Chapter – 15
ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT

15. ENVIRONMENTAL AND 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

ASPECT OF ENVIRONMENT	LIKELY IMPACTS
	Noise due to DG sets
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 BASELINE MONITORING

Sl. No.	Attribute	Parameter	Frequency	Source
Land Environment				
1	Soil	Soil Characteristics	Once	1/2
2	Geology	Geological Status	---	1
3	Seismology	Seismic Hazard	---	1
Water Environment				
4	Water Quality	Physical, Chemical and Biological parameters	Data	1/2
Air, Noise And Meteorology				
5	Air Quality	$PM_{2.5}$, PM_{10}, NOx, SO_2, CO, O_3, NH_3, Pb and HC	24 hourly	1/2
6	Meteorology	Temperature, Relative humidity, Rainfall, wind direction and speed	Data	ITD/1
7	Noise	Noise levels in dB (A)	24 hourly	3/1
Scio-Economic				
8	Socio-economy	Socio-economic characteristics	Once	1/2
Ecology				
9	Trees	Number/species	Once	2

1= Literature review, 2= Field Studies, 3= Field monitoring,
IMD=India Meteorological Department

15.1.1.1 Land Environment

Kanpur City is situated between the parallels of $25^{O}26'$ and $26^{O}58'$ North latitude and $79^{O}31'$ and $80^{O}34'$ East longitude. It is flat plain with some minor undulations. Kanpur City along with Kanpur Dehat lie between the fertile Doab region of the Ganges and Yamuna rivers. Kanpur City comes under the Indo-Gangetic plains of India.

Landuse Pattern of Kanpur Nagar

In 1997-98, Kanpur Metropolitan Area including Kanpur City, Cantonment and other municipalities and villages was spread over 89131.15 hectare out of which 4,743.9 hectare (5.31 %) was non-defined (prohibited area) and rest 29,683 hectare and 54,704 hectare (61.39%) was urban and rural area respectively. Over a period of time, Kanpur has developed linearly from east to west along Ganga River and G.T road.

The Central Business District (inner city) is located in the north central part. It is heavily built up and characterized by mixed commercial and transport related activities. The public, semi-public, residential and other land use activities have been mostly concentrated in the west. Due to physical constraints of river in the north and cantonment in the east, industrial concentration followed western/ southern expansion. The landuse pattern of Kanpur city is given in **Table 15.3**.

TABLE 15.3: LANDUSE PATTERN OF KANPUR CITY

Sl. No.	Particular	Area (in '000 Hec)
1	Cultivable area	234.8
2	Forest area	5.6
3	Land under nonagricultural use	42.4
4	Permanent pastures	3.7
5	Cultivable wasteland	8.9
6	Land under Misc. tree crops and groves	3.1
7	Barren and uncultivable land	14.8
8	Current fallows	25.0
9	Other fallows	8.7

Source: Agriculture Contingency Plan for District: Kanpur Nagar

Geology and Soils

The Kanpur Nagar is part of Indo Gangetic Plain. Soil samples were collected at representative locations along the corridors and results of analysis are presented in **Table 15.4**. The low sulphate content implies no special design considerations are needed in the structural design.

TABLE 15.4: SOIL TEST RESULTS

S. N.	Parameter	Unit	Location Nos.				
			1	2	3	4	5
1	**pH**		**7.81**	**7.73**	**7.95**	**7.88**	**7.72**
2	Soil Textures						
	Sand	%	12.40	13.20	14.20	10.60	15.80
	Silt	%	76.10	75.40	78.50	81.10	76.70
	Clay	%	11.50	11.40	7.30	8.30	7.50
3	Calcium as Ca	mg/kg	1324.5	1095.6	1389.9	1349.0	564.1
4	Potassium as K	Kg/ha	840.21	925.12	918.10	640.10	687.68
5	Sodium as Na	mg/kg	228.00	586.00	760.10	257.01	276.00
6	Magnesium as Mg	mg/kg	74.42	128.99	148.84	84.34	54.57
7	Chloride	mg/kg	335.00	593.43	640.12	392.43	287.15
8	Bicarbonate (HCO_3)	mg/kg	3.16	3.60	4.23	3.76	3.43
9	**Sulphate**	mg/kg	**32.14**	**28.16**	**46.14**	**44.18**	**41.86**
10	Total Nitrogen	Kg/ha	210.06	203.16	268.46	251.46	241.04
11	Total Phosphate	Kg/ha	78.10	81.46	92.48	82.41	72.15
12	Avail. Phosphorus	Kg/ha	16.80	15.23	18.13	17.42	16.02
13	Organic Matter	%	1.56	1.41	1.19	1.40	1.24
14	Organic Carbon	%	0.90	0.82	0.69	0.81	0.72
15	Orthophosphate	mg/kg	80.44	83.90	95.23	84.88	74.31
16	Carbonate	mg/kg	3.88	4.10	4.88	4.10	3.72
17	Sulphur	Kg/ha	21.46	19.88	24.61	21.56	19.68
18	Arsenic	mg/kg	BDL	BDL	BDL	BDL	BDL
19	Boron	mg/kg	0.61	0.56	0.78	0.52	0.41
20	Cadmium as Cd	mg/kg	21.46	19.62	25.46	30.14	21.18
21	Copper as Cu	mg/kg	32.71	30.18	32.15	23.14	28.16
22	Iron	mg/kg	76.14	73.18	83.14	74.18	68.46
23	Lead as Pb	mg/kg	7.84	7.22	9.46	8.18	7.88
24	Manganese as Mn	mg/kg	355.14	339.14	422.18	402.36	388.24
25	Mercury	mg/kg	BDL	BDL	BDL	BDL	BDL
26	Molybdenum	mg/kg	0.1	0.08	0.16	0.14	0.11
27	Nickel	mg/kg	8.41	8.04	9.66	8.26	7.88
28	Total Zinc as Zn	mg/kg	28.16	24.62	28.42	26.21	23.14

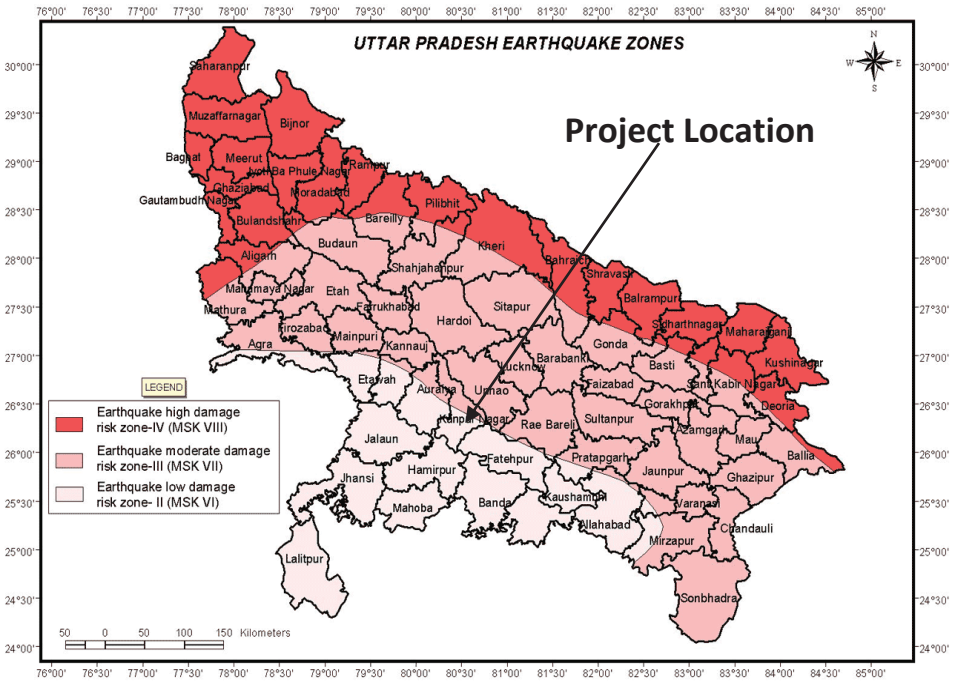
1. Near IIT Kanpur 2. Near Rawatpur Railway Station, 3. Naubasta, 4. Parade Chauraha, 5. Bara 8

Source: Primary Surveys, June 2015

Seismicity

Most of the state of Uttar Pradesh lies in the Gangetic Plain. Beneath Uttar Pradesh, runs the Delhi-Haridwar Ridge (DHR), trending NNE-SSW along New Delhi to the Gharwal region. Earthquakes have occurred in mostly all parts of Uttar Pradesh. The districts of Etawah, Kanpur, Jalaun, Jhansi, Hamirpur, Banda, Fatehpur, Allahabad and Lalitpur lie in Zone III. Seismic zoning map of Uttar Pradesh is given in **Figure 15.1.** Structural design for the Project has to be done accordingly.

FIGURE 15.1: SEISMIC ZONING MAP OF UTTAR PRADESH



15.1.1.2 **Water Environment**

Total demand of Kanpur city is 520 mld whereas supply is 413 mld. Hence, there is deficit in supply versus demand. Assuming that this deficit will remain same during the construction period and cost of treated surface water for construction is high, ground water is proposed to be used during construction.

Use of treated waste water is an option however in view of relatively high capital and operating cost of such facility for metro construction vis a vis small quantify of water required, this option is not considered. For extraction of ground water approval from competent authority i.e. Central Ground Water Board must be taken.

