Supplementary Report of Environmental Impact Assessment for Line-7 under DMRTS Phase-III

- **Consideration of alternative option**
- **Baseline data for Line-7 ext. (and its justification to use the same baseline with the EIA for original scope)**
- **Environmental Mitigation Plan, Management Plan & Monitoring Plan**

1.0 ANALYSIS OF ALTERNATIVES

1.1 Maujpur to Shiv Vihar extension (about 2.2 Km) of Line 7: Earlier the alignment was terminating at Yamuna Vihar, however, it is now shifted to Gokulpuri and the line extended up to Shiv Vihar for a length of 2.2 km with two more stations namely Johri Enclave and Shiv Vihar. This extension of alignment does not involve any displacement of properties and people.

The final corridors of the proposed Delhi Metro Phase III project have been finalised after taking into account environmental and social concerns, considerations of traffic, integration with the existing system and importantly, the overall economic and financial viability. The underlying principles for evaluation for each corridor, without affecting the overall usefulness of the corridor, are:

- Minimum or no private land acquisition,
- Least disturbance to properties,
- Minimum disturbance to people and
- Minimum disturbance to ecology/ biodiversity.

In the analysis of alternatives, a comparison of scenario with and without the project had also been made. Advantages and disadvantages have been spelt out and the analysis is quite exhaustive. The alignments have been finalized on the basis of positive impacts of the chosen corridors.

1.2 No Development Alternative

In case the phase III of Delhi Metro is not constructed, the city will be deprived of the following benefits:

- Employment Opportunities,
- Enhancement of Economy,
- Mobility,
- Safety,
- Traffic Congestion Reduction, Reduction in Number of Buses,
- Reduced Fuel Consumption,
- Reduced Air Pollution,
- Carbon Dioxide and Green House Gases (GHG) Reduction,
- Saving in Road Infrastructure.

Since the positive impacts are more than a few negative impacts, consideration of ‘no development alternative’ is a non-starter and has thus not merited any further consideration.

ENVIRONMENTAL BASELINE DATA

2.0 Baseline Environmental Data for Line 7

Environmental baseline data was generated for the four corridors of Phase III while carrying out the EIA/EMP study. Since the present project is an extension of Line 7 of Phase III and the area is contiguous, the monitoring data provided in the EIA report of Phase III is considered suitable to understand the baseline environmental status of the current project. The monitoring station, of Phase III, which is nearer to the proposed study area, is Arjun nagar / Jagatpuri located within the aerial distance of 2.5 km. The baseline environmental data of Arjun nagar / Jagatpuri monitoring station is replicated in the following section.

2.1 Geology

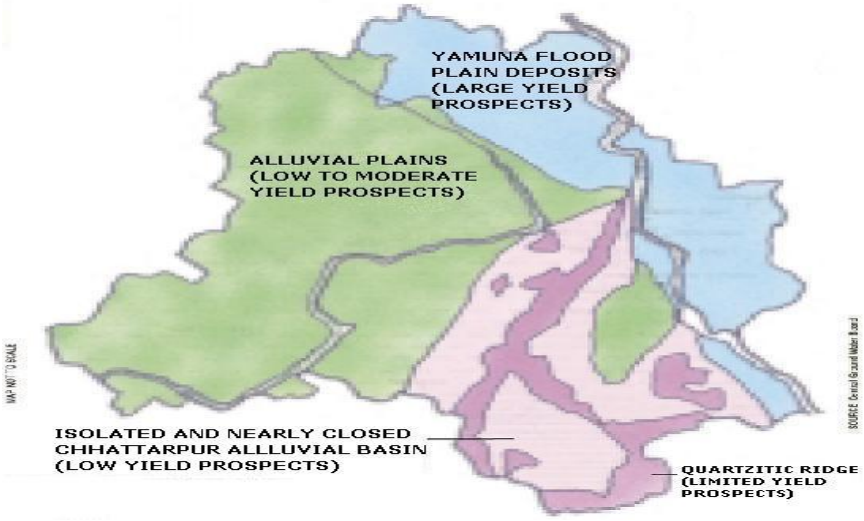
The area under study is part of the Yamuna Basin comprising the newer alluvium made up of fine to medium sand, silts, gravel, clay and kankar. The surface belts are admixed with wind-blown sediments or recent age. These alluvial sediments are known to be underlined by hard formations of Delhi system of rocks. Following is the general sequence of formations met with in the area:

Recent to Sub – Recent	:	Alluvium
Post-Delhi Intrusive	:	Pegmatic and basic intrusive
Algonkian (Delhi System)	:	Alwar Quartzites

The Details of the geology of the alignment is presented in the following paragraphs:

FIGURE 2.1

THE MAP SHOWING GEOLOGICAL UNITS OF DELHI



2.2 Soil Quality

In order to ascertain the quality and nature of soil within the vicinity of the study area, soil sample was collected from Jagatpuri location. The sample was collected at about 60 cm depth and tested for physical and chemical properties. The results of soil analysis are presented in **Table 2.1.** As per the test results it is observed that soil is tending to become alkaline. Soil is high in nitrogen and Phosphorus contents. The soil texture is of sandy silt.

TABLE 2.1

SOIL TEST RESULTS

S.No	PARAMETERS	Jagatpuri
1.	pH	8.06
2.	Organic Matter (%)	0.69
3.	Nitrogen (kg/Hectare)	1792
4.	Phosphorus (kg/Hectare)	1092
5.	Sodium (mg/100gm)	8.99
6.	Calcium (ppm)	1806
7.	Potassium (kg/Hectare)	65.6
8.	Magnesium (ppm)	65.0
9	Electrical Conductivity	802
10	Texture (%)	
	Sand	78.16
	Slit	19.48
	Clay	2.36

Source: Consultant study

Figure 2.2

Soil Sampling Station

2.3 WATER ENVIRONMENT

2.3.1 Water Quality

Water quality is the physical, chemical and biological characteristics of water. It is most frequently used with reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to drinking water, safety of human contact, and for health of ecosystems. An understanding of the various factors influencing water quality is thus very important as human health is largely dependent on the quality of water available for our use.

In order to collect baseline data on the existing water quality, ground water sample was collected from Jagatpuri location within in the study area and analyzed as per the procedure specified in standard methods for examination of water and wastewater published by American Public Health Association and the Bureau of Indian Standards (APHA/BIS). The results of the physio-chemical analysis are summarized in the **Table 2.2**. The test results when compared with the prescribed limits of various parameters as per IS 10500:1991 indicated that all parameters are within desirable limit.

