), if actual exposures exceeds the prescribed safety limits (8-hour long limit of 90 dB (A)) as per Factories Act / BOCW Act 1996.

Mitigation measures for minimizing noise levels during construction phase are as follows:

- ✓ Stationary equipment shall be located so as to minimize noise impact on the neighbouring community.
- ✓ Plant and equipment known to emit noise strongly in one direction shall be oriented, wherever possible, in a direction away from noise sensitive receptor;
- ✓ Silencers and mufflers shall be fitted and maintained on construction equipments.
- ✓ Work shall be scheduled in such a way that activities that generate high noise levels shall not be done simultaneously;
- ✓ Truck loading, unloading, and hauling operations shall be scheduled so as to minimize noise impact near noise sensitive locations and surrounding communities;
- ✓ Equipment and plant will not be kept idling when not in use
- ✓ Plant at site shall be serviced regularly
- ✓ Placards shall be displayed near high noise areas
- ✓ Earmuffs/Earplugs shall be made mandatory for workers working in high noise areas.

14.8.5 Vibration

Construction activities can result in varying degrees of ground vibration, depending on the equipment and methods employed. Ground vibrations from construction activities do not often reach the levels that can damage structures, but they can achieve the audible and feelable ranges in buildings very close to the site. The construction activities that typically generate the most severe vibrations are blasting and impact pile.

The following mitigation measures will be adopted to reduce the degree of impact due to vibration during construction phase.

- Avoid impact piling in vibration sensitive areas. Drill pile or sonic piling will be employed in such areas to reduce the impacts on nearby buildings.
- Vibration monitoring will be undertaken as suggested in the environmental monitoring plan and a plan shall be prepared by the contractor to control the damage due to vibration.

Night time pile driving operation or other high vibration generation activities will not be allowed in vibration sensitive areas.

14.8.6 Soil Quality

Site Runoff from unprotected excavated areas can result in excessive soil erosion, especially when soil is highly erodible. Mitigation measures include careful planning, timing of cut and fill operations and re-vegetation. Problems could arise from dumping of construction spoils (concrete, bricks), waste materials (from contractor's camp) etc. causing surface and ground water pollution

The proposed North-West corridor has a construction of underground metro of about 3Km. Underground construction is a specialised and complex task. This is safety reasons near airport. Elaborate measures need to be adopted for collection, transfer and disposal of excavated soil as suggested below.

- Soil collection, transportation, disposal and its treatment needs to be carried out in a systematic manner.
- Soil collection should be in containers from the construction sites. These containers should be such that soil should not spill during movement to disposal site.
- The excavated soil will be first collected at dumping ground and then transferred to disposal sites.
- Dumping areas shall be approved by the engineer before its disposal.
- Surplus earth may be used with prior approval by the engineer to the nearby site requiring earth filling.

14.8.7 Impact on Terrestrial Ecology

The main impact on biological environment will be from the tree felling. Data pertaining to the field survey indicates that total 41 species will be felled due to the project. Primary survey of the terrestrial ecology indicates that no rare endangered species listed in the IUCN are getting affected due to the project. The main species are given in baseline section of this report. About 159 trees are to be cut due to the project on the following corridors:

Necessary permission from Nagpur Municipal Corporation (NMC) garden department is to be obtained for trees cutting. Compensatory tree plantation will be done in ratio of 1tree to be cut: 10 trees to be planted (1:10).

14.8.8 Impact on Water Quality

Construction activities may have an adverse impact on water bodies due to disposal of waste. The waste could be due to: the spillage of construction materials, dumping of used water from the stone crusher, oils and greases and labour camp. But the quantities of such spills are very negligible. Care, however, needs to be taken to provide adequate sanitary facilities and drainage in the temporary colonies of the construction workers. Provision of adequate washing and toilet facilities with septic tanks and appropriate refuse collection and disposal system should be made obligatory. Contamination of ground water can take place, if the dump containing above substances gets leached and percolates into the ground water table. This is not the case with the present project, as the activity does not involve usage of any harmful ingredients. Moreover, activities are of short duration. Hence, no adverse impact on either ground or surface water quality is anticipated in the present project.