Hydrogeology

In Kanpur Nagar silt, gravel, and sands of different grades are main water bearing formations. In southern part specially along Yamuna river, feldspar-quartz, Jaspar sands and gravel (Mourum) are the main constituents of the granular zones that occurs comparatively at shallow levels i.e. 24 to 57 meter below ground level (mbgl) whereas in the northern parts along the Ganga river, these reworked sedimentary formations are existing at deeper levels i.e. 265 to 310 mbgl.

Depth to Water Level: The water level is measured four times in a year in C.G.W.B. National Hydrograph Network Stations in Kanpur Nagar district at eleven hydrograph stations. *The pre-monsoon period (year 2007) depth to water level varies from 2.20 to 27.13 mbgl whereas in post-monsoon period it varies from 2.08 to 27.13 mbgl*.

Long Term Water Level Trend: The long term water level trend for last ten years (1998-2007) shows annual declining trend in 14 numbers of hydrograph stations. In pre-monsoon period three hydrograph stations shows rising trend & these are Naramau (07 cm/year), Motipura (19 cm/year) and Chaubepur (43cm/year) and rest are showing declining trend which varies from 4 to 63 cm/year. *In post monsoon period except Motipura all hydrograph stations are showing declining trend and it varies from 4 to 84 cm/year.*

Status of Ground Water Development

The depth of irrigation borewell in Kanpur district varies from 20m to 96 mbgl. At present 74% of irrigation is through ground water. The net availability of ground water for future development is 28628 hectare meter.

Water Quality

As per CGWB study, the ground water of Kanpur Nagar district is colourless, odourless and slightly alkaline in nature. It is observed that quality of water is good for drinking, domestic and all other purposes. The arsenic content has been found ranging from Not Detectable to 42mg/l. The trace metals Zn, Mn, Ni, Pb are within the permissible limit except for copper 1249mg/l and iron 6.236 mg/l at Kanpur. Ground water quality of the project area was assessed

and the results are given in **Table 15.5**. Cost of water treatment facilities to be installed in the Metro Depots is included in the EMP.

TABLE 15.5: WATER QUALITY AT PROJECT SITE

S.N	Parameters	Location				
		1	2	3	4	5
1	pH (at 25^{O}C)	7.36	7.19	7.02	7.43	7.63
2	Turbidity, NTU	***161.9***	0.0	***45.7***	***6.4***	0.0
3	Total Dissolved Solids, mg/l	***1254***	***756***	***1684.0***	***816.0***	***1224***
4	Aluminium (as Al), mg/l	0.01	BDL	BDL	BDL	BDL
5	Free Ammonia (as NH3), mg/l	<0.1	<0.1	<0.1	<0.1	<0.1
6	Barium (as Ba), mg/l	0.01	0.009	BDL	BDL	0.177
7	Boron (as B), mg/l	BDL	BDL	BDL	BDL	BDL
8	Calcium (as Ca), mg/l	56.7	***105.3***	***178.1***	***105.3***	***105.3***
9	Chlorides (as Cl), mg/l	187.2	39.4	***325.2***	98.6	177.4
10	Copper (as Cu), mg/l	0.002	BDL	0.004	0.005	BDL
11	Fluorides (as F), mg/l	***>1.0***	<1.0	***>1.0***	<1.0	***>1.0***
12	Free Residual Chlorine, mg/l	NA	NA	NA	NA	NA
13	Iron (as Fe), mg/l	BDL	BDL	BDL	BDL	BDL
14	Magnesium (as Mg), mg/l	***49.2***	***44.3***	128.0	4.9	***69.0***
15	Manganese (as Mn), mg/l	0.060	BDL	0.065	0.007	0.005
16	Nitrates (as NO_3), mg/l	BDL	6.3	BDL	BDL	7.2
17	Phenolic Compounds (as C_6H_5OH) , mg/l	BDL	BDL	BDL	BDL	BDL
18	Selenium (as Se), mg/l	BDL	BDL	0.007	0.002	0.007
19	Silver (as Ag), mg/l	BDL	BDL	BDL	BDL	BDL
20	Sulphates (as SO_4),mg/l	58.0	48.0	61.6	52.0	65
21	Sulphide (as S), mg/l	BDL	BDL	BDL	BDL	BDL
22	Alkalinity (as $CaCO_3$), mg/l	***626.2***	***37.37***	***515.1***	***404.0***	***626.2***
23	Total Hardness (as $CaCO_3$), mg/l	***343.4***	***444.4***	***969.6***	***282.8***	***545.4***
24	Zinc (as Zn), mg/l	0.022	BDL	0.057	0.05	BDL
25	Cadmium (as Cd), mg/l	BDL	BDL	BDL	BDL	BDL
26	Cyanides (as CN), mg/l	BDL	BDL	BDL	BDL	BDL
27	Lead (as Pb), mg/l	BDL	BDL	BDL	0.004	BDL
28	Mercury (as Hg), mg/l	BDL	0.0002	BDL	BDL	BDL
29	Nickel (as Ni), mg/l	0.002	BDL	BDL	BDL	BDL
30	Total Arsenic (as As), mg/l	BDL	BDL	BDL	0.003	BDL
31	Total Chromium (as Cr) , mg/l	BDL	BDL	BDL	BDL	

S.N	Parameters	Location				
		1	2	3	4	5
32	Total Suspended Solid, mg/l	124.0	0.0	21.0	8.0	0.0
33	Vanadium (as V), mg/l	BDL	BDL	BDL	0.003	BDL
34	Ammonical Nitrogen (as N), mg/l	<0.1	<0.1	<0.1	<0.1	<0.1
35	Total Kjeldahl Nitrogen (as N), mg/l	<0.1	1.58	<0.1	<0.1	1.75
36	Chromium (as hexavalent Cr), mg/l	BDL	BDL	BDL	BDL	BDL
37	Oil & Grease, mg/l	0.0	0.0	0.0	0.0	0
38	Dissolved Oxygen, mg/l	6.8	7.0	6.1	6.7	6.7
39	COD , mg/l	3.8	0.0	65.3	3.8	3.8
40	Biochemical Oxygen Demand (3 day 27 deg C) , mg/l	1.0	Nil	23.0	1.0	1.0
41	Total Phosphate, mg/l	BDL	0.5	BDL	BDL	0.8
42	Dissolved Phosphate (as P) , mg/l	BDL	0.5	BDL	BDL	0.8
43	Sodium (as Na) , mg/l	265	53.5	145.0	175	210
44	Potassium (as K), mg/l	12.0	9.5	18.5	12	15.5
45	Nitrate Nitrogen, mg/l	BDL	1.42	BDL	BDL	1.63
46	Total Nitrogen, mg/l	<0.1	1.58	<0.1	<0.1	1.75
47	Organic Phosphorus, mg/l	BDL	BDL	BDL	BDL	BDL
48	Coliform Count (MPN)	Absent	Present	Absent	Absent	***Present***
49	Faecal Coliform	Absent	Absent	Absent	Absent	Absent
50	Total Coliform Organism	Absent	***Present***	Absent	Absent	***Present***

1. Near IIT Kanpur, 2. Near Rawatpur Railway Station, 3. Naubasta, 4. Parade Chauraha, 5. Bara 8;
2. ***37.37*** Values more than acceptable limit but less than permissible limit as per IS 10500:2012; ***626.2*** values more than permissible limit.

Source: Primary Surveys, June 2015

15.1.1.3 Meteorology and Air Environment

All air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological conditions. The main parameters are: temperature, humidity, rainfall, winds and cloud cover.

Meteorology

About 90% of rainfall takes place from third week of June to September. The mean daily maximum temperature in May is 41.7^{0}C, mean daily minimum temperature is 27.2^{0}C and maximum temperature rises up to 45^{0}C or over. The January is the coldest month with mean daily maximum temperature at 22.8^{0}C and mean daily minimum temperature at 8.6^{0}C. The mean wind velocity is 9.6 Kmph. Meteorological data of Kanpur from January 2014 to April 2015 as

collected from Indian Meteorological Department Lucknow is presented in the separate EIA Report.

Air Quality

The source activities for air pollution in the city of Kanpur can be broadly classified as: transport sector (motor vehicles and railways), commercial activities, industrial activities, domestic activities, institutional & official activities and fugitive sources. Under commercial activities, diesel/ kerosene generators are the most prevailing sources for air pollution in the city. The combustion of fuels like coal, kerosene, liquefied petroleum gas (LPG) and wood come under the source for domestic activities. As far as the industrial activities are concerned, the dominant source is the Panki Thermal Power Plant. Lots of small and medium scale industries are also responsible for the air pollution. In most of the institutions and offices, the diesel generators are used at the time of power failure. Unlike other cities, at several locations, garbage burning (mostly in the evening) is a common practice; it can be an important contributor to air pollution. The World Health Organization (WHO) urban air pollution database, released in September 2011, states that Kanpur is the second most polluted city in India. For Kanpur, vehicular emissions were found to contribute 21% of SPM (Suspended Particulate Matter) load in 2007. This secondary data is presented in the separate EIA Report.

In order to establish the baseline concentrations of air pollutants, air quality monitoring was carried out near to the corridors by setting up ambient air quality monitoring stations. The locations chosen near to habited area or near to sensitive receptors. Air Monitoring was carried out for PM2.5, PM10, NOx, SO2, CO, O3, NH3, Pb and HC. Results of the air quality monitoring are presented in **Table 15.6**.

