ENVIRONMENTAL IMPACT ASSESSMENT

INDIVIDUAL FINAL TERM PAPER

MASS RAPID TRANSIT SYSTEMS

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ABSTRACT

Cities play a vital role in promoting economic growth & prosperity. The development of cities largely depends upon their physical, social & institutional infrastructure. In this context, the importance of intraurban transportation is paramount. There is a considerable evidence to demonstrate that the current mega trends in transport are at odds with the imperative of maintaining ecological balance. Like world, India is becoming increasingly urbanized in which the dynamics of population growth, coupled with the current trends of urbanization are highly debilitating. Current trends of urbanization as inspired by better quality of life, are posing multiple stresses on our environment & human population. Coupled with rapid urbanization each city consists of a no. of supporting systems. Transport or Transit Systems are one of them, which provide mobility, flexibility & accessibility to urban people. The following paper, hence, deals with how the project can help to improve the overall transport environment and further how the involvement of EIA can further benefit the project.

KEYWORDS

Population, Urban Growth, Air & Noise Pollution, Rapid Transit Systems, MRTS.

WHAT ARE RAPID TRANSIT SYSTEMS?

There is no single and unambiguous definition of a Rapid Transit System, but the term often refers to systems that are called Metro, Subway or Underground. Whereas the words Subway and Underground indicate that the system is sub-surface, the terms Metro and Rapid Transit typically also include systems that are elevated or at surface level. A popular definition of metro is urban, electric passenger transportation system with high capacity and high frequency of service, which is totally independent from other traffic, road or pedestrians. The dividing line between rapid transit and other modes of public transport, such as light rail and commuter rail, is not always clear.

A common way to distinguish rapid transit systems from light rail is by their separation from other traffic. While light rail systems may share roads or have level crossings, a rapid transit system runs on a grade-separated exclusive right-of-way, with no access for pedestrians & other traffic. Rapid transit systems are primarily used for transport within a city & have higher service frequency. Furthermore, these systems do not share tracks with freight trains or inter-city rail services. The First Rapid Transit System was the London Underground, which opened in 1863. The technology quickly spread to other cities in Europe and then to the United States, where a number of elevated systems were built. Since then the largest growth has been in Asia and with driverless systems. More than 160 cities have rapid transit systems, totaling more than 8,000 km (4,900 miles) of track and 7,000 stations. Twenty-five cities have systems under construction.

INTRODUCTION

The urban population of the world as a whole has been expanding at the rate of nearly 3% per year, presumably faster than the existing world population growth rate. Roughly half of the global population lives in the cities (Peterson, J., 1984). Presently approx. 30% of India's population lives in urban areas. The current trends of urbanization inspired by the better quality of life are posing multiple stresses on our environment. Coupled with rapid urbanization each city consists of a no. of supporting systems. Transport or Rapid Transit Systems are one of them, which provide mobility, flexibility & accessibility to urban people.

Transport, is today, positioned in the conflicting role between Economic & Environmental interests. An efficient & robust transport system enhances production, consumption & improves the accessibility of all regions, while simultaneously being consistent with the environment. The environmental effects of transport itself are enormous as Traffic Congestion, Vehicular Emission causing Air pollution, Noise Pollution, Fatalities etc, which are subsequently discussed ahead. It erodes the natural resource base of an economy besides polluting the environment in a big way. Half of the current World's Oil production is consumed by motor vehicles alone. The world over, energy use & transportation are the two main contributors to the ozone & green house gases, besides polluting urban air.

NEED OF MASS RAPID TRANSIT SYSTEM

Transport demand in most Indian cities has increased substantially, due to increase in population as a result of both natural growth & migration from rural areas & smaller towns. Availability of motorized transport, increases in household income & increases in commercial & industrial activities have further added to transport demand. In many cases the demand has outstripped the road capacities. As the cities grow in size, the no. of circular trips on road system goes up. Individual cities cannot afford to cater only to private modes of transportation as cars & scooters or bikes. This necessitates a pragmatic policy to discourage private modes & encourage public or mass transit modes once the traffic along any travel corridor in one direction exceeds 20000 persons/hr. Thus the introduction of Mass Rapid Transit Systems is called for.

