# Chapter – 15
# ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT

# 15. ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT

## 15.1. EXISTING SCENARIO

### 15.1.1. Environmental Baseline

Data on land environment has been collected and compiled from various sources and during field surveys. Information about geology, hydrology, prevailing natural hazards like earthquakes etc have been collected from literature reviews and authenticated information made available by government departments. Water quality, soil quality, ambient air and noise environment in the surrounding areas were assessed primarily through field studies, and by undertaking monitoring and analysis of samples collected from field. Meteorological data was collected from Indian Meteorological Department (IMD). A scoping matrix was formulated to identify the attributes likely to be affected due to the development of proposed project and is presented in **Table 15.1**. The general environmental attributes pertaining to the proposed metro project along with parameters to be collected and its frequency are presented in **Table 15.2.**

**TABLE 15.1: SCOPING MATRIX**

| ASPECT OF ENVIRONMENT | LIKELY IMPACTS |
|---|---|
| **A. Land Environment** | |
| Construction Phase | Increased soil erosion |
| | Pollution by construction spoils |
| | Solid waste from worker colonies, construction sites |
| **B. Water Resources & Water Quality** | |
| Construction Phase | Water quality impacts due to disposal of wastewater from worker camps and construction sites, spoils. |
| | Depletion of groundwater resources |
| Operation Phase | Drainage, Water requirement, and Disposal of waste water |
| **C. Air Pollution** | |
| Construction Phase | Impacts due to emissions generated by construction machinery |
| **D. Noise Pollution** | |
| Construction Phase | Noise due to operation of various equipment |
| | Noise due to increased vehicular movement |
| Operation Phase | Noise from Metro operation |
| | Noise due to DG sets |

| ASPECT OF ENVIRONMENT | LIKELY IMPACTS |
|---|---|
| **E. Ecology** | |
| Construction Phase | Removal of vegetation cover/loss of biomass |
| **F. Socio-Economics** | |
| Construction Phase | Improved employment potential during project construction phase |
| | Development of allied sectors leading to greater employment |
| | Pressure on existing infrastructure facilities |
| Operation Phase | Increase in Employment Opportunities in direct and indirect sectors |
| | Increased revenue from business development |

The collection and compilation of environmental baseline data is essential to assess the impacts on environment due to the project activities. The environment includes water, land, air, ecology, noise, vibration and socio–economic issues etc.

**TABLE 15.2: ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING**

| S. NO. | ATTRIBUTE | PARAMETER | FREQUENCY | SOURCE |
|---|---|---|---|---|
| **LAND ENVIRONMENT** | | | | |
| 1 | Soil | Soil Characteristics | Once | Field studies/ literature review |
| 2 | Geology | Geological History | --- | Literature review |
| 3 | Seismology | Seismic Hazard | --- | Literature review |
| **WATER ENVIRONMENT** | | | | |
| 4 | Water Quality | Physical, Chemical and Biological parameters | One Season | Field studies/ literature review |
| **AMBIENT ENVIRONMENT** | | | | |
| 5 | Ambient Air Quality | $PM_{2.5}$ , $PM_{10}$, $SO_2$,, $NO_2$, CO, HC, $O_3$, Pb, and $NH_3$ | 24 hr in one Season | Field Studies |
| 6 | Meteorology | Temperature, Relative humidity, Rainfall, wind direction and speed | Last five years | India Meteorological Department/ literature review |
| 7 | Noise | Noise levels in dB (A) | 24 hr in one Season | Field studies |
| **SOCIO-ECONOMIC** | | | | |
| 9 | Socio-economic aspects | Socio-economic characteristics | Once | Field Studies, Literature review |
| **ECOLOGY** | | | | |
| 10 | Ecology | Flora & Fauna | Once | Literature and Field observations |

## 15.1.2. Land Environment

The land environment primarily consists of Physiography, soil, geology & minerals, and land use pattern.

**Physiography**: Agra is a city on the banks of river Yamuna in the northern state of Uttar Pradesh, India. It is 378 kilometers west of the state capital, Lucknow, 206 kilometers south of the national capital New Delhi and 125 kilometers north of Gwalior. It is located at latitude 270 18' N and longitude 780 02' E with an elevation of 171 m above mean sea level and having the area of 188.40 sq km. The physiographical map is shown in **Figure 15.1.**

**Soil**: The soil mostly consists of the quaternary sediments of the Indo-Gangetic plains. It consists of recent unconsolidated fluvial formations containing sand, silt and clay. Its texture is mostly fine. The seven soil samples were collected along both the corridors, location details are provided in **Table 15.3** and sampling location map is shown in **Figure 15.2**. The laboratory analysis results so obtained are reported in **Table 15.4**. The soils are slightly alkaline in nature. The soils are mainly clay loam, slightly silty and loam in texture. Organic matter content in soils varies from 0.66% to 0.86%. The soil map of Agra district is shown in **Figure 15.3.**

**TABLE 15.3: SAMPLING LOCATIONS FOR SOIL**

| Location |
|---|
| **Corridor - 1** |
| Near Agra Fort (Electric) office |
| Near Hotel Trident |
| Agra ISBT |
| **Corridor - 2** |
| Agra Cantt. Railway Station |
| St. John College |
| TYC Phase-II |
| Vijay Nagar |

*Corridor-1: Sikandara to Taj East Gate,*
*Corridor-2: Agra Cantt. Rly Station to Kalindi Vihar*

**Geology and Minerals:** Most of the state of Uttar Pradesh lies in the Gangetic Plain. This is a fore-deep, a downward of the Himalayan foreland, of variable depth, converted into flat plains by long-vigorous sedimentation. This is known as a geosyncline and the Gangetic Plain is the Indo-Gangetic Geosyncline. A generalized geological succession of the formations present in and around Agra city is given below:

| Formation | Lithology | Age |
|---|---|---|
| Quaternary | Gangetic Alluvium | Recent Pleistocene |
| ----------Unconformity---------- | | |
| Vindhyan | Upper Bhander Sandstone | Pre-cambrian |
| | Lower Rewa Sandstone | |

The entire city of Agra is underlain by quaternary sediments constituting an admixture of sand, silt, clay and kanker. The geological map of Uttar Pradesh is shown in **Figure 15.2.**

**FIGURE 15.1: PHYSIOGRAPHICAL MAP OF STUDY AREA**

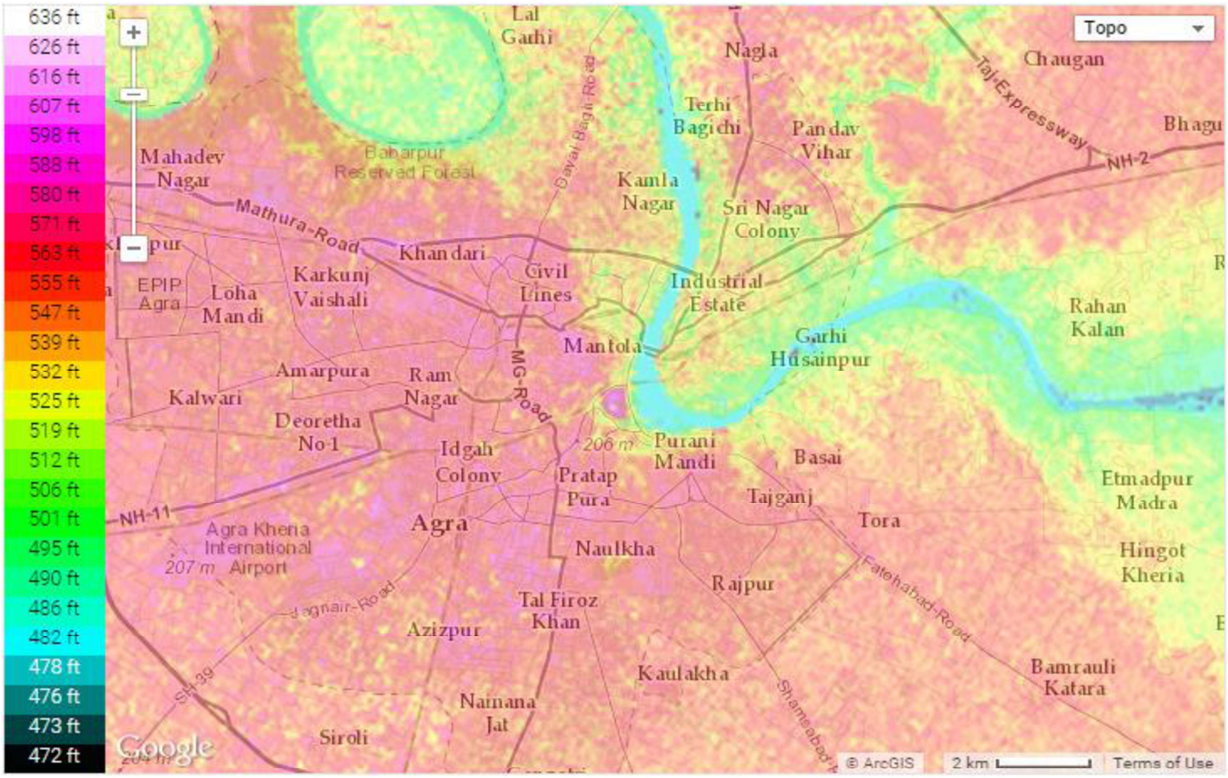



**FIGURE 15.2: GEOLOGICAL MAP OF UTTAR PRADESH**

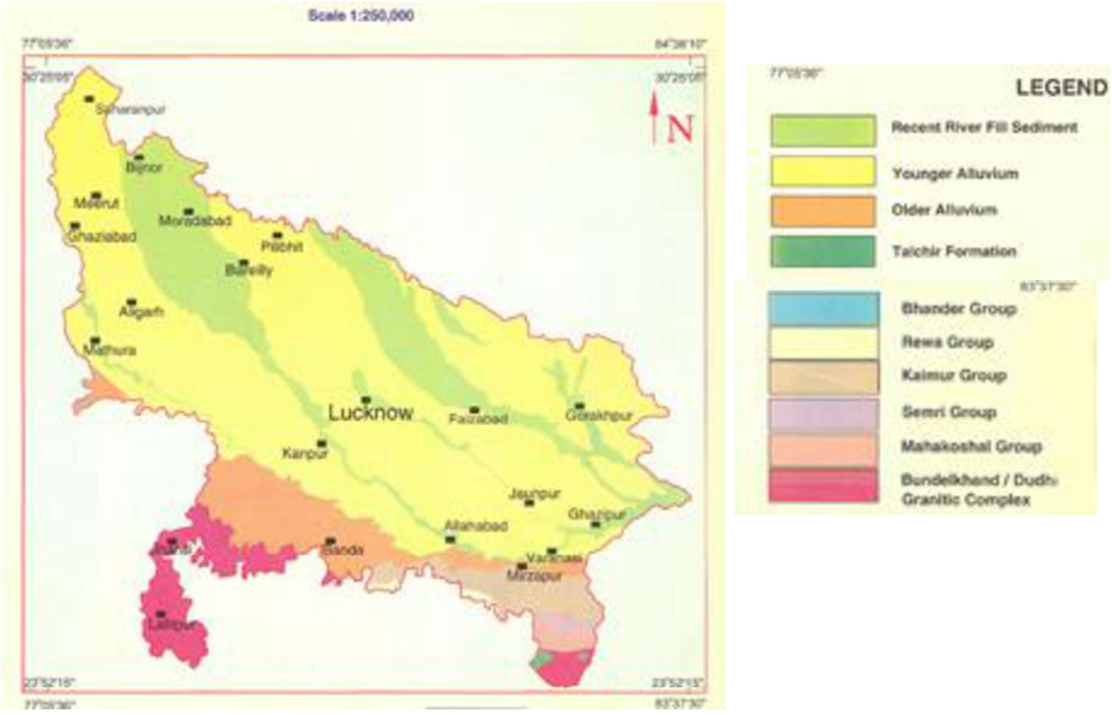
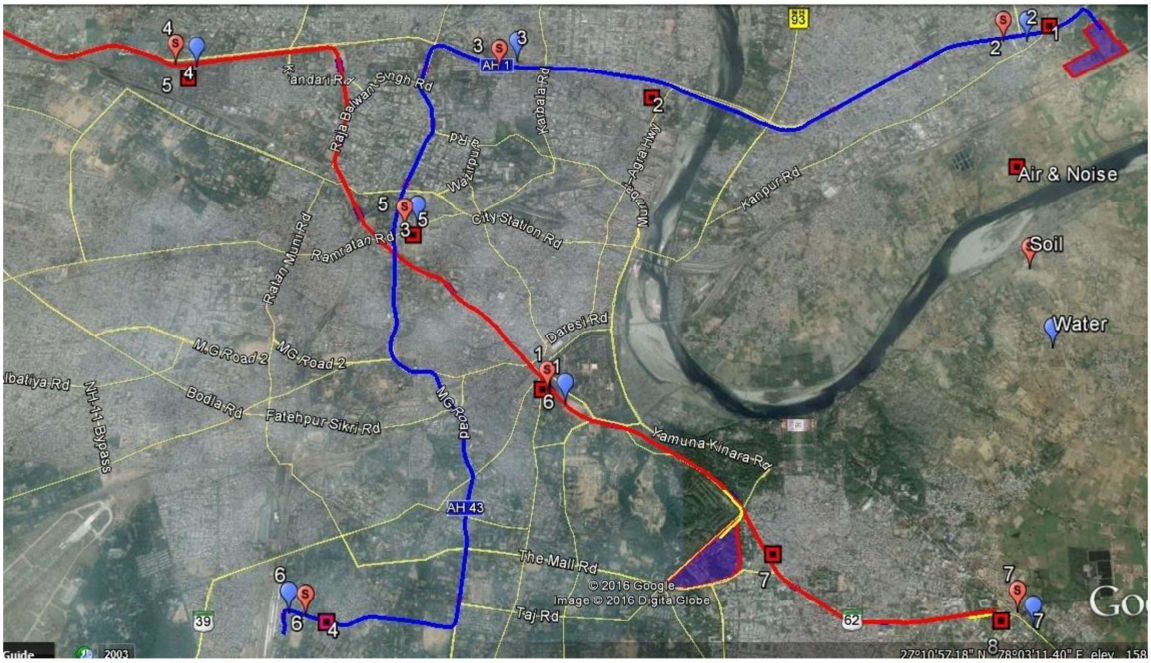


**FIGURE 15.3: MONITORING LOCATION MAP FOR AIR, NOISE, WATER AND SOIL**




**Sampling Location - Soil & Water:** 1) Near Agra Fort (Electric) office; 2) Near Hotel Trident; 3) St. John College; 4) Agra ISBT; 5) Agra Cantt. Railway Station; 6) TYC Phase-II; 7) Vijay Nagar

**Air & Noise:** 1)Near Agra Cant Railway Station 2) Near St. John's College 3) Near Kagarol Ki Sarai (Near Agra Fort) 4) Near Agra ISBT (Transport Colony) 5) Near Impeypur (Bansal Nagar) 6) Basai (Near Hotel Trident) 7) Near 100 foot road (Near Kuberpur) 8) Water Works near Langre Ki Chawki

**TABLE 15.4: RESULTS OF LABORATORY ANALYSIS OF SOIL SAMPLE**

| S. No. | Parameter | Unit | Corridor - 1 | | | Corridor - 2 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Near Agra Fort | Agra ISBT | Near Hotel Trident | St. John College | Trance Yamuna Colony Phase-II | Vijay Nagar | Agra Cantt Rly Stn |
| 1 | pH (at 25$^{o}$C) | - | 7.81 | 8.00 | 8.30 | 7.92 | 8.21 | 8.35 | 8.19 |
| 2 | Electrical Conductivity (EC) | mS/cm | 0.18 | 0.21 | 0.38 | 0.22 | 0.24 | 0.23 | 0.32 |
| 3 | Chloride | Mg/kg | 478.58 | 708.29 | 804.01 | 861.44 | 430.72 | 469.00 | 363.72 |
| 4 | Available Nitrogen | Kg/hec | 12.10 | 15.77 | 15.16 | 16.33 | 101.10 | 14.30 | 13.56 |
| 5 | Total Zinc as Zn | mg/kg | 87.43 | 78.16 | 84.14 | 81.65 | 81.41 | 84.10 | 71.86 |
| 6 | Manganese as Mn | mg/kg | 516.14 | 519.15 | 577.18 | 578.14 | 488.14 | 542.16 | 482.10 |
| 7 | Total Lead as Pb | mg/kg | 15.74 | 14.12 | 15.06 | 13.44 | 12.14 | 13.10 | 11.46 |
| 8 | Total Copper as Cu | mg/kg | 22.4 | 24.66 | 23.88 | 26.32 | 19.14 | 23.14 | 20.18 |
| 9 | Organic Carbon | % | 0.38 | 0.39 | 0.44 | 0.48 | 0.42 | 0.44 | 0.50 |
| 10 | Water soluble Sulphate | mg/kg | 60.55 | 61.23 | 53.14 | 57.46 | 46.14 | 54.18 | 48.62 |
| 11 | Boron | mg/kg | 0.61 | 0.71 | 0.52 | 0.63 | 0.48 | 0.54 | 0.43 |
| 12 | Iron | mg/kg | 101.10 | 81.32 | 64.12 | 76.18 | 82.16 | 78.14 | 62.14 |
| 13 | Nickel | mg/kg | 21.41 | 17.40 | 14.23 | 16.01 | 18.14 | 19.10 | 12.58 |
| 14 | Bicarbonate ($HCO_3$) | mg/kg | 4.50 | 4.45 | 4.31 | 4.08 | 3.76 | 4.10 | 3.65 |
| 15 | Calcium as Ca | mg/kg | 2084.96 | 842.16 | 1700.67 | 1913.26 | 147.17 | 1144.68 | 163.53 |
| 16 | Magnesium as Mg | mg/kg | 57.05 | 133.95 | 64.50 | 119.07 | 54.57 | 153.80 | 69.46 |
| 17 | Sand | % | 28.20 | 30.10 | 33.20 | 31.60 | 32.10 | 35.10 | 34.20 |
| 18 | Silt | % | 42.30 | 45.10 | 45.20 | 47.20 | 43.20 | 41.30 | 44.30 |
| 19 | Clay | % | 29.50 | 24.80 | 21.60 | 21.20 | 24.70 | 23.60 | 21.50 |
| 20 | Sodium as Na | mg/kg | 228.0 | 508.00 | 563.00 | 200.00 | 369.00 | 515.00 | 310.20 |
| 21 | Potassium as K | kg/hec | 518.20 | 387.52 | 320.32 | 618.20 | 302.40 | 176.90 | 565.31 |
| 22 | Nitrogen | Kg/hec | 203.67 | 223.14 | 234.14 | 233.10 | 184.15 | 211.41 | 207.41 |
| 23 | Sulphur | mg/kg | 24.15 | 26.18 | 22.14 | 28.14 | 21.14 | 23.41 | 20.14 |
| 24 | Phosphate | mg/kg | 102.10 | 103.18 | 82.14 | 110.14 | 92.00 | 98.14 | 88.22 |
| 25 | Organic Matter | % | 0.66 | 0.67 | 0.76 | 0.83 | 0.72 | 0.76 | 0.86 |
| 26 | Orthophosphate | mg/kg | 105.0 | 106.27 | 84.60 | 113.44 | 94.76 | 101.08 | 91.32 |
| 27 | Carbonate | mg/kg | 4.51 | 4.66 | 4.66 | 5.21 | 3.67 | 4.23 | 4.08 |
| 28 | Arsenic | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |

| S. No. | Parameter | Unit | Corridor - 1 | | | Corridor - 2 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Near Agra Fort | Agra ISBT | Near Hotel Trident | St. John College | Trance Yamuna Colony Phase-II | Vijay Nagar | Agra Cantt Rly Stn |
| 29 | Mercury | mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| 30 | Cadmium as Cd | mg/kg | 26.30 | 20.45 | 15.10 | 17.46 | 21.16 | 19.88 | 14.12 |
| 31 | Molybdenum | mg/kg | 0.14 | 0.16 | 0.18 | 0.21 | 0.09 | 0.10 | 0.08 |

**FIGURE 15.4: SOIL MAP OF AGRA DISTRICT**


**Alluvial plain (0-1% slope):** 1. Deep, loamy soils and slightly eroded, 2.Deep, fine soils moderately saline and sodic associated with loamy soils, slightly eroded, 3. Deep, fine soils and slightly eroded associated with loamy soils slightly saline and moderately sodic, 4. Deep, silty soils associated with loamy soils slightly eroded, 5. Deep, silty soils and slightly eroded associated with fine soils

**Ravinous land (3-5% slope):** 6. Deep, loamy soils and severely eroded, 7. Deep, loamy soils, very severely eroded associated with silty soils, very severely eroded

**Dissected uplands (3-5% slope)**: 8. Deep, loamy soils and moderately eroded associated with loamy soils, slightly eroded **Undulating Lands with hillocks (1-3% slope):** 9. Deep, loamy soils with moderate erosion associated with sandy soils with moderate erosion

Gentle to very gentle sloping lands with monad nocks:

10. Deep, loamy soils and slightly eroded associated with loamy skeletal soils, severely eroded, 11. Deep, loamy soils, moderately eroded, 12. Deep, loamy soils and slightly eroded associated with silty soils, slightly saline and moderately sodic, 13. Deep, loamy soils and slightly eroded associated with loamy soils, moderately eroded

*Source: NBSS & LUP, Regional Centre Delhi*

**Land-use:** Existing land use for the Agra Development Area is given in **Table 15.5**.The residential area having majority i.e. more than 60% of total area than the community facility and Traffic and Transportation.