The values shown in bold and italic exceeds the standards. Particulate matter exceeds the permissible limits. Other parameters are within permissible limits. Therefore measure to mitigate air pollution during construction will be recommended. Operation of the proposed Metro system will result in decrease of particulate pollution generated by road based vehicles. Cost of mitigation measures to be implemented during construction forms part of civil engineering cost.

TABLE 15.6: AMBIENT AIR QUALITY ALONG THE CORRIDORS

Parameter	Time	Location								Standard
		1	2	3	4	5	6	7	8	
PM $_{10}$ (µg/m^3)	24 Hr	***142***	***158***	***175***	***168***	***110***	***210***	***105***	98	100
PM $_{2.5}$ (µg/m^3)	24 Hr	59	***65***	***69***	***70***	56	***80***	50	48	60
SO_2 (µg/m^3)	24 Hr	12.6	18.5	25	15.5	10.6	7.5	8.5	5.5	80
NO_2 (µg/m^3)	24 Hr	22.5	34.6	39.5	28.8	25.8	19.9	29.9	12.5	80
Ammonia (NH_3) (µg/m^3)	24 Hr	44	30	35	38.5	24	15	20	10	400
Ozone (O_3) (µg/m^3)	16-00	25.5	28.5	36.2	37.8	18.9	8.5	9.5	7.5	100
	00-08	8.9	18	12.5	12.6	36.4	12.5	20.5	15.8	100
	08-16	55.2	66	69	89.9	88	50.2	66.8	48.5	100
Carbon monoxide (CO) ppm	16-00	23.0	575	1725	345	115	115	115	115	2000
	00-08	115	115	575	230	115	BDL DL=115	BDL DL=115	BDL DL=115	2000
	08-16	345	345	1035	690	230	BDL DL=115	115	BDL DL=115	2000
Lead (pb) (µg/m^3)	24 Hr	0.15	0.5	0.8	0.3	0.08	0.02	0.05	BDL DL=.01	1.0
HC as (CH_4) (ppm)	24 Hr	BDL DL=1	BDL DL=1	2.5	BDL DL=1	BDL DL=1	BDL DL=1	BDL DL=1	BDL DL=1	-

1. Kalyanpur Railway Station, 2) Rawatpura Railway Station, 3) Parade Chauraha, 4) Kanpur Central Railway Station, 5) Kidwai Nagar, 6) Naubasta, 7) Govind Nagar, 8) Barra 8

Source: Primary Surveys, 2015

15.1.1.4 **Noise Environment**

Noise is responsible for adverse impact on physical and mental health of the people.

The impact depends on:

- Characteristics of noise sources (instantaneous, intermittent or continuous in nature).
- Time of day at which noise occurs, for example high noise levels at night in residential areas are not acceptable because of sleep disturbance.
- Location of noise source, with respect to noise sensitive land use, which determines the loudness and period of exposure.

In Kanpur the factors/agents such as generators, loud speakers, automobile horns and fireworks/ crackers are responsible for noise pollution. Some commercial areas like Ghantaghar has noise level as high as 78.2 dB(A) and industrial area like Dada Nagar's noise level is 75.1 dB(A) against a permissible

limit of 65 dB during day time. Corresponding to that the permissible noise pollution level during night time fixed at 55 dB (A) for the above two localities have recorded 71.8 dB and 69.5 dB respectively.

A noise level survey was conducted along the alignments with an objective to establish the baseline noise levels and assess the impacts of total noise expected due to the proposed metro. The noise levels so obtained are summarized in **Table 15.7**. It could be concluded that the day time and night time noise levels recorded at various places are higher than prescribed permissible levels of 65-dBA (day) and 55-dBA (night) for commercial area and 55-dBA (day) and 45-dBA (night) for residential area.

Therefore measure to mitigate noise pollution during construction will be recommended. Estimated cost of noise barriers along the viaduct to mitigate noise generated by operation of Metro is included in the Civil Cost. Operation of the proposed Metro system will result in decrease of noise pollution generated by tempos and other road based vehicles on the Metro corridor.

TABLE 15.7: NOISE LEVEL

Sl. No.	Location	1	2	3	4	5	6	7	8
1	L_{eq}	66.4	67.8	66.0	70.8	58.9	66.8	64.5	67.2
2	L_{10}	74.4	74.1	72.4	75.9	66.6	72.9	68.6	70.5
3	L_{50}	65.2	66.2	64.2	69.2	56.3	64.3	63.3	65.1
4	L_{90}	57.1	57.7	55.6	61.1	47.0	54.5	55.1	54.8
5	L_{max}	75.1	76.3	74.8	77.2	67.3	75.1	70.7	72.1
6	L_{min}	52.0	53.5	53.6	56.3	45.2	50.1	50.1	50.1
7	L_{day}	71.0	71.5	69.7	73.1	64.7	66.9	67.8	68.0
8	L_{night}	63.2	64.2	63.2	64.5	55.6	52.8	54.1	51.2
9	L_{dn}	72.7	73.7	71.5	75.3	62.5	70.1	67.1	72.1

1) Kalyanpur Railway Station (C), 2) Rawatpur Railway Station (C), 3) Parade Chauraha (C), 4) Kanpur Central Railway Station (C), 5) Kidwai Nagar(C), 6) Naubasta(R), 7) Govind Nagar(R), 8) Barra 8(R)

Source: Primary Surveys, July 2015

15.1.1.5 **Ecology**

The project site is located in city area and it is free of any wildlife fauna. Kanpur city and Dehat has 5400 hectares of forest area. The city currently has negligible

area under forest: Allan Forest on 50 hectares which harbours the Kanpur Zoological Garden: the alignment at Gurudev Chauraha is around 1 km away from the zoo. The other area called Sanjay Van Banglia has 20 hectares. On site construction activities will result in loss of trees. The main species along the corridors are Bargad, Cassia, Champa, Gulmohar, Karanj, Neelgiri, Neem, Pakad, Peepal, Sagwan, Seijan and Sheesam. An inventory of trees in the two corridors and three depots likely to be lost has been prepared and summarized in the EIA Report. Estimated cost of compensatory afforestation is included in the EMP.

15.2 ENVIRONMENT NORMS AND REGULATIONS

The Environmental Acts, Legislation, Guidelines and Standards implementation is the responsibility of different government agencies like Central/State Pollution Control Boards, Project Authorities and State Level Committees. The principal environmental regulatory agency is the Ministry of Environment Forests and Climate Change (MoEFCC), New Delhi. The following Acts, legislation and laws are consulted with a view to ensure compliance with various requirements.

- 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)
- Environment (Protection) Act, 1986
- National Ambient Air Quality Standards November 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 Transboundary 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 ENVIRONMENTAL IMPACT ASSESSMENT

15.3.1 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.

i. 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 Kanpur Metro corridors.

ii. 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 details of which are given in the section on Civil Engineering.

iii. Impact on/loss of wildlife/trees/forest

The proposed corridors are in urban/city area and will not pass through any forests. There are approximately 1450 trees along the two corridors and in three depots. These trees are likely to be cut during construction. Trees are major assets in purifications of urban air, which by utilizing CO_2 from atmosphere, release oxygen into the air. Therefore with removal of these trees, the process for CO_2 conversion will get adversely affected and the losses are reported below:

i.	Total number of Trees	: 1450
ii.	Decrease in CO_2 absorption due to loss of trees	: 31,610kg/year
iii.	Decrease in Oxygen production due to tree loss	: 71,050 kg/year

The above loss of oxygen production is equivalent to loss of oxygen requirement of about 390 people round the year.

iv. 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. Cost of such diversions is covered in the section on Civil Engineering.

v. Impact on archaeological monuments

No archaeological monuments will be lost as a result of the proposed development.

15.3.2 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.

15.3.3 Impacts Due to Project Construction

Environmental hazards related to construction works are mostly of temporary nature. 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
- Excavated Soil Disposal and Debris Disposal
- Pollution Generation due to transportation of earth and material
- Increased water demand
- Labour Camp
- Welfare of Labour on construction site
- Safety of labor
- Impact due to Supply of Construction Material
- Impact of construction near archaeological monuments
- Impact on ground and surface water quality
- Noise and vibration

i. Soil Erosion and Pollution

Run off from unprotected excavated areas can result in excessive soil erosion, especially when the erodability of soil is high.

ii. Traffic Diversions 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. Such plans and their cost form part of the section on Engineering. The elevated and underground corridor does not pose any serious risk to existing buildings because minimum horizontal distance from centre of track to any structure is maintained in accordance with engineering norms. As part of pre-construction/construction/post-construction activities building condition survey will have to be conducted cost of which is not included in EMP.

iii. Excavated Soil Disposal and Debris Disposal

The metro route is both elevated and underground. The construction activity involves cut and cover, tunnel (bored and rock), foundation, fill and embankment. 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 1.994 Mm^3 of soil. Out of this, about 0.578 Mm^3 is likely to be reutilized in backfilling in underground stations and Depots. The balance 1.416 Mm^3 shall be disposed off in environmental friendly manner. Disposal of excess soil should be permitted in low lying areas owned by KDA. The excess soil disposal site will be those identified by KDA and communicated to KPMRC. Identification of measures required at soil disposal sites and their indicative cost forms part of EMP. About 10-15% of the construction material such as waste material from contractor camps is left behind by the contractor as construction waste/spoils. Dumping of construction waste/spoil in a haphazard manner may cause surface and ground water pollution near the construction sites.

iv. Pollution Generation due to transportation of earth and material

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 1.994 Mm^3 of earth will be transported in trucks for backfilling in depots and final disposal. The estimated truck movement required to transport the soil/earth will be about 219 truck trips per day for the entire length of construction period. On an average a truck is anticipated to move about 20 km per trip. Hence the total dust emission/pollution would be 5.5.427 kg/day of particulate matter, 26.23 kg/day of CO, 1.62 kg/day of HC, 40.65 kg/day of NOx and 3332.41 kg/day of CO_2.

v. 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).

vi. 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.

vii. Welfare of Labour on construction site

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

viii. Safety of Labour

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

ix. Impact due to Supply of Construction Material

A summary of approximate construction material required for the corridors is given in **Table 15.8**. 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.