MRTS are capital intensive & have a long gestation period. It has been observed that in developed countries, planning of for mass rapid transit system starts when the city population exceeds 1 million, the system is in position by the time the population reaches 2 to 3 million & once the population exceeds 4 million or so, planned extensions to the MRTS is vigorously taken up. But on the other hand, in developing countries including India, because of paucity of funds planning & implementation MRTS has been lagging behind the requirement. MRTS has been a victim of ignorance, neglect& confusion. As far as MRTS in Indian cities is concerned, dedicated city Bus Services are known to operate in 17 cities only & Rail Based Transit Systems in less than 10 cities out of all the cities with population in excess of 1 million.

To have a deep understanding of the need of MRTS & the role of EIA in the same let us have a brief look into some databases.

Trends in Urban Growth

The current trends of population growth coupled with urban growth are highly debilitating in India. Over the last ten decades, India has experienced more than two-fold increase in its level of urbanization during 1901 & 2001. One-fifth of the urban population of India lives in 6 mega cities (Shukla, at. El; 1996). The no. of metropolitan cities in India has reached a figure of 40 in 2001. Delhi's population in 1991 stood at 9.4 million, showing an increase of 3.2 millions over the 1981 figure. According to Census of India (2001), Delhi's population has reached a whopping figure of 13,782,976. The city of Chennai has reached a growth rate of 41.05% and the population has reached the figure of 4,216,268 (Census, 2001). Bangalore stood at a population of 5.7 million (Census, 2001) & is its population is expected to reach a figure of 11 million by the year 2021. Kolkata & Mumbai on the other have marked the entire domain, range & scope of problems arising out of unbridled urban growth.

Table 1: Urban Growth in India

Year	No. of Towns	% of Urban Popu.^n /Total Popu.^n	Growth Rate	Avg. Annual Growth Rate	Tempo of Urbanization
1901	1827	10.84	-	-	-
1911	1815	10.29	0.35	0.03	0.60
1921	1949	11.18	8.27	0.79	0.80
1931	2072	11.99	19.12	1.76	0.80
1941	2250	13.86	31.97	2.87	1.68
1951	2843	17.29	41.42	3.52	2.65
1961	2365	17.97	26.41	2.30	0.40
1971	2590	19.21	38.23	3.28	1.28
1981	3378	23.34	46.14	3.68	1.83
1991	3768	25.74	36.19	3.16	1.37

Source: Census of India 1991,2001

Vehicular Growth & Modal Split in India

In 2002, 58.8 million vehicles were plying on Indian roads. According to statistics provided by the Ministry of Road Transport & Highways, Govt. of India, the annual rate of growth of motor vehicle population in India has been about 10% during the last decade. The basic problem is not the number of vehicles in the country but their concentration in a few selected cities, particularly in metropolitan cities (million plus). It is alarming to note that 32% of these vehicles are plying in metropolitan cities alone, which constitute about 11% of the total population. During the year 2000, more than 6.2 million vehicles were plying in mega cities (Mumbai, Delhi, Kolkata, and Chennai) alone, which constitute more than 12.7% of all motor vehicles in the country (Table 2). Interestingly, Delhi, which contains 1.4% of the Indian population, accounts for nearly 7% of all motor vehicles in India.

Table 2. Total Number of Registered Motor Vehicles in Selected Metropolitan Cities in India: 1995–2000 (Year as of March 31 and Number of Vehicles in Thousands)

Metropolitan Cities	1995	1996	1997	1998	1999	2000
Bangalore	796	900	972	1130	1332	1550
Chennai	768	812	890	975	1056	1150
Delhi	2432	2630	2848	3033	3277	3423
Kolkata	561	588	588	664	N.A.	N.A.
Mumbai	667	724	797	860	911	970

Source: Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi. Motor Transport Statistics of India. Various issues.

Note: N.A. indicates unavailability of data.

Table 3 below presents the existing modal split in terms of % of trips made on different modes across Indian cities. When compared with the desirable level of modal split (Table 4), it was found that the share of Mass Transit is well below the desired range, while the share of personalized transport & paratransit is already above the optimal range in most Indian cities. Unfortunately, the modal split doesn't appear to be moving in the right direction. For e.g. share of mass transit in Delhi has stayed at the same level for the last 2 decades (Table 5).

