A report on

ENVIRONMENTAL IMPACT ASSESMENT OF DELHI METRO IN PHASE 3

submitted in the partial fulfilment of the requirement for the award of degree of

MASTER OF TECHNOLOGY

(Environmental Engineering)

by

ANAND PRAKASH

(2K15/EN/01)

under supervision of

Mrs. GEETA SINGH
Assistant Professor
(Supervisor)

Mr. ANUNAY A GOUR
Assistant Professor
(Co-Supervisor)

DEPARTMENT ENVIRONMENTAL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

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A few lines are too short to make a complete account of my deep appreciation for my advisor

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Anand Prakash

Certificate

This is to certify that Mr. ANAND PRAKASH, M.Tech. student in the Department of Environmental Engineering has submitted a project report on "ENVIRONMENTAL IMPACT ASSESMENT OF DELHI METRO IN PHASE 3" in partial fulfillment of the requirement for award of degree of Master of Technology in Environmental Engineering, during the academic year 2016-17.

It is a record of the student's research work prepared under our supervision and guidance.

Mrs. Geeta Singh

Asst. Professor
Department of Environmental Engineering,
Delhi Technological University

Mr. Anunay A Gour

Asst. Professor
Department of Environmental Engineering,
Delhi Technological University

Declaration of Originality

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I declare that this is the true copy of my/our report, including all revisions, as approved by my advisors and supervisors, and that this report has not been submitted for any other degree to any other University or Institution.

Anand Prakash
(2K15/ENE/01)

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ppm	Parts per million
A	Coefficient of thermal expansion (/^{o}C)
μ	Coefficient of friction
DMRC	Delhi metro rail corporation
EIA	Environmental impact assessment
NCR	National capital region
JICA	Japan International Cooperation Agency
CTE	Consent To Establish
SPM	Suspended Particulate Matter
AAQS	Ambient Air Quality Standards
CNG	Compressed natural gas

Chapter 1
Introduction

CHAPTER – 1

INTRODUCTION

Delhi is known to be inhabited since 6th century BC. Delhi is also widely believed to have been the legendary capital of the Pandavas. Delhi has a strong historical background owing to the fact that it was ruled over by some of the most powerful emperors in Indian history. The history of city dates back to the time of Mahabharata when it was known as Indraprastha. The other kings occupied and developed cities like Lalkot, Siri, Dinpanah, Quila Rai Pithora, Ferozabad, Jahanpanah, Tughlakabad and Sahajahanabad. The present city of Delhi was founded in 17th century by Mughal Emperor Shahajahan with about one lakh population. This area is now know as old Delhi. In the year 1857 the city came under Brithish rule. British shifted their capital from Calcutta to Delhi in 1911. It is the city of many ancient and medieval monuments and archaeological structures.

The National Capital Region (NCR) in India is a name for the conurbation or metropolitan area which encompasses the entire National Capital Territory of Delhi as well as urban areas ringing it in neighbouring states of Haryana, Uttar Pradesh and Rajasthan. The National Capital Territory of Delhi lies central to the National Capital Region. It includes the city of Delhi and New Delhi. This region has largest concentration of population in whole of the NCR.

Delhi, the capital of India is the largest metropolis by area and the second-largest metropolis by population in India. It is the eighth largest metropolis in the world by population. According to 2001 census, the population of Delhi, as on 1st March, 2001, was worked out at 13.85 millions as against 9.42 millions on 1st March, 1991. The corresponding percentage at All-India level has been worked out at 21.34%. Population [1].duringyears 1901 to 1911 the decennial growth of Delhi was 11.13%. And it increases to 106.58% in 1941-1951. Thereon it steadily decreased. The decennial growth reduces to 46.87% in 1981-1991. However in 1991-2001 decennial growth rises to 52.34%.

North – West and South districts are the most populated districts in Delhi with a population of 2.847 million and 2.258 million respectively. However North – East, Central and East are the densly populated with 29,395; 25,760 and 22,637 people /km^2. According to Census 2001, the

density of population in Delhi is worked out at 9,294 persons per sq. km. as against 6,352 persons in 1991. Density of population at All-India level has been worked out at 324 persons per sq. km. in 2001. The density of population in Delhi is highest in the country.

1.1 Objective and Scope of Study

The objective of the study is to facilitate the Delhi Metro Rail Corporation (DMRC) for EIA report as per requirement of regulatory or funding agency. The scope of EIA includes the impacts resulting from pre construction and operation phases of Phase III Metro corridors, Depots and sub-stations. DMRC plans for funding for the proposed four corridors of Delhi Metro Phase III from Japan International Cooperation Agency (JICA). In Addition it also proposed to establish environmental baseline and safeguard measures for protection of environment for sustainable development during project cycles. The MoEF, Government of India, Notification of 14th September 2006 and its amendment dated 1st December 2009 enlist projects in Schedule that require environmental clearance.

However as per the said notification metro projects does not require environmental clearance from MoEF.

The scope of the study is framed as per JICA guidelines for Environmental and Social considerations. The objectives of the JICA guidelines are to encourage Project proponents to have appropriate consideration for environmental and social impacts, as well as to ensure that JICA's support for examination of environmental and social considerations are conducted accordingly.

1.2 EIA Categorization System

Category A Projects are likely to have significant adverse impacts on the environment andsociety. It includes projects in sensitive sectors or with sensitive characteristics and projects located in or near sensitive areas.

Category B Projects are ones with potential adverse impacts on the environment and society less adverse than those of Category A projects.

Category C Projects have minimal or little adverse impacts on the environment and society.

1.3 Air Quality

The Air (Prevention and Control of Pollution) Act, 1981 and amended in 1987 including Rules 1982 and 1983 was enacted to prevent, control and reduce air pollution. According to Section 21 of the Act, no person shall establish or operate any activity, which can cause air pollution without obtaining Consent to Establish (CTE) as per the Air Act. The Act also lays down national ambient air quality standards for pollutants like SPM, Sulphur dioxide, Oxides of Nitrogen, Carbon monoxide, Lead, Ozone, Ammonia, Benzene and Benzo pyrene with the intent of managing air quality for different category of areas (residential, industrial and sensitive). Ambient Air Quality Standards have been notified by the CPCB vide Gazette Notification dated 16th November 2009, refer **Annexure 1.1.**

The Extended Producer Responsibility (EPR) also specifies source emission standards determined on the basis of the impact of pollutants on human health, vegetation and property for activities, which can pollute the air. The SPCBs, on a case to basis, can also make the emission standards more stringent on the considerations of the carrying capacity of a specific air shed and the existing pollution levels of ambient air quality.

With the objective of regulating ambient noise quality in the environment, the Central Government has notified the Noise Pollution (Regulation and Control) Rules, 2000 amended in 2002 and 2006 under the EPA. The noise standards for different category of areas are based on the weighted equivalent noise level (Leq). The EPR also lays down equipment noise standards for DG sets, Air conditioners and Construction Equipment, which would be in use for the project. Ambient Noise level standards have been notified by the MoEF vide Gazette Notification dated 26th December 1989 and also in the Schedule III of the Environmental (Protection) Rules 1986. It is based on the 'A' weighted equivalent noise level (L_{eq}). These are presented in **Annexure 1.2.**

1.3.1 Central and State Pollution Control Boards

The Central Pollution Control Board is responsible for pollution control throughout the country. In addition to the control of air, noise and water pollution it is also responsible to ensure effective control of disposal of hazardous wastes and storage and handling ofhazardous chemicals and substances. With the enactment of air and water pollution laws, states have set-up their own State

Pollution Control Boards (SPCBs) to monitor industrial emissions and effluents and to approve the operation of new industries after careful scrutiny. The functions of the SPCBs include:

- The planning of comprehensive state programs for the prevention and control of air and water pollution and to ensure the implementation thereof;
- Inspection of pollution control equipment/ plants for monitoring of their efficiency

The SPCB in consultation with the Central Pollution Control Board may establish norms for air quality, gaseous emission and noise level etc.

1.4 Approach and Methodology

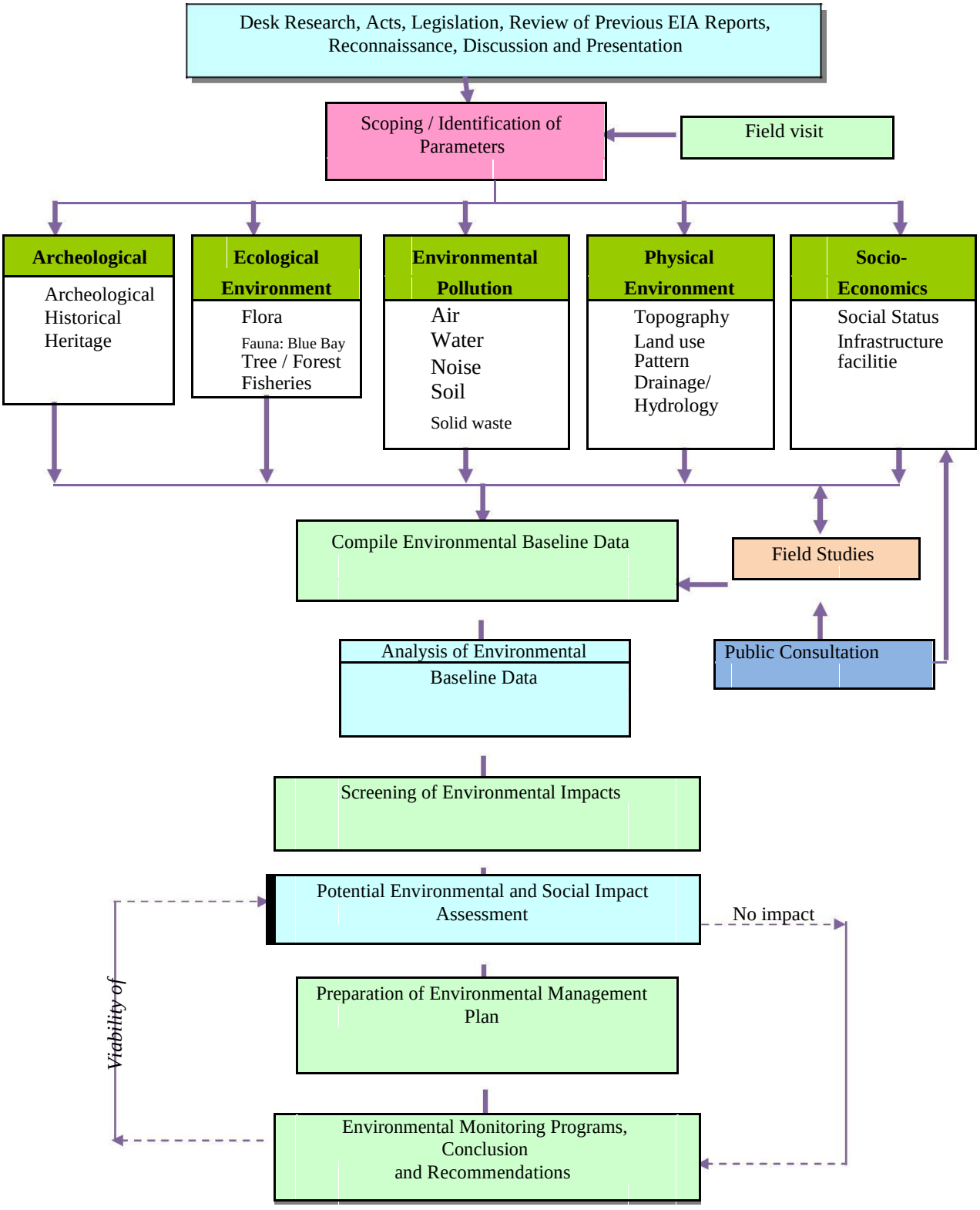
The DMRC has considered the different alternative. The final alternative was fixed based on Technical Feasibility, Socio-economic acceptability, and Environmental sustainability for Metro Corridors. The environmental study is carried out for the final alignment proposed by DMRC. The **approach** is to follow the sequence of steps adopted in an EIA study. The basic concept is to ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in different components of the environment viz. physical, biological / ecological, environmental and socio-economic etc. have been studied, analyzed and quantified, wherever possible. The identification of parameters for data generation and impact assessment are important. The accurate analysis of assessment depends upon the reliable data generated/ available on environmental attributed. RITES has document the baseline data for various parameters of physical (physiographic and soils), ecological (forestry, fisheries and wildlife), and environmental pollution (air, water, noise, and solid waste). The impacts are assessed for various phases of project cycle namely:

- Impacts due to project location,
- Impacts due to project design,
- Impacts due to project construction, and
- Impacts due to project operation.

The impacts are categorized as negative and positive. The cost of management and monitoring programs were estimated and budgeted.

The standard **methodology** for the data collection, impact assessment and formulation of management plans is adopted. The National Acts, Legislation and Laws along with **JICA** and **World Bank** guidelines were consulted with a view to ensure compliance withvarious requirements. The consultant collected and compiled the environmental baseline data for environmental attributes from primary and secondary sources. The primary sources include site visits, visual inspection, field studies, monitoring and analysis. The secondary sources include the books, reports, maps and documents from various government and non-government organizations on subject matter. The methodology proposed to be adopted for data collection, impact analysis, preparation of environmental management and monitoring plans is highlighted in brief, in the following paragraphs. However, more elaborate methodology is present in the main text in the relevant sections.

TABLE 1.1: Methodology for the EIA Study



Chapter–2

Environmental Baseline Data

CHAPTER – 2
ENVIRONMENTAL BASELINE DATA

2.1 Environmental Scoping

The information presented in this chapter stems from various sources. The objective of Environmental Impact Assessment (EIA) is to ascertain the baseline environmental conditions and then assess the impacts as a result of the proposed project during various phases of the project cycle. Identification of environmental parameters, data collection and impact predictions form the core of Environmental Impact Assessment process. Data on land environment has been collected and compiled from various reports and field surveys. The data on water quality, ground water hydrology, vegetation and fauna, air and noise quality was collected during field studies. Climatological data was collected from Indian meteorological Department. Efforts have been made to compile the available data from literature, books, maps and reports.