14.9 OTHER IMPACTS

14.9.1 Impact due to Construction Camp

Influx of construction work-force and supplier who are likely to construct temporary tents in the vicinity may be a source of impact on the existing environment. Likely sanitation, health hazards may impact the surrounding environment due to inflow of construction labourers.

14.9.2 Mitigation Measures

- Construction camps sites will be properly demarcated, fenced and access controlled.
- Adequate provision of sanitation, drinking water supply, and primary health facilities.
- Regular health check-ups of worker shall be organized.
- Proper accommodation amenities will be provided to the workers.
- Crèche arrangement for the kids of women labour shall be made.
- Contractor will make arrangement for cooking gas to the workers to prevent illegal tree cutting.
- The construction camps will be located away from the residential areas.
- Awareness program for workers will be arranged
- Preferably local labour will be employed

14.9.3 Impact due to Equipment Storage and Machinery Maintenance

Proper maintenance shed for regular maintenance of the construction vehicles will be provided in the construction yards. Waste emanating from the maintenance shed should not be allowed to spread over to the nearby areas. Oil and grease separator will be provided. Oil and grease change of equipment and vehicles should be carried out in the service areas designated for vehicles. Wastes should be collected and disposed of properly and expeditiously.

14.10 SOCIAL IMPACTS

14.10.1 Socio-Economic Profile of PAPs/ PAHs

The following sections present socio-economic profile of the households likely to be affected by the proposed project. The baseline information collected through household survey provides the socio-economic conditions of affected households. A wide range of data including religion, social category, loss of land and structures, present usage of structures, education, occupation, sources of income, etc. have been collected through the socio-economic survey of households likely to be affected. The data base provides broad understanding of social and economic conditions of project affected households and the likely impacts that people would experience due to proposed project. The Summary of Socio-Economic profile of PAHs is given in table 14.8

Table 14. 8 – Socio-Economic Profile of PAHs

Particulars		E-W	N-S	Total	
				No.	%
Male		138	33	171	53.94
Female		123	23	146	46.06
Total		**261**	**56**	**317**	**100.00**
PAPs by age group	Less than 6 years	19	3	22	6.94
	7 to 14 years	28	5	33	10.41
	15 to 59 years	184	44	228	71.92
	➢ 59 years	30	4	34	10.73
Total		**261**	**56**	**317**	**100.00**
Religion					
	Hindu	35	7	42	85.71
	Muslim	3	0	3	6.12
	Bodh	2	2	4	8.16
	Total	**40**	**9**	**49**	**100.00**
Social group					
	General	22	5	27	55.10

Particulars		E-W	N-S	Total	
				No.	%
	OBC	10	1	11	22.45
	SC	5	3	8	16.33
	ST	3	0	3	6.12
	Total	**40**	**9**	**49**	**100.00**
Occupation					
	Agriculture / Animal husbandry	2	0	2	0.63
	Govt. Service	2	5	7	2.21
	Housewife	71	12	83	26.18
	Private service	9	0	9	2.84
	Rent/ Pension	7	3	10	3.15
	Self employed	39	3	42	13.25
	Business	37	10	47	14.83
	Student	74	21	95	29.97
	Unemployed	2	0	2	0.63
	Skilled Worker	2	1	3	0.95
	Unskilled Worker	6	0	6	1.89
	Children	10	1	11	3.47
	Total	**261**	**56**	**317**	**100.00**
Education (excluding children below 6 years)					
	Illiterate	14	1	15	5.08
	Literate	11	2	13	4.41
	Primary	8	2	10	3.39
	Middle	40	8	48	16.27
	Matric	32	8	40	13.56
	Higher secondary	36	13	49	16.61
	Graduate	74	12	86	29.15
	Post Graduate	27	7	34	11.53
	Total	**242**	**53**	**295**	**100.00**
Household Income (Rs.)					
	< 5000	8	1	9	18.37
	5001 – 10000	14	2	16	32.65
	10001 – 20000	15	2	17	34.69
	20001 – 50000	3	3	6	12.24
	50001 – 100000	0	1	1	2.04
	100000 +	0	0	0	0.00
	Total	**40**	**9**	**49**	**100.00**

