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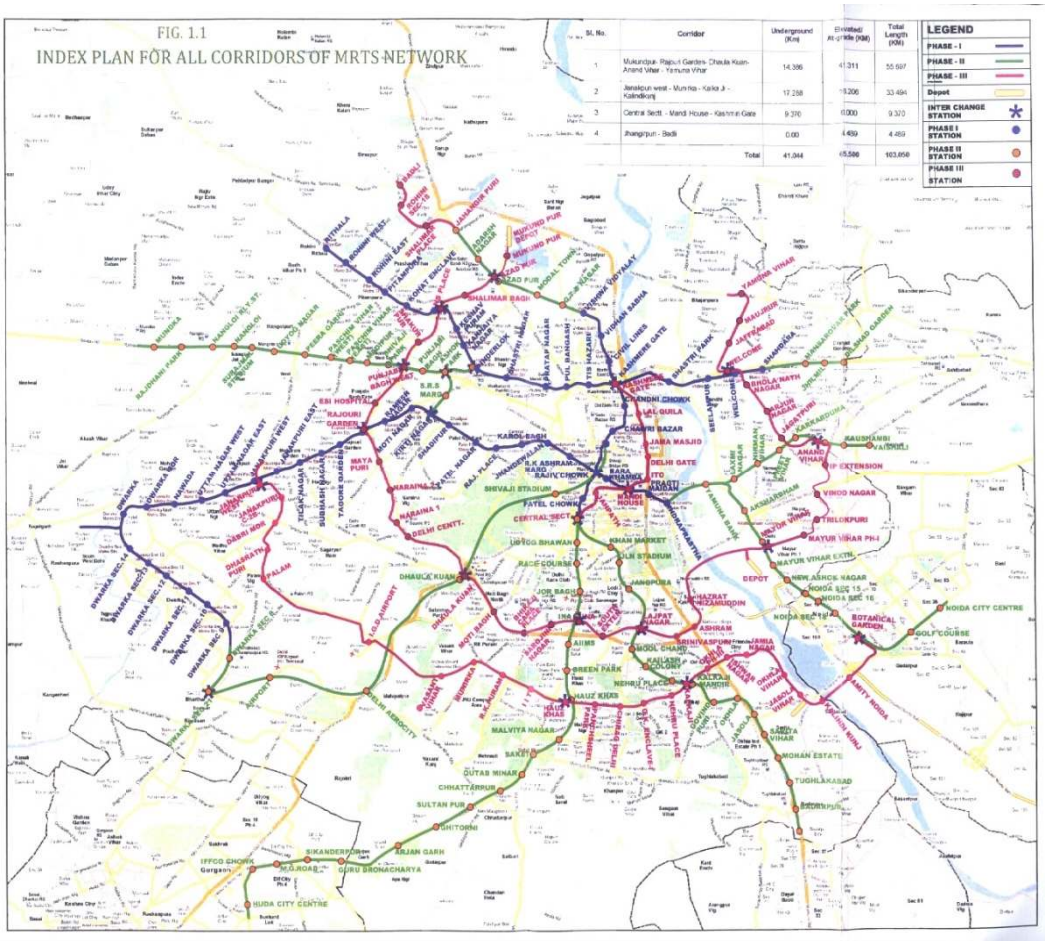
DELHI METRO RAIL CORPORATION LTD.

EIA FOR PHASE III CORRIDORS OF DELHI METRO



AUGUST 2011

DELHI METRO RAIL CORPORATION
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RITES
THE INFRASTRUCTURE PEOPLE
(A GOVERNMENT OF INDIA ENTERPRISE)
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Contents

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXURES

ABBREVIATIONS

AFC	-	Automatic Fare Collection System
AMASR	-	Ancient Monuments And Archaeological Sites and Remains
ASI	-	Archaeological Survey of India
ATO	-	Automatic Train Operation
ATP	-	Automatic Protection System
BIS	-	Bureau of Indian Standards
CATC	-	Continuous Automatic Train Control
CGWB	-	Central Ground Water Board
CPCB	-	Central Pollution Control Board
CRRI	-	Central Road Research Institute
CTE	-	Consent To Establishment
DAMEP	-	Delhi Airport Metro Pvt. Ltd.
DMRC	-	Delhi Metro Rail Corporation
DPCC	-	Delhi Pollution Control Board
DPR	-	Detailed Project Report
DTC	-	Delhi Transport Corporation
DTL	-	Delhi Transco Limited
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
EMP	-	Environmental Management Plan
EPA	-	Environmental Protection Act
EPR	-	Extended Producer Responsibility
ETP	-	Effluent Treatment Plant
FIRR	-	Financial Internal Rate of Return
GHG	-	Green House Gas
GSDP	-	Gross State Domestic Product
IMD	-	Indian Meteorological Department
JBIC	-	Japan Bank for International Cooperation
JICA	-	Japan International Cooperation Agency
KLD	-	Kilo Liter Per Day
MCD	-	Municipal Development Corporation
MGD	-	Million Galan Per Day
MoEF	-	Ministry of Environmental and Forest
MRTS	-	Mass Rapid Transit System
NCR	-	National Capital Region
NCT	-	National Capital Territory
NGO	-	Non Government Organization
NHAI	-	National Highway Authority of India
NOC	-	No Objection certificate
NSDP	-	Net State Domestic Product
OHE	-	Over Head Equipment
PAP	-	Project Affect People
PIU	-	Project Implementation Report
R & R	-	Rehabilitation and Resettlement
SPCB	-	State Pollution Control Board
SPM	-	Suspended Particulate Matter
STP	-	Sewage Treatment Plant
TBM	-	Tunnel Boring Machine
VVVF	-	Variable Voltage Variable Frequency
WHO	-	World Health Organization

Chapter –1

Introduction

CHAPTER – 1
INTRODUCTION

1.1 BACKGROUND

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.

It was made a Union Territory in 1956. Lying in the northern part of the country, Delhi is surrounded by Haryana on all sides except the east, where it borders with Uttar Pradesh. The 69th Constitutional amendment is a milestone in Delhi's history, as it got a Legislative Assembly with the enactment of the National Capital Territory Act, 1991. New Delhi houses important offices of the Federal Government, including the Parliament of India, as well as numerous national museums, monuments, and art galleries.

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 figures of Delhi are given in **TABLE 1.1.** [1] . During years 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%.

[1] Economic Survey of Delhi, 2005-2006

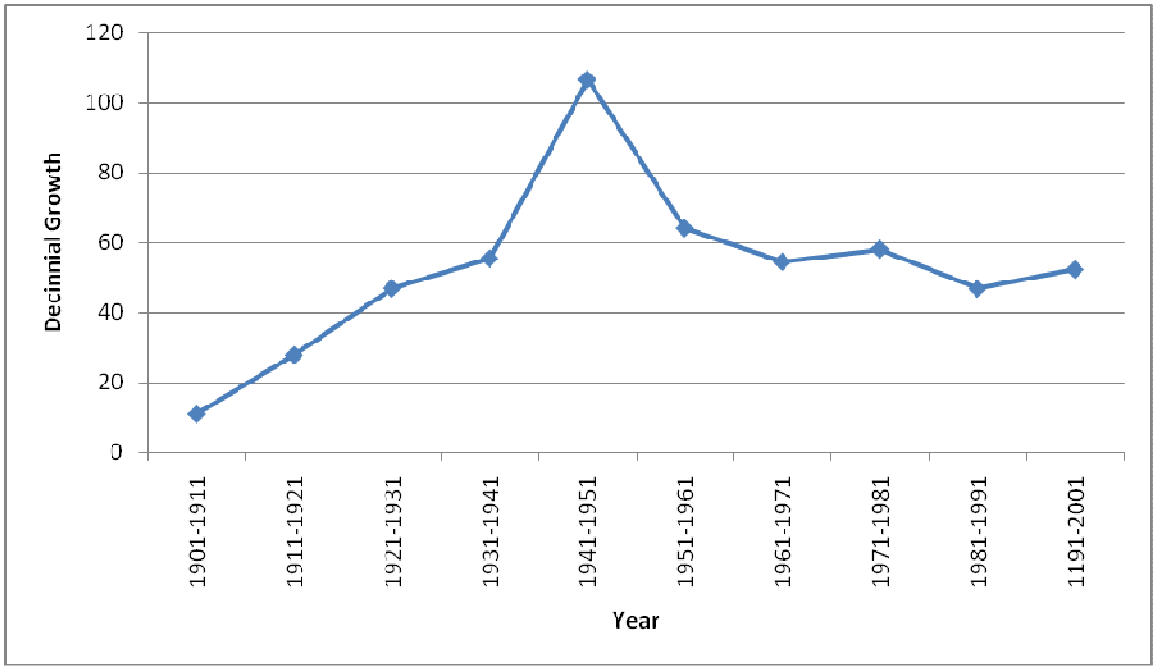
North – West and South districts are the most populated districts in Delhi with a population of 2.847 million and 2.258 million respectively. However North – East, Central and East are the densly populated with 29,395; 25,760 and 22,637 people /km^2. According to Census 2001, the density of population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

TABLE 1.1
POPULATION OF DELHI

S.No.	Year	Population	Decennial growth percent
1.	1901	4,05,819	-
2.	1911	4,13,851	11.13
3.	1921	4,88,452	27.94
4.	1931	6,36,246	46.98
5.	1941	9,17,939	55.48
6.	1951	17,44,072	106.58
7.	1961	26,58,612	64.17
8.	1971	40,65,698	54.57
9.	1981	62,20,406	58.16
10.	1991	94,20,644	46.87
11.	2001	1,38,50,507	52.34

Source: Economic Survey of Delhi, 2001-2002

FIGURE 1.1
DECENNIAL GROWTH OF DELHI



1.2 TRANSPORT

Delhi is well connected by roads, rail and air with all parts of India. It has three airports- Indira Gandhi International Airport for the international flights, Palam Airport for domestic air services and Safdarjung Airport for training purposes. It has three important railway stations - Delhi Junction, New Delhi Railway Station and Nizamuddin Railway Station. Delhi has three inter-state bus terminals at Kashmeri Gate, Sarai Kale Khan and Anand Vihar.

Vehicle population in Delhi is highest among all metropolitan cities (Bombay, Calcutta, Delhi and Madras). As on February 2011 there are 6,844,527 private and commercial vehicles registered in Delhi. **TABLE 1.2** shows the details of private and commercial registered vehicles in Delhi as on February 2011.[2] However details on all type of vehicles registered in Delhi as on February 2011 is available in **Annexure 1.1.** The analysis has indicated the vehicle growth rate 6.33% per year.

TABLE 1.2
REGISTERED VEHICLES IN DELHI

S.No.	Year	Vehicles		
		Private	Commercial	Total
1.	2002-03	3732481	207928	3940409
2.	2003-04	3980422	222033	4202455
3.	2004-05	4275642	232384	4508026
4.	2005-06	4529177	279833	4809010
5.	2006-07	4889710	295700	5185410
6.	2007-08	5307894	319490	5627384
7.	2008-09	5657313	354418	6011731
8.	2009-10	6068909	382974	6451883
9.	2010-11[3]	6454232	390295	6844527

1.3 OBJECTIVE AND SCOPE OF THE 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.

[2] Statistical Hand Book 2010
[3] Transport Department Delhi

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.

1.3.1 JICA Requirement

In its confirmation of environmental and social considerations, JICA places importance on dialogue with all involved partners (e.g. the host country, local governments, borrowers and project proponents) regarding environmental and social considerations. Transparent and accountable processes, as well as active participation of key stakeholders (e.g. local residents and local NGOs affected by the project) in all stages of the project are highly considered. JICA make clear in their "Guidelines for Environmental and Social

Considerations" that these are mandatory to receive JBIC's funding. JICA guidelines are formulated based on the World Bank Operational Policy (0P 4.01). According to JICA Guidelines for confirmation of Environmental and social Considerations, the current project is classified as Category A as it is likely to have significant environmental impacts on the environment. Category A includes sensitive sectors such as "Roads, railways and bridges" which is similar to that of the metro lines or located in or near sensitive areas such as such as areas of cultural, historical or archeological value.

BOX 1.1 EIA Categorization System in JICA Systems

Category A Projects are likely to have significant adverse impacts on the environment and society. 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.

1.4 LEGAL, POLICY AND INSTITUTIONAL FRAME WORK

Since the adoption of The Kyoto Protocol in December 1997 and was entered into force on 16 February 2005, that developing countries are principally responsible for the current high level of GHG emission into the atmosphere due to industrial activities. This protocol commits the developing countries to reduce 5 percent against 1990 level over the five years period 2008-12.

The need for a well-developed legal mechanism to conserve resources, protect the environment and ensures the health and well being of the people in India was felt. Keeping the pace with international laws, the Ministry of Environment and Forest enacted Environmental Protection Act in 1986. Over the years, the Government of India has framed several policies and promulgated number of Acts, Rules and Notifications aimed at management and protection of the environment. During last three decades an extensive network of environmental legislation has grown and presently it has a fairly complex body of environmental legislation aimed at ensuring that the development process meets the overall objective of promoting sustainability in the long run. The available legal Acts and Legislation referred during the study are:

- The Water (Prevention and Control of Pollution) Act, 1974 (Amendment 1988).
- The Water (Prevention and Control of Pollution) Cess Act 1977, (Amendment), 2003.
- The Water (Prevention and Control of Pollution) Cess Rules, 1978, 1991.
- The Air (Prevention and Control of Pollution) Act 1981, amended 1987.
- The Air (Prevention and Control of Pollution) (Union Territories) Rules, 1982, 1983
- Noise Pollution (Regulation and Control) Rules, 2000 amendment 2002, 2006.
- Municipal Solid Waste Rules, 2000
- The Environment (Protection) Act, 1986, amended 1991.
- The Environment (Protection) Rules,1986.
- The Indian Forest Act, 1927.
- Forest (Conservation) Act, 1980, amended 1988.
- Forest (Conservation) Rules, 2003.
- The Wild Life (Protection) Act 1972, Amendment, 2002

The EIA is conducted as per “Guidelines for Environmental and Social considerations” of JICA. These guidelines are formulated based on the World Bank Operation Policy (OP – 4.01)

The Environmental Impact Assessment covers the proposed on-site activities as well as the transportation of the generated waste to the waste disposal sites.

1.4.1 Water and Water Pollution

The use of water resources and also the discharge of polluted water (sewerage) are primarily regulated by the Water (Prevention and Control of Pollution) Act, 1974 amended in 1988. The Water Cess Act, 1977 amended in 1992 and 2003, including Rules 1978 and 1991 provides for levy and collection of Cess on water consumed with a view to generate resources for prevention and control of water pollution. The Act assigns functions and powers to the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCBs) for prevention and control of water pollution.

The Environment (Protection) Act 1986 amended in 1991 and Rules also lays down specific standards for quality of water effluents to be discharged into different type of water bodies (sewers, surface water bodies like lakes and rivers, marine discharge). Additionally, the water supplied to users for drinking shall also conform to the National Drinking Water Standard, IS-10500 **(Annexure 1.2)**. **Annexure 1.3** summarizes the general standards for discharge effluent in Inland Surface Water Bodies. To ascertain and categorize the existing water quality, the results of the analysis of water quality need to be compared with the water quality standards given in **Annexure 1.4.**

Off late, with rapid depletion of groundwater resources in several areas of the country, efforts have been initiated to regulate the use of groundwater resources. The focus of such acts and rules is to provide for mechanisms that would lead to replenishment of groundwater reserves through techniques like rain water harvesting. The Central Ground Water Board,(CGWB) the statutory authority set up by the Central Government has also restricted the drilling of tube wells and bore wells in certain water scarce areas in the country.

1.4.2 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 1.5.**
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.

1.4.3 Noise 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 1.6.**

1.4.4 Solid Waste Management

Project construction and operation generates solid waste at site. The DMRC would be responsible for collection and handling of solid waste as per the provisions of the Municipal Solid Waste Rules, 2000. The Hazardous Waste (Management and Handling) Rules, 2000 require facilities to classify wastes into categories, manage them as per the prescribed guidelines and obtain prior authorization from the SPCB for handling, treatment, storage and disposal of Hazardous Wastes.

1.5 INSTITUTIONAL FRAMEWORK

The Ministry of Environment and Forests (MoEF) is the nodal agency in the administrative structure of the central government for planning, promotions, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. The major responsibilities of MoEF include:

- Environmental resource conservation and protection, including environmental impact assessment, clearance of developmental projects;
- Co-ordination with the other ministries and agencies, voluntary organizations and professional bodies for environmental action plans;
- Promotion of research and development, manpower planning and training and creation of environmental awareness;
- Liaison and coordination with international agencies involved in environmental matters.

1.5.1 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 of

hazardous 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.

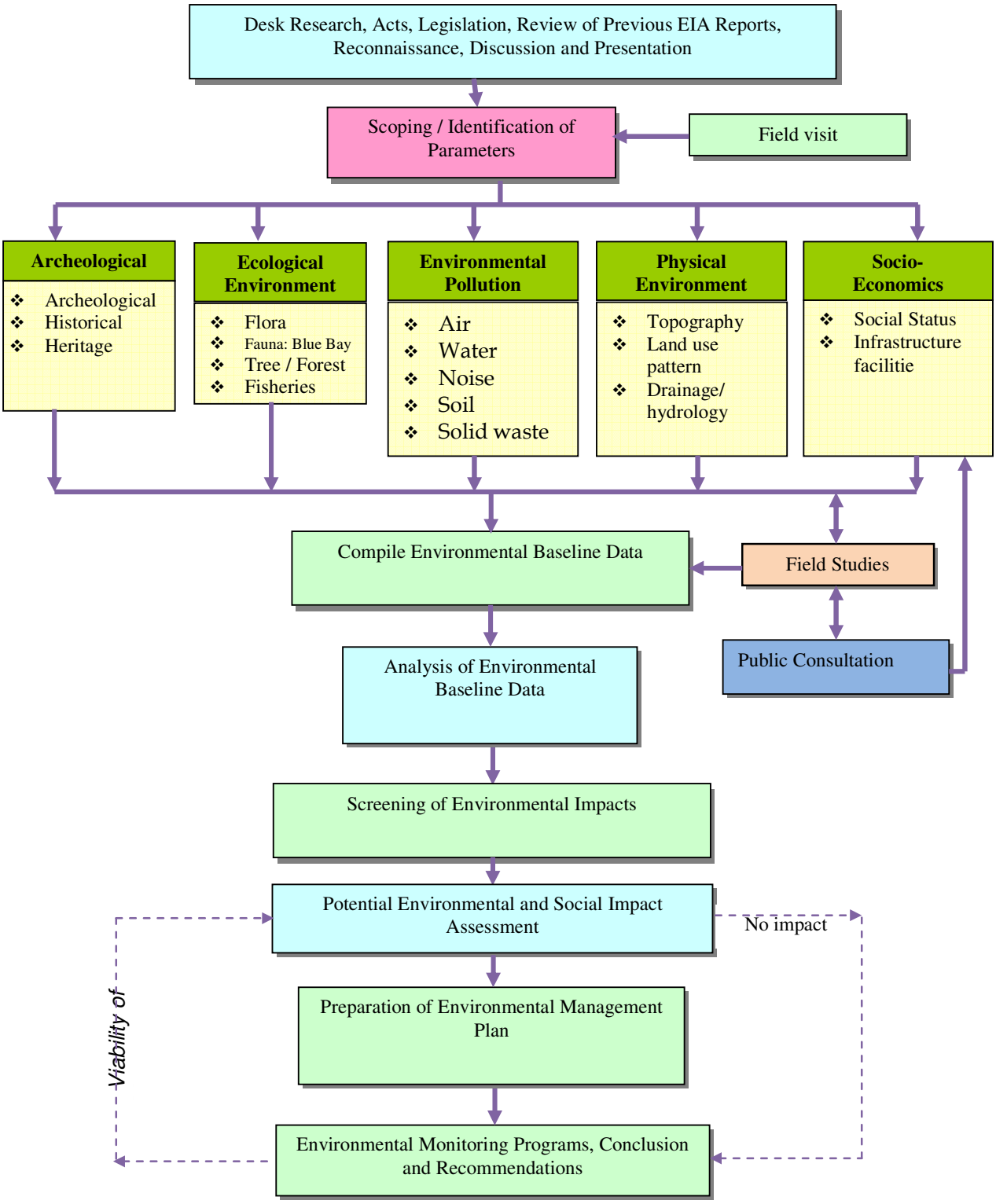
1.6 APPROACH AND METHODOLOGY

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 for. The approach for the study is presented in **Figure-1.2.**

FIGURE 1.2
METHODOLOGY FOR THE EIA STUDY



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 with various 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.

1.6.1 Data Collection

The existing **land-use** pattern of the area has been identified manly as urban human settlements, roads, Trees and water bodies. The ***Soils*** parameters are studied from the field surveys conducted during this study.

Water Resources in the project were considered in terms of precipitation, surface run off; quantity and quality of water. These will facilitate to decide various uses such as drinking, irrigation etc.

Air and Noise quality is an important consideration during construction and operation phases. Ambient air quality and noise levels were monitored in an around project area to develop present baseline levels in the area. The literature reviews were conducted to establish past air pollution and noise levels in the project area. The future air and noise quality were predicted using mathematical modeling.

Terrestrial **Ecology** were studied. The vegetation types were documented through the visual inspection, past research and filed investigations.

1.6.2 Environmental Impact Assessment

The objective of the study is to assess the impacts as a result of construction of the DMRC metro corridors along with depot and sub-stations. The changes likely to occur in different components of the environment were studied and analyzed. The core area of study is to be 200 m on either side of proposed alignment and 25 m for sensitive receptors. Based on project particulars and the existing environmental conditions, potential impacts were identified that are expected to be affected as a result of the proposed project and wherever possible, these are quantified. Both positive and negative impacts are evaluated to have an idea about resultant impacts. These impacts were assessed for various phases of project cycle namely, location, design, construction and

operation. The standard methodology was adopted for impact prediction and assessment. Prediction is essentially a process to forecast the future environmental conditions in the project area that might be expected to occur. The prediction of impacts can be through mathematical modeling, overlays/ super imposition of activity, or comparison of impacts observed. The environmental impact of the project includes changes in land use, soil, erosion, water quality, air quality and noise levels etc. The impact on soils due to disposal of waste water and erosion during storms were predicted. The impact on water quality in the water bodies was evaluated with the help of water quality analysis. The burning issues such as Green House Gases (GHGs) and Climate Change were also studied. More details on Environmental Impact Assessment are available in **Chapter 4.**

1.6.3 Environmental Management Plan

The project will provide higher living standard, better quality of life, less travel time, better connectivity and transport facilities. The management plans are essential to ensure that stress/ loads on the systems are within carrying capacity. The management plan aims at maintaining the environmental quality of project area at-least in pre-project stage. An environmental management strategy/ plans were developed to mitigate the adverse impacts. Efforts are made to enhance the quality of environmental attributes.

1.6.4 Environmental Monitoring

It is necessary to monitor during various phases of project cycles the environmental attributes. Monitoring would indicate any environmental problem, which has come up due to an ongoing activity. This will facilitate to assess the effectiveness of management / mitigation measures. The consultant has designed a post project environmental monitoring program for implementation. The cost estimates for environmental monitoring and management have been included in the project estimates.

1.6.5 Liaison With Authorities

For the preparation of this EIA, the project team and environmental experts have liaised with the DMRC, and Ministry of Environment and Forests in order to discuss the proposed scope of the EIA, available data in the specific area on environmental attributes and general comments / observations that these authorities may have on the project and its environs. In addition, informal consultations were organized with individuals and nearby people, in order to present the project and collect their views on the perceived positive and negative impacts on the environment on account of this new development.

1.7 FORMAT OF THE REPORT

The main elements of the study are as follows: In **Chapter-2** a concise documentation is given on current and planned activities and the expected main beneficiaries. **Chapter-3** summarises environmental baseline conditions including physical, biological and socio-economic parameters and pre-project environmental constraint such as air pollution, problems related to public health and traffic congestion. Potential negative and positive impacts are presented in **Chapters-4 and 5** respectively. These include issues such as loss of land, rehabilitation and resettlement, disposal of soil, loss of trees, noise and vibration, disruption of utilities/ facilities, socio-economic and other problems due to the development of proposed Mass Rapid Transport System Phase-III in Delhi. In addition the public consultation and its finding are also reported.

Based on the anticipated negative impacts, the project may bring about an environmental management strategy, which has been outlined in **Chapter-6. Chapter-7** includes post project environmental monitoring programmes. This programme aims at signalling any potential environmental problem during construction and operation of the project and it should allow for timely implementation of corrective measures. Finally, a summary of the costs of the environmental management and monitoring programmes falling under the responsibility of the project is presented in **Chapter-8.** This also includes the cost of disaster management plans and emergency information systems.

The literature, books, reports referred, is detailed in References. Where applicable, more detailed information on methods used is included in concerning paragraphs. The issue related to rehabilitation and resettlement and rehabilitation plan are available in another report, **Volume II.**

Chapter –2

Project Description

CHAPTER – 2
PROJECT DESCRIPTION

2.1 EXISTING SYSTEMS

Mass transport needs of Delhi are currently met by buses and Delhi Metro Rail Systems. The bus system is operated by Delhi Transport Corporation (DTC) supplemented by private operators. DTC and private operators have deployed 3,106 CNG buses for the city/NCR service. In addition there are about 2 lakhs cars and equal number of motor cycles are also in use in Delhi. The CNG vehicles are 3,33,924 in number in Delhi.[4] There are about 773 routes on Delhi roads. Delhi enjoys one of the India's highest density of road network with a total length of 1,749 kms of road /100 km^2. The total road length in Delhi is more than 28,508 km which also include 388 km of National Highways (NH).[5] Delhi consists of two ring roads (inner and outer) combined together of 87 km length.

Delhi's high population growth rate, coupled with high economic growth rate has resulted in an ever increasing demand for transport creating excessive pressure on the city's existing transport system. The project description in this chapter is based on the Detailed Project Report (DPR) for Phase III corridors of Delhi Metro Project, February 2011.

2.1.1 Existing Metro System

Delhi Metro Rail Corporation (DMRC) has already implemented Phase I and Phase II of Metro network. The total length developed in these phases is 189.63 km. Out of this 175.58 km is in Delhi, 7 km in Uttar Pradesh and 7.05 km is in Haryana. The Airport link of 22.70 km is operated by Delhi Airport Metro Express Pvt. Ltd. (DAMEP) a subsidiary of Reliance Infrastructure. This line is also known as orange line. The Details of Existing Metro Network of Delhi are presented in **Table 2.1.**

2.1.2 Delhi Metro's Master Plan 2021

As per the Master Plan 2021 prepared for Metro Network for Delhi, a total network of 413.83 kms is to be implemented by the end of Phase IV. The length of metro covered and likely to be covered under various phases of metro is presented in **Table 2.2**. Out of 413.83 kms, the length proposed in Delhi is 335.39 km and in NCR other than Delhi is 78.44 km.

[4] Indraprasthan Gas limited
[5] www.mapsofindia.com

TABLE 2.1
EXISTING NETWORK OF DELHI METRO[6]

S.No.	Corridor	No. of Stations	Length (km)
	Phase I		
I.	Shahdara – Rithala	18	22.06
II.	Vishwa Vidyalaya-Central Secretariat	10	10.84
III.	Indraprastha-Barakhamba Road - Dwarka Sub - city	31	32.10
	Sub Total (Phase I)	**59**	**65.00**
	Phase II		
I.	Vishwa Vidyalaya – Jahangirpuri	5	6.36
II.	Central Secretariat – HUDA City Centre	19	27.45
III.	Shahdra – Dilshad Garden	3	3.09
IV.	Indraprastha-New Ashok Nagar	11	15.07
V.	Yamuna Bank-Anand Vihar ISBT	5	6.17
VI.	Kirti Nagar-Mundka (with operational link to Line -1 at Inderlok)	15	18.46
VII.	Dwarka Sector 9 – Sector 21	2	2.76
VIII.	Anand Vihar-KB Vaishali	2	2.57
IX.	Central Secretariat – Badarpur	15	20.4
X.	Airport Express line (N.Delhi -Sector 21 Dwarka)	6	22.70
	Total (Phase II)	**83**	**124.63**
	Metro line extending into NCR towns		
	New Ashok Nagar – Noida City Centre		7.00
I	Arjan Garh – Sushant lok		7.05
ii	**Total in NCR**		**14.05**

TABLE 2.2
LENGTH OF DELHI METRO PHASES

S.No.	Phase	Length (km)
1	Phase I	65.10
2	Phase II	128.06
3	Phase III	112.17
4	Phase IV	108.50
	Total	**413.83**

The total intra-city trips in NCR-Delhi are projected to increase from 16.04 million in 2005 to 26.06 million in 2025. The multimodal split in favour of public transport system is proposed to increase to 82% due to introduction of Mass Rapid Transit System (MRTS) for Delhi. Thus the total public transport system trips are projected to increase from 13.15 million trips per day in 2005 to 21.37 lakhs trips per day in year 2025.[7] The DMRC has projected 5.86 million trips per day in 2025/26 by Delhi Metro. Hence the ridership contribution of Delhi Metro Rail will be about 27%.