Figure 2.3

Ground Water Sampling Station

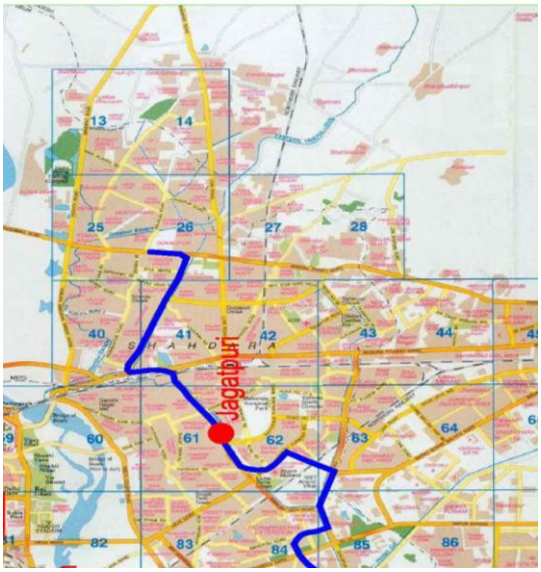


TABLE 2.2

WATER QUALITY AT PROJECT SITE

S.No.	PARAMETERS	Jagatpuri	S.No.	PARAMETERS	Jagatpuri	S.No.	PARAMETERS	Jagatpuri
1.	Alkanity(mg/l)	*392*	11.	Faecal Coliform	Absent	21.	Sodium (mg/l)	86
2.	Arsenic(mg/l)	<0.010	12.	Fluorides (mg/l)	0.86	22.	Phenolic compounds (mg/l)	<0.001
3.	BOD (mg/l)	<2.0	13.	Magnesium (mg/l)	*30.13*	23.	Potassium (mg/l)	4.1
4.	Copper (mg/l)	<0.02	14.	Manganese (mg/l)	<0.05	24.	Total Iron (mg/l)	0.209
5.	Chlorides (mg/l)	104.8	15.	Mercury (mg/l)	<0.001	25.	Total Dissolved Solids (mg/l)	*769.4*
6.	Chromium (mg/l)	<0.02	16.	Nitrates (mg/l)	22.49	26.	Total Hardness (mg/l)	252
7.	Calcium (mg/l)	51.2	17.	Nickle (mg/l)	<0.05	27.	Total Phosphate (mg/l)	<0.010
8.	Cadmium	<0.010	18.	Lead (mg/l)	<0.010	28.	Total Suspended Solids (mg/l)	<1.0
9.	COD	<4.0	19.	pH		29.	Temperature	28
10.	Dissolved oxygen (mg/l)	6.9	20.	Sulphates (mg/l)	84.49	30.	Total coliform	<2
11.	Faecal Coliform	Absent				31.	Zinc (mg/l)	0.609

Source: Consultant study

2.4 METEOROLOGY AND AIR ENVIRONMENT

Meteorology is an important parameter in an environmental impact assessment exercise. All air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. The main parameters are: temperature, humidity, rainfall, winds and cloud cover. The meteorology and air environment of the area are discussed in subsequent sections.

2.4.1 Meteorology

Delhi has an extreme climate, which is very cold in winter and hot in summer. The climatic conditions in project area are characterized by a rainy season (July-October), Winter (November-March) and Summer (April-June). The recorded meteorological data for the area have been summarised in Table 2.3 through 2.7. The mean annual rainfall of project area was 714 mm between the years 1980-90. Over 75% of the rainfall is received during rainy season (Ref Table 2.3).

Delhi has a monsoon climate with an average yearly rainfall of 730 mm. The air relative humidity at Delhi varies almost throughout the year but seldom drops below 30%. Records of monthly rainfall, mean maximum and mean minimum relative humidity of Delhi obtained from Indian Meteorological Department, from 2005 to 2009 are given in **Table 2.3 to Table 2.5**.

The mean monthly maximum temperatures are highest in April-May-June ($38^{O}C$). Mean minimum temperature is lowest during January ($7^{O}C$). Records of mean maximum and mean minimum temperatures from 2005 to 2009 are given in **Table 2.6** and **Table 2.7** respectively.

Winds are generally light to moderate (0.9 to 4.9 m/sec) but increases in April-May-June. Wind direction is mostly from North, North East; and North West..

TABLE 2.3
MONTHLY RAINFALL (In mm)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Annual Rainfall
2005	2	30.1	20.6	2.3	2.2	25.2	61.2	67.6	59.5	0	0.5	0	271.2
2006	0.6	0	10.2	2.4	22.9	52.4	103.3	58.6	51.6	2	0	3.2	307.2
2007	1.7	40.4	27.2	0.4	25.4	65.3	35.1	166.6	44.6	0	1.8	0.1	408.6
2008	1.8	2.7	0	22	36.9	31.3	31.8	76.4	61.8	0	0	0	264.7
2009	5.6	4.7	6.8	3.2	43.4	6.8	126	43.8	93.8	3.5	7.6	2.2	347.4

TABLE 2.4
MEAN MAXIMUM RELATIVE HUMIDITY (In %)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2005	89	85	83	51	53	61	86	78	87	85	82	88
2006	88	87	84	55	70	73	85	85	89	85	95	94
2007	94	92	82	60	69	73	86	88	90	84	95	90
2008	94	92	82	62	73	90	93	89	88	86	87	88
2009	90	85	71	52	59	56	75	90	85	89	97	97

TABLE 2.5
MEAN MINIMUM RELATIVE HUMIDITY (In %)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2005	47	40	39	16	19	33	65	52	57	32	27	32
2006	37	27	30	19	32	38	59	57	49	36	35	40
2007	36	46	36	21	29	44	56	60	52	26	34	35
2008	41	36	26	23	34	56	59	64	55	39	36	46
2009	44	35	29	20	26	29	52	62	51	29	34	33

TABLE 2.6
MEAN MAXIMUM TEMPERATURE (In degree centigrade)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2005	20.1	23.2	30.4	36.3	39.5	40.3	34.2	35.7	33.9	33.2	29	22.7
2006	22.4	29.7	29.6	37.5	39.8	38.2	34.9	35.4	34.5	33.6	28.9	23.3
2007	21.5	24.2	28.3	38.2	38.9	38.1	35.9	34.8	34.5	33.4	29	22.9
2008	20.9	23.5	33.4	36.2	37	35	35.3	33.7	33.9	34.2	29	24.5
2009	21.7	26.1	31.5	36.9	40.1	40.9	35.8	35.4	34.1	33	27.2	23.6

TABLE 2.7
MEAN MINIMUM TEMPERATURE (In degree centigrade)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2005	7.7	0.8	17.1	20.4	24.8	28.2	27.1	27.3	25.1	18.8	12.2	6
2006	7.1	13.5	15.3	20.1	24.5	24.3	27.1	26.8	24.7	20.5	13.9	9.2
2007	6.7	11.8	15.3	23	25.8	28.4	27.6	27.1	25.2	17.5	12.6	8
2008	6.5	8.3	17.1	21.2	24.5	26.7	27.1	26.4	24.5	20.9	12.9	10.2
2009	8.9	11.3	16.1	22.2	26	28.2	28	27.2	25.1	19.2	13.5	8.7

2.4.2 Air Quality

The atmospheric concentrations of air pollutants were monitored at Arjun Nagar during May 2011 by setting up ambient air quality monitoring station. Map showing the location of air monitoring station is shown in **Figure 2.3.** Air Monitoring was carried out for $PM_{2.5}$, PM_{10}, NOx, SO_2, CO, and Pb. Results of the air quality monitoring are presented in **Table 2.8.** The results show that the concentration of PM_{10} and $PM_{2.5}$ exceeds the standards whereas other parameters are within permissible limits. The main pollutants that come out from the exhaust of vehicle engine are:

- Carbon monoxide,
- Oxides of Nitrogen,
- Oxides of Sulphur,
- Hydro Carbon, and

- Particulate matter.