Table 3. Existing Modal Split in Indian Cities (as a % of Total Trips)

City Population (in millions)	Walk	Mass Transport	IPT Fast	IPT Slow	Car	Two-wheeler	Bicycle	Total
0.10–0.25	37.1	16.4	10.4	20.1	3.3	24.1	25.7	100.0
0.25–0.50	37.8	20.6	8.9	17.2	2.6	29.8	20.9	100.0
0.50–1.0	30.7	25.4	8.2	12.0	9.5	29.1	15.9	100.0
1.0–2.0	29.6	30.6	6.4	8.1	3.3	39.6	12.1	100.0
2.0–5.0	28.7	42.3	4.9	3.0	5.0	28.9	15.9	100.0
5.0+	28.4	62.8	3.3	3.7	6.1	14.8	9.4	100.0

Note: IPT denotes intermediate public transport vehicles such as taxies and three-wheeler auto rickshaws.

Table 4. Desirable Modal Split for Indian Cities (as a % of Total Trips)

City Population (in millions)	Mass Transport	Bicycle	Other Modes
0.1–0.5	30–40	30–40	25–35
0.5–1.0	40–50	25–35	20–30
1.0–2.0	50–60	20–30	15–25
2.0–5.0	60–70	15–25	10–20
5.0+	70–85	15–20	10–15

Source: Ministry of Urban Development, Government of India, New Delhi 1998. Traffic and Transportation Policies and Strategies in Urban Areas in India. Final Report.

Table 5: Modal Split Trend in Delhi

Mode	Modal Split (in percent)			
	1969	1981	1986	1994
Bus	41	62	62	62.0
Car	59	38	38	6.9
Two-wheeler				17.6
Bicycle				6.6
Cycle rickshaw				3.5
Others				3.4

Source: Singal 2000

Vehicular Emissions

Today, globally, motor vehicles put out 900 million tons of Carbon Dioxide a year which constitutes 15% of total emission. The combustion of fuel as petroleum & oil is the major source of the pollution. The various factors contributing are the types of engine used, the age of vehicles, road conditions, traffic congestion. Technical Pollution parameter suggests that 2-stroke engine vehicles are more polluting than the other. Delhi, once a green city, is now clubbed with the most polluted cities of the world. Delhi, is also worst ranked in levels of air pollution among the four metropolis in India. 72% of air pollution in Delhi is caused by vehicular emissions.