Of the total PAPs, majority (15-59 years) are in the prime age of working. Hindus comprise 86% of the total households likely to be affected. As regards, social category of project affected households is concerned General category of households constitute (55%). Major occupations of PAPs are business, self-employment and service (govt. & private). Women members are mainly housewives. Students comprise about 30% of the total PAPs. As regards qualification of PAPs, it may be

observed that graduate and post-graduate comprise 41% followed by those having completed higher secondary, matric, middle, etc. Indicative household incomes were also ascertained through survey. None of the households qualify for consideration as below poverty line family. Monthly income of majority of households is more than Rs. 10000/-. In fact, almost all the households possess assets and consumer durables like, Fridge, TV, Computer, Mobiles, two wheelers, washing machine, micro oven, etc. Overall, economic conditions of PAPs likely to be affected are very good. Adverse impacts of proposed project are not likely to result in impoverishment of PAPs but would have significant financial problems if not compensated as per the prevailing market price

14.10.2 Impact on Structures

A total of 101 structures (74 in EW Corridor and 27 in NS Corridor) of various dimensions shall be affected by the proposed project. Majority of the structures are privately owned. Distribution of structures likely to be affected is summarized in **T**able 14.9. It may be observed that majority of structures are likely to be affected in east-west corridor. More than 50% of the total structures are single storied followed by double storied structures. Further, multi storied structures (upto 6 floors) comprise about 26.73% of the total structures likely to be affected. Most of the multi storied structures are in CA Road falling in east-west corridor.

Table 14.9: Structures Affected

Structures Affected (source:CES Primary Survey 2013)				
Structures affected	Corridor		Total	
	E-W	N-S	No.	%
Single storied	40	14	54	53.47
Double storied	16	4	20	19.80
Multi storied (4 to 6 floors)	18	9	27	26.73
Total	74	27	101	100.00
%	73.27	26.73	100.00	

Structures likely to be affected are of three categories (pucca, semi-pucca and kutcha) as per the building materials used for the construction. Semi-pucca structures are those which do not have RCC roof whereas kutcha structures are those which are made of wood, bamboo, straw, GI sheet, etc and can be shifted from the existing place to another location without much damage. Pucca structures constitute about 77.23% of the structures whereas semi-pucca and kutcha together comprise the remaining structure (22.77%). Kutcha structures are located at Prajpat Nagar in East-West corridor. *This list is tentative and exact number of structures likely to be affected can be worked out during detailed planning stage before taking-up of construction activity.*

Table 14.10: Typology of Structures Affected

Typology of Structures Affected (source: CES Primary Survey 2013)				
Typology of structure	EW	NS	Total	
			No.	%
Pucca	57	21	78	77.23
Semi- pucca	13	6	19	18.81
Kutcha	4	0	4	3.96
Total	74	27	101	100.00

Structures likely to be affected have been identified as per the present use. Majority of the structures in both the corridors is being used for commercial purposes. Structures used for residential and residential cum commercial purposes comprise 25.74% and 25.74% respectively. Structures used for commercial purposes comprise 48.51% of the total structures. (Refer Table 14.11).

Table 14.11: Structures Affected Corridor-Wise

Structures Affected by Use (source: CES Primary Survey 2013)				
Present use	E-W	N-S	Total	
			No.	%
Residential	20	6	26	25.74
Commercial	35	14	49	48.51
Residential cum commercial	19	7	26	25.74
Total	**74**	**27**	**101**	**100.00**

Extent of impacts on individual structures was assessed based on drawings as well as site verification. Out of the total structures likely to be affected, in 101 structures, the extent of impact is more than 35% and as a consequence occupants of these structures will be displaced. In 19 structures, safety of individual structure after dismantling will determine the continuance or displacement of the occupants. Extent of impact on structures is given in Table 14.12

Table 14.12: Extent of Impacts on Structures

Extent of Impacts on Structures (source: CES Primary Survey 2013)				
Extent of Impact (in %)	Corridor		Total	
	E-W	N-S	No.	%
Less than equal to 35	17	2	19	18.81
More than 35	57	25	82	81.19
Total	74	27	101	100.00
%	73.27	26.73	100	

14.10.3 Impacts on Common Property Resources (CPRs)

Besides, impacts on structures and land area the proposed project will also affect several common property resources (government structures, community, religious, etc). Distribution of CPRs affected as per ownership is given in Table 14.13. Majority of the common property resources likely to be affected belong to different departments/agencies. These structures comprise boundary walls, office buildings, guard room and structures used for other purposes. Similarly, boundary walls and other structures of educational institutions are also likely to be affected. Further, a few temples (3 in E-W corridor and 1 in N-S corridor), one hand pump and and one Piau (drinking water post) are also likely to be affected. In both the corridors, major portions of the structures would be affected.