TABLE 15.8: CONSTRUCTION MATERIAL REQUIREMENT

Material	Unit	Total Quantity
Underground station		
Cement	MT	147433
Fly Ash	MT	53417
Sand	MT	323778
Aggregate 20mm	MT	315159
Aggregate 10mm	MT	234624
Reinforcement	MT	85059
Stone Work	sqm	123500
MS Structure	kg	312000
Stainless Steel	kg	447850
Paint	Ltr	78000
Tiles Work	sqm	22100
Tunnel		
Cement	MT	26461
Fly Ash	MT	4281
Sand	MT	47507
Aggregate 20mm	MT	34551
Aggregate 10mm	MT	42233
Silica	MT	7542
Reinforcement	MT	7542
Elevated Station		
Concrete	Cum	144591

Material	Unit	Total Quantity
Steel	MT	19623
Viaduct		
Concrete	Cum	326856
Steel	MT	46319
HT stand	MT	2353

x. Impact due to Construction near Archaeological Monuments

No archaeological monuments are involved.

xi. 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.

xii. 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. The Result of the noise prediction is presented in **Table 15.9**. 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*).

TABLE 15.9: NOISE LEVEL PREDICTION DURING CONSTRUCTION dB (A)

Distance	Concrete Batch Plant + Concrete Mixer Truck		Auger Drill Rig +Dump Truck + Generator + Slurry Plant		Dump Truck + Excavator + Pneumatic Tools	
	Lmax	Leq	Lmax	Leq	Lmax	Leq
5	92.7	87.5	94	92.5	94.9	93.3
10	86.7	81.5	88	86.5	85.8	85.3

Distance	Concrete Batch Plant + Concrete Mixer Truck		Auger Drill Rig +Dump Truck + Generator + Slurry Plant		Dump Truck + Excavator + Pneumatic Tools	
	Lmax	Leq	Lmax	Leq	Lmax	Leq
15	83.1	77.9	84.5	83	82.3	81.8
20	80.6	75.4	82	80.5	79.8	79.3
25	78.7	73.5	80.1	78.6	77.9	77.4
30	77.1	71.9	78.5	77	76.3	75.8
35	75.8	70.6	77.1	75.6	75	74.5
40	74.6	69.4	76	74.5	73.8	73.3
45	73.6	68.4	75	73.4	72.8	72.3
50	72.7	67.5	74	72.5	71.9	71.4
55	71.9	66.7	73.2	71.7	71	70.5
60	71.1	65.9	72.5	71	70.3	69.8
65	70.4	65.2	71.8	70.3	69.6	69.1
70	69.8	64.6	71.1	69.6	68.9	68.4
75	69.2	64	70.5	69	68.3	67.8
80	68.6	63.4	70	68.5	67.8	67.3
85	68.1	62.9	69.4	67.9	67.3	66.8
90	67.6	62.4	68.9	67.4	66.8	66.3
95	67.1	61.9	68.5	67	66.3	65.8
100	66.7	61.5	68	66.5	65.8	65.3

15.3.4 Impacts Due to Project Operation

Along with many positive impacts, 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
- Impact due to depot

i. Noise and Vibration

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 impact due to train operation. During the operation phase the main source of noise will be from running of

metro trains. Airborne noise is radiated from at-grade and elevated structures, while ground-borne noise and vibration are of primary concern in underground operations. Basic Sources of wayside airborne noise are wheel / rail interaction, propulsion equipment, auxiliary equipment, elevated structures.

Noise prediction with average train speed of 35 km/hr and no noise barriers is presented in **Table 15.10**. Impact of vibration during operation is mentioned in para xii under impacts due to construction.

TABLE 15.10: NOISE LEVELS AT DIFFERENT DISTANCES dB(A)

Distance (m)	IIT Kanpur to Naubasta			Agriculture University to Barra-8		
	2021	2031	2041	2021	2031	2041
10	71	72	79	70	71	72
20	67	68	69	65	67	68
30	64	65	66	62	64	65
40	62	63	64	60	62	63
50	61	62	63	59	61	62
60	60	61	62	58	60	60
70	59	60	61	57	59	59
80	58	59	60	56	58	58
90	57	58	59	55	57	58
100	56	57	58	55	56	57

ii. 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 15.11**. Water should be treated before use upto WHO drinking water standards. The water requirement for the stations will be met through the public water supply system after taking necessary approvals.

TABLE 15.11: WATER REQUIREMENT

Sl. No.	Particular	Water Demand (KLD)
1	At Stations for Drinking Purpose	186
2	In Underground Section	3185
3	In Elevated stations	540
	Total	**3911**

iii. Traffic Congestion at stations

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

iv. Impacts due to Depot

Three maintenance depots are planned for Kanpur Metro at Polytechnic, Agriculture University and stabling depot at Naubasta. In order to develop these areas as depot, it will need filling by earth brought from outside. The depots will have following facilities:

- Washing Lines,
- Operation and Maintenance Lines,
- Workshop, and
- Offices

These facilities will could generate water and noise issues. The earth from underground metro corridor tunnelling and cut and cover will be utilised to fill the deport site. Problems anticipated at depot sites are Water supply, Oil Pollution, Cutting of trees, Sanitation, Effluent Pollution, Noise Pollution, Loss of livelihood, Impact due to filling of area, and Surface drainage.

- **Water Supply**

Water supply will be required for different purposes in the depot. The water will be required for train washing purpose and for other requirement (Departments and Contractors office). A three day cycle is assumed for outside Cleaning (wet washing on automatic washing plant). Projected water demands are summarised in **Table 15.12**. This water will be collected through municipal supply at each Depot.

TABLE 15.12: WATER REQUIREMENT

S.No.	Depot	Year		
		2021	2031	2041
1	IIT Kanpur To Naubasta	117	121	127
2	Agriculture University to Barra-8	105	108	109

The water after conventional treatment can be processed through Reverse Osmosis (RO) technology for specific use such as drinking/ cooking and final washing of equipment/ trains.

- **Sewage and Effluent**

About 80 KLD of sewage will be generated from the each depot and estimate effluent that will be generated from the washing of trains is presented in **Table 15.13**. The wastewater will be treated and will be recycled to use at depot horticulture purpose. The remaining domestic waste /sewage generated at the Depot will be collected at one suitable point inside the depot from where it will discharge to the nearest manhole of existing sewerage system. Based on past experience in similar projects the wastewater characteristics could be as reported in **Table 15.14**.

TABLE 15.13: EFFLUENT QUANTITY (KLD) AT DEPOTS

S.No.	Depot	2021	2031	2041
1	Corridor 1	13	17	22
2	Corridor 2	4	6	7

TABLE 15.14: SEWAGE & EFFLUENT CHARACTERISTICS

S. No.	Parameter	Unit	Sewage	Effluent
1.	pH	---	6-8	6-8.5
2.	BOD	mg/l	250-350	150
3.	Suspended Solids	mg/l	200-450	500
4.	COD	mg/l	600-800	300
5.	Oil and Grease	mg/l	Upto 50	500
6.	Detergents	mg/l	---	100

- **Oil Pollution**

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

- **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. The vibration of concrete structures also radiates noise.

- **Surface Drainage**

Due to the filling of the low-lying area for the construction of depots, the surface drainage pattern may change specially during monsoon. Suitable drainage measures will be required to drain off the area.

- **Solid Waste**

Solid waste will be generated from each of the Depot sites which will be taken by the cleaning contractor weekly and disposed to the KDA waste disposal sheds. Sludge will be generated from ETP/STP, oil and grease will be produced from car maintenance and iron turning of the PWL for the wheel profiling will be generated from each of the metro Depot.

15.3.5 Benefits

- Employment Opportunities
- Benefits to Economy
- Traffic Congestion Reduction, Quick Service and Safety
- Traffic Noise Reduction
- Reduction of Traffic on Road
- Decreased air pollution
- Carbon Credits

15.3.5.1 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. More people would be indirectly employed for allied activities. In post-construction phase, about 1460 people will be employed for operation and maintenance of the system. The system would result in growth in the entire City as well as the Metropolitan Area.

15.3.5.2 Benefits to Economy

In the present context, the project will streamline and facilitate movement of public from different parts of Meerut. These corridors will yield tangible and non tangible saving due to equivalent reduction in road traffic and certain

socio-economic benefits. Introduction of this metro will result in the reduction in number of busses, usage of private vehicles. This in turn will result in significant social benefits due to reduction in fuel consumption, vehicle operating cost and travel time of passengers. With the development of the 2 corridors of Meerut Metro project, it is likely that more people will be involved in trade, commerce and allied services.

15.3.5.3 **Traffic Congestion Reduction, Quick Service and Safety**

With the implementation of two metro corridors, travel time of passengers travelling by other modes will get 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 and increase safety of persons.

15.3.5.4 **Traffic Noise Reduction**

Reduction in road traffic volume affects the noise levels. A 50% reduction of the traffic volume may results 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.

