Chapter - 8
ENVIRONMENTAL IMPACT ASSESSMENT

8.1 ENVIRONMENTAL BASELINE DATA

The main aim of the EIA study is to ascertain the existing baseline conditions and to assess the impacts of all the factors as a result of the proposed corridor during its construction and operation phases. The changes likely to occur in different components of the environment viz. Natural Physical Resources, Natural Ecological (or Biological) Resources, Human/Economic Development Resources (Human use values), Quality of life values (socio-economics), would be studied and assessed to a reasonable accuracy. The area of study include Hydrology, Surface Water Quality, Air Quality, Soils, Noise, Geology, Socio- economics, archaeological /historical monuments etc.

The information presented in this section stems from various sources such as reports, field surveys and monitoring. Majority of data on water quality, vegetation, and air and noise quality was collected during field studies in February 2005. This data have been further analysed and utilized to assess the incremental impact, if any, due to the project which is a baseline data essential to assess the impact on environment due to the project. The study area Metro Corridors ((Phase 1) is from

APMC Vasna – Akshardham (via Ashram road)
Kalupur – Thaltej (via Delhi Darwaja)

8.1.1 General Environment

Except for a few rocky features in the extreme southern portion of Ahmedabad, as a whole it forms a level plain gradually rising towards the north and east. The chief natural feature is the spreading bed of Sabarmati, which stretches through it from end to end. However, average gradient of terrain is gentle, of the order of 1 to 3-m/km. Geology of the area is discussed in detail in Chapter-04. The depth of water table is observed 20 metres below ground level or even lower. About 95 percent of the rainfall is received during the southwest monsoon season from June to September. The annual average rainfall is 728 mm. The climate in Gujarat ranges from humid in the coastal regions to extreme in the interiors. Summers get extremely hot and winters cold in areas like the Rann of Kutch. The coastal regions and the eastern belt of Gujarat experience a mild pleasant climate with moderate rainfall during the monsoons.. The mean monthly maximum temperature is highest in April – May – June (42-45^0 C) and lowest during January (14^{0}C). Air humidity varies through out the year, with relative humidity above 60 percent in southwest monsoon season to less than 25 percent in the summers, which is the driest. Winds are generally light, blowing between directions southwest and northwest. Wind velocity for most part of the year is below 15 km/hr and occasionally rising to 55 km/hr. Sky is generally heavily cloudy during southwest monsoon season and generally cloud free or clear for rest of the year.

8.1.2 Water and Soil

The water and soil samples have been tested for chemical analysis. The results so obtained are summarised in Tables 8.1 and Table 8.2. All the parametres of the samples collected from various locations of the alignment are within the permissible limits except the total dissolved solids at four locations. The texture of soil is mainly sandy. The higher concentration of phosphate and organic matter is an indication of good fertility value.

Table 8.1
CHEMICAL ANALYSIS OF WATER SAMPLES

S. No.	Parametre	Sample Locations					
		Laldar waja (Jain Temple Area)	Near Sardar Patel Institute (Along E W Corridor)	Near Vishal (Along NS Corridor	Motera Village (Along N S Corridor)	Gandhi Nagar (Along N S Corridor)	Near Sachivalaya area in Gandhi Nagar (N S Corridor)
1	BOD (mg/l)	<2	<2	<2	<2	<2	<2
2	Calcium(asCaCO3)	115.88	83.91	267.73	51.95	55.94	75.92
3	Total Suspended Solids(mg/l)	7.09	0.5	7.2	1.79	5.19	1
4	Phosphate (asPO4)	<0.003	1.4	<0.003	<0.003	<0.003	<0.003
5	pH value	8.14	7.52	7.03	7.92	7.75	8.07
6	Total Iron	0.078	0.047	0.2	0.078	0.13	0.078
7	Chloride, Cl (mg/l)	511.49	19.98	535.46	419.58	135.86	19.98
8	Total Dissolved Solids (mg/l)	1782.38	88.8	1993.56	1805.19	1032.64	241.39
9	Sulphates	146.27	5.1	165.49	135.75	31.24	6.3
10	Nitrates as	12.43	6.76	46.28	37.61	35.05	1.85

S. No.	Parametre	Sample Locations					
		Laldarwaja (Jain Temple Area)	Near Sardar Patel Institute (Along E W Corridor)	Near Vishal (Along NS Corridor	Motera Village (Along N S Corridor)	Gandhi Nagar (Along N S Corridor)	Near Sachivalaya area in Gandhi Nagar (N S Corridor)
	NO3 mg/l						
11	Fluorides (asF) (mg/l)	0.093	0.019	0.2	0.019	0.037	0.58
12	Alkalinity, mg/L	351.65	127.87	347.65	519.48	443.56	123.88