2.2 Air Quality

Delhi, in terms of air pollution, is ranked among the most polluted cities in the world. The ambient air quality monitoring is carried out regularly by Central Pollution Control Board and Delhi Pollution Control Committee. The annual average levels of suspended particulate matter increased to 450 $\mu g/m^3$ during 1996, which is nearly three times the National Ambient Air Quality Standard of 140 $\mu g/m^3$ for residential areas as notified by the Ministry of Environment, Govt. of India. During this period, the annual average levels of CO also increased to 5587 $\mu g/m^3$ as against the National Ambient Air Quality Standard of 2000 $\mu g/m^3$ for the residential areas. In fact, 1996 is considered the peak year in terms of air pollution load. The transport, industrial and the domestic sectors were the major contributors towards the rising ambient air

pollution levels, in addition to the presence of natural dust due to meteorological conditions. [11].

The atmospheric concentrations of air pollutants were monitored at 16 locations during May 2011 by setting up ambient air quality monitoring stations. Locations of air monitoring stations is shown in **Figure 2.1.** 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 2.1.** The results show that the concentration of $PM_{10}$and $PM_{2.5}$exceeds the standardsat all locations whereas other parameters are within permissible limits at all the locations. Delhi Pollution Control Committee has carried out air monitoring at 41 locations in Delhi from December 2007 to June 2009 for SPM, RSPM, CO, NOx, SO_2. The SPM concentration has indicated that SPM levels are showing decreasing trend from 2007 onwards. This decrease may be attributed to increased use of Metro rail, CNG as fuel and better vehicle conditions. 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 2.1: Ambient Air Quality Results

Timing	PM_{10}	PM2.5	NO_x	SO_2	CH_4	Pb
Limits as per CPCB	**100**	**60**	**80**	**80**	**-**	**1**
Hauz Khas						
02:00PM To 10 PM	196	134	38.8	8.3	2.6	BDL
10:00 PM To 06:00 AM	155	85	29.5	< 5.0	2.0	BDL
06:00 AM To 02:00 PM	182	110	41.5	8.9	2.2	BDL
Average	177	109	36.6	7.4	2.3	BDL
Nehru Place						
02:00PM To 10 PM	207	127	43.5	9.1	2.5	BDL
10:00 PM To 06:00 AM	169	91	32.2	< 5.0	2.2	BDL
06:00 AM To 02:00 PM	190	117	37.4	7.3	2.4	BDL
Average	188	111	37.7	7.1	2.4	BDL
Near Jamia University						
02:00PM To 10 PM	175	102	34.3	6.5	2.6	BDL
10:00 PM To 06:00 AM	141	66	26.9	< 5.0	2.3	BDL
06:00 AM To 02:00 PM	167	95	37.1	< 5.0	2.2	BDL
Average	161.0	87.7	32.8	5.5	2.4	BDL
Lajpat Nagar						
02:00PM To 10 PM	188	103	35.5	6.1	2.5	BDL
10:00 PM To 06:00 AM	147	69	26.7	< 5.0	2.0	BDL
06:00 AM To 02:00 PM	172	87	40.4	< 5.0	2.0	BDL
Average	169	86	34.2	5.4	2.2	BDL
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
Near Botanical Garden						
02:00PM To 10 PM	203	122	41.5	7.6	2.2	BDL
10:00 PM To 06:00 AM	160	80	26.7	< 5.0	2.0	BDL
06:00 AM To 02:00 PM	171	97	37.5	7.2	2.4	BDL
Average	178	99	35.2	7.4	2.2	BDL
I.P. Extension						
02:00PM To 10 PM	190	94	33.2	6.8	2.1	BDL
10:00 PM To 06:00 AM	159	62	24.7	< 5.0	2.0	BDL
06:00 AM To 02:00 PM	178	81	34.9	< 5.0	2.2	BDL
Average	175	79	30.9	5.6	2.1	BDL
Trilok Puri						

02:00PM To 10 PM	234	142	42.6	8.2	2.5	BDL
10:00 PM To 06:00 AM	176	97	31.5	< 5.0	2.2	BDL
06:00 AM To 02:00 PM	210	124	36.8	6.8	2.3	BDL
Average	206	121	37.0	7.5	2.3	BDL
Janpath						
02:00PM To 10 PM	197	127	44.7	9.5	2.5	BDL
10:00 PM To 06:00 AM	161	82	33.9	7.0	2.2	BDL
06:00 AM To 02:00 PM	204	120	47.6	6.5	2.4	BDL
Average	187	109	42.1	7.7	2.4	BDL
Bhikaji Kama Place						
02:00PM To 10 PM	228	140	48.5	9.9	2.9	BDL
10:00 PM To 06:00 AM	184	96	38.3	8.3	2.3	BDL
06:00 AM To 02:00 PM	217	134	46.9	10.3	2.5	BDL
Average	209	123	44.6	9.5	2.6	BDL
Shalimar Place						
02:00PM To 10 PM	218	133	47.8	8.6	3.2	BDL
10:00 PM To 06:00 AM	182	95	31.3	< 5.0	2.4	BDL
06:00 AM To 02:00 PM	211	107	44.2	7.8	2.7	BDL
Average	203	111	41.1	8.2	2.8	BDL
Kashmeere Gate						
02:00PM To 10 PM	229	140	50.2	9.3	2.8	BDL
10:00 PM To 06:00 AM	191	100	34.7	7.1	2.2	BDL
06:00 AM To 02:00 PM	222	112	46.4	8.2	2.4	BDL
Average	214	117	43.8	8.2	2.5	BDL
Janakpuri West						
02:00PM To 10 PM	208	127	38.6	8.2	2.8	BDL
10:00 PM To 06:00 AM	165	81	29.6	< 5.0	2.2	BDL
06:00 AM To 02:00 PM	180	105	36.1	7.5	2.4	BDL
Average	184	104	34.8	7.9	2.5	BDL
Azadpur						
02:00PM To 10 PM	256	165	55.2	11.2	3.5	BDL
10:00 PM To 06:00 AM	198	123	40.7	7.8	2.7	BDL
06:00 AM To 02:00 PM	235	154	55.9	8.3	2.3	BDL
Average	229	147	50.6	9.1	2.8	BDL
Punjabi Bagh						
02:00PM To 10 PM	234	131	43.8	10.7	3.7	BDL
10:00 PM To 06:00 AM	160	84	31.5	8.3	2.4	BDL
06:00 AM To 02:00 PM	205	112	49.2	11.3	2.9	BDL
Average	199.7	109.0	41.5	10.1	3.0	BDL
Narvana						
02:00PM To 10 PM	242	140	48.3	8.9	2.5	BDL
10:00 PM To 06:00 AM	193	126	36.8	7.0	2.0	BDL
06:00 AM To 02:00 PM	227	131	41.2	9.3	2.9	BDL
Average	220	132	42.1	8.4	2.5	BDL

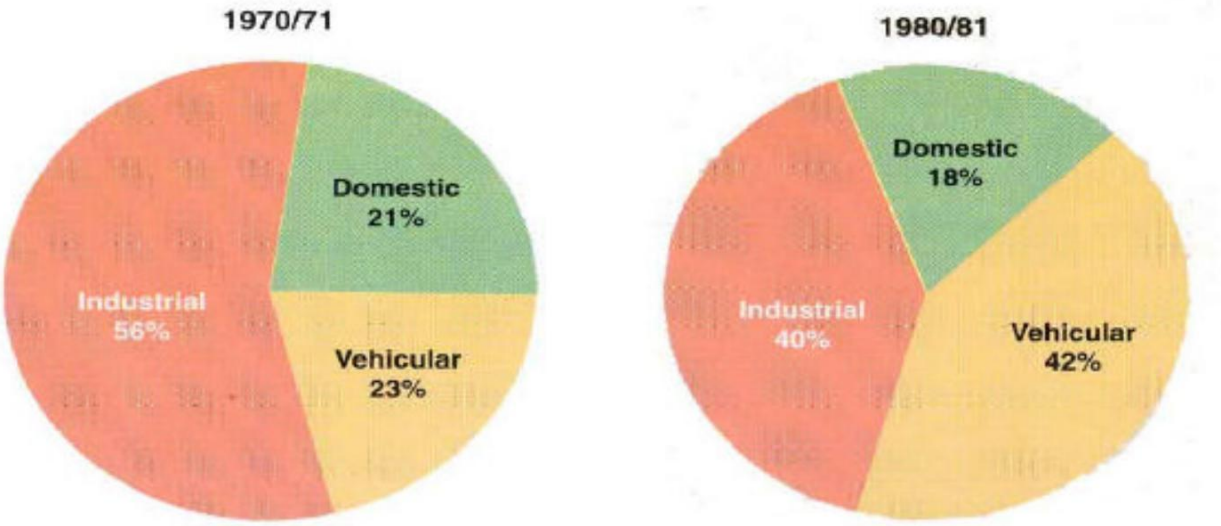
2.3 Noise Environment

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.



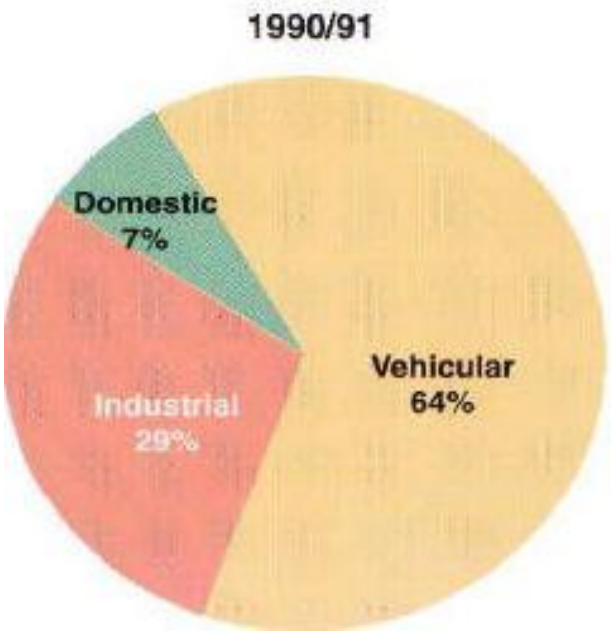


FIGURE 2.1: Contribution of Various Sectors to Ambient Air Pollution in Delhi

Noise level survey was conducted along the alignment with an objective to establish the baseline noise levels and assess the impacts of total noise expected due to the proposed metro. Noise levels were measured at sixteen locations where air monitoring was conducted. Hourly Noise levels were recorded at 2 m away from source as per standard practice. The noise levels so obtained are summarised in **Table 2.2** and hourly data is presented in **Table 2.3** The results of observations indicate that the equivalent noise levels at all the these sites are more than the limit prescribed for residential areas. In addition to above a literature survey was also carried out for noise levels. Delhi Pollution Control Committee carried out noise monitoring at 41 locations in Delhi. The analysis of data has indicated that at a number of places the day and night levels exceed the CPCB National Noise Standards. The noise level standards are documented in **Annexure 1.2**

TABLE 2.2: Noise levels

Monitoring Locations	L_{eq} (24Hrs)	L_{10}	L_{50}	L_{90}	L_{day}	L_{night}	L_{dn}	L_{max}	L_{min}
1	72.5	77.1	75.2	73	74.1	61.2	73.4	78.4	54.6
2	69.1	73.4	71.9	69.7	70.7	60.0	70.5	74.2	49
3	69.3	73.8	72.0	69.8	70.9	59.1	70.4	74.6	47.6
4	71.5	75.8	74.1	72.0	72.9	64.2	73.1	76.1	53.7
5	70.5	76.3	73.3	71.1	72.0	62.3	72.1	77.2	48.1
6	67.0	72.6	69.6	67.5	68.6	56.2	67.9	72.6	47.3
7	58.6	63.5	61.3	59.1	60.2	48.7	59.8	64.8	43.5
8	70.3	76.1	73.0	70.8	71.9	57.6	70.9	77.2	50.8

9	61.7	66.8	64.4	62.2	63.3	49.7	62.4	67.8	44.6
10	64.3	69.1	66.9	64.8	65.8	55.2	65.6	69.6	48.3
11	70.8	75.8	73.5	71.4	72.5	58.6	71.5	76.3	51.5
12	64.8	70.9	67.5	65.4	66.5	51.6	65.4	71.5	46.8
13	62.7	67.9	65.3	63.2	64.2	53.9	64.1	68.5	47.1
14	70.2	74.8	73	70.8	71.6	63.3	72.3	75.9	50.5
15	69.5	73.9	72.2	70.1	71.1	60.4	70.9	74	50.2
16	63.2	68.5	65.9	63.8	64.8	55.3	64.9	69.2	46.0

1) Azadpur 2) Punjabi Bagh 3) Narainya 4) Bhikaji Kama Place 5) Lajpat Nagar 6) Trilokpuri 7) I P Extension 8) Arjun Nagar 9) Jamia University 10) Botanical garden 11) Nehru Place 12) Hauz Khas 13) Janakpuri West 14) Janpath 15) Kashmiri Gate 16) Shalimar Place