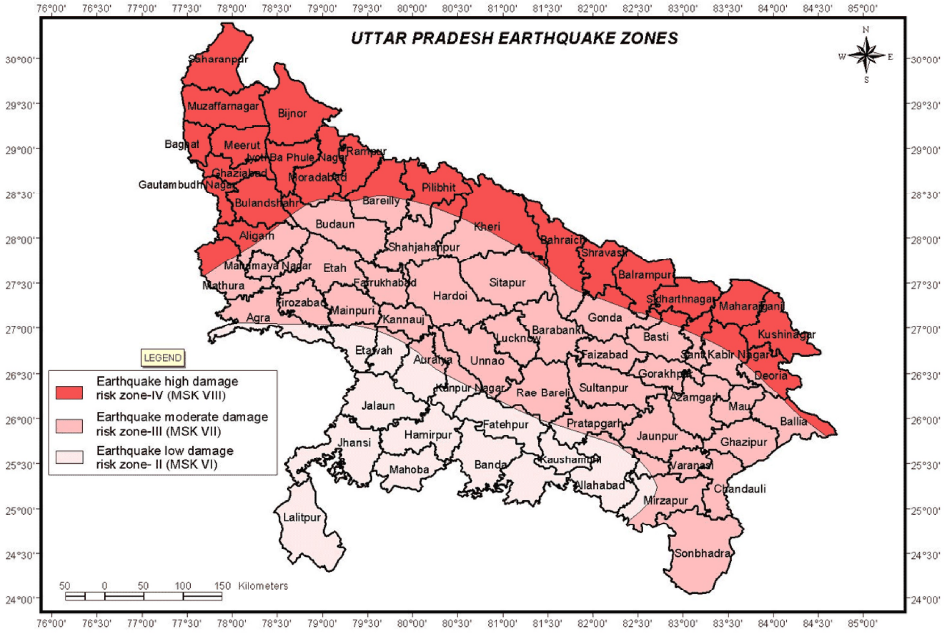
**TABLE 15.5: EXISTING LAND USE OF AGRA DEVELOPMENT AREA 2001**

| Land use class | Area | Percentage (%) |
|---|---|---|
| Residential | 4886.34 | 61.84 |
| Commercial | 148.74 | 1.88 |
| Wholesale Commercial | 58.88 | 0.75 |
| Industrial | 542.72 | 6.87 |
| Community facility | 842.62 | 10.66 |
| Office | 177.93 | 2.25 |
| Traffic & Transportation | 858.65 | 10.87 |
| Crenulations / Burial ground | 31.25 | 0.4 |
| Park Place Ground | 105.22 | 1.33 |
| Historical Monument | 116.48 | 1.47 |
| Nursery | 24.09 | 0.3 |
| Gardens | 69.12 | 0.87 |
| Sewage Farms | 38.35 | 0.49 |
| Total | 7901.39 | 100 |
| Other Agricultural, forest, settlement, rivers, open spaces etc | 4411 | |
| **Total** | **52020.63** | |

*Source: Agra Master Plan – 2021*

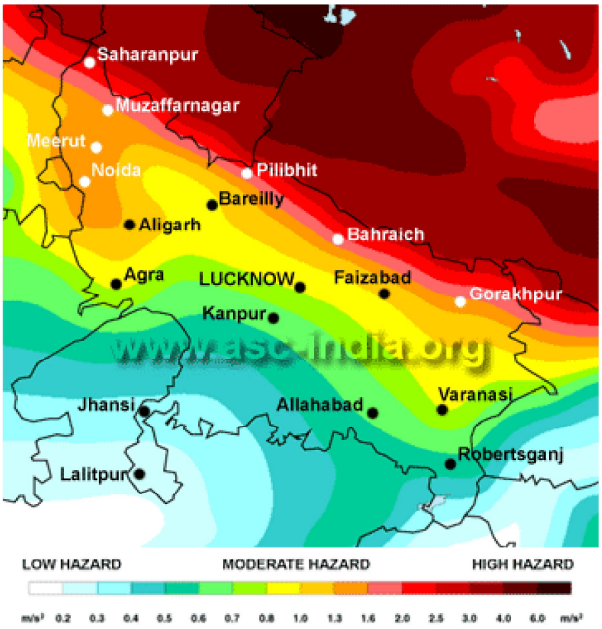
**Seismicity:** In the seismic zoning map of India prepared by Bureau of Indian Standards (BIS) the area of Agra and its neighborhood lies in Zone III as shown in **Figure 15.5**.

**FIGURE 15.5: SEISMIC ZONING MAP OF UTTAR PRADESH**



According to Global Seismic Hazard Assessment Program (GSHAP) data, the state of Uttar Pradesh falls in a region of moderate to high seismic hazard as shown in **Figure 15.6**.

**FIGURE 15.6: SEISMIC HAZARD MAP OF UTTAR PRADESH**




*Source: Amateur Seismic Centre, Pune*

Agra falls in moderate to least active seismic zone and corresponds to MSK intensity VII, making it prone to Earthquakes. The existence of the Great Boundary Fault near Jalesar, dense urban population and weak structures in old Agra city make it highly vulnerable to seismic hazards. Although no major earthquake has occurred in Agra in recent years, yet tremors have been felt whenever there is an earthquake in the NCR. One of the most powerful earthquakes in Uttar Pradesh struck the districts of western Uttar Pradesh at 21:01 IST on October 10th, 1956. The massive shock was centered near Jehangirpur, in Bulandshahr District. No fatalities were reported. The shock was also strongly felt at Delhi, where there was some minor damage.

## 15.1.3. Water Environment

Water environment consists of water resources and its quality. Its study is important from the point of view to assess the sufficiency of water resources for the needs of in its various stages of the project cycle and also to assess the impact of the project activities on water environment.

**Hydro-geological Characteristics:** Groundwater occurs under unconfined to semi-confined conditions. Depth to water level varies from 17 to 23 m below ground level (bgl) but in the topographic lows and in the vicinity of Agra canal and Yamuna, water table is within depth of 10 mbgl. The water level data show a declining trend. The regional water table data shows that the ground water movement in general is from west to east on the right bank and east to west on the left bank. The local topography plays an important role in controlling the ground water movement in the area. Some of the portion of the corridors like Jama Masjid

to Tajmahal for Corridor -1 and Kamla Nagar to Foundary Nagar for Corridor – 2 is falling near Yamuna River where ground water level is about 10mbgl.

**Water Resources:** The source of water supply in the city is mainly surface water. The river Yamuna is the onlysurface water source, which enters the town from northeast corner, flow towards south of thecity for some distance and then turns towards left. The Jal Nigam has also installed Hand-pumps to supplement the required water supply. The urban water supply is a perpetual problem in this saline tract, where fresh water is available only in patches. According to the Agra JalSansthan (AJS), the total water demand of the city is 320 million litres per day (MLD), which includes the demand for bulk supply, estimated at 75 MLD in the year 2006. The water demand as estimated for the 1.42 million-population in 2005 was 245 MLD, which was calculated on a 170 litres per capita daily (lpcd) standard. For this, the city has two water treatment plants with a capacity to treat 410 MLD in entirety. The forecasted water demand for 2016 is 402 MLD.

**Drainage:** River Yamuna forms the major drainage of the city and it flows from North to South-East of the city. The overall drainage is controlled by the Yamuna River. The drainage system of Agra was laid about 55 years back and drains are in bad condition. The system comprises hierarchy of natural and man-made drains that ultimately discharge surface run off and sewage to River Yamuna because at most part of the city there is no sewerage system. Natural nalhas are the main carriers of the storm water. These drains were formerly natural water drainage. Now they serve as sewage disposal drains.

**Water Quality:** Water quality includes the physical, chemical and biological characteristics of water. An understanding of the various factors influencing water quality is thus very important as human health is largely dependent on the quality of water available for use.

In order to assess the baseline water quality status of the study area, 7 samples along both the corridors were collected in the project area. The sample locations from which water sample were collected are shown in **Figure 15.2** and description of water sample locations are given in **Table 15.6**. The samples were analyzed for physical and chemical constituents for the purpose of domestic and irrigation use. The results of water analysis are compared with CPHEEO manual for Drinking Water Specifications and IS 10500-2012. The results of analysis are presented in **Table 15.7**.

**TABLE 15.6: DESCRIPTION OF WATER QUALITY MONITORING LOCATIONS**

| S. No. | Location No. | Location | Environmental Setting |
|---|---|---|---|
| **Corridor - 1** | | | |
| 1 | Loc-1 | Near Agra Fort (Electric) office | Bore well |
| 2 | Loc-4 | Agra ISBT | Bore well |
| 3 | Loc-7 | Near Hotel Trident | Hand pump |
| **Corridor - 2** | | | |
| 4 | Loc-2 | TYC Phase-II | Hand pump |
| 5 | Loc-3 | Vijay Nagar | Bore well |
| 6 | Loc-5 | St. John College | Hand pump |
| 7 | Loc-6 | Agra Cantt. Railway Station | Bore well |

*Corridor-1: SikandaratoTaj East Gate,*
*Corridor-2: Agra Cantt. Rly Station to Kalindi Vihar*

**TABLE 15.7: PHYSICO-CHEMICAL ANALYSIS OF WATER SAMPLES IN PROJECT AREA**

| S. No | Parameter | Units | Corridor – 1 | | | | Corridor - 2 | | | Acceptable Limit/Permissible Limit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Loc-1 | Loc-4 | Loc-5 | Loc-7 | Loc-2 | Loc-3 | Loc-6 | |
| 1 | pH at 25$^{O}$C | - | 7.23 | 7.62 | 7.01 | 7.32 | 7.67 | 7.32 | 6.69 | 6.5-8.5/no relaxation |
| 2 | Turbidity | NTU | 0 | 0 | 17.8 | 64.3 | 0 | 0 | 0 | 1/5 max |
| 3 | Total Dissolved Solids | mg/l | 1708 | 1375 | 2280 | 1928 | 1264 | 2618 | 3896 | 500/2000 max |
| 4 | Aluminium as Al | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.03/0.02 max |
| 5 | Free Amonia (as NH3) | mg/l | <1 | <1 | <1 | <1 | <1 | <1 | <1 | - |
| 6 | Barium (as Ba) | mg/l | BDL | 0.003 | BDL | BDL | 0.009 | BDL | BDL | 0.7 max/ no relaxation |
| 7 | Boran (as B) | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.5/1 |
| 8 | Calcium as Ca | mg/l | 162 | 121.4 | 194.3 | 113.3 | 105.3 | 145.7 | 307.7 | 75/200 |
| 9 | Chloride as Cl | mg/l | 384.3 | 266.1 | 611 | 473 | 167.5 | 680 | 1202.3 | 250/1000 |
| 10 | Copper as Cu | mg/l | BDL | BDL | 0.016 | 0.006 | BDL | BDL | BDL | 0.05/1.5 |
| 11 | Fluoride as F | mg/l | >1 | >1 | >1 | >1 | >1 | >1 | >1 | 1.0/1.5 |
| 12 | Iron as Fe | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.3/ no relaxation |
| 13 | Magnesium (as Mg) | mg/l | 29.5 | 59 | 128 | 123 | 5 | 132.8 | 226.3 | 30/100 |
| 14 | Manganese as Mn | mg/l | 0.024 | BDL | 0.03 | 0.09 | BDL | BDL | BDL | 0.1/0.3 |
| 15 | Nitrate as NO3 | mg/l | BDL | 11.2 | BDL | BDL | 1.1 | 17.7 | 2.2 | 45/ no relaxation |
| 16 | Phenolic Compounds | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.001/0.002 |
| 17 | Seleniem (as Se) | mg/l | BDL | 0.003 | 0.099 | BDL | BDL | 0.004 | BDL | 0.01/ no relaxation |
| 18 | Silver (as Ag) | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.01/ no relaxation |
| 19 | Sulphate as SO4 | mg/l | 62.4 | 95.2 | 73.1 | 66.5 | 59.1 | 155.2 | 152 | 200/400 |
| 20 | Sulphide (as S) | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.05/ no relaxation |
| 21 | Total Alkalinity as CaCO3 | mg/l | 484.8 | 636.3 | 899 | 666.6 | 495 | 444.4 | 565.6 | 200/600 |
| 22 | Total Hardness as CaCO3 | mg/l | 525.2 | 545.4 | 1010 | 787.8 | 282.8 | 909 | 1696.8 | 200/600 |
| 23 | Zinc as Zn | mg/l | BDL | BDL | BDL | 0.07 | BDL | BDL | BDL | 5/15 |
| 24 | Cadmium (as Cd) | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.003/ no relaxation |
| 25 | Cynide (as CN) | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.05/ no relaxation |
| 26 | Lead as Pb | mg/l | BDL | 0.003 | BDL | 0.003 | BDL | BDL | BDL | 0.050.01/ no relaxation |
| 27 | Mercury (as Hg) | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.001/ no relaxation |
| 28 | Nickel | mg/l | BDL | BDL | BDL | 0.005 | BDL | BDL | BDL | 0.02/ no relaxation |
| 29 | Arsenic as As | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.01/0.05 |
| 30 | Total Chromium (as Cr) | mg/l | BDL | 0.008 | BDL | BDL | BDL | 0.013 | BDL | 0.05 max/no relaxation |
| 31 | Total Suspended Solids | mg/l | 0 | 0 | 78 | 25 | 0 | 0 | 0 | - |

| S. No | Parameter | Units | Corridor – 1 | | | | Corridor - 2 | | | Acceptable Limit/Permissible Limit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Loc-1 | Loc-4 | Loc-5 | Loc-7 | Loc-2 | Loc-3 | Loc-6 | |
| 32 | Vanadium (as V) | mg/l | BDL | 0.0024 | BDL | BDL | BDL | BDL | BDL | - |
| 33 | Amonical Nitrogen (as N) | mg/l | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.5/No relaxation |
| 34 | Total Kjeldahl Nitrogen (as N) | mg/l | <0.1 | 2.66 | <0.1 | <0.1 | 0.38 | 6.5 | 0.64 | - |
| 35 | Chromium (as Hexavalent Cromium) | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | - |
| 36 | Oil and Grease | mg/l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| 37 | Dissolved Oxygen | | 7 | 4.2 | 6.2 | 6.6 | 7.1 | 6.8 | 5.4 | - |
| 38 | Chemical Oxygen Demand | mg/l | 0 | 12.4 | 16.5 | 0 | 0 | 3.8 | 20.6 | - |
| 39 | Biochemical Oxygen Demand (3 day 27 deg C) | mg/l | Nil | 5 | 7 | Nil | Nil | 2 | 6 | - |
| 40 | Total Phosphate as P | mg/l | BDL | 0.69 | BDL | BDL | 0.57 | 0.4 | 0.78 | - |
| 41 | Dissolved Phosphate (as P) | mg/l | BDL | 0.6 | BDL | BDL | 0.5 | 0.4 | 0.70 | |
| 42 | Sodium as Na | mg/l | 230 | 285 | 380 | 335 | 310 | 555 | 580 | - |
| 43 | Potassium as K | mg/l | 160 | 9 | 10.5 | 160 | 9.5 | 11 | 14 | - |
| 44 | Nitrate Nitrogen | mg/l | BDL | 2.53 | BDL | BDL | 0.25 | 4.2 | 0.5 | - |
| 45 | Total Nitrogen | mg/l | <0.1 | 2.66 | <0.1 | <0.1 | 0.38 | 6.5 | 0.64 | - |
| 46 | Organic Phosphorus | mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.002 max |
| 47 | Coliform Count | MPN/100 ml | Absent | Present | Absent | Absent | Present | Present | Present | Absent |
| 48 | Fecal Coliform | MPN/100 ml | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 50 | Total Coliform Organism | MPN/100 ml | Absent | Present | Absent | Absent | Absent | Present | Absent | Absent |

(Acceptable Limit/Permissible Limits as per IS 10500-2012)

The results of analysis of water samples indicates that most of the parameters are within the permissible limit except Turbidity at location 5 & 7, TDS at location 3, 5 & 6, Calcium and Chloride at location 6, Magnesium at location 3, 5, 6 & 7, Total Alkalinity at location 4, 5 & 7, Total Hardness at location 3, 5, 6 & 7, COD at 3, 4, 5 & 6, BOD at location 3, 4, 5 & 6 and Coliform 2, 3, 4 & 6. Water from these sources should be treated before using it for drinking purposes. Bacteriological contamination may be due to existing sewer/drains flowing adjacent to the source.

### 15.1.4. Meteorology and Air Environment

Meteorology is an important parameter in environmental impact assessment study. It is responsible for the movement of air and air pollutants. Meteorological data like mean rainfall and maximum & minimum temperature of the district for a period of 1901 to 2000 and of other parameters relative humidity, wind speed and cloud for a period of 1971 to 2000 are given in **Table 15.8**. It is depicted from the table that temperature of the district varies from 22.3$^{O}$C - 41.7$^{O}$C in summer to a minimum of around 8.2$^{O}$C – 28.8$^{O}$C in winter and Relative humidity varies from 37% to 78%.

**TABLE 15.8: METEOROLOGICAL DATA**

| Month | Mean Temperature (Deg. Cent) | | Mean Rainfall (mm) | Relative Humidity (%) | Wind Speed (Kmph) | Cloud (octas) |
|---|---|---|---|---|---|---|
| | Max | Min | | | | |
| January | 22.3 | 7.7 | 13.2 | 69.53 | 2.75 | 1.93 |
| February | 25.5 | 10.3 | 17.6 | 60.02 | 4.26 | 1.94 |
| March | 31.9 | 15.5 | 9.3 | 48.99 | 5.43 | 1.87 |
| April | 37.9 | 21.5 | 6.3 | 37.78 | 6.76 | 1.64 |
| May | 41.7 | 26.5 | 11.3 | 37.84 | 7.95 | 1.54 |
| June | 40.7 | 28.9 | 55.7 | 61.64 | 8.16 | 2.85 |
| July | 35.3 | 26.8 | 203.3 | 72.7 | 7.52 | 5.33 |
| August | 33.2 | 25.7 | 243.2 | 78.59 | 6.24 | 5.31 |
| September | 34 | 24.3 | 129.7 | 70.18 | 5.22 | 3.04 |
| October | 34 | 19.1 | 24.8 | 59.45 | 2.52 | 1.05 |
| November | 29.2 | 12.5 | 4.3 | 62.23 | 1.34 | 0.89 |
| December | 23.9 | 8.2 | 6.1 | 69.67 | 1.55 | 1.52 |

*Source: Indian Meteorological Department, Pune (National Data Centre, Pune)*

The latest rainfall data for the year 2009-2013 is given in **Table 15.9** which depicts the highest rainfall i.e. 281.3 mm in the month of August 2012. August month is generally having highest rainfall in the area.