ND-Not Detectable

Table 8.2
PHYSICO-CHEMICAL CHARACTERISTICS OF SOILS

S. No.	Parametres	Laldarwaja(Jain Temple Area) Along N S Corridor	Near Sardar Patel Institute(Aong E W Corridor)	Vishala (N S Corridor)	Near Motera Village(Along N S Corridor)	Near Indrada Depot area in Gandhi Nagar (Along N S Corridor)
1	pH	8.51	8.15	7.78	8.68	7.2
2	Texture					
	Sand (%)	75.79	82.94	81.25	83.49	79.17
	Clay (%)	21.81	9.06	7.35	9.34	8.28
	Silt (%)	2.4	8	11.39	7.17	12.54
3	Nitrogen (kg/hectare)	535.31	508	1547.74	796.66	2102
4	Phosphorus (kg/ha)	352.49	2.96	283.87	1.51	369.94
5	Potassium (K) meq/100gm	2.3	0.2	1.12	0.15	0.97
6	Calcium (Ca) (meg/100gm)	8.23	10.96	7.59	11.78	10.12
7	Magnesium (Mg) (meg/100g	5.05	1.79	5.37	2.28	2.52

	m)					
8	Sodium (Na) (meg/100g m)	1.08	1.38	1.41	1.61	0.68
9	Organic matter (%)	0.33	0.63	1.05	0.67	1.27

8.1.3 Forestry

Tree survey was carried out along the proposed alignment. No forest area exists along the project alignment or its corridor. Most of the trees were planted along the roads on both the sides in the path. However upkeep of trees on both sides of road in Indroda –Akshardham is vested with State Forest Department. A few plantation of trees at the centre have been observed. The type of species observed are Papdi, Gul mohar, babool, Pipal, Ashok, Badaam, Dhodkher, Kodumar, Neem and other types of tress etc. No rare or endangered species of trees have been noticed during field studies. Most of the trees contain the girth size of about 30cm and more. Approximately 4889trees have been observed along the project alignment. The average numbers of trees are 12 per km along the alignment while on average 8-10 trees exist. About 2500 trees are in Depot area Since the exact number of loss of trees is only possible during construction phase. Hence, it is expected that 100% of trees falling along the alignment are likely to be lost i.e. about **4889 trees** may be lost due to construction of proposed project.. An inventory of trees falling along the alignment is presented in Table 8.3.

Table 8.3
DETAILS OF TREES
AHMEDABAD-THALTEJ

FROM	TO	LEFT	CENTRE	RIGHT
APMC Vasna Chain No. 0	Vasna village Chain No. 0975	13	---	10
Vasna Chain No. 0975	Vasna Crossing Chain No. 2100	28	13	21
Vasna Crossing Chain No. 2100	Paldi Chain No. 3550	25	18	22
Paldi Chain No. 3550	V S Hospital Chain No. 4350	18	---	15
Vs Hospital Chain No. 4350	Nava Gandhigram Chain No. 5175	27	---	24
Nava Gandhigram Chain No. 5175	Nav Rang Pura Chain No.6100	41	12	34
Nav Rang Pura Chain No.6100	ITO Chain No. 6750	35	---	25
ITO Chain No. 6750	Usman Pura Chain No. 7900	39	12	36
Usman Pura	Gandhi Ashram	85	---	65

FROM	TO	LEFT	CENTRE	RIGHT
Chain No. 7900	Chain No. 10,014.121			
Gandhi Ashram Chain No. 10,014.121	RTO Chain No.	31	---	23
RTO Chain No.	Sabarmati Chain No. 11800	---	100	---
Sabarmati Chain No. 11800	Shankarpura Chain No. 12850	15	---	10
Shankarpura Chain No. 12850	Acher Chain No.	40	---	30
Acher Chain No.	Sardar Patel Stadium Chain No. 14700	25	---	5
Sardar Patel Stadium Chain No. 14700	Motera Village Chain No. 15900	10	---	3
Motera Village Chain No. 15900	Radha Swami Satsang Vyas Chain No. 17300	32	---	16
Radha Swami Satsang Vyas Chain No. 17300	Amiyapur Chain No. 18700	41	---	23
Amiyapur Chain No. 18700	Narmada Main Canal Chain No. 20050	35	120	7
Narmada Main Canal Chain No. 20050	Koba Circle	15	10	22
Koba Circle	Amba Pur Chain No.22,000	20	---	15
Amba Pur Chain No.22,000	Por Chain No. 23200	88	---	61
Por Chain No. 23200	Kudasan Chain No. 24500	47	---	30
Kudasan Chain No. 24500	Dhaula Kuan Chain No. 25850	78		26
Dhaula Kuan Chain No. 25850	Info City Chain No.26800	71		15
Info City Chain No.26800	Indroda Circle Chain No. 27750	18	15	6
Indroda Circle Chain No. 27750	Akshardham Chain No. 29800	70		27
TOTAL		908	300	571
AT VARIOUS STATION LOCATION				300
AT DEPOT AREA				2500
TOTAL				4579

AHMEDABAD-THALTEJ

FROM	TO	LEFT	CENTRE	RIGHT
Vasant Hospital	Indraprastha	20	10	18
Indraprastha	Vijay Crossing	33	---	23
Vijay Crossing	ITO	31	---	54
ITO	Delhi Darwaja	16	10	15
Delhi Darwaja	Police Chowki	27	10	11
Police Chowki	Station Ahmedabad	12	22	8
TOTAL		139	42	129
GRAND TOTAL		310		

8.1.4 Air Quality

As a part of this study, in order to establish the base line data Ambient Air Quality Monitoring (AAQM) has been carried out by setting up ambient air quality monitoring stations through mobile van at three locations for the parametres SPM, RSPM, NOx and SO2, CO and HC. The results so obtained are reported below. Based on analysis it can be said that the project alignment is moderately polluted, may be due to more traffic etc.,

8.1.5 Seismicity

Gujarat has been classified in Zone II, III &IV in various stretches. The project area falls in Zone-III of Seismic Zoning Map of India. The India Meteorological Department (IMD) has considered suitable seismic factor to be adequate for design purpose for Civil Engineering structures, which shall be suitably incorporated while finalising civil structures.