[6] www.delhimetrorail.com/project
[7] www.ncrpb.nic.in

2.2 ANALYSIS OF ALTERNATIVES

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

- Minimum private land acquisition,
- Least disturbance to properties,
- Minimum disturbance to people and
- Minimum disturbance to ecology/ biodiversity.

In the analysis of alternatives, a comparison of scenario with and without the project has also been made. Advantages and disadvantages have been spelt out and the analysis is quite exhaustive. The positive impacts of the chosen corridors are further elaborated in Chapter 5. These being the over-riding criteria, financial implications of these alternatives were not worked out.

2.2.1 No Development Alternative

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

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

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

2.2.2 Phase III Metro Corridors

For the Phase III of Delhi Metro following Six corridors were considered at initial stage

1. Ananad Vihar to Dhaula Kuan
2. Mukundpur to Rajouri Garden
3. Malviya Nagar to Kalindi Kunj

4. Ashol Park to Delhi Gate
5. Central Secretariat to Lal Quila
6. Jahangir Puri to Badli

The alignment map of previous Phase III corridors is shown in **Figure 2.1.** The brief description of the corridors is presented in following paragraphs.

2.2.2.1 Ananad Vihar to Daula Kuan and Mukundpur to Rajouri Garden Corridors

The Mukundpur – Rajaouri Garden and Dhaula Kuan- Rajouri Garden were aligned along the ring road. However, there was missing gap on the ring road in the portion from Rajouri Garden to Dhaula Kuan. Therefore a new corridor from Rajouri Garden to Dhaulan Kuan was proposed so as to complete the inner ring road circular loop linking the proposed metro lines. The expected PHPDT in Dhaula Kuan – Rajouri Garden portion in 2016 is 26051.

2.2.2.2 Malviya Nagar to Kalindi Kunj Corridor

The Malviya Nagar to Kalindi Kunj section was stand alone section and was not serving its purpose. There was poor intergartion with the existing/proposed lines. Moreover PHPDT on this line was expected to be only 9800. In view of this consideration the Malyiya Nagar – Kalindi Kunj corridor was dropped and a new corridor was suggested along the outer ring road from Kalindi Kunj to Janakpuri West which will have a PHPDT of 267757 in the year 2016. The corridor will serve the area with maximum population density along the outer ring road.

2.2.2.3 Ashok Park to Delhi Gate Corridor

The alignment was running parallel to two existing metro corridors in West- East direction, namely the Inderlok to Kashmere Gate and Kirti Nagar to Indraprastha line. Also as per the study of Integrated Road Cum Multi Modal Public Transport Network for NCT, the corridors from Ashok Park and Delhi Gate were considered more suitable for a Light Rail System. So this corridor was dropped from consideration in Phase III.

2.2.2.4 Central Secretariat to Lal Quila Corridor

This corridor is extended upto Kashmere Gate for better integration with existing Rithala – Dilshad Garden line to get the benefit of integration of two metro lines.

2.2.2.5 Jahangir Puri to SGT Nagar Badli Corridor

This corridor is kept as per the pervious recommendation.

In view of the above, following four corridors are finalized for Phase III Metro which are shown in **Figure 2.2**

FIGURE 2.1
PREVIOUS ROUTE MAP OF DELHI METRO PHASE III (RED LINES INDICATING PHASE III PROPOSED CORRIDORS)

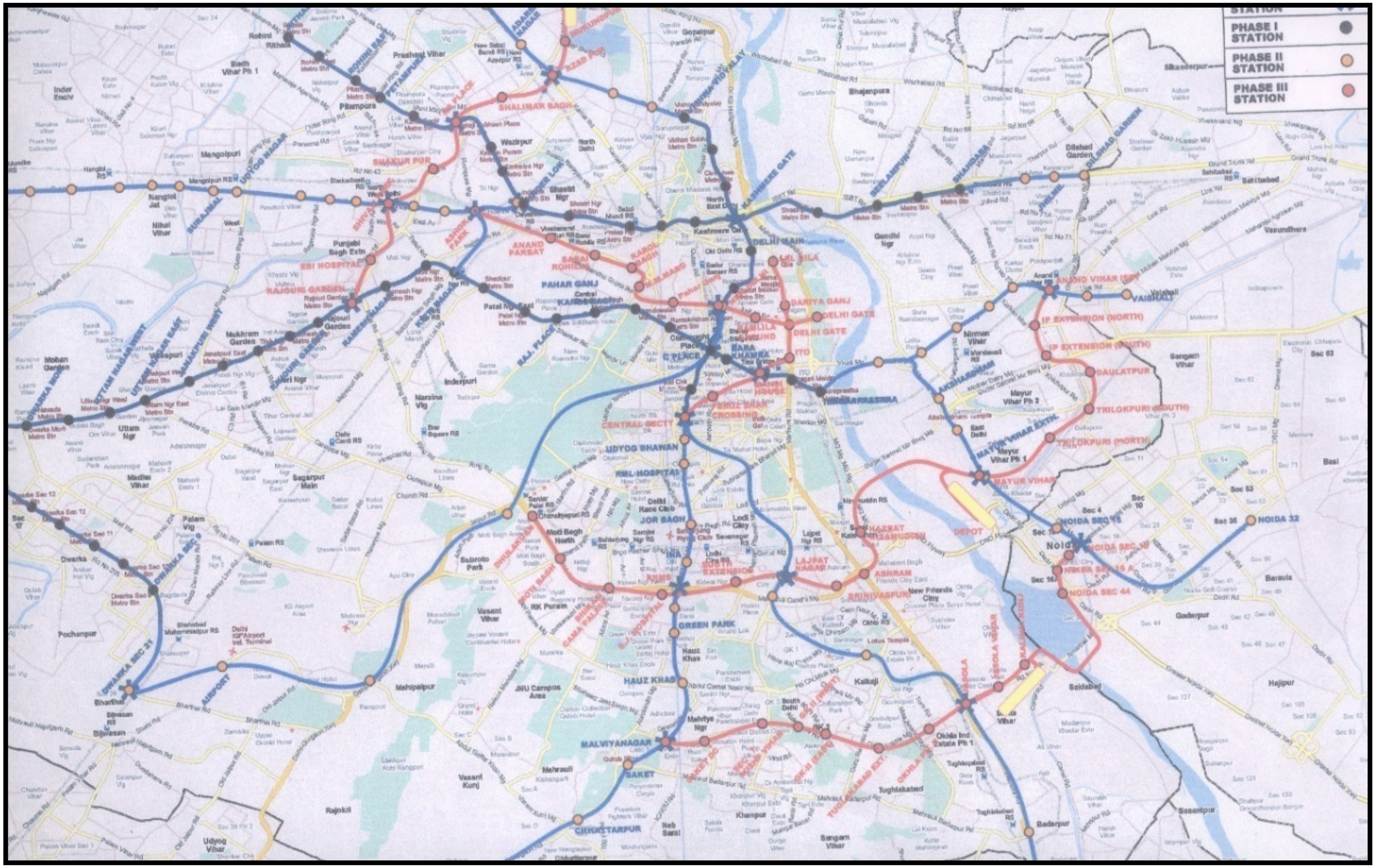
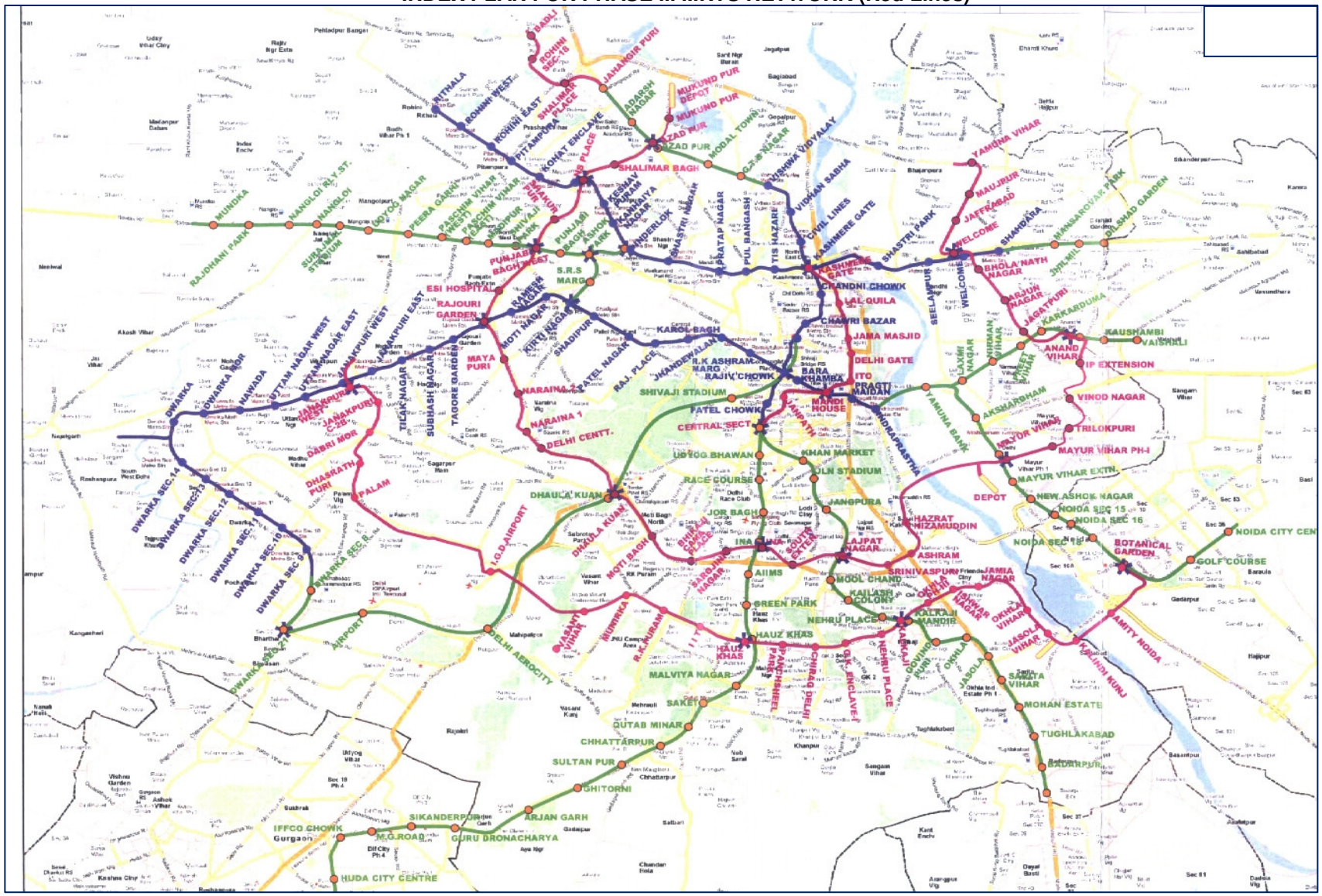


FIGURE 2.2
INDEX PLAN FOR PHASE III MRTS NETWORK (Red Lines)



2.2.3 Environment and Social Considerations

The alignment of the above corridors are so selected that they will serve the maximum population, will entail less private land acquisition, least demolition of private and government structures, least tree cutting and will avoid impact on archaeological and historical structures. To achieve the above goals, the alignment suggested is mainly on the central verge of the road. In the highly densely populated area like Bhikaji Cama Place, Sarojini Nagar, INA, South extension, Lajpat Nagar, Srinivaspuri, Ashram, Hazrat Nizamuddin in **Mukundpur to Yamuna Vihar section,** Palam, I G D Airport, Vastant Vihar, Munirka, R.K. Puram, IIT, Hauz Khas, Panchsheel Park, Chirag Delhi, G.K. Enclave – I, Nehru Place, Kalkaji in **Jankpuri West to Kalindi Kunj section** the alignment is kept under the ground so as to lessen the social impacts that may have resulted from acquisition of property. Similarly to protect the archaeological/historical monuments, the alignment from **Central Secretariat to Kahsmere Gate** is kept fully underground. The entire underground section will be constructed by tunneling through State of Art Tunnel Boring Machine (TBM). The following refinements have been made so as to achieve the objectives of environment and social consideration :

TABLE 2.3
REFINEMENT OF FINAL CORRIDORS

FINAL ALIGNMENT	PREVIOUS ALIGNMENT AND REASON FOR CHANGES
MUKUNDPUR – YAMUNA VIHAR CORRIDOR	
Alignment between Shalimar Bagh and Azdpur is about 0.5 km of length	Earlier the alignment was about 200 m to 300 m away on the side of ring road from the present finalized alignment. It was to effect number of hutments, office of Jafarani Zarda, M2K Vardhman apartments under construction.
Alignment near Punjabi Bargh between Station ESI hospital and Punjabi Bagh Station for about 2kms	Earlier the alignment was passing on club road, North Avenue road and effecting the important facilities like Punjabi Bagh Club and number of flats on North Avanue road. With the view to avoid these acquisitions and inconvenience to public, the alignment was revised to follow the ring road with no acquisition in this area.
Alignment between proposed station of Naraina-1 to proposed metro stations Naraina -2 for about 1.6 kms	There was planning to align the metro along the ring road on the left side facing Rajouri Garden. It was effecting large number of residential and commercial assets in the length of approximately 0.5

FINAL ALIGNMENT	PREVIOUS ALIGNMENT AND REASON FOR CHANGES
	km. To avoid these acquisitions, metro route was aligned in the rear of this habituated area along the divider road between Civil area and Defense.
Alignment between Dhaula Kuan and Mayapuri for the length of about 6 kms	Earlier the alignment was proposed to follow Cariappa Marg (Station road), crossing the railway line near Janak Sethu, taking turn in Salvage Park area and thereafter following Satguru Ram Singh Marg and joining to ring road near Rajyoga institute. This alignment was affecting number of residential units and also Shops on Satguru Ram Singh Marg.
Alignment between Bhikaji Cama Place and South Extension for the length of about 4.5 kms	Old alignment between Bhikaji Cama Place and South Extension was following ring road. It involved acquisition of some portion of even Safderjung Hospital for providing the station in addition to acquisition at other station locations. This alignment has now been changed via Sarojini Nagar, INA to join at South Extension.
Alignment between South Extension and Srinivaspuri for length of about 3.6 kms and	In this length also the alignment was initially proposed was along the ring road which was to affect number of structures at the station location. Moreover number of flyovers were also to be taken into account in the implementation of tunneling. By changing the alignment the acquisition of assets near Moolchand Proposed station (earlier) could be avoided. Also the difficulty of construction in underground to existing flyovers can be avoided while it will connect the more traffic originating area like central market in Lajpat Nagar.
Alignment between Mayur Vihar Pocket 1	The Old alignment between Mayur Vihar

FINAL ALIGNMENT	PREVIOUS ALIGNMENT AND REASON FOR CHANGES
and Trilokpuri for the length of about 2 kms	Pocket 1 and Trilokpuri was to pass on narrow road running by the side of MCD primary school where large number of G+2, G+1 residential buildings were affected. With the revised alignment these large acquisition can now be avoided only very few will be needed while turning towards Indra Gandhi Mahila Park on the road between Trilokpuri I and Trilokpuri II.
JANKPURI WEST TO KALINDI KUNJ S CORRIDOR:	
Alignment between Jankpuri West and Janakpuri C-2B for the length of about 2 kms	Earlier the alignment between Jankpuri West and Janakpuri C-2B was planned following the road between Janakpuri Club and Police Quarters and thereafter on the road connecting C2B sector of Jankpuri to outer ring road. This alignment was affecting a number of important buildings at the turning points on the road between Janakpuri District Centre and Police Quarters. To avoid these acquisition the alignment has now been planned by the side of the existing parks without affecting any buildings.
Alignment between Dasrathpuri and Palam for the length of about 0.6 kms	In Dasrathpuri area alignment was earlier planned on the flat curves which was affecting large number of residential units and shops. The alignment was revised by adopting the sharper curvature however within the prescribed standards. It has saved acquisition of significant number of buildings.
Alignment between Nehru Place and Kalkaji for about 0.5 kms and	Earlier the alignment in this stretch was affecting fire station, cremation ground due to Kalkaji station location. Hence to avoid the acquisition of these utilities/facilities alignment was revised and thereby Kalkaji Station could be

FINAL ALIGNMENT	PREVIOUS ALIGNMENT AND REASON FOR CHANGES
	located without affecting these facilities.
Alignment between Jamia Nagar and Okhla Vihar for about 2 kms.	In this stretch the number of alignments were tried with the view to avoid the maximum of acquisitions due to area being very congested. Finally the alignment has been chosen which will affect very few numbers of residential properties.

2.3 PROPOSED PHASE III METRO CORRIDORS

As discussed above, based on the traffic surveys, alternative alignments and habitation the, Central Road Research Institute (CRRI) recommended 6 corridors as documented in **Table 2.4**. Detailed Project Report (DPR) for Phase III for these corridors was finalised in February 2010 and submitted to Delhi Government on 16.3.2010. The DPR was discussed by Government of Delhi and approval of Delhi Cabinet for proposed Phase III Metro lines was communicated to DMRC with some decisions and observations. In view of the decision of Delhi Cabinet, observations of Transport Department and keeping in view the Report on Integrated Road Cum Multi-Modal Public Transport Network of NCT of Delhi, the corridors have been modified.

TABLE 2.4
PREVIOUS METRO PHASE III CORRIDORS

S.No.	Corridors	Under Ground (km)	Elevated/At Grade (km)	Total (km)
1.	Anand Vihar – Dhaula Kuan	12.52	13.14	25.66
2.	Mukundpur-Rajouri Garden	6.58	5.82	12.40
3.	Malviya Nagar – Noida Sector 18	7.28	4.36	11.64
4.	Askhok Park- Delh Gate	5.28	4.36	9.54
5.	Central Secretariat – Lal Quila	6.80		6.80
6.	Jangir Puri – Badli	-	3.43	3.43
Total		**38.46**	**31.11**	**69.57**

As per the revised DPR, 4 (four) corridors are now proposed. Out of these, two are on the ring road and remaining two are the extensions of the existing corridors. With the proposed new corridors and extensions, most parts of Delhi will get covered except Bawana and Narela area

which is still under development. The corridors recommended to be included in Phase III are given in **Table 2.5**. Index plan for all corridors of MRTS Network are shown in **Figure 2.3** through **Figure 2.6**

2.3.1 Route Length and Break Up

At grade tracks are proposed to the extent possible. Elevated Option has been proposed where several roads or railway lines cross the alignment or where availability of land is limited. Underground option has been adopted only in the busy congested areas. Both elevated and at-grade are designated as rail corridors and underground sections are designated as Metro corridors. The details of proposed corridors like, the type of construction, their length and number of stations are indicated in **Table 2.6.** The list of Metro/rail corridor stations is presented in **Annexure 2.1**

TABLE 2.5
FINAL METRO PHASE III CORRIDORS

S.No	Corridor	Route Length (kms)
1.	Mukundpur to Yamuna Vihar via Azadpur, Shalimar Bagh, Netaji Subhas Place, Punjabi Bagh, Rajouri Garden, Naraina, Daula-Kuan, Bhikaji Cama Place, Sarojini Nagar, INA, South Extension, Lajpat Nagar, Ashram, Hazrat Nizammudin, Mayur Vihar, Anand Vihar and Welcome.	55.697
2.	Jankpuri (West) to Kalindi Kunj via Janakpuri Sector 2-C, Dabri Morh, Dasrathpuri, Palam, Palam Airport, Vasant Vihar, Munirka, R.K. Puram, IIT, Hauz Khas, Panchsheel Park, Chiragh Delhi, Nehru Place, Kalkaji, Okhla Phase III, Jamia Nagar, Okhla Vihar, Jasola Vihar, Kalindi Kunj	33.494
3.	Central Secretariat to Kashmere Gate via Raj Path, Mandi House, ITO, Lal Quila,	9.370
4.	Jahangirpuri to Badli	4.489
	TOTAL	**103.05**