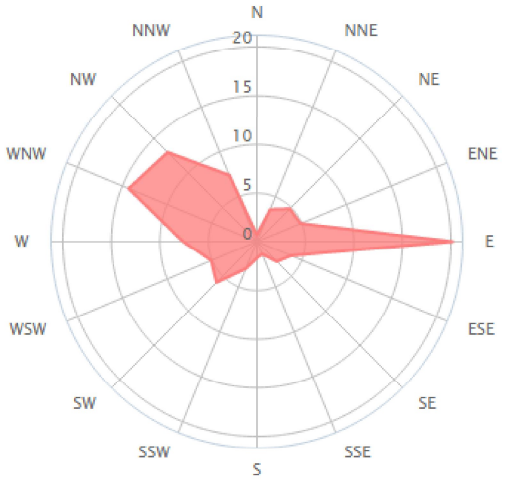
The wind rose diagram has been prepared based on the daily data for the period of 09/2011 to 05/2015. The prominent direction is East, North West and West North West. Wind rose diagram for the Agra is shown in **Figure 15.7.**

**TABLE 15.9: AVERAGE RAINFALL (MM)**

| Month/Year | Rainfall (mm) | | | | |
|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2012 | 2013 |
| January | 0 | 1.3 | 0 | 23.4 | 10.5 |
| February | 0 | 8.6 | 16.9 | 1.1 | 27.3 |
| March | 0 | 0 | 3 | 0 | 2.3 |
| April | 1.6 | 0 | 2.7 | 5.4 | 0.5 |
| May | 38 | 0 | 14.3 | 0.7 | 3.2 |
| June | 16.8 | 13.5 | 86.9 | 5.7 | 70.6 |
| July | 74.1 | 98.2 | 110.5 | 184.8 | 163.1 |
| August | 76.7 | 119.7 | 116.6 | 281.3 | 269.1 |
| September | 84.4 | 146.7 | 66.4 | 90.2 | 76 |
| October | 62.6 | 1.5 | 0 | 0.6 | 83.2 |
| November | 14.8 | 27.8 | 0 | 0 | 0.2 |
| December | 2 | 1.7 | 0 | 0 | 5 |

*Source: Indian Meteorological Centre, Delhi*

**FIGURE 15.7: WIND ROSE DIAGRAM**




**Air Quality:** Eight monitoring stations selected at strategic locations along both the corridors. The monitoring result for ambient air quality is presented in **Table 15.10.** The monitoring stations were selected to generate the representative samples for air quality covering residential, institutional and industrial area along the corridors. Locations map for air monitoring stations are shown in **Figure 15.2**. The monitoring was done from 08.06.2015 (9 am) to 12.06.2015 (9 am).

The National Ambient Air Quality Standard (NAAQ) laid down by Ministry of Environment, Forest &Climate Change (MoEFCC) on 16$^{th}$November 2009 has been given in **Table 15.11**. The result of air quality monitoring compared with National Ambient Air Quality Standard and found that particulate matter ($PM_{10}$ &$PM_{2.5}$) is exceeding the permissible limit in residential areas at all monitoring locations except $PM_{10}$ at location 8. Whereas other parameters like $SO_2$, $NO_2$, $O_3$, Pb, $NH_3$, CO and HC are within permissible limit except CO at locations 4, 7 & 8 are exceeding permissible limit.

**TABLE 15.10: AIR QUALITY RESULT**

| SN | Parameters | Unit | Concentration of Pollution | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Corridor - 1 | | | | Corridor – 2 | | | |
| | | | 3 | 4 | 5 | 6 | 1 | 2 | 7 | 8 |
| 1 | Sulphur Dioxide ($SO_2$) | $\mu g/m^3$ | BDL | 11.2 | BDL | BDL | 9.8 | BDL | 8.5 | 10.4 |
| 2 | Nitrogen Dioxide ($NO_2$) | $\mu g/m^3$ | 17.1 | 26.6 | 13.6 | 16.3 | 19.4 | 15.3 | 20.3 | 24.6 |
| 3 | Particulate matter ($PM_{10}$) | $\mu g/m^3$ | 166 | 253 | 138 | 147 | 185 | 156 | 172 | 223 |
| 4 | Particulate Matter ($PM_{2.5}$) | $\mu g/m^3$ | 96 | 126 | 72 | 84 | 98 | 84 | 93 | 116 |
| 5 | Ozone ($O_3$)* | $\mu g/m^3$ | 29.4 | 43.8 | 25.4 | 27.5 | 31.5 | 28.6 | 30.4 | 37.3 |
| 6 | Lead (Pb) | $\mu g/m^3$ | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| 7 | Carbon Monoxide (CO)* | $mg/m^3$ | 1.7 | 2.3 | 1.4 | 1.2 | 1.9 | 1.5 | 1.6 | 2.2 |
| 8 | Ammonia ($NH_3$) | $\mu g/m^3$ | 22.3 | 18.9 | 16.3 | 12.8 | 14.6 | 12.4 | 15.2 | 14.1 |
| 9 | Hydrocarbon | $\mu g/m^3$ | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL |

*BDL- Below Detection Limit; BDL for Pb< 0.2 $\mu g/m^3$, Hydrocarbon < 5 $mg/m^3$*

**Total monitoring period 8 hours*

*1)Near Agra Cant Railway Station 2) Near St. John's College 3) Near Kagarol Ki Sarai (Near Agra Fort) 4) Near Agra ISBT (Transport Colony) 5) Near Impeypur (Bansal Nagar) 6) Basai (Near Hotel Trident) 7) Near 100 foot road (Near Kuberpur) 8) Water Works near Langre Ki Chawki*

**TABLE 15.11: NATIONAL AMBIENT AIR QUALITY STANDARDS**

| Pollutant | Time | Concentration | |
|---|---|---|---|
| | | Industrial, Residential, Rural & other Area | Ecological Sensitive area |
| Sulphur Dioxide ($SO_2$) in µg/m3 | Annual | 50 | 80 |
| | 24 Hours | 80 | 80 |
| Oxides of Nitrogen (NOx) in µg/m3 | Annual | 40 | 30 |
| | 24 Hours | 80 | 80 |
| Particulate Matter size less than 10µm ($PM_{10}$) in µg/m3 | Annual | 60 | 60 |
| | 24 Hours | 100 | 100 |
| Particular Matter size less than 2.5µm ($PM_{2.5}$) in $\mu g/m^3$ | Annual | 40 | 40 |
| | 24 Hours | 60 | 60 |
| Carbon Monoxide (CO) in mg/m3 | 8 Hours | 02 | 02 |
| | 1 Hour | 04 | 04 |
| Ozone ($O_3$) in $\mu g/m^3$ | 8 Hours | 100 | 100 |
| | 1 Hour | 180 | 180 |
| Lead (Pb) $\mu g/m^3$ | Annual | 0.50 | 0.50 |
| | 24 Hours | 1.0 | 1.0 |
| Ammonia ($NH_3$)$\mu g/m^3$ | Annual | 100 | 100 |
| | 24 Hours | 400 | 400 |

*Source: CPCB guidelines for AAQM*

## 15.1.5. Noise Environment

The hourly noise monitoring was carried out for 24 hours on 08.06.2015 (9 am) to 12.06.2015 (9 am) at eight locations along the proposed metro corridors. The result was analysed to evaluate Leq, $L_{10}$, $L_{50}$, $L_{90}$, $L_{day}$, $L_{night}$, $L_{DN}$, $L_{MAX}$ and $L_{MIN}$ which are depicted in **Table 15.12**. The Ambient Noise Quality criteria laid down by CPCB has been given in **Table 15.13**. The noise level monitoring results are exceeding the permissible limit specified for residential area.

**TABLE 15.12: AMBIENT NOISE LEVEL MONITORING RESULT**

| S.No. | Monitoring Location | Leq | $L_{10}$ | $L_{50}$ | $L_{90}$ | $L_{max}$ | $L_{min}$ | $L_{day}$ | $L_{night}$ | $L_{DN}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| **Corridor - 1** | | | | | | | | | | |
| 1 | Near Kagarol Ki Sarai (Near Agra Fort) | 65.2 | 73.3 | 68.0 | 65.7 | 84.9 | 48.1 | 66.7 | 58.7 | 67.5 |
| 2 | Near Agra ISBT (Transport Colony) | 69.3 | 78.0 | 72.1 | 69.7 | 103.5 | 49.6 | 70.9 | 59.4 | 70.4 |
| 3 | Near Impeypur (Bansal Nagar) | 57.7 | 66.4 | 60.5 | 58.1 | 91.9 | 38.0 | 59.3 | 47.3 | 58.7 |
| 4 | Basai (Near Hotel Trident) | 59.8 | 68.5 | 62.7 | 60.3 | 94.1 | 39.0 | 61.5 | 48.4 | 60.7 |
| **Corridor - 2** | | | | | | | | | | |
| 5 | Near Agra Cant Railway Station | 68.2 | 77.4 | 71.2 | 68.6 | 91.3 | 45.0 | 69.3 | 64.2 | 71.6 |
| 6 | Near St. John's College | 59.1 | 66.6 | 61.9 | 59.6 | 89.2 | 42.0 | 60.2 | 55.7 | 62.9 |
| 7 | Near 100 foot road (Near Kuberpur) | 66.1 | 74.5 | 68.9 | 66.6 | 94.9 | 46.1 | 67.8 | 54.6 | 66.9 |
| 8 | Water Works near Langre Ki Chawki | 67.6 | 75.9 | 70.4 | 68.0 | 96.2 | 45.3 | 69.0 | 61.3 | 69.9 |

**TABLE 15.13: AMBIENT NOISE STANDARDS CRITERIA**

| Area Code | Category of Area | Limits in dB (A) Leq | |
|---|---|---|---|
| | | Day time* | Night time |
| A | Industrial area | 75 | 70 |
| B | Commercial area | 65 | 55 |
| C | Residential area | 55 | 45 |
| D | Silence Zone** | 50 | 40 |

***Source:*** *CPCB guideline (as per The Noise Pollution (Regulation and Control) Rules, 2000)*

**** Day time is from 6.00 AM to 9.00 PM, **Silence Zone is defined as an area up to 100m around premises of Hospitals, Educational Institutions and Courts.***

## 15.1.6. Ecology

No rare or endangered species are known in this section of river Yamuna: the nearest access point to riverine National Chambal sanctuary is about 50km from Agra. Babarpur Reserved Forest is about 1.5 km and Soor Sarovar Bird Sanctuary about 9 km away from the proposed Sikandara Metro Station of Corridor-I. Soor Sarovar Bird Sanctuary comprises of fresh water wetland, popularly known as Keetham jheel. Unique for scenic beauty, religion-cultural heritage and rich assembling of fauna and flora. It is an important birding destination for ornithologists. The predominant tree species along the corridors are Bargad, Cassia, Champa, Gulmohar, Karanj, Neelgiri, Neem, Pakad, Peepal, Sagwan, Seijan, Arjun, Jamun, Mango, Khajur, Babul, Gularand Sheesam etc.The predominant shrub species observed in the study area is *ProsopisJulifera*. Site construction activities will results in loss of trees about 2729. An inventory of trees in the two corridors and two depots likely to be lost has been prepared and summarized in the **Table 15.14**. Estimated cost of compensatory afforestation is included in the EMP.

**TABLE 15.14: SUMMARY OF TREE INVENTORY**

| S. No | Description | Number of Trees |
|---|---|---|
| **Corridor-I (Sikandara – Taj East Gate)** | | |
| 1 | Alignment | 784 |
| 2 | PAC Depot | 1226 |
| **Sub-Total** | | **2010** |
| **Corridor-II (Agra Cantt. – KalindiVihar)** | | |
| 3 | Alignment | 565 |
| 4 | Kalindi Vihar Depot | 154 |
| **Sub-Total** | | **719** |
| **Total** | | **2729** |

Common birds observed in the project area are pigeons, parrot, crows, and doves. The Saras Crane was observed near Kalindi Vihar Depot. On consultation with the local people in the vicinity of the project area, it is learnt that peacocks and swift are frequently observed at lush green vegetation of Shahjahan Park. The predominant mammals observed in the project area are mongoose, bat, monitor lizard, monkey, languor and mice etc.

### 15.1.7. Archaeological Sites

There are about 67archaeological monuments protected by Archaeological Survey of India (ASI) in Agra Circle including two world heritage sites i.e. Taj Mahal and Agra Fort. These monuments are as per Archaeological Survey of India (ASI) under the provision of Ancient Monument and Archaeological Sites and Remains (Amendments and Validation) Act, 2010 (AMASR).The Act specifies the prohibited area of 100 m from site whereas regulated area is 200m from the limit of prohibited area. No construction is allowed in prohibited area while construction can be taken up in regulated area after getting the approval from the Archaeological Survey of India(ASI).There are 2 monuments along Corridor-1 and 2 monuments along Corridor-2 are coming under prohibited area of ASI as listed in **Table 15.15**.

**TABLE 15.15: ASI SITES/MONUMENTS ALONG THE CORRIDORS**

| S No | Name of Monument or Site | Distance from boundary (M) |
|---|---|---|
| **Corridor-1** | | |
| 1 | Akbar's Tomb, Sikandara | 305 |
| 2 | PatharKaGhoda | 20 |
| 3 | Guru Ka Tal | 12.5 |
| 4 | Tomb of Salamat Khan | 160 |
| 5 | Sadiq Khan Tomb | 160 |
| 6 | Delhi Gate | 140 |
| 7 | Jama Masjid | 170 |
| 8 | Agra Fort | 103 |
| 9 | Taj Mahal | 505 |
| **Corridor-2** | | |
| 10 | Delhi Gate | 355 |
| 11 | Roman Catholic Cemetery | 14 |
| 12 | Lal Masjid (Jafar Khan's Masjid) | 65 |
| 13 | Ram Bagh | 105 |

### 15.1.8. Depot

Two depots are proposed for the Agra metro. One depot is at PAC land, Mall Road Agra has been proposed having 16.3 hectare land and another depot near Kalindi Vihar along NH 2 having 11.9 hectare land. PAC Depot is in between Taj Road and Fatehabad Road as shown in **Figure 15.8**. Depot site at Kalindi Vihar is near NH 2 is mostly vacant land/agriculture land as shown in **Figure 15.9**.

**FIGURE 15.8: PROPOSED PAC DEPOT FOR CORRIDOR-1**

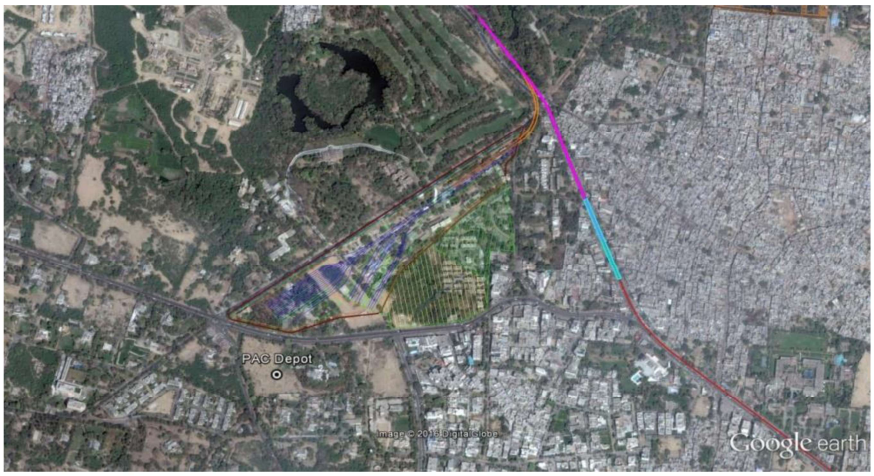
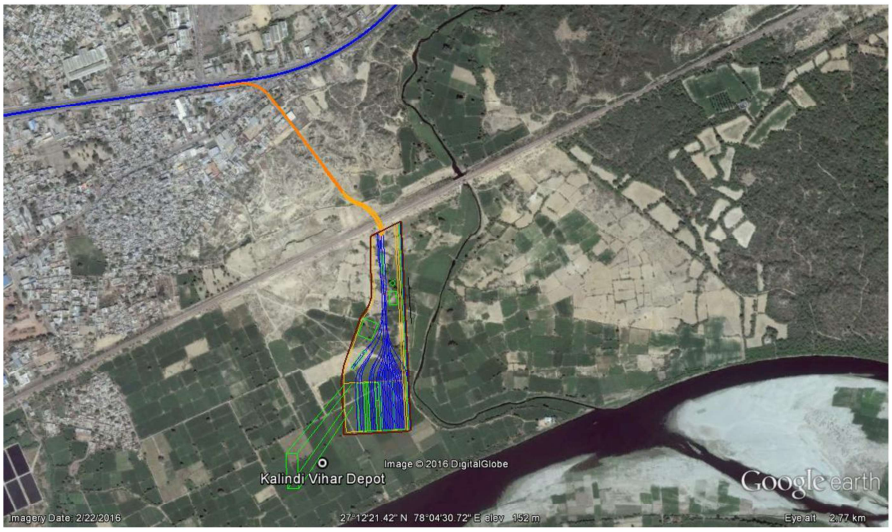



**FIGURE 15.9: PROPOSED KALINDI VIHAR DEPOT FOR CORRIDOR-2**




## 15.2. ENVIRONMENTAL NORMS AND REGULATIONS

The following legislative Acts and standards have been referred:

- Amendment dated 9 December 2016 to EIA Notification 2006: Integration of environmental Conditions in local building byelaws
- The Air (Prevention and Control of Pollution) (Union Territories) Rules 1982, 1983 (Consent to establish and operate)
- The Water (Prevention and Control of Pollution) Rules 1975 (Consent to establish and operate)
- National Ambient Air Quality Standards 2009

- Guidelines for Ambient Air Quality Monitoring , CPCB, 2003
- The Water (Prevention and Control of Pollution) Act 1974 amended 1988
- Guide Manual – Water and waste water analysis, CPCB
- Drinking water – Specifications IS 10500: 2012 and CPHEEO Manual 2012
- Protocol for Ambient Level Noise Monitoring, CPCB, 2015
- Noise Pollution (Regulation and Control) Rules, 2000 amendment in 2010
- Construction and Demolition Waste Management Rules 2016
- Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules 2016
- Solid Waste Management Rules 2016
- Forest (Conservation) Act, 1980, amended 1988.
- Forest (Conservation) Rules 2003 and Forest (Conservation) Amendment Rules, 2014 (procedure for FC)
- The Indian Wild Life (Protection) Act 1972 and The Wildlife (Protection) Amendment Act 2002
- The Ancient Monuments and Archaeological sites and Remains (Amendment and Validation Act) 2010
- The Uttar Pradesh Ground Water (Management and Regulation) Bill 2017 and Guidelines/Criteria for evaluation of proposals/requests for ground water abstraction (With effect from 16.11.2015), Central Ground Water Authority
- Right to Fair Compensation and Transparency in land acquisition, Rehabilitation and Resettlement Act, 2013(RTFCTLARR Act).

## 15.3. DETAILED ENVIRONMENT IMPACT ASSESSMENT

### 15.3.1. Positive Environmental Impacts

Based on project particulars and existing environmental conditions, positive potential impacts have been identified that are likely to result from the proposed metro project and where feasible within the scope of this Report these are quantified. The positive environmental impacts are listed below:

- Employment Opportunities
- Benefits to Economy
- Traffic Congestion Reduction, Quick Service and Safety
- Traffic Noise Reduction
- Reduction of Traffic on Road
- Less Fuel consumption
- Reduced Air pollution

**1. Employment Opportunities**

The civil works of the project is likely to be completed in a period of 5 years. During this period manpower will be needed for various project activities. In post-construction phase,

about 980 people will be employed for operation and maintenance of the system. Thus, the project would provide substantial direct employment equal to the above number. In addition to these, more people would be indirectly employed for allied activities.