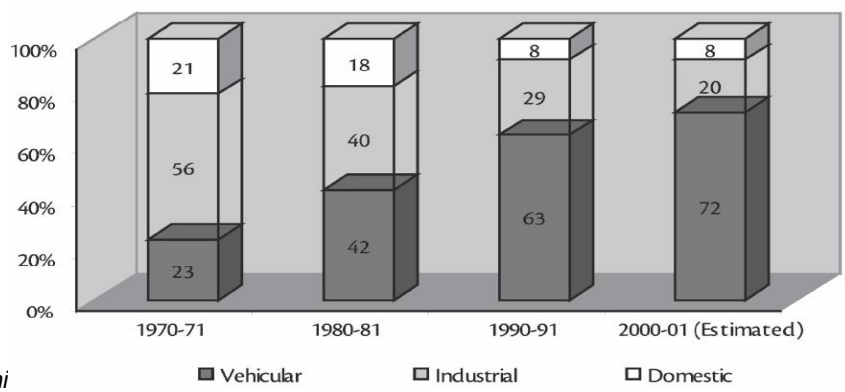


Fig 1: Air Pollution in Delhi

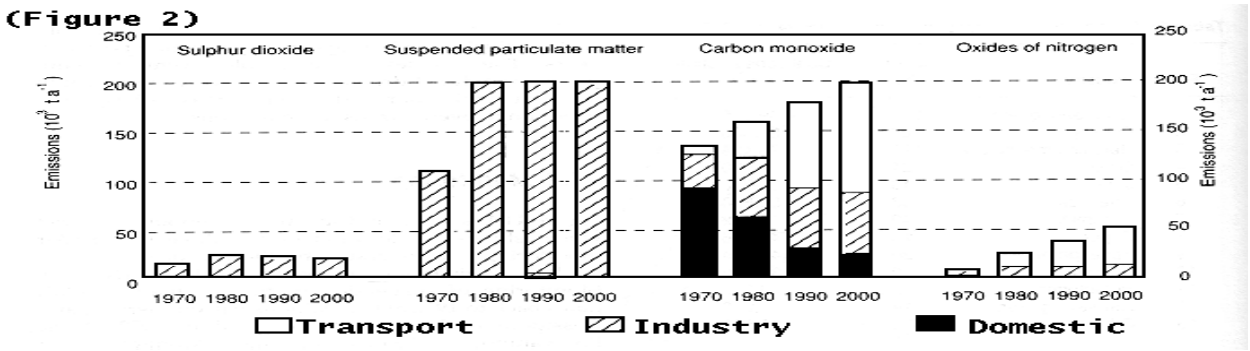
Source: Planning Department, Govt of NCT of Delhi, March 2000

Table 6: Estimated Vehicular Emission Load in selected Metropolitan Cities

Name of the city	Vehicular pollution load (tones per day)					
	Particulates	Sulfur dioxide	Oxide of the Nitrogen	Hydrocarbons	Carbon monoxide	Total
Delhi	10.30	8.96	126.46	249.57	651.01	1046.30
Mumbai	5.59	4.03	70.82	108.21	469.92	659.57
Bangalore	2.62	1.76	26.22	78.51	195.36	304.47
Calcutta	3.25	3.65	54.69	43.88	188.24	239.71
Chennai	2.34	2.02	28.21	50.46	143.22	226.25

Source: CPCB, New Delhi "Urban Statistics", Oct 1996, Town & Country Planning Organization.

Figure 2 below shows levels of emissions by various sources in Kolkata.



Source: Air Quality Status by NEERI

Traffic Congestion

Indian cities face severe traffic congestion. Growing traffic and limited road space have reduced peak-hour speeds to 5 to 10 km/hour in many major cities. This also leads to higher levels of vehicular emission. According to the Centre for Science and Environment (CSE), the quantity of all three major air pollutants (namely, CO, hydrocarbons, and nitrogen oxides) drastically increases with reduction in motor vehicle speeds. For e.g., at a speed of 75 kmph, emission of CO is 6.4 gm/veh.-km, which increases by five times to 33.0 gm/veh.-km at a speed of 10 kmph. Similarly, emission of hydrocarbons, at the same speeds, increases by 4.8 times from 0.93 to 4.47 gm/veh.-km. Thus, prevalent traffic congestion in Indian cities, particularly during peak hours, not only increases the delay but also increases the pollution level.

Table 7: Congestion Indices of selected roads in Bangalore city

Name of the Road	Peak Hr Service Volume	Practical Capacity	Congestion Index
Platform Road	14,375	2,486	5.78
Seshadri Road	10,105	3,813	2.65
Race Course Road	7,375	1,371	5.38
Subedar Chatram Road	5,934	2,057	2.88
J.C.road	11,813	4,971	2.30
Dickenson Road	5,511	1,971	2.80
Airport Road	7,767	2,900	2.68

Table 8: Pollution rate & congestion Effect of Private & Public Transport Vehicles

Type of Vehicle	Average Passenger per Vehicle	Pollution Load in gm/pass.-km	Congestion Effect in in PCU/Pass.
Two-stroke two-wheeler petrol engine	2	7.13	0.375
Four-stroke two-wheeler petrol engine	2	4.76	0.375
Car with catalytic converter petrol engine	4	0.93	0.25
Bus with diesel engine	40	1.00	0.075

Source: Agarwal 2001.

Note: PCU = Passenger Car Unit where 1 car = 1 PCU, 1 bus = 2.5 PCU, 1 scooter = 0.75 PCU, etc.

Health Impacts due to Vehicular Emissions & Fatalities

Table 9: Main Pollutants & Health Effects

Pollutant	Health Effect
SPM	Damage of lungs, bronchitis and asthma
SO_2	Acid rain, damage to lungs, eyes and skin
NO_x	Form Smog damage to respiratory system and eye irritation
CO	Toxic causes blood poisoning
HC	Cancer
Pb	Nervous system slow down ad brain development is retarded; slow reaction time.