In addition to above pollutants un-burnt products like aldehydes, formaldehydes, acrolein, acetaldehydes and smoke would also be emitted from petrol, diesel and CNG vehicles. The concentration of these pollutants in the engine exhaust varies with the type of engine.

TABLE 2.8

AMBIENT AIR QUALITY RESULTS

Timing	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	NO_x ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	HC as (CH_4) (ppm)	Lead as (Pb) ($\mu g/m^3$)
Limits as per CPCB	**100**	**60**	**80**	**80**	**-**	**1**
Arjun Nagar						
02:00PM To 10 PM	211	137	45.8	9.2	2.7	BDL
10:00 PM To 06:00 AM	173	102	32.5	6.7	2.0	BDL
06:00 AM To 02:00 PM	187	114	43.1	7.8	2.4	BDL
Average	190	117	40.5	7.9	2.4	BDL

2.5 NOISE ENVIRONMENT

Noise is responsible for adverse impact on physical and mental health of the people. The other impacts are:

- Physiological effects,
- Hearing impairment,
- Communication interference, and
- Sleep disruption

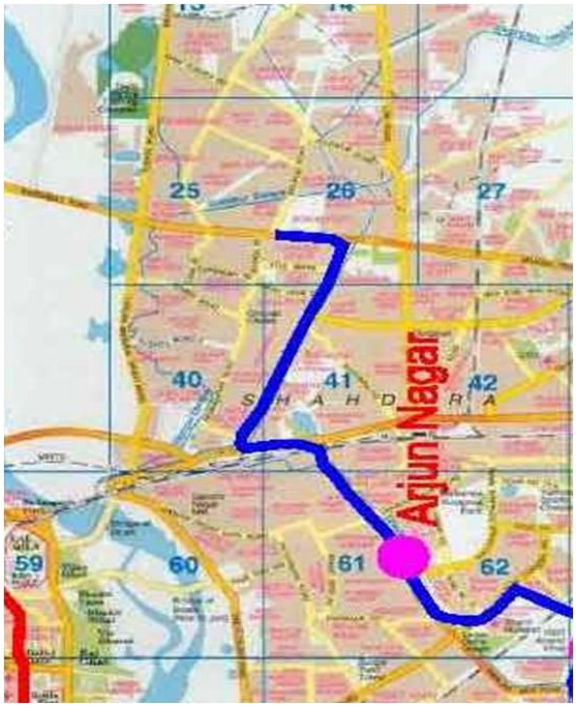
The assessment of impacts of noise sources on surrounding community depends on:

- 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.

Noise levels were measured at Arjun Nagar where air monitoring was conducted. Hourly Noise levels were recorded at 2 m away from source as per standard practice.

Figure 2.4

Monitoring location of Air and Noise



The noise levels so obtained are summarized in **Table 2.9** and hourly data is presented in **Table 2.10.** The results of observations indicate that the equivalent noise levels are more than the limit prescribed for residential areas.

TABLE 2.9

NOISE LEVELS

Monitoring Locations	L_{eq} (24Hrs)	L_{10}	L_{50}	L_{90}	L_{day}	L_{night}	L_{dn}	L_{max}	L_{min}
Arjun Nagar	70.3	76.1	73.0	70.8	71.9	57.6	70.9	77.2	50.8

TABLE 2.10

HOURLY NOISE LEVELS

S. No.	Time	Arjun Nagar
1.	Mid Night	52.4
2.	1:00 AM	53.4
3.	2	52.5
4.	3	51.5
5.	4	50.8
6.	5	52.9
7.	6	61.5
8.	7	62.4
9.	8	68.8
10.	9	69.4
11.	10	69.3
12.	11	72.8
13.	12 Noon	76.5

14.	13	77.2
15.	14	72.9
16.	15	72.6
17.	16	71.9
18.	17	71.5
19.	18	74.0
20.	19	69.0
21.	20	67.7
22.	21	63.3
23.	22	61.0
24.	23	55.2

2.6 Vibration

The sources of the vibration and noise induced by the metro trains are mainly the rolling stock, track and the interaction between them. The vibration induced by the train first causes the vibration of track structure as well as tunnel structure, and then, propagate through the strata to the surrounding environment. The vibration due to track structure occupies 35 percent of the total vibration.

2.7 ECOLOGY

An ecological study of the project area is essential to understand the impact due to project development activities on flora and fauna of the area. The project site is located in city area and it is free of any wildlife fauna. The construction activities whether on-site or off-site do not involve any loss of biomass, deforestation or any kind of disturbance to an ecological habitat. As such no adverse impact is anticipated on ecology as a result of the project.

2.8 SOCIO- ECONOMIC CONDITIONS

Delhi was a small town in 1901 with a population 0.4 million. Delhi's population started increasing after it became the capital of British India in 1911. The 2001 Census recorded 138.51 lakh population of Delhi with 3.85% annual growth rate and 47.02% decennial growth rate during 1991-2001. With the rapid pace of urbanization the rural area of Delhi is shrinking. The number of rural villages has decreased from 314 in 1921 to 165 in 2001 census. The percentage of rural population of Delhi has also declined from 47.24% in 1901 to 6.99% in 2001.

2.8.1 Economy

As the country’s capital, Delhi has vibrant trade and commerce and excellent employment opportunities. Delhi has attracted people from all over the country and its population today reflects the characteristics of almost every region. Delhi truly reflects the wealth and diversity of India wherein diverse religions, languages, customs and cultures co-exist in splendid plural harmony. Religious, cultural and social functions of different socio-cultural groups have transformed Delhi into a city of festivals. Delhi is among the top three States/Union Territories in terms of per capita income. More than 80% of the state income is from the tertiary sector. The Net State Domestic Product (NSDP) of Delhi was about US$ 32.8 billion in 2007-08. The average NSDP growth rate between 1999-2000 and 2007-08 was about 14.7 per cent. Delhi’s economy is dependent on commerce and trade more than on

manufacturing and agriculture In 1996, the Supreme Court of India ordered over 90,000 industrial units to relocate outside the state in order to control increasing levels of pollution. Consequently, the state has small scale industries which are mostly non-polluting. Delhi's economy is primarily dominated by knowledge based service industry such as information technology, consulting etc. In 2007-08, at US$ 28.3 billion, the tertiary sector contributed 79 per cent to the GSDP of Delhi at current prices followed by secondary sector which contributed US$ 7.2 billion (20.3 per cent).

2.9 ARCHAEOLOGICAL SITES

The Line 7 extension does not involve any archaeological sites.

2.10 Sensitive Receptor

There is no sensitive receptor along the line 7 extension

ENVIRONMENTAL MANAGEMENT PLAN

3.1 MANAGEMENT PLANS

The Delhi Mass Rapid Transit System (MRTS) will provide employment opportunity, quick mobility service and safety, traffic congestion reduction, less fuel consumption and air pollution on one hand and problems of muck disposal, traffic diversion, utility dislocation etc. on the other hand.

Protection, preservation and conservation of environment have always been a primary consideration in Indian ethos, culture and traditions. Management of Environment by provision of necessary safeguards in planning of the project itself can lead to reduction of adverse impacts due to a project. This chapter, therefore, spells out the set of measures to be taken during project construction and operation to mitigate or bring down the adverse environmental impacts to acceptable levels based on the proposed Environmental Management Plan (EMP).