2. **Benefits to Economy**

The project will streamline and facilitate movement of public from different parts of Agra. These corridors will yield saving due to reduction in road traffic and reduction in number of buses, usage of private vehicles. Reduction in fuel consumption, vehicle operating cost and travel time of passengers was observed. With the development of the 2 corridors of Agra Metro project, it is likely that more people will be involved in trade, commerce and allied services.

3. **Traffic Congestion Reduction, Quick Service and Safety**

With the implementation 2 corridors of Metro, travel time of passengers travelling by other modes of vehicles in the absence of Metro will got reduced. The proposed development will reduce journey time and hence congestion and delay. Also, implementation of the metro will provide improved safety and lower number of accidents, injuries and accidental deaths. The reduced vehicles on road in turn will reduce accidents and increase safety of persons.

4. **Traffic Noise Reduction**

Reduction in traffic volume affects the noise levels. A 50% reduction of the traffic volume may result in a 3 dB reduction in noise levels, regardless of the absolute number of vehicles. Reduction in traffic volume of 10% & 50% reduces noise at the tune of 0.5 dB & 3.0 dB respectively. An introduction of Agra Metro Rail substantially reduces the vehicular traffic which ultimately reduces noise level.

5. **Reduction of Traffic on Road**

The basis of reduction of vehicle is shift of ridership from road vehicle to the proposed system. The reduction in number of vehicles gives benefits to economy by reduction in Vehicle Operating Cost (VOC), Fuel Consumption, Pollution Load, Accidents and Travel Time etc. On implementation of the project, the consumption of petrol, diesel and CNG will get reduced. The estimated numbers of vehicle trips that will be reduced due to construction of Agra Metro are given in **Table 15.16**.

**TABLE 15.16: VEHICLE KM SAVED PER DAY**

| Mode | Daily Vehicle Km Reduced due to MRTS | | | |
|---|---|---|---|---|
| | 2024 | 2031 | 2041 | 2051 |
| Car | 29369 | 36031 | 45016 | 56240 |
| 2-Wheeler | 468645 | 625663 | 742389 | 927495 |
| Auto Rickshaw | 7904 | 15120 | 16752 | 20929 |
| Bus | 175923 | 222009 | 283827 | 354597 |

6. **Less Fuel Consumption**

Based on number of vehicle kilometre reduction, reduction in fuel (diesel and petrol) consumption is reported in **Table 15.17**. The saving of Diesel and Petrol will directly benefit the country in monetary terms. Net saving on fuel expenditure at current price level is given in **Table 15.18**.

**TABLE 15.17: FUEL SAVED PER YEAR**

| Year | Diesel (Lakh liters) | Petrol (Lakh liters) | CNG (Lakh Kg) |
|---|---|---|---|
| 2024 | 1.5 | 23.5 | 129.6 |
| 2031 | 1.9 | 31 | 164 |
| 2041 | 2.3 | 37 | 209.4 |
| 2051 | 2.9 | 46.2 | 261.6 |

**TABLE 15.18: SAVING IN FUEL EXPENDITURE PER YEAR (RS. Lakh)**

| Fuel | 2024 | 2031 | 2041 | 2051 |
|---|---|---|---|---|
| Diesel | 80 | 100 | 120 | 150 |
| Petrol | 1670 | 2200 | 2630 | 3280 |
| CNG | 2330 | 2950 | 3770 | 4710 |
| **Total** | **4080** | **5250** | **6520** | **8150** |

**7. Reduced Air Pollution**

Compared to other modes of transport, the metro is least polluting and can be classified as an environment friendly technology since no air emissions are involved in running and operating the metro trains. The major vehicular pollutants that define the ambient air quality are: Particulate matter, Nitrogen oxides, Carbon monoxide, Hydro Carbons and Carbon dioxide. In addition to the above pollution, un-burnt products like aldehydes, formaldehydes, acrolein, acetaldehyde and smoke are by products of vehicular emissions. The reduction of air pollutants with the present corridors are presented in **Table 15.19**.

**TABLE 15.19: POLLUTION REDUCTION (TONS/YEAR)**

| Pollutant | 2024 | 2031 | 2041 | 2051 |
|---|---|---|---|---|
| Carbon Monoxide (CO) | 428 | 555 | 686 | 857 |
| Hydro-Carbons (HC) | 304 | 389 | 489 | 611 |
| Nitrogen Oxide (NOx) | 468 | 596 | 754 | 942 |
| Particulate Matter (PM) | 6 | 8 | 10 | 13 |
| Carbon Dioxide (CO2) | 56389 | 71482 | 90893 | 113556 |

Cost of Human Health saving from lifecycle emissions of $PM_{2.5}$ and cost of carbon capture from lifecycle emissions of GHG caused by gasoline and diesel is worked out (Climate change and health costs of air emissions from bio-fuels and gasoline, Jason Hill et al, PNAS, 2008) at rate of Rs 5.82 per litre and Rs.6.42 per litre in **Table 15.20** for period up to year 2051.

**TABLE 15.20: LIFE CYCLE SAVINGS FROM EMISSIONS (Rs. LAKH)**

| Year | Diesel (Lakh liters) | Petrol (Lakh liters) | Total (Lakh liters) | Cost of Human Health saving from lifecycle emissions of $PM_{2.5}$ | Cost of carbon capture savings from lifecycle emissions of GHG |
|---|---|---|---|---|---|
| 2024 | 1.5 | 23.5 | 25 | 145.4 | 160.4 |
| 2031 | 1.9 | 31 | 32.9 | 191.2 | 210.9 |
| 2041 | 2.3 | 37 | 39.3 | 229 | 252.9 |
| 2051 | 2.9 | 46.2 | 49.2 | 286.1 | 315.6 |

## 15.3.2. Negative Environmental Impacts

Based on project particulars and existing environmental conditions potential negative impacts likely to result from the proposed development are quantified. Negative impacts are listed under the following headings:

- Impacts due to Project Location
- Impacts due to Project Design
- Impacts due to Construction and
- Impacts due to Project Operation
- Impacts due to Depot

**1. Impacts due to Project Location**

During this phase, those impacts, which are likely to take place due to the layout of the project, have been assessed. These impacts are:

- Displacement and loss of livelihood of Project Affected People (PAPs)
- Change of Land use
- Impact on/loss of wildlife/trees/forest
- Utility/Drainage Problems
- Impact on archaeological monuments and
- Impact on Local Transport Facilities

**a. Displacement and loss of livelihood of Project Affected People (PAPs)**

People who have their properties along the alignment will be affected due to the acquisition of land for proposed Agra Metro corridors.

**b. Change of Land use**

Land will be required permanently for stations, Depot, Ramp and running section. Both government and private land will be acquired for the project the detail of which is given in the section on Civil Engineering.

**c. Impact on/loss of wildlife/trees/forest**

By virtue of being not listed in EIA Notification 2006, the project does not require Environmental Clearance under this Notification. In regard to the requirement (as per Order of Hon. Supreme Court) that activities in ESZ of Protected Areas require clearance of NBWL before EC is considered, MoEF has clarified vide letter dated 2 July 2012 that for projects which do not attract EIA Notification 2006, NBWL clearance for activities within ESZ is not require. The project does not require forest clearance as it does not involve diversion of forest land. However activities proposed in the project should be regulated as per ESZ norms. Vide letter dated 31 July 2013, MoEF&CC informed States that a default area of 10 km from the boundary will be the ESZ of such protected areas for which proposals identifying ESZs were not forwarded by the States to MoEF&CC.

In February 2011, Guidelines for declaration of environmentally sensitive zones (ESZ) around national parks and wildlife sanctuaries were issued by MoEF&CC in which the following were clarified: i) the purpose of declaring ESZ is to create shock absorber for the protected areas ii) the Guidelines of September 2000 (Report of the Committee on identifying parameters

for designating ecologically sensitive areas in India, Pronab Sen, Sept 2000) were meant to identify specific units as sensitive zones and were not meant to serve the purpose of shock absorbers.

These Guidelines identified activities in ESZ in three groups: prohibited, regulated and permitted: activities relevant to the project are tabulated below. Activities involved in the project are regulated; discharge of effluents and solid waste in natural water bodies is prohibited.

**TABLE 15.21: CLASSIFICATION OF ACTIVITIES IN ESZ AROUND NATIONAL PARKS AND WILDLIFE SANCTUARIES**

| S.No | Activity | Prohibited | Regulated | To be promoted |
|---|---|---|---|---|
| 1 | Setting up of industries** causing pollution | Yes | -- | -- |
| 2 | Use or production of hazardous substances | Yes | -- | -- |
| 3 | Discharge of effluents and solid waste in natural water bodies or terrestrial area | Yes | -- | -- |
| 4 | Felling of trees | --- | Yes | --- |
| 5 | Commercial ** use of natural water resources including ground water harvesting | --- | Yes | --- |
| 6 | Erection of electrical cables | --- | Yes | --- |
| 7 | Widening of roads | --- | Yes | --- |
| 8 | Movement of vehicular traffic at night | --- | Yes | --- |
| 9 | Air and vehicular pollution | --- | Yes | --- |
| 10 | Sign boards and hoardings | --- | Yes | --- |
| 11 | Underground cabling | --- | --- | Yes |
| 12 | Rain water harvesting | --- | --- | Yes |
| 13 | Renewable energy | --- | --- | Yes |
| 14 | Green technology for all activities | --- | --- | Yes |

*** For purpose of this EIA Report, the spirit of the guidelines has been considered: ``industrial`` to mean polluting; ``commercial`` to mean large scale.*

There are approximately 2729 trees along the two corridors and the two depot sites. These trees are likely to be affected during construction. Trees are major assets in purifications of urban air, which by utilizing CO2 from atmosphere, release oxygen into the air. However, with removal of these trees, the process for CO2 conversion will get effected and the losses are reported below:

i. Total number of Trees : 2729
ii. Decrease in CO2 absorption due to loss of trees : 59,492 kg/year
iii. Decrease in Oxygen production due to tree loss : 1,33,721 kg/year

**d. Utility/Drainage Problems**

The proposed Metro corridors are planned to run through the urban area above the ground i.e. elevated in less densely populated and underground in populated and sensitive areas. The alignment will cross drains, large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals etc. These utilities/ services are essential and have to be maintained in working order during different stages of construction by temporary/permanent diversions or by supporting in position. Plans and cost of such diversions are covered in the section on Civil Engineering.

**e. Impact on archaeological monuments**

The proposed metro rail project will affect residential and commercial structures at some of the portion of alignment and metro stations where construction be made by cut and cover method. No Archeological Monuments are directly affected. Some of the Archeological Monuments are close to the proposed metro alignment as depicted in **Table 12.15**. Utmost care needs be taken so that no significant impact is anticipated on the historical structures due to project activities during construction and operation.

**f. Impact on Local Transport Facilities**

The metro rail has been proposed to cater the additional demand of present and future traffic requirement. Hence, no loss of job to the existing transport facilities is anticipated. The drivers of local transport facilities like buses, taxis, autos and rickshaws may be utilized to cater the requirement of transport from metro stations to work place and vice-versa. Additional employment opportunities are also anticipated due to the proposed metro.

**2. Impacts due to Project Design**

Impacts due to project design are seen in following ways;

- Consumption of energy and water at stations and vibration impact of underground line in trade off with visual intrusion.
- Inter-modal integration will lead to increased use of metro while avoiding congestion outside stations.

**3. Impact Due to Project Construction**

Although environmental hazards related to construction works are mostly of temporary nature, it does not mean that these should not be considered. Appropriate measures should be included in the work plan and budgeted for. The most likely negative impacts related to the construction works are:

- Soil erosion and pollution
- Traffic diversion and risk to existing buildings
- Muck disposal and Debris Disposal
- Dust Generation and Air Pollution
- Increased water demand
- Impact due to labor camp
- Welfare of labor on site

- Safety of labor
- Impact due to Supply of Construction Material
- Impact due to construction near Archaeological Monuments
- Impact on Ground water and Surface water quality
- Noise and Vibration

**a. Soil Erosion and Pollution**

Minor incidence of soil erosion due to runoff from unprotected excavated areas may result especially when erodibility of soil is high.

**b. Traffic Diversion and Risk to Existing Buildings**

During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities are on the road. Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during Metro construction of various corridors under Metro Rail Project network. Such plans and their cost form part of the section on Engineering. As part of pre-construction/construction activities building condition survey will have to be conducted cost of which is not included in EMP.

**c. Muck Disposal**

The metro route is both elevated and underground. The construction activity involves cut and cover, tunneling, excavation and fill. Owing to paucity of space in busy cites and for safety reasons, elaborate measures need to be adopted for collection, storage, transfer and disposal of soil. All these activities will generate about 3.68 Mm3 of soil. Out of this, about 1.10 Mm3 is likely to be reutilized in backfilling in underground stations and Depots. The balance 2.57 Mm3 shall be disposed off in environmental friendly manner. Disposal of excess soil should be permitted in low lying areas owned by ADA. The excess soil disposal site will be those identified by ADA and communicated to UPMRC. Identification of measures required at soil disposal sites and their indicative cost forms part of EMP.

Problems could arise from dumping of construction soils (concrete, bricks), waste materials (from contractor's camp) etc. causing surface and ground water pollution. About 10% to 15% of the construction material such as waste material from contractor camps is left behind by the contractor as construction waste/spoils.

**d. Dust Generation and Air Pollution**

Transportation of earth and establishment of the material will involve use of heavy machinery like compactors, rollers, water tankers, and dumpers. This activity is machinery intensive resulting in dust generation. However, this activity will be only short-term. Protective measures shall be undertaken during construction phase. It is estimated that, about 0.87 Mm3 of earth will be transported in trucks for backfilling in stations, depots and final disposal. The estimated truck movement required to transport the soil/earth will be about 48 trucks per day for the entire length of construction period. On an average a truck is anticipated to move about 20 km per trip for some quantity of muck used in depot site and stations as well as final disposal. Hence total distance travelled would be 960 km per day. The total dust emission/pollution would be 1.24 gm/km or 2.2 kg/day. The emission due to truck movement i.e. CO, HC, NOx and PM will be 2.69 kg/day, 0.74 kg/day, 4.8 kg/day and 0.1 kg/day respectively.

**e. Increased Water Demand**

The water demand will increase during construction phase. Water requirement for construction of metro will be met through municipal supply: in exceptional cases and for short term tube-wells bored specially for the purpose of metro construction will be used after taking approval from competent authority i.e. Central Ground Water Board (CGWB).

**f. Labour Camp**

Facilities such as temporary living accommodation for construction workers at locations away from construction sites; facilities for water supply, treatment / disposal of waste water, sewage and solid waste; collection and disposal of solid waste; health care are statutory requirement and essential to productivity.

**g. Welfare of Labor on construction site**

Facilities such as shelter at workplace, canteen, first aid and day crèche are statutory requirement and essential to productivity.

**h. Safety of Labor**

Safety of labor during construction on elevated and underground sections is a statutory requirement and also has impact on progress of work.

**i. Impact due to Supply of Construction Material**

Construction material such as aggregate and earth are sourced from approved quarries such that environmental impacts as well as wastage of natural resources are minimized and mitigated.

**j. Impact due to Construction near Archaeological Monuments**

No archaeological monuments are directly affected. There are 2 Archaeological Monuments along the corridor-1 and 2 along the Corridor-2 are within prohibited area of 100 meters and 6monuments are passing within 200 meters of regulated area.

In underground section the tunnel will be constructed by State of Art Technology i.e. Tunnel Boring Machine (TBM) and stations will be constructed by Cut and Cover method which is widely accepted and the safest technique being adopted by metro in India and abroad.

**k. Impact on Ground and Surface Water Quality**

Ground water contamination can take place if chemical substances get deposited in soil and are leached by water and percolate to the ground water table. Surface water source can be contaminated if untreated construction wash water is let in from construction sites. One major bridge is planned on the alignment on river Yamuna, proposed to be constructed with well foundation in lean season.

**l. Noise and Vibration**

Construction noise and vibration may disturb people at home, office, school or retail religious buildings depending upon their vicinity to construction site. The major sources during construction are movement of vehicles for transportation of construction material and operation of construction equipment. There are number of sensitive receptors like School, College, Hospital, Temple, Mosque, near the alignment. Typical predicted noise levels for combination of dumper, excavator and pneumatic tools during construction are as

follows: Leq of 93.3 dB (A) at 5m distance; Leq of 65.3 dB (A) at 100m distance.

Damage to structures due to vibration is a possibility in case of pile driving or trains passing within 7.5 m from normal buildings or unreinforced structures or between 15m to 30m from historical buildings or buildings in poor condition; heavy truck traffic within 30m, major construction within 60m, freight trains within 90m or pile diving within 180m can cause disruption of operation of sensitive instrumentation (*Transportation and Construction Vibration Guidance Manual, Caltrans, September 2013*).

## 4. Impacts Due to Project Operation

The project may cause the following negative impacts during operation of the project due to the increase in the number of passengers and trains at the stations:

- Noise and Vibration
- Water supply and sanitation at Stations
- Traffic congestion

### a. Noise and Vibration

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. There are number of sensitive receptors like School, College, Hospital, Temple, Mosque, near the alignment. The major impacts on sensitive receptors during operation phase will be noise and vibration. Noise prediction with average train speed of 25 km/hr and no noise barriers is presented **Table 15.22**. Impact of Vibration during Vibration is mentioned in **para (l) on page 15-26** under Impact due to Construction.

**TABLE 15.22: NOISE LEVELS AT DIFFERENT DISTANCES DURING OPERATION**

| Distance (m) | Noise Level in dB (A) |
|---|---|
| 10 | 84 |
| 20 | 78 |
| 30 | 74 |
| 40 | 71 |
| 50 | 70 |
| 60 | 68 |
| 70 | 67 |
| 80 | 65 |
| 90 | 64 |
| 100 | 64 |

It is assumed that train average speed is 25 km/hr, and no barrier is present. Due to reduction of vehicular traffic, the road traffic noise is expected to come down.

### b. Water Supply and Sanitation

The water demands will be on station for drinking and toilet primarily of staff, station cleaning and AC chiller. Water Demand is calculated and presented in **Table 15.23.**

**TABLE 15.23: WATER REQUIREMENT**

| S. No. | Particular | Water Demand at Each Station (KLD) | Total Water Demand (KLD) |
|---|---|---|---|
| 1 | At Stations for Drinking Purpose | 6.000 | 186 |
| 2 | In Underground stations for AC, cleaning, chiller and other purposes with softening plant | 85.000 | 680 |
| 3 | In Elevated stations for AC, cleaning, chiller and other purposes | 16.600 | 382 |
| **Total** | | | **1248** |

**c. Traffic congestion**

Upon operation of metro services passenger rush at stations will increase resulting in congestion around stations.

**5. Impacts Due to Depot**

In order to develop areas as depot, it will need filling by earth brought from outside. The earth from underground metro corridor tunnelling and cut and cover will be utilised to fill the deport site. The facilities will generate water and noise issues. Problems anticipated at depot sites are:

- Water supply
- Sewage and Effluent disposal
- Oil Pollution
- Noise Pollution
- Surface drainage
- Solid Waste
- Cutting of trees.

**a. Water Supply**

Water supply will be required for different purposes in the depot. As per the Indian Railway Work Manual, the water demand for train washing and other purposes (Departments, workshop and Contractor office) is 3600 liter per day in each case. The water demand at PAC depot would be 133 KLD and for Kalindi Vihar depot will be 155 KLD. This water will be collected through bore wells at each Depot after taking approval from competent authority. Hence, there will be no negative impact on the residents living in the vicinity of tube wells whose water demand is, in any case, met by municipal water.

**b. Sewage and Effluent**

About 107 KLD waste water will be generated at Depot at PAC land near Mall Road and 124 KLD at Kalindi Vihar Depot. Hence total waste water generation from both depots will be about 231 KLD, which will be treated at effluent treatment plant. The treated waste water will be tested for Inland Water Discharge Standard before release in to surface water body. The part of the water will be recycled to use at depot horticulture purpose. The domestic waste /sewage generated at the Depot will be collected at one suitable point inside the depot and will be treated at packaged type sewage treatment plant. From here it will

discharge to the nearest manhole of existing sewerage system of the corporation for that necessary permission/ approvals from the AMC are required. There will be minimal impact due to wastewater from the Depot.