8.1.6 Noise

Noise levels were measured at different places along the alignment at 2.0-m distance from source as per standard practice. The noise levels measured at different locations are summarised in Table 8.5. It is observed that the noise levels recorded at various places are higher than prescribed permissible levels of 55-dBA (day) and 45dBA (night) for residential area as prescribed by the Central Pollution Control Board (CPCB).

Table 8.5
NOISE LEVELS ALONG THE ALIGNMENT DB(A)

Location	Time	Leq	Lmax	L10	L50	L90	Lmin	Lday	Lnight	Ldn
Near Railway Station	08-10	70.56	73.60	72.33	69.77	68.14	67.83	70.23	63.27	70.99
	12-14	69.78	72.13	71.49	68.53	67.54	67.03			
	16-18	70.35	73.63	72.45	69.47	66.99	66.40			
	24-02	63.27	66.00	65.09	62.83	60.39	59.83			
Income Tax Circle	08-10	68.67	71.63	70.33	67.90	66.40	65.93	69.17	51.89	67.35
	12-14	71.27	73.30	73.15	70.80	67.62	66.63			

Location	Time	Leq	Lmax	L10	L50	L90	Lmin	Lday	Lnight	Ldn
	16-18	67.57	70.40	69.65	66.97	63.21	62.37			
	24-02	51.89	54.20	53.48	51.60	49.25	48.57			
RTO Crossing	08-10	65.23	67.73	67.15	64.63	62.25	61.77	67.57	49.70	65.61
	12-14	69.34	71.43	70.91	68.87	66.96	66.33			
	16-18	68.15	70.90	70.25	66.93	65.25	64.90			
	24-02	49.70	51.43	50.90	49.60	47.95	47.67			
Thaltej Crossing	08-10	62.79	65.07	64.71	61.77	58.79	57.40	64.97	50.88	63.95
	12-14	65.94	67.77	67.30	65.37	64.10	63.63			
	16-18	66.19	68.77	68.06	65.97	62.37	61.10			
	24-02	50.88	53.03	52.66	50.00	48.44	48.07			
Anjali Crossing (Near United Co-operative Bank)	08-10	66.34	68.43	68.13	65.80	63.51	63.00	66.76	55.34	66.40
	12-14	66.54	68.60	68.12	66.93	63.65	63.17			
	16-18	67.39	62.27	69.31	67.00	63.55	62.27			
	24-02	55.34	58.93	57.28	53.17	51.64	51.33			
Near Sector29/30 Crossing	08-10	62.13	65.40	64.76	60.73	56.84	56.00	62.75	47.16	61.35
	12-14	64.73	69.97	65.95	57.90	55.87	55.47			
	16-18	61.40	64.43	63.74	59.80	57.55	57.07			
	24-02	47.16	49.23	48.55	46.67	45.34	45.03			
Indroda Circle (Gandhinagar)	08-10	61.17	64.63	63.62	59.53	55.77	54.80	62.70	55.02	63.28
	12-14	62.66	67.53	64.92	59.53	57.98	67.53			
	16-18	64.27	96.23	66.71	60.33	58.24	57.67			
	24-02	55.02	60.17	55.73	48.33	45.95	45.50			

Note: L10, L50 and L90 are the sound level, which is exceeded 10%, 50% & 90% of the total time

8.2 SOCIO ECONOMIC ASSESSMENT

A detailed socio-economic study has been carried out for metro corridor. The study is conducted through socio – economic survey by field visit and analysis.

8.2.1 Dislocation Due to the Proposed Corridor: In order to keep acquisition of private land to the barest minimum, the alignment has been so chosen, that it remains mostly within the government land. However, at some of the station locations private land is required for entry, exit and other facilities of station and running section. The details of land permanently required for the project are given in Table 8.6.

Table 8.6
LAND REQUIREMENT

Agency	Purpose	Land Area Required in ha
Government	At stations & other locations	60.24
Private	At stations & other locations	9.65
Total		

8.2.2 Survey Design

The present study is based on descriptive survey design. This descriptive design was picked up for portraying accurately the socio-economic characteristics of project affected families. It is observed that along APMC Vasna – Gandhi Nagar corridor, along Sabarmati River on the project alignment near proposed ITO metro station, about 100 jhuggies who are getting affected due to this project. However, based on the discussions with the authority/officials, it is informed that the above jhuggies dwellers have already been given notice to vacate the land with due compensation under the Ahmedabad Municipal Corporation project of Sabarmati River Front Development project and is being implemented by the Sabarmati River Front Development Authority (SRFDA). Hence, those area have not been considered for relocation/resettlement in Ahmedabad Metro project. It was observed during the field study that people in about three areas would be affected due to development of metro projects of two corridors (Table 8.7).