The most reliable way to ensure that the plan will be integrated into the overall project planning and implementation is to establish the plan as a component of the project. This will ensure that it receives funding and supervision along with the other investment components. For optimal integration of EMP into the project, there should be investment links for:

- Funding,
- Management and training, and
- Monitoring.

The purpose of the first link is to ensure that proposed actions are adequately financed. The second link helps in embedding training, technical assistance, staffing and other institutional strengthening items in the mitigation measures to implement the overall management plan. The third link provides a critical path for implementation and enables sponsors and the funding agency to evaluate the success of mitigation measures as part of project supervision, and as a means to improve future projects. This chapter has been divided into three sections:

- Mitigation measures,
- Disaster management, and
- Emergency measures.

3.2 MITIGATION MEASURES

The main aim of mitigation measures is to protect and enhance the existing environment of the project. This section includes measures for:

- Compensatory Afforestation,
- Construction Material Management,

- Labour Camp,
- Energy Management
- Hazardous Waste Management
- Housekeeping,
- Utility Plan,
- Air Pollution Control Measures,
- Noise Control Measures,
- Vibration Control Measures,
- Traffic Diversion/Management,
- Soil Erosion Control,
- Water Supply, Sanitation and Solid Waste management,
- Rain water harvesting
- Training and Extension.

3.2.1 Compensatory Afforestation

The objective of the afforestation program should be to develop natural areas in which ecological functions could be maintained on a sustainable basis.

3.2.2 Construction Material Management

The major construction material to be used for construction of the proposed corridor are coarse aggregates, cement, coarse sand, reinforcement steel, structural steel, water supply, drainage and sanitary fittings etc. The material will be loaded and unloaded by engaging labour at both the locations by the contractor.

The duties of the contractor will include monitoring all aspects of construction activities, commencing with the storing, loading of construction materials and equipment in order to maintain the quality. During the construction period, the construction material storage site is to be regularly inspected for the presence of uncontrolled construction waste. Close liaison between the DMRC Officer and the head of the construction crew will be required to address any environmental issues and to set up procedures for mitigating impacts. The scheduling of material procurement and transport shall be linked with construction schedule of the project. The Contractor shall be responsible for management of such construction material during entire construction period of the project. Sufficient quantity of materials should be available before starting the each activity. The contractor should test all the materials in the Government labs or Government approved labs in order to ensure the quality of materials before construction. This is also the responsibility of the contractor, which would be clearly mentioned in the contractor's agreement.

3.2.3 Labour Camp

The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the DMRC. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. Safe drinking water should be provided to the dwellers of the construction

camps. Adequate washing and bathing places shall be provided, and kept in clean and drained condition. Construction camps are to the responsibility of the concerned contractors and these shall not be allowed in the construction areas but sited away. Adequate health care is to be provided for the work force.

Sanitation Facilities: Construction camps shall be provided sanitary latrines and urinals. Sewerage drains should be provided for the flow of used water outside the camp. Drains and ditches should be treated with bleaching powder on a regular basis. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner

Shelter at Workplace: At every workplace, shelter shall be provided free of cost, separately for use of men and women labourers. The height of shelter shall not be less than 3m from floor level to lowest part of the roof. Sheds shall be kept clean and the space provided shall be on the basis of at least $0.5m^2$ per head.

Canteen Facilities: A cooked food canteen on a moderate scale shall be provided for the benefit of workers wherever it is considered necessary. The contractor shall conform generally to sanitary requirements of local medical, health and municipal authorities and at all times adopt such precautions as may be necessary to prevent soil pollution of the site.

First aid facilities: At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances will be provided. Suitable transport will be provided to facilitate taking injured and ill persons to the nearest hospital.

Day Crèche Facilities: At every construction site, provision of a day crèche shall be worked out so as to enable women to leave behind their children. At construction sites where 20 or more women are ordinarily employed, there shall be provided at least a hut for use of children under the age of 6 years belonging to such women. Huts shall not be constructed to a standard lower than that of thatched roof, mud walls and floor with wooden planks spread over mud floor and covered with matting. Huts shall be provided with suitable and sufficient openings for light and ventilation. There shall be adequate provision of sweepers to keep the places clean. There shall be two maidservants (or aayas) in the satisfaction of local medical, health, municipal or cantonment authorities. Where the number of women workers is more than 25 but less than 50, the contractor shall provide with at least one hut and one maidservant to look after the children of women workers. Size of crèches shall vary according to the number of women workers employed.

3.2.4 Energy Management

The contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon DMRC request.

Measures to conserve energy include but not limited to the following:

- Use of energy efficient motors and pumps,
- Use of energy efficient lighting, which uses energy efficient luminaries,
- Adequate and uniform illumination level at construction sites suitable for the task,
- Proper size and length of cables and wires to match the rating of equipment, and
- Use of energy efficient air conditioner.

The contractor shall design site offices maximum daylight and minimum heat gain. The rooms shall be well insulated to enhance the efficiency of air conditioners and the use of solar films on windows may be used where feasible.

3.2.5 Hazardous Waste Management

The contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities and shall file a 'Request for Authorization' with Delhi Pollution Control Committee along with a map showing the location of storage area. Outside the storage area, the contractor shall place a 'display board', which will display quantity and nature of hazardous waste, on date. Hazardous Waste needs to be stored in a secure place. It shall be the responsibility of the contractor to ensure that hazardous wastes are stored, based on the composition, in a manner suitable for handling, storage and transport. The labeling and packaging is required to be easily visible and be able to withstand physical conditions and climatic factors. The contractor shall approach only Authorized Recyclers for disposal of Hazardous Waste, under intimation to the DMRC.

3.2.6 Environmental Sanitation

Environmental sanitation also referred to as Housekeeping, is the act of keeping the working environment cleared of all unnecessary waste, thereby providing a first-line of defense against accidents and injuries. Contractor shall understand and accept that improper environmental sanitation is the primary hazard in any construction site and ensure that a high degree of environmental sanitation is always maintained. Environmental sanitation is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

General environmental sanitation shall be carried out by the contractor and ensured at all times at Work Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices and toilets/urinals. Towards this the Contractor shall constitute a special group of environmental sanitation personnel. This group shall ensure daily cleaning at work sites and surrounding areas and maintain a register as per the approved format by the DMRC.

Team of environmental sanitation squad shall carry out:

- Full height fence, barriers, barricades etc. shall be erected around the site in order to prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience to and endanger the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the Employer. These shall be maintained in one line and level.

    - The structure dimension of the barricade, material and composition, its colour scheme, DMRC logo and other details.
    - All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exits fire doors, break-glass alarm points, fire-fighting equipment, first aid stations, and other emergency stations shall be kept clean, unobstructed and in good working order.
    - All surplus earth and debris are removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving.
    - No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.
    - Roads shall be kept clear and materials like: pipes, steel, sand boulders, concrete, chips and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.
    - Water logging or bentonite spillage on roads shall not be allowed.
    - Proper and safe stacking of material are of paramount importance at yards, stores and such locations where material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored / stacked in an orderly and safe manner.
    - Flammable chemicals / compressed gas cylinders shall be safely stored.
    - Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to identified locations(s).
    - All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).
    - Empty cement bags and other packaging material shall be properly stacked and removed.