Source: Delhi Environmental Status Report: Pollution Monitoring & technical Corporation Division, New Delhi, 1975.

As studied, following facts are worth-mentioning to grasp the health problems generated by air pollutants:

- A World Bank report underlines that more than 40,000 people die prematurely per year in India due to health problems caused by air pollution.
- Studies reveal that the cases of respiratory diseases and allergies have almost doubled since 1990.
- Nearly 80-90% lead in ambient air is attributed to the composition of leaded petrol (Compendium of Environment Statistics, 1999). Unleaded petrol in India contains a very high level of benzene, which may cause lung cancer.
- It is estimated that almost 50% population in Mumbai has absorbed 30 microgram of lead in 100 milliliter of blood, while simply 50 microgram is sufficient to culminate in brain damage and muscular problems.

- The levels of air pollution in large cities have been increasing with such a tremendous magnitude that the WHO has suggested the international tourists to limit their visits to the four mega cities of India- Kolkata, Mumbai, Delhi and Chennai.
- By the year 2001, carbon monoxide levels were estimated to increase by seven times and that of hydrocarbons by 9 times. The levels of other pollutants are expected to rise by 5 times (Satyaramchandar, 1997).
- According to a study 84,000 deaths were directly attributed to Outdoor Air pollution across Indian cities (WHO, 1996).

In India, like clockwork, more than 80,000 people get wiped out on roads every year. According, to a WHO report, with just 16% of world's fleet of motor vehicles, Asia accounts for more than half of the roughly 1.2 million traffic fatalities.

Table 10: Motor Vehicle Accidents (nos.) in Metropolitan cities, India (1996-1998)

City	1996			1997			1998		
	Number Of Accidents	Persons killed	Persons injured	Number Of accidents	Persons killed	Persons injured	Number of accidents	Persons killed	Persons injured
Bangalore	8474	715	6566	8722	704	6637	8360	726	6358
Chennai	5458	615	3783	5171	749	3797	5121	682	4813
Delhi	11315	2361	10558	10957	2342	10700	10217	2123	8948
Hyderabad	2034	342	2080	2108	377	2000	2208	370	1981
Kolkata	9294	474	3133	10260	471	3046	10999	454	3446
Mumbai	29808	405	7577	27421	401	6475	26980	370	6614

Source: TERI Energy Data directory & yearbook 2001/2002

Thus the above database establishes a subtle relationship between vehicle ownership, socio economic & demographic attributes of a society. Henceforth, there is an urgent need of shift from the personal modes of transport to A Mass Rapid Transit System to lower the ever increasing vehicular emissions & traffic congestion.

IMPORTANT CASE EXAMPLES OF MRTS IN INDIA

Kolkata

Till 1912, Kolkata was the capital of India, when the British moved the capital to Delhi. Kolkata became an important port and trading center and by 1735 with population of 1,00,000. the history of Kolkata's Metro rail goes as far back as 1949, when the idea of setting up an underground railway system for public commuting to solve the burgeoning traffic problem in the city was conceived by the then Chief Minister Dr. B.C.Roy. The project remained in conception for almost two decades. In Kolkata, roads account for only 4.2% of the total surface area, as against 25% in Delhi and 30% in Mumbai. Kolkata has a population of 4.58 millions in 2001. In fact the use of Rapid Transit systems in Kolkata date back as far as the year 1873 when on Feb 23rd the first Tram was rolled out onto the streets of Kolkata. Braving out the illustrious moments of our Indian freedom struggle, World wars, Kolkata tram had come a long way and still its wheel continue to pave its way as a rail witness of the present era and hopefully for the future too. No doubt Kolkatan tram can be designated as a priceless pride having served as a rail witness from the era of Governor Generals, maharajas

to our present Kolkata & without which the Kolkatan history would remain incomplete. Kolkata Tramways-' wheels that writes & sights our glorious past, present & our future too'.