Table 14.13: Common Property Resources

Common Property Resources (source: CES Primary Survey 2013)				
CPRs	E-W	N-S	Total	
			No.	%
Govt. structures				
Boundary Wall	10	5	15	31.25
Guard room	1	0	1	2.08
Other structures	6	6	12	25.00
Educational Institutions			0	0.00
Boundary Wall	6	2	8	16.67
Others	2	4	6	12.50
Religious (Temple)	3	1	4	8.33
Piau/ Well	1	1	2	4.17
Total	**29**	**19**	**48**	**100.00**

14.10.4 Impacts on Land

Metro stations have been planned within the road land mostly and as such additional land area is not proposed for it. But, additional land area is required for providing access to metro stations, parking facilities near stations, running sections, yards, curves, etc. Land area required for the proposed project has been worked out as per the design. Distribution of land area required for various purposes is presented in Table 14.14.

Table 14.14 - Area Likely to be Affected (Sqm)

LAND REQUIREMENT DETAILS				
NAGPUR METRO RAIL PROJECT				
LAND DETAILS	EAST-WEST CORRIDOR PRAJAPATI NAGAR TO LOKMANYA NAGAR		NORTH-SOUTH CORRIDOR AUTOMATIVE SQUARE TO KHAPRI DEPOT	
	GOVT. LAND (in sqm)	PVT. LAND (in sqm)	GOVT. LAND (in sqm)	PVT. LAND (in sqm)
STATIONS EXIT/ENTRY	3644.80	7769.40	7525.30	13812.50
RUNNING SECTION	3255.30	5680.80	101882.00	19025.90
DEPOT AREA	258973.00		339000.00	
TRAFFIC INTEGRATION/PARKING	8779.10	1465.70	53759.80	5179.20
TOTAL	**274652.20**	**14915.90**	**502167.10**	**38017.60**
TOTAL GOVT LAND	**776819.30**	**SAY 77.68 HECTARES**		
TOTAL PVT LAND	**52933.50**	**SAY 5.3 HECTARES**		

Additional private land required for the project shall be acquired as per the provisions of Land Acquisition Act, 1894. The Act provides for compulsory acquisition of land which includes vacant as well as built up properties. Private land constitutes about 4.83% of the total land requirement. Majority of the land required (94.56%) is government land. Government land shall be transferred as per the established procedure. Besides, 0.17% of the land likely to be affected belongs to religious institutions.

14.11 Impacts during Operation Phase

The operation phase impacts are as follows:

14.11.1 Water Quality

During operation phase the main source of water pollution will be Oil spillage during change of lubricants, cleaning and repair processes, in the maintenance Depot cum workshop for maintenance of rolling stock. The spilled oil will be trapped in grit chamber for settling of suspended matter. The collected oil should either be auctioned or incinerated, so as to avoid any underground water contamination.

14.11.2 Water Supply

Water requirement at railways stations will be 45 l/d as per the recommendation of CPHEEO. Since all the station are locate in the urban areas, water requirement

meeting the need has been take for personal use of staff, fire demand, make up water for air conditioning and ventilation and water loss. The water demand for each station will be approximately 100m^3per day. Adequate provisions for meeting the water demand at each station have been taken. Platform washing requirement has been worked out at metro stations has been taken at the rate of 2 liter per m^2. Fire fighting requirement has been taken as per the existing norms of Maharashtra Government.

14.11.3 Waste Disposal

The refuse from railway station includes; Garbage, Rubbish, and Floor Sweepings. The collection and removal of refuse in a sanitary manner from the Station is of importance for effective vector control, aesthetic improvement, and nuisance and pollution abatement.