FIGURE 2.3
INDEX PLAN FOR MUKUNDPUR TO YAMUNA VIHAR

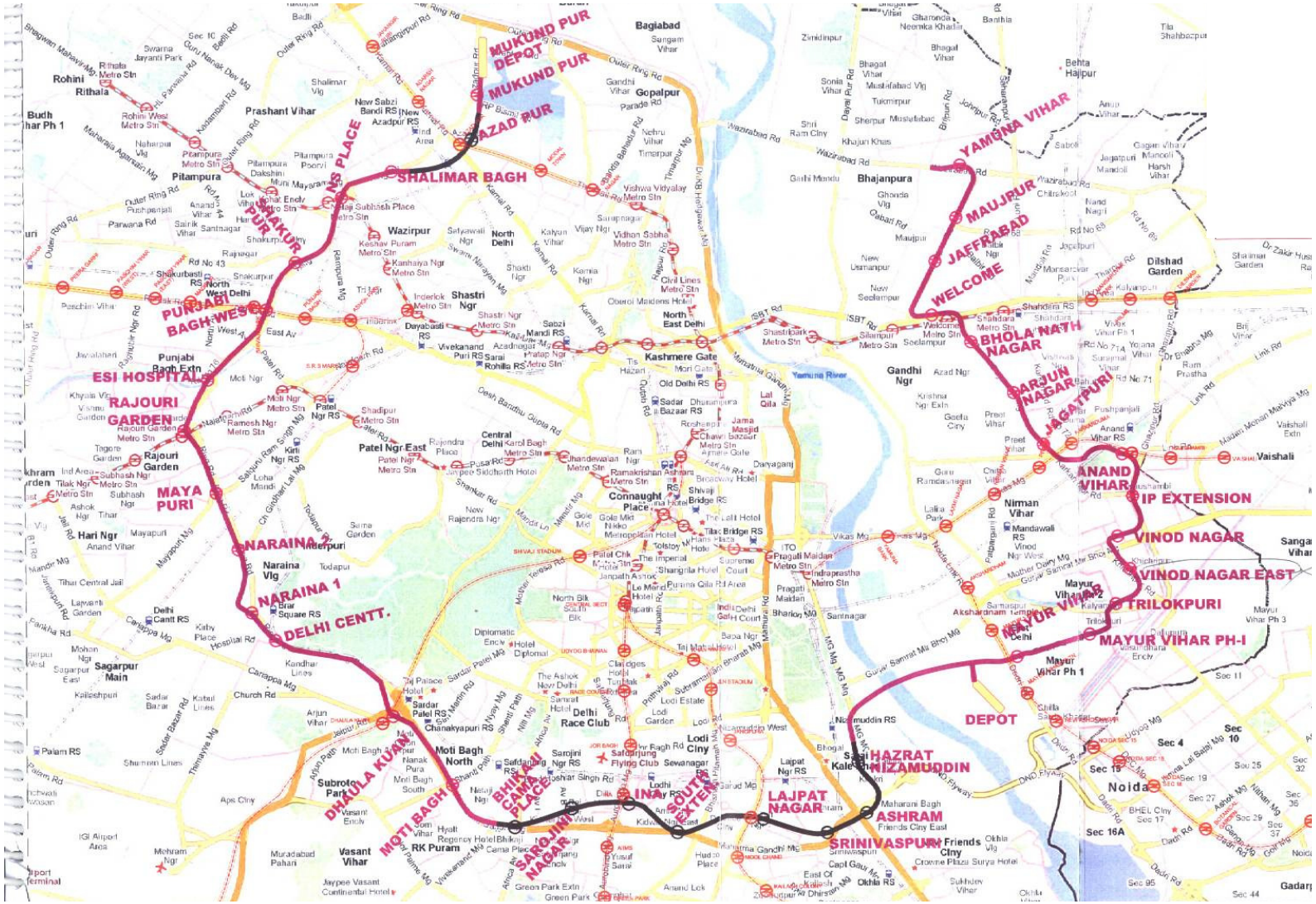


FIGURE 2.4
INDEX PLAN FOR JANKPURI WEST TO KALINDI KUNJ

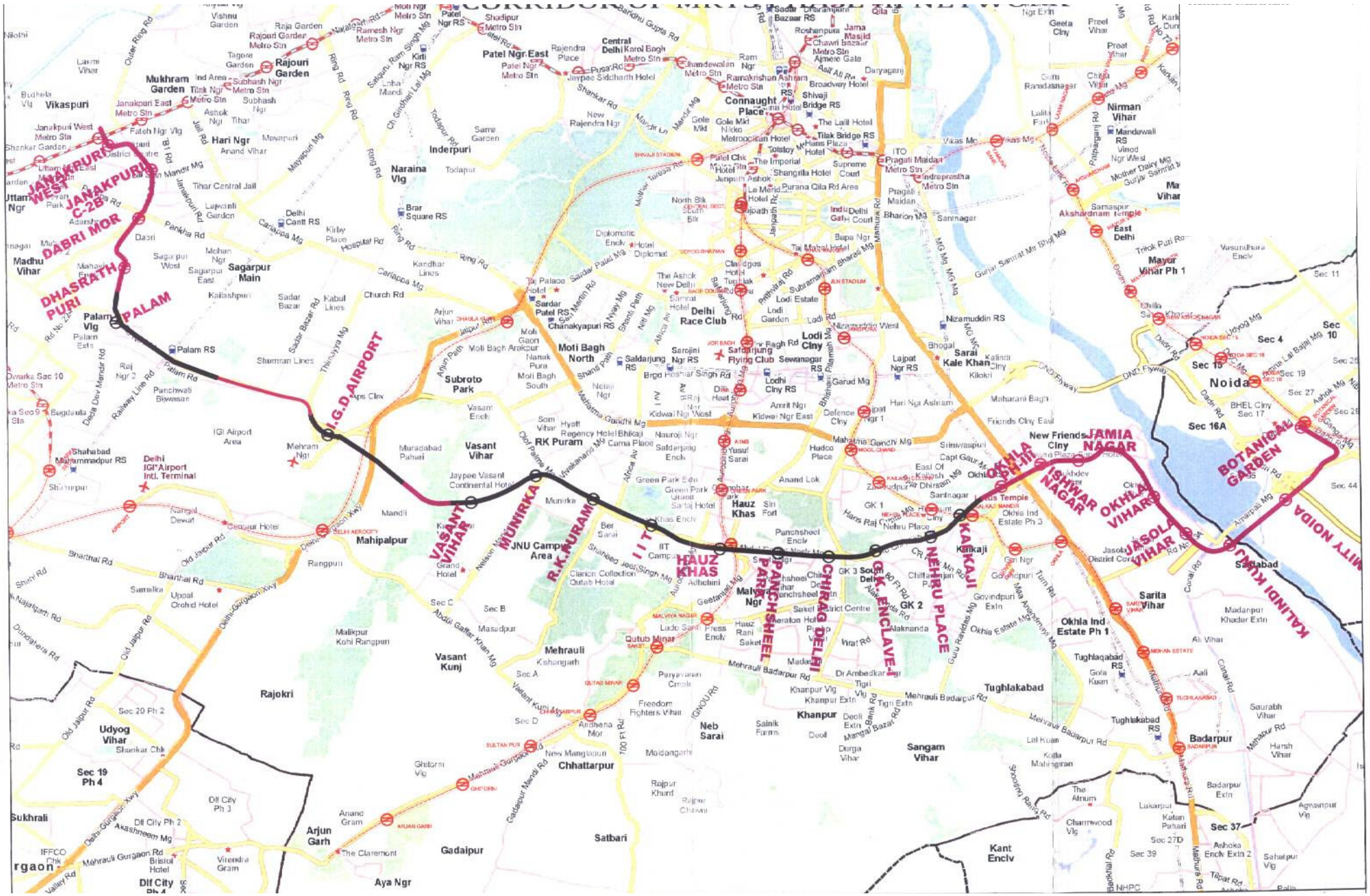


FIGURE 2.5
INDEX PLAN FOR CENTRAL SECRETARIAT TO KASHMERE GATE

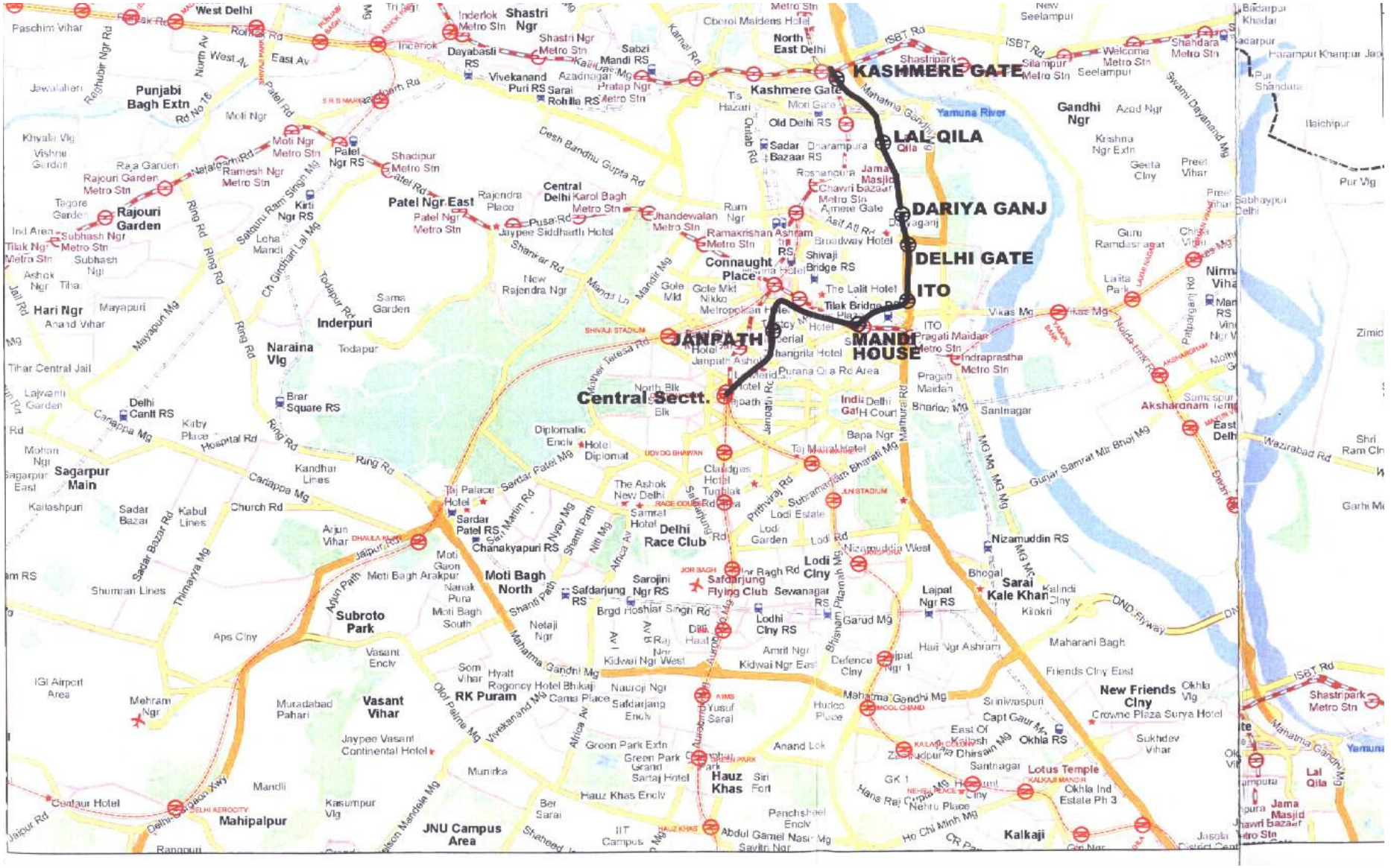


FIGURE 2.6
INDEX PLAN FOR JAHANGIRPURI TO BADLI

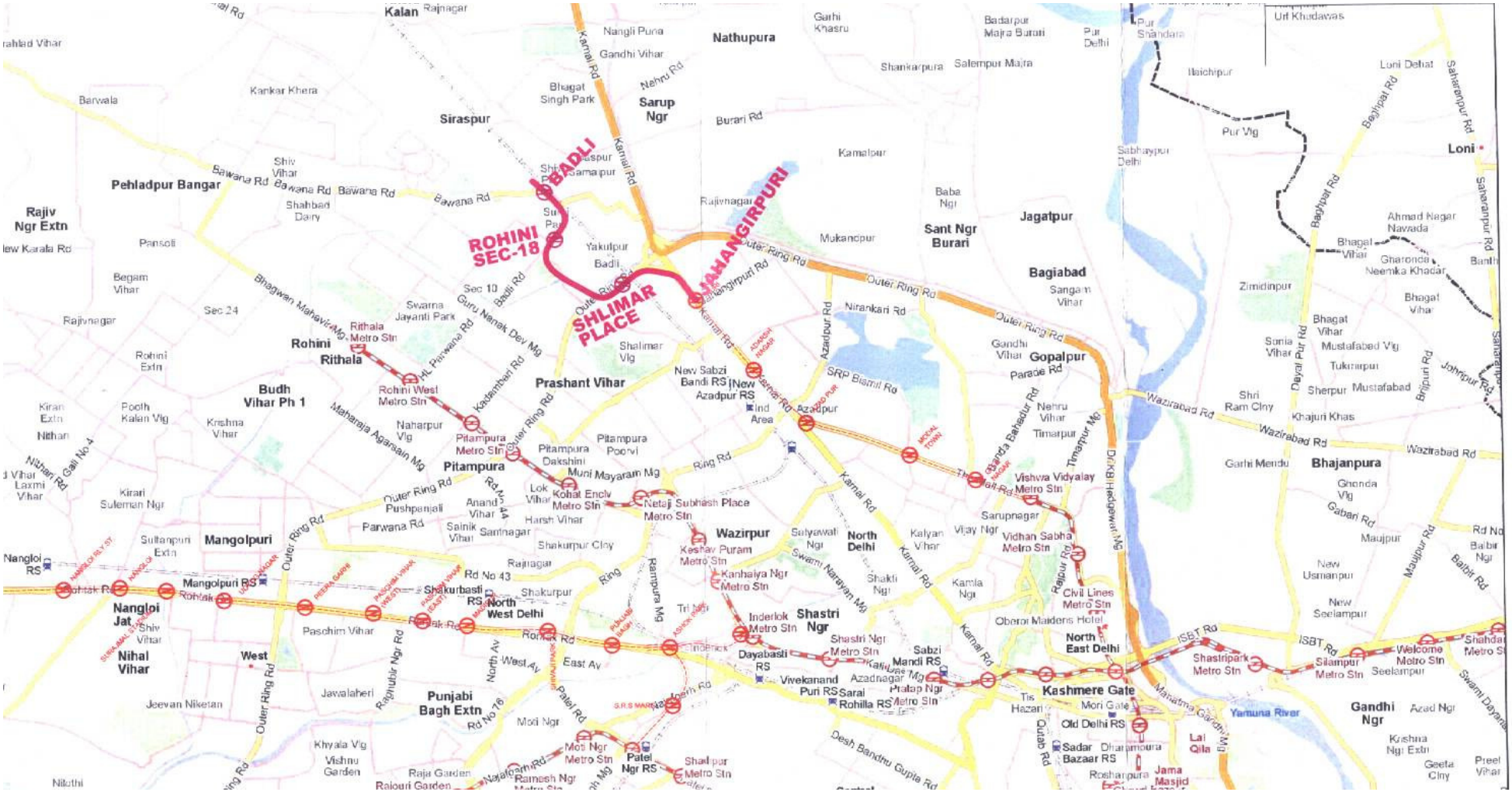


TABLE 2.6
DETAIL OF CORRIDORS

S.No	Corridor	Under-ground	Elevated /at Grade	Total Length (km)	Stations (Nos)		
					Under-ground	Elevated/ At Grade	Total
1.0	Mukundpur-Yamuna Vihar	14.386	41.311	55.697	9	26	35
2.0	Janakpuri West- Kalindi Kunj	17.288	16.206	33.494	12	10	22
3.0	Central Sectt.-Kashmiri Gate	9.370	0	9.370	7	0	7
4.0	Jhangirpuri Badli		4.489	4.489	0	3	3
	Total	**41.044**	**65.5**	**103.05**	**28**	**39**	**67**

2.3.2 Ridership On Phase III

There have been a continuous increase in the ridership in Phase I and Phase II. This trend is likely to continue for Phase III also. The estimated increase in daily ridership in different phases is shown in **Table 2.7**. Section wise passenger boarding and alighting ridership details for Phase III are presented in **Table 2.8.** The analysis of above two table indicates that the passenger will have influence on the ridership of other line than the line on which boarding.

TABLE 2.7
RIDERSHIP ON DIFFERENT PHASES AT DIFFERENT HORIZON YEARS

Year	2016	2021	2026	2031
Phase	**Ridership**	**Ridership**	**Ridership**	**Ridership**
Phase 1	589,234	696,458	814,698	948,988
Phase 2	1,505,038	1,835,994	2,146,550	2,472,714
Phase 3	1,856,426	2,300,542	2,719,146	3,141,264
Total	**3,950,698**	**4,832,994**	**5,680,394**	**6,562,966**

TABLE 2.8
SUMMARY OF DAILY PASSENGER BOARDING IN DIFFERENT HORIZON YEARS

Corridor	Length (in km)	2016	2021	2026	2031
Mukundpur – Yamuna Vihar	55.697	636,062	782,860	931,115	1,070,189
Janakpuri West- Kalinidi Kunj	33.494	361,356	453,267	531,839	612,723
Central Secretariat- Kashmiri Gate	9.370	134,879	167,994	196,116	229,901
Jahangirpuri - Badli	4.489	28,945	34,407	40,347	46,248
Total	**103.05**	1,161,242	1,438,528	1,699,417	1,959,061

2.3.3 Rolling Stock, Traction and Signalling

The salient features of proposals for Metro Corridor (underground) and Rail Corridors (above ground) in respect of rolling stock, power supply, traction system and signalling are summarised in DPR and reproduced below:

- The rolling stock for Broad Gauge Section shall be of the same design as being procured by Delhi Metro Rail Corporation (DMRC) for Phase II (RS2 Stock) ; while for the standard gauge network extensions RS3 stock will be used.

- Variable voltage variable frequency (VVVF), light weight coaches, 3.2m wide with regenerative braking has been proposed for metro corridor
- Continuous Automatic Train Control (CATC) system, comprising cab signalling and automatic train protection system (ATP), along with automatic Train Operation (ATO) and automatic Train supervision (ATS) has been adopted. It also has train describer-cum-passenger information system. Signalling and train control system will be capable of running trains at operation headway between 100 to 120 seconds.

- The temperature and humidity of underground metro tunnels and stations are planned to be controlled at 29^{O}C and 70% respectively.

- The 25 kV electric traction has been proposed for Phase III similar to II of Delhi Metro. 25 kV AC traction has the economical advantages of minimal number of sub-stations and potential to carry large traffic (60,000-90,000 PHPDT). The system requires catenaries masts on surface/elevated section. In tunnel section 25 kV rigid overhead equipment OHE is proposed.

- Integrated system with Fibre Optics Cable, SCADA, Train radio, PA system will be provided for telecommunication. The Technologies proposed to be adopted for telecommunication systems are shown in **Annexure 2.2.**

- UIC -60 (60 kg/m) rail section has been adopted for the project. These rails are to be imported as these are not manufactured in India. The grade on main line will be 1080 Head Hardened. For the Depot lines, the grade of rails will be 880, which can be manufactures indigenously.

- The Central Secretariat to Kashmiri Gate and Jahangir Puri to Badli corridors are basically the extension of Phase I / Phase II corridors and rest of the corridors are stand alone corridors. Standard Gauge (1435 mm) is adopted for all the three corridors except Jahangirpuri-Badli extension which shall be of Broad Gauge (1676 mm).

- Computer bases Automatic Fare Collection system (AFC) is proposed for the system. For multiple journey, the media shall be as utilised as Contactless Smart Token. The media shall be same as that existing on Phase I & II, so as to allow seamless travel.

2.4 PASSENGER CARRYING CAPACITY

In order to maximise the passenger carrying capacity, longitudinal seating arrangement shall be adopted. Criteria for the calculation of standing passengers are 3 persons per square metre of floor area in normal state and 6 persons in crush state of peak hour.

Carrying Capacity of Broad Gauge Cars is shown in **Table 2.9**. The carrying capacity for Standard Gauge Type 'A' and Type "B' are shown in **Table 2.10** and **Table 2.110** respectively

TABLE 2.9

CARRYING CAPACITY OF BROAD GAUGE CAR

Description	Driving Trailer car		Trailer car/ Motor car		4 car train	6 car train	8 car train
	Normal	Crush	Normal	Crush	Crush	Crush	Crush
Seated	42	42	50	50	184	284	384
Standing	120	240	124	248	976	1472	1968
Total	**162**	**282**	**174**	**298**	**1160**	**1756**	**2352**

TABLE 2.10

CARRYING CAPACITY OF TYPE 'A' STANDARD GAUGE CAR

Description	Driving Trailer car		Trailer car/ Motor car		4 car train	6 car train
	Normal	Crush	Normal	Crush	Crush	Crush
Seated	43	43	50	50	186	286
Standing	102	204	110	220	848	1288
Total	**145**	**247**	**160**	**270**	**1034**	**1574**

TABLE 2.11

CARRYING CAPACITY OF TYPE 'B' STANDARD GAUGE CAR

Description	Driving Trailer car		Trailer car/ Motor car		4 car train	6 car train
	Normal	Crush	Normal	Crush	Crush	Crush
Seated	42	42	50	50	284	434
Standing	120	240	124	248	1472	2216
Total	**162**	**282**	**174**	**298**	**1756**	**2650**

2.5 MAINTENANCE DEPOTS

Three maintenance depots along with full workshop facilities have been proposed at Mukundpur, Mayur Vihar and Kalindi Kunj, whereas three existing depots i.e Sarita Vihar, Mundka and Khyber Pass shall be utilized for the proposed corridors of DMRC Phase III network. Provision for strengthening the existing depot at Najafgarh and Yamuna Bank has been kept in the estimate.

2.6 SUB STATIONS

The traction system of 25 kV AC single phase will be adopted for the phase III corridors. At elevated and at grade section flexible over head equipment (OHE) and in underground rigid overhead catenary system will be provided. For 25 kV AC single phase overhead catenary traction system, the power supply at 66 kV or 220 kV level will be taken from the Grid Sub Stations of Delhi Transco Limited (DTL). Sources indicated by DTL are presented in **Table 2.12**

TABLE 2.12

TRACTION SYSTEM

Corridor		**Location of Source of Power (GSS)**
Yanuna Vihar – Mukundpur	1	At 66 kV level from proposed 220/66kv Anand Vihar GSS
	2	AIIMS (Troma Centre) at 220 kV level
	3	Naraina at 220 kV level
	4	A 22 kV bay at Shalimar Bagh 220 kV GSS
	*	Subash Nagar Papappankal-1 to be upgraded to provide alternate source.
Janakpuri West-Kalindi Kunj	1	At 66 kV from Sarita Vihar GSS
	2	At 66 kV from Mehrauli GSS after modification of yard, alternatively two bays can also be made available at 66kV level from Lodhi Road Grid Sub Station at 220 kV level
	3	At 66 kV from Vasan Kunj GSS
	4	At 66 kV level from two bays at Papan Kalan – I
	*	Sarita Vihar, Qutab Minar/Ambedkar colony, sub-stations may be upgraded by providing additional bay and laying 33 and 25 kV cables upto the alignment
Central Secretariat-Kahsmiri Gate	*	At Kashmere Gate (KG), additional bay to be created at existing 220/25, 220/33 kV RSS of line -1 to provide proven alternate supply
Jahangirpuri – Badli		No additional source required

* Up gradation of existing Sub-Station

The sub stations are planned to be constructed in an area of about 60m x 80m. 8 Nos of Substation will be required for the four corridors. Sub Station at Mukundpur and Kalindi kunj will be constructed at Depot location. Land has also been identified for other 6 Sub station which will be on Government land.

2.7 CONSTRUCTION METHODOLOGY

It is proposed to provide single box – shaped girders as superstructure for the viaduct as adopted in various section in Phase I and II. Construction of the underground section shall be done by "Cut and Cover" as well as by Tunnel Boring Machine (TBM). Cut and cover methodology for various sections of proposed corridors under MRTS Phase III network will be the same as already done in Phase I and II.

2.7.1 Construction Strategy

It is proposed to carry out the civil works through following construction contracts:

a) *Viaduct Construction*- Each contract can be limited to about 5 to 6 kms in length,
b) *Station Contracts*- Each station contract comprises of 3 to 6 stations

2.7.2 Construction Period

It is proposed to complete the project in a time period of 48 months. Most of the activities will be complete in a period of 36 months from award of work.

2.8 COST ESTIMATES

Project cost estimates for all the 4 proposed Phase III corridors have been prepared covering civil, electrical, signalling and telecommunication work, rolling stock, environmental protection and rehabilitation, at January 2011 price level. The Capital Cost for these corridors works out to ₹ 27,308 crores (₹ 273.08 billion) without taxes and Duties. Taxes and Duties such as Custom Duty, Excise Duty, Sales Tax/VAT etc have been estimated to be Rs. 4,649 Crores (₹ 46.49 billion). The total estimated cost is ₹ 31957 crores (₹ 319.57 billion)

TABLE 2.13

CORRIDOR – WISE ESTIMATED COST (₹Crores)

Corridors	Estimated cost at Jan 2011 price level	Land cost	Total Cost including land	Cutoms Duty and Excise duty	State Taxes (VAT)	Total Taxes	Total Cost
Mukundpur to Yamuna Vihar	11,391	745	12,136	1,426	596	2,022	14,158
Janakpuri West to Kalindi Kunj	8,451	482	8,933	1,049	451	1,500	10,433
Central Sectt. to Kashmiri Gate	3,819	20	3,839	497	189	686	4525
Jahangirpuri to Badli	2,355	45	2,400	383	58	441	2,841
Total	**26016**	**1,292**	**27,308**	**3,355**	**1,294**	**4649**	**31,957**

Source: DPR 2011 Table No. 9.2

Chapter –3

Environmental Baseline Data

CHAPTER – 3
ENVIRONMENTAL BASELINE DATA

3.1 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. The methodology adopted for data collection is highlighted wherever necessary. Environmental Attributes and Frequency of Baseline Survey is presented in **Table 3.1**. A scoping matrix has been formulated to identify the attributes likely to be affected due to the proposed project and summarized in **Table 3.2**.

TABLE 3.1
ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING

S. No	Attribute	Parameter	Frequency	Source
LAND ENVIRONMENT				
1	Soil	Soil Characteristics	Once	Field studies and Detailed project report
2	Geology	Geological Status	---	Literature review
3	Seismology	Seismic Hazard	---	Literature review
WATER ENVIRONMENT				
4	Water Quality	Physical, Chemical and Biological parameters	One Season	Field studies/literature review
AIR, NOISE AND METEOROLOGY				
5	Ambient Air Quality	PM2.5 , PM10, SO_2,, NO_x, CO, HC	One Season	Field Studies/literature review
6	Meteorology	Temperature, Relative humidity, Rainfall, wind direction and speed	Data	India Meteorological Department/literature review
7	Noise	Noise levels in dB (A)	One Season	Field monitoring
SCIO-ECONOMIC				
8	Socio-economic aspects	Socio-economic characteristic	Once	Field Studies, Literature review.
Ecology				
9	Trees	Number/species	Once	Filed Studies

TABLE 3.2
SCOPING MATRIX

No.	Impacts	Rating	Brief Description	Assumed mitigation measures	Survey for assessing impacts in this study
Social Environment					
1	Involuntary resettlement	A	Involuntary resettlement is required for construction of Phase III corridors.	- To provide proper compensation and rehabilitation. - To obtain consensus with the inhabitants.	- Social condition of the area will be studied through interview of PAP/PAF's **(Social baseline survey)**
2	Local economy such as employment and livelihood, etc.	A	Local economy and livelihood in the land acquisition area will be affected since the people need to be relocated.	(same as No.1)	(same as No.1)
3	Land use and utilization of local resources	A	Private and government properties will be acquired for alignment and stations.	(same as No.1)	(same as No.1) - Properties will be identified during topographical survey and route alignment.
4	Social institutions such as social infrastructure and local decision-making institutions	D			
5	Existing social infrastructures and services	B B	Infrastructures such as water lines, sewer, storm water drains, telephone lines, gas pipelines, overhead electrical lines Traffic at the existing road may be affected during the construction work.	- The utility services will be maintained in working order during different stages of construction by temporary / permanent diversions or by supporting in position - The utilities will be restored to normal positions after construction - Diversion/ suggest alternative routes for smooth flow of traffic	Departments whose utilities bare being impacted will be identified. Existing condition of the road and road traffic will be observed through traffic survey.
6	The poor, indigenous and ethnic people	D			
7	Misdistribution of benefit and damage	D			
8	Cultural heritage	C	Few small religious structures may be affected.	(same as No.1)	- Cultural heritages will be identified during survey.

No.	Impacts	Rating	Brief Description	Assumed mitigation measures	Survey for assessing impacts in this study
9	Local conflict of interests	D			
10	Water Usage or Water Rights and Rights of Common	D	No impact is anticipated as water requirement will be met from separate tube wells for the project	-	- .
11	Sanitation	B	Sanitation condition may deteriorate due to inflow of large number of construction workers.	Proper sanitation facilities will be provided (e.g. portable toilets) and ensure the proper management of waste.	- Current sanitation condition at the project site will be ascertained.
12	Hazards (Risk) Infectious diseases such as HIV/AIDS	B	The risk of infectious diseases may increase due to inflow of large number of construction workers.	- To consider health care programs.	- Information about diseases will be collected through the interview survey. **(Social baseline survey)**
Natural Environment					
13	Topography and Geographical features	D	No Impact on topography and geographical features is anticipated	-	-
14	Soil Erosion	B	Run off from unprotected excavated areas, and underground tunnel faces can result in excessive soil erosion	Careful planning, timing of cut and fill operations and revegetation	Soil condition will be assessed by taking soil sample and geotechnical study
15	Groundwater	B	Impact on ground water is expected as requirement of water for construction and operation of depot will met though tube well.	Rainwater harvesting will be done	Baseline data of ground water table and availability
16	Hydrological Situation	D	No impact on hydrological situation is anticipated.		
17	Coastal Zone (Mangroves, Coral reefs, Tidal flats, etc.)	D	The project area is not in the coastal zone.		
18	Flora, Fauna and Biodiversity	B D	Trees will be cut which are falling along the alignment. No rare and endangered species are found	- Compensatory afforestation will be carried out.	- Tree survey will be carried out during the study

No.	Impacts	Rating	Brief Description	Assumed mitigation measures	Survey for assessing impacts in this study
		D	. No impact on fauna is anticipated as the project is in urban area where there is no wildlife		
19	Meteorology	D	No impact on meteorology in anticipated		
20	Landscape	D	There is no valuable landscape to be protected at the project site.		
21	Global Warming	D	No activity which will cause the global warming is anticipated.		
Pollution					
22	Air Pollution	B	Emission from construction equipments and vehicles will increase air pollutants.	- To use proper construction vehicles with good condition to minimize emission.	- Air quality monitoring in project area
23	Water Pollution	C	Construction of bridge on Yamuna may create water pollution	- To select proper construction method. -	- Water quality of the river will be surveyed by water sampling.
24	Soil Contamination	D	Oil spills, paints, solvents may cause soil contamination	To provide for oil trays and drip pans and provision of separate storage	- Soil testing
25	Waste	B	Construction surplus soil will be generated.	- To select proper site to dispose the soil.	- Quantity of surplus soil will be identified.
26	Noise and Vibration	B	Construction noise will be generated. Noise and vibration from metro operation may impact surrounding area.	- To restrict construction at night. - To install noise barriers if necessary	- Noise quality monitoring in project area
27	Ground Subsidence	C	There will be possibility of subsidence.	- the detailed survey of condition of buildings/houses along proposed alignment will be conducted. During construction monitoring of condition of buildings/houses will be conducted. In case of occurrence of crack at wall of buildings/houses, damaged wall will be	

No.	Impacts	Rating	Brief Description	Assumed mitigation measures	Survey for assessing impacts in this study
				repaired immediately	
28	Offensive Odor	D	No odour is anticipated		
29	Bottom sediment	D	No Sedimentation is expected		
30	Accidents	B	There are risks of accidents during construction. During operation accidents will be reduced	- To secure the safely control.	-

3.2 LAND ENVIRONMENT

The Project area is situated in Delhi, the Capital of India. The average elevation of Delhi plains is 200 m above the sea level (a-MSL). The ridge however has a higher elevation going upto 300 m above mean sea level and is about 15 to 60 m above the surrounding plains. Delhi is located between $28^{O}24'15"$ and $25^{O}53'00"$ North latitude and $76^{O}50'24"$ and $77^{O}20'30"$ East Longitude. Parameters involved in land environment are, physiography, geology and soils, and seismicity. These are discussed in the following paragraphs.

3.2.1 Physiography

The physiography of Delhi is dominated by the river Yamuna, and the Aravalli range, and the plains in between, formed by alluvium deposits of recent formation. The Delhi Ridge and its four sections, the northern, the central, the south central and the southern constitute the farthest extension of the Aravalli range, its spurs meeting the Yamuna at two points, in the north and the east. The project area is divided in two parts by Yamuna. The project area is from Kalindi Kunj in South East to Janakpuri in West; Jangirpuri in North to IIT/Vasnat Kunj in South. The Noida or Shahdara area drains from east to west into the Yamuna river. Similarly Delhi and New Delhi areas also drain in Yamuna river through various drains such as Najafgarh drain. The average gradient is gentle, of the order of 1 to 4 m/km. Delhi area is generally flat except for a gentle rise to form a central ridge from North – East to South – South – West. The Yamuna river is Delhi's source of drinking water.

3.2.2 Geology and Soils

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

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

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

Rajouri Garden to Mukundpur; Anand Vihar to Dhaula Kuan area consists mainly, newer alluvium made up of fine to medium sands, silts, gravel and kankar. Soils are mainly sandy silt of low to medium plasticity (CL) or Silty sand/Fine to medium sand (SM/SP-SM) non-plastic in nature with a small proportion of graves. Rock is encountered at various depths from AIIMS Trauma Centre to Dhaula Kuan. Soils of Central Secretariat to Kashmere gate corridor are mainly sandy silt of low to medium plasticity (CL) or Silty sand/Fine to medium sand (SM/AP-SM) non-plastic in nature.

The area from Jahangirpuri to Badli consist mainly, newer alluvium made up of fine to medium sand and silt. Soils are mainly sandy silt of low to medium plasticity (CL) or Silty sand/Fine to medium sand (SM) non-plastic in nature.

In order to ascertain the quality and nature of soil within the vicinity of the project site, soil samples were collected. These samples were collected about 60 cm depth. The samples were tested for physical and chemical properties. The results of soil analysis are presented in **Table 3.3.** As per the test results it is observed that soil is tending to become alkaline. Soil is high in nitrogen and the carbon contents at most of the places. However phosphors and potassium content is low. Calcium and magnesium content is adequate at most of the places. At all places the soil texture is of sandy silt.