New Delhi

Delhi has experienced phenomenal population growth in the last few decades. Its population has increased from 57 lakhs in 1981 to approx 162 lakhs in 2006 & is poised to reached 190 lakh by the year 2011. for want of an efficient mass transport system, the number of motor vehicles has increased from 5.4 lakhs in 1981 to 51 lakh in 2007 and is increasing at a rate of 6.21 per annum. The number of motor vehicles in Delhi is now more than that of Kolkata, Mumbai & Chennai put together. The result is extreme congestion on Delhi roads, ever slowing speeds, increase in road accidents, fuel wastage and above all environmental pollution with motorized vehicles alone contributing to about two-thirds of the atmospheric pollution.

The History of planning the Metro project for Delhi dates back to 70's. The Central Road Research Institute (CRRI) undertook the first exhaustive study on traffic & travel characteristics of Delhi in 1969-70. Existing Modal Split Trend in Delhi is given in Table 5. The city of Delhi as of today should have had an MRTS network of at least 100 Km by this time, whereas actually it is still 65.10 Km.

Bangalore

Bangalore city, is the principal administrative, industrial, commercial, educational and cultural capital of Karnataka. Bangalore is witnessing a tremendous growth in industry, trade and commerce leading to rapid growth of the city & large scale urbanization. The population of Bangalore stood at 5.7 million in 2001 and is expected to reach 11 million in 2021. While most of the infrastructure aspects as energy supply, water and sewerage system, road, rail and air network, telecommunication systems etc are reasonably met with in Bangalore, It is the domain of public transport, which appears the be woefully inadequate to meet even the existing demands. The city's mass transport system, BMTC, is exerting to do its best, is unable to meet the commuter's demands. This has led to explosive growth of private vehicles & thus a need for establishing the MRTS.

ENVIRONMENTAL IMPACTS OF MRTS PROJECT

The MRTS project (all over India, which are passing through a phenomenal growth rate & rapid urbanization while providing a strong infrastructure & serve as a vastly efficient transportation system for the respective cities, will have implications on the environmental front. While the accrued benefits to the urban community in terms of alternative & superior would be sustainable & far reaching, the very size & nature of the project could have significant bearing due to numerous Positive & Negative Impacts.

Positive Impacts of the Project

- Reduced Traffic Density on the Roads.
- Reduced Vehicular Emission levels thereby reducing Air Pollution.
- Reduction in Fatalities due to Road Accidents.
- Reliable & Safer Journeys.
- Reduced Fuel Consumption thereby saving of Natural Resources.
- Reduced Vehicular Operating Costs.
- Increase in Average Speed of Road Vehicles.
- Reduction in Noise Levels.

- Saving in Productive Man-Hours due to Rapid Mode of Transport.
- Improvement in Road Conditions & Extended life of roads due to decrease in Vehicular Load.
- Enhanced Socio-Economic Development.
- Reduced need for Expansion of Roads, Flyovers, laying of new roads etc.
- Better environmental aesthetics & Landscape.
- Boost to Industry, Trade, Commerce, Communication & Culture.

According to a report by CRRI Delhi Metro recently helped save 33,000 tons of fuel & prevented the creation of over 2,275 tons of poisonous gases in the national capital. It stated that, "As a result of less use of vehicles with the coming of the Metro, 57,858 tons of Petrol, Diesel & CNG would be saved by the end of the year 2007. over 33,000 tons of this have already been saved between 2002 & 2006.". The other highlights of the report are:

- Since the Metro began operations in December 2002, the DMRC has already taken 22,697 vehicles load onto its system which is likely to increase to about 40,000 by the end of the year 2007.
- 16.6 lakh vehicle Km would be saved & Rs 218 Crore would be saved on maintenance of vehicles by the end of the year 2007 apart from fuel savings of Rs 172 Crore.
- Apart from Monetary & Environmental benefits, the metro has made substantial improvement in travel conditions & earning capacity per person in the capital.
- A person saves around 66 minutes every day by traveling in Metro, which translates to the additional earning capacity of Rs 715 Crore by the Year end 2007.
- In terms of Road Accidents Delhi Metro has helped in saving 280 lives upto 2006.
- The Report concluded that the Metro would lead to a total savings of around Rs 2072 Crore for the people of Delhi by the end of the year 2007.