Table 2.3 Hourly Noise Levels

S. No.	Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Mid Night	56.5	52.9	50.6	56.0	53.0	51.2	47.8	52.4	44.6	49.8	53.4	48.5	49.6	53.6	54.8	49.3
2.	1:00 AM	54.6	50.1	50.6	56.1	48.9	51.1	45.6	53.4	44.8	50.7	52.4	47.6	49.7	51.9	52.9	49.4
3.	2	54.7	49.2	49.6	55.5	48.1	50.4	45.9	52.5	45.1	49.9	51.5	46.8	48.1	51.4	52.2	48.8
4.	3	56.6	49.0	48.4	54.6	49.2	49.5	45.0	51.5	44.9	48.9	52.5	47.7	47.2	50.5	50.2	46.0
5.	4	55.5	50.9	47.6	53.7	50.7	47.3	43.5	50.8	47.3	48.3	52.9	48.1	47.1	50.6	51.2	47.3
6.	5	57.8	51.2	52.8	55.6	51.7	48.5	45.3	52.9	50.1	50.3	60.0	54.5	48.2	52.4	55.5	50.9
7.	6	62.6	55.0	58.9	57.6	54.2	50.3	50.6	61.5	54.9	58.4	65.7	59.7	53.8	53.3	57.2	50.7
8.	7	64.9	57.3	61.3	62.6	58.4	53.6	51.4	62.4	55.8	59.3	66.7	60.6	56.6	56.0	63.4	53.1
9.	8	70.1	62.4	65.8	68.1	62.4	56.3	53.3	68.8	58.6	61.4	70.1	63.7	60.1	61.9	66.1	59.9
10.	9	74.9	68.2	68.0	73.0	67.2	60.4	55.7	69.4	57.4	61.9	70.5	62.4	62.4	66.4	69.6	62.2
11.	10	78.4	71.6	72.6	76.0	68.3	67.9	60.6	69.3	63.1	63.8	71.1	64.2	65.3	72.7	73.7	68.9
12.	11	76.1	70.3	73.2	75.2	70.8	69.8	62.3	72.8	65.4	66.2	72.2	65.6	67.6	73.8	74.0	69.2
13.	12 Noon	74.2	72.5	74.6	74.2	69.5	72.6	62.8	76.5	65.1	66.7	75.8	70.8	68.5	72.9	72.9	66.3
14.	13	76.0	71.2	71.2	75.0	68.2	72.6	62.4	77.2	67.8	69.3	75.1	71.5	67.5	70.9	70.7	63.0
15.	14	75.3	72.5	73.6	73.4	71.2	69.3	61.9	72.9	66.5	67.3	72.2	64.7	64.4	72.2	73.8	64.6
16.	15	76.3	71.5	72.5	76.1	72.2	67.9	58.5	72.6	64.2	65.0	71.9	65.4	64.4	73.7	71.7	67.0
17.	16	74.1	73.4	70.5	72.6	74.9	68.5	58.8	71.9	64.7	65.3	76.3	70.3	63.4	72.4	73.8	63.9
18.	17	75.8	74.2	71.4	74.2	77.2	67.4	60.2	71.5	65.9	66.9	72.8	66.2	61.5	71.1	72.9	66.3
19.	18	73.2	72.5	70.7	73.5	74.2	72.6	64.8	74.0	63.0	68.3	75.4	68.5	63.5	75.9	70.7	64.7
20.	19	72.6	71.9	71.9	71.7	76.4	71.2	62.6	69.0	58.8	69.6	72.3	63.9	65.5	74.3	68.6	64.1
21.	20	70.8	70.1	70.0	70.3	74.6	65.5	56.7	67.7	59.7	66.3	69.0	62.7	63.2	72.1	69.4	63.9
22.	21	67.8	67.1	65.8	70.8	69.6	63.4	53.9	63.3	53.9	62.1	64.5	58.6	60.7	70.7	66.7	62.3
23.	22	62.9	62.3	62.7	67.6	64.0	56.4	50.4	61.0	54.0	56.0	62.2	56.5	54.9	66.0	63.7	55.5
24.	23	58.7	58.1	56.2	62.0	61.9	52.9	47.2	55.2	49.0	52.4	56.2	51.1	51.0	58.2	59.6	54.6

1) Azadpur 2) Punjabi Bagh 3) Narainya 4) Bhikaji Kama Place 5) Lajpat Nagar 6) Trilokpuri 7) I P Extension 8) Arjun Nagar 9) Jamia University 10) Botanical garden 11) Nehru Place 12) Hauz Khas 13) Janakpuri West 14) Janpath 15) Kashmiri Gate 16) Shalimar Place

2.4 AMBIENT AIR QUALITY MONITORING (PM10 EMISSION)

The monitoring of PM10 emission has been monitored in casting yard and stations.

Table 2.4: PM10 monitoring -1st 24 Hrs.

Parameters	PM10			
Unit	µg/m^3			
Frequency	24 Hrs			
S.NO	LOCATION	JAN-17	FEB-17	MARCH-17
1	Casting Yard	375	469	506
2	Shaheed Nagar	366	389	163
3	Raj Bagh	342	297	176
4	Rajendra Nagar	369	285	188
5	Shyam Park	334	317	168
6	Mohan Nagar	381	276	156
7	Arthla	329	273	172
8	Hindon	294	267	184
9	New Bus Adda	337	309	203

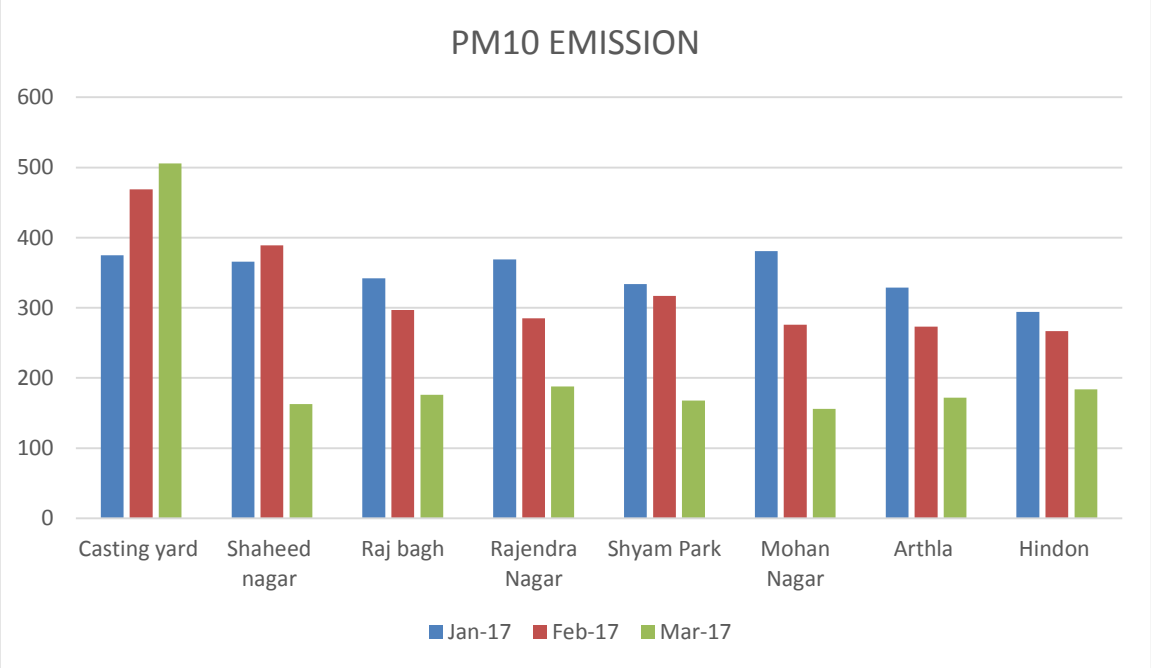


Figure 2.2:PM10 Monitoring -1ST 24 Hrs.

Table 2.5: PM10 monitoring -2nd 24 Hrs.

Parameters	PM10			
Unit	µg/m^3			
Frequency	24 Hrs			
S.NO	LOCATION	JAN-17	FEB-17	MARCH-17
1	Casting yard	486	598	534
2	Shaheed nagar	413	341	188
3	Raj bagh	395	408	217
4	Rajendra Nagar	409	352	195
5	Shyam Park	357	346	187
6	Mohan Nagar	427	382	173
7	Arthla	364	328	203
8	Hindon	312	307	171
9	New Bus Adda	359	312	182

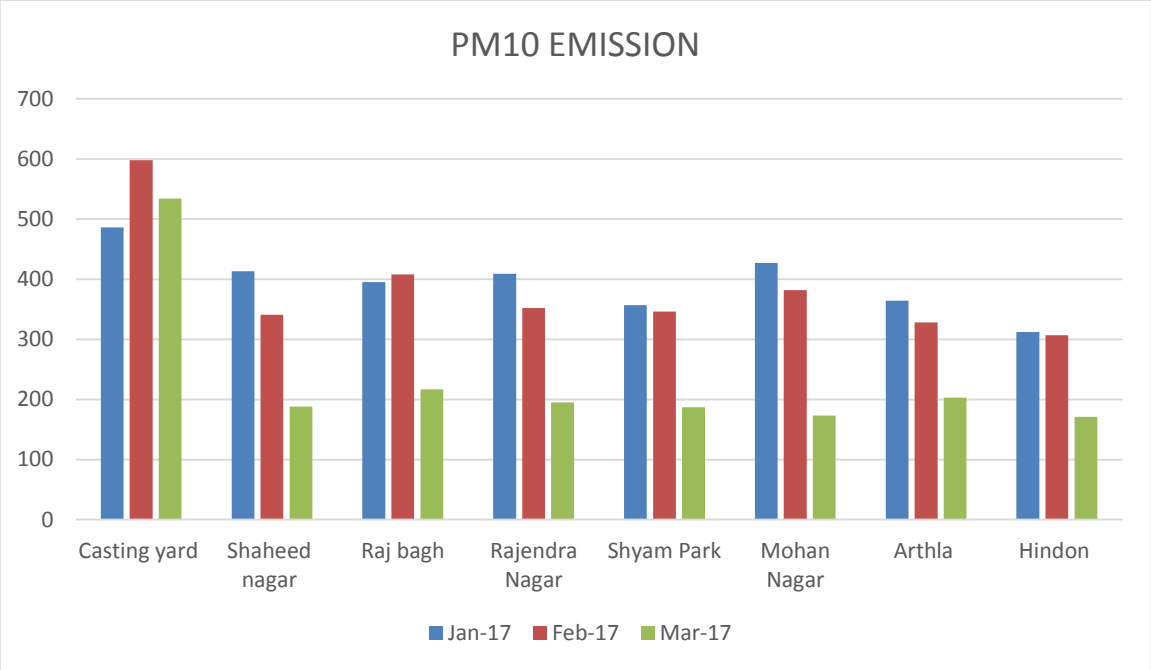


Figure 2.3: PM10 Monitoring -2ND 24 Hrs

2.5 Construction Noise Monitoring

Monthly Noise Monitoring for construction activites have been carried out during day time and night time as per the Environmental Plan; a summary of the results is shown in Table

Table 2.6: Noise level (1st week)

PARAMETERS		DAY TIME NOISE LEVEL			NIGHT TIME NOISE LEVEL		
Unit		dB(A)			dB(A)		
DMRC requirements (Leq)		75			70		
Frequency		16 Hrs			8 Hrs		
S.NO	LOCATION	JAN-17	FEB-17	MAR-17	JAN-17	FEB-17	MAR-17
1	Casting yard	71.5	73	68.4	67.2	67.5	63.9
2	Shaheed nagar	77.5	68.9	71.1	60.1	62.5	65.4
3	Raj bagh	66.5	72.7	69.7	58.7	62.6	64.4
4	Rajendra Nagar	70.3	72.1	70.9	62	60.9	68.2
5	Shyam Park	69.1	79.7	68	61	66.6	64.2
6	Mohan Nagar	72.2	74.3	75.9	68	63	64.3
7	Arthla	69.1	70.9	70.1	60.3	62.8	64.4
8	Hindon	72.1	69.3	68	69	58	64
9	New Bus Adda	76.1	72.9	71.1	60.5	59.4	68

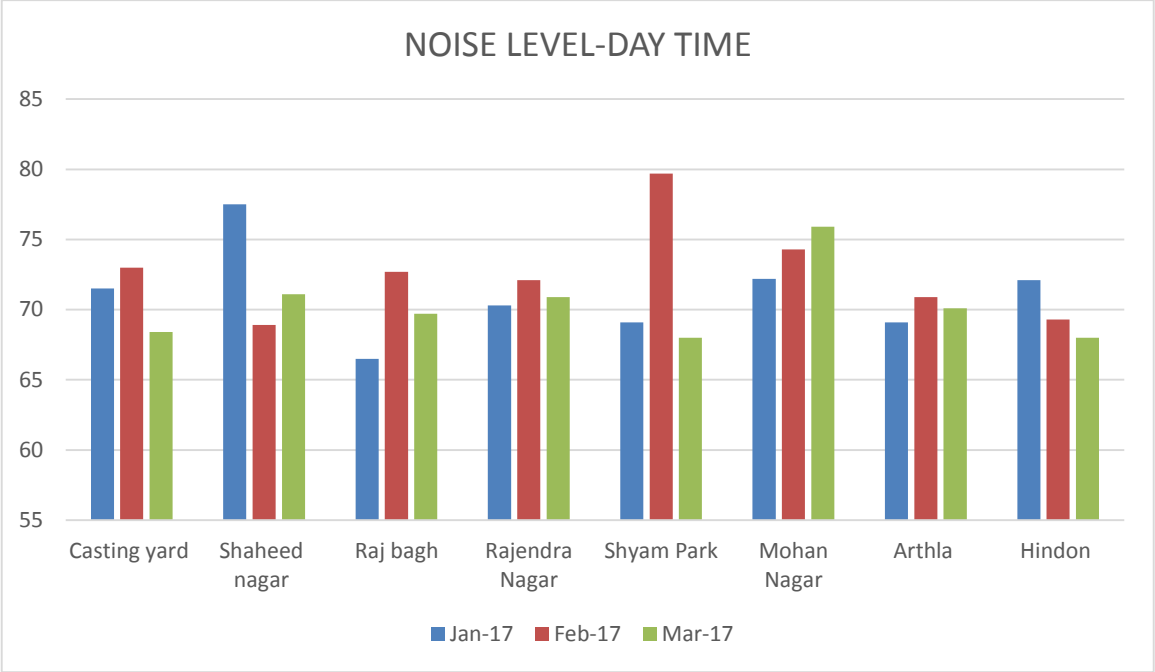


Figure 2.4: Noise level Day Time (1st week)