FIGURE 3.1
THE MAP SHOWING GEOLOGICAL UNITS OF DELHI

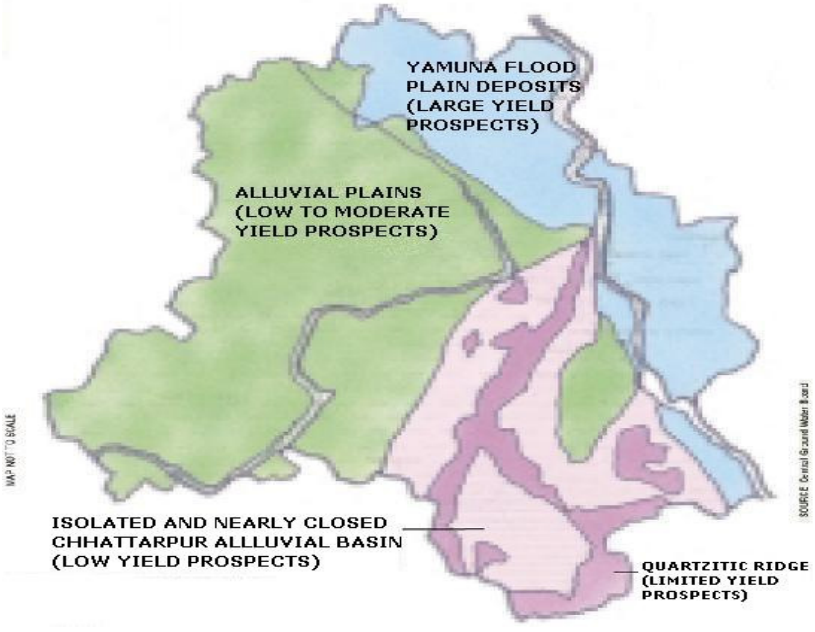


FIGURE 3.2
SOIL SAMPLE LOCATIONS

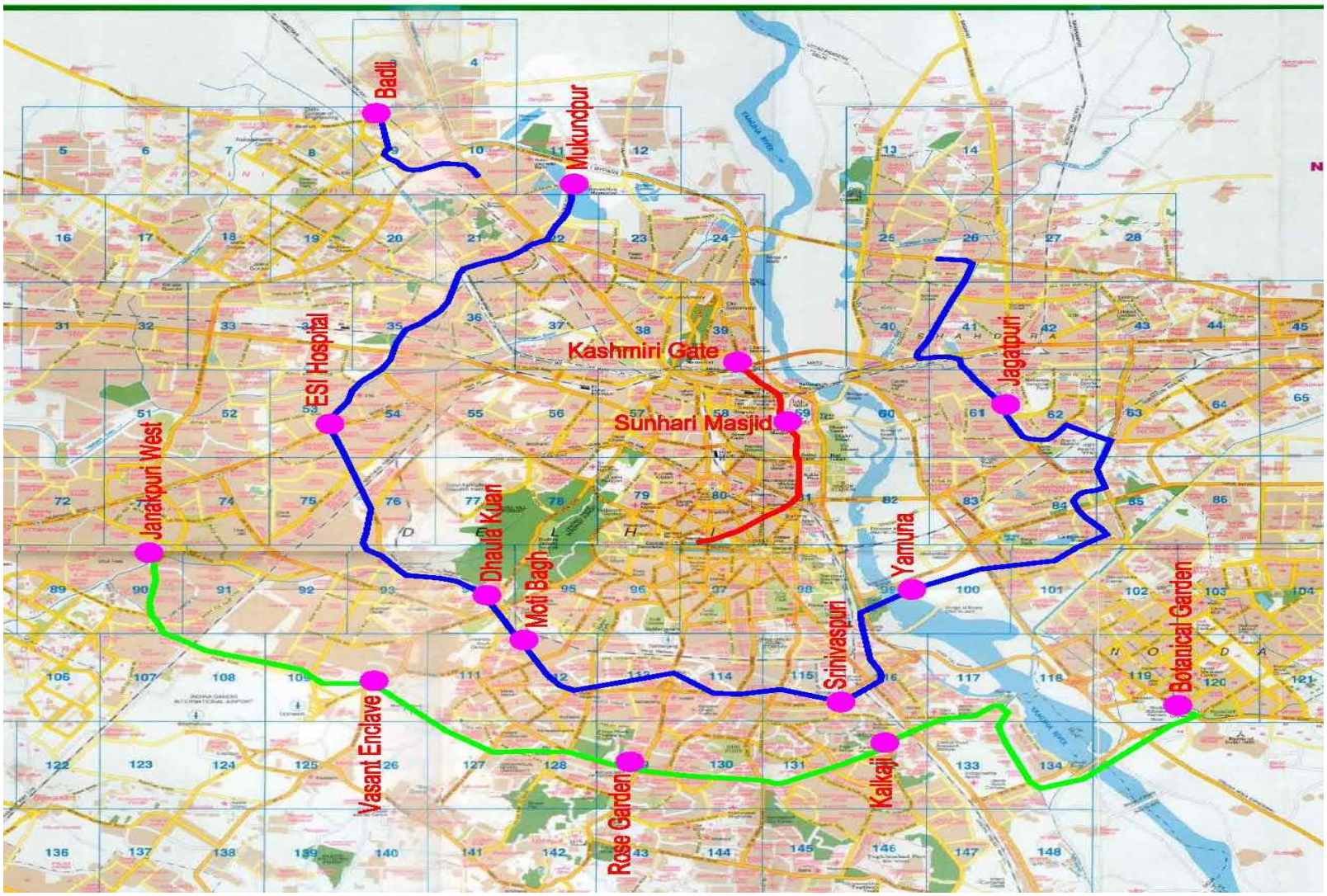


TABLE 3.3
SOIL TEST RESULTS

S.No	PARAMETERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	pH	8.443	7.805	7.40	7.654	7.654	7.87	8.16	7.76	7.90	8.456	8.06	7.667	7.63	7.240	7.234
2.	Organic Matter (%)	0.68	6.36	1.75	3.94	11.06	6.97	0.68	4.58	5.19	0.49	0.69	2.56	0.69	0.62	3.48
3.	Nitrogen (kg/Hectare)	1574.6	2811.2	3336.0	3120	5136	3618	2216	1668	3572	1618	1792	2936	2136	1175.05	4582.75
4.	Phosphorus (kg/Hectare)	<1.0	<1.0	21.38	13.98	65.36	65.12	4.38	28.19	56.84	<1.0	1092	16.39	20.52	16.52	47.78
5.	Sodium (mg/100gm)	10.9	10.63	11.25	8.64	11.2	8.6	8.94	88.41	8.04	10.6	8.99	6.25	10.9	35.13	45.76
6.	Calcium (ppm)	2610	1498	1560	1340	1680	1380	1680	1461	1398	2086.2	1806	1463	1468	3847.68	5170.30
7.	Potassium (kg/Hectare)	112	98	132	212	132	136	64.8	67.16	138.16	64.92	65.6	83.72	92	291.4	438.4
8.	Magnesium (ppm)	280	82	69	66	90	48.52	63.60	68.6	96.21	78.42	65.0	74.08	102	840	410.45
9	Electrical Conductivity	623.5	766.3	629.23	390	3384	480	690	448	526	896	802	560	608	1070	359.6
10	Texture (%)															
	Sand	79.46	72.528	82.19	92.92	90	68.68	87.18	76.21	82.19	68.0	78.16	81.16	82.19	76.92	82.10
	Slit	16.40	21.06	16.49	6.64	8.46	18.61	8.19	12.86	6.46	29.46	19.48	16.19	12.19	3.85	16.42
	Clay	4.14	6.36	1.32	0.44	1.54	12.71	4.63	10.93	11.35	2.54	2.36	2.65	5.62	19.23	1.48

1) Botanical Garden, 2) Klakaji, 3) Rose Garden 4) Biodiversity Park, Vasant Enclave 5) Janakpuri West, 6) Mukundpur, 7) Daula Kuan 8) ESI Park Soil 9) Moti Bagh 10) Srinivaspuri 11) Jagatpuri 12) Yamuna Bed 13) Badli 14) Jama Masjid 15) Kashmiri Gate

Source: Consultant study

3.2.3 Seismicity

The country has been classified into different zones indicating the intensity of damage or frequency of earthquake occurrences. These zoning maps indicate broadly the seismic coefficient that could generally be adopted for design of buildings in different parts of the country. These maps are based on subjective estimates of intensity from available information on earthquake occurrence, geology and tectonics of the country. Delhi is located in zone IV of seismic zoning map of India (**Figure 3.3).** The zone has fairly high seismicity with general occurrence of earthquakes of 5-6 magnitude, a few of magnitude 6-7 and occasionally of 7-8 magnitude. Delhi thus lies among the high-risk areas.

Seismicity around Delhi appears to be associated with a major geological structure, known as the Delhi-Haridwar Ridge. This ridge constitutes an important tectonic block between 28^{O} - 30^{O} N and 76^{O} - 79^{O} E with a NE-SW trend. It coincides with the extension of the Aravalli Mountain belt beneath the alluvial plains of the Ganga basin to the northeast of Delhi towards the Himalayan Mountain.[8] The first recorded major earthquake in this region occurred on 15^{th} July 1720 of intensity 9.0. Subsequent other earthquake events occurred in 1803, 1819, 19005, 1934, 1937, 1945, 1949, 1958, 1960, 1966, 1975, 1980, 1994, of intensity between 7.0 to 9.0.

3.3 WATER ENVIRONMENT

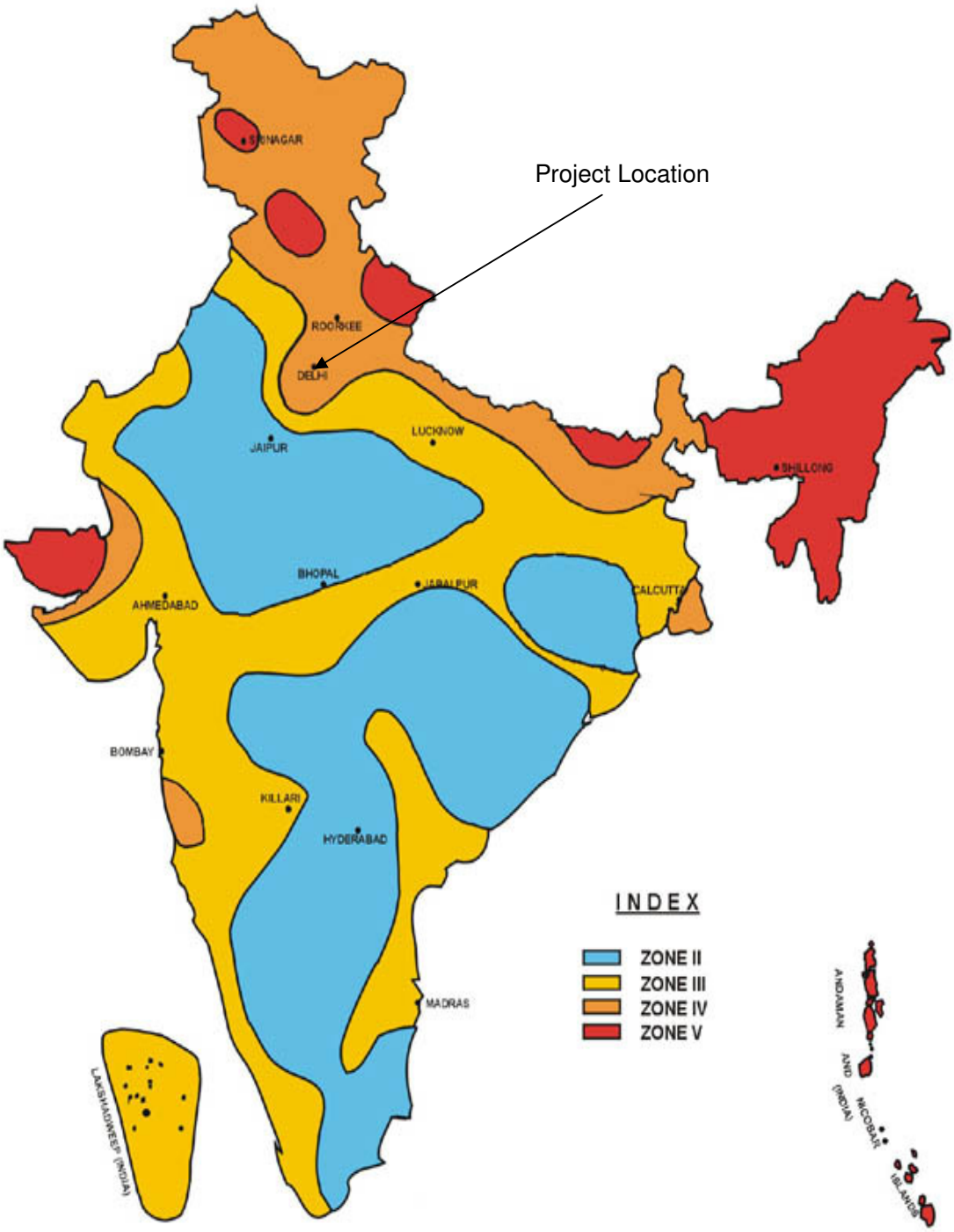
Water environment consists of water resources and its quality. Its study is important from the point of view to assess the sufficiency of water resources for the needs of the project in its various stages of the project cycle and also to asses the impact of the project on water environment. In the proposed project, ground water is proposed to be used during construction as well as post construction period; hence its quality has been tested to evaluate its suitability for the intended purpose. Anticipated impacts of the proposed project on water environment have also been addressed.

3.3.1 Water Resources

The water availability and its quality play a significant role in this project. Water supply to Delhi is from Yamuna river which flows through the project area. The Yamuna river originates from the Yamnotri glacier in the lower Himalayas at an elevation of about 6,387 metre above mean sea level., The river sluggishly meanders from Tajewala via Delhi to its confluence with the Ganga at Allahabad after flowing a distance of about 1,200 kms [9]. The project area receives raw water from the following main sources:

[8] http://delhi.gov.in/wps/wcm/connect/doit_dm/DM/Home/Vulnerabilities/
[9] http://www.delhi.gov.in/DoIT/DOIT_DM/district%20profile.pdf

FIGURE 3.3
SEISMIC ZONING MAP OF INDIA



River Yamuna: Delhi's share of this river's resources, as per inter-state agreements, is 4.6%. The water availability at 90% dependability during different seasons in a year is as follows:

- Mansoon : 10.0 Mm^3/day
- Post mansoon : 1.2 Mm^3/day
- Winter : 0.8 Mm^3/day
- Summer : 0.1 Mm^3/day

The hydro-geological situation characterized by occurrence of alluvial formation and quartzitic hard rocks controls the availability of groundwater in the National Capital Territory of Delhi.

Delhi gets it water from the Ganga Canal, the western Yamuna canal, the Bhakra Canal and the river Yamuna river. The demand of water by end of this year is expected to be 1600 MGD (million Gallons per day) versus a proposed treatment capacity of 990 MGD. The ground water table in Delhi has depleted to 20-30 m in various area across the city. It is said that water table is falling about 3 m/year. Ground water levels have depleted by 2-6 m in Alipur and Kanhwla Blocks, 10m in Najafgarh block and about 20m in Mehrauli Block[10] . The proposed alignment is to cross the river Yamuna only at one location. The flow of river varies from season to season as reported above. During summer the flow is less, since most of the treated sewage, untreated flow from drains are directly discharged into the river at at-least 17 locations which make the river unsuitable for supporting any aquatic life specially the fish species. Plans by the Government, to clean up the river, under the Yamuna Action Plan, are underway.

Rainwater: Delhi receives a normal rainfall of 611.8 mm in 27 rainy days. The utilized rainwater runoff is 193 Mm^3 per year. Apart from these the Bhakra storage and the Upper Ganga Canal also provide water.

3.3.2 Ground Water

It is estimated that ground water availability in Delhi is 292 Mm^3. Salinity and over exploitation have contributed to depletion and drastically affected the availability of water in different parts of the city. As per the analysis of long term water level data (2001-2010) collected during pre-monsoon period (May) by Central Ground Water Board (CGWB), decline in ground water levels has been observed in some parts of Delhi. District wise details of fall in ground water levels are given below in **Table 3.4**. The main reasons for decline in ground water levels in NCT of Delhi include increasing ground water withdrawal for various purposes especially in areas where piped water supply is inadequate and rapid pace of urbanization resulting in reduced natural recharge to aquifers.

[10] www.rainwaterharwesting .org/index

3.3.3 Water Quality

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

Delhi Pollution Control Committee (DPCC) is carrying out water quality analysis of river Yamuna and ground water analysis at various locations in Delhi. Results of water quality of river Yamuna and Ground water quality analysis carried out by Delhi Pollution Control Board for the month of January 2011 is presented in **Annexure 3.1 and 3.2** respectively.

TABLE 3.4
GROUNDWATER FALL IN DELHI

District	Total No. of observation wells monitored	No. of wells showing fall in ground water levels	Minimum fall (m)	Maximum fall (m)
Central	2	1	1.91	1.91
East	21	14	0.13	3.34
New Delhi	23	22	0.05	5.83
North	11	9	0.01	1.10
North East	7	5	0.07	0.91
North West	40	27	0.04	3.97
South	39	34	0.04	7.92
South West	46	39	0.05	9.25
West	12	9	0.16	2.36

Source: http://pib.nic.in/newsite/erelease.aspx?relid=68305

In order to collect baseline data on the existing water quality, ground water samples were collected from 15 different locations along the alignment in the project study area and analyzed as per the procedure specified in standard methods for examination of water and wastewater published by American Public Health Association and the Bureau of Indian Standards (APHA/BIS). The results of the physio-chemical analysis are summarized in the **Table 3.5**.The test results when compared with the prescribed limits of various parameters as per IS 10500:1991 indicated that at some locations certain parameters are more than desirable limit. These values are shown in bold italics in the table. Alakalinity at a Park at ESI hospital; Magnesium at Janakpuri West, Sunhari Masjid and Kashmiri gate; and total hardness at Janakpuri West are more than permissible limit.. At rest of the locations, the parameters are within limit as per IS 10500:1991.

FIGURE 3.4
WATER SAMPLE LOCATION

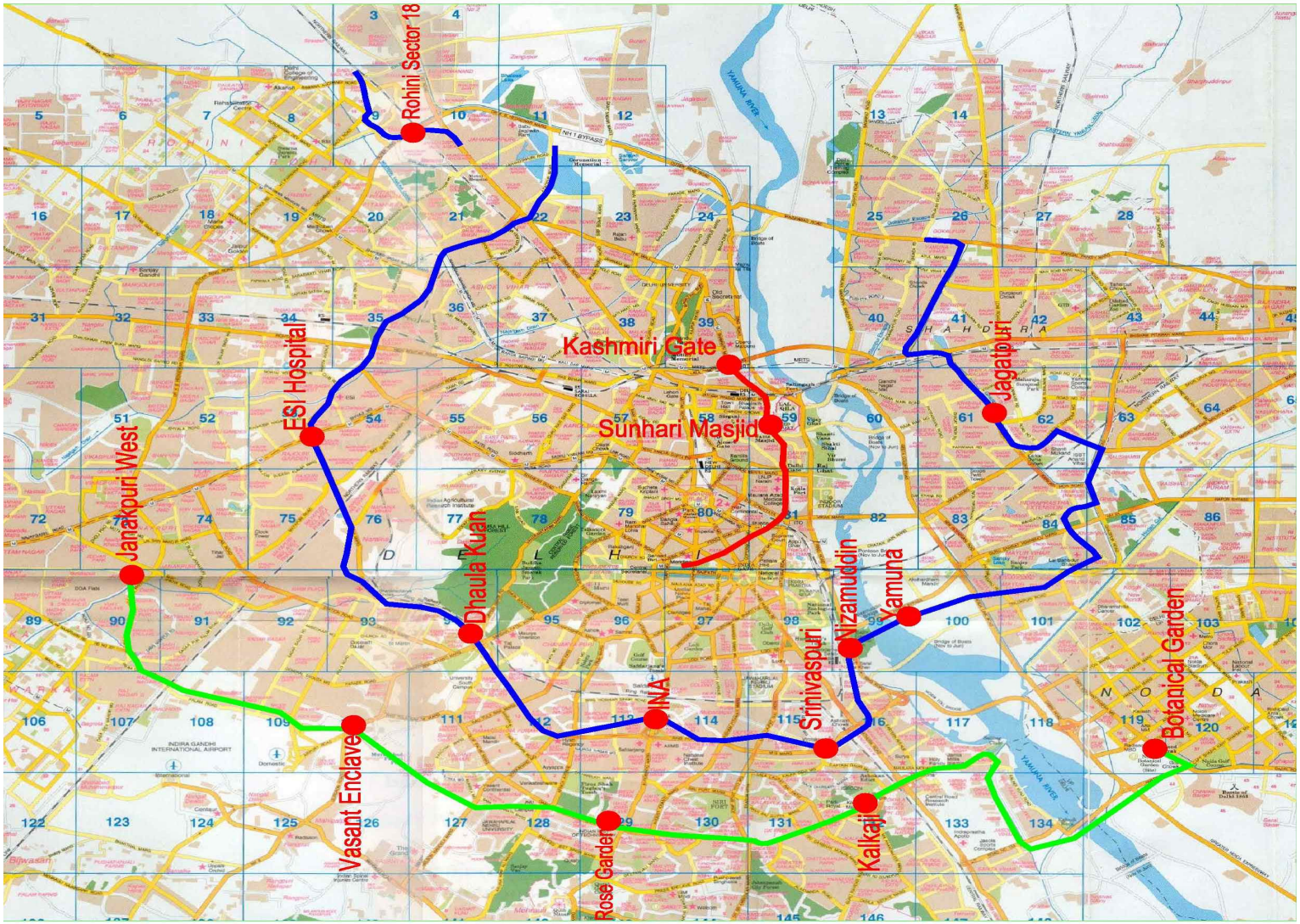


TABLE 3.5
WATER QUALITY AT PROJECT SITE

S.No.	PARAMETERS	SAMPLE LOCATIONS														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Alkanity(mg/l)	*280*	*68.0*	*420*	*352*	*300*	*368*	*444*	***636***	*524*	*404*	*392*	*390*	*228*	*360*	*356*
2.	Arsenic(mg/l)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01
3.	BOD (mg/l)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	4.0	<2.0	<2.0	<2.0
4.	Copper (mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
5.	Chlorides (mg/l)	*395.2*	20.16	125.0	120.98	*935.61*	137	*314.5*	*512*	*306.4*	*366.9*	104.8	*252*	28.2	193.5	*395.2*
6.	Chromium (mg/l)	<0.010	<0.01	<0.010	<0.010	<0.010	<0.05	<0.05	<0.05	<0.05	<0.02	<0.02	<0.05	<0.05	<0.01	<0.01
7.	Calcium (mg/l)	*116.8*	24.0	62.4	*76.8*	*116.8*	*80.16*	*75.35*	68.8	57.72	70.4	51.2	19.23	21.04	*157.8*	*93.1*
8.	Cadmium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
9.	COD	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	16	<4.0	<4.0	<4.0
10.	Dissolved oxygen (mg/l)	6.6	6.7	6.6	6.7	6.8	6.6	6.6	6.8	7.1	7.1	6.9	5.2	6.4	6.6	6.7
11.	Faecal Coliform	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
12.	Fluorides (mg/l)	0.56	0.61	0.59	0.76	0.67	0.83	0.52	0.76	0.62	0.42	0.86	0.86	0.25	0.76	0.45
13.	Magnesium (mg/l)	*57.35*	4.86	34.99	13.61	***183.71***	17.5	6.08	10.69	48.6	*85.54*	*30.13*	29.16	18.69	***226.7***	***506***
14.	Manganese (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
15.	Mercury (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
16.	Nitrates (mg/l)	26.46	<1.0	24.82	11.93	28.14	21.69	21.06	28.46	34.86	28.86	22.49	38.90	4.89	19.5	28.96
17.	Nickle (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
18.	Lead (mg/l)	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.02
19.	pH	7.521	7.596	7.276	7.354	7.638	7.119	7.313	7.25	7.766	7.119	7.015	7.421	7.192	6.719	6.743
20.	Sulphates (mg/l)	160.26	4.56	86.52	64.82	*356.16*	160.10	120.61	80.4	86.42	152	84.49	110	1.76	*263.1*	*260.4*
21.	Sodium (mg/l)	226.1	3.61	162.2	111.52	215.5	120	98	112	110	115	86	65	48.0	91.1	240

S.No.	PARAMETERS	SAMPLE LOCATIONS														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
22.	Phenolic compounds (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23.	Potassium (mg/l)	9.46	2.39	1.70	3.30	8.0	2.1	1.5	3.6	3.1	4	4.1	6.8	<1	15.1	18.2
24.	Total Iron (mg/l)	0.106	0.096	0.206	0.209	*0.369*	0.206	0.206	0.286	0.108	0.108	0.209	1.06	0.106	0.121	0.15
25.	Total Dissolved Solids (mg/l)	*1452.15*	122.22	*837.27*	*678.9*	2581.7	*907*	*1262*	*1890*	*1536*	*1552*	*769.4*	*1104.8*	433.6	*1121.5*	*1825.2*
26.	Total Hardness (mg/l)	*528*	80.0	300	248.0	***1048***	272	205	216	*344*	*528*	252	*380*	182.1	*384.5*	*599.1*
27.	Total Phosphate (mg/l)	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
28.	Total Suspended Solids (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	11	<1.0	<1.0	<1.0	31	<1.0	<1.0	<1.0
29.	Temperature	26	28	28	27	26	27	26	29	27	28	28	29	29	34.7	34.7
30.	Total coliform	Absent	Absent	Absent	Absent	Absent	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
31.	Zinc (mg/l)	0.396	0.068	0.406	0.298	0.562	0.108	0.409	0.436	0.209	0.369	0.609	0.609	0.260	0.510	0.341

1. Botanical Garden, 2) Klakaji, 3) Rose Garden 4) Vasant Enclave 5) Janakpuri West, 6) INA 7) Daula Kuan 8) Park at ESI Hospital 9) Srinivaspuri 10) Indraprastha Par (Nizamuddin)11) Jagatpuri 12) Yamuna River 13) Rohini Sector 18 14) Sunhari Mazid 15) Kashmiri Gate

Source: Consultant study

3.4 METEOROLOGY AND AIR ENVIRONMENT

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

3.4.1 Meteorology

Delhi has an extreme climate, which is very cold in winter and hot in summer. The climatic conditions in project area are characterized by a rainy season (July-October), Winter (November-March) and Summer (April-June). The recorded meteorological data for the area have been summarised in Table 3.5 through 3.9. The mean annual rainfall of project area was 714 mm between the years 1980-90. Over 75% of the rainfall is received during rainy season (Ref Table 3.5).
Delhi has a monsoon climate with an average yearly rainfall of 730 mm. The air relative humidity at Delhi varies almost throughout the year but seldom drops below 30%. Records of monthly rainfall, mean maximum and mean minimum relative humidity of Delhi obtained from Indian Meteorological Department, from 2005 to 2009 are given in **Table 3.6 to Table 3.8**.

The mean monthly maximum temperatures are highest in April-May-June (38^{O}C). Mean minimum temperature is lowest during January (7^{O}C). Records of mean maximum and mean minimum temperatures from 2005 to 2009 are given in **Table 3.9** and **Table 3.10** respectively.

Winds are generally light to moderate (0.9 to 4.9 m/sec) but increases in April-May-June. Wind direction is mostly from North, North East; and North West. Wind speed and direction observed at 8:30 and 17:30 hrs are placed at **Annexure 3.3** and Windrose diagrams are given in **Annexure 3.4.** The sky is moderately cloudy in July-August and is generally cloud free from February till May.

TABLE 3.6
MONTHLY RAINFALL (In mm)

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

TABLE 3.7
MEAN MAXIMUM RELATIVE HUMIDITY (In %)

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

TABLE 3.8
MEAN MINIMUM RELATIVE HUMIDITY (In %)

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

TABLE 3.9
MEAN MAXIMUM TEMPERATURE (In degree centigrade)

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

TABLE 3.10
MEAN MINIMUM TEMPERATURE (In degree centigrade)

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

3.4.2 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 µg/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]. **Figure 3.5** indicates the contribution from various sectors to ambient air pollution in Delhi.

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 3.6.** 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 3.11.** The results show that the concentration of PM_{10} and $PM_{2.5}$ exceeds the standards at 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. These results are presented in **Annexure 3.5**. 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 3.11

AMBIENT AIR QUALITY RESULTS

Timing	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)	NO_x (µg/m^3)	SO_2 (µg/m^3)	HC as (CH_4) (ppm)	Lead as (Pb) (µg/m^3)
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

[11] Towards Cleaner Air, A case Study of Delhi, Published by Department of Environment, Government of NCT of Delhi

Timing	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	NO_x ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	HC as (CH_4) (ppm)	Lead as (Pb) ($\mu g/m^3$)
Limits as per CPCB	**100**	**60**	**80**	**80**	**-**	**1**
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

Timing	PM $_{10}$ ($\mu g/m^3$)	PM $_{2.5}$ ($\mu g/m^3$)	NO_x ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	HC as (CH_4) (ppm)	Lead as (Pb) ($\mu g/m^3$)
Limits as per CPCB	**100**	**60**	**80**	**80**	**-**	**1**
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
Naryana						
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

3.5 NOISE ENVIRONMENT

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

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

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

- Characteristics of noise sources (instantaneous, intermittent or continuous in nature).

- Time of day at which noise occurs, for example high noise levels at night in residential areas are not acceptable because of sleep disturbance.

- Location of noise source, with respect to noise sensitive land use, which determines the loudness and period of exposure.