**c. Oil Pollution**

Oil spillage during change of lubricants, cleaning and repair processes in the maintenance Depot cum workshop for maintenance of rolling stock should be trapped in oil and grease traps and disposed off to authorised collectors, so as to avoid any underground/ surface water contamination.

**d. Noise Pollution**

The main source of noise from depot is the operation of workshop. The roughness of the contact surfaces of rail and wheel and train speed is the factors, which influence the magnitude of rail - wheel noise.

**e. Surface Drainage**

In case of filling in low-lying area of depot sites, the surface drainage pattern may change.

**f. Solid Waste**

Solid waste will be generated from each of the Depot sites which will be taken by the cleaning contractor weekly and recycled/disposed of at ADA waste disposal sites.

**g. Loss of Trees**

About 1226 numbers of trees are observed at PAC Land Depot and about 154 trees at Kalindi Vihar Depot.

## 15.4. POSITIVE AND NEGATIVE ENVIRONMENTAL IMPACTS

### 15.4.1. Positive impacts

- Employment Opportunities
- Benefits to Economy
- Traffic Congestion Reduction, Quick Service and Safety
- Traffic Noise Reduction
- Reduction of Traffic on Road
- Less Fuel consumption and
- Reduced Air pollution

### 15.4.2. Negative impacts

**1. Impacts due to Project Location**

- Displacement and loss of livelihood of Project Affected People (PAPs)
- Change of Land use
- Impact on/loss of wildlife/trees/forest
- Utility/Drainage Problems
- Impact on archaeological monuments and
- Impact on Local Transport Facilities

**2. Impacts due to Project Design**

- Consumption of energy and water at stations and vibration impact of underground line in trade off with visual intrusion.
- Inter-modal integration will lead to increased use of metro while avoiding congestion outside stations

**3. Impact Due to Project Construction**

- Soil erosion and pollution
- Traffic diversion and risk to existing buildings
- Muck disposal and Debris Disposal
- Dust Generation and Air Pollution
- Increased water demand
- Impact due to labour camp
- Welfare of labour on site
- Safety of labour
- Impact due to Supply of Construction Material
- Impact due to construction near Archaeological Monuments
- Impact on Ground water and Surface water quality
- Noise and Vibration

**4. Impacts Due to Project Operation**

- Noise and Vibration
- Water supply and sanitation at Stations
- Traffic congestion

**5. Impacts Due to Depot**

- Water supply
- Sewage and Effluent disposal
- Oil Pollution
- Noise
- Surface drainage
- Solid Waste
- Cutting of trees

## 15.5. ENVIRONMENTAL MANAGEMENT PLAN

Environmental Management Plan is presented in two sections:

- Mitigation measures and
- Enhancement measures

### 15.5.1. Mitigation Measures

i. Compensatory Afforestation
ii. Construction Material Management
iii. Safety Management Measures
iv. Labour Camp
v. Welfare of labour

vi. Safety of labour
vii. Energy Management
viii. Hazardous Waste Management
ix. Water Pollution Management
x. Environmental Sanitation
xi. Utility Plan
xii. Protection of Archaeological Monuments
xiii. Air Pollution Control Measures
xiv. Noise Control Measures
xv. Vibration Control Measures
xvi. Traffic Diversion/Management
xvii. Soil Erosion Control
xviii. Muck Disposal
xix. Construction and Demolition Waste Management
xx. Draining of Water from Tunnel
xxi. Water Supply, Sanitation and Solid Waste management
xxii. Management Plan for Depot
xxiii. Training
xxiv. Environment Division
xxv. Disaster Risk Management

**i. Compensatory Afforestation**

The Department of Forests, Government of Uttar Pradesh is responsible for the conservation and management of trees/forests in the project area. According to the results of the present study, it is found that about 2729 trees are likely to be lost along the two corridors and two depots. It is proposed to plant ten saplings for each tree to be cut. Hence, 28440 trees need to be planted. Cost of afforestation is taken as Rs 5,01,090/-per ha. Compensatory afforestation cost thus will be about **Rs 91.56 Lakh** for Corridor-I and **Rs 33 Lakh** for Corridor-II. The native plant species and miscellaneous indigenous tree species recommended for afforestation. 27290 trees, on maturing will absorb about 595 ton of CO2 per year and will release 1337 ton of Oxygen per year.

**ii. Construction Material Management**

The duties of the contractor will include monitoring all aspects of construction activities, commencing with the storing, loading of construction materials and equipment in order to maintain the quality. During the construction period, the construction material storage site is to be regularly inspected for the presence of uncontrolled construction waste. Close liaison with the officer of the UPMRC and the head of the construction crew will be required to address any environmental issues and to set up procedures for mitigating impacts. The scheduling of material procurement and transport shall be linked with construction schedule of the project. The Contractor shall be responsible for management of such construction material during entire construction period of the project.

**iii. Safety Management Measures**

Prior to the construction/operation, identification of safety hazards would be made by Project Authority and prepare safety programmes following rules, regulations and guidelines.

**iv. Labour Camp**

In accordance with the Construction Contract the Contractor shall provide the following facilities at the labour camps: (temporary) living accommodation, sanitation facilities like toilets and drains, health awareness campaigns, facilities for water supply and waste water treatment and solid waste management. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

**v. Welfare of Labour on construction site**

In accordance with the Construction Contract the Contractor will be required to provide shelter at workplace, canteen facilities, first aid facilities, day crèche facilities on work sites.

**vi. Safety of labour**

Construction works shall be executed as laid down in the Safety Health and Environment (SHE) manual prepared by the Contractor and approved by PIU.

**vii. Energy Management**

The contractor shall use and maintain equipment so as to conserve energy. Measures to conserve energy include but not limited to the following: use of tools, plant and equipment of correct specifications; energy efficient motors and pumps; efficient lamps; optimal maintenance. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

**viii. Hazardous Waste Management**

The contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities and shall and shall obtain authorization from State Pollution Control Board. Hazardous waste would mainly arise from the maintenance of equipment which may include used engine oils, hydraulic fluids, waste fuel, spend mineral oil/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spend solvents etc. Hazardous Waste needs to be stored in a secure place and adequately labelled and packaged. The contractor shall maintain a record of sale, transfer, storage of such waste and make these records available for inspection.

**ix. Water Pollution Management**

Precipitation systems will be installed to prevent wash water from construction sites polluting surface water courses.

**x. Environmental Sanitation**

Environmental sanitation also referred to as Housekeeping is the act of keeping the working environment cleared of all construction material/debris, scraps and used material/items, thereby providing a first-line of defence against accidents and injuries. General environmental sanitation shall be carried out by the contractor and ensured at all times at Work Site, Construction Depot, Batching Plant, Stores, Offices and toilets/urinals.

### xi. Utility Plan

The proposed Metro alignment runs along major arterial roads of the city which serves Institutional, Commercial and Residential areas. Large number of sub-surface, surface and overhead utility services, viz. sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. already exist along the proposed alignments. These utility services are essential and have to be maintained in working order during different stages of construction by temporary/permanent diversions or by supporting in position. As such, these may affect construction and project implementation time schedule/costs, for which necessary planning/action needs to be initiated in advance.

Prior to the actual execution of work at site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility. While planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of Metro, the following guidelines could be adopted:

- Utility services shall be kept operational during the entire construction period and after completion of project.
- Sewer lines and water supply lines are mainly affected in underground cut and cover construction. These services are proposed to be maintained by temporarily replacing them with CI/Steel pipelines and supporting them during construction, these will be encased in reinforced cement concrete after completion of construction and retained as permanent lines.
- Where permanent diversion of the affected utility is not found feasible, temporary diversion with CI/Steel pipes without manholes is proposed during construction. After completion of construction, these will be replaced with conventional pipes and manholes.
- In case of underground utility services running across the alignment, the spanning arrangement of the viaduct may be suitably adjusted.

### xii. Protection of Archaeological Monuments

The proposed alignment is passing within the prohibited area,2 archaeological monuments in case of Corridor-1 and 2 archaeological monuments in case of Corridor-2 coming in prohibited area. During construction stage, archaeological or historical structures may get affected by construction activity. Necessary procedure will be followed for Construction within the regulated area of Archaeological Monuments. Prior to the initiation of construction, UPMRC will conduct condition survey of all archaeological/heritage structures in the vicinity of alignment so as to follow up during construction and operation of the project.

### xiii. Air Pollution Control Measures

During the construction period, the impact on air quality will be mainly due to increase in Particulate Matter (PM) along haul roads and emission from vehicles and construction machinery. Mitigation measures which shall be adopted to reduce the air pollution are presented below:

- The Contractor shall take all necessary precautions to minimize fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport, handling, construction or storage activity to remain visible in atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.

- Contractor's transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.

- The Contractor shall cover loads of dust generating materials like debris and soil being transported from construction sites. All trucks carrying loose material should be covered and loaded with sufficient free - board to avoid spills through the tailboard or sideboards.

- The temporary dumping areas shall be maintained by the Contractor at all times until excavate is re-utilized for backfilling or as directed by Employer.

- The Contractor shall place material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control methods must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.

- The Contractor shall water down construction sites as required to suppress dust, during handling of excavation soil or debris or during demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed especially where the work is near sensitive receptors.

- The Contractor shall design and implement blasting techniques so as to minimize dust, noise, and vibration generation and prevention fly rock.

Capital and operating cost are included in engineering cost and therefore is not included in EMP.

**xiv. Noise Control Measures**

There may be an increase in ambient noise level due to construction. The exposure of workers to high noise levels can be minimized by job rotation, automation, protective devices and soundproof compartments, control rooms etc. Cost is to be included in the project engineering cost.

Noise level from loading and unloading of construction materials can be reduced by usage of various types of cranes and placing materials on sand or sandy bag beds.

Cost of noise barriers required to be deployed during operation is estimated as part of EMP cost. Noise barriers shall be placed along the curved portion of the viaduct and at sensitive

places during operation. The estimated cost of noise barrier is about **Rs 79.15 Lakh** for Corridor-I and **Rs 432.05 Lakh** for Corridor-II.

### xv. Vibration Control Measures

In the case of vibrations from pile driving very deep barriers (in excess of 10 m) were found to reduce vibration. In-ground barriers are trenches that are either left open or filled with a material (such as bentonite or concrete) that has stiffness or density significantly different from that of the surrounding soil. However, trenches may be too costly for situations involving houses. They could perhaps be justified for larger buildings with strict vibration limits, such as operating theatres of hospitals or high-tech factories with sensitive processes. An economical alternative to trenches in a residential area could be a row of lime or cement piles of diameter 0.5 m to 1 m and a depth of 15 m in the right-of-way adjacent to the road. However, the effectiveness of such pile-walls has not yet been demonstrated.

Ballast-less track is supported on two layers of rubber pads to reduce track noise and ground vibrations.

### xvi. Traffic Diversion/Management

In order to retain satisfactory levels of traffic flow during the construction period; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads, acquisition of service lanes, etc.

- All construction workers should be provided with high visibility jackets with reflective tapes at most of viaduct/tunneling and station works or either above or under right-of-way.
- Provide safe and clearly marked lanes for guiding road users.
- Provide safe and clearly marked buffer and work zones
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.

Various construction technologies like cut and cover can be employed to ensure that traffic impedance is minimized. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

During operation decongestion scheme should involve taxi and auto rickshaw stands, a halting space for public buses, drop off-pick up for owned modes. Parking space at stations if any is to be planned well.

### xvii. Soil Erosion Control

Prior to the start of the relevant construction, the Contractor shall submit to the UPMRC for approval, his schedules for carrying out temporary and permanent erosion/sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage

excavation, embankment/sub-grade construction and other structures across water courses, pavement courses and shoulders and his plan for disposal of waste materials. The surface area of erodible earth material exposed by clearing and grubbing, excavation shall be limited to the extent practicable. Works such as construction of temporary berms, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation may be involved. Mitigation measures include careful planning, timing of cut and fill operations and re-vegetation. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

### xviii. Muck Disposal

Measures need to be adopted for collection, transfer, temporary storage and disposal of excavated muck. Sites for muck disposal will be decided by UPMRC before start of construction in consultation with respective authority like Municipal Corporation etc. such that the sites are away from residential areas and do not require displacement. The transfer and disposal of surplus soil may create air pollution and leached water problem. To mitigate these problems following mitigation measure are proposed to be adopted:

- The disposal sites will be cleaned and then treated so that leached water does not contaminate the ground water.
- Material will be stabilized each day by watering or other accepted dust suppression techniques.
- The height from which soil will be dropped shall be minimum practical height to limit the dust generation.
- The stock piling of earth in the designated locations with suitable slopes
- During dry weather, dust control methods such as water sprinkling will be used daily especially on windy, dry day to prevent any dust from blowing.
- Sufficient equipment, water and personnel shall be available on dumping sites at all times to minimize dust suppression.
- Dust control activities shall continue even during work stoppages.
- The muck shall be filled in the dumping site in layers and compacted mechanically. Dumping sites on sloping ground shall be protected adequately against any possible slide/slope failure through engineering measures.
- It is desirable to first clean the disposal area site for vegetation biomass exists over it. The faces and top should be treated/ vegetated to avoid erosion. Once the filling is complete, the entire muck disposal area shall be provided with a layer of good earth on the top, dressed neatly, and covered with vegetation.

Capital and operating cost are included in engineering cost and therefore is not included in EMP.

### xix. Construction and Demolition Waste Management

Construction and Demolition (C&D) debris is that part of the solid waste stream that results from land clearing, excavation, construction, demolition, remodeling and repair of structures, roads and utilities. C&D waste generated from metro construction has potential use after processing and grading. Post-grading the waste should be disposed at sites identified by UPMRC in consultation with respective authority like Municipal Corporation etc. such that the sites are away from residential areas, water body/ water course and do not require displacement.

### xx. Draining of Water from Tunnel

Water from underground works shall be led by construction drains into sumps and then to trunk sewers or used to recharge groundwater or re-use for construction. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

### xxi. Water Supply, Sanitation and Solid Waste Management

Public health facilities such as water supply, sanitation and toilets are needed at the stations. Drinking water and raw water requirement for underground and elevated stations can be provided from municipal source in consultation with local agencies. Water should be treated to WHO drinking water standards before use. During operation rainwater harvesting will be carried out at elevated stations and Depots. To avoid excess usage of water during construction following measures will be taken to reduce water consumption:

- Recycle of water consumed in wheel washing.
- Discarded water from the R/O plant at Batching Plants shall be used for re-charge of ground water.
- Water from dewatering will also be used for ground water recharge.

Solid waste will be collected and transported to local municipal bins for onward disposal to disposal site by municipality. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

### xxii. Management Plan for Depot

Two maintenance depots are planned for Agra Metro. These are at i) PAC land Near Mall Road and ii) Kalindi Vihar. The management plan for depot site includes:

- Water Supply
- Oil Pollution Control
- Sewage/Effluent Pollution Control
- Solid waste disposal
- Surface Drainage
- Green belt development
- Rain water harvesting and
- Recycling of treated waste water

**Water supply**: Water will be required for operation and functioning of depot which will be through municipal supply or boring tube well into the ground. The ground water will need treatment depending upon its use. For Domestic application a Reverse Osmosis (RO) system will be appropriate. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

**Oil Pollution Control**: The oil tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil and grease removal tank has to be installed at initial stage of effluent treatments. The tank may be designed for a detention period of 5 to 15 minutes. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

**Sewage/Effluent Pollution Control**: Sewage will be generated from depot which could be treated up to the level so that it could be used for horticulture purpose in the campus and can also be discharged into the stream. Similarly effluent is likely to be generated from Depots. This has to be treated as per requirement of UP Pollution Control Board. The estimated cost of packaged type Sewage Treatment Plant (STP) is about Rs 10 Lakh and cost of Effluent Treatment Plant (ETP) is Rs 141 Lakh at PAC depot. And, the estimated cost of Sewage Treatment Plant (STP) is about Rs 10 Lakh and cost of Effluent Treatment Plant (ETP) is Rs 164 Lakh at Kalindi Vihar Depot.

**Solid Waste Disposal**: The solid waste generated from the Depot will be taken by the cleaning contractor weekly and disposed to the Agra Municipal Corporation waste disposal sites in accordance with relevant National and State laws and regulations.Capital and operating cost are included in engineering cost and therefore is not included in EMP.

**Surface Drainage**: The area should have proper drainage. The Storm water of the depot will be collected through the drains. Rain water harvesting pits shall be provided at different locations in the drains and for surplus storm water, the drainage system should be connected to a nearby disposal site. Capital and operating cost are included in engineering cost and therefore is not included in EMP.

**Green belt development**: The greenbelt development/ plantation in the depot area not only functions as landscape features resulting in harmonizing and amalgamating the physical structures of proposed buildings with surrounding environment but also acts as pollution sink noise barrier. Estimated cost for green belt development is about Rs 10.02 Lakh and Rs 9.01 Lakh for PAC Depot and Kalindi Vihar Depot respectively. Treated sewage and effluent in the best combination should be used for green belt development.

**Rain water harvesting**: To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure of suitable capacity in the proposed depots. Most of the area in depot will be open to sky and it is estimated that approximately 10% area will be covered. Rainwater harvesting potential of depots is calculated as 17,106 cubic meter per year. The estimated cost for rainwater harvesting for both the depots is Rs 32.32 Lakh.

**Recycling of treated waste water**: Waste-Water generated at depots is proposed to be collected at ETP & STP through separate sewer lines for treatment. The treated waste water will be recycled for horticulture work of the depots.

### xxiii. Training

The training for engineers and managers will be impacted by UPMRC on regular basis to implement the environmental protection clauses of the tender document and to implement the best environmental practices during the construction phase. Apart from training, programme should include guidelines for safety, methods of disaster prevention, action required in case of emergency, fire protection, environmental risk analysis etc. The cost involved for such programmes is estimated as Rs 10.20 Lakh for Corridor-Iand Rs 13.80 Lakh for Corridor-II, details are given in **Table 15.24.**

**TABLE 15.24: COST FOR TRAINING PROGRAMME**

| S. No. | Item | Cost (Rs) | |
|---|---|---|---|
| | | Corridor-I | Corridor-II |
| 1 | Curriculum Development and course preparation 1 months Rs.50000/month | 50,000 | 50,000 |
| 2 | Extension Officer (1 year) Rs. 20,000/month | 480000 | 720000 |
| 3 | Instructor 20 sessions of 10 days each | 240000 | 360000 |
| 4 | Demonstration/Presentation Aids | 1,00,000 | 1,00,000 |
| 5 | Material etc | 150000 | 150000 |
| **Total** | | **10,20,000** | **13,80,000** |

### xxiv. Establishment of Environmental Division

It is recommended that UPMRC establishes an Environment Division at the initial stage of the project itself. This division should have an Environmental Officer and an Environment Engineer. The task of the division would be to supervise and coordinate studies, environmental monitoring and implementation of environmental mitigation measures, and it should report directly to Chief Engineer of the project authority. Progress of the division should be reviewed by an Environmental Advisor once in a year. The environmental Advisor should be an experienced expert familiar with environmental management in similar projects. Costs for the first ten years (including 10% annual increase has been) given **Table 15.25**. The estimated cost for one corridor is **Rs 174.24 Lakh** and for two Corridors the cost will be **Rs 348.48 Lakh**.

**TABLE 15.25: ENVIRONMENTAL DIVISION COSTS PER YEAR FOR ONE CORRIDOR**

| S. No. | Particulars | In Rupees |
|---|---|---|
| 1. | Environmental Engineer (1No.) | 6,00,000 |
| 2. | Assistant Environmental Engineer (1No.) | 4,20,000 |

| S. No. | Particulars | In Rupees |
|---|---|---|
| 3. | Miscellaneous Expenditure | 5,64,000 |
| **Total Cost for One Year** | | **15,84,000** |
| **Total Cost for Ten Years with 10% annual increase** | | **1,74,24,000** |

**xxv. Disaster Risk Management**

**Some basic concepts:** Hazard is a threat or event which can cause damage; disaster is a major hazard event. Disaster risk is expressed as the likelihood of loss of life, injury or destruction and damage from a disaster.