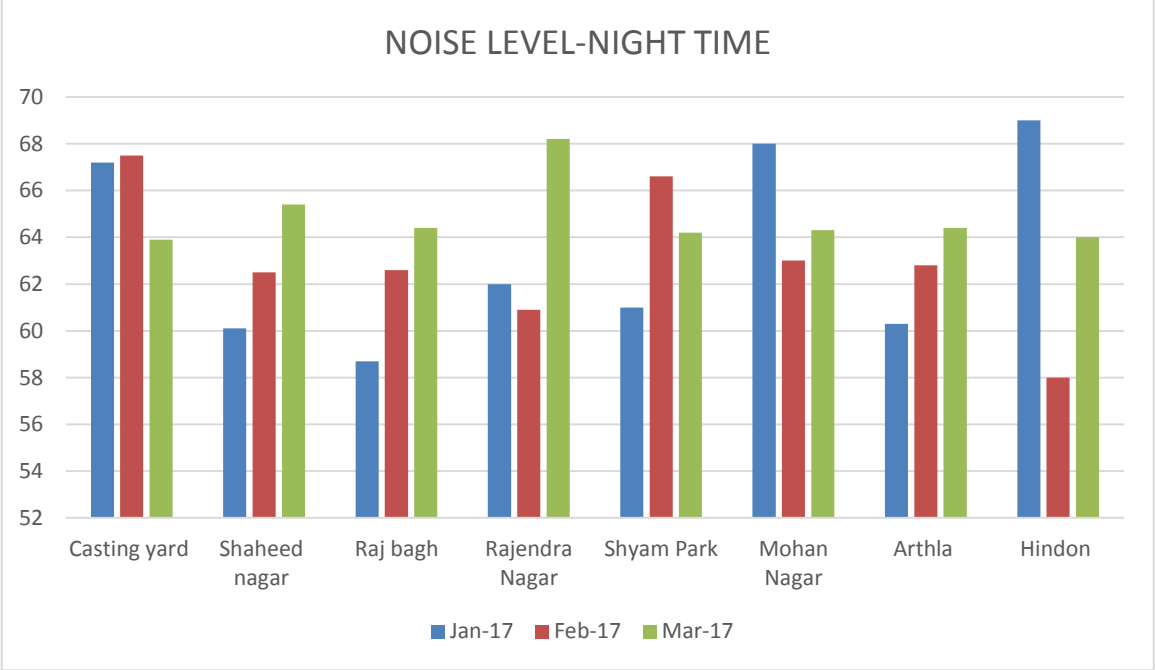


Figure 2.5: Noise level Night Time (1st week)

Table 2.7:Noise level (2nd week)

PARAMETERS		DAY TIME NOISE LEVEL			NIGHT TIME NOISE LEVEL		
Unit		dB(A)			dB(A)		
DMRC requirements (Leq)		75			70		
Frequency		16 Hrs			8 Hrs		
S.NO	LOCATION	JAN-17	FEB-17	MAR-17	JAN-17	FEB-17	MAR-17
1	Casting yard	80.7	69.3	68	61.1	61.3	62.8
2	Shaheed nagar	70.2	70.3	73.1	63.9	63.1	54.7
3	Raj bagh	74.9	76.5	65.6	58.4	63.3	59
4	Rajendra Nagar	74.4	73.6	76.2	68.7	63.9	61.5
5	Shyam Park	78.2	76.1	72.9	59.7	60.4	60.4
6	Mohan Nagar	77.9	72	77.4	63	61.4	54.1
7	Arthla	72.2	78.2	69.7	60.9	62	58
8	Hindon	70.5	70.8	68	58.6	59.9	54.9
9	New Bus Adda	73.5	72.8	68	64.5	61	54.9

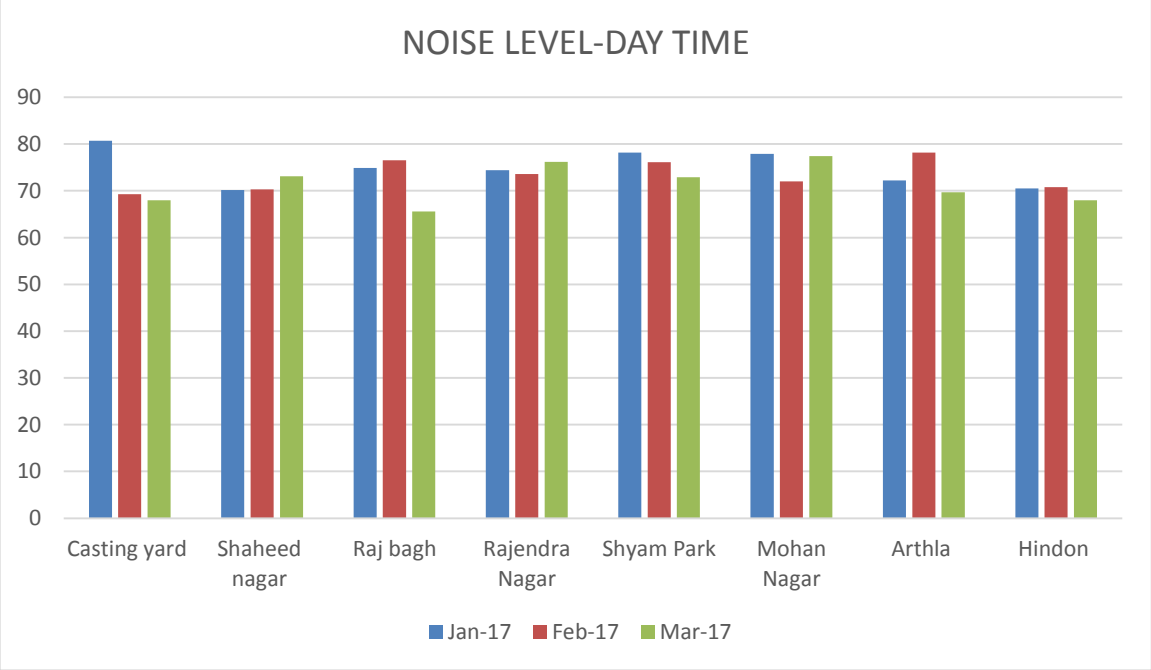


Figure 2.6:Noise level Day Time (2nd week)

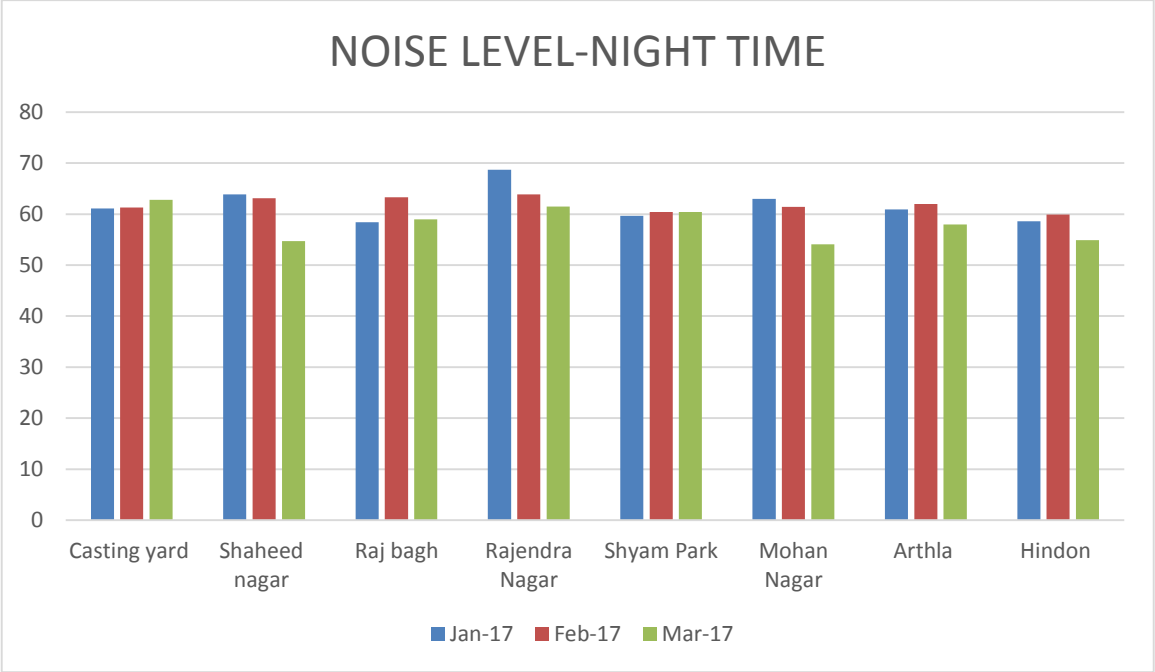


Figure 2.7:Noise Level Night Time (2nd week)

Table 2.8: Noise level (3rd week)

PARAMETERS		DAY TIME NOISE LEVEL			NIGHT TIME NOISE LEVEL		
Unit		dB(A)			dB(A)		
DMRC requirements (Leq)		75			70		
Frequency		16 Hrs			8 Hrs		
S.NO	LOCATION	JAN-17	FEB-17	MAR-17	JAN-17	FEB-17	MAR-17
1	Casting yard	72.6	72.8	79.6	68.9	63.5	61.9
2	Shaheed nagar	76.5	73.9	73.5	62	68.1	64.8
3	Raj bagh	70.9	74.7	64.6	63.5	68.8	60.1
4	Rajendra Nagar	69.5	71.3	71.5	58.4	62.8	67
5	Shyam Park	78.6	77	65.3	63.4	61.1	63.9
6	Mohan Nagar	75.8	71.6	72.5	60.1	63	65.8
7	Arthla	79.5	74.6	70.1	67.2	61	63.9
8	Hindon	72.9	76.8	73.5	67	64.7	64.6
9	New Bus Adda	73.3	73.4	70.3	69.1	62	64.8

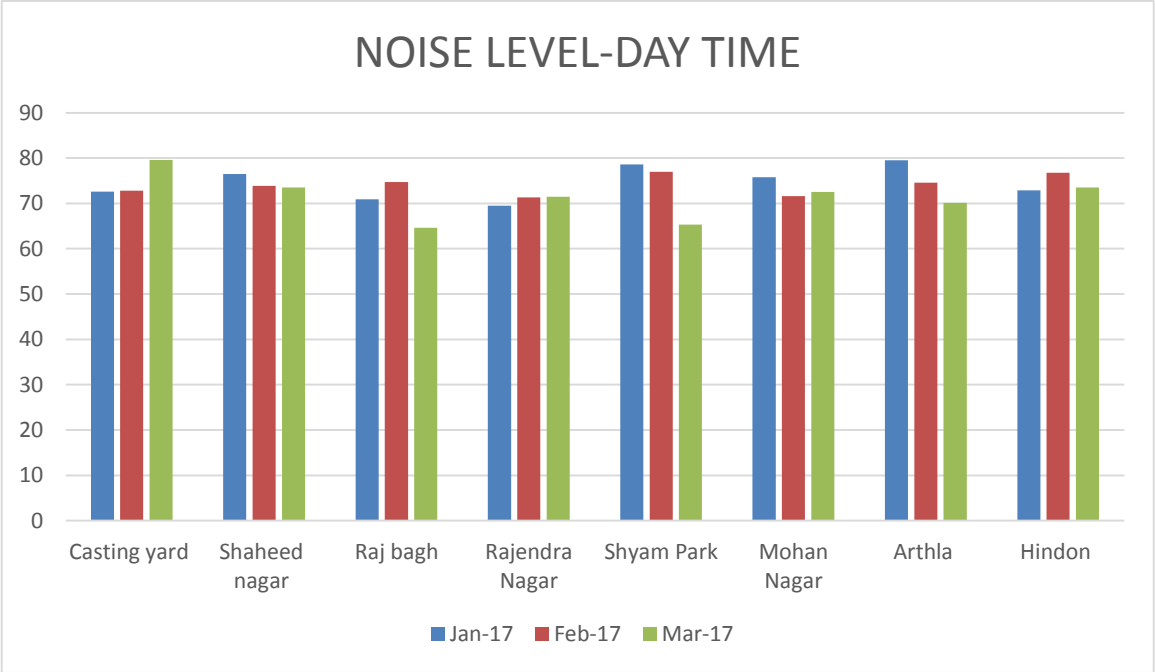


Figure 2.8: Noise level Day Time (3rd Week)

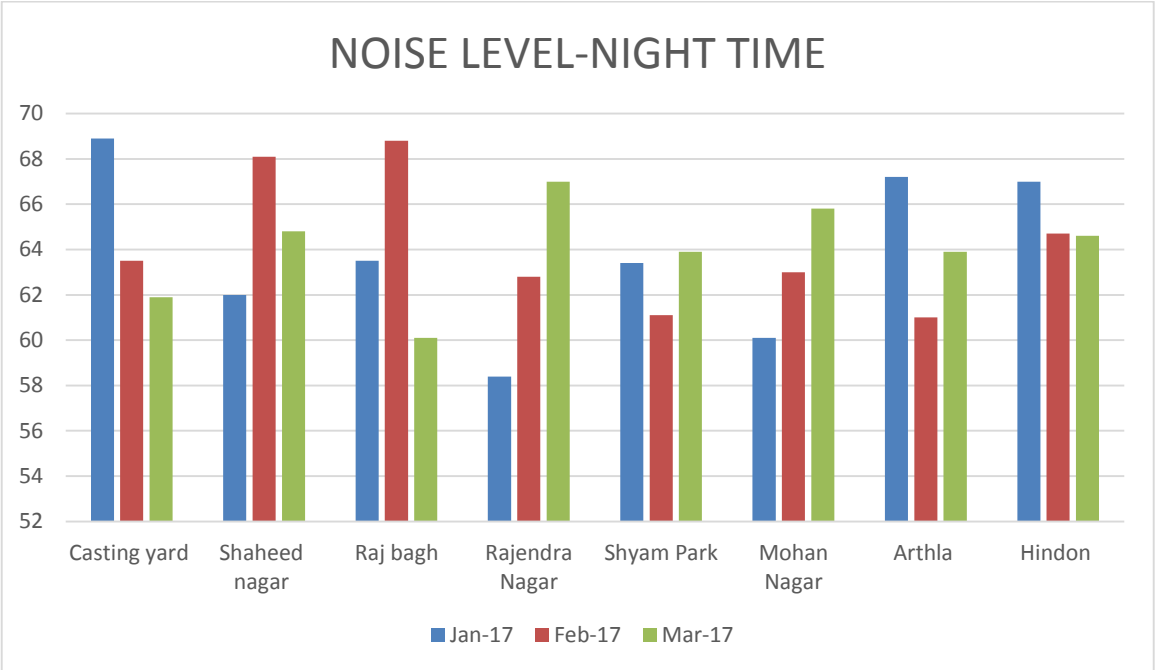


Figure 2.9: Noise Level Night Time (3rd week)

Table 2.9: Noise level (3rdweek)