15.3.5.5 **Reduction of Traffic on Road**

The estimated numbers of vehicle km that will be reduced daily due to construction of Kanpur Metro Phase I are given in **Table 15.15**. Based on number of vehicle trips reduction, reduction in fuel (diesel, petrol and CNG) consumption and respective cost is reported in **Table 15.16.**

TABLE 15.15: REDUCTION IN DAILY VEHICLE KM

Metro	Fuel	2024	2031	2041
Bus	CNG	272744	316934	390242
2 wheeler	Petrol	972586	1170139	1614587
Car(petrol)	Petrol	74489	68411	71725
Car(diesel)	Diesel	37244	34206	35862
Car(CNG)	CNG	12415	11402	11954
Auto	CNG	54615	22226	6633

15.3.5.6 **Decreased Air Pollution**

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 Metro corridors are presented in **Table 15.17.**

TABLE 15.16: REDUCTION IN ANNUAL FUEL CONSUMPTION AND ANNUAL SAVINGS IN FUEL COSTS

Metro	Diesel (million litre per year)	Petrol (million litre per year)	CNG (million kg per year)	Fuel Type	Total Cost (Rs million per year)
2024					
Bus			19.9	Diesel	38.7
2 wheeler		4.2		Petrol	395.5
car	0.6	1.3	0.2	CNG	370.9
Auto			0.5		
Total	**0.6**	**5.5**	**20.6**		
2031					
Bus			23.1	Diesel	35.5
2 wheeler		5.1		Petrol	449.4
Car	0.6	1.2	0.2	CNG	423.3
Auto			0.2		
Total	**0.6**	**6.3**	**23.5**		
2041					
Bus			28.5	Diesel	37.2
2 wheeler		7.0		Petrol	591.9
Car	0.6	1.2	0.2	CNG	517.2
Auto			0.1		
Total	**0.6**	**8.3**	**28.7**		

TABLE 15.17: POLLUTION REDUCTION (TON/YEAR)

Pollutants	2024	2031	2041
Carbon Monoxide (CO)	788	911	1177
Hydro-Carbons (HC)	512	595	752
Nitrogen Oxide (Nox)	772	895	1120
Particulate Matter (PM)	14	16	22
Carbon Dioxide (CO_2)	93812	106718	130987

Cost of Human Health saving from lifecycle emissions of $PM_{2.5}$ and cost of carbon capture from lifecycle emissions of Green House Gases (GHG) caused by gasoline and diesel is worked out (Climate change and health costs of air emissions from biofuels and gasoline, Jason Hill et al, PNAS, 2008) is presented in **Table 15.18.**

TABLE 15.18: 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 (INR) Savings from Lifecycle Emissions of GHG
2024	6.5	55.3	61.7	359.4	396.4
2031	5.9	62.8	68.8	400.1	441.4
2041	6.2	82.7	89	517.7	571.1

15.3.5.7 **Carbon Credits**

Carbon credits earned by projects in developing countries are bought by the companies of developed countries - mostly European. Carbon credits are measured in units of Certified Emission Reductions (CERs). Each CER is equivalent to one ton of carbon dioxide reduction. With the construction of 2 corridors of Kanpur Metro, Carbon credits of the tune of Rs 12 lakh in 2024, which will increase to Rs 17 lakh in 2041 at current price level can be earned due to reduction of vehicles.

15.4 POSITIVE AND NEGATIVE ENVIRONMENTAL IMPACTS

15.4.1 Negative Impacts

15.4.1.1 **Impacts due to Project Location**

- Displacement and loss of livelihood of Project Affected People (PAPs)
- Change of Land use
- Loss of trees
- Utility/Drainage Problems
- Impact on archaeological monuments.

15.4.1.2 **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.

15.4.1.3 **Impacts due to Project Construction:**

- Soil erosion and pollution
- Traffic diversion and risk to existing buildings
- Excavated Soil Disposal
- Pollution Generation due to transportation of earth and material

- Increased water demand
- Labour Camp
- Welfare of Labour on construction site
- Safety of labour
- Impact due to Supply of Construction Material
- Impact of construction near archaeological monuments
- Impact on ground and surface water quality
- Noise Pollution

15.4.1.4 **Impacts due to project Operation:**

- Noise pollution,
- Water supply and sanitation at Stations,
- Traffic congestion
- Impact due to depot

15.4.2 Positive Impacts

- Employment Opportunities
- Benefits to Economy
- Traffic Congestion Reduction, Quick Service and Safety
- Traffic Noise Reduction
- Reduction of Traffic on Road
- Decreased air pollution
- Carbon Credits

15.5 ENVIRONMENTAL MANAGEMENT PLAN

Environmental Management Plan is presented in two sections:

- Mitigation Measures
- Enhancement Measures

15.5.1 Mitigation Measures

i. Compensatory Afforestation
ii. Construction Material Management
iii. Safety Management
iv. Labour Camp
v. Welfare of Labour on construction site
vi. Safety of labour
vii. Energy Management

viii. Hazardous Waste Management
ix. Water Pollution Management
x. Environmental Sanitation
xi. Utility Plan
xii. Air Pollution Control Measures
xiii. Noise Control Measures
xiv. Vibration Control Measures
xv. Traffic Diversion/Management
xvi. Soil Erosion Control
xvii. Muck Disposal
xviii. Construction and Demolition Waste Management Plan
xix. Draining of Water from Tunnel
xx. Water Supply, Sanitation and Solid Waste management
xxi. Management Plan for Depot
xxii. Training
xxiii. Environmental Division
xxiv. 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 1450 trees are likely to be lost along the two corridors and three depots. It is proposed to plant 10 saplings for each tree to be cut. Hence 14500 trees need to be planted. Cost of afforestation is taken as Rs. 3,000/- per tree. Compensatory afforestation cost thus will be about Rs 4.35 Crore. During Afforestation Plan, the planting of miscellaneous indigenous tree species should be applied. 14500 trees, on maturing will absorb about 316 ton of CO_2 per year and will release 711 ton of Oxygen per year meeting oxygen demand of 488 persons per year.

ii. Construction Material Management

The duties of 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. 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 during construction

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 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. The contractor shall approach only Authorized Recyclers for disposal of Hazardous Waste, under intimation to KPMRC.

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, scrap 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 run along major arterial roads of the city, which serve 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. All proposals should therefore, ensure their uninterrupted functioning.

- In case of underground utility services running across the alignment, the spanning arrangement of the viaduct may be suitably adjusted.

xii. Air Pollution Control Measures

During the construction period, 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 transportation and disposal of waste and soil.
- Contractor's transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.
- The temporary dumping areas shall be maintained by the Contractor at all times until the excavation is re-utilised for backfilling or as directed by Employer.
- 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.
- It is proposed to have mix concrete directly from batching plant for use at site. Batching plants will be located away from the site and from human settlement. The other construction material such as steel, bricks, etc. will be housed in a fenced stored yard.

xiii. 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.

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.

xiv. 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.

xv. 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.
- Warn the road user clearly and sufficiently in advance.
- 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 minimised. 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.

xvi. Soil Erosion Control

Prior to the start of the relevant construction, the Contractor shall submit to the KPMRC 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. In general, construction works are stopped during monsoon season.

xvii. 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 KMRC 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 stabilised 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 stockpiling 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 minimise 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.

xviii. Construction and Demolition Waste Management

Construction and Demolition (C&D) debris is defined as 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 needs to be focused upon in view of the potential to save natural resources (stone, river sand, soil etc.) and energy, its bulk which is carried over long distances for just dumping, its occupying significant space at landfill sites and its presence spoils processing of bio-degradable waste as well as recyclable waste. 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 MMRC 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.

xix. 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.

xx. 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 re- charge.

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:

xxi. Management Plan for Depot

Three maintenance depots are planned for Kanpur Metro. These are at i) Polytechnic College (16.2 Ha), ii) Agriculture University (12.0 Ha) and iii) Naubasta (3.3 Ha). Depot at Naubasta will have stabling lines only. The management plan for depot site includes:

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

Water Supply: Water will be sourced from municipal supply. The estimated cost of water supply treatment plant for two depots is about Rs. 3.30 Crore.

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. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in bottom of the tank. The tank may be designed for a detention period of 5 to 15 minutes.

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 will have oil, grease and, detergent as main pollutants. This has to be treated as per requirement of UP Pollution Control Board. Total estimated cost of sewage treatment plant at two depots is about Rs 2.10 Crore. Cost of effluent treatment plant at two depots will be about Rs 2.40 Crore.

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.

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. In addition to augmenting present vegetation, it will also check soil erosion, make the ecosystem more diversified and functionally more stable, make the climate more conducive and restore balance. Estimated cost for green belt development is about Rs 1.10 Crore.

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 depots will be open to sky and it is estimated that approximately 10% area will be covered. Rainwater harvesting potential of depots is calculated as 37,621 cum per year. Estimated cost for rainwater harvesting is about Rs 0.20 Crore for depots.