Table 8.7
SAMPLE SPECTRUM OF PAFs

Sl. No.	Location	Type of family	Total no. (Approx.)	Sample taken
Thaltej – Ahmedabad corridor				
1.	Proposed Thaltej deport area	Squatters	150	16
2.	Vasant nature cure hospital	PAPs	1	1
Vishala - Gandhinagar				
3.	Near Ambedkar Nagar	Squatters	100	11
TOTAL NO. OF PAFs			251	28

It was therefore decided to conduct a social survey in all affected areas along the alignment on 10 % of the total project affected families from each area by using random sampling method. This gave us a final sample of 251 project affected families. The primary data for the study was collected through interviews with the project affected people using the help of pre-tested structured interview schedule.

8.2.3 Socio-economic Profile of the Project Affected Families (PAF's)

8.2.3.1 Socio-economic Conditions

The details of socio-economic condition of project-affected families are shown in Table 8.8. As many as 53% members in project affected families are male as against 47% female. This shows that male preponderate in the sample. It is evident from the table that majority (23.4%) of family members falling in the age range of 26-40 years, 20.6% belong to the age of 40-60 years and only 19.9 % belong to the age up to 15 years. Remaining 4.3% of family members belong to the age of 60 and above. However, average age of members in project-affected families is 26.3years. The vast majority of the population are

Hindus (100). A look at the data regarding the caste heritage reveals that the majority of the people (75%) come from Scheduled Caste. But the second largest group of the people in project-affected areas belong to Other Backward Castes (14%), followed by those coming from general caste (11%).

Main occupation of the people is labour (71%) followed by service (21%). It is observed that education percentage is evenly distributed. Majority (29%) of them studied up to secondary school. It is important to note that 26.2% out of total project affected people are illiterate. Around 67% of the families have an annual income range upto Rs. 50,000/-, 21.4% of them have an income of Rs50,000-1,00,000/- per annum. About 3.6% of the families have an income of more than 1,00,000/- per annum. Average income of PAFs is Rs. 43,125/- per annum.

Table 8.8
Socio-economic Profile of Project Affected People

Sl. No.	Socio-economic condition	Frequency	Percentage (%)
1.	Sex	(N=141)	
	Male	75	53
	Female	66	47
2.	Age Composition	(N=141)	
	0-5yrs	24	17
	6-15 yrs	28	19.9
	16-25yrs	21	14.9
	26-40yrs	33	23.4
	40-60 yrs	29	20.6
	>60	6	4.3
		Average age = 26.3 Years	
3.	Religion	(N=28)	
	Hindu	28	100
4.	Social Group	(N=28)	
	SC	21	75
	ST	0	0
	OBC/BC	4	14
	General	3	11
5.	Occupation	(N=28)	
	Labour	20	71
	Business	1	3.6
	Service	6	21
	Unemployed	1	3.6
6.	Education	(N=141)	
	Illiterate	37	26.2
	Primary	34	24.1
	Secondary	41	29.1
	Graduate/Tech.	29	20.6
7.	Family Income (Annual Rs.)	(N=135)	

	0- 25000	11	39.3
	25001-50000	8	28.6
	50001-100000	6	21.4
	100001-150000	1	3.57
	150001-200000	1	3.57
	> 200000	1	3.57
		Average income per annum=Rs.43125/-	

8.2.3.2 Family Particulars of PAPs

The family particulars of PAPs are given in Table 8.9. Out of total Project Affected Families majority (50%) are nuclear, 46% are joint and remaining 4% are individual. Family size has been classified into four categories i.e., individual, small (2-4), medium (5-7) and large (7 & above). About 17.9% families are Medium, 28.6%are small and 3.6 % are individual and 50%of families are large respectively. Average family size is 5. So far as marital status of family members are concerned it is observed that out of 141 members, majority of them (51%) are unmarried and only 49%are married.

Table 8.9
Family Particulars

Sl. No.	Family Particulars	Frequency	Percentage (%)
1.	Type Of Family (N=28)		
	Joint	13	46
	Nuclear	14	50
	Individual	1	4
2.	Size Of Family (N=28)		
	Individual	1	3.6
	Small (2-4)	8	28.6
	Medium (5-6)	5	17.9
	Large (7 & above)	14	50
		Average size of family =5	
3.	Marital Status (N=141)		
	Married	69	49
	Unmarried	72	51

8.2.3.3 Details of Structure

The details of structures to be acquired of project-affected families are given in Table 8.10. About 93% are loosing their house followed by 3.6% each are losing shop and house respectively. It is evident from the data that majority of houses are to be lost due to the development of project. About 53.6% and 42.8% construction of structures are kuchha and semi-pucca respectively. 3.6% of PAFs are losing their open land. It is also to be noted that about 96.4% of people are squatters on the government land. Remaining 3.6%of people are the squatters on private land.