For the maintenance of adequate sanitary facilities, containers/collection bins not exceeding 120-litres and equipped with side handles will be appropriately designed and installed at stations and platforms.

14.11.4 Noise Quality

During the operation phase the main source of noise will be from running of metro trains. Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from at-grade and elevated structures, while ground-borne noise and vibration are of primary concern in underground operations.

The wayside noise levels (Leq) has been worked out for peak headway to be 66.92 dB (A) for North South Corridor and 77.63 dB (A) for at 15m distance in 2041. The noise levels have been worked at elevated section for different distance from the metro is given in the following table 14.15.

Table 14.15: Cumulative Impact due to Increase Noise

Locations	Project Noise level at 10m distance (Peak Headway)	Ambient noise level L_{10}	Cumulative Impact
Automotive Square	74.06	70.05	75.65
Sri Guru Govind Singh Educational Institute	74.06	74.7	77.4
Z.P. School Patawardhan Technical High School & College	74.06	64.09	74.47
Bank of Maharashtra near	74.06	72.06	76.18

Locations	Project Noise level at 10m distance (Peak Headway)	Ambient noise level L_{10}	Cumulative Impact
proposed Sitaburdi station (Munje Chawk)			
NEERI Campus	74.06	74.57	77.07
Mayuresh Apartment (at proposed mayuresh station)	74.06	63.25	74.39
Existing Terminal Building	74.06	70.0	75.49
Barren land of MIHAN SEZ	74.06	55.38	74.06
Saboo Hospital	80.24	72.31	80.88
Ashish Tower	80.24	70.08	80.71
Mayo Hospital	80.24	71.03	80.73
Ram Mandir	80.24	75.09	81.40
Govardhan Das Rawal High School	80.24	67.00	80.24
Salpeker's Brother's Petrol Pump	80.24	75.44	81.48
Dharampeth Polytechnic & Science College	80.24	71.23	80.75
St. Xavier's High School	80.24	69.91	80.62

It is observed from the above table that there will be significant increase in noise levels during in 2041 due to the operation of metro.

It may be inferred from the above that there will be significant impact due to increase in the sound level. Therefore it is proposed to provide 6mm thick Poly-carbonated solid Plate may be provided as noise barriers. The noise transmission loss due to these barriers will be about 29dB (A).

Stretches identified for the provision of Noise Barriers are presented in Table 14.16.

Table 14.16: Provision of Noise Barriers in Different Stretches

Sl. No.	Name of Stretch	Length of Noise Barrier (km)
1	**East-West Corridor**	
1.1	Ambedkar Chowk – Jhansi Rani Chowk	6.5
1.2	Jhansi Rani Chowk-Dharampeth College	4.0
2	**North-South Corridor**	
2.1	Karvi Chowk-Kasturchand Park	2.5
2.2	Sitabuldi-Shekhar Nagar	6.0
	Total length of Noise barrier	**19.0**

14.11.6 Vibration

As discussed earlier, it is observed that the vibration is ranging from 29 VdB to 60 VdB along the project corridor. High vibrations (78VdB-84.7VdB) were recorded along the sections which are passing through existing NH7 and Hingna Road. It is due to movement of heavy vehicles on the highway. It is expected that vibration levels are likely to be increased due to operation of the Metro. Past studies (Source: http://indiatoday.intoday.in/story/delhi-metro-line-tremors-every-three-minutes/1/158027.html) have shown that the vibrations have been recorded between 60VdB and 72VdB due to operation of the Metro. It is also recorded that vibration levels have reached up to 95VdB when metro is running at a high speed 75-80Km/h. Therefore it is suggested that following mitigation measures are to be adopted to reduce the intensity of impact due to vibration.

- Metro underground lines should be laid at least 50 meter below.
- If this is not possible, mass spring system should be provided in the underground section.
- Rubber pads should be provided to reduce the intensity of the vibration.
- To keep vibration minimum at elevated section, foundation system shall be designed in such a way that vibration can be suppressed at source by providing rubber pads or sand filling.
- Speed reduction upto 50 Km/h may also be considered at critical section.

14.12 Impact on Terrestrial Ecology

There will no impact on terrestrial ecology due to operation of the project.