  The Contractor shall ensure that all his sub-contractors maintain the site reasonably clean through provisions related to environmental sanitation (housekeeping).

3.2.7 Utility Plan

The proposed Metro alignment run along major arterial roads of the city, which serve Institutional, Commercial and Residential areas. A 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 alignment. 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 alignment, 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.

- The elevated viaduct does not pose any serious difficulty in negotiating the underground utility services, especially those running across the alignment. In such situation, the spanning arrangement of the viaduct may be suitably adjusted to ensure that no foundation need be constructed at the location, where utility is crossing the proposed Metro alignment. In case of utility services running along the alignment either below or at very close distance, the layout of piles in the foundations shall be suitably modified such that the utility service is either encased within the foundation piles or remains clear of them.

3.2.8 Air Pollution Control Measures

During the construction period, the impact on air quality will be mainly due to increase in Particulate Matter (PM) along haul roads and emission from vehicles and construction machinery. Though the estimation of air quality during construction shows insignificant impact on ambient air quality, nevertheless certain mitigation measures which shall be adopted to reduce the air pollution are presented below:

- The Contractor shall take all necessary precautions to minimize fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport, handling, construction or storage activity to remain visible in atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.
- The Contractor shall use construction equipment to minimize or control of air pollution. He shall maintain evidence of such design and equipment and make these available for inspection by Employer.
- Contractor's transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.
- The Contractor shall cover loads of dust generating materials like debris and soil being transported from construction sites. All trucks carrying loose material should be covered and loaded with sufficient free - board to avoid spills through the tailboard or sideboards.

- The temporary dumping areas shall be maintained by the Contractor at all times until the excavated soil is re-utilized for backfilling or as directed by Employer. Dust control activities shall continue even during any work stoppage.
- The Contractor shall place material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control methods must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.
- The Contractor shall water down construction sites as required to suppress dust, during handling of excavation soil or debris or during demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed specially where the work is near sensitive receptors.
- The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.

3.2.10 Noise Control Measures

There will be an increase in noise level in the tunnel and nearby ambient air due to construction and operation of the Metro corridors. However, noise levels in the core city are expected to go down. The increase in levels are marginal; hence local population will not be adversely affected. However the exposure of workers to high noise levels especially, near the engine, vent shaft etc. need to be minimized. This could be achieved by:

- Job rotation,
- Automation,
- Construction of permanent and temporary noise barriers,
- Use electric instead of diesel powered equipment,
- Use hydraulic tools instead of pneumatic tools,
- Acoustic enclosures should be provided for individual noise generating construction equipment like DG sets,
- Scheduling truck loading, unloading and hauling operation,
- Schedule work to avoid simultaneous activities that both generated high noise levels,
- Anti drumming floor and noise absorption material,
- Low speed compressor, blower and air conditioner,
- Mounting of under frame equipments on anti-vibration pad,
- Smooth and gradual control of door,
- Provision of GRP baffle on the via-duct for elimination of noise transmission,
- Provision of sound absorbing material in the supply duct and return grill of air conditioner,
- Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes, and
- Sound proof compartments control rooms etc.

The workers employed in high noise level area could be employed in low noise level areas and vice-versa from time to time. Automation of equipment and machineries, wherever possible, should be done to avoid continuous exposure of workers to noise. At work places, where automation of machineries is not possible or feasible, the workers exposed to noise should be provided with protective devices. Special acoustic enclosures should be provided for individual noise generating equipments, wherever possible.

Workers in those sections where periodic adjustment of equipment/machinery is necessary, should be provided with sound proof control rooms so that exposure to higher noise level is reduced. During construction, there may be high noise levels due to pile driving, use of compressors and drilling machinery. Effective measures should be taken during the construction phase to reduce the noise from various sources. The noise from air compressor can be reduced by fitting exhaust and intake mufflers.

The pile driving operation can produce noise levels up to 100 dB (A) at a distance of 25-m from site. Suitable noise barriers can reduce the noise levels to 70 dB (A) at a distance of 15m from the piles. A safety precaution as stipulated in IS: 5121 (1969) '*Safety Code for Piling and other Deep Foundation'* need to be adopted.

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

The ballast-less track is supported on two layers of rubber pads to reduce track noise and ground vibrations. The concept of a "low-noise" electric locomotive must be adopted at a very early state of planning and must be followed up with detailed work throughout the project execution and operation. In addition, baffle walls as parapets will be constructed at up to the rail level so as to reduce sound levels.

In addition, we have proposed to provide skirting of coach shell covering the wheel which will screen any noise coming from the rail wheel interaction as of propagating beyond the viaduct. In sensitive areas, track can be suitably designed so as to avoid propagation of noise to adjacent structures. Additional screening of noise can be arranged by providing parabolic noise reflecting walls on each side of the track. In the operational stage, there may be issues of noise at sensitive receptors near the elevated track. At the viaduct, reflective type sturdy and weather resistant noise barriers are proposed near such sensitive receptors. A provision in the DPR has also been made to employ noise mitigation measures at sensitive locations.

3.2.11 Vibration Control Measures

Vibration emanates from rail - wheel interaction and the same can be reduced by minimizing surface irregularities of wheel and rail, improving track geometry, providing elastic fastenings, and separation of rail seat assembly from the concrete plinth with insertion of resilient and shock absorbing pad.

While designing the track structure for Mass Rapid Transit System all the above points have been taken into consideration in the following ways:

- To prevent development of surface irregularities on the rail, a fairly heavy rail section of 60 kg/m, 90 UTS rail, supported at every 60 cms has been proposed further rail grinding at regular intervals by rail grinding machine and also lubrication of rail by vehicle mounted lubricator have been contemplated.
- Rails will be continuously welded and also will be laid to fine tolerances so that any noise/vibration on account of track geometry could be reduced.
- The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used.

The lower vibration has been achieved by providing of bolster less type bogies having secondary air spring.

3.2.12 Traffic Diversion/ Management

During such construction, traffic is most likely to be affected. Hence Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during Metro construction of various corridors under the corridor. Any reduction of road space during Metro construction results in constrained traffic flow. 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. Maintenance of diverted roads in good working condition to avoid slow down and congestion shall be a prerequisite during construction period.

Various construction technologies are in place to ensure that traffic impedance is done at the minimum. They are:

- The requirement would be mainly along the central verge, as has already been done in case of elevated construction of metro corridors in earlier Phases.
- As regards to the alignment cutting across a major traffic corridor, 'Continuous Cantilevered Construction Technology' would be applied to prevent traffic hold-ups or diversions of any kind.
- Wherever the stations are isolated, areas available around it should be utilized for road diversion purposes such as lay-byes and service roads.

Only temporary diversion plans will be required during construction of the Metro corridor. At the onset, all encroachments from road ROW will have to be removed. These encroachments vary from 'on-street' parking to informal activities.

Keeping in view the future traffic growth and reduction of carriageway due to Metro construction, implementation of traffic management/diversion plans shall become

inevitable for ensuring smooth traffic movement and similar traffic diversion plans shall be formulated and followed during the execution stage of as has been done in earlier Phases.