Table 8.10
Details of Structure

Sl. No.	Details of Structure	Frequency	Percentage (%)
1.	Type of Structure (N=28)		
	House	26	92.8
	Shop	1	3.6
	House + Shop	1	3.6
2.	Construction of Structure (N=28)		
	Kucha	15	53.6
	Semi-pucca	12	42.8
	Pucca	0	0.0
	Land	1	3.6
3.	Ownership of Structure (N=135)		
	Owned (land)	1	3.6
	Leased/rented	0	0.0
	Squattered	27	96.4

8.3 POSITIVE ENVIRONMENTAL IMPACTS

8.3.1 Based on project particulars and existing environmental conditions (Section 8.1), potential impacts have been identified that are likely to result from the proposed MRTS project. The positive environmental impacts are listed below:

- Traffic congestion reduction,
- Reduction in road accidents
- Quick service and safety,
- Less fuel consumption,
- Reduction in Air Pollution,
- Improvement in roads
- Reduction in number of busses etc.,

8.4 NEGATIVE ENVIRONMENTAL IMPACTS

8.4.1 Based on project particulars and existing environmental conditions (Section 8.1), potential negative impacts likely to result from the proposed development have been identified. Negative impacts have been listed under the following headings:

- Impacts due to project location,
- Impacts due to construction works, and
- Impacts due to project operation.
- Impacts Due to Project Location

a) **Change of Land use:** The metro alignment is designed such that both the land requirement and change of land use is minimum. The change in land use is estimated to be 69.89ha (includes both government and private land).

b) **Loss of Trees:** The total value of these trees lost is about Rs. 50000 lakhs as mentioned in Table 8.11.

Table 8.11
LOSS OF FOREST PRODUCTS

Total loss of Trees (Nos.)	4889
Average cost of one tree (Rs.)	1000*
Total loss (Rs. lakhs)	48.89 lakhs

* - Based on market survey

c) **Loss of Historical and Cultural Monuments:** No historical/cultural monuments will be affected as a result of the proposed development.

d) **Impacts on sea:** since the proposed metro alignment is far from the sea coast, hence no impact on sea due to the proposed project is anticipated.

8.4.3 Impacts Due to Project Construction

a) Soil Erosion and Health Risk at Construction Site: Though the project may not have significant impact on soil erosion, however, minor impact on soil erosion due to runoff from unprotected excavated areas may result in soil erosion, especially when erodibility of soil is high. Mitigation measures include careful planning, timing of cut-and-fill operations and re-vegetation. Problems could arise from dumping of construction spoils (concrete, bricks), waste materials (from contractor's camp) etc. causing surface and ground water pollution. Hence, it is proposed to have ready mix concrete directly from batching plant for use at site. Batching plants should be located preferably away from the site and from the human settlements. Health risks during construction activity include disease hazards to workers due to lack of sanitary facilities like safe disposal of human waste and garbage clearance and disposal facility. In order to avoid such a situation, proper mitigation measures should be incorporated, which should include proper water supply, sanitation, drainage, healthcare and human waste disposal facilities in labour camps. In addition least contaminated water spillage and adoption of disease control measures should be adopted to reduce the health risks.

b) Traffic Diversions and Risk to Existing Buildings: During construction, traffic diversions on roads will be essentially required. As most of the construction activities will be confined to centre of the road and most of the roads are double lane, it will be appropriate that the side lanes may also be utilised for traffic and also for smooth progress of construction activities. Advance information on communication systems will be an advantage to users of any particular road. As most of the proposed section are elevated and located in the middle of the road with deck width being less than the existing road width, hence risk to the existing buildings all along the route may be negligible.

c) Impact on Water Quality: Construction activities may have impact on water bodies due to disposal of waste. The waste could be due to: the spillage of construction materials, dumping of used water from the stone crusher, oils and greases, and labour camp. But the quantities of such spills are very negligible. Care, however, needs to be taken to provide adequate sanitary

facilities and drainage in the temporary colonies of the construction workers. Provision of adequate washing and toilet facilities with septic tanks and appropriate refuse collection and disposal system should be made obligatory. Contamination of ground water can take place, if the dump containing above substances gets leaked and percolate into the ground water table. This is not the case with the present project, as the activity does not involve usage of any harmful ingredients. Moreover, activities are of short duration. Hence, in overall, the impact on either ground or surface water quality is anticipated to be minimum due to the proposed project.

8.4.4 Impacts due to Project Operation

a) **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 grit chamber for settling of suspended matter. The collected oil shall be suitably treated, so as to avoid any underground water contamination.

b) **Noise:** Noise and Vibration is of similar phenomenon. Noise is a random vibration. It can be broken down into a set of unrelated, elementary components. The main sources of noise from the operation of trains include: engine noise, cooling fan noise, wheel-rail interaction, electric generator and miscellaneous noise like passenger's chatting. The roughness of the contact surfaces of rail and wheel and train speed are the factors, which influence the magnitude of rail - wheel noise. The vibration of concrete structures also radiates noise. The maximum noise level is estimated as 64DB(A). However, due to reduction of vehicular traffic, the road traffic noise as compared with existing levels may come down.

c) **Accidental Hazards**: In view of the hazards potential involved due to failure of system and accident the on-site and off- site emergency measures have been formulated and shall be implemented by the construction agency during construction and operational phases.

d) Water Supply: CPHEEO (Central Public Health Environmental Engineering Organisation) has recommended 45-litres/day water supply to persons working at railway stations. All the stations are in urban area. Water requirement at stations has various components, viz. Personal use of staff, fire demand, make up water for air conditioning and ventilation, and wastage. The water demand at each station would be about 100m3 per day. Adequate provision of drinking water has to be made for passengers at the concourse.. Platform washing requirement has been worked out at the rate of 2-litre per sqm.

e) Railway Station Refuse: Due to non-availability of solid waste data, it is assumed that about 64 gm per person per day of solid waste will be generated. The total refuse, generated will be about 4 tonnes/day with the assumption that only about 25% of the passengers visiting various stations will be producing refuse as the transit time of the corridor is less.