The recommended approach (UNISDR) is to manage disaster risk rather than managing disasters. Disaster risk is the combination of the severity and frequency of a hazard, the numbers of people and assets exposed to the hazard, and their vulnerability to damage. The main opportunity in reducing risk lies in reducing exposure and vulnerability.

Disaster Risk Management includes the following actions:

i. **Reduction and prevention: M**easures to reduce existing and avoid new disaster risks, for instance relocating exposed people and assets away from a hazard area. In case of mass transit like Metro such measures are not actionable.

ii. **Mitigation:** The lessening of the adverse impacts of hazards and related disasters. For instance implementing strict land use and building construction codes. This aspect is accounted for in design and construction of the project.

iii. **Transfer:** The process of formally or informally shifting the financial consequences of particular risks from one party to another, for instance by insurance. This is not yet available.

iv. **Preparedness:** The knowledge and capacities of governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from the impacts of hazard events or conditions, for instance installing early warning systems, identifying evacuation routes and preparing emergency supplies.

Risk Management process (*A. Berrado, Em El-Koursi, A. Cherkaoui, M. Khaddour. A Framework for Risk Management in Railway Sector: Application to Road-Rail Level Crossings. Open transportation Journal, Bentham Open, 2010, 19p. HAL Id: hal-00542424 https://hal.archives-ouvertes.fr/hal-00542424 Submitted on 2 Dec 2010*) comprise the following stages:

a) Description of the system that is at risk

b) Identify the potential hazards or sources of risk (the list of initiating events or scenarios of events leading to the undesired outcome – technological and human)

c) Risk analysis to estimate the likelihood of the scenarios or events occurring and each scenario's consequence

d) Compare and rank the various risk drivers

e) Action plan in response to the identified major risks

f) Regular monitoring, review and updating of the process

1) For example, the system at risk needs to be defined as to include inter-modal integration.

2) Examples of potential hazards are fire risk or security alarms or failure of train control or motive power or passenger doors / escalators / platform screen doors on trains or in stations; staff training and work environment; inadequate maintenance.

3) Action plan shall include the following.

**Reporting procedures:** Surveillance and incident reporting schedules shall be established.

**Identification of resources:** Sources of repair equipment, personnel, transport and medical aid for use during emergency will be identified.

**Emergency systems:** Back-up systems for ventilation, communication and train control, lighting etc shall be established.

**Evacuation procedures: E**vacuation procedures will be prepared in consultation with local administration and notified. To ensure coordinated action, an Emergency Action Committee shall be constituted.

**Communication System:** Primary and back-up system shall be put in place

4) **Review and Updation**: Drawing inputs from the incident reporting system the Action Plan shall be reviewed at pre-decided intervals and upon occurrence of defined ``trigger events`` and suitably updated.

## 15.5.2. Measures to enhance positive impacts

### i. Rain water harvesting

To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure of suitable capacity at the elevated stations and in the elevated alignment. Each pillar can have inbuilt downpipes to collect the rainwater from the viaduct and into the underground tanks. A recharge tank shall be constructed at suitable distance. The water collected will percolate down to the subsoil through numerous layers of sand, gravel and boulders. Total elevated length of the corridors is about 22.4 km. Annual rainfall of Agra is 724.8 mm. Considering a runoff coefficient of 0.85 the annual rainwater harvesting potential of elevated stations and elevated section is estimated as 8,10,220 cubic meter per year. Estimated cost for rainwater harvesting for viaduct and elevated stations is Rs 79.34 Lakh for Corridor-I and Rs 192.33 Lakh for Corridor-II.

**ii. Green Buildings**

Green building (also known as sustainable building) refers to both a structure and the using of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. Green buildings help in better preservation of environment as in such structures there are provisions for better saving of energy, water and CO2. Such buildings also have better waste management arrangements.

The Indian Green Building Council (IGBC) conducts a rating process for New Buildings which addresses the green features under the following categories:

- Sustainable Architecture and Design
- Site Selection and Planning
- Water Conservation
- Energy Efficiency
- Building Materials and Resources
- Indoor Environmental Quality
- Innovation and Development

All stations and Depots can be designed as green buildings.

# 15.6. ENVIRONMENTAL MONITORING PLAN AND ENVIRONMENT MANAGEMENT SYSTEM

## 15.6.1. Environment Monitoring Plan

The environmental monitoring programme is a vital process of any Environmental Management Plan (EMP) of development project for review of indicators and for taking immediate preventive action. Environmental monitoring should be an integral part of works towards better environmental management of air, noise, vibration, water quality etc both during construction and in operation phases of the project. The following parameters are proposed to be monitored:

- Water Quality,
- Air Quality,
- Noise and Vibration,
- Environmental Sanitation and Waste Disposal
- Ecological Monitoring and Afforestation,
- Workers Health and Safety

Environmental monitoring during pre-construction phase is important to know the baseline data and to predict the adverse impacts during construction and operations phases.

Estimated cost for Environmental monitoring during the construction and operation phases are **Rs 52.17 Lakh** for Corridor-I and **Rs 23.64 Lakh** for Corridor-II.

## 15.6.2. Construction Phase

During construction stage environmental monitoring will be carried out for air quality, noise levels, vibrations, water quality, and ecology. At this stage it is not possible to visualize the exact number of locations where environmental monitoring must be carried out. However keeping a broad view of the sensitive receptors and also the past experience an estimate of locations has been made and are summarized in **Table 15.26.** These numbers could be modified based on need when the construction actually commences.

**TABLE 15.26: CONSTRUCTION STAGE MONITORING SCHEDULE**

| Parameter | Frequency | Locations | Years |
|---|---|---|---|
| Air Quality | 2x24 hours, twice a month | 8 | 5 |
| Noise | 24 hours, once a week | 8 | 5 |
| Vibration | 24 hours, once a week | 5 | 5 |
| Water | Once in 6 months | 5 | 5 |

### i. Water Quality

The water quality parameters are to be monitored during the entire period of project construction. Monitoring should be carried out by NABL Accredited/MoEFCC recognized private or Government agency. Water quality should be analyzed following the procedures given in the standard methods. Parameters for monitoring will be as per BIS: 10500. The monitoring points could be ground and surface water.

### ii. Air Quality

Air quality is regularly monitored by Central Pollution Control Board at number of places in Agra. In addition to these, air quality should be monitored at the locations of baseline monitoring. The parameter recommended is Particulate Matter (PM2.5 and PM10), SO2, NOX, CO and HC. The contractor will be responsible for carrying out air monitoring during the entire construction phase under the supervision of UPMRC.

### iii. Noise and Vibration

The noise and vibration will be monitored at construction sites for entire phase of construction by the site contractor and under the supervision of UPMRC.

### iv. Ecological Monitoring

The project authority in coordination with the Department of Forest shall monitor the status of ecology/trees along the project corridors at least 4 times in a year during construction phase in order to maintain the ecological environment. The plantation/afforestation of trees by Department of Forest, Government of Uttar Pradesh will be review four times a year during construction phase.

**v. Workers Health and Safety**

Monitoring of health risk issues that might arise throughout the project life time will be done. Epidemiological studies at construction sites will be performed to monitor the potential spread of diseases. Regular inspection and medical checkups shall be carried out to workers health and safety monitoring.

Any reoccurring incidents such as irritations, rashes, respiratory problems etc shall be recorded and appropriate mitigation measures shall be taken. Contractor will be the responsible person to take care health and safety of workers during the entire period of the construction and project proponent is responsible to review/audit the health and safety measures/plans.

**vi. Operation Phase**

Even though the environmental hazards during the operation phase of the project are minimal, the environmental monitoring will be carried out for air, noise, vibration, water and ecology during operation phase of the project. The parameters monitored during operation will be Particulate Matter (PM2.5 and PM10), SO2, NOX, CO and HC for air. Water quality parameters that will be monitored will be as per BIS 10500.

The monitoring schedule is presented in Table 15.26. Monitoring should be carried out by NABL Accredited/MoEFCC recognized private or Government agency under the supervision of Uttar Pradesh Metro Rail Corporation. Project Operator i.e. UPMRC will be responsible for successful environmental monitoring of the proposed project during operation phase.

**TABLE 15.27: OPERATION STAGE MONITORING SCHEDULE**

| Parameter | Frequency | Locations | Years |
|---|---|---|---|
| Air Quality | 2x24 Hour, once in a month | 8 | 3 |
| Noise | 24 hours once a year | 8 | 3 |
| Vibration | 24 hours once a year | 5 | 3 |
| Water | Once a year | 2 (Depots) | 3 |
| Waste Water | Once in 4 months | 2 (Depots) | 3 |
| Solid Waste | Once a year | (Depots) | 3 |

## 15.6.3. Formation of Environment Management System (EMS)

Environment Management System is intended to facilitate implementation, tracking and reporting of mitigation and monitoring measures proposed for the project. Roles and responsibilities are summarized in **Table 15.28** and **Table 15.29**.

**TABLE 15.28: ROLES AND RESPONSIBILITIES - SECURING APPROVALS/CLEARANCES**

| S N | Issue | Provision of Laws & Regulations | Due Date | Approving Authority |
|---|---|---|---|---|
| **Pre-Construction Phase** | | | | |
| 1 | Permission for felling of trees and compensatory afforestation | Tree removal will be guided as per state government rules. | Before Construction | Municipal Corporation/Forest Department |
| 2 | Environmental Clearance for Depot, stations, property development | Amendment dated 9 December 2016 to EIA Notification 2006 | | Municipal Corporation |
| 3 | Archaeological / heritage assets | The Ancient Monuments and Archaeological sites and Remains (Amendment and Validation Act) 2010 | | National Monuments Authority for protected Archaeological assets / Municipal Corporation for heritage assets |
| 4 | Utility / traffic diversion | Respective Acts and Rules | | Local Offices of respective Agencies. |
| 5 | Consent to Establish Depot | Water (Prevention and Control of Pollution) Act 1974 ; Hazardous Waste (Management and Handling and transboundary movement) Rules 2016 | | State Pollution Control Board; Development Authoruty for landuse clearance |
| **Construction Phase** | | | | |
| 6 | Consent to Establish and Operate hot mix plant, crushers, batching plant etc and Consent to Establishlabour camps | Air (Prevention and Control of Pollution) Act 1981 | Before Construction | State Pollution Control Board<br>MunicipalCorporation |
| 7 | Permission for drawalof groundwater for construction (**not recommended**) | Environment (Protection) Act, 1986 | Before Construction | Regional Director, Central Ground Water Board and Municipal Corporation |
| 8 | Authorization for Disposal of Hazardous Waste | Hazardous Waste (Management and Handling and trans-boundary movement) Rules 2016 | Before Construction | State Pollution Control Board |
| 9 | Consent for disposal of waste water from construction sites | Water (Prevention and Control of Pollution) Act 1974 | Before Construction | State Pollution Control Board |

| S N | Issue | Provision of Laws & Regulations | Due Date | Approving Authority |
|---|---|---|---|---|
| | and sewage from labour camps | | | |
| 10 | Labour employment, safety, welfare measures | The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 | Before Construction | District Labour Commissioner |
| 11 | Permission for management of C&D waste and muck | Environment Protection Act 1956 | Before Construction | MunicipalCorporation and State Pollution Control Board |
| **Operation Phase** | | | | |
| 12 | Consent to Operate Depot | Environment Protection Act 1956 | After Construction | State Pollution Control Board |
| 13 | Installation and operation of DG sets at stations | Air (Prevention and Control of Pollution) Act 1981 | After construction | State Pollution Control Board |

**TABLE 15.29: ROLES AND RESPONSIBILITIES –PREPARATION AND IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT PLAN (EMP) AND ENVIRONMENTAL MONITORING PLAN (EMOP)**

| SN | Environmental Impact | Mitigation Measure | Implementing Entity | Responsible Entity |
|---|---|---|---|---|
| **Location and Design Phase** | | | | |
| 1 | Displacement and private property acquisition, impact of environmentally sensitive areas. | Alignment design to avoid or minimize impact. | DPR and design consultant | PIU |
| 2 | Loss of trees and water bodies | | DPR and design consultant | PIU |
| 3 | Visual intrusion | Capital and operating cost and vibration impact of underground line in trade off with visual intrusion. To design aesthetic structures of viaduct and stations on elevated sections. | DPR and design consultant | PIU |
| 4 | Archaeological monuments | Alignment design to avoid or minimize impact. | DPR and design consultant | PIU |
| **Pre-construction Phase** | | | | |
| 5 | Displacement and private property acquisition. | Implement R&R Plan | PIU | PIU |
| 6 | Loss of trees and water bodies | Implement compensatory afforestation | Forest Department | Forest Department |
| 7 | Site measures | Prepare Safety, Health and Environment (SH&E) Manual and secure approval. | Contractor | PIU |

| SN | Environmental Impact | Mitigation Measure | Implementing Entity | Responsible Entity |
|---|---|---|---|---|
| 8 | Water supply; sewage and solid waste disposal | Requirement for construction to be planned so as to avoid use of ground water. | Contractor | PIU |
| 9 | Environmental Management and Monitoring | Implement institutional requirements for implementation of EMP and EMoP. | Contractor | PIU |
| **Construction Phase** | | | | |
| 10 | Soil erosion, fugitive dust generation, muck disposal and C&D waste management | Implement suitable construction methods and as per SH&E Manual | Contractor | PIU |
| 11 | Air and noise Pollution | Vehicles and machinery are to be maintained to emission standards; machinery noise muffles etc and personal protective gear to workers. | Contractor | PIU |
| 12 | Vibration | Implement vibration monitoring and building condition surveys at sensitive structures | Contractor | PIU |
| 13 | Water pollution | Implement measures such as precipitation tanks on site | Contractor | PIU |
| 14 | Soil pollution | Implement measures to prevent ingress of toxic / heavy metals | Contractor | PIU |
| 15 | Labour camp: water supply; sewage and solid waste disposal; health | Implement measures as per SH&E Manual | Contractor | PIU |
| 16 | Facilities on site and workplace safety | | Contractor | PIU |
| 17 | Incident Management | Prepare Incident Management Plan with reporting formats. | Contractor | PIU |
| 18 | Environmental Monitoring | Prepare Environmental Monitoring Plan. | | |
| 19 | Availability of institutional capacity | Implement training and establish environment unit. | Contractor | PIU |
| **Operation Phase** | | | | |
| 20 | Noise Pollution | Implement and maintain noise barriers on viaduct | PIU | PIU |
| 21 | Vibration | Implement vibration monitoring and building condition surveys at sensitive structures. | PIU | PIU |
| 22 | Water supply, sanitation, sewage and solid waste disposal at stations and depots | Implement prescribed measures including rain water harvesting at stations and depots; green belt and water recycling at depots. | PIU | PIU |
| 23 | Sewage and effluent disposal | Implement STP and ETP at depots. | PIU | PIU |

| SN | Environmental Impact | Mitigation Measure | Implementing Entity | Responsible Entity |
|---|---|---|---|---|
| 24 | Incident Management | Implement Incident Management Plan. | PIU | PIU |
| 25 | Environmental Monitoring | Implement Environmental Monitoring Plan. | PIU | PIU |

The range of documentation required to be generated and maintained as part of EHS before and during construction and during operation is as follows:

- Controlled documents of mandatory environmental Approvals and clearances along with record extensions thereof
- Controlled documents of approved SH&E Manual, EMP and EMoP with revisions thereof and time schedule of such revisions if any
- Controlled documents of formats of site inspection checklists with revisions thereof and time schedule of such revisions if any
- Reports of site inspections, monitoring data, reports of internal or external audit, observations of PIU and local statutory agency if any like Pollution Control Board, local municipal authority, Forest Department etc. and subsequent remedial action taken by Contractor if any
- Records of coordination meetings of PIU/GC and Contractor with subsequent remedial action taken by Contractor if any
- Records of incident reporting and remedial action taken by Contractor if any and follow-up of such incidents

A typical EMS organization is depicted in **Figure 15.10**. One indicative activity i.e., approval of EMS documents is shown in this organization chart.

## 15.7. SUMMARY OF COSTS

Estimated cost of implementation of EMP, EMoP and Training for the proposed metro project is about **Rs 1840 Lakh**. Summary of cost estimate is given in the following **Table 15.30.**

**TABLE 15.30: SUMMARY OF COST ESTIMATE**

| S No | Item | Amount (Rs in Lakh) | |
|---|---|---|---|
| | | Corridor-I | Corridor-II |
| 1 | Compensatory Afforestation | 91.56 | 33.00 |
| 2 | Noise Barriers | 79.15 | 432.05 |
| 3 | Rainwater Harvesting | 95.50 | 208.49 |
| 3 | Sewage Treatment Plant for Depot | 10.00 | 10.00 |

| S No | Item | Amount (Rs in Lakh) | |
|---|---|---|---|
| | | Corridor-I | Corridor-II |
| 4 | Effluent Treatment Plant for Depot | 141.00 | 164.00 |
| 5 | Green Belt Development for Depot | 10.02 | 9.01 |
| 6 | Environmental Monitoring | 78.36 | 108.00 |
| 7 | Training and Extension | 10.20 | 13.80 |
| 8 | Environment Division | 174.24 | 174.24 |
| **Total** | | **687.21** | **1152.59** |

## 15.8. SOCIAL IMPACT ASSESSMENT

Development of proposed two metro rail corridors involves acquisition of land for stations, running sections, TSS, Depot and for other facilities. Acquisition of this private land may cause social disruption and economic loss for the families/people who are likely to be affected. While implementing the project, there is a need to take into account these disturbances and losses due to the project, their impact on socio-economic condition of the people and plan for their mitigation measures to minimize any negative impacts. The details of land acquisition, number of affected structures (legal and illegal) and affected families and socio-economic profile of affected families on the basis of sample survey and Resettlement Action Plan (RAP) is presented in this section.

### 15.8.1. Objective of SIA and RAP

The objectives of Social Impact Assessment are:

i. Identify PAPs by type and extent of loss

ii. Identify the possible adverse effects of the project on the people and the area

iii. Suggest culturally and economically appropriate measures for mitigation of adverse effects of the project

iv. Provision of institutional mechanism for implementation of RAP

v. Provision for grievance redresses mechanism;

vi. A time frame for implementation of RAP

vii. Provision of budget for each activity of RAP, and,

viii. Monitoring and Evaluation (M&E) of implementation of RAP

The SIA includes RAP is based on an integrated and holistic approach to deal with project impacts and aims at rebuilding lives and livelihoods of those affected as quickly as possible.

## 15.8.2. Approach & Methodology

Socio-economic survey was conducted in the corridor of impact zone to identify the affected structures, families/persons and list out the adverse impacts of the project. The SIA which includes RAP has been prepared in accordance with Right to Fair Compensation and Transparency in land acquisition, Rehabilitation and Resettlement Act, 2013, and multi/bilateral funding agencies' guidelines on social and environmental consideration. The methodology adopted to prepare SIA report was desk research, site visits and information dissemination, enumeration of structure, socio-economic survey, compilation, verification and analysis of data, public consultation at local level. Various steps involved in the study have been described in brief in the following paragraphs.

- The consultant reviewed the final topographical maps and Detailed Project Report (DPR) of the project.