Traffic Management Guidelines: The basic objective of the following guidelines is to lay down procedures to be adopted by contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen at construction sites.

- All construction workers should be provided with high visibility jackets with reflective tapes as most of viaduct and station works are on the right-of-way. The conspicuity of workmen at all times shall be increased so as to protect from speeding vehicular traffic.
- 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
- Provide adequate measures that control driver behavior through construction zones.
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.

The contractor will hire a transportation consultant that carryout the traffic survey and suggest alternative routes for smooth flow of traffic.

3.2.13 Soil Erosion Control

Prior to the start of the relevant construction, the Contractor shall submit to the DMRC 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, bridges and other structures across water courses, pavement courses and shoulders. He shall also submit for approval his proposed method of erosion/sedimentation control on service road and his plan for disposal of waste materials. Work shall not be started until the erosion/sedimentation control schedules and methods of operations for the applicable construction have been approved by the DMRC.

The surface area of erodible earth material exposed by clearing and grubbing, excavation shall be limited to the extent practicable. The Contractor may be directed to provide immediate control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearby streams or other watercourses. Such work may involve the construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation.

The Contractor shall be required to incorporate all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures.

Temporary erosion/sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices, but may neither be foreseen during design stage nor associated with permanent control features on the Project. Under no conditions shall a large surface area of credible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the DMRC.

The DMRC may limit the area of excavation, borrow and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and other such permanent erosion, sedimentation and pollution control measures, in accordance with the accepted schedule.

Temporary erosion is sometimes caused due to the Contractor's negligence, carelessness or failure to install permanent controls. Sedimentation and pollution control measures then become necessary as a part of the work as scheduled or ordered by the DMRC, and these shall be carried out at the Contractor's own expense. Temporary erosion, sedimentation and pollution control work required, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, will be performed as ordered by the DMRC.

3.2.14 Water Supply, Sanitation and Solid Waste Management

The public health facilities, such as water supply, sanitation and toilets are much needed at the stations. Water should be treated before use up to WHO drinking water standards. The collection and safe disposal of human wastes are among the most important problems of environmental health. The water carried sewerage solves the excreta disposal problems. The sewerage disposal systems should be adopted for sewage disposal.

Requirement of drinking water supply at an elevated station is about 6 KL/day. Raw water requirement for the elevated station is about 25 - 30 KL/Day. This shall be provided from municipal source.

Solid waste will be generated at station is about 0.8 – 1.2 m^3/Day. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the DMRC project authorities. The storage containers for this purpose need to be designed. However it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals. This should be collected and transported to local municipal bins for onward disposal to disposal site by municipality.

During construction there will be excessive usage of ground water. To avoid excess usage of water during construction following measures will be taken to reduce water consumption.

1. Recycle of water consumed in wheel washing.
2. Water from dewatering will also be used for ground water re- charge.

During operation, as mitigation measures rainwater harvesting will be carried out at stations and Depots.

3.2.15 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 alignment. The total length of the proposed extension line is about 2.2 km.

3.3 DISASTER MANAGEMENT

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire and accidents. The first step is to identify the causes which develop/ pose unexpected danger to the structural integrity of Metro tunnel or overhead rail. The potential causes are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, etc. These need to be looked into with care.

3.3.1 Preventive Action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Engineers responsible for preventive action should identify sources of repair equipments, materials, labour and expertise for use during emergency.

3.3.2 Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details.

The Engineer-in-Chief should notify the officer for the following information:

- Exit points for the public,
- Safety areas in the tunnel/overhead rail, and
- Nearest medical facilities.

3.3.2 Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and full proof communication system.

3.3.3 Emergency Action Committee

To ensure coordinates action, an Emergency Action Committee should be constituted. The civic administrator may be the Chairman of this Committee. The committee may comprise of:

- Station Master concerned,
- Police Officer of the area,
- Delhi Transport Corporation Representative,
- Home Guard representative,
- Fire Brigade representative,
- Health Department representative,
- Department of Information and Publicity, and
- Non-Governmental Organization of the area.

Emergency Action Committee will prepare the evacuation plan and procedures for implementation based on local needs and facilities available. The plan should include:

- Demarcation of the areas to be evacuated with priorities,
- Safe route to be used, adequacy of transport for evacuation, and traffic control,
- Safe area and shelters,
- Security of property left behind in the evacuated areas,
- Functions and responsibilities of various members of evacuation teams, and
- Setting up of joint control room.

All personnel involved in the Emergency Action Plan should be thoroughly familiar with all the elements of the plan and their responsibilities. They should be trained through drills for the Emergency Action Plan. The staff at the site should be trained for problem detection, evaluation and emergency remedial measures. Individual responsibility to handle the segments in emergency plan must be allotted.

Success of an emergency plan depends on public participation, their response to warning notifications and timely action. Public has to be educated on the hazards and key role in disaster mitigation by helping in the planned evacuation and rescue operations.

It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination

of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

3.4 EMERGENCY MEASURES

The emergency measures are adopted to avoid any failure in the system such as lights, fire, means of escape etc. The aim of Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of accident. The action plan should also include preventive action, notification, warning procedures and co-ordination among various relief authorities. These are discussed in following sections.

3.4.1 Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power to at least 25% of the lights at the station, platforms, viaducts for a period of 2 hours.

3.4.2 Fire Protection

The building materials should be of appropriate fire resistance standard. The fire resistance period should be at least 2 hours for surface or over head structures. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

- Fire prevention measures,
- Fire control measures,
- Fire detection systems,
- Means of escape,
- Access for fireman, and
- Means of fire fighting.

Accumulations of refuse of any inflammable material like paper, plastic cartons constitute a major fire hazards and should not be permitted. Smoking should be strictly prohibited at all locations of MRTS.

All aspects of fire prevention and control will be dealt in close collaboration with the city fire fighting authority. Smoke control will be achieved. In enclosed public areas of above ground stations (e.g. a concourse located below a platform) arrangement for smoke extraction will be provided.

A minimum of 30 minutes supply of water is to be assured in the case of fire. The pumps/overhead tanks shall have the capacity to discharge the water at the rate of 1100 litres per minute at a head of 21 m at nozzle mouth.

The storage capacity in an underground or overhead tank may be divided into two parts i.e. dead storage and running storage. Fire fighting pumps shall be provided with a diesel pump as a standby arrangement, in case of power failure.

In case of fire of electrical origin, water cannot be used until the electric system has been made dead and earthened. For electrical fires, non-aqueous agents like ABC Power, Chloro Bromo Methane or CO_2 gas are utilized for fire fighting. Fire extinguishers with these agents shall be liberally provided at static installations and on the rolling stock.

Generally there are often more casualties from smoke inhalation than from burning. Smoke need to be transported away from the site of the fire. In order to achieve this, both fresh air has to be introduced and exhaust gases should be sucked out from other section.

Openings, including ducts and passages, between Metro property and any adjoining structures which allow free access into the Metro property will be protected by fire doors, fire shutters, fire dampers etc. as appropriate. Fire detection and alarm systems will be provided as per the prevailing state of art technology.