PARAMETERS		DAY TIME NOISE LEVEL			NIGHT TIME NOISE LEVEL		
Unit		dB(A)			dB(A)		
DMRC requirements (Leq)		75			70		
Frequency		16 Hrs			8 Hrs		
S.NO	LOCATION	JAN-17	FEB-17	MAR-17	JAN-17	FEB-17	MAR-17
1	Casting yard	77.1	77.4	70.1	62.9	64.7	60.8
2	Shaheed nagar	69.6	78.8	67.9	61.1	68.5	63.1
3	Raj bagh	68.1	74	71.9	60.6	67.3	66
4	Rajendra Nagar	70.2	69.3	70.8	60.4	64.1	66
5	Shyam Park	72.4	74.2	68.7	61.9	69	62.8
6	Mohan Nagar	73.5	74	70.4	62.9	68.4	66.9
7	Arthla	72.6	72	71.8	64	64.2	64.7
8	Hindon	71.7	71.9	76.3	62.4	66.1	65.7
9	New Bus Adda	70.9	76.8	73.1	66.3	63.3	67.7

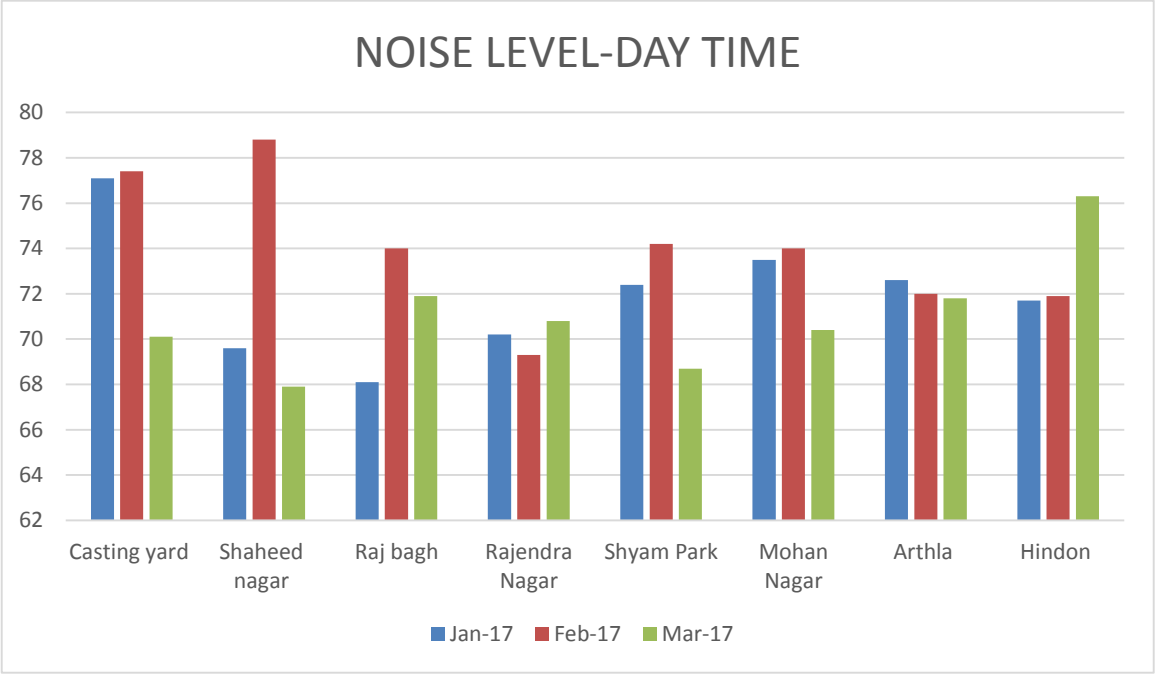


Figure 2.10: Noise Level Day Time (4th week)

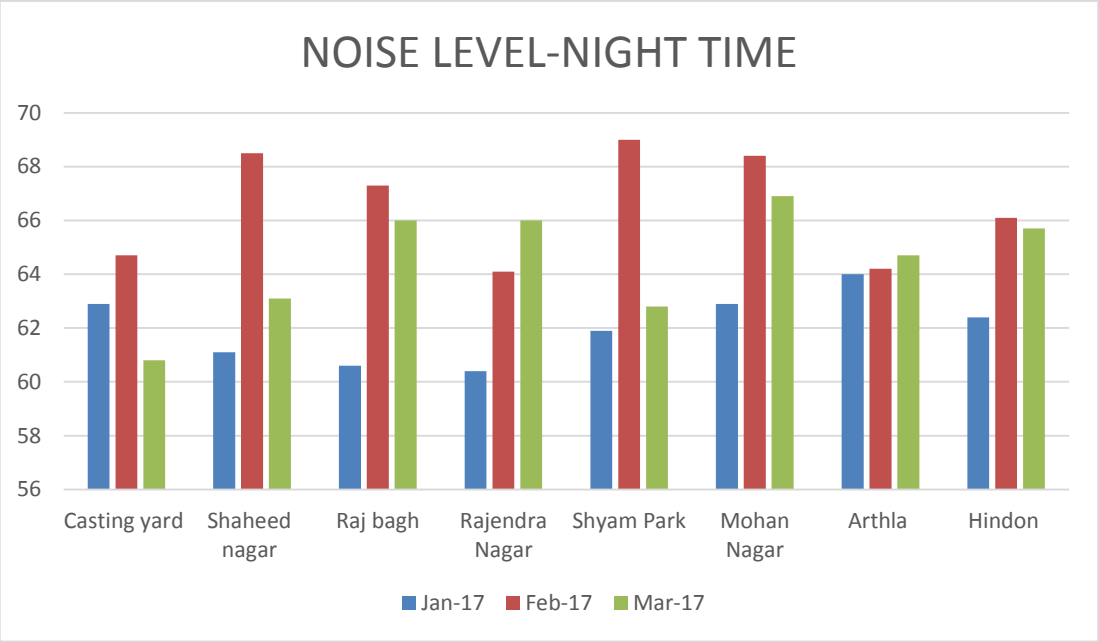


Figure 2.11: Noise Level Night Time (4th week)

CHAPTER – 3

NEGATIVE ENVIRONMENTAL IMPACTS

CHAPTER – 3
NEGATIVE ENVIRONMENTAL IMPACTS

3.1 General

The primary function of an environmental impact assessment study is to predict and quantify the magnitude of impacts, evaluate and assess the importance of the identified changes and formulate plans to monitor and mitigate the actual changes. Environmental impacts could be positive or negative, direct or indirect, local, regional or global, reversible or irreversible.

With rapid strides in economic development, particularly in urban development, the need for rationalizing and upgrading the transport system is imperative. In the process of development, there has been intensive use of natural resources. Very often the process of development has adversely affected the environment leading to ecological imbalances. The importance of conserving and enhancing the environmental assets has assumed urgency. Apart from land-use, conservation of water, flora and fauna, transportation planning is an important aspect of economic development.

The main aim of the project is to decongest the road traffic. The project is designed keeping in view population growth, future traffic demands and environmental protection aspects. Moreover any connection from/to Phase- I and Phase- II existing Metro-Stations will help in direct interchange. This will not only reduce vehicles on road and vehicular pollution but also the pedestrians. The reduction of air pollution in Delhi is reported in Chapter 5.

The process began by identifying the development and operational activities resulting from the proposed project as contained in **Chapter-2**. It was dedicated for providing information on the baseline environmental conditions for various parameters. This chapter discusses the potential impacts on environment. As far as possible, attempts have been made to quantitatively predict the impacts due to proposed project. For non-quantitative impacts, qualitative assessment has been made.

Negative impacts likely to result from the proposed development have been listed under the following headings:

Impacts due to Project Location;

Impacts due to Project Design;

Impacts due to Construction; and

Impacts due to Project Operation.

For each of these headings, potential impacts have been considered, while recommendations for mitigating measures have been stated in **Chapter –5.**

3.2 Environmental Impacts

This section identifies and appraises the negative as well as positive impacts on various aspects of the environment likely to result from the proposed development. It is pertinent to mention that the negative environmental impacts listed below are based on the assumption that no negative impact mitigation measure or benefit enhancements are adopted.

- Land Environment
- Water Environment
- Air Environment
- Noise Environment
- Biological Environment
- Socio-Economic Environment

The impacts on the above environmental components have been further assessed during various phases of project cycle namely project location, project design, construction and operation.

3.3Impacts Due to Project Location

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

- Project Affected People (PAPs)
- Change of Land use;
- Loss of trees/forest;
- Utility/Drainage Problems, and
- Impact on Historical and Cultural Monuments

3.4 Impacts Due to Project Construction

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

- Soil erosion, pollution and health risk at construction site,
- Traffic diversion and risk of existing building,
- Excavated soil disposal problems,
- Dust Generation
- Increased water demand
- Impact due to Construction of Bridges on Yamuna
- Impact due to Supply of Construction Material
- Impact due to Construction near Archaeological Structures
- Noise Pollution

3.4.1 Noise Pollution

Construction noise in the community may not pose a health risk or damage to peoples' hearing, but it can adversely affect peoples' quality of life. To some

degree, construction noise can be a contributing factor to the degradation of someone's health in that it can cause people to be irritated and stressed and can interrupt their ability to sleep - all of which may lead to higher blood pressure, anxiety, and feelings of animosity toward the people or agencies responsible for producing the noise. Construction noise may disturb people at home, in office buildings or retail businesses, in public institutional buildings, at locations of religious services depending upon their vicinity to construction site. Construction noise is unwelcome during nighttime in residential areas during sleep; it can be equally unwelcome during the daytime in commercial areas if it interferes with peoples' ability to conduct business.

The major sources of noise pollution during construction are movement of vehicles for transportation of construction material to the construction site and the noise generating activity at the construction site itself. The Metro construction is equipment intensive. A noise prediction is carried out for Lmax and Leq for different combinations of construction equipments working simultaneously at a site. While predicting the noise levels, average day time noise levels is taken as 67.9dB(A), average evening time noise levels as 67.8 dB(A) and night time average noise levels as 51.9 dB(A). These assumed values are average of the noise level monitoring carried out for this project at different locations. . The Result of the noise prediction is presented in **Table 3.1** and shown graphically in **Figure 3.1** to**Figure 3.3.**

Table 3.1: Noise Levels Predection During Construction

Distance	Concrete Batch Plant + Concrete Mixer Truck		Auger Drill Rig +Dump Truck + Generator + Slurry Plant		Dump Truck + Excavator + Pneumatic Tools	
	Lmax	Leq	Lmax	Leq	Lmax	Leq
5	103	97.8	104.4	102.9	105.2	103.6
10	97	91.8	98.3	96.8	99.2	97.6
15	93.5	88.3	94.8	93.3	95.6	94.1
20	91	85.8	92.3	90.8	93.1	91.6
25	89	83.8	90.4	88.9	91.2	89.6
30	87.4	82.2	88.8	87.3	89.6	88
35	86.1	80.9	87.5	86	88.3	86.7
40	84.9	79.7	86.3	84.8	87.1	85.5
45	83.9	78.7	85.3	83.8	86.1	84.5
50	83	77.8	84.4	82.9	85.2	83.6
55	82.2	77	83.5	82	84.4	82.8
60	81.4	76.2	82.8	81.3	83.6	82
65	80.7	75.5	82.1	80.6	82.9	81.3
70	80.1	74.9	81.4	79.9	82.3	80.7
75	79.5	74.3	80.8	79.3	81.7	80.1
80	78.9	73.7	80.3	78.8	81.1	79.5
85	78.4	73.2	79.8	78.2	80.6	79
90	77.9	72.7	79.3	77.8	80.1	78.5
95	77.4	72.2	78.8	77.3	79.6	78
100	77	71.8	78.3	76.8	79.2	77.6