8.5 CHECKLIST OF IMPACTS

A typical checklist identifying anticipated environmental impacts is shown in Table 8.12.

Table 8.12.
CHECKLIST OF IMPACTS

Parametre		Negative Impact	Positive Impact	No Impact
A)	**Impacts Due To Project Location**			
i)	Change of Land Use and	✓		
ii)	Ecology			Nil
iii)	Impact on Historical/Cultural Monument			NIL
	Impact on sea			
B)	**Impact Due To Project Construction**			
i)	Soil Erosion, Pollution and Health Risk at Construction Site	✓		
ii)	Traffic Diversions and Risk to Existing Buildings	✓		Nil
iii)	Impact on Water Quality	✓		
C)	**Impact Due To Project Operation**			
i)	Oil Pollution	✓		
ii)	Noise and Vibration	✓		
iii)	Accidental Hazards	✓		
iv)	Water Supply	✓		
v)	Railway Station Refuse	✓		
D)	**Positive Impacts**			
i)	Traffic Congestion Reduction,		✓	
	Quick Service and Safety,		✓	
ii)	Less Fuel Consumption,		✓	
iii)	Reduction in Air Pollution,		✓	
iv)	Reduction in number of busses		✓	
v)	Improvement in roads		✓	
vi)	Reduction in Road accidents		✓	

✓ - Yes

8.6 ENVIRONMENTAL MANAGEMENT PLAN

Based on environmental baseline conditions, planned project activities and its impacts assessed, the set of measures to be taken during implementation and operation to avoid or offset adverse environmental impacts or to reduce them to acceptable levels, together with the action which needs to be taken to implement them are enumerated in this section.

8.6.1 Mitigation Measures: Based on project description, Environmental Baseline Data and Environmental Impacts, it is proposed to prepare the Environmental Management Plan for the following:

a) Compensation for Loss of Land,
b) Compensation for Loss of Trees,
c) Compensatory Afforestation and Fencing,
d) Compensation for Relocation/Resettlement,
e) Water Supply & Sanitation,
f) Oil Pollution Control
g) Noise Control
h) Vibration Control
i) Soil disposal
j) Provision of rain water harvesting at construction depot site
k) Provision of green belt development
l) Occupational health hazards and control

a) **Compensation for Loss of Land:** The land likely to come under project is ---- ha. The cost of land for compensation is taken under the project cost.

b) Compensation for Loss of Trees: There are 4889 trees on the proposed alignment, which are required to be uprooted. The compensation for loss of trees works out to Rs. 48.89 lakhs. **c) Compensatory Afforestation and Fencing:** According to the survey, about 4889 trees are likely to be lost due to the project. 10 times the number of trees are to be planted as per the general norms of Department of Forests, administration stipulations. Hence, about 48890 plants are required to be planted. The total area required for afforestation of these tress comes to about 40.74ha. It is presumed that government land will be provided for afforestation, hence no land cost will be involved. Compensatory afforestation cost (excluding fencing) for 40.74ha will be about Rs. 61.11 lakhs @ about Rs.1, 50,000 per ha. Fencing shall be provided in order to save the saplings from the animals. The cost towards fencing is estimated to be about Rs. 261.57lakhs. Thus, the total cost of compensatory afforstation and fencing works out to Rs. 322.68 lakhs. The recommended plant species may be as per the following Table 8.15

Table 8.15
RECOMMENDED TREE SPECIES FOR AFFORESTATION

S.NO.	LOCAL NAME
1.	Neem (Limda)
2.	Pipal
3.	Badam
4.	Babool (Bawal)
5.	Ashok (Asav Palav)
6.	Gulmohar

d) Compensation for Relocation/Resettlement: The project involves relocation of shops, commercial cum residential buildings and hutments along the alignment. As per the discussions with the Local Authorities, it is understood that no separate State Government policy on Resettlement

&Rehabilitation are not available, hence the National Resettlement policy shall be adopted for this project.

Based on the National Policy on Resettlement and Rehabilitation for Project Affected Families –2003, PAFs will be paid as compensation for relocation of shops, commercial cum residential buildings etc., likely to be affected due to the Metro project. It is seen some of the families have been covered by Sabarmati River Front Development Authority (SRFDA) for relocation. It is suggested that State Administration should appoint Special Officer to process the case of identification and relocation / rehabilitation of PAFs that are affected as per the final location survey by project Implementation SPV. The proformae of details of resettlement cost are presented in Table 8.16 and resettlement cost is shown in Table 8.17.