Recycling of treated waste water: Waste Water generated at depots is proposed to be collected at ETP & STP through separate sewer lines for treatment and the treated waste water will be recycled for horticulture work of the depots. Estimated cost of recycling of treated waste water for depots is about Rs 1.10 Crore.

xxii. Training

The training for engineers and managers will be ensured by KPMRC on regular basis to implement the environmental protection clauses of the tender document and to implement the best environmental practices during the construction phase. Such programme should include guidelines for safety, methods of disaster prevention, etc. The cost involved for such programme is presented in **Table 15.19.**

TABLE 15.19: COST FOR TRAINING PROGRAMME

S. N.	ITEM	COST (Rs)
1	Curriculum Development and course preparation 2 months Rs.50000/month	100,000
2	10 Extension Officer (1 year) Rs.20, 000/ month	1200000
3	Instructor 20 sessions of 10 days each	600000
4	Demonstration/Presentation Aids	100,000
5	Material etc.	150000
	Total	**2,150,000**

xxiii. Establishment of Environmental Division

It is recommended that KMRC 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. Estimated cost of the Division is summarized in **Table 15.20**.

TABLE 15.20: ANNUAL ENVIRONMENTAL DIVISION COSTS

S. N.	Particulars	Cost (in Rs.)
1.	Environmental Officer (1No.)	9,60,000
2.	Environmental Engineer (1No.)	6,00,000
3.	Miscellaneous Expenditure	5,00,000
	Total Cost for One Year	**20,60,000**
	Total Cost for Ten Years with 10% annual increase	**3,28,31,095**

xxiv. 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:** Measures 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 organisations, 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*) comprises 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 updation of the process.

1) 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: Evacuation 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

Rainwater harvesting has been made mandatory in all new buildings with an area of 1000 sqm or more in Kanpur. 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 corridor is about 19.610 km. Annual rainfall of Kanpur is 821.9mm per year. Considering a runoff coefficient of 0.85, annual rainwater harvesting potential of elevated stations / section is estimated as 1,53,915 cum/year.

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 CO_2. 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 Environmental 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. Environment 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. The preconstruction stage environment monitoring has been carried out during this EIA study and proposed construction and operation stage monitoring is presented below:

15.6.1.1 Construction Phase

During construction stage environmental monitoring will be carried out for air quality, noise levels, vibrations, water quality, and ecology. Keeping a broad view of the sensitive receptors and also the past experience an estimate of locations has been made.

Water Quality

Since water contamination leads to various water related diseases, the project authorities shall establish a procedure for water quality surveillance and ensure safe water for the consumers. The water quality parameters are to be monitored during the entire period of project construction. Monitoring should be carried out by NABL Accredited / MoEF 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.

Air Quality

Air quality is regularly monitored by Central Pollution Control Board at number of places in Kanpur. 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 KPMRC.

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 KPMRC.

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 reviewed four times a year during construction phase.

Workers Health and Safety

Monitoring of health risk issues that might arise throughout the project life time will be done. Regular inspection and medical checkups shall be carried out to workers health and safety monitoring. Any recurring 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. The schedule is presented in **Table 15.21**.

TABLE 15.21: 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

15.6.1.2 Operation Phase

In order to evaluate impact of the Metro system and mitigate the reduced environmental hazards during the operation phase, 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 ($PM_{2.5}$ and PM_{10}), SO_2, NO_X, 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 15.22**. The monitoring program shall be conducted by an external agency which is NABL Accredited / MoEFCC recognized under the supervision of Kanpur Metro Rail Corporation. Project Operator i.e. KPMRC will be responsible for successful environmental monitoring of the proposed project during operation phase.

TABLE 15.22: 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	2 (Depots)	3

The results of air quality, water quality, noise and vibration will be submitted to management quarterly during construction phase and semi annually during operation phase.

15.6.2 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 15.23** and **Table 15.24**.

TABLE 15.23: ROLES AND RESPONSIBILITIES - SECURING APPROVALS/CLEARANCES

SN	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.	Utility / traffic diversion	Respective Acts and Rules		Local Offices of respective Agencies.
4.	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 Authority for landuse clearance
Construction Phase				
5.	• Consent to Establish and Operate hot mix plant, crushers, batching plant etc and • Consent to Establish labour camps	Air (Prevention and Control of Pollution) Act 1981	Before Construction	• State Pollution Control Board • Municipal Corporation

SN	Issue	Provision of Laws & Regulations	Due Date	Approving Authority
6.	Permission for drawalof groundwater for construction (**not recommended**)	Environment (Protection) Act, 1986	Before Construction	Regional Director, Central Ground Water Board and Municipal Corporation
7.	Authorization for Disposal of Hazardous Waste	Hazardous Waste (Management and Handling and transboundary movement) Rules 2016	Before Construction	State Pollution Control Board
8.	Consent for disposal of waste water from construction sites and sewage from labour camps	Water (Prevention and Control of Pollution) Act 1974	Before Construction	State Pollution Control Board
9.	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
10.	Permission for management of C&D waste and muck	Environment Protection Act 1956	Before Construction	Municipal Corporation and State Pollution Control Board
Operation Phase				
11.	Consent to Operate Depot	Environment Protection Act 1956	After Construction	State Pollution Control Board
12.	Installation and operation of DG sets at stations	Air (Prevention and Control of Pollution) Act 1981	After construction	State Pollution Control Board

Note: This project is not located near and has no impact on forests, wildlife / bird sanctuaries / bio-reserves, wetlands or their associated ecologically sensitive zones.

TABLE 15.24: ROLES AND RESPONSIBILITIES – PREPARATION AND IMPLEMENTATION OF 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
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
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

SN	Environmental Impact	Mitigation Measure	Implementing Entity	Responsible Entity
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 followup of such incidents.

A typical EMS organization is depicted in **Figure 15.2.** One indicative activity i.e. approval of EMS documents is shown in this organisation chart.

15.7 SUMMARY OF COSTS

Cost towards environmental management is presented in **Table 15.25**.

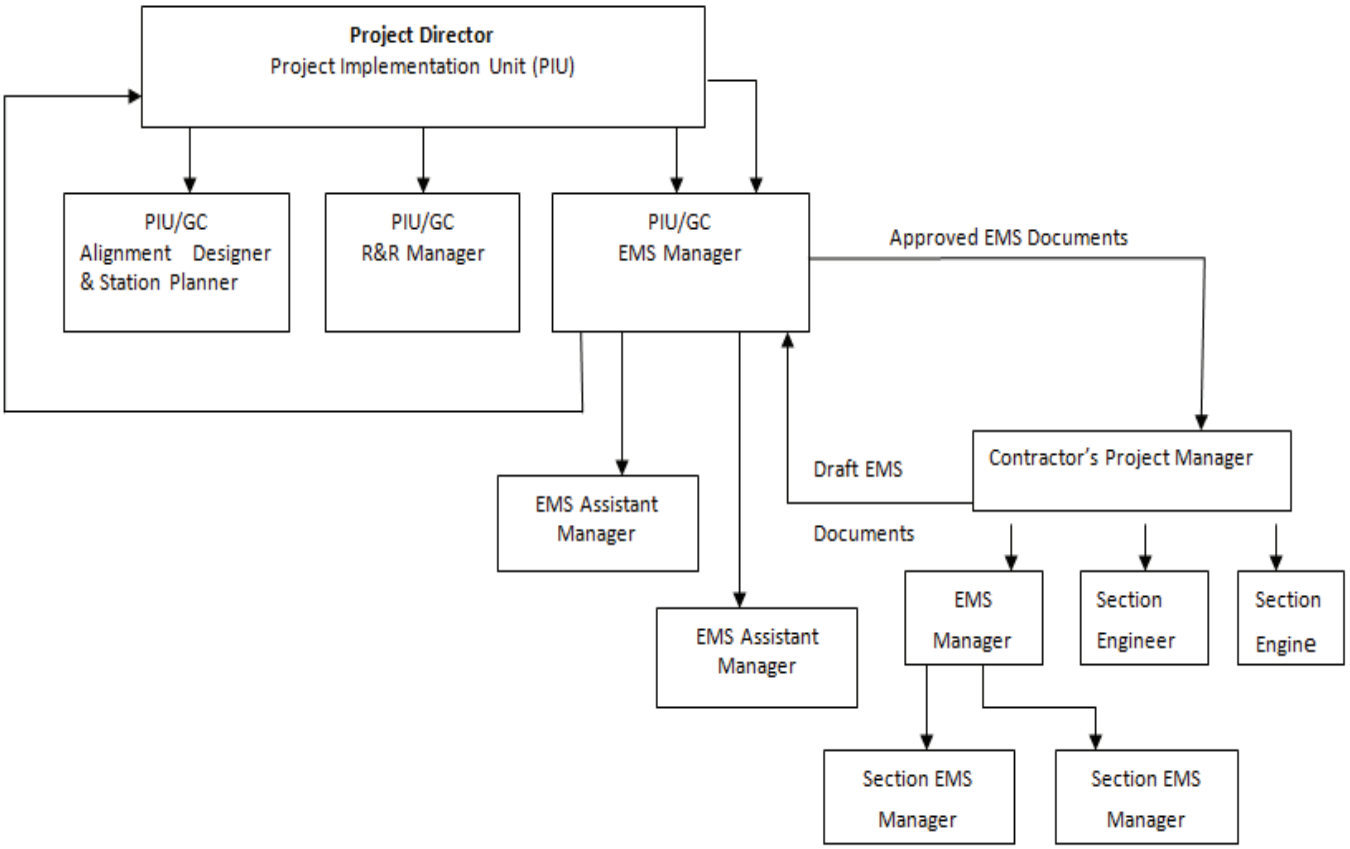
TABLE 15.25: COST OF ENVIRONMENTAL MANAGEMENT PLAN

SN	Item	Amount (Rs. In Crore)
1.	Compensatory Afforestation	4.35
2.	Water Supply Treatment for Depot	3.30
3.	Sewage Treatment for Depot	2.10
4.	Effluent Treatment for Depot	2.40
5.	Drainage for Depot	1.60

SN	Item	Amount (Rs. In Crore)
6.	Rainwater harvesting for Depot	0.20
7.	Management of Muck disposal site	14.51
8.	Sanitation facilities at labour Camps	0.69
9.	Green Belt Development for Depot	1.10
10.	Recycling of Treated Waste Water for Depot	1.10
11.	Air, Noise, vibration, Water, during construction and operation	5.45
12.	Ecological monitoring	0.30
13.	Environment Division	3.28
14.	Training And Extension	0.22
	Total	**40.60**

* Cost of items 5 and 6 in respect of stations is included in Civil Engineering cost

FIGURE 15.2: EMS Organization



* GC: General Consultant as Project Management Consultant

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 minimise 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 objective of Social Impact Assessment is (i)Identify PAPs by type and extent of loss (ii)Identify the possible adverse effects of the project on the people and the area (ii)Suggest culturally and economically appropriate measures for mitigation of adverse effects of the project (iii)Provision of institutional mechanism for implementation of RAP (iv)Provision for grievance redress mechanism;(v)A time frame for implementation of RAP (vi)Provision of budget for each activity of RAP, and (vii) 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 Resettlement Policy Framework of Lucknow Metro Rail Corporation. 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.