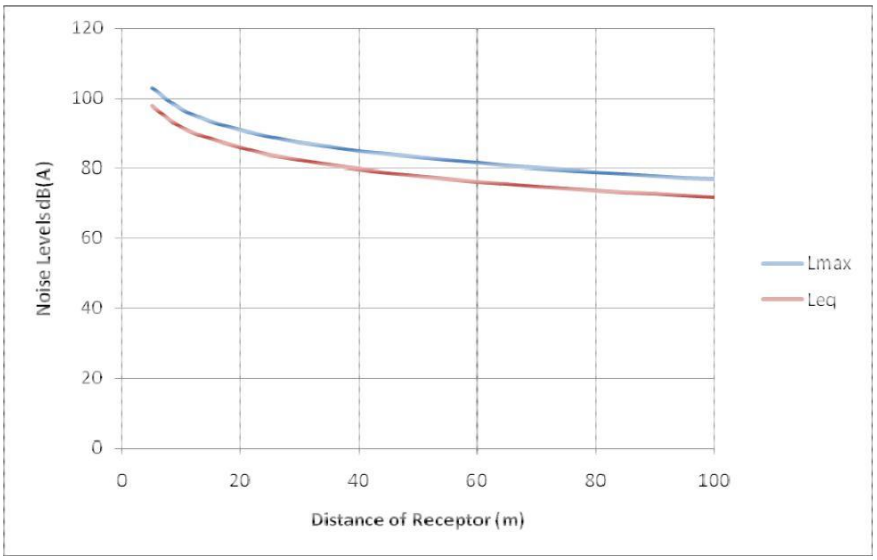


FIGURE 3.1:NOISE LEVELS dB(A)DUE TO CONCRETE BATCH PLANT + CONCRETEMIXER TRUCK

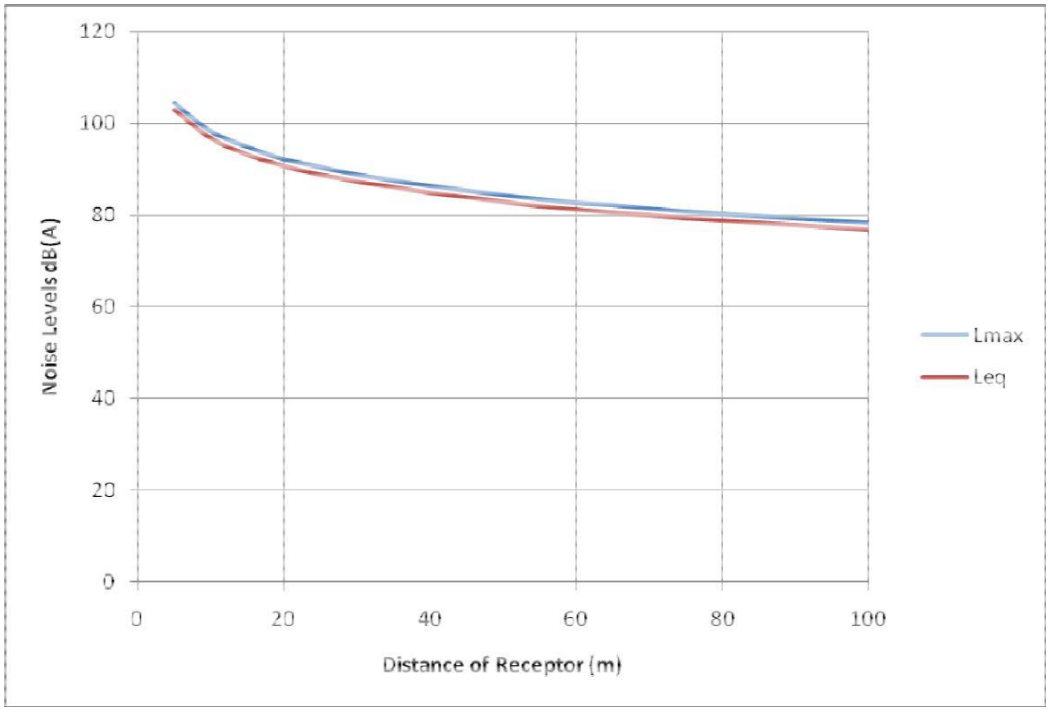


FIGURE 3.2:NOISE LEVELS dB(A)DUE TO AUGER DRILL RIG + DUMP TRUCK +GENERATOR + SLURRY PLANT

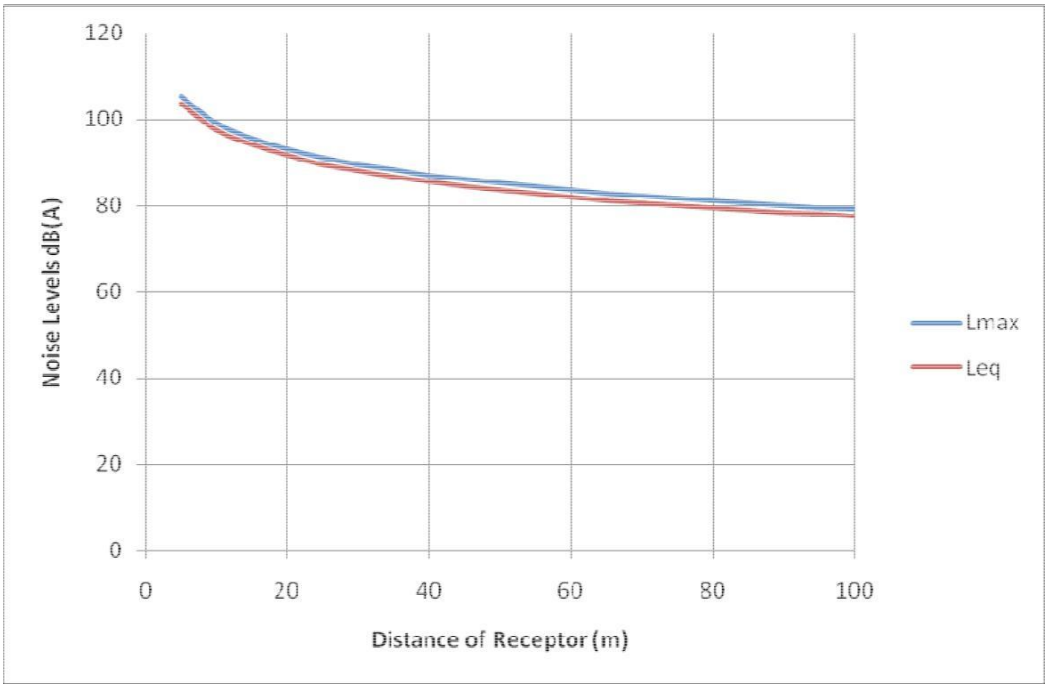


FIGURE 3.3:NOISE LEVELS dB(A)DUE TO DUMP TRUCK + EXCAVATOR + PNEUMATICTOOLS

3.5 IMPACTS DUE TO PROJECT OPERATION

Along with many positive impacts, the project may cause the following negative impacts during operation of the project due to the increase in the number of passengers and trains at the stations:

- Noise pollution,
- Water supply and sanitation at Stations,
- Refuse disposal and sanitation, and
- Pedestrainisation and visual issues

3.5.1Noise Pollution

During the operation phase the main source of noise will be from running of metro trains. Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from at-grade and elevated structures, while ground-borne noise and vibration are of primary concern in underground operations.

Basic Sources of wayside airborne noise are:

i) Wheel / Rail Noise : Due to wheel /rail roughness
ii) Propulsion Equipment: Traction motors, cooling fans for TM, reduction gears etc.
iii) Auxiliary Equipment: Compressors, motor generators, brakes, ventilation systems, other car mounted equipment
iv) Elevated Structure Noise
    - At low speed(<15 km/h) auxiliary equipment may predominate
    - At speeds up to approx. 50 km/h, W/R noise predominates
    - At speeds greater than 50 km/h, the propulsion equipment noise predominates
    - For light weight steel elevated structures, the structure noise can predominate at all speeds above 15 km/h

US data shows that the noise levels inside the rail transit cars range from about 65 to 105 dB(A) during normal operation. Wide range of noise levels depends on following factors:

i) **Train** Speed **(V):** Car interior noise levels vary From $15 \log_{10} V$ to $40 \log_{10} V$.
ii) **Type of Way structure:**Noise levels lowest on AG ballast and tie-weldedtrack and highest for operations on light-weight structures and in tunnels with concrete track bed and no acoustic treatment.
iii) **Sound Insulations of car body:** Single leaf or Sandwich construction.
iv) **Type &Design of Mechanical Equipment:** Propulsion system & AuxiliaryEquipment(A/c system, compressorsand motor generator sets).
v) **Wheel and Rail conditions**: Rail corrugations and wheel flats can increasethe noise levels by 10-15 dB(A)

A study was carried out by National Physical Laboratory for Delhi metro noise levels in elevated and underground metro stations for various operations The results of the noise levels are presented in **Table 3.2** and **Table 3.3.** Wayside Noise Level at 15 m from track Centre Line and at 25 km/h =71.5± 2.0

Table 3.2: Exterior Noise Levels in Metro Station

S. No	DESCRIPTION	AVERAGE NOISE LEVELS (dB)A		
		AG	EL	UG
1	Background Noise Level	58.0± 1.5	64.0± 1.5	56.0± 0.5
2	Train entering the PF (Max)	83.0± 1.0	84.0± 1.5	87.5± 1.5
3	Train leaving the PF (Max)	83.0± 1.0	84.0± 0.5	87.5± 1.5
4	Train stopping in PF	76.5± 1.0	79.0± 0.0	79.5± 1.0
5	Train stationary in PF	76.0± 2.0	76.0± 0.5	76.0± 2.0
6	Train starting from PF	80.0± 1.0	78.5± 1.0	80.5± 2.0
7	Train braking	85.0± 0.5	86.0± 0.0	86.0± 2.0
8	Announcement	72.0± 1.0	74.0± 0.5	70.5± 0.0
	Overall	**75.0± 8.0**	**76.0± 7.0**	**75.0± 10.0**

Table 3.3: Interior Noise Levels in Metro Trains

S. No	DESCRIPTION	AVERAGE NOISE LEVELS (dB)A		
		AG	EL	UG
1	Train stationary	62.0± 1.0	62.0± 1.0	68.0± 0.5
2	Train starting	63.0± 1.0	62.0± 1.0	69.5± 0.5
3	Train motoring	66.0± 1.5	70.0± 2.5	77.0± 2.0
4	Train coasting	68.0± 3.0	72.0± 2.0	85.0± 3.0
5	Train at max. speed	77.0± 1.0	78.0± 1.0	90.0± 1.0
6	Train decelerating	66.0± 0.5	69.0± 0.5	79.0± 2.0
7	Train stopping	65.0± 1.0	64.4± 1.0	74.0± 2.0
8	Train braking	69.5± 3.0	74.5± 1.0	84.0± 4.0
9	W/R Noise	68.0± 1.5	75.0± 1.5	86.5± 2.0
10	Door operations (max.)	77.0± 0.5	-	75.0± 0.0
	Overall	**67.0± 4.0**	**69.0± 5.0**	**78.0± 8.0**

Noise prediction has been done for different horizon years for different corridors for elevated and at grade sections and are presented in **Table 3.4** and shown graphically in **Figure 3.4** though **Figure 3.8.** It is assumed that train average speed is 32km/hr, and no barrier is present. It is observed that at 20m, the noise level will be less than 70dB. From Central Secretariat to Kashmiri gate the section will be underground so there will be no impact on the ambient noise. However, due to reduction of vehicular traffic, the road traffic noise is expected to come down.

Table 3.4: Noise levels Due at Different Distances(leq)

Corridor	Peak Hour Headway	Distance from Metro Corridor					
		5	10	20	30	40	50
Janakpuri West to IGD and Okhla Phase III to Kalindi Kunj							
Elevated	7.5	75	70	65	63	61	60
At Grade	7.5	71	66	61	59	57	56
Okhla Phase II to IGD							
Elevated	3.5	78	73	68	66	64	63
At Grade	3.5	74	69	64	62	60	59
Janakpuri to Badli							
Elevated	5	76	72	67	65	63	61
Yamuna Vihar-Welcome and NS place to Welcome							
Elevated	7.5	75	70	65	63	61	60
At Grade	7.5	71	66	61	59	57	56
Welcome to Ns place							
Elevated	3.5	78	73	68	66	64	63
At Grade	3.5	74	69	64	62	60	59

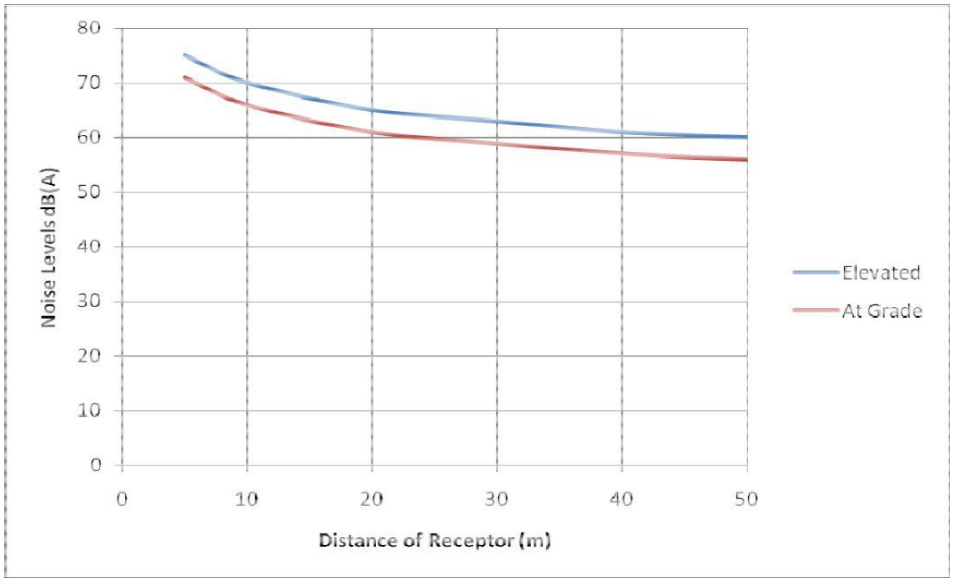


Figure 3.4: Predicted noise levels db(a) for janakpuri west to igd and okhla phase iii to kalindi kunj