14.12.1 Accidental Hazards

In view of the hazards potential involved due to failure of system and accident the on-site and off- site emergency measures have been formulated and will be implemented.

14.12.2 Visual Impacts

The construction of the above corridor will bring about a change in visual look of the streets through which it will operate. An architecturally well-designed structure, which could be aesthetically pleasing and able to reduce impact due to visual disfiguration have been incorporated in present corridor. Since a low profile will cause least intrusion, the basic elevated section should be optimised at the design stage itself.

14.13 ENVIRONMENTAL MANAGEMENT PLAN

The proposed Nagpur Metro Project (east-west & north- south corridor) will provide quick service and safety, traffic congestion reduction, less fuel consumption, employment opportunity, and less air pollution on one hand and problems of Rehabilitation and Resettlement (R&R), soil disposal, etc. on other hand. The environmental issues likely to develop during project construction and operation phases could be minimized by making necessary provision in the project design and adopting Environmental Management Plan (EMP). Summary of Environmental management plan is given in Table 14.17.

Table 14.17: Environmental Management Plan

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
DESIGN PHASE				
Metro Alignment	The proposed corridor alignment was selected to minimise the land disturbance to avoid archaeological sites, temples and other environmentally sensitive areas in least.	During Design	DPR and design consultant	PIU of NIT
Cultural Heritage	Avoided by adjustment of alignment.	During Design	DPR and design consultant	PIU of NIT
Loss of Water Bodies	Utmost care taken to avoid alignment crossing water bodies	During Design	DPR and design consultant	PIU of NIT
Inadequate design provision for safety against seismological hazard	Make sure that design provides for safety of structures against worst combination of forces in the probability of an earthquake likely to occur in seismic zone-III.	DPR and detailed design stage	DPR and design consultant	PIU of NIT
PRE –CONSTRUCTION STAGE				
Water requirement	The requirement of water shall be for construction purpose etc., shall be planned and shall be arranged in order to avoid digging of Tube wells.	Pre construction stage	Contractor	PIU of NIT (implementing agency)
Disposal of final treated effluent from treatment	Options for final disposal shall be studied and the suitable	During design stage / and pre	Contractor	PIU of NIT (implementing agency)

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
plat	disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	construction of treatment plant		
CONSTRUCTION PHASE				
Environmental Management and Monitoring	This will include institutional requirements, training, environmental management and monitoring	During and after construction	Contractor	PIU of NIT (implementing agency)
Dust	Water should be sprayed during construction phase, wherever it is required to avid dust. Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.	During construction	Contractor	PIU of NIT (implementing agency)
Air Pollution	Vehicles and machinery are to be regularly maintained so that emissions conform to National and State AAQ Standards.	Beginning with and continuing throughout construction	Contractor	PIU of NIT (implementing agency)
Equipment Selection maintenance and operation	Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures relevant air, noise, and discharge regulations are met.	During construction	Contractor	PIU of NIT (implementing agency)
Noise	Noise standard at processing sites, will be strictly enforced as per GOI noise standards. Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. At construction sites within	Beginning and through construction	Contractor	PIU of NIT (implementing agency)

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
	150m of sensitive receptors construction will be stopped from 22:00 to 06:00. Machinery of noise barriers (Stone walls and plantation) for silence zones including schools and hospitals.			
Vibration	The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak p velocity as given in article project SHE Manual	Beginning and through constructi on	Contractor	PIU of NIT (implementing agency)
WATER				
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into rivers and irrigation system	Througho ut constructi on period	Contractor	PIU of NIT (implementing agency)
Wastage of water	Measures shall be taken to avoid misuse of water. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking purpose.	Beginning with and continuing throughou t constructi on	Contractor	PIU of NIT (implementing agency)
Sewerage disposal during construction at Service Centres	A minimum distance of any sewage or toilet facility from water sources should be 200 meters	Througho ut constructi on period	Contractor	PIU of NIT (implementing agency)
Sanitation and Waste Disposal in Construction Camps	Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. Waste in septic tanks will be cleared periodically. Drinking water will meet Indian National Standards.	Before and during building of constructi on camps	Contractor	PIU of NIT (implementing agency)