- 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.
- In order to understand social issues associated with the proposed project we require baseline data. 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 in 2015.
- Development of proposed metro project has significant positive impacts. 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.

15.8.3 Potential Social Impacts

The proposed metro rail will have 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 project may bring myriad forms of adverse impacts on socio-economic condition of families/people who 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. Both the Depot lands at Polytechnic and Agricultural University belong to the State

Government and will be transferred to Metro Rail Authority free of cost by the State Government. The land belonging to Agricultural University is open land. Hence, no rehabilitation is involved. In Polytechnic land relocation of some buildings will be required, which will be done in the same campus.

15.8.3.1 Land Requirement and Acquisition

Summary of land requirement and acquisition are presented in **Table 15.26**.

TABLE 15.26 LAND REQUIREMENT AND ACQUISITION (in Ha)

Corridor	Type of Land	Permanent	Temporary
IIT Kanpur to Naubasta	Government	91.06	25.86
	Private	2.34	0
	Sub Total	*93.40*	*25.86*
Agriculture University to Barra 8	Government	18.86	11.50
	Private	0.12	0
	Sub Total	*18.98*	*11.50*
	Total	**112.38**	**37.36**

15.8.3.2 Inventory of Affected Structures

Table 15.27 presents the usage type of structures likely to be affected.

TABLE 15.27: CORRIDOR WISE IMPACT ON STRUCTURES

Corridor/Station	Type of Structures			Total
	Residential	Commercial	Others	
IIT Kanpur to Naubasta				
CSJM University	0	0	1	1
Gurudev Chauraha	0	0	2	2
Geeta Nagar	0	15	0	15
Rawatpur Railway Station	0	50	2	52
Lala Lajpat Rai Hospital	0	0	7	7
Moti Jheel	1	4	0	5
Naya Purva upto Nala	10	0	0	10
Chunni Ganj	0	0	2	2
Navin Market	0	7	0	7
Bada Chauraha	0	15	2	17
Phool Bagh	0	0	2	2
Naya Ganj*	0	18	0	18
Transport Nagar	2	38	0	40
Baradevi Chauraha	5	2	0	7

Corridor/Station	Type of Structures			Total
	Residential	Commercial	Others	
Sub Total	**18**	**149**	**18**	**185**
Agriculture University to Barra 8				
Double Pulia	0	10	1	11
Vijay Nagar Chouraha	0	0	1	1
Dada Nagar	208	13	1	222
Shastri Chouraha	1	11	0	12
Sub Total	**209**	**34**	**3**	**246**
Total	**227**	**183**	**21**	**431**

Source: Primary Surveys, 2015

*Number of structures are 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 during site visit that out of total 431 structures, about 375 structures (87%) will be fully affected and remaining about 56 structures (13%) will be partially affected (**Table 15.28**). However, the exact number of fully and partially affected structures will be known after peg marking on the ground level.

TABLE 15.28: MAGNITUDE OF PROJECT IMPACTS

Name of Corridor	Magnitude of Impacts		
	Fully	Partially	Total
IIT Kanpur to Naubasta	152 (82.2)	33 (17.8)	185 (100)
Agriculture University to Barra 8	223 (90.6)	23 (9.4)	246 (100)
Total	**375 (87.0)**	**56 (13.0)**	**431 (100)**

Source: Primary Surveys, 2015

15.8.3.3 Impact on PAFs/PAPs

About 458 families consisting 2178 persons will be affected due to the proposed metro project. Majority of families will be affected at Dada Nagar Slums in Agriculture University to Barra 8 corridor and Navin Market

and Transport Nagar in IIT Kanpur to Naubasta corridor. Corridor wise number of PAFs and PAPs is presented in **Table 15.29**. *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 15.29: IMPACT ON PAFs AND PAPs

Name of Corridor	Total PAFs	Total PAPs*
IIT Kanpur to Naubasta	215	968
Agriculture University to Barra 8	243	1210
Total	**458**	**2178**

Source: Primary Surveys, 2015

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

Out of the total 458 families, 22.5% are in the category of Title Holders (TH) and the remaining 77.5% 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 15.30**.

TABLE 15.30 TITLEHOLDERS AND NON-TITLEHOLDERS

Name of Corridor	Titleholders	Non-Titleholders	Total PAFs
IIT Kanpur to Naubasta	98 (45.6)	117 (54.4)	215 (100)
Agriculture University to Barra 8	5 (2.1)	238 (97.9)	243 (100)
Total	**103 (22.5)**	**355 (77.5)**	**458 (100)**

Source: Primary Surveys, 2015

Table 15.31 indicates that out of the total 458 PAFs, 227 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 Agriculture University to Barra 8 corridor.

TABLE 15.31: LOSS OF RESIDENCE

Name of the Location	Total PAFs	Residentially Affected Family
IIT Kanpur to Naubasta	215	18
Agriculture University to Barra 8	243	209
Total	**458**	**227**

Source: Primary Surveys, 2015

Table 15.32 indicates that out of total 458 affected families, there are 183 PAFs whose business/livelihoods will be affected due to the loss of the commercial structures vis-a-vis business base in both corridors. Majority (149) of commercial PAFs are likely to be affected in IIT Kanpur to Naubasta corridor. About 34 PAFs are likely to be affected in Agriculture University to Barra 8 corridor.

TABLE 15.32: LOSS OF LIVELIHOOD

Name of the Location	Total PAFs	Commercially Affected Family
IIT Kanpur to Naubasta	215	149
Agriculture University to Barra 8	243	34
Total	**458**	**183**

Source: Primary Surveys, 2015

15.8.3.4Impact 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 15.33** indicates that eight religious structures and three 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 15.33: LOSS OF COMMON PROPERTY RESOURCES

Name of the Corridors	Common Property Resources			Total
	Religious structures	Public toilet	Others	
IIT Kanpur to Naubasta	3	2	11	16
Agriculture University to Barra 8	4	0	1	5
Total	**7**	**2**	**12**	**21**

Source: Primary Surveys, 2015

15.8.4 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.

15.8.4.1 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 55.6% are male and remaining 44.6% are female. It is observed that male dominate in both corridors. The sex ratio is 821 per 1000 males in IIT Kanpur to Naubasta corridor and 778 is Agriculture University to Barra 8 in corridor (**Table 15.34**).

TABLE 15.34: GENDER AND SEX RATIO

Corridor	Total Surveyed PAFs	Total PAPs	Gender		Sex Ratio
			Male	Female	
IIT Kanpur to Naubasta	88	386 (100)	212 (54.9)	174 (45.1)	821
Agriculture University to Barra 8	76	359 (100)	202 (56.3)	157 (43.7)	778
Total	**164**	**745 (100)**	**414 (55.6)**	**331 (44.6)**	**800**

Source: Primary Surveys, 2015

15.8.4.2 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 15.35** shows that only two religions are followed in the study area viz., Hindu and Muslims. The study result shows that about 84.7% of the surveyed families are Hindu followed by Muslim (15.3%). Majority of families are Hindu in both corridors.

TABLE 15.35: RELIGIOUS GROUP

Corridor	Hindu	Muslim	Total PAFs
IIT Kanpur to Naubasta	75 (85.2)	13 (14.8)	88 (100)
Agriculture University to Barra 8	64 (84.2)	12 (15.8)	76 (100)
Total	**139 (84.7)**	**25 (15.3)**	**164 (100)**

Source: Primary Surveys, 2015

Table 15.36 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 48.9% belong to Other Backward Caste followed by general (36.7%) and Scheduled Caste (12.2%) and Scheduled Tribe (17%). Scheduled Castes families are found in both corridors whereas Scheduled Tribe families are found only in Agricultural University to Barra 8 corridor. Therefore, special attention is required to address their issues.

TABLE 15.36: SOCIAL GROUP

Corridor	General	OBC	Schedule Castes	Schedule Tribes	Total PAFs
IIT Kanpur to Naubasta	20 (26.7)	44 (58.7)	11 (14.6)	0	75 (100)
Agriculture University to Barra 8	31 (48.4)	24 (37.5)	6 (9.4)	3 (4.7)	64 (100)
Total	**51 (36.7)**	**68 (48.9)**	**17 (12.2)**	**3 (2.2)**	**139 (100)**

Source: Primary Surveys, 2015

15.8.4.3 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.