Table 8.16
RESETTLEMENT COST

S. No	Plot No.	Location	Area in Sqm	Storey	Land ownership	Average construction Cost @ Rs ___per sqm (Rs. Lakhs)
1					Govt	
2					Govt	
	Total compensation for squatters structures Sub total - B					

Table 8.17
SUMMARY OF RESETTLEMENT COST

Sr. No.	Description	Quantity	Rate (Rs.)	Total (Rs. lakhs)
A	Compensation for Land Acquisition : Considered in the Project cost			
B	Compensation for Residential structures			
C	Acquisition of Squatters structure			
D.	Compensation for loss of economic base			
E				
	BPL/ SC/ ST/ WHH/ Old Age people			
F	Shifting Allowance of PAFs			
G				
	Add Contingency@ 5%			
	GRAND TOTAL			

2 . Compensation for economic base is calculated based on National Resettlement policy.
3 . Assuming that 50% of affected population falls in this category

e) Water Supply & Sanitation: The public health facilities, such as water supply, sanitation and toilets are much needed at project location. Water should be treated before use upto WHO/ Indian drinking water standards. In addition, water will be required for contractor's camps during construction, for which additional arrangements have to be made in consultation with the Ahmedabad Municipal Corporation & Ahmedabad Urban Development Authority. The collection and safe disposal of human wastes are among the most important problems of environmental health. Innovative sewerage disposal systems should be adopted for sewerage disposal. The total of app. 370 bins of 50-120 litres capacity will be required which can be accommodated at different stations and platforms. The total cost for bins works out to be Rs. 8 lakhs. A Provision of Rs. 75 Lakhs for construction of sewage treatment plant have been proposed at construction depot site. A provision of Rs. 120 Lakhs at Depot site have been proposed for construction of water treatment plant. The treatment technology shall be designed based on the affluent characteristics and the final discharge options of the effluent.

f) Oil Pollution Control: 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 source. Such tanks usually employ compressed air to coagulate oil and grease and cause it to rise promptly to surface. Compressed air may be applied through porous plates located at the bottom of the tank. The tank may be designed for a detention period of 5 to 15 minutes. Adding Chlorine in an amount of 2.0-mg/l will increase the efficiency of removal. A Provision of Rs. 75 Lakhs for construction of effluent treatment plant have been proposed at construction depot site. The treatment technology shall be designed based on the influent characteristics and the final discharge options of the effluent.

g) Noise: There may be an increase in noise level in ambient air due to construction and operation of this corridor. However, noise levels in the core city may slightly go down. The increase in levels is 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 can be achieved by job rotation, automation, protective devices, noise barriers, and soundproof 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.

Pile driving operation can produce noise levels upto 100 dB (A) at a distance of 25-m from site. The noise levels could be reduced by using a suitable sound absorbent, which can reduce the noise levels upto 70 dB (A) at a distance of 15m from the piles. Safety precautions 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. Sound barriers are usually effective along route having fast traffic. The reduction in noise level increases with height of barrier. Ballast-less track is supported on two layers of rubber pads to reduce track noise and ground vibrations.

h) Vibration Control: 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 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 54 kg UIC IRS T-12 on ballastless track 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.

- Rail will be continuously welded and also will be laid to fine tolerances, so that any noise/vibration on account of irregular 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.

In sensitive areas, track on floating slab can be provided so as to avoid propagation of noise/vibration to adjacent structures. Additional screening of noise/vibration can be arranged by providing parabolic noise/vibration reflecting walls on each sides of the track, as being provided by DMRC in ongoing rail corridor.

i Soil Disposal : Owing to paucity of space in the busy cities and for safety reasons, elaborate measures need to be adopted for collection, transfer and disposal of excavated soil. Soil collection, transportation, disposal and its treatment need to be carried out in a systematic manner. Soil collection should be in containers from the dredging sites / places. These containers should be such that soil should not spill during movement to disposal site. The excavated soil will be first collected at dumping ground and then transferred to a identified disposal sites.

j. Provision of Rain water harvesting: To conserve and augment the storage of groundwater and arrest seawater intrusion in groundwater, if any, it has been proposed to construct roof top rainwater harvesting structure of suitable capacity in the construction depot site. A provision of Rs 10.00 Lakhs (excluding the cost of storage tank) has been kept in the cost estimate.

k. Provision for Green belt development: The greenbelt development / plantation in the depot area not only functions as landscape features resulting in harmonising 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. It is recommended to have a provision of Rs. 20 lakhs in the cost estimate for the green belt development.

l. Occupational health hazards and control : Exposure to air pollutants and higher noise levels, increased levels of heat & humidity at work place depot site may lead to occupational health disorder and diseases. It is therefore necessary to provide safe and clean working environment for the control/prevention of such health hazards. Care shall be taken to provide good working conditions during operation of depot area and also the metro corridor. Provision of conditions in contract and good construction practices will take care of any occupational health hazard issues and provide environmentally safe work areas. However, a provision of Rs. 50 Lakhs have been proposed for health related issues and its control for this project.

8.6.2 DISASTER MANAGEMENT

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earth quakes, 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.