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
	Garbage will be collected in a tank and disposed of daily. Special attention shall be paid to the sanitary condition of camps. Camps will be located at a minimum distance of 200 m from water sources.			
SOIL				
Quarrying	Quarrying will be carried out at approved and licensed quarries only.	During construction	Contractor	PIU of NIT (implementing agency)
FLORA AND FAUNA				
Loss of trees and Avenue Plantation	Areas of tree plantation cleared will be replaced according to Compensatory afforestation Policy under the Forest Conservation Act. Trees will be planted against every tree cut as per norms.	After completion of construction activities	Forest Department	PIU of NIT (implementing agency)
SOCIAL				
Loss of Access	Temporary access should be built at the interchange and other roads.	During construction	Contractor	PIU of NIT (implementing agency)
Traffic jams and congestion	If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department	During construction	Contractor	PIU of NIT (implementing agency)

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
Safety with vehicles, people and livestock and signage	• Safety education and fines. • Allow for adequate traffic flow around construction areas • Provide adequate signage, barriers and flag persons for safety precautions. • Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions	During construction	Contractor	PIU of NIT (implementing agency)
Increase in disease Water-borne Insect-borne Communicable diseases	• Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. • Provide adequate sanitation and waste disposal at construction camps. • Provide adequate health care for workers and locate camps away from vulnerable groups	During construction At start-up Throughout construction	Contractor	PIU of NIT (implementing agency)
Location of camps depots and storage areas	Location of camps depots and storage areas shall be as per the contract specifications.	Throughout construction	Contractor	PIU of NIT (implementing agency)
OPERATION PHASE				
Noise and Vibration	Suitable measures should be considered where warranted. The public shall be educated about the regulations of noise and vibration pollution and its implications.	After completion of construction	PIU/EMP implementing agency	PIU of NIT (implementing agency)

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
WATER				
Oil pollution	Suitable treatment shall be taken for treatment oil before discharging the wastewater specially in depot areas.	During operation of the treatment plant	PIU/EMP implementing agency	PIU of NIT (implementing agency)
Maintenance of Storm Water Drainage System	The urban drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	Beginning and end of monsoon	PIU/EMP implementing agency	PIU of NIT (implementing agency)
Disposal of final treated effluent from treatment plat	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	During operation of the treatment plant	PIU/EMP implementing agency	PIU of NIT (implementing agency)
SOCIAL				
Safety and noise disturbances	New buildings should be prohibited within 50 m of the edge of carriageway. No new schools and hospitals should be allowed within 200 m of carriageway.	Throughout and after project development period.	Planning Department /PIU	PIU of NIT (implementing agency)

14.14 MITIGATION MEASURES

The main aim of mitigation measures is to protect and enhance the existing environment of the project. These measures should have positive effects on environment. Environmental mitigations are essential and shall be undertaken in various phase of project cycle viz. pre-construction, construction and operation stage of the project. Some of these have been described in the following section, which includes measures for:

- Compensatory Afforestation and Fencing
- Construction Material Management
- Labour Camp
- Hazardous Waste Management
- Archaeological and Historical Preservation

- Air Pollution Control Measures,
- Noise Control Measures,
- Vibration Control Measures
- Muck Disposal
- Soil Erosion Control
- Water Supply, Sanitation and Solid Waste management
- Traffic Diversion/Management
- Draining of Water from Tunnel
- Rain water harvesting
- Management Plans for Depot
- Utility Plan
- Energy Management
- Training and Capacity Building

14.15 Environmental Monitoring Programme

The environmental monitoring is required for the construction and operational phases. The parameters need to be monitored are water quality, air quality, Noise levels Erosion and Siltation, ecology and vibration levels. The detail monitoring programmes during construction and operational stages are presented in Table 14.8.