15.8.4.4 Age Group

The distribution of person's age in various group shows that 5.4% of the total persons belong to below five years, about 10.3% belong to the 5-18 years age group. About 23% belong to 18-35 years that is potentially productive group. About 48% belong to the age group of 35 to 60 years. About 13% of total persons belong to above 60 years, who are dependent population. It is observed that majority of persons belong to 35 to 60 years age group.

15.8.4.5 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.

15.8.4.6 Family Pattern and Family Size

Majority of surveyed families are nuclear (57.9%) followed by joint (43.3%). Majority of surveyed families belong to nuclear family (51.1%) in IIT Kanpur to Naubasta corridor and Joint family (52.6%) in Agriculture University to Barra 8 corridor. Family size has been classified into three categories i.e. individual, small (2-4), medium (5-7) and large (7 & above). Majority of families (48.8%) are medium in size followed by 33.5% families are small type and remaining 17.7% families have their members more than seven. Medium size families are found in both corridors.

15.8.4.7 Educational Attainment

The analysis indicates that out of the total surveyed people, about 19.4% are illiterate, 18.4% are educated up to primary class, 24.7% are educated up to High School, and 23.3% have studied up to higher secondary level. Other than this, about 11.5% of persons have attained college. More illiterate are found in Agriculture University to Barra 8 corridor. Education level of surveyed people is better in IIT Kanpur to Naubasta corridor as compared to Agriculture University to Barra 8 corridor.

15.8.4.8 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 33.5% of families reported less than Rs.5000/- monthly income. About 31.7% of families' monthly income is less then Rs.5001-10000, 18.3% of

families' income is between Rs.10001 to 20000/-, 9.8% of families' income is between Rs.20001 to 40000.Families' earning more than Rs.40000/- monthly constitutes about 6.7%. 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 15.37)**.

TABLE 15.37 FAMILY MONTHLY INCOME

Corridor	Family Monthly Income (in INR)					Total PAFs
	<5000	5001 - 10000	10001 - 20000	20001 - 40000	>40000	
IIT Kanpur to Naubasta	17 (19.3)	28 (31.8)	18 (20.5)	14 (15.9)	11 (12.5)	88
Agriculture University to Barra 8	38 (50)	24 (31.6)	12 (15.8)	2 (2.6)	0 (0.0)	76
Total	**55 (33.5)**	**52 (31.7)**	**30 (18.3)**	**16 (9.8)**	**11 (6.7)**	**164 (100)**

Source: Primary Surveys, 2015

15.8.4.9 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 62.8% of them are involved in business, 25% are in daily labour and 6.1% are in private sector. About two percent are working as maid servant and 3.7% are unemployed. It is observed in both corridors that majority of PAPs are involved in business/trade activities.

15.8.4.10 Household Assets

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

15.8.4.11 Vulnerable Groups

As per the JICA 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 64 families belong to vulnerable category. Out of these about three families are

women headed households, 17 families are Scheduled Castes, three families are Scheduled Tribes, 35 families are below the line of poverty including women headed households, and six families having disability people. Numbers of vulnerable families are found more in Agriculture University to Barra 8 corridor.

15.8.4.12 Gender Issues

There are three woman-headed household among the surveyed vulnerable families found in the Agriculture University to Barra 8 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.

15.8.4.13 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.

15.8.4.14 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 15.38**.

TABLE 15.38: PROJECT RELATED INFORMATION

S. N.	Description	IIT Kanpur to Naubasta	Agriculture University to Barra 8
1	**Awareness about the Project**		
	Yes	82	63
	No	6	13
2	**Source of Information**		
	News Paper	42	26
	Survey Team	10	9
	Television	21	15
	Friends/People	13	26
3	**Opinion about the Project**		
	Good	80	58
	Bad	4	11
	Can't Say	4	7

Source: Primary Surveys, 2015

15.8.5 Public Consultation and Participation

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:

- People at Rawatpur station demanded that alignment and metro stations should be underground from IIT to Medical College.
- Vacant Government land should be used for metro station instead of acquiring residential and commercial plots or structures of local people.
- Commercial buildings and shops should not be disturbed.
- People should be informed properly before start of construction work of the project.
- In case, any property affected due to the project, adequate compensation should be provided to the affected people.
- Government should cooperate local people and people should be informed and involved in all stages of the project for its successful completion.
- Government has declared Kanpur to be developed as smart city and introduction of metro rail project in the city is a positive step.
- 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.
- Safety should be given first priority during construction and operation of the metro rail project.
- People at Dada Nagar (near proposed Govind Nagar station) said that if the people of Dada Nagar are displaced due to the proposed metro rail project, then people should be rehabilitated properly in resettlement colony before start of construction work. Majority of people in Dada Nagar are labour class. Therefore, people of this area should be provided jobs opportunity during construction and operation of the project.
- Shop for shop- All shop keepers should be rehabilitated by constructing market complex in nearby area.
- Government should provide a constructed house for each affected family.
- All development facilities should be centered for the utilization of project affected people and community development programmes should be implemented in project affected areas.

- People feel that common people will get better transportation facilities, avoid traffic jam, commuting time will be reduced, accidents will be avoided, people will get more jobs etc.
- Some persons were thinking beyond the personal level and reported that Kanpur city will progress and will look better and will be free from pollution.

It is evident from the discussion with local people during social survey that the people in Kanpur have no objection to the proposed metro rail project. According to them loss of residential, commercial 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.

15.8.6 Resettlement Policy, Framework and Entitlement Matrix

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

1. Right to Fair Compensation and Transparency in land acquisition, Rehabilitation and Resettlement Act, 2013(RTFCTLARR Act).
2. 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.

The Entitlement Matrix

An Entitlement Matrix **(Table 15.39 & Table 15.40)** 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 15.39: ENTITLEMENT MATRIX – LAND ACQUISITION

(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.

S.No	Category of Impact	Eligibility for Entitlement	LMRC Adopted Policy/Entitlement
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.**

TABLE 15.40 ENTITLEMENT MATRIX – REHABILITATION

(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. 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. 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.**

S.No	Category of Impact	Eligibility of Entitlement	LMRC Adopted Policy/Entitlement
			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 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.

15.8.7 Institutional Framework

The SPV formed 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.

15.8.8 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 15.3**.

15.8.9 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.

FIGURE 15.3: RAP IMPLEMENTATION SCHEDULE FOR KANPUR METRO PHASE-I CORRIDORS

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								

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 15.41**.

TABLE 15.41: INDICATORS FOR MONITORING OF RAP PROGRESS

Indicators	Parameters Indicators
Physical	Extent of land acquired Number of structures dismantled Number of land users and private structure owners paid compensation Number of families affected Number of families purchasing land and extent of land purchased Number of PAPs receiving assistance/compensation Number of PAPs provided transport facilities/ shifting allowance Extent of government land identified for house sites
Financial	Amount of compensation paid for land/structure Cash grant for shifting oustees Amount paid for training and capacity building of staffs
Social	Area and type of house and facility at resettlement site PAPs knowledge about their entitlements Communal harmony Morbidity & mortality rate Taken care of vulnerable population Women concern
Economic	Entitlement of PAPs-land/cash Number of business re-established Utilization of compensation House sites/business sites purchased Successful implementation of Income Restoration Schemes
Grievance	Number of community level meeting Number of GRC meetings Number of cases disposed by IA to the satisfaction of PAPs Number of grievances referred and addressed by GRC Cases of LA referred to court, pending and settled

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.

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. Submission of the draft report would be carried out after completion of assignment and the final report should be submitted after receiving feedback from IA.

15.8.3 Cost Estimate of R&R

The cost for implementation of Resettlement and Rehabilitation Plan on account of two corridors of Kanpur Metro is presented in **Table 15.42**. The total cost for R&R implementation plan is **Rs.5.32 crore**.

TABLE 15.42: COST FOR RESETTLEMENT & REHABILITATION*

Sl. No.	Description	Unit	Quantity	Rate (Rs.)	Amount (Rs.in crore)
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	19	36000	0.068

Sl. No.	Description	Unit	Quantity	Rate (Rs.)	Amount (Rs.in crore)
D	Transportation allowance	no	19	50000	0.095
E	Resettlement Allowance	no	19	50000	0.095
F	**Commercial PAFs**				
G	Subsistence allowance	no	97	36000	0.349
H	Transportation allowance	no	97	50000	0.485
I	Loss of Small traders/self employment	no	97	25000	0.242
J	Resettlement Allowance	no	97	50000	0.485
Compensation for Non-Titleholders					
	Squatters				
K	One time financial assistance	no	355	25000	0.887
Assistance for SCs ,STs or Vulnerable group					
L	Additional Subsistence Allowance	no	64	50000	0.320
Training for Skill Development					
M	Training Assistance(LS)	no	64	15000	0.096
Compensation for Community Structures					
N	Religious structures(LS)	no	7	2000000	1.400
O	Public Toilets(LS)	no	2	1000000	0.200
Engagement of NGO					
P	NGO Cost (LS)	no	1	4000000	0.400
Monitoring & Evaluation					
Q	Cost of Independent Evaluation Agency(LS)		1	2000000	0.200
	Total (B+C+D+E+F+G+H+I+J+K+L+M+N+O+P+Q)				4.838
	Miscellaneous items @ 10% of sub total				0.483
	TOTAL				**5.322**

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