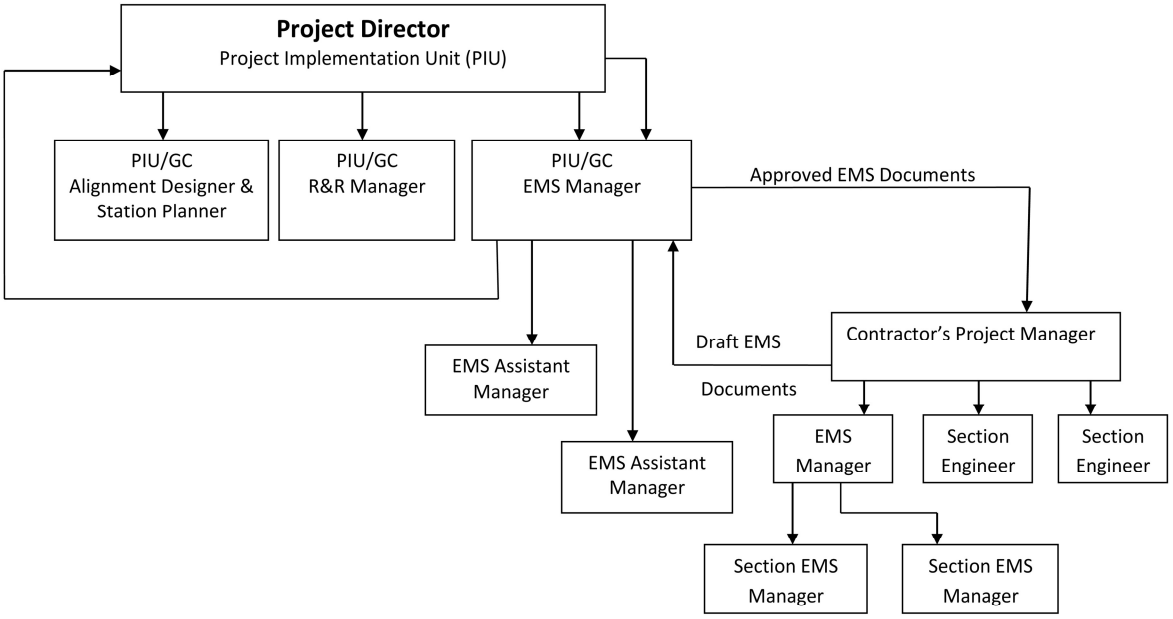
- Conducted sample socio-economic survey covering affected households, squatters, kiosks and small business entrepreneurs with the help of pretested "Household Questionnaire". Important aspects covered in the questionnaire were identification particulars of PAPs, his or her family details, social profile, occupation, income, details of structure, commercial / self employment activities, household income, annual expenditure, employment pattern, type of effects / loss etc. Most part of the questionnaire has been pre-coded except those reflecting the opinion and views of the PAP, which have been left open-ended.

- The base line data have been collected from secondary sources such as the Census and the Statistical Hand Book. Primary data have been collected through household survey conducted by RITES Social team. The Socio-Economic Baseline data was collected during October 2015.

- The development of proposed metro project has significant positive impacts in Agra city. The project may also bring myriad forms of unavoidable adverse impacts on the socio and economic environment around. "Social Risk Assessment" approach has been used to determine the associated risk of adverse impacts.

- Consultations with concerned stakeholders at the project level with affected families, communities, local leaders, and vulnerable groups were conducted for the purpose of disseminating information among the people and obtaining their views, comments and concerns.

**FIGURE 15.10: EMS ORGANIZATION**




* GC: General Consultant as Project Management Consultant

### 15.8.3. Potential Social Impacts

The proposed metro rail will have number of positive impacts like:

i. Generate Employment opportunity
ii. Economic growth
iii. Mobility
iv. Safety in travelling
v. Reduced traffic congestion
vi. Savings in fossil fuel (reduction in air pollution)
vii. More systematic and cheaper way of commute

At the same time the project may bring myriad forms of adverse impacts on socio-economic condition of families/people that are likely to be affected due to acquisition of land. The anticipated negative impacts are

i. loss of land
ii. loss of structures
iii. loss of livelihood
iv. loss of residence
v. impact on vulnerable families/persons
vi. impact on gender
vii. Loss of common property and religious structures.

### 15.8.4. Inventory of Affected Structures

**Table 15.31** presents the usage type of structures likely to be affected.

**TABLE 15.31: CORRIDOR WISE IMPACT ON STRUCTURES**

| Corridor/Station | Type of Structures | | | Total |
|---|---|---|---|---|
| | Residential | Commercial | Others | |
| **Corridor-I (Sikandra to Taj East gate)** | | | | |
| Sikandra | 3 | 0 | 2 | 5 |
| Guru Ka Taal | 3 | 0 | 0 | 3 |
| ISBT | 7 | 5 | 0 | 12 |
| Shastri Nagar | 5 | 6 | 2 | 13 |
| University | 0 | 1 | 0 | 1 |
| RBS College | 0 | 0 | 1 | 1 |
| Raja Ki Mandi | 0 | 0 | 1 | 1 |
| Agra College | 0 | 0 | 2 | 2 |
| Medical College | 0 | 0 | 1 | 1 |
| Jama Masjid | 13 | 0 | 1 | 14 |
| Agra Fort | 0 | 0 | 0 | 0 |
| Taj Mahal | 0 | 0 | 0 | 0 |
| Fatehabad Road | 5 | 0 | 1 | 6 |
| Basai | 0 | 0 | 1 | 1 |
| Taj East Gate | 2 | 0 | 0 | 2 |

| Corridor/Station | Type of Structures | | | Total |
|---|---|---|---|---|
| | Residential | Commercial | Others | |
| **Sub Total** | **38** | **12** | **12** | **62** |
| **Corridor-II (Agra Cantt. Railway Station to KalindiVihar)** | | | | |
| Agra Cantt. | 0 | 0 | 0 | 0 |
| Sultanpura | 1 | 3 | 0 | 4 |
| Sadar Bazaar | 0 | 0 | 1 | 1 |
| Partap-Pura | 0 | 0 | 1 | 1 |
| Collectorate | 5 | 0 | 1 | 6 |
| Subhash park | 0 | 0 | 2 | 2 |
| Agra College | 1 | 0 | 1 | 2 |
| Hariparvat Chauraha | 0 | 0 | 1 | 1 |
| Sanjay Place | 0 | 0 | 1 | 1 |
| M G Road | 10 | 0 | 1 | 11 |
| Sultanganj Crossing | 6 | 0 | 5 | 11 |
| Kamla Nagar | 4 | 2 | 2 | 8 |
| Rambagh | 35 | 0 | 0 | 35 |
| Foundary Nagar | 0 | 0 | 0 | 0 |
| Agra Mandi | 0 | 0 | 0 | 0 |
| KalindiVihar | 0 | 0 | 0 | 0 |
| **Sub Total** | **62** | **5** | **16** | **83** |
| **Total** | **100** | **17** | **28** | **145** |

*Source: Primary Surveys, 2016*

*Note: R: Residential, C: Commercial, R+C: Residential+ Commercial*

**Number of structures is identified based on sample socio-economic survey, site visits with the help of alignment drawings and not on the basis of peg marking on the ground. Therefore, these are only approximate figures and not exact. The exact number of affected families, persons, properties and detail of ownership will be considered after census (100%) survey.*

The magnitude of project impact on the structures, which is categorized as partially and fully affected structures are presented here. On the basis of alignment drawings it was found that out of total 145 structures, about 125 structures (86.2 %) will be fully affected and remaining about 20 structures (13.7%) will be partially affected (**Table 15.32**). However, the exact number of fully and partially affected structures will be known after peg marking on the ground level.

**TABLE 15.32: MAGNITUDE OF PROJECT IMPACTS**

| Name of Corridor | Magnitude of Impacts | | |
|---|---|---|---|
| | Fully | Partially | Total |
| Sikandara to Taj East Gate | 54<br>(12.9) | 8<br>(87.1) | 62<br>(100) |
| Agra Cantt. Railway Station to Kalindi Vihar | 71<br>(85.5) | 12<br>(14.5) | 83<br>(100) |
| **Total** | **125**<br>**(86.2)** | **20**<br>**(13.7)** | **145**<br>**(100)** |

*Source: Primary Surveys, 2016*

### 15.8.5. Impact on PAFs/PAPs

About 119 families consisting 572 persons will be affected due to the proposed metro project. Corridor wise number of PAFs and PAPs is presented in **Table 15.33**. Exact number of affected and displaced families/persons will be quantified during detailed Census/Baseline Socio-Economic Survey (BSES) after peg marking of alignment on the ground.

**TABLE 15.33: IMPACT ON PAFs AND PAPs**

| Name of Corridor | Total PAFs | Total PAPs* |
|---|---|---|
| Sikandara to Taj East Gate | 52 | 250 |
| Agra Cantt. Railway Station to Kalindi Vihar | 67 | 322 |
| **Total** | **119** | **572** |

*Source: Primary Surveys, 2016*

**Number of PAPs is counted based on average size of family*

Out of the total 119 families, 42 are in the category of Title Holders (TH) and the remaining 77 are in Non Title Holders (NTH) category. The NTH category includes tenants, squatters and kiosks. The squatters and kiosks are on public land without any legal permission. Corridor wise detail of title holders and non-title holders are given in **Table 15.34**.

**TABLE 15.34: TITLEHOLDERS AND NON-TITLEHOLDERS**

| Name of Corridor | Titleholders | Non-Titleholders | Total PAFs |
|---|---|---|---|
| Sikandara to Taj East Gate | 6 | 46 | 52 |
| Agra Cantt Railway Station to Kalindi Vihar | 36 | 31 | 67 |
| **Total** | **42** | **77** | **119** |

*Source: Primary Surveys, 2016*

**Table 15.35** indicates that out of the total 119 PAFs, 17 PAFs shall be affected physically as their residential units are getting affected due to the proposed project. Majority of PAFs are likely to be affected residentially in Sikandara to Taj East corridor.

**TABLE 15.35: LOSS OF RESIDENCE**

| Name of the Location | Total PAFs | Residentially Affected Family |
|---|---|---|
| Sikandara to Taj East Gate | 52 | 12 |
| Agra Cantt Railway Station to KalindiVihar | 67 | 5 |
| **Total** | **119** | **17** |

*Source: Primary Surveys, 2015*

**Table 15.36** indicates that out of total 119 affected families, there are 102 PAFs whose business/livelihoods will be affected due to the loss of the commercial structures vis-a-vis business base in both corridors. Majority (62) of commercial PAFs are likely to be affected in Agra Cantt Railway Station to Kalindi Vihar corridor. About 40 PAFs are likely to be affected in Sikandara to Taj East Gate corridor.

**TABLE 15.36: LOSS OF LIVELIHOOD**

| Name of the Location | Total PAFs | Commercially Affected Family |
|---|---|---|
| Sikandara to Taj East Gate | 52 | 40 |
| Agra Cantt Railway Station to Kalindi Vihar | 67 | 62 |
| **Total** | **119** | **102** |

*Source: Primary Surveys, 2015*

## 15.8.6. Impact on Community and Religious Structures

The proposed project shall also affect the common property resources. The common property includes religious structures and public toilets. **Table 15.37** shows that 14 religious structures and five public toilets shall be affected. These structures may not be saved as they are falling within the right of way and the corridor of impact. These common properties of the same size and type shall be redeveloped by the project developer at the desired place in consultation with local people.

**TABLE 15.37: LOSS OF COMMON PROPERTY RESOURCES**

| Name of the Corridors | Common Property Resources | | | Total |
|---|---|---|---|---|
| | Religious structures | Public toilet | Others | |
| Sikandara to Taj East Gate | 6 | 1 | 5 | 12 |
| Agra Cantt Railway Station to Kalindi Vihar | 8 | 4 | 4 | 16 |
| **Total** | **14** | **5** | **9** | **28** |

*Source: Primary Surveys, 2016*

## 15.8.7. Demographic and Socio-Economic Profile of PAFs

The socio-economic analysis of surveyed household has been presented here. The data collected through sample socio-economic survey generated demographic and socio-economic profile of project affected families. The data has been compiled and presented in tabular form.

### 1. Gender and Sex Ratio

The data on gender and sex ratio is very helpful indicator to know the participatory share of male and female in the society, which is also an important indicator for human development index. Among the surveyed population it is observed that there are 53.52 % are male and remaining 46.47 % are female. It is observed that male dominate in both corridors. The sex ratio is 837 per 1000 males in Sikandara to Taj East Gate corridor and that in Agra Cantt. Railway Station to Kalindi Vihar is 895 in corridor (**Table 15.38**).

**TABLE 15.38: GENDER AND SEX RATIO**

| Corridor | Total Surveyed PAFs | Total PAPs | Gender | | Sex Ratio |
|---|---|---|---|---|---|
| | | | Male | Female | |
| Sikandara to Taj East Gate | 36 | 147 (100) | 80 (54.42) | 67 (45.58) | 837 |
| Agra Cantt Railway Station to Kalindi Vihar | 54 | 208 (100) | 110 (52.8) | 98 (47.11) | 895 |
| **Total** | **90** | **355 (100)** | **190 (53.52)** | **165 (46.47)** | **866** |

*Source: Primary Surveys, 2016*

## 2. Religious and Social Group

Data on religious groups were collected in order to identify people with the specific religious belief among the surveyed families. The religious beliefs and social affiliation of the people are indicators that help understand cultural behaviour of the groups. The social and cultural behaviour will help understand the desires and preferences of PAPs, which is a prerequisite to rehabilitate the affected people and their families. **Table 15.39** shows that only two religions are followed in the study area viz., Hindu and Muslims. The studies results show that about (80.00%) of the surveyed families are Hindu followed by Muslim (20.00%). Majority of families are Hindu in both corridors.

**TABLE 15.39: RELIGIOUS GROUP**

| Corridor | Hindu | Muslim | Total PAFs |
|---|---|---|---|
| Sikandara to Taj East Gate | 27 (75.00) | 9 (25.00) | 36 (100) |
| Agra Cantt Railway Station to KalindiVihar | 45 (84.2) | 9 (15.8) | 54 (100) |
| **Total** | **72 (80.00)** | **18 (20.00)** | **90 (100)** |

*Source: Primary Surveys, 2016*

**Table 15.40** discloses information about social affiliation of a group. The social affiliation of the group differentiates them for benefits under government schemes. Social groups indicate ranking within the society, preferences and vulnerability. In general, the families belonging to Scheduled Castes (SCs) and Scheduled Tribes (STs) under the provisions of Constitution of India get preferential treatment in the government benefits because the group includes the people who are traditionally vulnerable. Except general category, all other groups need attention and to be addressed for their backward socio-economic conditions. The survey results show that about (48.88%) belong to Other Backward Caste followed by general (44.44%) and Scheduled Caste (4.0%) and Scheduled Tribe (2.0%). Scheduled Castes and Scheduled Tribe families are found in Agra Cantt Railway Station to Kalindi Vihar corridors. Therefore, special attention is required to address their issues.

**TABLE 15.40: SOCIAL GROUP**

| Corridor | General | OBC | Schedule Castes | Schedule Tribes | Total PAFs |
|---|---|---|---|---|---|
| Sikandara to Taj East Gate | 11 (30.55) | 24 (66.66) | 1 (2.77) | 0 | 36 (100) |
| Agra Cantt Railway Station to Kalindi Vihar | 29 (53.7) | 20 (37.03) | 3 (5.5) | 2 (3.7) | 54 (100) |
| **Total** | **40 (44.44)** | **44 (48.88)** | **4 (4.4)** | **2 (2.2)** | **90 (100)** |

*Source: Primary Surveys, 2016*

### 3. Mother Tongue and Place of Nativity

It was found in both corridors that all surveyed families speak Hindi as a mother tongue. Majority of surveyed families are from Uttar Pradesh followed by Bihar state.

### 4. Age Group

The distribution of person's age in various group shows that 17.3% of the total persons belong to below five years, about 25.6 % belong to the 6-18 years age group. About 30.7 % belong to 19-35 years that is potentially productive group. About 43.2% belong to the age group of 36 to 60 years. About 13.9% of total persons belong to above 60 years, who are dependent population. It is observed that majority of persons belong to 36 to 60 years age group.

### 5. Marital Status

The marital status of the surveyed family members is indicated under three categories – married, unmarried, and other (widow/widower, separated, divorced). It is observed that out of total surveyed people, majority of them (56%) are married, 42 % are unmarried and about two percent are widowed/divorced/separated.

### 6. Family Pattern and Family Size

Majority of surveyed families are nuclear (92.22%) followed by joint (7.77%). Majority of surveyed families belong to nuclear family (96.29%) in Agra Cantt Railway Station to Kalindi Vihar corridor and Joint family (3.70%) in Sikandara to Taj East Gate corridor. Majority of nuclear families are found in both corridors. Family size has been classified into three categories i.e. individual, small (2-4), medium (5-7) and large (7 & above). Majority of families (67.77%) are small in size followed by 23.33% families are medium type and remaining 8.88 % families have their members more than seven. Small size families are found in both corridors.

### 7. Educational Attainment

The analysis indicates that out of the total surveyed people, about 7.7% are illiterate, 19.4% are educated up to primary class, 16.5 % are educated up to High School, and 19.7% have studied up to higher secondary level. Other than this, about 36.7 % of persons have attained

college. Education level of surveyed people is better in Agra Cantt Railway Station to Kalindi Vihar corridor as compared to Sikandra to Taj East Gate corridor.

## 8. Economic Conditions

The economic condition of PAFs describes occupational pattern, family income, employment information and number of earning and dependent members. The occupational pattern includes work in which the head of the project affected families are involved. The family income includes income of all the earning members. The earning members include the people who work and earn to contribute to the family; however dependents include housewife, children, elderly people and others who cannot work and earn.

About 1.1% of families reported less than Rs.5000/- monthly income. About 14.5% of families' monthly income is less then Rs.5001-10000, 38.9% of families' income is between Rs.10001 to 20000/-,(30.0) % of families' income is between Rs.20001 to 40000.Families' earning more than Rs.40000/- monthly constitutes about 15.6 %. The average income of a family is Rs.12400/- per month. Average family expenditure is Rs.10200/- per month. On an average earning member per family is two **(Table 15.41)**.

**TABLE 15.41: FAMILY MONTHLY INCOME**

| Corridor | Family Monthly Income (in INR) | | | | | Total PAFs |
|---|---|---|---|---|---|---|
| | <5000 | 5001 - 10000 | 10001 - 20000 | 20001 - 40000 | >40000 | |
| Sikandara to Taj East Gate | 0 (0) | 5 (13.9) | 20 (55.5) | 7 (19.5) | 4 (11.1) | 36 (100) |
| Agra Cantt Railway Station to Kalindi Vihar | 1 (1.8) | 8 (14.8) | 15 (27.8) | 20 (37.1) | 10 (18.5) | 54 (100) |
| **Total** | **1 (1.1)** | **13 (14.5)** | **35 (38.9)** | **27 (30.0)** | **14 (15.6)** | **90 (100)** |

*Source: Primary Surveys, 2016*

## 9. Occupational Pattern

Occupational pattern of the surveyed persons is recorded to assess their skill so that income generation plan can be prepared accordingly for alternative income generating scheme. Secondly, occupational pattern helps in identifying dominating economic activity in the area. The survey shows that majority of surveyed persons are employed in business and trade activities. Out of the total surveyed PAPs, about 64.5% of them are involved in business, 17.7 % are in daily labour and 10% and 7.8% are in government and private sector respectively. It is observed in both corridors that majority of PAPs are involved in business/trade activities.

## 10. Household Assets

The TV, Refrigerator, two wheeler, and telephone are owned by majority. The other prominent assets are bicycle and computer.

## 11. Vulnerable Groups

As per the international funding agencies guidelines vulnerable group is defined as indigenous people, ethnic minorities, the poorest, women, the aged, the disabled and other socially/economically vulnerable groups who would be adversely affected from a project. As regards vulnerability among surveyed PAFs, there are twenty one families belong to vulnerable category. Out of these about one family are women headed households, three families are Scheduled Castes, two families are Scheduled Tribes, twelve families are below the line of poverty including women headed households, and four families having disability people. Numbers of vulnerable families are found more in Agra Cantt Railway Station to Kalindi Vihar

**Gender Issues:** There are two woman-headed household among the surveyed vulnerable families found in the Sikandra to Taj East Gate corridor. About 45 percent of total surveyed population is female. Socio-economic parameters like literacy, work force participation rate and general health conditions etc. reveals that social status of women is low respectively, thereby brought forward the scope of considering the families headed by women as vulnerable.

The proposed project is expected to open up new economic opportunities for women to upgrade their skills and also better accessibility to educational and health facilities. Women as a segregated class are not involved in any economic activity, which demands attention for their special needs. To ensure that women are secure in receiving payments all benefits will be provided in joint-account where the woman will be the first beneficiary accounts. During discussion with PAPs, women members of the family are also consulted. Consultations with women will be carried out during project implementation stage to provide more opportunities to them to voice their concerns and suggestions.