FIGURE 3.5
CONTRIBUTION OF VARIOUS SECTORS TO AMBIENT AIR POLLUTION IN DELHI

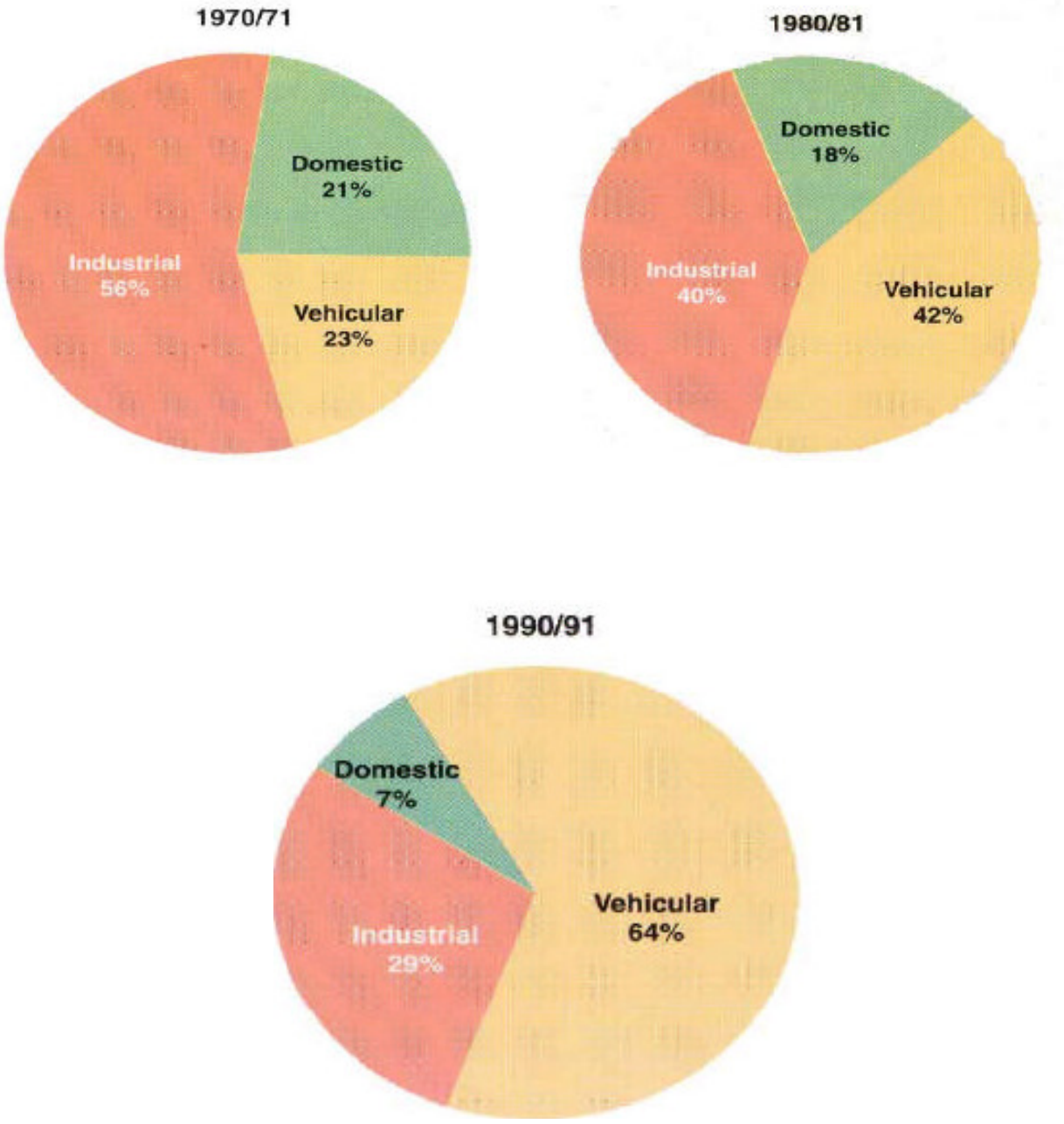
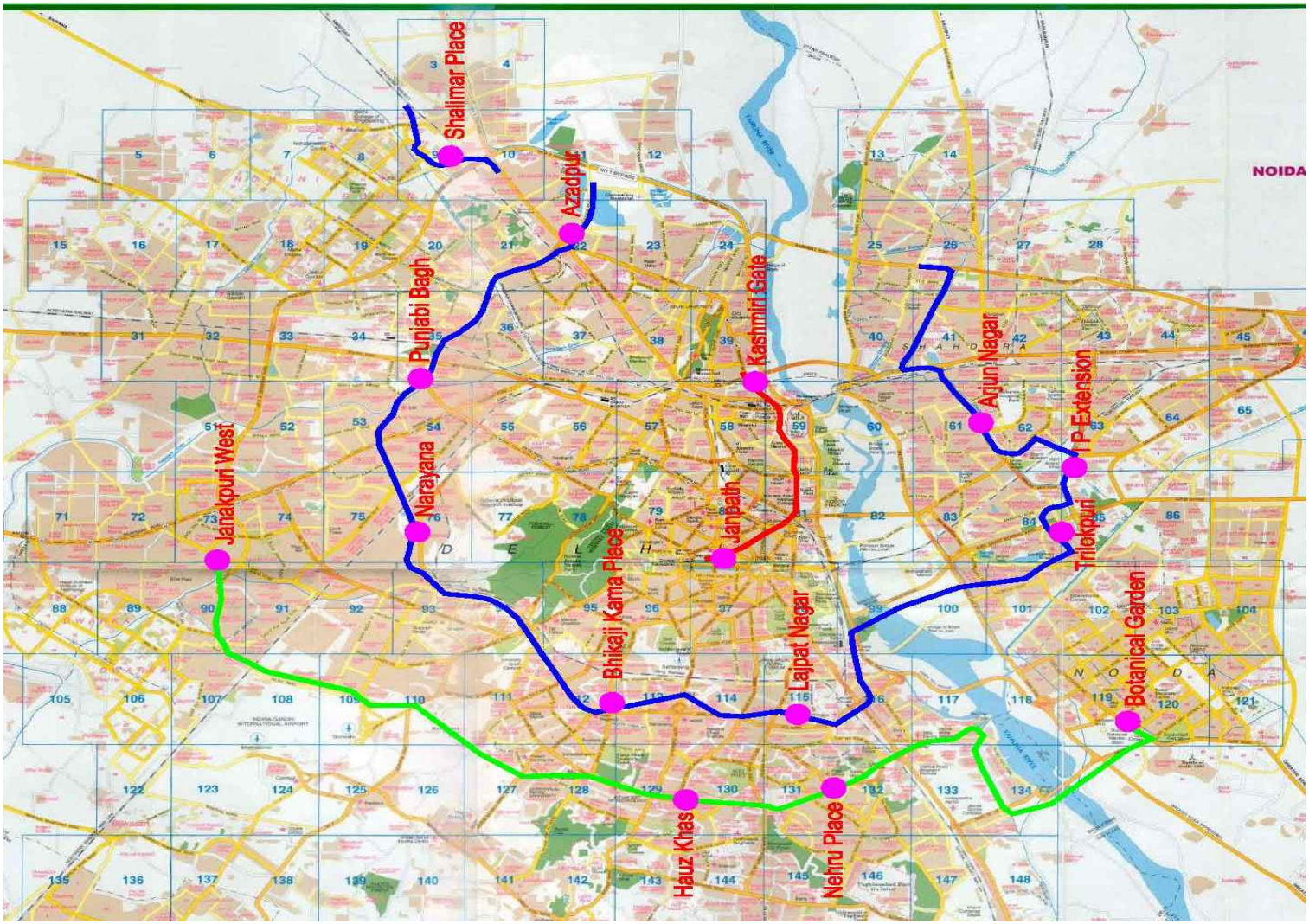


FIGURE 3.5
AIR AND NOISE MONITORING LOCATIONS



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 3.12** and hourly data is presented in Table **3.13** 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. These results are presented in **Annexure 3.6**. 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 1.6**

TABLE 3.12
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 3.13
HOURLY NOISE LEVELS

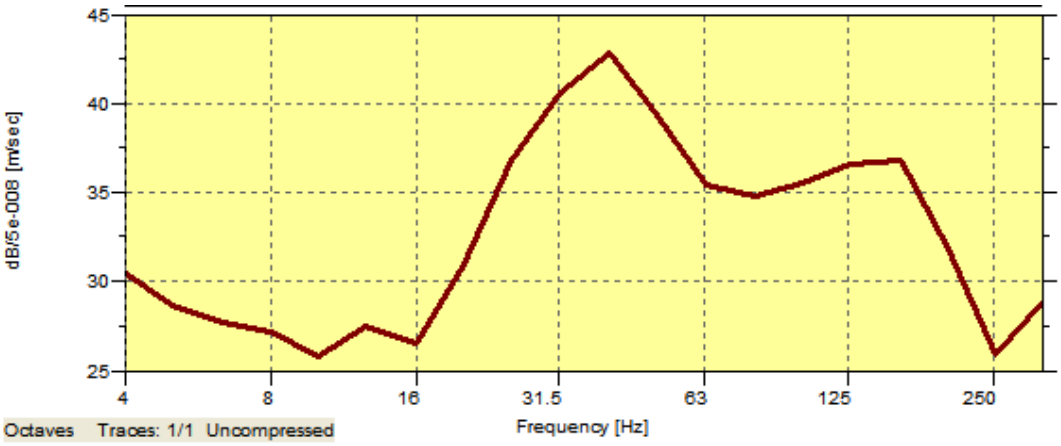
S. No.	Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Mid Night	56.5	52.9	50.6	56.0	53.0	51.2	47.8	52.4	44.6	49.8	53.4	48.5	49.6	53.6	54.8	49.3
2.	1:00 AM	54.6	50.1	50.6	56.1	48.9	51.1	45.6	53.4	44.8	50.7	52.4	47.6	49.7	51.9	52.9	49.4
3.	2	54.7	49.2	49.6	55.5	48.1	50.4	45.9	52.5	45.1	49.9	51.5	46.8	48.1	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

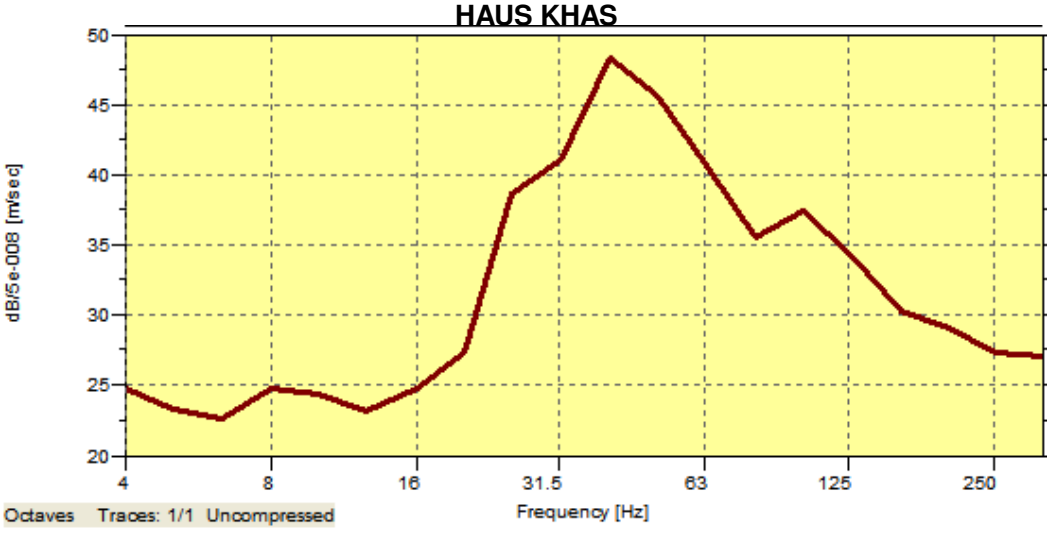
3.6 Vibration

The sources of the vibration and noise induced by the metro trains are mainly the rolling stock, track and the interaction between them. The vibration induced by the train first causes the vibration of track structure as well as tunnel structure, and then, propagate through the strata to the surrounding environment. The vibration due to track structure occupies 35 percent of the total vibration. In order to assess the vibration level due to running of metro trains, DMRC has conducted Vibration monitoring in tunnel and at Saket and Huaz Khas residential houses; near Viaduct structures(elevated), at Moolchand Hospital and at basement of Hyudai Car showroom. The vibrations recorded at these locations are given in **Figures 3.7** through **Figure 3.18**

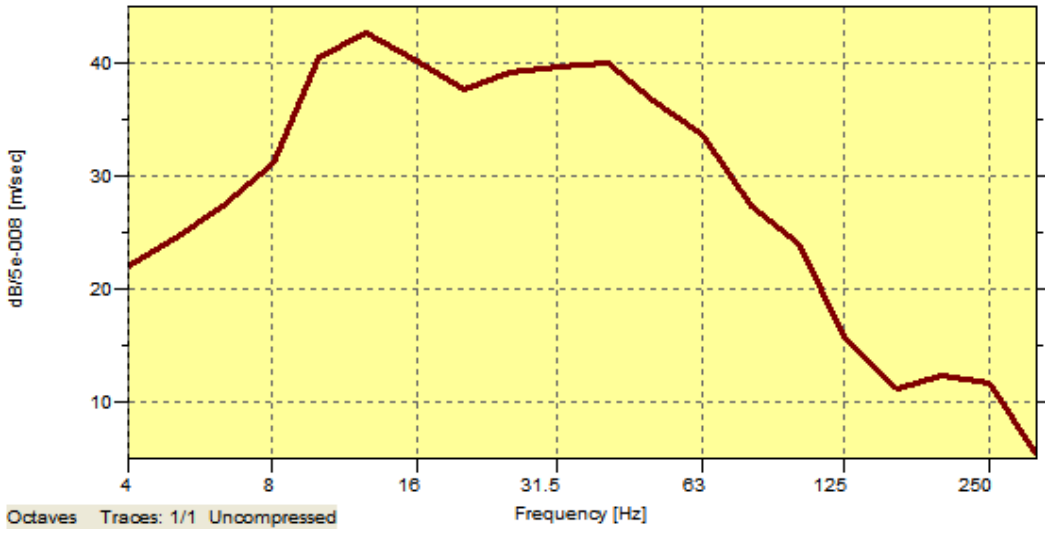
FIGURES 3.7
TRAIN PASS – ENERGETICALLY AVERAGED VIBRATION LEVEL AT TUNNEL AT SAKET



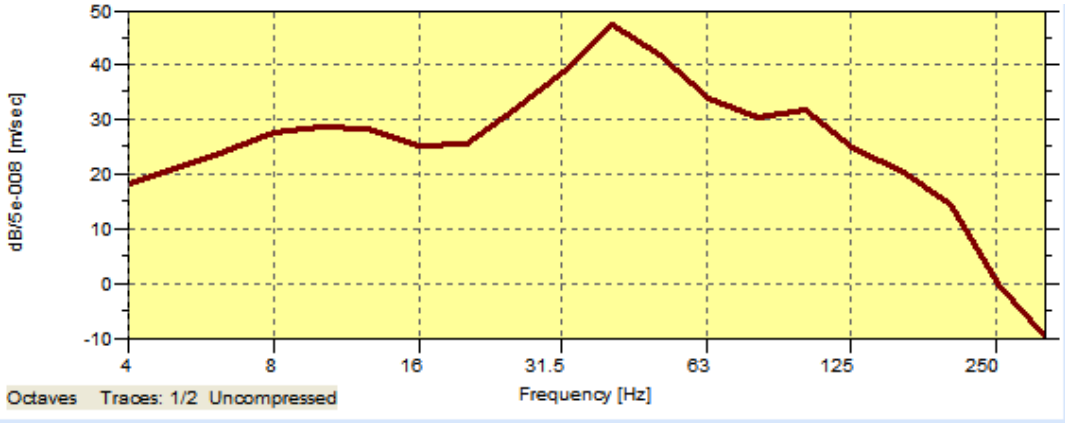
FIGURES 3.8
TRAIN PASS – ENERGETICALLY AVERAGED VIBRATION LEVEL AT TUNNEL AT HAUS KHAS



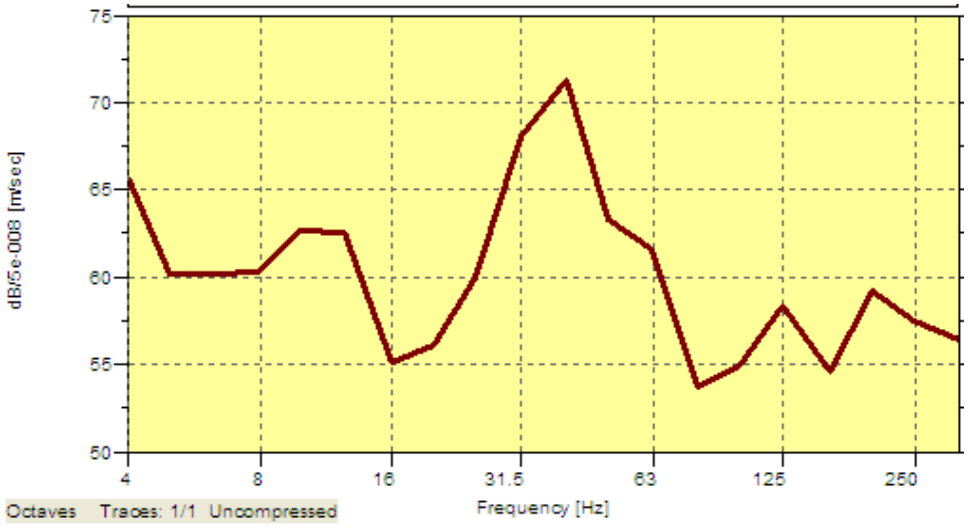
FIGURES 3.9
TRAIN PASS – ENERGETICALLY AVERAGED VIBRATION LEVEL AT HOUSE AT SAKET



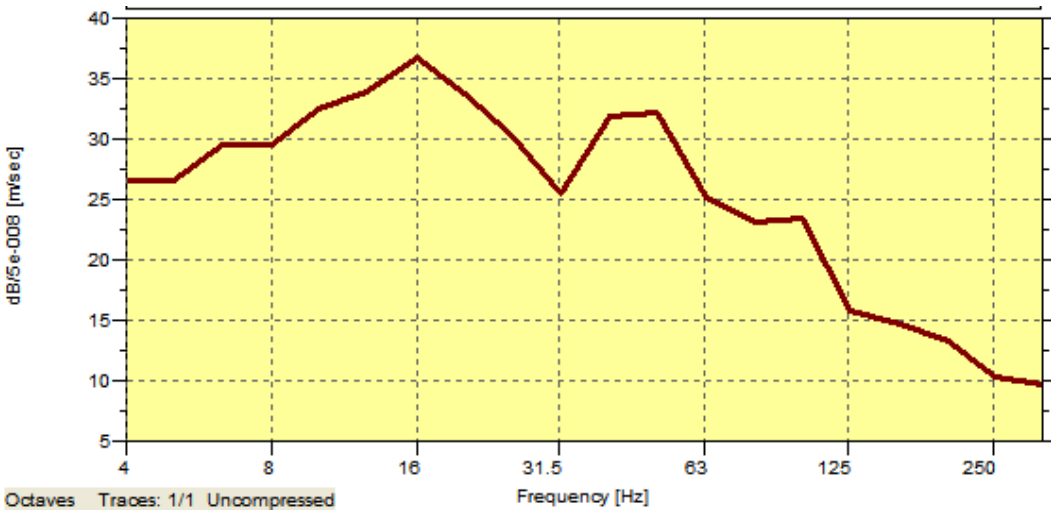
FIGURES 3.10
TRAIN PASS – ENERGETICALLY AVERAGED VIBRATION LEVEL AT HOUSE AT HAUS KHAS



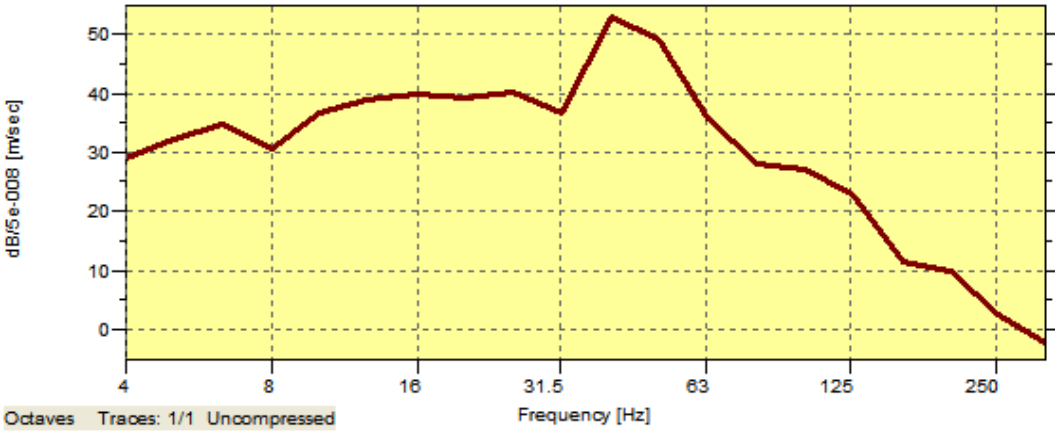
FIGURES 3.11
TRAIN PASS – ENERGETICALLY AVERAGED VIBRATION LEVEL AT VIADUCT



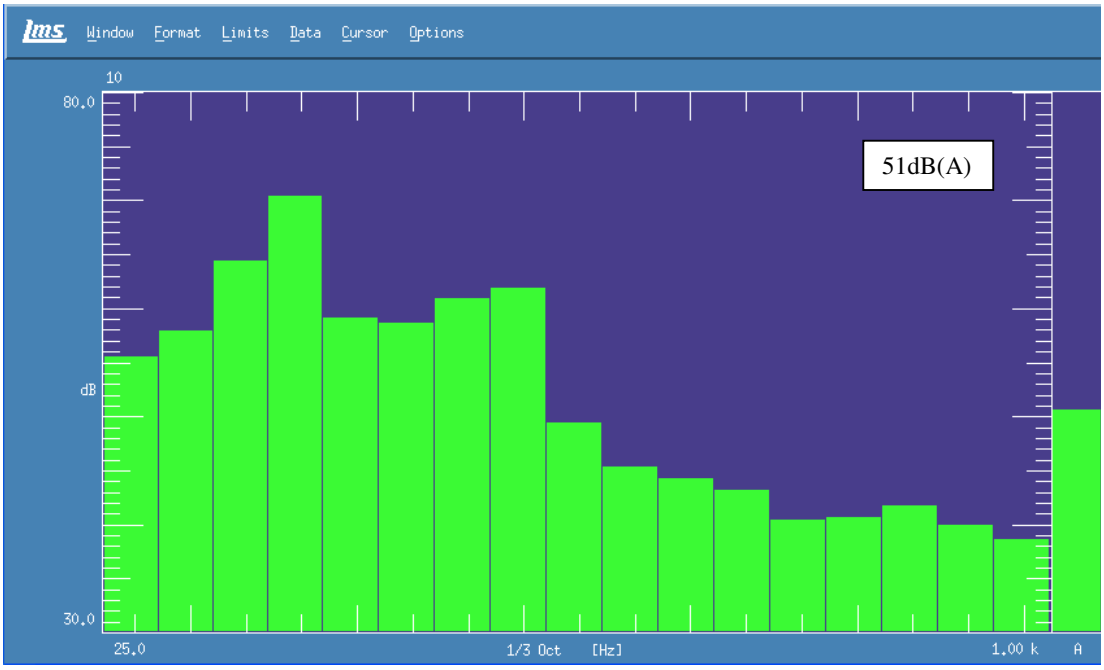
FIGURES 3.12
TRAIN PASS – ENERGETICALLY AVERAGED VIBRATION LEVEL AT MOOLCHAND



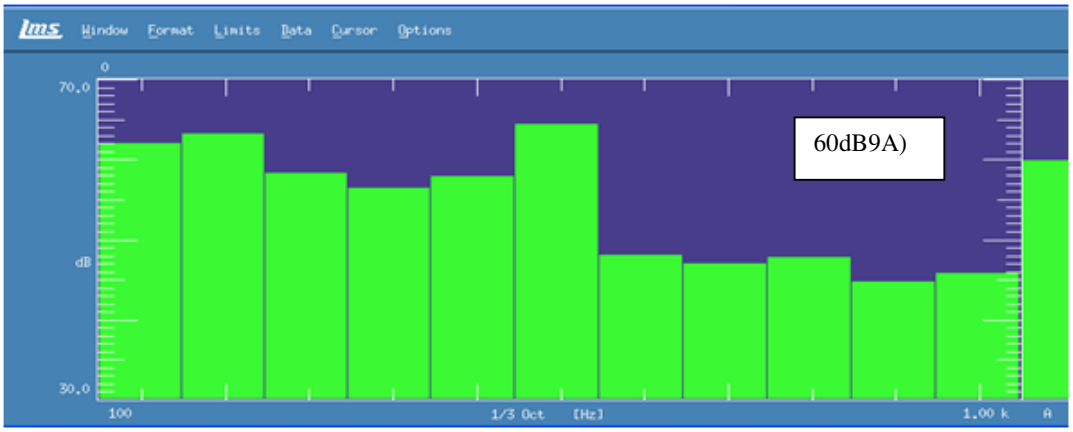
FIGURES 3.13
TRAIN PASS – ENERGETICALLY AVERAGED VIBRATION LEVEL AT HYUNDAI SHOWROOM



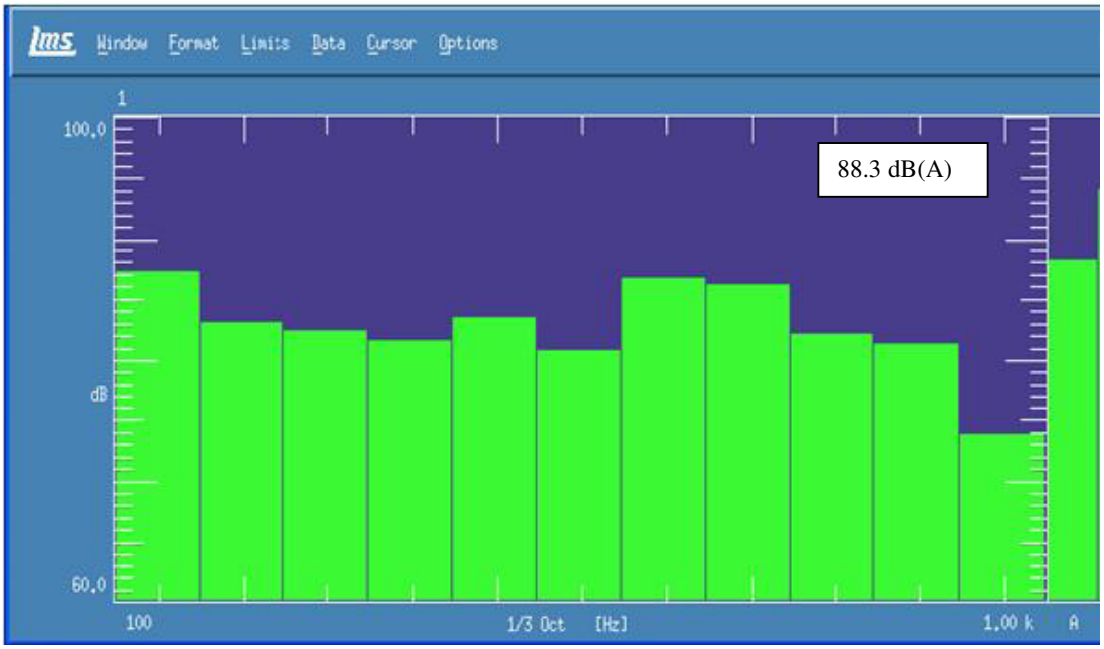
FIGURES 3.14
PEAK HOLD 125 m sec TIME SAMPLING NOISE LEVEL AT SAKET (HOUSE MEASUREMENT)



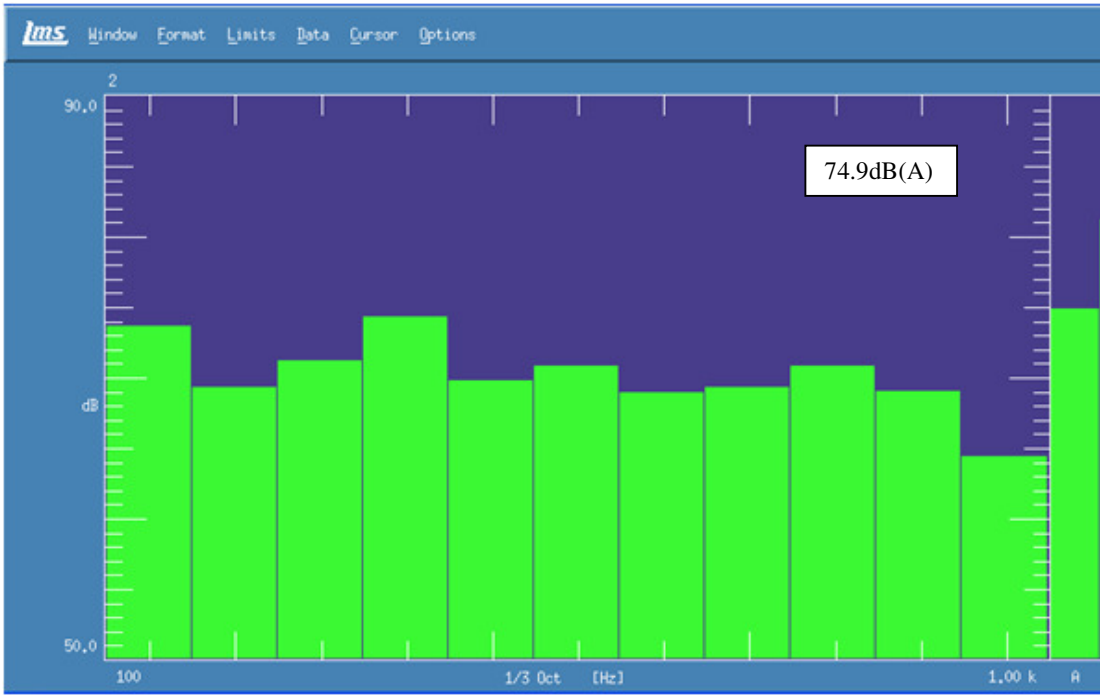
FIGURES 3.15
PEAK HOLD 125 msec TIME SAMPLING NOISE LEVEL AT HAUSKHAS (HOUSE MEASUREMENT)



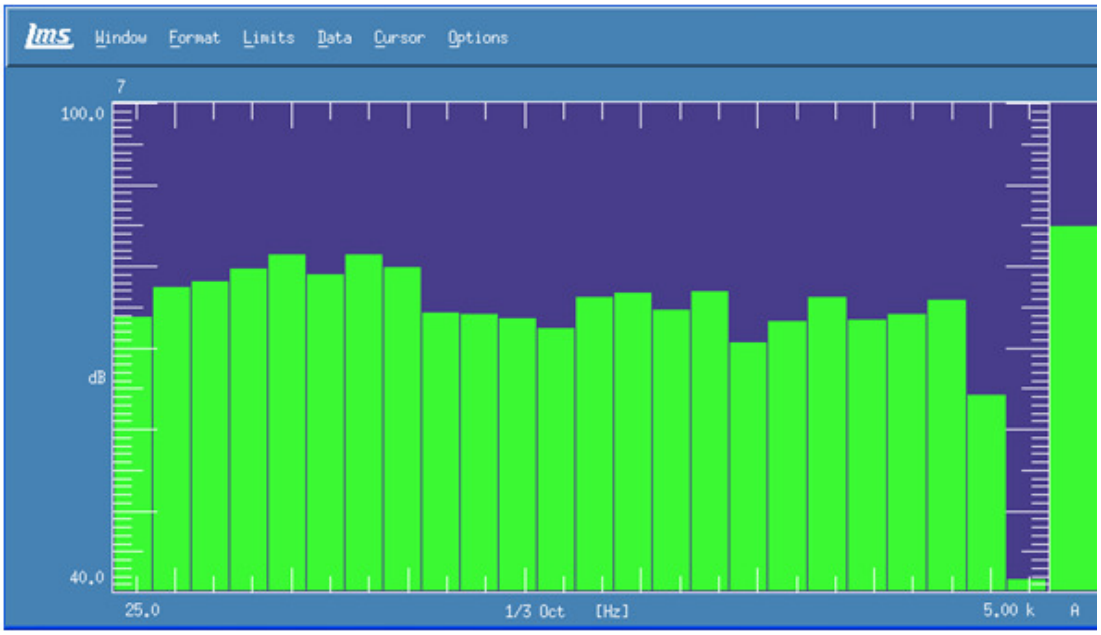
FIGURES 3.16
PEAK HOLD 125 msec TIME SAMPLING NOISE LEVEL AT MOOLCHAND HOSPITAL



FIGURES 3.17
PEAK HOLD 125 msec TIME SAMPLING NOISE LEVEL AT HYUNDAI SHOWROOM (BASEMENT)



FIGURES 3.18
PEAK HOLD 125 msec TIME SAMPLING NOISE LEVEL AT HYUNDAI SHOWROOM (PASS-BY)



3.7 ECOLOGY

An ecological study of the project area is essential to understand the impact due to project development activities on flora and fauna of the area. The project site is located in city area and it is free of any wildlife fauna. The construction activities whether on-site or off-site do not involve any loss of biomass, deforestation or any kind of disturbance to an ecological habitat. As such no adverse impact is anticipated on ecology as a result of the project. However, to have a general understanding of the project area ecology, brief information about flora and fauna of Delhi as compiled from secondary sources is given below.