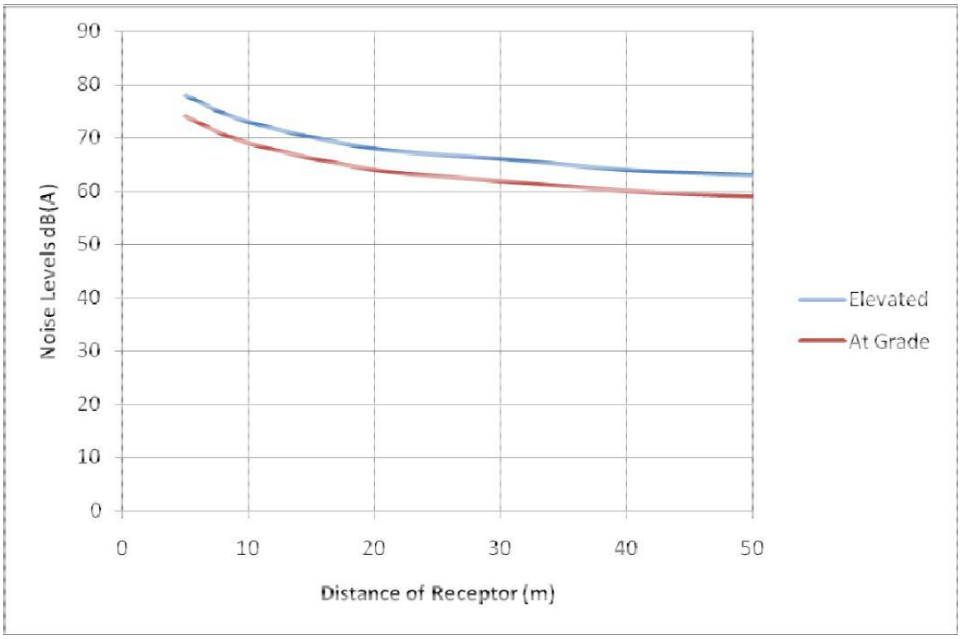


Figure 3.5: Predicted noise levels db(a) for okhla phase ii to igd

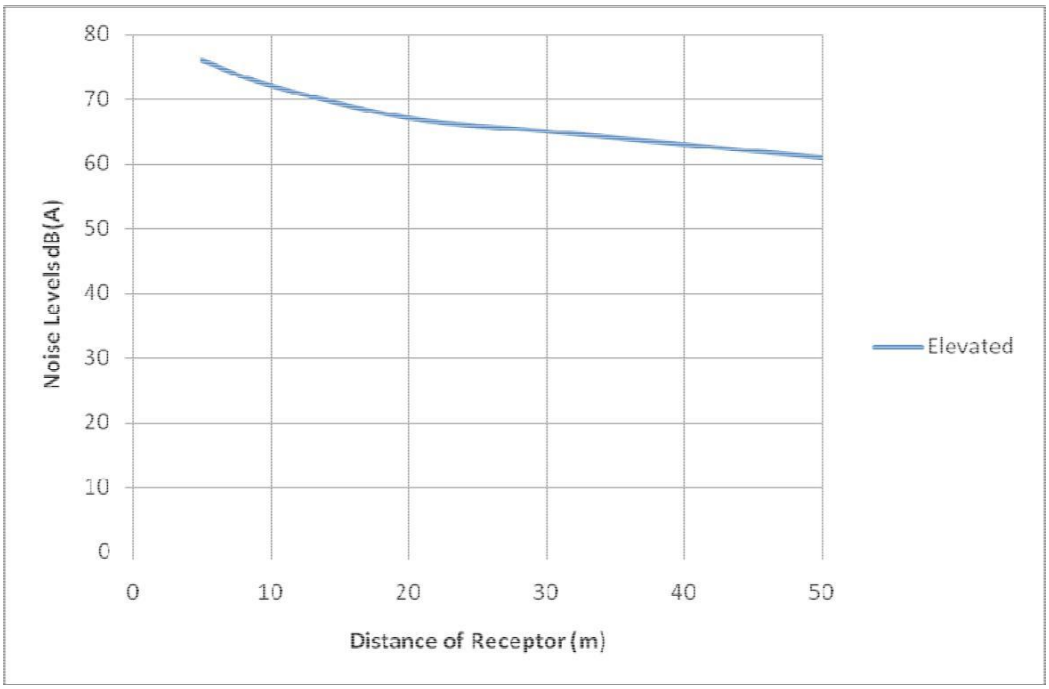


Figure 3.6: Predicted noise levels db(a) for janakpuri to badli

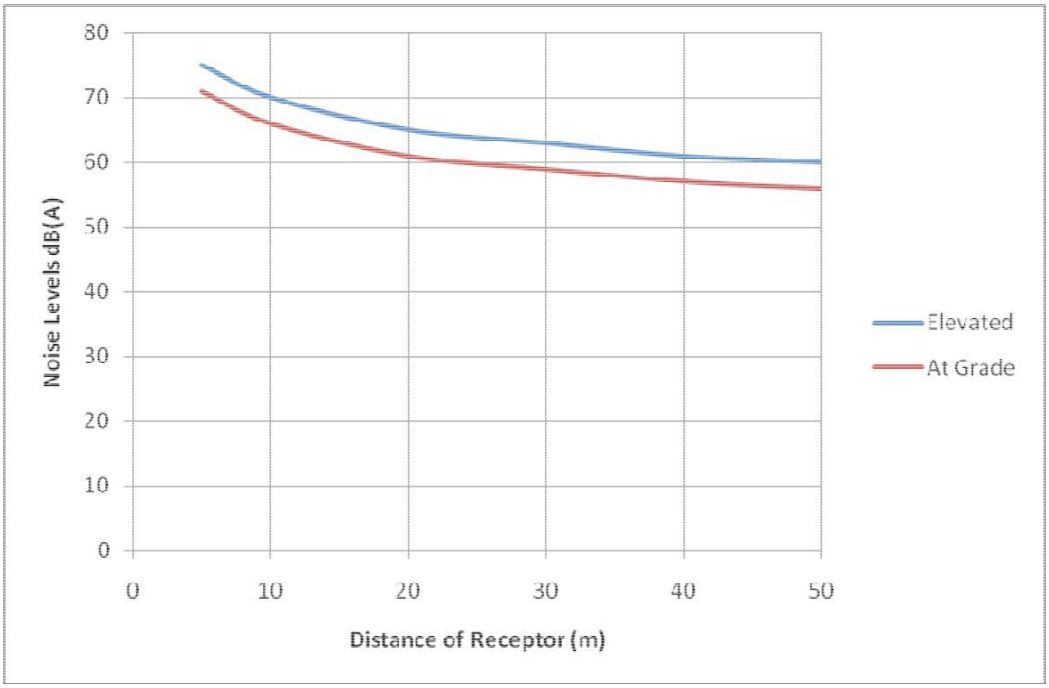


Figure 3.7: Predicted noise levels db(a) for yamuna vihar-welcome and nsplace to welcome

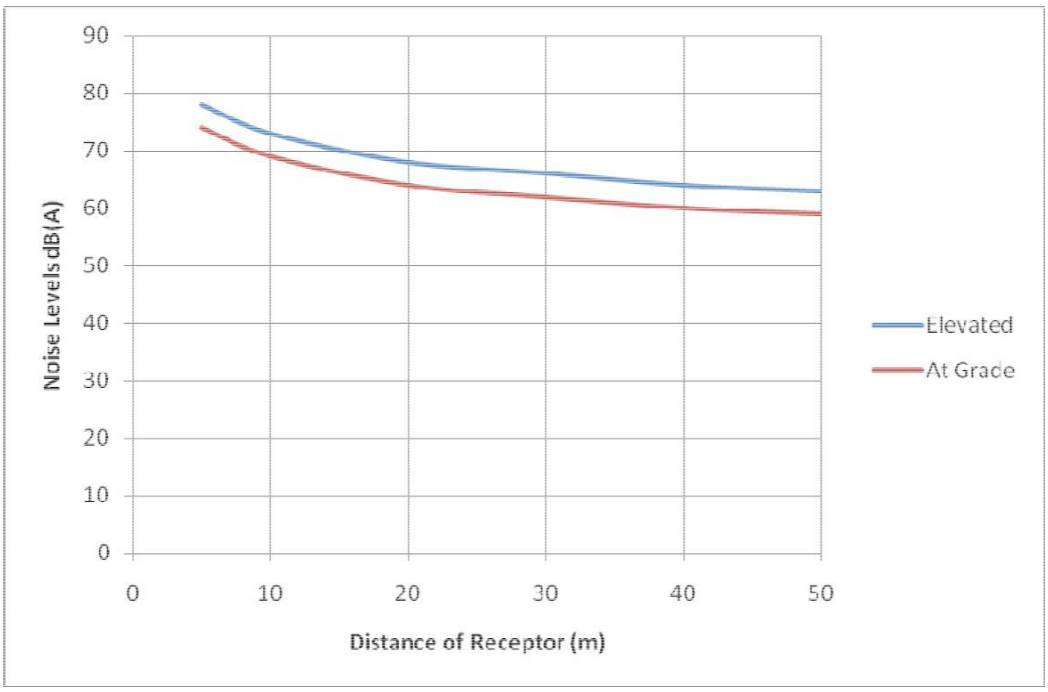


Figure 3.8: predicted noise levels db(a) for welcome to ns place

CHAPTER - 4

POSITIVE ENVIRONMENTAL IMPACTS

CHAPTER - 4
POSITIVE ENVIRONMENTAL IMPACTS

4.1Positive Environmental Impacts

Based on project particulars **(Chapter - 2)** and existing environmental conditions **(Chapter - 3)**, potential impacts that are likely to result from the proposed DMRC PhaseIII development have been identified and wherever possible these have been quantified. This chapter deals with the positive impacts of the project. The introduction of DMRC Phase III will also yield benefits from non-tangible parameters such as saving due to equivalent reduction in road construction and maintenance, vehicle operating costs, less atmospheric air pollutiom and socio-economic benefits of travel time, better accessibility, better comfort and quality of life. However, all benefits cannot be evaluated in financial terms due to non-availability of universally accepted norms. The parameters such as economic growth, improvement in quality of life, reduction in public health problems due to reduction in pollution, etc have not been quantified.

Various positive impacts have been listed under the following headings:

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

4.1.1Employment Opportunities

The project is likely to be completed in a period of about 4 years. During this period manpower will be needed to take part in various activities. About 10,000 persons are likely to work during peak period of activity. In operation phase of the project about 35 persons per kilo meter length of the corridor, ie (approx. 3,726 persons) will be employed for operation and maintenance of the proposed system. Thus the project would provide substantial direct employment; besides, more people would be indirectly employed in allied activities and trades.

4.1.2 Enhancement of Economy

It is estimated that Delhi has a population 13.85 million in 2011, out of these about 10% (1.38 million) live in rural area of Delhi. The population of NCT is projected to be 29.50 million by 2021[14]. About 28% population of rural area is engaged in agriculture and allied works. The third phase of project will connect Mukundpur to Yamuna Vihar; Jahangirpur to Badli; Central Secretariat to Kashmiri Gate; and Janakpuri to Botanical Garden. This will facilitate the rural population to move from one end of the city to another and from one state to another state to bring and sell their produce. The proposed transport facility of DMRC Phase III will facilitate rural population to move quickly towards urban centres and return there from. With the development of DMRC Phase III, it is likely that more people will be involved in trade, commerce and allied services. The population dependent on agriculture may be only about 7.8% in 2015 in Delhi. DMRC will, however, make it convenient for more people to move in these present rural areas. This will reduce population pressure on DUA and will be a boom to rural economy.

The total area of the NCR is 30,242 sq.km which is shared by NCT Delhi (1,483 km^2), Uttar Pradesh (10,853 km^2), Haryana (13,343 km^2) and Rajasthan (4,493 km^2). The projected population of the region will be 69.59 million in 2011.

4.1.3 Mobility

The proposed DMRC Phase III networks are estimated to carry 3.141 million passengers per day, in the year 2031. The maximum PHPDT on any section will be more than 30,000 by 2031. Passenger average time saved will be about 32.51 minutes by year 2031. The proposed development will reduce journey time to an extent as indicated in the **Table 4.1**.

TABLE 4.1: **JOURNEY TIME**

S. No	Section	Length in km	Journey Time (Min)	Type of Corridor Proposed
1.	Mukundpur to Yamuna Vihar	55.697	112	Elevated/Underground
2.	Janakpuri West to Botanical Garden	36.915	73	Elevated/Underground
3.	Central Secretariat to kashmiri Gate	9.370	19	Underground
4.	Jahangirpuri to Badli	4.489	11	Elevated

4.1.4 Safety

For estimating the number of accidents causing damage to vehicles, the data published by Statistical Hand Book 2010 has been used and the data available for Delhi for the last five years has been given in **Table 4.2**. The analysis of data has indicated a decreasing trend after 2007 for road accidents, vehicle involved and person injured. The decreasing trend may be due to implementation of Metro Phase I and better traffic management.

TABLE 4.2: ACCIDENTS IN DELHI (2005-09)[15]

	2005	2006	2007	2008	2009
Road Accidents	9,580	9,699	10,528	8,604	7,614
Persons Killed	2,014	2,167	2,122	2,085	2,272
Persons Injured	8,983	8,769	8,482	7,392	5,342
Vehicles Involved	9,580	9,699	10,528	8,604	7,614

Using regression technique the number of accidents was estimated. Quantification of accidents was done by correlating annual number of accidents reported with the vehicle Km run per annum. The vehicle data was multiplied by average run per day per vehicle and summed up.

It is reported that on an average 6.2 persons die in road accident every day in Delhi. This figure is likely to increase to 7.0 by the year 2025. DMRC Phase III will provide improved safety and lower the number of accidental deaths. The accidental death risk involved may still be about 6.4 persons per day i.e. 0.22 person per year per million population in Delhi by 2025.

4.1.5 Traffic Congestion Reduction

To meet the forecast transport demand in the year 2026, it is estimated that the number of buses will have to be more by 4%. During this period personalised vehicles may also grow by 4%. Together, they will compound the existing problems of congestion and delay. The proposed development will reduce journey time and hence congestion and delay.

4.1.6 Reduced Fuel Consumption

On implementation of the project, it is estimated that both petrol and diesel consumption will get reduced. The saving will be due to two factors namely Reduction in vehicles and decongestion on roads.

The reductions in vehicle due to the proposed Metro Phase III; will directly benefit in foreign exchange to the tune of about ` 3,058.13 million in 2016 and ` 4,348.31 million in 2025. The net saving in rupees is summarised in **Table 4.3**.

TABLE 4.3: NET SAVING ON FUEL EXPENDITURE IN 2016 AND 2025

Vehicle	2016			2025		
	Reduction in Number of Vehicles	Reduction in Fuel Consumption in Lit/day	Cost Saving in Fuel Consumption in Million ` per year	Reduction in Number of Vehicles	Reduction in Fuel Consumption in Lit/day	Cost Saving in Fuel Consumption in Million ` per year
Bus	1,237	24,276	265.82	1,760	34,540	378.21
3 Wheeler	5,454	11,999	131.39	7,755	17,061	186.82
2 Wheeler	47,401	42,661	934.27	67,395	60,656	1328.36
Car	51,870	103,740	1,726.65	73,748	147,496	2,454.92

4.1.7 Reduced Air Pollution

Ambient air quality is monitored regularly at number of places in Delhi by the Central Pollution Control Board. Based on available data, an attempt has been made to model the air quality scenario for future, through prediction of air quality scenario in Delhi. Daily vehicle saved by implementation of metro phase III for the year 2025 has been taken to predict the reduction in ambient pollution reduction by the vehicles. Emission factors are considered from the discussion paper on the impact of Delhi's CNG Program on Air Quality (Feb 2007) and from the article "Emissions from India's Transport Sector: Statewise Synthesis,

Atmospheric Environment (2009). The predicted reduction in emissions of air pollution with DMRC Ph III is summarised in **Table 4.4**.

TABLE 4.4: **Reduction in ambient air quality levels in2025in ton/year**

	CO_2	CO	HC	NOx	PM
Bus	51,961.42	147.25	197.48	673.72	2.02
Three Wheeler	11,265.12	18.68	386.71	46.70	3.74
Two Wheeler	23,556.17	1,948.25	619.90	265.67	44.28
Car (Diesel)	216,679.29	261.64	37.79	145.36	20.35
Car (CNG)	-	228.50	450.61	267.46	5.81
Car (Petrol)	-	767.49	96.90	77.52	11.63
Total	**303,462.01**	**3,371.49**	**1,789.40**	**1,476.44**	**87.82**

4.1.8 Carbon Dioxide Reduction

In the "Business as Usual (BAU)" scenario or "Do Nothing Scenario"; 3,371.49 tonnes per year of carbon monoxide will be reduced in the year 2025. The corresponding carbon dioxide reduction will be 303,462.01 tonnes in 2025 with the project. The cumulative reduction in CO_2 will be about 4.808 million tonnes in the life time of DMRC (70 Years) (**Table 4.5**). However, with more share of DMRC trips and improvement in fuel efficiency and energy use efficiency in transport sectors in Delhi and the cumulative CO_2 reduction is expected more than above.