Table 14.18: Environmental Monitoring Programme

Sl. No	Environment Component	Environmental Monitoring Programme			Institutional Responsibility	
		Parameters	Locations	Frequency	Implementation	Supervision
DURING PROJECT CONSTRUCTION PHASE						
1	Air Quality	PM_{10}, $PM_{2.5}$ SO_2, NOx, CO, HC	Total -6 suitable locations. Plant Sites i.e. HMP/Crusher, Construction sites, Settlements	24 hourly samples, Twice a week every season during construction Period except monsoon season. One hourly, twice a week every season during Construction Period except monsoon season.	Concessioner	NIT

Sl. No	Environment Component	Environmental Monitoring Programme Parameters	Locations	Frequency	Institutional Responsibility Implementation	Supervision
DURING PROJECT CONSTRUCTION PHASE						
2	Water Quality	As per relevant IS Codes. 10500	At 3- suitable locations, Ground water sampling.	Quarterly, Once in every season.	Concessioner	NIT
3	Noise Level	Noise levels on dB (A) scale Leq dB(A) Day /Night. Days : Max.& Min Night :Max. & Min.	At 16-suitable locations i.e. At equipment yards, sensitive sites.	Quarterly, Once in every season.	Concessioner	NIT
4	Vibration Level	Noise levels on VdB (A) scale; Day /Night. Max.& Min	At 10 locations i.e. Sensitive sites and residential area.	Once in every years.	NIT	NIT
5	Soil Erosion	Visual Observation.	2 Entire length of alignment and agricultural fields	Pre-monsoon and post-monsoon season.	Concessioner	NIT
6	Compensatory Afforestation	No. of roadside plantation	Along the side of the carriageway	Comparison should be done for every six months	Concessioner	NIT
7	Flora & Fauna	Aquatic ecosystem	All crossings of surface water bodies along the road and project influence area.	Two times in a month Periodically inspections of environmentally sensitive sites	Concessioner	NIT
8	Borrow Area Management	Borrow areas redevelopment and Top soil Managements	Identified borrow areas	Once in a week	Concessioner	NIT
DURING OPERATION PHASE						

Sl. No	Environment Component	Environmental Monitoring Programme Parameters	Locations	Frequency	Institutional Responsibility Implementation	Supervision
DURING PROJECT CONSTRUCTION PHASE						
1	Air Quality	PM_{10}, $PM_{2.5}$ SO_2, NOx, CO	At 4- suitable locations.	24 hourly samples, Twice a week every season during construction Period except monsoon season. One hourly, twice a week every season during Construction Period except monsoon season.	NIT	NIT
2	Water Quality	PH, SS, $CaCo_3$, Alkalinity, Cl^- F^-, So_4, No_3	At 3- suitable locations of Ground water	Pre-monsoon & post-monsoon, once in every two years	NIT	NIT
3	Noise Level	Noise levels on dB (A) scale;Leq dB(A) Day /Night. Days : Max.& Min Night:Max.& Min.	At 16 suitable locations i.e. Sensitive sites and residential area.	Once in every years.	NIT	NIT

Sl. No	Environment Component	Environmental Monitoring Programme Parameters	Locations	Frequency	Institutional Responsibility Implementation	Supervision
DURING OPERATION PHASE						
4	Vibration Level	Noise levels on VdB (A) scale; Day /Night. Max.& Min	At 20 locations i.e. Sensitive sites and residential area.	Once in every years.	NIT	NIT
5	Erosion and siltation	Soil erosion rates, stability of bank embankment, etc.	High Emb of Bridge,shoulders and slopes	Twice a year	NIT	NIT

6	Ecology	Status of Afforestation programmes of green belt	All along available land either side of the project road	Once every year	NIT	NIT

14.16 ENVIRONMENTAL BUDGET

A budgetary cost estimate for environmental monitoring is suggested for construction phase period assuming 3 years and per annum cost for operation phase. Construction phase monitoring cost (tentatively) is worked out to be INR **5.904 million** and operation phase monitoring cost per annum is worked to be INR **1.128 million.**

R&R Provisions have been made according to the existing Govt. Policies such as NRRP, 2007 and policies followed for Maharashtra Urban Transport Project. Budgetary estimate for R&R Provisions (tentatively) is estimated as **Rs. 288 Crore**

A budget of **Rs. 87.252 million** has tentatively been kept towards the Environmental Management Plan of the Nagpur Metro project. The cost for Dust suppression during Construction, Solid Waste Management, Facilities & equipment and Cooking Fuel for construction workers is incidental to the Concessionaire.