3.7.1 Forests/Flora

Forests/trees play an important role in maintaining the eco-system balance. The project layout was superimposed on land-use maps to assess the number of trees in the project area. Delhi state seems overwhelmingly green. However, the green cover is not uniformly distributed, as some areas have considerably more green patches than the others. The districts of New Delhi and South Delhi are much greener compared to other districts. As per the State Forest Report 2001, Delhi has 151 Sq. Km forest and tree cover which constitutes only 10.2% of the Delhi's geographical area of 1,483 Sq. km. In terms of forest cover, Delhi ranks 15th among the States and Union Territories in the country. The district wise forest cover of Delhi is given is **Table 3.14.**

TABLE 3.14
DISTRICT WISE FOREST COVER OF DELHI

District	Geographical Area	Forest Area in Sq km	Percentage of Forest Cover
Central Delhi	24.68	2.27	9.20
East Delhi	63.76	1.57	2.46
New Delhi	34.90	9.73	27.88
North Delhi	59.16	3.18	5.38
North East Delhi	60.29	1.85	3.07
North West Delhi	440.31	8.37	1.90
South Delhi	249.85	52.51	21.02
South West Delhi	420.54	30.09	7.16
West Delhi	129.52	1.76	1.36
Total	**1483.00**	**111.33**	**7.51**

Tree survey was carried out along the proposed alignment. As such no 'forest area' exists along the metro alignment or its corridors. Most of the trees were planted along the road in the past. An inventory of trees likely to be lost has been prepared and summarized in **Table 3.15.** The main species are Peepal, Kaner, Sheesham, Kikar,

Shahtoot, Eucalyptus, Jamun, Ashok, Mango, Bhor etc. No rare or endangered species of trees have been noticed during field survey. A list of the common trees and shrubs observed in Delhi is given in **Annxure 3.6.**

TABLE 3.15
NUMBER OF TREES ON ALIGNMENT

Location	Number of Trees
Mukundpur-Yamuna Vihar (Chainage wise / station wise)	
Chainage -1105.00 to -110 (Mukundpur Depot and Stations)	52
Chainage -110 to 755	23
Chainage 755 to 1715.00	0
Chainage 1715 to 2015	219
Chainage 2015 to 3000	0
Chainage 3000 to 3700 (End of Ramp)	27
Chainage 3682 to 6900	300
Chainage 6900 to 8800	255
Chainage 8800 to 10800	370
Chainage 10800 to 11800	555
Chainage 11800 to 13400	385
Chainage 13400 to 16800	180
Chainage 16800 to 20400	378
Chainage 20400 to 22000	240
Chainage 22000 to 22300	195
Bhikaji Kama Place (Including Ramp)	362
Sarojini Nagar Market Station	94
INA Station	82
South Extension Station	56
Lajpat Nagar Station	409
Shrinivaspuri Station	138
Ashram Station	98
Nizammudin (Including Ramp) Station	373
Chainage 33061.1 to 33500.00	70
Chainage 33500 to 36500	65
Mayur Vihar Depot	64
Aprroach to Mayur Vihar Depot to 37000	21
Chainage 37000 to 37210	60
Chainage 37000 to 37210	72
Chainage 37210 to 38070	419
Chainage 38070 to 39550	312
Chainage 39550 to 40600	222

Location	Number of Trees
Chainage 40600 to 41550	103
Chainage 41550 to 42850	320
Chainage 42850 to 45000	183
Chainage 45000 to 45800	12
Chainage 45800 to 47250	103
Chainage 47250 to 48000	70
Chainage 48000 to 49050	39
Chainage 49050 to 50350	92
Chainage 50350 to 52150	18
Chainage 52150 to 55598.32	162
Sub Total (A)	**7123**
Janakpuri West- Botanical Garden	
Chainage -450 to 0	119
0 to 1000	82
1000 to 2000	290
2000 to 3000	99
3000 to 4000	64
4000 to 5000	83
5000 to 6000	40
6000 to 7000	21
7000 to 8000	42
8000 to 9000	10
9000 to 10000	51
10000 to 11000	39
11000 to 12000	0
13000 to 14000	158
14000 to 15000	65
15000 to 16000	697
16000 to 16900	0
16900 to 18000	182
1800 to 19000	231
19000 to 20000	270
20000 to 21000	308
21000 to 21900	0
21900 to 22700	252
22700 to 23700	451
23700 to 25000	2010
25000 to 25700	110
25700 to 26730	175

Location	Number of Trees
25730 to 25976	25
25976 to 26764	120
26764 to 28088	186
28088 to Okhla Vihar Station	329
Okhla Vihar Station to 30016	393
30016 to 30897	408
30897 to 32544 (Kalindi Kunj)	222
32544 (Kalindi Kunj) to Yamuna Edge	68
Kalindi Kunj Depot	410
Sub Total (B)	**7891**
Central Sectt.-Kashmiri Gate	
Janpath Station	52
Mandi House Station	137
Chelmsford Club Area	11
ITO Station	263
Delhi Gate Station	327
Jama Maszid Station	224
Lal Quila Station	17
Kashmiri Gate v	18
Sub Total (C)	**1049**
Jhangirpuri Badli	
Jahangir puri End to DMRC RSS (chaingae 3635.426 to 2680.91)	204
Between DMRC RSS to Shalimar Place Station (Chainage 2680.916 to 2309.611)	163
Between Shalimar Place To Rohini Sector 18 Station (Chainge 2309.611 to 500.977)	149
Between Rohini Sector 18 to Badli Dead End (Chainage 500.977 to (-) 763.239	30
Sub Total (D)	**546**
Total (A+B+C+D)	**16609**

3.7.2 Fauna

Over 80 years ago Delhi was the haunt of a large variety of animals. Foxes and hare were present. Blackbuck was common in the plains while the Chinkara was found on the Ridge and in the hilly range North-east of Delhi. Wolves roamed such inhabited places as the Cantonments and were occasionally shot by the British Soldiers. Leopards too were not uncommon, especially in Tughlakabad. Bluebull or Nilgai was easily sighted. Peafowl, duck, snipe were plentiful, so were the black and gray partridge. There were deer, wild

boar, blue bull, panther and a wide variety of bird life on huge trees. Hare were plentiful and so were hyenas, jackals and porcupines. Mahasir, Rohu and Betchwa were among the varieties of fish that were plentiful. Unpolluted river was infested with crocodiles.

But such wildlife in Delhi has vanished because of indiscriminate shooting after partition in 1947 and the ever-increasing human activities. The domestic animals in the project area consist of cows, bullock, sheep, goat, cat and dogs. No wildlife sanctuary/park is located within the 7km radius of project area. No rare or endangered species have been reported in the project area. No wildlife has been observed with in the project area or its surroundings.

3.8 SOCIO- ECONOMIC CONDITIONS

Delhi was a small town in 1901 with a population 0.4 million. Delhi's population started increasing after it became the capital of British India in 1911. During the Partition of the country, a large number of people migrated from Pakistan and settled in Delhi. Migration into the city continued even after Partition. The 2001 Census recorded 138.51 lakh population of Delhi with 3.85% annual growth rate and 47.02% decennial growth rate during 1991-2001.

With the rapid pace of urbanization the rural area of Delhi is shrinking. The number of rural villages has decreased from 314 in 1921 to 165 in 2001 census. The percentage of rural population of Delhi has also declined from 47.24% in 1901 to 6.99% in 2001.[12]

3.8.1 Economy

As the country's capital, with vibrant trade and commerce and excellent employment opportunities. Delhi has attracted people from all over the country and its population today reflects the characteristics of almost every region. Delhi truly reflects the wealth and diversity of India wherein diverse religions, languages, customs and cultures co-exist in splendid plural harmony. Religious, cultural and social functions of different socio-cultural groups have transformed Delhi into a city of festivals. Delhi is among the top three States/Union Territories in terms of per capita income. More than 80% of the state income is from the tertiary sector. The Net State Domestic Product (NSDP) of Delhi was about US$ 32.8 billion in 2007-08. The average NSDP growth rate between 1999-2000 and 2007-08 was about 14.7 per cent. Delhi's economy is dependent on commerce and trade more than on manufacturing and agriculture In 1996, the Supreme Court of India ordered over 90,000 industrial units to relocate outside the state in order to control increasing levels of pollution. Consequently, the state has small scale industries which are mostly non-polluting. Delhi's economy is primarily dominated by knowledge based service industry such as information technology, consulting etc. In 2007-08, at US$ 28.3 billion, the tertiary sector contributed 79 per cent to the GSDP of Delhi at current prices

[12] Economic Survey Of Delhi, 2007-2008

followed by secondary sector which contributed US$ 7.2 billion (20.3 per cent). The per capita GSDP of Delhi increased almost 2.4 times from US$ 901 in1999-2000 to US$ 2,136 in 2007-08. Per capita GSDP recorded CAGR of 11.4 per cent between 1999-2000 and 2007-08.[13]

3.9 ARCHAEOLOGICAL SITES

There are about 174 buildings of national importance protected by Archaeological Survey of India in Delhi. These Ancient Monuments are in existence for more than 100 years. The Archaeological survey of India (ASI) under the provision of Ancient Monument and Archaeological Sites and Remains (AMASR) Act 1995 protects monuments, sites and remains of National Importance. The Ancient Monument and Archaeological Sites and Remains (Amendment and validation) Act 2010 specifies that there should not be any construction activity within 100 m on all four sides of a protected monument.

The proposed alignment of Central Secretariat – Kashmiri Gate corridor which is a part of Phase III MRTS Project passes through the regulated/prohibited zone of Sunehari Masjid, Lal Quila and Kashmere Gate. List of these monuments are given in **Table 3.16**.

TABLE 3.16
DETAILS OF ARCHAEOLOGICAL STRUCTURES AND THEIR DISTANCE FROM METRO CORRIDOR

S.No.	Monument	Locality	Horizontal Distance Between Monument & DMRC Structure (m)	Depth of the DMRC Structure from G.L. (m)
1	Jantar Mantar	Connaught Place	233.00	15.863
2	Uggarsain Ki Baoli	Near Jantar Mantar	189.000	23.937
3	Khooni Darwaza (Lal Darwaza)	Near Delhi Gate	24.600	19.977
4	Feroz Shah Kotla	Near Delhi Gate	121.800	19.977
5	Delhi Gate,	Delhi Gate	100.800	15.372
6	Delhi Gate	Delhi Gate	5.380	15.479
7	Sunheri Masjid	Delhi Fort	103.196	16.404
8	Red Fort	Delhi Fort	118.900	15.317
9	Red Fort	Delhi Fort	120.818	16.428
10	Kashmiri Gate	Kashmiri Gate	101.100	13.513

[13] www.ibef.org

3.10 Sensitive Receptor

A list of sensitive receptor like school, colleges, hospitals, place of worship, monuments/heritage structures etc. with in 25m and within 200m on either side of each metro is prepared and presented in **Table 3.17.**

TABLE 3.17
LIST OF SENSITIVE RECEPTORS

Description	25 m	200 m	Total
Janakpuri West to Kalindi Kunj			
Temple	8	37	45
Gurudwara	0	2	2
Mosque	0	6	6
Church	0	4	4
Tomb	3	4	7
Hospital/Nursing Home	7	10	17
Dispensary	3	4	7
Graveyard	0	2	2
Cremation Ground	0	3	3
Institute	0	20	20
Schools	3	40	43
Library	0	1	1
Sub total	**24**	**133**	**157**
Mukundpur – Yamuna Vihar			
Temple	9	85	94
Gurudwara	3	7	10
Mosque	3	11	14
Church	0	4	4
Tomb	0	4	4
Hospital/Nursing Home	1	26	27
Dispensary	0	12	12
Graveyard	1	7	8
Cremation Ground	0	5	5
Institute	1	11	12
Schools	6	61	67
Library	0	1	1
Sub total	**24**	**234**	**258**
Central Secretariat – Kashmiri Gate			
Temple	3	5	18
Mosque	2	15	17
Church	1	1	2

Description	25 m	200 m	Total
Tomb	0	2	2
Hospital/Nursing Home	1	5	6
Dispensary	2	2	4
Graveyard	1	3	4
Institute	2	9	11
Schools	0	13	13
Library		2	2
Monuments	1	4	5
Sub total	**13**	**61**	**84**
Jahangirpuri – Badli			
Temple	1	4	5
Hospital/Nursing Home	0	1	1
Graveyard	0	1	1
Institute	0	1	1
Sub total	**1**	**7**	**8**

Chapter –4

Negative Environmental Impacts

CHAPTER – 4
NEGATIVE ENVIRONMENTAL IMPACTS

4.1 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**. **Chapter-3** 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 –6.**

4.2 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.

4.3 IMPACTS DUE TO PROJECT LOCATION

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

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

4.3.1 Project Affected People (PAPs)

Rehabilitation and Resettlement (R&R) of displaced families is an important issue addressed in **Volume II** The main point to be addressed is the extent to which the “land for land” policy can be maintained for those who have their own land/house and suitable compensation to those who fall in the category of unauthorized occupants.

4.3.2 Change of Land Use

Under the present study, project layout maps were superimposed on land use maps to find out the change in land use. It is estimated that about 3.019 ha of private land, 6.421 of railway land and 180.982 ha of Government land have to be acquired for the project. In addition to this, another 91.715 ha of Government land is required, albeit temporarily, for casting yards and for meeting the requirements of construction working space. Temporary land acquisition will only be from Government Department and will be transferred back on completion of construction works. The change of land use is presented in **Table 4.1.** More details are available in Chapter-4 of DPR for MRTS Phase-III report. From the data it could be concluded that out of total permanent land requirement about 1.59% land to be acquired is from private sector, 95.04% from Government and 3.37% from railways. It may be mentioned here that railways are also a government department. Like most other rail based mass urban transport systems, this system, now in its third phase of construction, also needs to undertake property development to make it financially viable and economically attractive. The compensation for land is included in **Volume II** of this study.

TABLE 4.1
CHANGE IN LAND USE

S.No.	Corridor	Land Requirement (ha)			
		Permanent			Temporary
		Government	Railway	Private	Government
1	Mukundpur to Yamuna Vihar	112.2.13	4.401	0.613	58.281
2	Janakpuri West to Botanical Garden	64.062	0.584	2.302	21.771
3	Central Sect. To Kashmiri Gate	1.750		0.104	7.518
4	Jahangir Puri to Badli	2.841	1.436		4.145
Total		180.983	6.421	**3.019**	91.715

source: DPR 2011

4.3.3 Loss of Forests/Trees

The proposed metro lines are in urban/ city area and will not pass through any forests. Hence no loss to forest is anticipated due to the project. However, planted trees do exist throughout the corridors selected for the project. There are 16,609 trees along the alignment (**Refer Table 3.14)**. These trees are likely to be cut during construction. These trees may be equivalent to 5537 mature trees. Trees are major assets in purifications of urban air, which by utilizing CO_2 from atmosphere, release

oxygen into the air. However, with removal of these trees, the process for CO_2 conversion will get effected and the losses are reported below:

i)	Total number of Mature Trees	:	5537
ii)	Decrease in CO_2 absorption @ 21.8 Kg/ year tree for 8 years	:	965653 kg
iii)	Oxygen production @ 49 kg/ year tree For 8 years	:	2170504 kg

The average consumption of oxygen for a person is about 182 kg/ year. It means these trees will meet the requirement of about 1491 people round the year. Trees help carbon sequestration acting a carbon sink. By removing the carbon and storing it as cellulose, trees release oxygen back into the air.

4.3.4 Utility/Drainage Problems

Metro lines are mostly planned to run through the urban area at grade, underground and above . The alignment will cross river systems, drains/nalas large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals etc. These utilities/ services are essential and have to be maintained in working order during different stages of construction by temporary/permanent diversions or by supporting in position. In addition, cross drainage works such as bridges, culverts etc. will be required. Since these affect construction and project implementation time schedule/ costs for which necessary planning/ action needs to be initiated in advance.

4.3.5 Impact on Archaeological Sites

There are 174 building of national importance protected by the Archaeological Survey of India in Delhi. Department of Archaeology, GNCTD, is responsible for protection, conservation and maintenance of monuments of regional importance in Delhi. It derives its authority and jurisdiction under the provisions of the Delhi Ancient and Historical Monuments and Archaeological Sites and Remains Act, 2004.

The corridor between Central Secretariat to Kashmiri Gate passes through some of the important archeological structures viz. Jantar Mantar, Uggarsain Ki Baoli, Delhi Gate, Feroz Shah Kotla, Khooni Darwaza, Sunhari Masjid, Red Fort and Kashmiri Gate (Refer **Table 3.15**). Utmost care needs be taken so that no significant impact is anticipated on the archeological structures due to any pollution arising from the project activities during construction and operation. Ancient Monuments and

Archeological Sites and Remain (AMASR) Act 2010 prohibits any construction activity within 100 m on all sides of a protected monument. However, Khooni Darwaza is about 27 m from the tunnel alignment, Kahmiri Gate is above the proposed underground rail track while Delhi Gate is 77 m from the exit structure of proposed metro station. Prior to the initiation of construction of Metro Phase III, DMRC should develop and periodically review a 'monuments protection plan' developed for above sensitive locations that may be affected by the project. This plan shall be developed by DMRC/Contractor in consultation with ASI.

4.4 IMPACTS DUE TO PROJECT DESIGN

Considered impacts, due to project designs are:

- Platform inlets and outlets,
- Ventilation and lighting,
- Railway station refuse, and
- Seismological factors.

4.4.1 Platforms Inlets and Outlets

The stations of Phase III have been planned on the basis of the norms and criteria already adopted in existing Phase I and Phase II corridors. The platform level is about 12.5 m above the ground level for elevated and minimum 13 m below for underground stations. However Phase III lines run across some of the existing Phase I and Phase II elevated and underground lines. At these interchanges, the rail level is about 26 m in elevated stations and at a depth of 27 m in underground stations. With the increase in ridership, 9 coach trains are envisaged in future. To accommodate such trains, 210 meters long stations are proposed.

A typical elevated station is planned with two side platforms (each 4.5m wide). The concourse is concentrated in a length of about 72 m in the middle of the station with staircases leading from either side of the road. Maximum width of the station at concourse is about 33 m and at the narrowest part is 16.5 m. Minimum vertical clearance of 5.5 m has been provided under the concourse.

The typical underground station is a two level station with platforms at the lower level and concourse on the upper level. Concourse are provided at the ends in such a manner that the total depth of the underground station and cost is kept to the minimum. Two emergency staircases are also being planned in the traffic islands.

Provision has been made for escalators to connect concourse to platforms. On each platform one escalator has been proposed. In addition, two staircases, with a combined width of 4 m are provided on each platform connecting with the concourse.

These stairs and escalators together provide an escape capacity to evacuate passengers in emergency, from platforms to place of safety, in 5.5 minutes . While calculating the waiting passengers on the platform in emergency, 2 missed headways are assumed. One lift has been provided on either platform to provide access for elderly and disabled. Additional staircases have been provided for the fire escape at the two ends of each platform. These stairs of combined width of 8 m lead directly to the footpaths below or open spaces near the station depending upon the ground situation. For emergency evacuation purposes, it is assumed that the waiting passengers at the station along with the section load will have to be evacuated from the platforms within 5.5 minutes.

The station planning standards are listed in **Table 4.2**. From this table it can be concluded that all stations have necessary provision for space at inlet, outlet, elevators and platforms to accommodate people in normal as well as in emergency situation. Hence no hazard is anticipated due to the proposed sizes of inlets and outlets.

TABLE 4.2
STATION PLANNING STANDARDS

a.	Design passenger flow/2 min	5% of peak hour flow
b.	Escalators carrying capacity 2/min (1.11m width 30° slope) up & down	267 passengers
c.	Unidirectional staircase/m/s min. Up & Down	126, 140 passengers.
d.	Unidirectional staircase/m/s min. Up & Down	177 Passengers
e.	Ticket issuing machines/2 min	20 passengers
f.	Turnstile gates /2 min.	60 passengers
g.	Side platform	2.5 persons/sq.m
h.	Island platform	1.5 persons/sq.m
i.	Concourse	2.5 persons/sq.m
j.	Platform during emergency	5 persons/sq.m (including safety zone)
k.	Safety zone	0.65 m train side 0.25 m wall side
l.	Min. Platform widths	Island 8m : Side 6 m
m.	Emergency evacuation time	5.5 min
n.	Maximum travel distance in emergency	60 m
o.	Walking speed for passengers	1 m/sec.
p.	Escalator carrying capacity in emergency/2 min	240 passengers
q.	Stair case carrying capacity in emergency/2 min	114 passengers
r.	Time taken for reversing escalators	1 min.
s.	No. of passengers in 6 coach train with dense crush loading	2000 Nos.

4.4.2 Ventilation and Lighting

The platforms, concourse, staircase and escalator areas both for underground and elevated stations will have adequate and uniform fluorescent lighting to provide pleasant and cheerful environment. It is proposed to adopt the norms prevailing in Delhi Metro Phase I and II for illumination as reported in **Table 4.3**.

TABLE 4.3
ILLUMINATION AT DIFFERENT LOCATIONS

LOCATION/PREMISES	ILLUMINATION (LUX)
Entrance to stations from the road	250
Booking/Concourse	200
Platforms	150
Passenger staircase and escalator areas	250
Toilets	100
Offices	200
Tunnels	100
Sub-ways	250
Emergency lighting of stations, platforms, passages, escalators & public utilities.	50

4.4.3 Railway Station Refuse

The collection and removal of refuse from railway stations in a sanitary manner is of great importance for effective vector control, nuisance abatement, aesthetic improvement and fire protection. The refuse from railway station includes;

- Garbage,
- Rubbish, and
- Floor Sweepings.

As per the available data from Delhi Metro Phase I and II, the solid waste generation is about 0.8 – 1.2 cum/day at elevated stations and 0.5-1.0 cum/day at underground stations. At elevated stations, the solid waste generation is more due to airborne dust. Thus about 28 cum of solid waste will be generated from underground stations and 29.25 cum from elevated stations from all four corridors of Phase III metro stations. Thus a total of 57.25 cum of solid waste per day will be generated from all metro stations. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the DMRC project authorities. The storage containers for this purpose need to be designed. However it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals.

4.4.4 Risk Due to Earthquake

The project area lies in Zone IV of Bureau of Indian Standards (BIS) Seismic Zoning Map. Earthquakes of 3 to 9 magnitude on Richter scale have occurred in the past in

the zone. Seismic factor proposed by India Meteorological Department (IMD) for the purpose of design of Civil Engineering structures shall be incorporated suitably while designing the structures. It is understood that such measures have already been taken in construction of earlier phases.

4.5 IMPACT 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

4.5.1 Soil Erosion, Pollution and Health Risk at Construction Site

Run off from unprotected excavated areas, and underground tunnel faces can result in excessive soil erosion, especially when the erodability of soil is high. Mitigation measures include careful planning, timing of cut and fill operations and revegetation. In general, construction works are stopped during monsoon season.

Problems could arise from dumping of construction spoils (Concrete, bricks) waste materials (from contractor camps) etc. causing surface and ground water pollution. However, it is proposed to have mix concrete directly from batching plant for use at site. Batching plants will be located away from the site and from human settlement. The other construction material such as steel, bricks, etc. will be housed in a fenced stored yard. The balance material from these yards will be removed for use/disposal.

Health risks include disease hazards due to lack of sanitation facilities (water supply and human waste disposal) and insect vector disease hazards of local workers and disease hazards to the local population. Mitigation measures should include proper water supply, sanitation, drainage, health care and human waste disposal facilities. In addition to these, efforts need to be made to avoid water spills, adopt disease control measures and employment of local labour. Problems could arise due to difference in customs of workers from outside and local residents. These risks could

be reduced by providing adequate facilities in worker's camps, raising awareness amongst workers and by employment of preferably local labour.

4.5.2 Traffic Diversions and Risk to Existing Buildings

During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities are on the road but most of the roads are double lane. Hence, wherever possible, rather than completely blocking the roads it will be advisable to make these roads as one way to allow for operation of traffic together with construction activities. Moreover, on both sides of the roads, a clear passage of 8 m will be maintained for smooth operation of traffic, emergency and local movements. Advance traffic updates/information on communication systems will be an advantage to users of affected roads. The rail corridor does not pose any serious risk to existing buildings. However, the situation in the underground corridor is not the same as it passes under the road/ buildings of some congested areas. Sufficient care has to be taken while designing the system underground. Still it will be appropriate to carry out stability and ground settlement analysis for proceeding further during construction.

4.5.3 Problems of Excavated Soil Disposal

The metro route is both elevated and underground. The underground portion is 41.044 km. The construction activity involves cut and cover, tunnel (bored and rock), foundation, fill and embankment. Owing to paucity of space in busy cites and for safety reasons, elaborate measures need to be adopted for collection, storage, transfer and disposal of soil. All these activities will generate about 13.17 $Mm^3$of soil. Out of this about 2.42 Mm^3 is likely to be reutilized in backfilling at stations and Depot. The balance 10.75 Mm^3 shall be disposed off in environmental friendly manner. Disposal of excess soil is permitted in low lying areas owned by Delhi Development Authority. The excess soil disposal site will be those identified by DDA and communicated to DMRC. The quantity of earthwork is summarised in **Table 4.4**.

4.5.4 Dust Generation

Transportation of earth and establishment of the material will involve use of heavy machinery like compactors, rollers, water tankers, and dumpers. This activity is machinery intensive resulting in dust generation. However, this activity will be only short-term. Protective measures shall be undertaken during construction phase. As per above **Table 4.4** it is estimated that about 2.42M^3 of earth will be used in backfilling and filling of Depot sites and 10.75 Mm^3 will be disposed off. Thus a total of 12.75 Mm^3 soil has to be transported through trucks. It is assumed that the material will be hauled over a period of 900 days. The truck movement required to transport the soil/ earth will be about 2832 truck trips per day for the entire length. On

an average a truck is anticipated to move about 50 km per trip. Hence total distance travelled would be 141,600 km per day. The total dust emission/pollution would be 1.24 gm/km or 175 kg/day. The total particulate emission will be about 158 tons during construction period.