Table 11: Potential Annual Savings per person in Air pollution from using MRTS instead of private vehicles

	HC	CO	NO_2	SO_2	PM
Kg	13.47	99.50	7.05	0.14	0.12
Percent	98.6	97.3	85.1	46.1	27.6

Source: Rutter; et al- 1997.

According to a Public Opinion Survey conducted in Bangalore, about 50% of the 2-wheeler & 3-wheeler commuters expressed their willingness to shift to Metro Rail. So, even a conservative realistic figure would be 30% of 2-wheeler & 20% of 3-wheeler commuters would shift to MRTS. Based on this the reduction in the consumption of fuel are worked out & furnished in the table below.

Table 12: Expected Reduction of Fuel Consumption in 2011

Category of Vehicles	No. of Vehicles Without Metro	No. of Vehicles with Metro	Fuel Consumption without Metro (Lts.)	Fuel Consumption with Metro (Lts.)	Fuel Saved (Lts.)
Two Wheelers	2394075	1676137	1795556	1257102	538454
Three Wheelers	157224	125829	786120	629145	156975
Total Saving in Fuel, Liters per day					**695429**

Negative Impacts of the Project

- Change in Land Use Pattern at he Station Areas & neighborhood.
- Impact on green Cover & Felling of Trees.
- Barricading of Sites.
- Traffic Diversions during Construction Phase.
- Soil Erosion & Health Risks at Construction Sites.
- Accidental Hazards during Construction Phase.
- Noise & Vibrations due to Construction activities.
- Impact on Water Quality due to runoff from construction sites.
- Oil Spillage during project operation.
- Station Refuse.

ROLE OF EIA IN PROJECT IMPROVISATION

Environmental Impact Assessment can help achieve the following for the project:

- Strive for Continual Improvement in the Environment, Health & Safety Policies, Processes & Procedures of the project.
- It can help prepare a Management Plan to attain compliance with the local & national Environmental Health & safety laws.
- Most Indian cities have failed to address transportation problems effectively, mainly because they are not equipped with the appropriate institutional capacity & required financial resources. This is because functional responsibilities for urban transport are fragmented among central, state & local govt. where no one entity is in charge of overall condition. Local govts. lack the capacity to generate their own revenues. Thus there is a pressing need to empower the Urban Local Bodies for these projects & thence EIA can play am important role in this related to laying of policies etc for the project, setting up an authorized institution etc.
- Strive to optimize the use of energy, mitigate the negative impacts of the project through a well planned Environmental Management Plan. For e.g. some of the brief points for the EMP of Delhi Metro are:
    - Compensation for Loss of Land.
    - Compensation for Loss of Trees.
    - Compensatory Afforestation & Fencing: 10 times the no. of trees shall be planted as per the Deptt. Of Forests, Delhi administration Stipulations. Fencing shall be done to protect the saplings from the animals.
    - Compensation for Re-Location/Resettlement: Where applicable payment of compensation shall be made according to the Government Policy.
    - Water Supply & Sanitation: Adequate public health facilities as water supply, sanitation & washrooms shall be provided. Water shall be treated before use upto WHO standards.
    - Oil Pollution Control: Oil tends to spill from scum in sedimentation chambers, clog fine screens, interfere with filtration & reduce the efficiency of treatment plants. Hence, oil & grease removal tank shall be installed at the source. Compressed air shall be employed to

coagulate oil & grease & cause it to rise to surface. Such tanks can be designed for a detention period of 5 to 15 minutes. Further adding chlorine in an amount of 2.0mg/l will increase the efficiency of the removal.

- Noise Control: There will be an increase in noise levels due to construction & operation of MRTS corridor but however the noise levels of the core city will go down. The increase in levels is marginal, hence the local population shall not be affected. But the exposure of workers is high. Measures as job rotation, automation, noise barriers, soundproof compartments, control rooms etc shall be implemented to minimize the noise levels.
- Vibration Control: Noise emanates from rail – wheel interaction shall be reduced by minimizing surface irregularities of wheel & rail, improving track geometry, providing elastic fastenings, use of resilient & shock absorbing pads etc.

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