TABLE 4.5: Air Pollution levels in 2025

Particulars	**Tonnes/Year in 2025**	
	Without Project	**With Project**
Carbon Monoxide	278,507.84	275,136.02
Carbon di Oxide	16,334,975.62	16,031,513.62
Nitrogen Oxide	86,243.87	84,767.44
Hydro Carbons	109,043.17	107,253.77

4.1.9 Reduction in Number of Buses

The requirement of buses is estimated to reduce to 1,760 in the year 2025, if the DMRC Ph III is introduced as per programme. This will save an amount equal to ` 4,682 million towards capital cost of bus system.

4.1.10Saving in Road Infrastructure

In order to accommodate the vehicles on road, additional 55 ha of land for parking and additional road infrastructure of about 106 ha (530 km) will be required. The savings due to road infrastructure will be about `10,600 million. In addition, cost of 161 ha of land will also be saved on implementation of DMRC Ph III project.

4.2 CHECKLIST OF IMPACTS

The impact evaluation determines whether a project development alternative is in compliance with existing standards and regulations. It uses acceptable procedures and attempts to develop a numeric value for total environmental impact. A transformation of the review of multiple environmental objectives into a single value or a ranking or projects is the final step in impact assessment. There are about hundred methods for carrying out impact assessment, which can be grouped into the following categories:

Checklist,
Matrix,
Network,
Overlays,
Environmental Index and Cost
Benefit analysis.

Each of the methods is subjective in nature and none of these is applicable in every case. Of the 6 methods listed above, checklist has been used and presented.

Checklist is a list of environmental parameters or impact indicators which encourages the environmentalist to consider and identify the potential impacts. A

typical checklist identifying anticipated environmental impacts is shown in **Table 4.6**.

TABLE 4.6: Checklist of impacts

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
A.	**Impacts due to Project Location**			
i.	Displacement of People	*		
ii.	Change of Land Use and Ecolog	*		
iii.	O Loss f cultural and Religious Structures	*		
iv.	Drainage & Utilities Problems	*		
B.	**Impact due to Project Design**			
i.	Platforms - Inlets and Outlets		*	
ii.	Ventilation and Lighting		*	
iii.	Railway Station Refuse	*		
iv.	Risk due to Earthquakes		*	
C.	**Impact due to Project Construction**			
i.	Soil Erosion, Pollution And Health risk	*		
ii.	Traffic Diversions and Risk to Existing Buildings	*		

iii.	Problems of Soil Disposal and seepage risk	*		
D.	**Impact due to Project Operation**			
i.	Oil Pollution	*		
ii.	Nois e	*		
iii.	Water Demands	*		
iv.	Pedestrian Issues		*	
v.	Visual Impacts		*	
vi.	Employment Opportunities			*
vii.	Enhancement of Economy			*
viii.	Mobility			*
ix.	Safety			*
x.	Traffic Congestion Reduction			*
xi.	Less fuel Consumption			*
xii.	Less Air Pollution			*
xiii.	Carbon dioxide Reduction			*
xiv.	Reduction in Buses			*
xv.	Reduction in Infrastructure			*

4.3 DRMC Reply to Public Suggestions

DMRC replies to public suggestions are as under:

- During construction, a route plan will developed in consultation with a traffic/transportation expert. Proper barricading of works will be carried out for pedestrian safety. Access to the shops will not be obstructed and care will be taken so that construction does not affect day to day working of nearby shops.
- People were informed that at the design stage itself, the basic unit of 6-car train is proposed for all the new upcoming corridors and provisions for extension of 9

cars has been kept in the design. The number of exclusive bogies for ladies, which is presently one, could be increased depending on the prevailing demand.

- The Station design shall take into consideration features which are old and disabled people friendly.
- Proper care will be taken so that noise pollution does not cross the permissible limits during construction.
- Possibility for providing Metro feeder bus facility will be looked into.
- A passage will be provided at underground metro stations for outside commuters to cross the road without entering in paid area.
- Proper safety measures will be taken during construction to avoid any mis-happening and efforts will be made that people will face least difficulties during construction.
- Before construction, concerned agencies will be contacted for relocation/temporary shifting of the pipeline/transmission lines as was done during construction of earlier two phases.
- All efforts will be made to minimize the period of excavation during construction and all precautions will be taken to avoid air and noise pollution.
- The Phase III construction should be environment and public friendly.

CHAPTER – 5

ENVIRONMENTAL MANAGEMENT PLAN

CHAPTER – 5

ENVIRONMENTAL MANAGEMENT PLAN

The Delhi Mass Rapid Transit System (MRTS) Phase III 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 has 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.

For every issue discussed for above measures, the implementing agency as well as staffing, equipment, phasing and budgeting have been presented as far as possible. Allrequired funds will be channeled through the project authority. The Environmental Management Plans have been prepared and discussed in subsequent sections.

5.1 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,
- Archaeological
- Historical Preservation
- Air Pollution Control Measures,
- Noise Control Measures,
- Vibration Control Measures,
- Traffic Diversion/Management,
- Soil Erosion Control,
- Muck Disposal,
- Draining of Water from Tunnel,
- Water Supply, Sanitation and Solid Waste management,

- Rain water harvesting
- Management Plans for Depot, and
- Training and Extension.

5.2 Air Pollution Control Measures

During the construction period, the impact on air quality will be mainly due to increase in Suspended Particulate Matter (SPM) 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 minimise 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 minimise 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 excavate is re-utilised 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.

The Contractor shall design and implement his blasting techniques so as to minimize dust, noise, and vibration generation and prevention fly rock.
Blasting technique should be consistent not only with nature and quaintly of rock to be blasted but also the location of blasting.

5.3 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,

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 forPiling 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.

5.4 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.
In addition, locations where the alignment is close to historical / heritage structures, the contractor shall prepare a monitoring scheme prior to construction at such locations. This scheme shall include:
Monitoring requirements for vibrations at regular intervals throughout the construction period.
Pre-construction structural integrity inspections of historic and sensitive structures in project activity.
Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.

5.5 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 MRTS Phase-III network. 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.

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

- 'Cut-and-Cover' method is proposed for construction of the underground segment. This means that the stretch between two points will have to beblocked during construction. However, temporary decking may be provided by blocking the road carriageway partially to permit traffic movement along the same stretch. Construction of switch-over-ramp also requires some road space.
- For elevated section wherever it is passing along the road, the requirement would be mainly along the central verge, as has already been done in case of elevated construction of metro corridors in Phase-I & II.
- 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 corridors under MRTS Phase-III network. At the onset, all encroachments from road ROW will have to be removed. These encroachments vary from 'on-street' parking to informal activities. During the construction of works on underground section in Phase-III network, it is proposed that temporary decking may be provided by blocking the road carriageway partially to permit 'through' as well as right-turning traffic movements. Total blockage of traffic along the underground section is not recommended due to non-availability of reasonably good alternate road network.

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 Phase-III, as has been done in Phase-I & II.

5.6.1 Traffic Management Guidelines

The basic objective of the following guidelines is to laydown 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 /tunneling and station works or either above or under 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.

5.6SUMMARY 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**,** 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 Phase II 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.

CHAPTER – 6

ENVIRONMENTAL MONITORING PLAN

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ENVIRONMENTAL MONITORING PLAN

6.1 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 take 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. During construction, management of dust was carried out by monitoring Suspended Particulate Matter. Now, the same is being done by monitoring Particulate Matter (size less than 10microns).Similarly, for example, noise and vibration monitoring is carried out by recording dB(A) and mm/s values respectively. Monitoring of specific environmental parameters has also been driven by requirements of erstwhile JBIC. 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. If it is observed that environmental conditions are deteriorating, then proper mitigation measures will be taken. The monitoring parameters are thus those that are generally impacted during construction activities. Impact monitoring during construction help to discipline the contractors and assist them in meeting their contractual obligations. Construction phase monitoring data is also intended to evaluate the efficacy of some control mechanisms found in the environmental manual which are then either modified, upgraded or deleted. Monitoring is also extended to the operational phase, to ascertain the impacts over a long term period. These parameters are also of immediate public concern. Over a period of time, much environmental monitored data has been generated and is also of academic interest. The data is much sought after by Institutions, NGOs and interested public.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
- Environmantal 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.

6.2 Construction Phase

During construction stage environmental monitoring will be carried out for air quality, noise levels, vibrations, water quality, and ecology. At this stage it is not possible to visualize the exact number of locations where environmental monitoring must be carried out. However keeping a broad view of the sensitive receptors at all the 4 corridors and also the past experience of Phase 1 and 2 an estimate of locations has been made and are summarised in **Table 6.1** These number could be modified based on need when the construction actually commences.

6.2.1 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 the standard methods. Parameters for monitoring will be as per BIS: 10500. The monitoring points could be ground and surface water.

6.2.2 Air Quality

Air quality is regularly monitored by Central/State Pollution Control Boards at number of places in Delhi. In addition to these, air quality should be monitored at the locations of baseline monitoring as reported in Chapter 3. The parameter recommended 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.

6.2.3 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.

6.2.4 Ecological Monitoring

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

6.2.5 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 6.1**

TABLE 6.1: Construction Stage Monitoring Schedule

Parameter	Frequency	Locations	Years
Air (PM10)	2 x 24 hours, twice a month	20	4
Noise	24 hours, once a week	30	4
Vibration	24 hours, once a week	10	4
Water	Once in 6 months	20	4

6.3 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 6.2**. The monitoring program shall be conducted by an external agency certified byNABL under the supervision of DMRC. Project proponent (DMRC) is responsible for successful environmental monitoring of the proposed project during operation phase.

TABLE 6.2: Operation Stage Monitoring Schedule

Parameter	Frequency	Locations	Years
Air (PM_{10})	2x24 Hour, once in a month	10	3
Noise	24 hours once a year	15	3
Vibration	24 hours once a year	15	3
Water	Once a year	3	3
Waste Water	Once in 4 months	3 (Depots)	3
Solid Waste	Once a year	3 (Depots)	3

The results of Air quality, water quality, waste water, vibration will be submitted to management quarterly during construction phase and semi annually during operation phase. The reporting formats of these results are presented at **Annexure 6.1.** The monitoring locations of various parameters during construction and operation phases are presented at **Annexure 6.2** respectively.

Chapter 7

Conclusion

Chapter 7

Conclusion

From the observations taken by Respirable Dust Sampler and Noise Level at the selected stations it was found that the:

- Summary Of Air Quality Monitoring (PM_{10} Emission)

  Analysis of 24 hrs. average concentration of ambient air quality reveals that 8 stations and casting yard exceeds the standard of 100 $\mu g/m^3$in reisdential / industrial / rural / other area with respect to PM_{10}.

- Summary Of Noise Level During Day And Night

  Analysis of 16 hrs equivalent noise level revels that at 2 stations during day in 1st week of january, and at 1 station during day in 2nd week of march exceeds the standard of national ambient noise standard of 75 dB(A).

  Analysis of 16 hrs equivalent noise level revels that at 3 stations during day in 2nd week of january, 3 stations during day in 2nd week of feburary and at 2 station during day in 2ndweek of march exceeds the standard of national ambient noise standard of 75 dB(A).

  Analysis of 16 hrs equivalent noise level revels that at 4 stations during day in 3rd week of january,2 stations during day in 3rd week of feburary and at 1 station during day in 3rd week of march exceeds the standard of national ambient noise standard of 75 dB(A).

  Analysis of 16 hrs equivalent noise level revels that at 1 stations during day in 4th week of january, 1 stations during day in 4th week of january and at 1 station during day in 4thweek of march exceeds the standard of national ambient noise standard of 75 dB(A).

From the observations taken by using respirable dust sampler and noise level it was found that it exceeds the permissible limits at some places which can cause sever effects on health such as poor concentrations, stress, cardiovascular problems and many more. It is very essential to control dust pollution and noise pollution.

Annexure

Annexure 1.1

NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Time Weighted Average	Industrial, Residential, Rural & Other Area	Ecologically Sensitive Area (notified by Central Government
Sulphur Dioxide (SO_2), $\propto m^3$	Annual 24 Hours**	50 80	20 80
Nitrogen Dioxide as NO_2, $\propto m^3$	Annual 24 Hours**	40 80	30 80
Particulate Matter (size less than 10$\propto$m) or PM_{10} $\propto m^3$	Annual 24 Hours**	60 100	60 100
Particulate Matter (size less than 2.5$\propto$m) or PM2.5 $\propto m^3$	Annual * 24 Hours**	40 60	40 60
Ozone (O3) $\propto m^3$	8 hours** 24 Hours**	100 180	100 180
Lead (Pb) $\propto m^3$	Annual * 24 Hours**	0.50 1.0	0.50 1.0
Carbon Monoxide (CO) mg/m^3	8 Hours** 1 Hour**	02 04	02 04
Ammonia (NH_3) $\propto m^3$	Annual * 24 Hours**	100 400	100 400
Benzene (C_6H_6) $\propto M^3$	Annual *	05	05
Benzo (a) pyrene (BaP)particulate phase only nm^3	Annual *	01	01
Arsenic (AS) $\propto nm^3$	Annual *	06	06
Nickle (Ni) nm^3	Annual *	20	20

Source: Central Pollution Control Board Notification dated 18th November 2009

** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week hourly at uniform intervals*

*** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.*

Annexure 1.2

NATIONAL AMBIENT NOISE STANDARDS

Category of Zones	Leq in dB (A)	
	Day *	Night
Industrial	75	70
Commercial	65	55
Residential	55	45
Silence Zone **	50	40

Source: Central Pollution Control Board

**Day Time is from 6.00 AM to 9.00 PM.*

***** Silence Zone** is defined as an area up to 100m around premises of Hospitals, Educational Institutions andCourts. Use of vehicle horn, loudspeaker and bursting of crackers is banned in these zones.*

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Vitae

S.No	Name	Designation	Photo
1.	Anand Prakash	B.Tech in Civil Engineering, M.Tech in Environmental engineering Working in DMRC	
2.	Mrs. Geeta Singh	B.Tech, M.Tech, P.hd(Persuing) Assistant Professor in DTU	
3.	Mr. Anunay A Gour	B.Tech, M.Tech, P.hd(Persuing) Assistant Professor in DTU