TABLE 4.4
QUANTITY OF EARTHWORK

S.No.	Particular	Quantity (cum)
1	**Tunnels (TBM) (Dia. of bore = 6.5m) in Underground Line**	
	Length (km)	41.044
	Deduction for 28 nos. of stations 300 m length each	-8.4
	Total Length (km)	32.644
	Length (km) of up & down Tunnels	65.288
	Total Excavation(m^3)= 65.288x ∏/4*6.5*6.5 (A)	**8,661,433**
2	**Underground Stations (nos.)**	28
	Length (m)	300
	Width (m)	25
	Depth (m)	17
	Total Excavation(m^3) (B)	**3,570,000**
3	**Elevated Viaduct**	
3.1	**For Pile cap (nos.) / km**	30
	Length (m)	5
	Width (m)	5
	Depth (m)	2.4
	Total Excavation(m3)	1800
	For complete Length =65.5km (m^3) (C)	**117,900**
3.2	**For Piles (nos.) / km**	120
	Dia. Of Pile(m)	1
	Depth (m)	30
	Total Excavation(m3) =120 x ∏/4 x 1 x 1	11304
	For complete Length =65.5km (m^3) (D)	**734,760**
4	**Stations foundation @ 2000 m^3/station for 41 nos. (E)**	**82000**
5	**Total Excavation(m^3) = A+B+C+D+E**	**13,166,093**
6	**Back Filling**	
	Stations	28
	Length (m)	300
	Width (m)	25
	Depth (m)	2
a)	**Backfilling(m^3)**	**420,000**
b)	**Filling in Depots**	**2,000,000**
7	**Total Backfilling(m^3) (a+b)**	**2,420,000**
8	**Net Earth for disposal (m^3)**	**10,746,093**

4.5.5 Increased Water Demand

The water demand will increase during construction phase. Sufficient water for construction purpose is made available by digging borehole / borewell within the vicinity of the project site during the construction phase. Hence proper care shall be taken while deciding the location of these activities or drawing water from public facilities. Water requirement for construction of Phase III Metro will be met through the tube-wells bored specially for the purpose of metro construction after taking approval from competent authority. Hence, there will be no negative impact on the residents living in the vicinity of tube wells whose water demand is, in any case, met by municipal water.

4.5.6 Impact due to Construction of Bridges on Yamuna

Ground water contamination can take place only if chemical substances get leached by precipitation of water and percolate to the ground water table. This is not the case with the present project, as the activity does not use any harmful ingredients, which could leach down to water table. Therefore, no impact on ground water quality is anticipated from the project during the construction phase. Proposed project will not alter the existing water quality of River Yamuna. One major bridge is planned on the alignment on river Yamuna. It is proposed to Construct Bridge with well foundation, substructure with mass concrete and superstructure with PSC girder. Because of such construction, no major impact on flow of water, surface and ground water quality is anticipated. Foundation of piers shall be on wells. Activities of well foundation and sinking shall be taken at intervals, so that the obstruction to the flow of water is limited. Care shall be taken that construction activities are not carried out during the monsoon period. Contamination of surface water bodies may result due to spilling of construction materials, however, the quantity of such spills will be negligible.

4.5.7 Impact due to Supply of Construction Material

Metro construction is a material intensive activity. Different quantity of construction material will be required for construction of metro corridors. A summary of approximate construction material required for Phase III corridors is given in **Table 4.5.**

Quarry operations are independently regulated activities and outside the purview of the project proponent. It is nonetheless, appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, ignore safety of their employees, or cause the loss of natural resources.

About 10-15% of the construction material such as waste material from contractor camps is left behind by the contractor as construction waste/spoils. Dumping of construction waste/spoil in an haphazard manner may cause surface and ground water pollution near the construction sites.

TABLE 4.5

CONSTRUCTION MATERIAL REQUIREMENT

Material	Unit	Total Qty
Underground station		
Cement	MT	317,548
Fly Ash	MT	115,052
Sand	MT	697,368
Aggregate 20mm	MT	678,804
Aggregate 10mm	MT	505344
Reinforcement	MT	183,204
Stone Work	m^2	266,000
MS Structure	Kg	672,000
Stainless Steel	Kg	964,600
Paint	Ltr	168,000
Tiles Work	m^2	47,600
Tunnel		
Cement	MT	67,801
Fly Ash	MT	10,968
Sand	MT	121,729
Aggregate 20mm	MT	88,530
Aggregate 10mm	MT	108,214
Silica	MT	848
Reinforcement	MT	19,325
Elevated Station		
Concrete	m^3	313,281
Steel	MT	42,516
Viaduct		
Concrete	m^3	896,729
Steel	MT	127,076
HT stand	MT	6456

4.5.8 Loss of Historical and Cultural Monuments

No historical/cultural monuments will be lost as a result of the proposed development.

4.5.9 Impact due to Construction near Archaeological Structures

The proposed Central Secretariat – Kashmiri Gate line passes below the following sensitive structures: Jantar Mantar, Uggarsain Ki Baoli, Khuni Darqaza, Delhi Gate, Sunhari Maszid, Lal Quila and Kashmiri Gate. These are also famous tourist places in Delhi, because of their historical background. The alignment along this corridor is

completely underground. The distance of these structures to the underground corridor is given in **Table 3.15.**

As per Ancient Monuments and Archeological Sites and Remain (Amendment and Validation) Act 2010, every area beginning at the limit of protected area or the protected monument, as the case may be and extending to a distance of one hundred metres in all directions shall be the prohibited area or protected monument. However there is no clarity on prohibiting underground digging or tunneling. The tunnel will be constructed by State of Art Technology i.e Tunnel Boring Machine (TBM) which gives negligible vibration and does not affect the surrounding structures. Stations will be constructed by Cut and Cover method which is widely accepted and the safest technique being adopted by metro in India and abroad. Due to construction of underground Metro alignment near these Archaeological Structures, it is expected that the construction activity may have only little impact on tourist activities. However once the corridor becomes operational, tourist activity may increase because of better accessibility to these historical sites.

4.5.10 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 4.6** and shown graphically in **Figure 4.1** through **Figure 4.3.**

TABLE 4.6
NOISE LEVEL PREDICTION 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 4.1
NOISE LEVELS dB(A)DUE TO CONCRETE BATCH PLANT + CONCRETE MIXER TRUCK

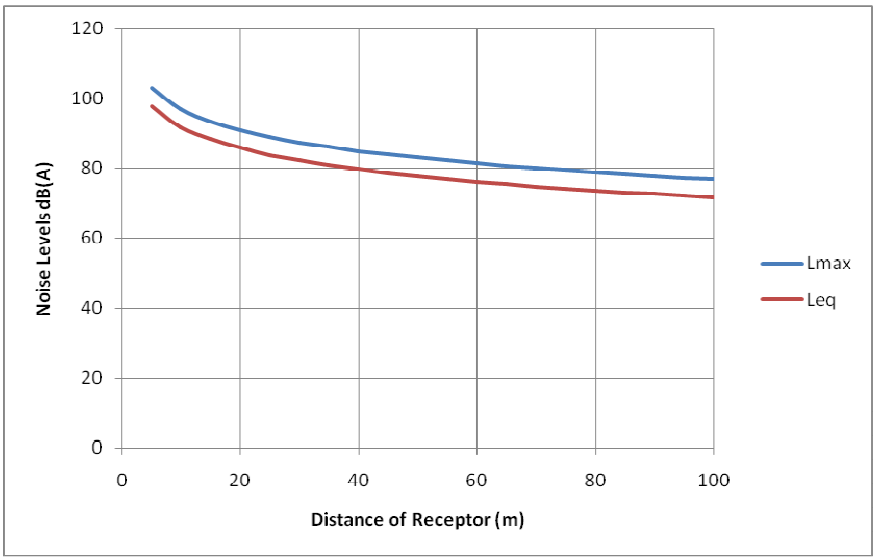


FIGURE 4.2
NOISE LEVELS dB(A)DUE TO AUGER DRILL RIG + DUMP TRUCK + GENERATOR + SLURRY PLANT

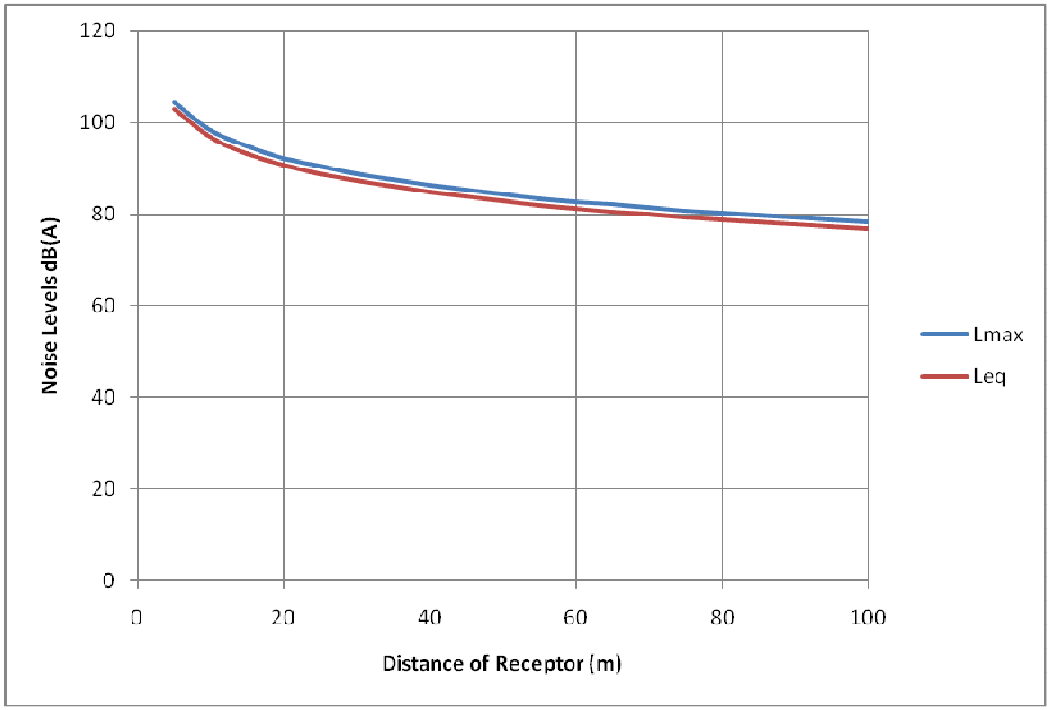
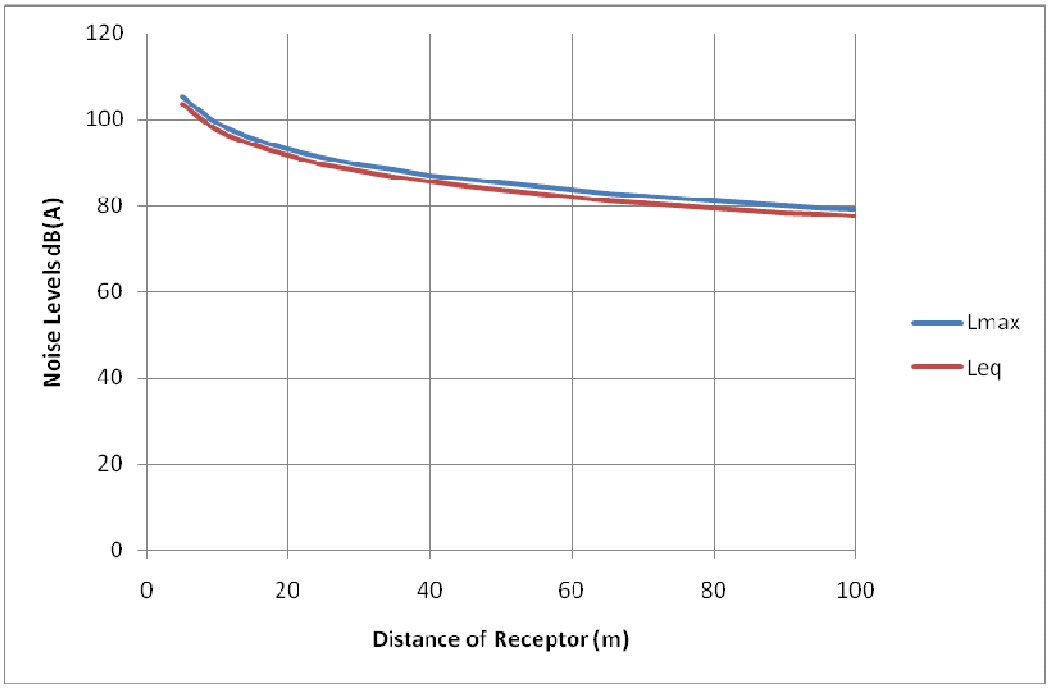


FIGURE 4.3
NOISE LEVELS dB(A)DUE TO DUMP TRUCK + EXCAVATOR + PNEUMATIC TOOLS



4.6 IMPACTS DUE TO PROJECT OPERATION

Along with many positive impacts, (Refer **Chapter 5**) 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

4.6.1 Noise 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-welded track 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 & Auxiliary Equipment (A/c system ,compressors and motor generator sets).

v) **Wheel and Rail conditions**: Rail corrugations and wheel flats can increase the 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 4.7** and **Table 4.8.** Wayside Noise Level at 15 m from track Centre Line and at 25 km/h =71.5± 2.0

TABLE 4.7
EXTERIOR NOISE LEVELS IN METRO STATIONS

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 4.8
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 4.9** and shown graphically in **Figure 4.4** though **Figure 4.8.** 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 4.9
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 4.4
PREDICTED NOISE LEVELS dB(A) FOR JANAKPURI WEST TO IGD AND OKHLA PHASE III TO KALINDI KUNJ

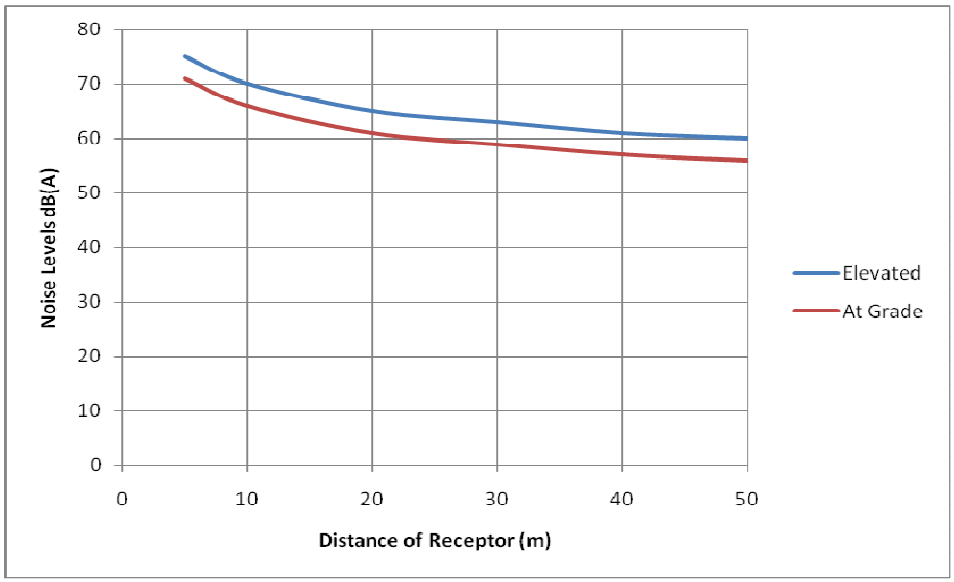


FIGURE 4.5
PREDICTED NOISE LEVELS dB(A) FOR OKHLA PHASE II TO IGD

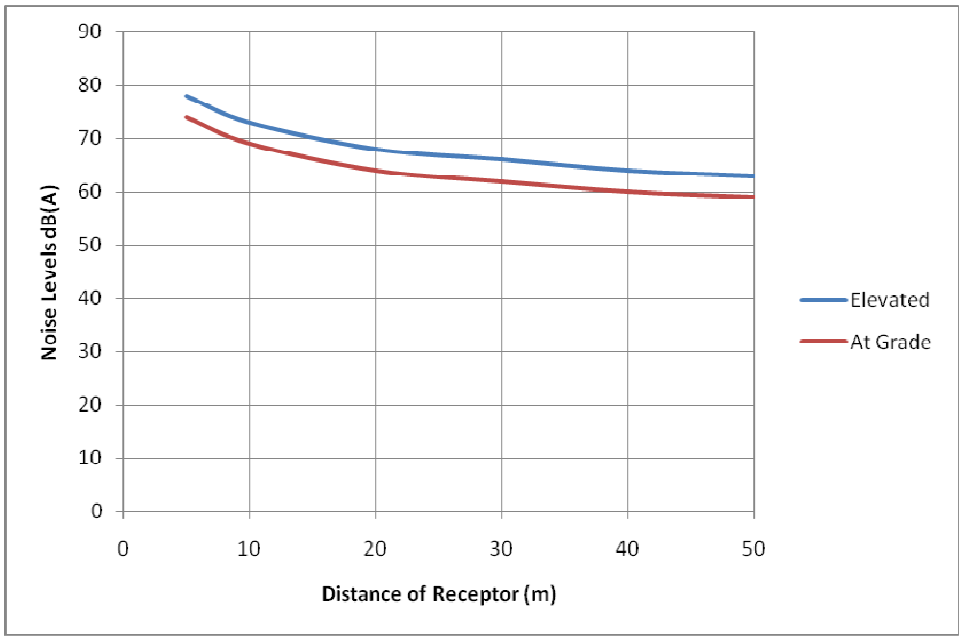


FIGURE 4.6
PREDICTED NOISE LEVELS dB(A) FOR JANAKPURI TO BADLI

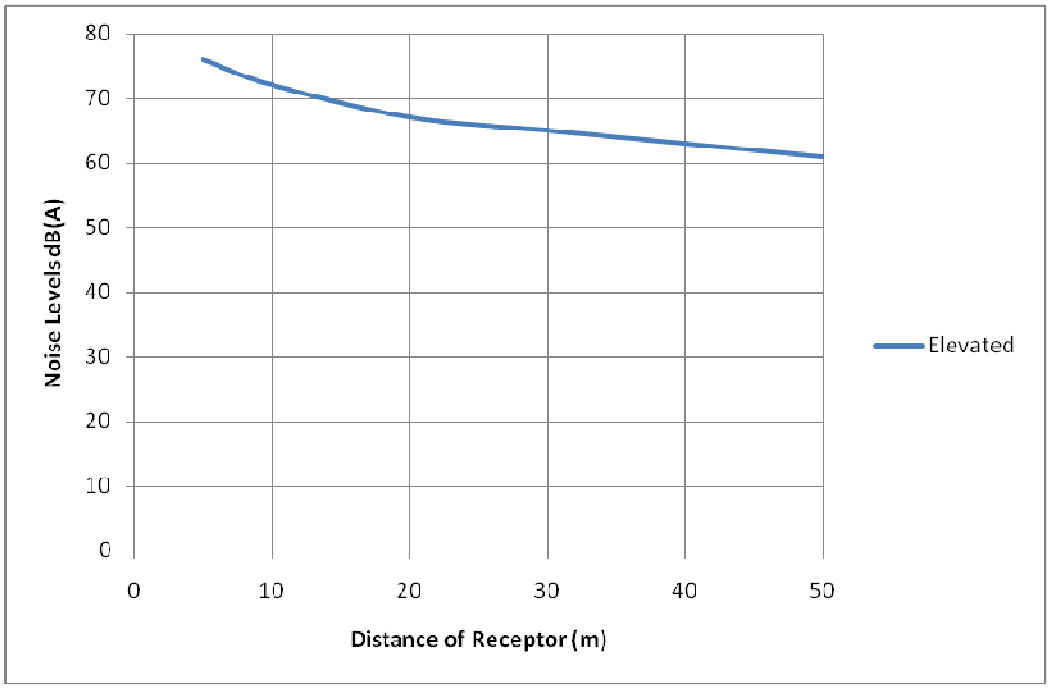


FIGURE 4.7
PREDICTED NOISE LEVELS dB(A) FOR YAMUNA VIHAR-WELCOME AND NS PLACE TO WELCOME

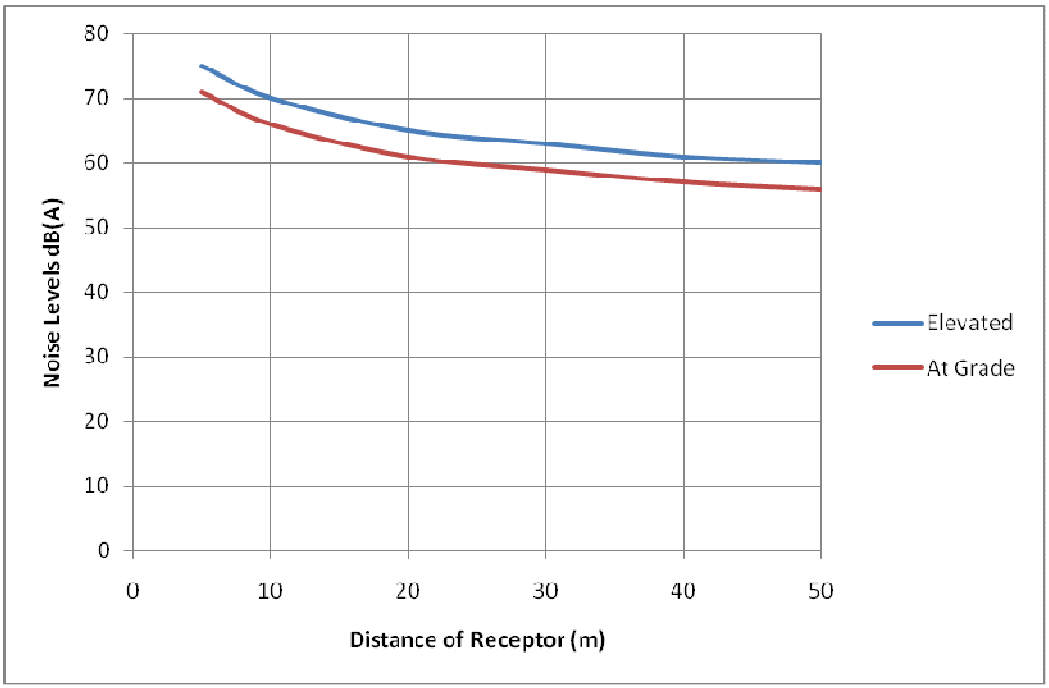
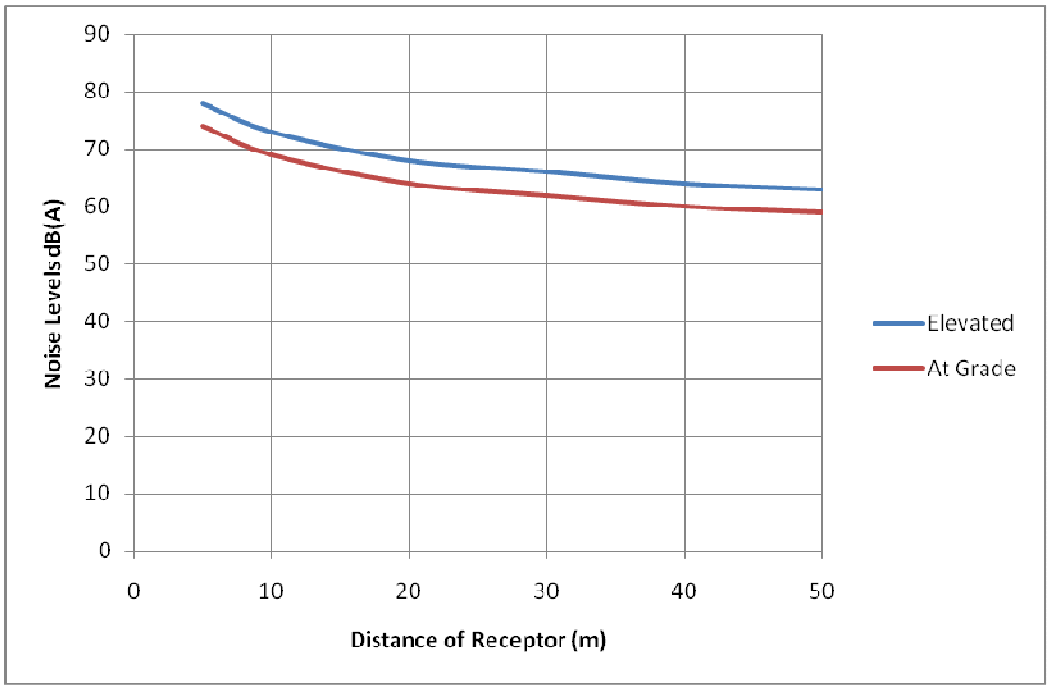


FIGURE 4.8
PREDICTED NOISE LEVELS dB(A) FOR WELCOME TO NS PLACE



4.6.2 Water Supply and Sanitation

Public Health facilities such as water supply, sanitation and wash rooms are very much needed at the stations. The water demands will be on station for drinking, toilet, cleaning and also for other purpose like AC, chiller and other purposes. Water Demand as per existing Delhi Metro Phase I and Phase II corridors is calculated and presented in **Table 4.10**. It is assumed that there would be similar water requirements in Phase III corridors also. Water should be treated before use upto WHO drinking water standards. Ground water shall be used for this purpose. In addition, water will be required for contractor's camps during construction. The water requirement for the stations will be met through the public water supply system after taking necessary approvals. However as an environmental conservation measure, rainwater harvesting will be also carried out at stations.

4.6.3 Pedestrian Issues

There is an expectation that MRTS will increase the pedestrianisation in CBD. As has been demonstrated in several countries, notably in Western Europe and North America, pedestrian station of certain localities is a desirable change in CBDs of the city. While initial reactions of the residents or commercial establishments are sometimes unfavourable to the concept, in no case has dissatisfaction been expressed, or a reversal of Pedestrainisation instituted, once an area has been so developed. The benefits are seen to out weigh any disadvantages of increased

movements for access etc. The main aim of MRTS system is to decongest the road traffic in Central Business Districts. The connections will further reduce the pedestrian number, which are available now on the roads.

TABLE 4.10
WATER REQUIREMENT

S.No.	Particular	Water Demand at Each Station (KLD)	Total Water Demand (KLD)
1	At Stations for Drinking Purpose	6	402
2	In Underground stations for AC, cleaning, chiller and other purposes	240-250	7000
3	In Elevated stations for AC, cleaning, chiller and other purposes	25-30	1170
		Total	**8572**

4.6.4 Visual Impacts

The introduction of MRTS implies a change in streets through which it will operate. An architecturally well designed elevated section can be pleasing to the eyes of beholders. Recent MRTS projects have attempted to incorporate this objective in their designs, as in the case of Singapore. Same has been incorporated in Delhi MRTS also. Since a low profile would cause the least intrusion, the basic elevated section has been optimised at this stage itself.

4.7 IMPACTS DUE TO DEPOT

Three depots are planned for Phase III metro corridors. These Depots will be a Kalindi Kunj (40 hectare), Mukundpur and Mayur Vihar (77 hectare). The area here is barren and with no habitation. In order to develop these areas as depot, it will need substantial filling by earth brought from outside. The depots will have following facilities:

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

These facilities will could generate water and noise issues. The depot areas are about 3 m lower than the surrounding area and hence have to be filled up. The earth from underground metro corridor tunnelling and cut and cover will be utilised to fill the deport site. Problems anticipated at depot sites are:

- Water supply,
- Oil Pollution,
- Cutting of trees
- Sanitation,
- Effluent Pollution,
- Noise Pollution,
- Loss of livelihood,
- Impact due to filling of area, and
- Surface drainage.

4.7.1 Water Supply

Water supply will be required for different purposes in the depot. The water requirement for train washing purpose will be 500 litre per day and 1,00,000 litre per day for other requirement (Departments and Contractors office). Projected water demands are summarised in **Table 4.11.** About 543 KLD of water will be required at all the three Depots of Phase III corridors for different uses. This water will be collected through 4 Nos bore wells at each Depot after taking approval from competent authority. Hence, there will be no negative impact on the residents living in the vicinity of tube wells whose water demand is, in any case, met by municipal water.

TABLE 4.11
WATER DEMAND AT DEPOTS

S.No.	Depot	Projected Number of cars	Projected water Requirement per day (litres)
1	Yamuna Vihar	156	178000
2	Mukundpur	156	178000
3	Kalindi kunj	174	187000
	Total	**486**	**543000**

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

4.7.2 Sewage and Effluent

About 80 KLD of sewage and 63 KLD of effluent is expected to be generated at Yamuna Vihar and Mukundpur Depots and 80 KLD of sewage and 70 KLD of effluent is expected to be generated at Kalindi Kunj Depot. About 64 KLD of treated waste water will be used for horticulture at Yamuna Vihar and Mukundpur Depots and about 67 KLD at Kalindi Kunj Depot. Based on past experience in similar projects the wastewater characteristics could be as reported in **Table 4.12.**

4.7.3 Oil Pollution

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

TABLE 4.12
SEWAGE & EFFLUENT CHARACTERISTICS

S. NO.	PARAMETER	UNIT	SEWAGE	EFFLUENT
1.	pH	---	6-8	6-8.5
2.	BOD	mg/l	250-350	150
3.	Suspended Solids	mg/l	200-450	500
4.	COD	mg/l	600-800	300
5.	Oil and Grease	mg/l	Upto 50	500
6.	Detergents	mg/l	---	100

4.7.4 Noise Pollution

The main source of noise from depot is the operation of workshop. The roughness of the contact surfaces of rail and wheel and train speed are the factors, which influence the magnitude of rail - wheel noise. The vibration of concrete structures also radiates noise. Due to less activity, no impact on the ambient noise is anticipated.