A. Fire Prevention and Safety Measures

Fire prevention measures will be designed and implemented to minimize the risk of outbreak of fire by appropriate choice, location and installation of various materials and equipment. In stations planning, potential sources of fire can be reduced by:

i. Fire Prevention

- Use of non-combustible or smoke retardant materials where possible,
- Rolling stock is provided with fire retarding materials, low smoke zero halogen type electric cable is also provide,
- Provision of layout which permits ease of maintenance for equipment and cleaning of the station premises,
- Provision of special storage spaces for combustible materials such as paint and oil,
- Prohibition of smoking in fire prone areas,
- Provision of cigarette and litter bins, and
- Good housekeeping.

ii. Safety

Following provisions will be required from fire safety point of view:

- Automatic sprinkler/detection system to be provided if floor area exceeds 750 sq.m
- One wet riser-cum-down comer per 1000 sqm floor area with static underground storage tank, overhead tanks and pumps of suitable capacity with hydrants, first-aid reel, etc.

- Portable fire non-aqueous extinguishers of Carbon di Oxide, chemical dry powder etc. at suitable places.
- Automatic smokes venting facilities.
- Two separate means of exit shall be provided, if more than 10 persons are working and the area exceeds 1400 sq.m
- Fire resisting doors shall be provided at appropriate places along the escape routes to prevent spread of fire and smoke.
- The travel distance for fire escape shall not exceed 20 m where escape is available in more than one direction; the distance could be upto 40 m.

B. Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Noida Fire Services/ Ghaziabad Fire Services shall be provided through out each station and ancillary buildings including entrance passageways, subways and adits etc. to give visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g. detector heads, linear heat detecting cables etc. The system shall be operated from 24 V DC Power sources.

Manually operated call points shall be provided at every hydrant and nose reel points, station head wall, tail wall and other locations. Alarm bells shall be installed in each plant room complex at both platform and concourse level and shall be clearly audible at all points in the room/area.

Beam detector or heat detector shall be installed at roof level, ceiling and floor cavity, whilst linear detecting cables shall be installed in under platform cable ducts and cable shafts.

Smoke probe units shall be installed in rooms/compartments. When an alarm point is operated, the fire pump shall start to operate automatically. A station fire control and indicating panel shall be provided an installed in the station controllers room, for the control, indication and monitoring of the whole detection and fire fighting systems. While designing the fire fighting system, the zone of Delhi Fire Services shall be taken into account for linking with the same.

C. Fire Control Measures

Control of the spread of fire and smoke will be achieved by partition of fire risk areas, planning for smoke extraction, and arrangement for smoke containment. Partition is aimed at limiting the extent of a fire. The openings must be capable of being sealed in the event of fire. With the exception of station public areas, a fire compartment will not exceed 1500 m^2. Partition of the public areas in stations is not practicable for operational reasons. The fire resistance period of this separated area should be about 3 hours.

D. Access for Fireman

A secondary access to the station, not used by passengers for evacuation, shall be available to fireman should the need arise. The entry point shall be easily accessible from the road. Access shall be available to all levels of the station. The minimum width of the stairs is 1.0 m and maximum height should not exceed 60 cm.

3.4.3 Emergency Door

The rolling stock is provided with emergency doors at both ends of the cab to ensure directed evacuation of passengers in case of any emergency including fire in the train.

3.5 SUMMARY OF ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The environmental impacts stemming out of the proposed project can be mitigated with simple set of measures, dealing with careful planning and designing of the metro alignment and structures. Adequate provision of environmental clauses in work contracts and efficient contract management will eliminate or reduce significantly all possible problems. A common problem encountered during implementation of environmental management plans of such projects is lack of environmental awareness among engineers and managers concerned with day to day construction activities, which can be solved through regular environmental training programs. A set of preliminary EMP is presented in **Table 6.2,** which defines actions to be undertaken during the design stage, pre-construction, construction and operation stage of the project. The effectiveness of environmental considerations will, however, depend on appropriate inclusion of these in the work contracts.

The major concern during the construction stage is that the contractors, due to lack of enforcement, would not practice good environmental sanitation (housekeeping) may intend to get unauthorized use of the easily available natural resources and other available infrastructure like roads and water resources. This would result in degradation of ambient air quality, water resources and land environment around the construction sites and workers camp. Improper management of earthwork and bridge construction activities would disrupt the natural drainage and increase soil erosion. Improper management may result in spillage of explosives into the hands of unsocial elements. Finally the implementation of the mitigation actions requires that the project implementation unit would record an end-of-construction mitigation checklist, before releasing the final payment of any work contract.

In addition to that DMRC, should prepare and established Environmental and Health Policy and Procedures as per earlier Phases and that should become an integral part of contract document.

Operational phase mitigation would involve good environmental sanitation (housekeeping) practice at metro establishments including effective solid waste collection and disposal, wastewater disposal, upbringing of plantations and green area. Protection of earth slopes in landslide prone area would be a very important task. During the operation period, the metro operating unit will be required to confirm receipt of the construction period mitigation report through the PIU and prepare a follow on timetable of actions.

TABLE 3.2

ENVIRONMENTAL MANAGEMENT ACTION PLAN (EMP)

Environmental Impact	**Mitigation Measures Taken or To Be Taken**	**Time Frame**	**Implementing Organization**	**Responsible Organization**
DESIGN PHASE				
Metro Alignment	The proposed corridor alignment was selected to minimize the land disturbance to avoid environmentally sensitive areas.	During Design	DPR and design consultant	PIU
Cultural Heritage	Avoided by adjustment of alignment.	During Design	DPR and design consultant	PIU
Flood	Bridges shall be well designed	During Design	DPR and design consultant	PIU
Loss of Water Bodies	Utmost care taken to avoid alignment crossing water bodies	During Design	DPR and design consultant	PIU
Inadequate design provision for safety against seismological hazard	Make sure that design provides for safety of structures against worst combination of forces in the probability of an earthquake likely to occur in seismic zone-III.	DPR and detailed design stage	DPR and design consultant	PIU
PRE –CONSTRUCTION STAGE				
Water requirement	The requirement of water for construction purpose etc., shall be planned and shall be arranged in order to avoid digging of Tube wells.	Pre construction stage	Contractor	PIU/EMP implementing agency
Disposal of final treated effluent from treatment plat	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact on receiving bodies. As far as possible zero discharge rules may be adopted.	During design stage / and pre construction of treatment plant	Contractor	PIU/EMP implementing agency
CONSTRUCTION PHASE				
Environmental Management and Monitoring	This will include institutional requirements, training, environmental management and monitoring	During and after construction	Contractor	PIU/EMP implementing agency
Dust	Water should be sprayed during construction phase, wherever it is	During construction	Contractor	PIU/EMP implementing

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
	required to avoid dust. Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.			agency
Air Pollution	Vehicles and machinery are to be regularly maintained so that emissions conform to National and State AAQ Standards.	Beginning with and continuing throughout construction	Contractor	PIU/EMP implementing agency
Equipment Selection maintenance and operation	Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures that relevant air, noise, and discharge regulations are met.	During construction	Contractor	PIU/EMP implementing agency
Noise	Noise standard at processing sites, will be strictly enforced as per GOI noise standards. Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. At construction sites within 150m of sensitive receptors construction will be stopped from 22:00 to 06:00. Machinery of noise barriers (Stone walls and plantation) for silence zones including schools and hospitals.	Beginning and through construction	Contractor	PIU/EMP implementing agency
Vibration	The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak velocity as given in article project SHE Manual	Beginning and through construction	Contractor	PIU/EMP implementing agency
WATER				
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into rivers and irrigation system	Throughout construction period	Contractor	PIU/EMP implementing agency
Wastage of water	Measures shall be taken to avoid misuse of water. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking purpose.	Beginning with and continuing throughout construction	Contractor	PIU/EMP implementing agency