## 12. Tribal Issues

There are three families who belong to scheduled tribes. Moreover, they are found in the project area no longer live in forests/hills. The tribal population has integrated with the main stream population. Few of them fall within the category of BPL population; compensation packages provided in the Entitlement Matrix would sufficiently take care of their R&R needs. There is also a number of State and Central Government schemes targeted at this population and annually about 5 to 6 percent of budget allocation is made to finance special programmes for tribal development.

## 13. Awareness and Opinion about the Project

During socio-economic survey, some questions were asked to the families regarding the awareness, source of information and opinion about the proposed metro rail project. The findings of the survey with regards to awareness, source of information and opinion about the proposed project is presented in **Table 15.42**.

**TABLE 15.42: PROJECT RELATED INFORMATION**

| S. N. | Description | Sikandara to Taj East Gate | Agra Cantt Railway Station to Kalindi Vihar |
|---|---|---|---|
| 1 | Awareness about the Project | | |
| | Yes | 36 | 54 |
| | No | 0 | 0 |
| 2 | Source of Information | | |
| | News Paper | 36 | 41 |
| | Survey Team | 0 | 0 |
| | Television | 0 | 0 |
| | Friends/People | 0 | 13 |
| 3 | Opinion about the Project | | |
| | Good | 35 | 54 |
| | Bad | 1 | 0 |
| | Can't Say | 0 | 0 |

*Source: Primary Surveys, 2016*

## 15.8.8. Public Consultation and Participation

Public consultation were organised at medical college, ISBT, Agra University, St. John's College, RBS, Guru katal, Kamlanagar, Foaundry Nagar, Ram bagh, Agra fort, Taj East Gate, Raja ki Mandi from 16/09/2015 to 19/09/2015.The consultant briefed the participants about the objectives of the meeting regarding various social issues related to the project i.e., alignment plan, land acquisition, displacement, rehabilitation & resettlement and compensation and employment etc. The participants were invited to give their valuable suggestions on the above issues and were assured for suitable incorporation of such suggestions in the project within the technical limitations and scope of the project. Some of the views expressed, suggestion given or queries raised by the participants are as follows:

- Local people showed happiness during public consultations as the project will provide hassle free movement in the congested part of the city.
- Suitable safety measures should be taken in the project during construction and operation phases
- Vacant land should be used for metro station instead of acquiring residential and commercial plots or structures of local people.
- Employment opportunity should be provided to the local people particularly to the project-affected people on priority basis in all stages of the metro project.
- Compensation for acquired land should be provided on time to the affected families/people at market rate.
- Source of livelihood should not be disturbed. The affected businessmen should be given alternate employment.
- Shop for shop- All shop keepers should be rehabilitated by constructing market

complex in nearby area.

- Govt. should provide a constructed house for each affected family.
- During construction phase, traffic on the roads should be managed in such a way that it should not cause congestion of traffic and accidents during construction phase.
- Construction labor camps should not be located near the core city area that is frequented by the tourists
- It is evident from the discussion with local people during social survey that the people in Agra have no objection to the proposed metro rail project. According to them loss of residential structures and homestead land will mean a lot of problem for people. Compensation for acquisition of private land should be given to those who are likely to lose their land at the current market price.

## 15.8.9. Resettlement Policy, Framework and Entitlement Matrix

The applicable laws on land acquisition, rehabilitation and resettlement for the proposed metro rail project are:

a. Right to Fair Compensation and Transparency in land acquisition, Rehabilitation and Resettlement Act, 2013(RTFCTLARR Act).

b. Government Order (G.O) of Government of Uttar Pradesh bearing no. 24/2015/387/8-1-15-50-LDA/204 specifically for LMRP Project dated 04.02.2015. This is in accordance with provisions of Section 46 of the Act, 2013 formulating a committee of officials from relevant Government departments for determination of negotiated price for land acquisition.

c. Multi/Bilateral Agencies' Involuntary Resettlement Policy

**The Entitlement Matrix**

An Entitlement Matrix **(Table 15.43 & Table 15.44)** has been developed in compliance with National Laws. The entitlement matrix summarizes the types of losses and corresponding nature and scope of entitlements. PAPs who are squatters and not legal titleholder of land and buildings shall also be eligible for R&R if enumerated during the census survey. Therefore, the date of completion of census survey shall be the Cut-off Date. It is on this date that all impacted persons will be identified and the nature of the impact disclosed. PAPs who settle in the affected areas after the cut-off date will not be eligible for compensation and/or other assistance. They, however, will be given sufficient advance notice, requested to vacate premises and dismantle affected structures prior to project implementation. Their dismantled structures will not be confiscated and they will not pay any fine or suffer any sanction. The entitlement matrix presents the entitlements of the affected and displaced people in the following order.

a) Entitlement for titleholders consisting of

- loss of private land;
- Loss of private residential structure;
- Loss of private commercial structures;
- Impact to tenants(residential/commercial/residential cum commercial)

b) Entitlement to Non-Titleholders consisting of

- Impact to squatters, Encroachers, kiosks

c) Loss of Employment to workers/employees

d) Assistance to affected and displaced vulnerable people

e) Common infrastructure and Common Property Resources (CPRs)

**TABLE 15.43: ENTITLEMENT MATRIX**

(Compensation for Land Acquisition)

| S. No. | Category of Impact | Eligibility for Entitlement | LMRC Adopted Policy/Entitlement* |
|---|---|---|---|
| 1. | Loss of Land | Titleholder | Market value/ Circle rate as per stamp Act. |
| 2. | Loss of other immovable assets (value of assets attached to land or building) | Titleholder | Will be determined on the basis of valuation by authorized expert based on a replacement value. |
| 3. | Solatium for loss of Land, Structure and other immovable assets | Titleholder | 100% of arrived value of land and building. The compensation is calculated for land, structures and such assets attached to the building or land as applicable and the total of all considered before considering the solatium, including any transaction costs and fees. |
| 4. | Loss of other immovable assets (value of assets attached to land or building) | Squatters | Onetime financial assistance based on valuation of the property subject to a minimum of Rs. 25,000. |

**Same entitlement matrix will be followed for Agra Metro Rail Project*

**TABLE 15.44: ENTITLEMENT MATRIX**

(Compensation for Rehabilitation)

| S. No. | Category of Impact | Eligibility of Entitlement | LMRC Adopted Policy/Entitlement |
|---|---|---|---|
| 1. | Construction allowance | Displaced family whose residential structure is lost due to acquisition | **Rs. 1,50,000** will be given to displaced family whose dwelling units are lost completely or become unviable due to displacement. The amount has been worked out on the basis of construction of house as per Indra Awas Yojana of GOI. |
| 2. | Subsistence grant for displaced family | Displaced family | Onetime payment of **Rs. 36,000** shall be paid to each Displaced Family.<br>Displaced Family belonging to the Scheduled Castes or the Scheduled Tribes or vulnerable group shall receive an amount equivalent to fifty thousand rupees. (**Rs. 50,000**). This amount is additional to subsistence grant.<br>Additionally, Vulnerable groups who are impacted will be extended facility of Skill Improvement Training. |
| 3. | Transportation cost | Displaced family | One time financial assistance of **Rs.50,000** for shifting family, building material, belongings and cattle shall be given to each displaced family. |
| 4. | Cattle shed / petty shops cost | Affected Family | Each Affected Family having cattle shed or having a petty shop in the acquired land shall get one-time financial assistance based on valuation of the structure subject to a minimum of **Rs. 25,000** for re-construction of cattle shed or petty shop out of as the case may be. |
| 5. | One time grant to artisan, small traders and certain others | Affected Family | Each Affected Family of an artisan, small trader or self-employed person or a Displaced Family which owned non-agricultural land or commercial, industrial or institutional structure in the |

| S. No. | Category of Impact | Eligibility of Entitlement | LMRC Adopted Policy/Entitlement |
|---|---|---|---|
| | | | affected area, shall get one-time financial assistance based on valuation subject to minimum of **Rs. 25,000**. |
| 6. | One time resettlement allowance | Affected Family | Each Affected Family will be given a one-time resettlement allowance of **Rs. 50,000**. |
| 7. | Loss of community structures | Community | 100% replacement cost of equal type. |

## 15.8.10. Institutional Framework

The SPV, that will be formed will be the in charge of the overall project activities and will facilitate land acquisition, capacity building and implementation of RAP. The PIU headed by the Project Director (PD) is responsible for the overall execution of the project and planning and implementation of resettlement and rehabilitation component of the project. The PIU will coordinate with all implementing agencies and monitoring the progress of the project. Implementing Agency will set up a Social Management Unit (SMU) which shall look after land acquisition, resettlement and rehabilitation activities. A Social Development Officer (SDO) with educational background of Social Work or Sociology will be appointed in SMU as full time by IA. The SMU shall ensure that all land acquisition issues are handled according to the Land Acquisition and Rehabilitation & Resettlement policy/guidelines as it is laid down in this report. It will also monitor that all the procedural and legal issues involved in land acquisition are fulfilled. The SMU will assist the IA for getting all the necessary clearances and implementation of the resettlement activities prior to start of any civil work. A Resettlement and Rehabilitation Officer (RRO) with background of social science may be appointed in this SMU to supervise and monitor overall activities of RAP and he/she will report day to day progress to SDO. RRO will also work closely with the District Collector to expedite the payment of compensation for land acquisition and assistance to APs. The RRO will form Local Resettlement Committees (LRC) in each project affected areas consisting of local representatives and other stakeholders including APs, women to assist in the implementation of RAP activities within the project area. Some of the specific functions of the SMU in regards to resettlement management will include the following:

- Overall responsibility of planning, implementation and monitoring of land acquisition, resettlement and rehabilitation activities in the project;
- Ensure availability of budget for R&R activities;
- Liaison lined agencies support for land acquisition and implementation of land
- acquisition and resettlement;
- Coordinating with line Departments

NGO will be appointed by IA to extend implementation support to IA in the form of assisting affected families/persons during relocation and preparation of Income Restoration Plan (IRP). The NGO will help educating PAPs on proper utilization of compensation and rehabilitation grant and help them in getting financial assistance.

During implementation phase of RAP, IA will appoint a consultant(R&R) through General Engineering Consultancy (GEC) to assist IA in implementation of resettlement plan. The consultant will carry out due diligence in the implementation of resettlement and rehabilitation programmes as per the provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 through periodic monitoring. The consultant will be responsible for (i)preparation of database of affected structures, families, persons, (ii)verification of database through field survey,(iii)improve monitoring system,(iv)capacity building of implementation staffs,(v)regular follow up implementation activities and other relevant activities.

Efficient grievance Redressal mechanism will be developed to assist the PAPs resolve their queries and complaints. Grievances of PAPs will be first brought to the attention of field level staffs of IA. Grievances not redressed by the staffs (field level) will be brought to the Grievance Redressal Committee (GRC). The composition of the proposed GRC will have representatives from PAPs, women representative, Project Director (PIU),SDO, SMU of IA, NGO representative, representative of local body, and Land Acquisition Officer (LAO). The main responsibilities of the GRC are to: (i) provide support to PAPs on problems arising from land/property acquisition; (ii) record PAPs grievances, categorize, and prioritize grievances and resolve them; (iii) immediately inform the SMU of serious cases; and (iv)report to PAPs on developments regarding their grievances and decisions of the GRC.

## 15.8.11. Work Schedule

The R&R activities of the proposed project are divided in to three broad categories based on the stages of work and process of implementation. In the project preparation stage, identification of required land for acquisition, census & socio-economic survey, public consultation, preparation and review/approval of draft RAP, disclosure of RAP, establishment of GRC and preparation of resettlement site shall be carried out. Activities like notification of land acquisition, valuation of structure, payment by competent authority, shifting of PAPs shall be taken up during RAP implementation. During monitoring and evaluation stage internal monitoring will be carried out by IA and mid and end term evaluation will be carried out by an independent evaluation agency, **Figure 15.11**.

## 15.8.12. Monitoring and Evaluation of RAP

RAP implementation will be monitored both internally and externally. IA will be responsible for internal monitoring through their field level officers of Social Management Unit and will prepare quarterly reports on the progress of RAP implementation. An Independent Evaluation Consultant may be hired by IA for mid and end term evaluation of RAP implementation.

### i. Internal Monitoring

The internal monitoring for RAP implementation will be carried out by IA. The main objectives of internal monitoring are to:

- Measure and report progress against the RAP schedule;
- Verify that agreed entitlements are delivered in full to affected people;
- Identify any problems, issues or cases of hardship resulting from the resettlement process, and to develop appropriate corrective actions, or where problems are systemic refer them to the management team;
- Monitor the effectiveness of the grievance system
- Periodically measure the satisfaction of project affected people.

Internal monitoring will focus on measuring progress against the schedule of actions defined in the RAP. Activities to be undertaken by the IA will include:

- Liaison with the Land Acquisition team, construction contractor and project affected communities to review and report progress against the RAP;
- Verification of land acquisition and compensation entitlements are being delivered in accordance with the RAP;
- Verification of agreed measures to restore or enhance living standards are being implemented;
- Verification of agreed measures to restore or enhance livelihood are being implemented;
- Identification of any problems, issues, or cases of hardship resulting from resettlement process;
- Through household interviews, assess project affected peoples' satisfaction with resettlement outcomes;
- Collection of records of grievances, follow up that appropriate corrective actions have been undertaken and that outcomes are satisfactory.

Monitoring is a continuous process and will be carried out by field level officers of Social Management Unit on regular basis to keep track of the R&R progress. For this purpose, the indicators suggested have been given in **Table 15.45**.

**TABLE 15.45: INDICATORS FOR MONITORING OF RAP PROGRESS**

| Indicators | Parameters Indicators |
|---|---|
| Physical | Extent of land acquired<br>Number of structures dismantled<br>Number of land users and private structure owners paid compensation<br>Number of families affected<br>Number of families purchasing land and extent of land purchased<br>Number of PAPs receiving assistance/compensation<br>Number of PAPs provided transport facilities/ shifting allowance<br>Extent of government land identified for house sites |
| Financial | Amount of compensation paid for land/structure<br>Cash grant for shifting ousters<br>Amount paid for training and capacity building of staffs |

| Indicators | Parameters Indicators |
|---|---|
| Social | Area and type of house and facility at resettlement site<br>PAPs knowledge about their entitlements<br>Communal harmony<br>Morbidity & mortality rate<br>Taken care of vulnerable population<br>Women concern |
| Economic | Entitlement of PAPs-land/cash<br>Number of business re-established<br>Utilization of compensation<br>House sites/business sites purchased<br>Successful implementation of Income<br>Restoration Schemes |
| Grievance | Number of community level meeting<br>Number of GRC meetings<br>Number of cases disposed by IA to the satisfaction of PAPs<br>Number of grievances referred and addressed by GRC<br>Cases of LA referred to court, pending and settled |

**ii. Independent Evaluation**

As mentioned earlier, an Independent Evaluation Agency (IEA) will be hired by IA for mid and end term evaluation. The external evaluation will be carried out to achieve the following:

- Verify results of internal monitoring,
- Assess whether resettlement objectives have been met, specifically, whether livelihoods and living standards have been restored or enhanced,
- Assess resettlement efficiency, effectiveness, impact and sustainability, drawing lesions as a guide to future resettlement policy making and planning, and
- Ascertain whether the resettlement entitlements were appropriate to meeting the objectives, and whether the objectives were suited to affected persons' conditions,
- This comparison of living standards will be in relation to the baseline information available in the BSES. If some baseline information is not available then such information should be collected on recall basis during the evaluation.

**iii. Reporting Requirement**

IA will be responsible for supervision and implementation of the RAP. IA will prepare quarterly progress reports on resettlement activities. The Independent Evaluation Agency will submit draft and final reports of their assignment to IA and determine whether resettlement goals have been achieved, more importantly whether livelihoods and living standards have been restored/ enhanced and suggest suitable recommendations for improvement.

## 15.8.13. Cost Estimate of R&R

The cost for implementation of Resettlement and Rehabilitation Plan on account of two corridors of Agra Metro is presented in **Table 15.46**.The total cost for R&R implementation

plan is Rs.53.7 million.

**TABLE 15.46: COST FOR RESETTLEMENT & REHABILITATION***

| S. No. | Description | Unit | Quantity | Rate (Rs.) | Amount (Rs.in million.) |
|---|---|---|---|---|---|
| A | Compensation for loss of private land and structure has been presented in capital estimate of DPR | | | | |
| **Compensation for Titleholders** | | | | | |
| B | Residential PAFs | | | | |
| C | Subsistence allowance | no | 4 | 36000 | 0.14 |
| D | Transportation allowance | no | 4 | 50000 | 0.20 |
| E | Resettlement Allowance | no | 4 | 50000 | 0.20 |
| F | Commercial PAFs | | | | |
| G | Subsistence allowance | no | 38 | 36000 | 1.37 |
| H | Transportation allowance | no | 38 | 50000 | 1.90 |
| I | Loss of Small traders/self employment | no | 38 | 25000 | 0.95 |
| J | Resettlement Allowance | no | 38 | 50000 | 1.90 |
| **Compensation for Non-Titleholders** | | | | | |
| | Squatters | | | | |
| K | One time financial assistance | no | 119 | 25000 | 2.98 |
| **Assistance for SCs ,STs or Vulnerable group** | | | | | |
| L | Additional Subsistence Allowance | no | 8 | 50000 | 0.40 |
| **Training for Skill Development** | | | | | |
| M | Training Assistance(LS) | no | 119 | 15000 | 1.79 |
| **Compensation for Community Structures** | | | | | |
| N | Religious structures(LS) | no | 14 | 2000000 | 28.00 |
| O | Public Toilets(LS) | no | 5 | 1000000 | 5.00 |
| **Engagement of NGO** | | | | | |
| P | NGO Cost (LS) | no | 1 | 2500000 | 2.50 |
| **Monitoring & Evaluation** | | | | | |
| Q | Cost of Independent Evaluation Agency(LS) | | 1 | 1500000 | 1.50 |
| **Total (B+C+D+E+F+G+H+I+J+K+L+M+N+O+P+Q)** | | | | | **48.82** |
| **Miscellaneous items @ 10% of sub total** | | | | | **4.88** |
| **TOTAL** | | | | | **53.70** |

**R&R cost is calculated as per the Resettlement Policy Framework of Lucknow Metro Rail Corporation provided by LMRC, Lucknow.*

**FIGURE 15.11: RAP IMPLEMENTATION SCHEDULE FOR AGRA METRO RAIL**

| SN | Description | 2018 | | | | 2019 | | | |
|---|---|---|---|---|---|---|---|---|---|
| **A** | **Project Implementation** | | | | | | | | |
| 1 | **Approval of DPR and Notification of detailed SIA - Jan 2018** | | | | | | | | |
| 2 | Community /Public Consultation | | | | | | | | |
| 3 | Preparation of Detailed SIA by Government after Notification | | | | | | | | |
| 4 | Review/Approval of SIA and Preliminary Notification of Acquisition | | | | | | | | |
| 5 | Census Survey | | | | | | | | |
| 6 | Finalization of updated R&R Scheme | | | | | | | | |
| 7 | Disclosure of SIA and R&R Scheme | | | | | | | | |
| **B** | **RAP Implementation** | | | | | | | | |
| 8 | Notice to Persons Interested | | | | | | | | |
| 9 | Joint Measurement Survey | | | | | | | | |
| 10 | Suggestion & Objection of PAPs | | | | | | | | |
| 11 | Declaration of Award of Compensation and R&R amounts as per RTFCTLARR,Act and payment | | | | | | | | |
| 12 | Shifting of PAPs | | | | | | | | |
| 13 | Grievance Redress | | | | | | | | |
| 14 | Start of Civil Works in affected areas | | | | | | | | |
| **C** | **Monitoring and Evaluation** | | | | | | | | |
| 15 | Internal Monitoring | | | | | | | | |
| 16 | External Monitoring | | | | | | | | |