8.7 ENVIRONMENTAL MONITORING PLAN

Environmental Monitoring: The environmental monitoring will be required for the construction and operational phases. The parametres need to be monitored are: Water Quality, Air quality and Noise levels etc.

a) Water Quality: Though it is expected that, no impact on water quality is anticipated, monitoring of water quality may be required to assess the impact of the project before and after construction. Water quality parametres shall be monitored one year before the construction, during the construction phase and also for at least three years after the completion of the project (total 7years). Monitoring shall be carried out at least four times a year to cover seasonal variations. The parametres for monitoring would be: pH, Dissolved

Oxygen, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids, Chlorides, Nitrates, Sulphates, Total Nitrogen, Total Phosphates, oils and grease etc (about ten parametres as essential depending on the site conditions). The cost for water quality analysis works out to be Rs. 5.6lakhs.

Air Quality and Noise Levels: Ambient air quality and Noise levels should be monitored one year before the construction, during the construction phase and for at least three years after the completion of the project (total 7years). It is proposed to have the monitoring programme at four locations as suggested above in water quality monitoring. The cost for ambient air quality and Noise levels monitoring works out to be Rs. 18.48 lakhs as per the break up given in Table 8.18.

Table 8.18
COST OF ENVIRONMENTAL MONITORING

S.No	Description of monitoring	Frequency	Cost
1.	Air quality monitoring	Seasonal	Twice (2) in a week x Four (4) weeks in a season x Four (4) seasons in a year x Seven (7) years x four (4) locations x Rs. 2000/- per monitoring per location for all parametres = 2x4x4x7x4 x 2000 = Rs. 17.92 Lakhs.
2.	Noise monitoring	Seasonal	Once (1) in a season x Four (4) seasons in a year x seven (7) years x four(4) locations x Rs. 500/- per monitoring per location = 1x4x7x4x500 =Rs. 0.56 Lakhs
		Total	Rs. 18.48 Lakhs say Rs 19 lakhs

A summary of the environmental monitoring program attributed due to construction of the proposed project during construction and operation phase are as shown in Table 8.19 and Table 8.20.

TABLE 8.19
SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME DURING PROJECT CONSTRUCTION PHASE

S.No.	ITEM	PARAMETRES	FREQUENCY	LOCATION
1.	Effluent from septic tank	pH, BOD, COD, TSS, TDS	Once every month	Before and after treatment from each septic tank.
2.	Water related diseases	Identification of water related diseases, adequacy of local vector control and corrective measure etc.	Three times a year.	Labour camps and colonies.
3	Noise	Equivalent noise level	Once in three months	At major construction sites

S.No.	ITEM	PARAMETRES	FREQUENCY	LOCATION
4	Air quality	SPM, RPM, SO2, and NOx	Once every season	At major construction sites (total 4 stations)
5	Meteorological aspects	Wind direction & velocity temperature humidity, rain.	Once every season	At one of the ambient air quality sampling sites.

TABLE 8.20
SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME DURING PROJECT OPERATION PHASE

S.No.	ITEM	PARAMETRES	FREQUENCY	LOCATION
1.	Water	pH, temperature, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Total Hardness, Chlorides, DO, COD, BOD,	Seasonal	At suitable locations as required
2	Noise	Equivalent noise level	Once in three months	At major construction sites
3	Air quality	SPM, RPM, SO2, and NOx	Once every season	At major construction sites (total 4 stations)
4.	Water related diseases	Identification of water related diseases, sites, adequacy of local vector control measures etc.	Three times a year	As appropriate adjacent to project sites.

8.8 ENVIRONMENTAL MANAGEMENT SYSTEM

The Environmental Management System constitutes provision of an Environmental Division, which should be staffed by an Environmental Engineer/Officer, an Environmental Assistant and two other assistants (miscellaneous works). The task assigned should include supervision and co-ordination of studies, monitoring and implementation of environmental mitigation measures. An Environmental Advisor shall review progress of the division every year. Cost of such an establishment has been estimated as Rs. 30.60 lakhs. However, it may be mentioned that this division will be for the entire MRTS. Therefore, the costs are attributable to another system.

8.9 COST ESTIMATES

8.9.1 All costs involved in Environmental mitigation, resettlement management and monitoring to be put on the account of the proposed metro corridor alignment are summarised in Table 8.21

Table 8.21
SUMMARY OF COSTS

S. No.	ITEM	Rs. (Lakhs)
1	Compensation for loss of trees	50
2	Compensatory Afforestation & fencing	322
3	Compensation for Resettlement	To be calculated separately
4	Monitoring of Water	6
5	Monitoring of air/noise during construction & operation	19
6	Establishment of Environment Division	31
7	Provision of bins for Railway Station Refuse	8
8	Construction of water treatment plant at depot site	120
9	Provision for Rain water harvesting	10
10	Provision for Sewage &Effluent treatment plants	150
11	Provision for Green belt development	20
12	Health and safety measures	50
	Sub total	785
	Miscellaneous items @10%	78.5
	GRAND TOTAL	864.5

8.9.2 The Environment Management Plan should be implemented in phases, so that optimum benefit could be achieved and it should be synchronised with the construction schedules.