Sewerage disposal during construction at Service Centres	A minimum distance of any sewage or toilet facility from water sources should be 200 meters	Throughout construction period	Contractor	PIU/EMP implementing agency
Sanitation and Waste Disposal in Construction Camps	Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. Waste in septic tanks will be cleared periodically. Drinking water will meet Indian National Standards. Garbage will be collected in a tank and disposed of daily. Special attention shall be paid to the sanitary condition of camps. Camps will be located at a minimum distance of 200 m from water sources.	Before and during building of construction camps	Contractor	PIU/EMP implementing agency
SOIL				
Quarrying	Quarrying will be carried out at approved and licensed quarries only.	During construction	Contractor	PIU/EMP implementing agency
FLORA AND FAUNA				
Loss of trees and Avenue Plantation	Areas of tree plantation cleared will be replaced according to Compensatory afforestation Policy under the Forest Conservation Act. Trees will be planted against every tree cut as per norms.	After completion of construction activities	Forest Department	Forest Department
SOCIAL				
Loss of Access	Temporary access should be built at the interchange and other roads.	During construction	Contractor	PIU/ Traffic department
Traffic jams and congestion	If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department	During construction	Contractor	PIU/ Traffic department

Safety with vehicles, people and livestock and signage	• Safety education and fines. • Allow for adequate traffic flow around construction areas • Provide adequate signage, barriers and flag persons for safety precautions. • Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions	During construction	Contractor	PIU/ Traffic department
Increase in disease Water-borne Insect-borne Communicable diseases	• Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. • Provide adequate sanitation and waste disposal at construction camps. • Provide adequate health care for workers and locate camps away from vulnerable groups	During construction At start-up Throughout construction	Contractor	PIU/EMP implementing agency
Location of camps depots and storage areas	Location of camps depots and storage areas shall be as per the contract specifications.	Throughout construction	Contractor	PIU/EMP implementing agency
OPERATION PHASE				
Noise and Vibration	Suitable measures should be considered where warranted. The public shall be educated about the regulations of noise and vibration pollution and its implications.	After completion of construction	PIU/EMP implementing agency	PIU/EMP implementing agency
WATER				
Oil pollution	Suitable treatment shall be taken for treatment oil before discharging the wastewater specially in depot areas.	During operation of the treatment plant	PIU/EMP implementing agency	PIU/EMP implementing agency
Maintenance of Storm Water Drainage System	The urban drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	Beginning and end of monsoon	PIU/EMP implementing agency	PIU/EMP implementing agency
Disposal of final treated effluent from treatment plat	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	During operation of the treatment plant	PIU/EMP implementing agency	PIU/EMP implementing agency

SOCIAL				
Safety and noise disturbances	New buildings should be prohibited within 50 m of the edge of carriageway. No new schools and hospitals should be allowed within 200 m of carriageway.	Throughout and after project development period.	Planning Department /PIU	PIU/EMP implementing agency

ENVIRONMENTAL MONITORING PLAN

4.0 PRE-CONSTRUCTION PHASE

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. This helps in signalling the potential problems resulting from the proposed project activities and will allow for prompt implementation of corrective measures. Historically, environmental monitoring has been integral part of works of DMRC towards better environmental management of air, noise, vibration, water quality etc both during construction and in operation. Generation of dust and noise are two main issues during any large construction activity. Degradation of water quality is another. The parameters are monitored in pre- construction, construction and operation phase and are based on the need to evaluate the deviation of environmental conditions from baseline environmental conditions due to construction and operation of the Metro. The environmental monitoring will be required during both construction and operational phases. 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. Pre-construction phase monitoring has been done for the proposed project for air, noise, water, soil quality and ecology.

4.1 CONSTRUCTION PHASE

During construction stage environmental monitoring will be carried out for air quality, noise levels, vibrations, water quality, and ecology. At this stage it is not possible to visualize the exact number of locations where environmental monitoring must be carried out. However keeping a broad view of the sensitive receptors and also the past experience of Phase 1 and 2 an estimate of locations has been made and are summarized in **Table 7.1** These number could be modified based on need when the construction actually commences.

4.1.1 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 certified private or Government agency. Water quality should be analyzed following the procedures given in standard methods. Parameters for monitoring will be as per BIS: 10500. The monitoring points could be ground and surface water.

4.1.2 Air Quality

Air quality should be monitored at Shiv Vihar. The recommended parameter is Particulate Matter (PM_{10}). The contractor will be responsible for carrying out air monitoring during the entire construction phase under the supervision of DMRC.

4.1.3 Noise and Vibration

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

4.1.4 WORKERS HEALTH AND SAFETY

Monitoring of health risk issues that might arise throughout the project life time will be done. Epidemiological studies at construction sites and workers camp will be performed to monitor the potential spread of diseases. Regular inspection and medical checkups shall be carried out to workers health and safety monitoring. Any reoccurring incidents such as irritations, rashes, respiratory problems etc shall be recorded and appropriate mitigation measures shall be taken. Contractor will be the responsible person to take care health and safety of workers during the entire period of the construction and project proponent is responsible to review/audit the health and safety measures/plans. The monitoring Schedule for Water Air, noise, vibration, and water are presented in **Table 4.1**

TABLE 4.1
CONSTRUCTION STAGE MONITORING SCHEDULE

Parameter	Frequency	Locations	Years
Air (PM10)	2 x 24 hours, twice a month	1	2
Noise	24 hours, once a week	1	2
Vibration	24 hours, once a week	1	2
Water	Once in 6 months	1	2

4.2 OPERATION PHASE

Even though the environmental hazards during the operation phase of the project are minimal, the environmental monitoring will be carried out for air, noise, vibration, water, waste water, solid waste and ecology during operation phase of the project. The parameters monitored during operation will be PM_{10} for air, heavy metals for solid waste, pH, TSS, BOD, COD, oil and grease for waste water. However water quality parameters that will be monitored will be as per BIS 10500. The monitoring schedule is presented in **Table 4.2**. The monitoring program shall be conducted by an external agency certified by NABL under the supervision of DMRC. Project proponent (DMRC) is responsible for successful environmental monitoring of the proposed project during operation phase.

TABLE 4.2
OPERATION STAGE MONITORING SCHEDULE

Parameter	Frequency	Locations
Air (PM_{10})	2x24 Hour, once in a month	1
Noise	24 hours once a year	1
Water	Once a year	1

The results of Air quality, water quality, waste water will be submitted to management quarterly during construction phase and half yearly during operation phase..

4.3 ESTABLISHMENT OF AN ENVIRONMENTAL DIVISION

DMRC already has the setup for environmental Management and the proposed corridor is an extension of already existing operative line, additional set-up for environmental management is not recommended. Existing set up for environmental management can also handle this extension.