4.7.5 Impact due to filling of Area (Leachate)

About 2.0 Mm^3 of earth will be required to fill the Depot sites. This earth will be collected from the excavation of metro corridor. The soil has to be compacted at site before levelling which will reduce the permissibly and thus possibility of leachate is not anticipated.

4.7.6 Surface Drainage

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

4.7.7 Solid Waste

At per available data, it is estimated that about 2 Ton per month of solid waste will be generated from each of the Depot sites which will be taken by the cleaning contractor weekly and disposed to the MCD waste disposal sheds. Sludge of the order of 250 kg/year is expected to be generated from each ETP/STP that will be stored in leak proof containers and disposed off as per Delhi Pollution Control Board site. Oil and grease of the order of 2652 lts/year will be produced from Depot which will be disposed off through approved re-cyclers. About 2.5 ton/month of iron turning of the PWL for the wheel profiling will be generated from each of the metro Depots

4.8 EPILOGUE

Based on above negative impacts, a checklist of impacts has been prepared along with positive impacts in **Chapter-5.** The net resultant impacts without management plans are also summarised. The management plans to mitigate the negative impacts are reported in **Chapter-6.**

Chapter –5

Positive Environmental Impacts

CHAPTER - 5
POSITIVE ENVIRONMENTAL IMPACTS

5.1 POSITIVE 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 Phase III 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, and
- Saving in Road Infrastructure.

5.1.1 Employment 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.

5.1.2 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.

5.1.3 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 5.1**.

TABLE 5.1
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

[14] http://ncrpb.nic.in

5.1.4 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 5.2**. 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 5.2
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.

5.1.5 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.

5.1.6 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.

[15] Delhi Statistical Hand Book 2010

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 5.3**.

TABLE 5.3
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

5.1.7 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 5.4**.

TABLE 5.4
REDUCTION IN AMBIENT AIR QUALITY LEVELS IN 2025 IN 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**

5.1.8 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 5.5**). 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 5.5
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

5.1.9 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.

5.1.10 Saving 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.

5.2 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:

- Ad – hoc method,
- 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 7 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 5.6**.

TABLE 5.6
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 Ecology	*		
iii.	Loss of 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.	Noise	*		

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
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			*

5.3 Environmental Public Consultation

DMRC's information disclosure strategy includes wide dissemination of project related information, in print and electronic media regarding significant project details. Such dissemination is carried out both during construction and operation by DMRC's Public Relations Department and is aided by interviews and public discussions in which very senior DMRC management participate. The public is thus kept well informed and all significant issues concerning the public are incorporated in DMRC's web site for the techno-savvy. Furthermore, the project EIA report is also accessible to the public. Copies of the report are available not only in the DMRC office but in other government offices. The report is also web hosted by DMRC from where it can be downloaded.

As per information disclosure strategy, the details on Environmental Impact Assessment Report were presented to the people living near the corridors through Environmental Public Consultation. The stakeholders were communicated about the venue, time and date in advance for the presentation, discussion and consultation on various issues related to environment. These were fixed in consultation with the Resident Welfare Associations(RWA) and Shopkeepers Association(SA) of the area along the corridors. The venue, date and time of such public consultations is presented in **Table 5.7.**

Table 5.7
Public Consultation Venue

S.No.	Venue of the Public Consultation	Time and Venue
1	Janpath, DMRC office	11:00 AM, 19th July 2011
2	Amar Jyoti Restaurant, Sarojini Nagar Market	04:00 PM, 19th July 2011
3	Star Rock Hotel, opposite IIT Delhi	11:00 aM, 20th July 2011
4	Shiv Mandir Dharamshala, Shanti Niketan, near Dhaula Kuan	04:00 PM, 20th July 2011

5.3.1 Disclosure

During the public consultation, the public were informed about the project description, environmental baseline data, negative and positive environmental impacts, proposed mitigation measures and management plans. The public were also informed about the project benefits. The mode of information disclosure was Power Point Presentation in English and the mode of presentation was in Hindi (vernacular language). The details of the number of Participants at the all the 4 locations as presented in **Table 5.8.**

Table 5.8
Details of Participants

S.No.	Name	Address	Mobile Number
Venue: Janpath			
1	Vikram Verma	Shop No:4, Tibet Market, Janpath, Delhi	9868782665
2	Tenzin Lhakpa Negi	Himalaya Art Centre, Shop No: 21, Tibetan Market, Janpath	9911179795
3	Deepak Kumar Chauhan	Shop No:1, Tibet Market, Janpath, Delhi	9818551802
4	Nagender Dass	P.Dass & Sons #23 Tibetan Market	9899518223
5	Davemdar Singh	No 11 Tibetan Market, Janpath, New delhi	9810919028
6	Sanjeev Negi	Art Center, 19, Tibetan Market, Janpath, New Delhi	9999335548
7	Angju Negi	Shop # 14, Tibetan Market, Janpath	9868090635
8	Rattan Negi	7, Tibetan Market, Janpath Road	9873428620
9	Subash Singh Bhatia	20, Tibetan Market, Janpath, New Delhi	9810077608
10	Guman Singh	34, Janpath	9717534255
11	Nareen Malik	Shop No -26, Tibetan Market, Janpath, New Delhi	9810104363, 23368878 (o)
12	Rajinder Singh	Shop No - 2, Tibetan Market, New Delhi	9891264604

S.No.	Name	Address	Mobile Number
13	S Rawdhir Singh Sandhu	M/s Janpath tourish Taxi Service, 36, Janpath, New Delhi	011-23323460
14	S Rawdhir Singh Sandhu	M/s Janpath tourish Taxi Service, 36, Janpath, New Delhi	9818443691
15	Amar Pal Singh	Booth No.9, Imperial tourish Taxi Service, 36 Janpath, New Delhi 110001	9971186211
16	P Singh	17 Tibetan Market, Janpath, New Delhi	9891746955
17	M M Singh	Shop No:11, Tibet Market, Janpath, Delhi	011-23368015
18	Sarabjit Singh	KTC India Pvt Ltd, 34, Janpath, New Delhi	9810099337
19	R K Grover	15, Tibetan Market, Janpath, New Delhi	9810190572
20	Mingmar Singh Bhotia	16, Tibetan Market, Janpath Road, New Delhi	9811011229
21	Surinder Singh	WCTTS, 36 Janpath, New Delhi - 110001	9810039121
22	Charanjit Singh	Tourist Taxi Company, 36-Janpath, Outside Kidwai Bhawan	9871159595
23	Rajesh Kumar	Shop No:3, Tibet Market, Janpath, Delhi	9891424290
24	Tashi Singh	Shop No:5, Tibet Market, Janpath, Delhi	9818249982
Venue: Sarojini Nagar			
1	Gulbugh Chudh	103, Sarojini Nagar Market	9818302605
2			
3	Gulshan Bhatra	118, Sarojini Nagar Market	9810884043
4	Dinesh Khalra	114, Sarojini Nagar Market	9811083006
5	Ajay Arora	185, Sarojini Nagar Market	9910906339
6	Asha Rani	C-362, Sarojini Nagar	9874592519
7	Ashok Kumar	115, Sarojini Nagar Market	9810754123
8	Meena Kushwah	D-361, Sarojini Nagar	921243937
9	R K Meena	C-363, Sarojini Nagar	9013477438
10	Rajendra Kumar	D-363, Sarojini Nagar	9971092086
Venue: Proposed IIT Metro Station			
1	Ms. Madhubaca	C-4/67 S. D. A. New Delhi-16	9810014402
2	Tilak Raj Kalka	C-6/48 S. D. A. New Delhi-16	9811881819
3	Ranjana Kumar	C-6/37 G. F. S. D. A.	9312262663

S.No.	Name	Address	Mobile Number
4	Adesh Agarwal	C-4/88/2 S. D. A. New Delhi-16	9810204035
5	Naresh K Malik	C-2/27 S. D. A. New Delhi-16	9310666897
6	P K Jain	C-1/42 S. D. A.	9810037819
7	A P Saxena	C-1/44 S. D. A.	9810039606
8	Ashok Mehta	D-2, Bhim Nagar, S.D.A. New Delhi	9810905067
9	Rakesh Aggarwal	C-8, S.D.A. Market, N. Delhi -16	9810991177
10	C.N. Amar	C-6, Bhim Nagar, S.D.A. Hauz Khas New Delhi -16	9871580160
11	Daljit Singh	C-24 S.D.A. Area Market	9810038578
12	Sudershan Tandon	C-21/1 SDA MarketSafdarjung Area New Delhi -16	9810264624
13	Mohd Saleem Ahmed	C-18, Satkar Complex SDA Market New Delhi	9213373696/9990227208
Venue: Proposed Dhaula Kuan Metro Station			
1	Surjeet Singh	84 Satya Niketan	9911326832
2	Kishore Kumar	16 Satya Niketan	9891169455
3	Ramesh Kumar Agarwal	Shop No 8 Satya Niketan	9899050525
4	Rakesh kumar	Shop No 11 Satya Niketan	9650726240
5	Jagjit singh	188 Satya Niketan	9350993661
6	Ram Kishore	11 JJ colony Satya Niketan	
7	R S Yadav	169 Satya Niketan	9899608851
8	Rajeev Sotie	259 Satya Niketan	9873653193
9	Sanjeev Arora	14-B Satya Niketan, 143 Sandesh vihar Pitam pura	9810253974
10	Harish chander yadav	Shiv mandir Satya Niketan, Moti Bagh II	8447821265
11	Swarnjit Singh	256 Satya Niketan	9810174288
12	L R Gupta	61 Satya Niketan	9871240840
13	Roop Narayan	78 Satya Niketan	26112135,

S.No.	Name	Address	Mobile Number
	Khandelwal		26111976
14	T R Gogia	House no. 182 Satya Niketan	9971877552
15	B P Yadav	69 Satya Niketan	9810257909
16	K J Bagga	2 Satya Niketan	9312585914
17	Jasbir Singh Kohli	90 Satya Niketan, nanak pura, Moti Bagh	9868007202
18	Bhupinder Singh Sabharwal	161-162 Satya Niketan	9971644334
19	Vikas Vashist	198 Satya Niketan	9810421159
20	vivek Bagga	2 Satya Niketan	9810391997
21	Jagdish Makkar	25 Satya Niketan	9811045495
22	Dr B R Gupta	109 Satya Niketan	9968334386

5.3.2 Observations and Comments:

After the presentation, the public was asked to share their views on the details of the project presented to them. They were also asked to fill a simple questionnaire for submission about the disclosure and for recording their objections and suggestions regarding the environmental issues. Format of the questionnaire in presented at **Annexure 5.1.**

5.3.3 Findings

Most of the people present in these public consultation have communicated that the details about the project which were explained to them, were very useful. Since both positive and negative impacts were explained to these participants, they expressed their satisfaction with the presentation. About 17% people have objections related to land issues. Another equal percentage have made suggestions on the disclosure. These suggestion are as follows:

- While developing Metro Phase III, Pedestrian problem should be taken care of and construction should not affect day to day operation of their shops nearby.
- More rail cars to be increased during the peak hours. Special ladies bogies should be increased.
- Change from one station to another should be ‘old age people friendly’.
- Noise pollution should be controlled during construction.
- Metro feeder bus facility should be available between residence and the metro stations.
- All weather subway may be connected to link IIT (across road).

- Observe efficiency in implementing the safety measures as explained during presentation on all accounts.
- All necessary precaution may be taken during construction to avoid any mis-happening. Efforts should be made that people should face less difficulties as far as possible
- It is observed that Indra Prastha gas pipeline is passing through Satya Niketan area. Care may please be taken. Over head high tension line is also passing in the area, and suitable precautions are required.
- The excavation period needs to be fast tracked near residential colonies to minimize air and noise pollution.
- Construction should be environment and public friendly

5.3.4 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.

Evidence of such consultations is available separately, in photographs and videos, recorded in Compact Discs. A copy of the power point presentation, used in the public consultation is presented at **Annexure 5.2**.

Chapter –6

Environmental Management Plan

CHAPTER – 6
ENVIRONMENTAL MANAGEMENT PLAN

6.1 MANAGEMENT PLANS

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. All

required funds will be channeled through the project authority. The Environmental Management Plans have been prepared and discussed in subsequent sections.

6.2 MITIGATION MEASURES

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

- Compensatory Afforestation,
- Construction Material Management,
- Labour Camp,
- Energy Management
- Hazardous Waste Management
- Housekeeping,
- Utility Plan,
- Archaeological and 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.

6.2.1 Compensatory Afforestation

The objective of the afforestation programme should be to develop natural areas in which ecological functions could be maintained on a sustainable basis. The Department of Forests, Delhi Administration is responsible for the conservation and management of trees/forests in the project area. According to the results of the present study, it is found that about 16,609 trees are likely to be lost due to the project. As per the provision of the Delhi Preservation of Trees Act, 1994, 10 saplings are to be planted for cutting a single tree. Hence 166,090 trees need to be planted. For cutting one tree, an applicant would have to deposit Rs 28,000 with the forest department. Of this, Rs 14,000 would be used by the department for plantation and upkeep of five saplings. Out of the total security deposit, Rs 14,000 would be refunded after 10 years if compensatory plantation is found to be satisfactory.

Cost of Compensatory reafforestation will be about Rs 465.052 million considering ₹ Rs 28,000 per tree. Out of this Rs 232.526 million will be refunded after 10 years. As per compensatory afforestation, it is proposed to plant 10 times the trees to be cut. As such 1,66,090 tree are proposed to be planted. These trees, on maturing will absorb about 3,621 ton of CO_2 per year and will release 36 ton of Oxygen per year meeting oxygen demand of 5590 persons per year.

6.2.2 Construction Material Management

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

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

6.2.3 Labour Camp

The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the DMRC. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. Safe drinking water should be provided to the dwellers of the construction camps. Adequate washing and bathing places shall be provided, and kept in clean and drained condition. Construction camps are to the responsibility of the concerned contractors and these shall not be allowed in the construction areas but sited away. Adequate health care is to be provided for the work force.

Sanitation Facilities: Construction camps shall be provided sanitary latrines and urinals. Sewerage drains should be provided for the flow of used water outside the camp. Drains

and ditches should be treated with bleaching powder on a regular basis. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner

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

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

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

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

6.2.4 Energy Management

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

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

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

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

6.2.5 Hazardous Waste Management

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

6.2.6 Environmental Sanitation

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

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

Team of environmental sanitation squad shall carry out:

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

- The structure dimension of the barricade, material and composition, its colour scheme, DMRC logo and other details.

- All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exits fire doors, break-glass alarm points, fire-fighting equipment, first aid stations, and other emergency stations shall be kept clean, unobstructed and in good working order.

- All surplus earth and debris are removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving.

- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.

- Roads shall be kept clear and materials like: pipes, steel, sand boulders, concrete, chips and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.

- Water logging or bentonite spillage on roads shall not be allowed.

- Proper and safe stacking of material are of paramount importance at yards, stores and such locations where material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored / stacked in an orderly and safe manner.

- Flammable chemicals / compressed gas cylinders shall be safely stored.

- Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to identified locations(s).

- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).

- Empty cement bags and other packaging material shall be properly stacked and removed.

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

6.2.7 Utility Plan

The proposed Metro alignments under Phase-III network run along major arterial roads of the city, which serve Institutional, Commercial and Residential areas. Large number of sub-surface, surface and overhead utility services, viz. sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. already exist along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction by temporary / permanent diversions or by supporting in position. As such, these may affect construction and project implementation time schedule /costs, for which necessary planning / action needs to be initiated in advance.

The Organizations / Departments responsible for concerned utility services are reported in **Table 6.1.**

Prior to the actual execution of work at site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility.

While planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of Metro alignment under Phase-III, the following guidelines could be adopted:

- Utility services shall be kept operational during the entire construction period and after completion of project. All proposals should therefore, ensure their uninterrupted functioning.

- The elevated viaduct does not pose any serious difficulty in negotiating the underground utility services, especially those running across the alignment. In such situation, the spanning arrangement of the viaduct may be suitably adjusted to ensure that no foundation need be constructed at the location, where utility is crossing the proposed Metro alignment. In

case of utility services running along the alignment either below or at very close distance, the layout of piles in the foundations shall be suitably modified such that the utility service is either encased within the foundation piles or remains clear of them.

TABLE 6.1
ORGANIZATIONS RESPONSIBLE FOR UTILITIES AND SERVICES

S. NO.	ORGANIZATION/ DEPARTMENT	UTILITY/SERVICES
1.	Delhi Jal Board	Sewerage and drainage lines. Water mains and their service lines, including hydrants and fountains etc, water treatment plants, pumping stations etc. in non NDMC area
2.	New Delhi Municipal Committee	Roads, surface water drains, nallahs, sewer lines, street lights, high mast lights etc. in NDMC area etc.
3.	Central Public Works Department	Roads, surface water drains, nallahs etc.
4.	NHAI	Roads, surface water drains, nallahs etc.
5.	NDPL and BSES	Power cables and their appurtenances, pole mounted transformers, power cables of 33 & 11KVs
6.	Mahanagar Telephone Nigam ltd. (MTNL)	Telecommunication cables, junction boxes, telephone posts, O.H. lines etc.
7.	Office of Commissioner of Police, Delhi	Traffic signal posts, junction boxes and cable connection etc.
8.	Reliance Mobile India Limited, Idea, Airtel and Tata Tele service India Limited	Telecommunication cables, junction boxes etc.
9.	Indraparastha Gas Limited	Gas Pipelines

6.2.8 Archaeological and Historical Preservation

No damage to Archeological and Historical Monuments is anticipated. However, during the construction period, archaeological or historic resources may be affected by direct or indirect construction activity. Prior to the initiation of construction, DMRC intends to review without objection a resources protection plan for historic structures where it appears they may be affected by the project. This plan will be develop by the contractor in consultation with the Archaeological Survey of India (ASI) and other parties. This plan will identify the sensitive resources as well as specify the construction monitoring

requirement. These requirements may include ground vibration monitoring and recording any component inadvertently subjected to impact.

The proposed alignment of Central Secretariat – Kashmere Gate Corridor which is part of Phase – III MRTS Project passes through the regulated /prohibited zone of the various protected momuments like Jantar Mantar, Khooni Darwaza, Delhi Gate, Suneheri Masjid, Lal Quila and Kashmere Gate. In this alignment, the tunnel for the metro network is being constructed by using the state of the art technology i.e. Tunnel Boring Machine which gives negligible vibration and does not affect the surrounding structure. The stations are being constructed by cut and cover method which is widely accepted and the safest technique being adopted by metros in India and abroad. The above technology has been adopted by DMRC in the past while carrying out works in the regulated/prohibited areas (ASI protected monuments) as well as close to public and private buildings and no damage has been caused to these structures by the construction activities of DMRC.

In the present alignment all the station are beyond 100 m of protected monuments and therefore do not fall in the prohibited zone. However the tunnel alignment passes in vicinity of the protected monuments i.e Khooni Darwaza, Delhi Gate and Kashmere Gate.

Since the alignment, at places, runs within the prohibited/regulated area, DMRC have applied for No Objection Certificate (NOC) from the competent authority as per provision of National Monuments and Archeological Sites and Remains (Amendment & Validation Act 2010). Presently the proposal is under consideration of the competent authority, which will forward the proposal to National Monument Development Authority.

6.2.9 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.

6.2.10 Noise Control Measures

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

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

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

Workers in those sections where periodic adjustment of equipment/machinery is

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

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

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

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

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

6.2.11 Vibration Control Measures

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

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

- To prevent development of surface irregularities on the rail, a fairly heavy rail section of 60 kg/m, 90 UTS rail, supported at every 60 cms has been

proposed further rail grinding at regular intervals by rail grinding machine and also lubrication of rail by vehicle mounted lubricator have been contemplated.

- Rails will be continuously welded and also will be laid to fine tolerances so that any noise/vibration on account of track geometry could be reduced.
- The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used.

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

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.

6.2.12 Traffic Diversion/ Management

During such construction, traffic is most likely to be affected. Hence Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during Metro construction of various corridors under 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 be

blocked 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.

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

- All construction workers should be provided with high visibility jackets with reflective tapes as most of viaduct /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.

6.2.13 Soil Erosion Control

Prior to the start of the relevant construction, the Contractor shall submit to the DMRC for approval, his schedules for carrying out temporary and permanent erosion/sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment/sub-grade construction, bridges and other structures across water courses, pavement courses and shoulders. He shall also submit for approval his proposed method of erosion/sedimentation control on service road and his plan for disposal of waste materials. Work shall not be started until the erosion/sedimentation control schedules and methods of operations for the applicable construction have been approved by the DMRC.

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

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

Temporary erosion/sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal

construction practices, but may neither be foreseen during design stage nor associated with permanent control features on the Project. Under no conditions shall a large surface area of credible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the DMRC.

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

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

6.2.14 Muck Disposal

Construction of underground metro projects is a specialised and complex task. Owing to paucity of space in the busy cities and for safety reasons, elaborate measures need to be adopted for collection, transfer, storage and disposal of excavated muck. Muck collection, transportation, disposal and its treatment need to be carried out in a systematic manner. Muck collection should be in containers from the dredging sites / places. These containers should be such that muck should not spill during movement to disposal site. The excavated muck will be first collected at dumping ground and then transferred to disposal sites. Dumping areas are essential to store the excavated earth temporarily for back filling at later date and final disposal.

All these activities will generate about 13.17 Mm^3 of muck. Out of this about 2.42 Mm^3 is likely to be reutilized in backfilling at stations and Depot. The balance 10.75 Mm^3 shall be disposed off in environmental friendly manner.

Generally 5 m^3 capacity trucks are utilized for this purpose. About 2.00 Mm^3 muck will need to be transported to depot for filling and 10.75 Mm^3 muck need to be transported to disposal site. The total muck need to be transported is about 12.75 Mm^3. About 2832 trip/per day will be required in a span of 900 days for this purpose. Disposal of excess soil is permitted in low lying areas owned by Delhi Development Authority. The excess soil disposal site will be those identified by DDA and communicated to DMRC.. An application for allotment of land for disposal of surplus earth has already been submitted to DDA. The transfer and disposal of surplus soil may create air pollution and leached

water problem. To mitigate these problems following mitigation measure are proposed to be adopted:

1. The disposal sites will be cleaned and then treated so that leached water does not contaminate the ground water.
2. Material will be stabilised each day by watering or other accepted dust suppression techniques.
3. The height from which soil will be dropped shall be minimum practical height to limit the dust generation.
4. The stockpiling of earth in the designated locations with suitable slopes.
5. During dry weather, dust control methods such as water sprinkling will be used daily especially on windy, dry day to prevent any dust from blowing.
6. Sufficient equipment, water and personnel shall be available on dumping sites at all times to minimise dust suppression.
7. Dust control activities shall continue even during work stoppages.
8. The muck shall be filled in the dumping site in layers and compacted mechanically. Dumping sites on sloping ground shall be protected adequately against any possible slide/slope failure through engineering measures.

It is desirable to first clean the disposal area site for vegetation biomass exists over it. The faces and top should be treated/ vegetated to avoid erosion. Once the filling is complete, the entire muck disposal area shall be provided with a layer of good earth on the top, dressed neatly, and covered with vegetation.

6.2.15 Draining of Water from Tunnel

The water table generally varies from 1.4 to 29 m, which rises after the rains to about 2 m in low-lying areas. Problems of water flow associated with tunneling are bound to take place. In cut and cover type construction continuous pumping is an economical alternative.

The well point system is recommended for dewatering as the volume of water to be pumped out is not large. The deep well system is adopted where the water table has to be lowered over a large depth in a small area. The deep wells can be installed either inside or outside the diaphragm walls or inside the cut.

A suitable piezometer is installed to monitor the water table constantly and to see how much lowering has been effectively done. The dewatering should not be stopped unless it is ensured from design calculations that the load of the constructed box component has reached a stage where it will be able to counter act the hydrostatic pressure from below.

The dewatering can be achieved by:

- Leading the ground water to a sump by drains and pump out the water from the sump. To prevent loss of fines, inverted filter may have to be used.

- Dewatering as suggested above may not be effective in preventing sand flows. Lowering of the ground water by properly designed single or double stage well points will be effective in such cases.

- The construction of diaphragm walls of concrete along the side of channels, before the commencement of excavation will be required. The concrete walls are taken down to rest on bed rock or impervious strata or, in their absence, deep enough below the bottom of excavation, to serve as an effective cut off for the inflow of ground water into the proposed excavation. The trenches are made in lengths of 2.5 to 5m and kept continuously filled with a thiotropic material like Bentonite slurry, which has the effect of stabilising the trench and preventing any subsidence. As the excavation proceeds, concrete wall can be strutted mutually or anchored with surrounding rocks or soil with long tie rods.

- During operation phase, seepage water have to be drained along the side of walls (retaining). Proper drainage system need to be incorporated in design and implemented during construction phase.

The pumped water from sump wells will be put into storm water drain to avoid any load to waste water treatment plants. These storm water drains finally join natural existing streams/nallahs.

6.2.16 Water Supply, Sanitation and Solid Waste Management

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

Requirements of drinking water supply at underground as well as elevated station is about 6 KL/day. Raw water requirement for underground and elevated station is about 240 - 250 KL/Day and 25 - 30 KL/Day respectively. This shall be provided from municipal source.

Solid waste will be generated at underground station and elevated station is about 0.5 – 1.0 m^3/Day and 0.8 – 1.2 m^3/Day respectively. The maintenance of adequate sanitary

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

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

1. Recycle of water consumed in wheel washing.
2. Discarded water from the R/O plant at Batching Plants shall be used for re-charge of ground water.
3. Water from dewatering will also be used for ground water re- charge.

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

6.2.17 Rain water harvesting

To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure of suitable capacity in the elevated alignment. The total length of elevated alignment is about 65.5 km. The estimated cost of rain water harvesting for elevated alignment is about ₹ 1.1 million per km. A provision of ₹ 72.05 million has been kept in the cost estimate.

6.2.18 Management Plans for Depot

Three depots are planned for Phase III metro corridors. These Depots will be a Kalindi Kunj (40 hectare), Mukundpur and Mayur Vihar (77 hectare). The management plans for depot site includes:

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

Water supply: About 543 KLD of water will be required for operation and functioning of depot. This could be either collected from Municipal Corporation or through boring tube well into the ground. The ground water will need treatment depending upon its use. Domestic and some of the industrial application, a reverse Osmosis (RO) plant of 8 liter/ minute capacity will be appropriate. The water treatment plant flow chart is given in **Figure 6.1**. The estimated cost of water supply plant is about ₹ 12.05 million per plant. Hence total cost of water supply treatment plant at all three depots is about ₹ 36.15 million.

Oil Pollution Control: The oil tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil and grease removal tank has to be installed at initial stage of effluent treatments. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in bottom of the tank. The tank may be designed for a detention period of 5 to 15 minutes.

Sewage/Effluent Pollution Control: About 80 KLD of sewage is likely to be generated at each depot i.e.Yamuna Vihar, Mukundpur and Kalindi Kunj. The sewage could be treated up to the level so that it could be used for horticulture purpose in the campus and can also be discharged into the stream a process flow chart is presented in **Figure 6.2.** The estimated cost of sewage treatment plant is about Rs 7.8 million per plant. Hence total cost of sewage treatment plant at all three depots is about Rs 23.4 million.

About 63 KLD of effluent is likely to be generated at Yamuna Vihar and Mukundpur Depot. And about 70 KLD of effluent is likely to be generated at Kalindikunj Depot. This will have oil, grease and, detergent as main pollutants. This has to be treated as per requirement of regulatory pollution control agency of the state (DPCC). Process flow chart of effluent treatment plant is shown in **Figure 6.3.** The estimated cost of effluent treatment plant is about Rs 8.85 million per plant. Hence total cost of effluent treatment plant at all three depots is about Rs 26.55 million.

Surface Drainage: The area should have proper drainage. The Storm water of the depot will be collected through the drain. Rain water harvesting pits at different locations in the drains and for surplus storm water, the drainage system is connected to a nearby disposal site. The drainage costs have been included in project cost.

Green belt development: The greenbelt development / plantation in the depot area not only functions as landscape features resulting in harmonizing and amalgamating the physical structures of proposed buildings with surrounding environment but also acts as pollution sink / noise barrier. In addition to augmenting present vegetation, it will also check soil erosion, make the ecosystem more diversified and functionally more stable, make the climate more conducive and restore balance. It is recommended to have a

provision of Rs 4 million per depot in the cost estimate for the green belt development. Hence total cost for green belt development is about Rs 12 million.

Rain water harvesting: To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure of suitable capacity in the constructed depot site. A provision of Rs 0.85 million per depot has been kept in the cost estimate. Hence total cost for rainwater harvesting is about Rs 2.55 million.

Recycling of treated waste water: Waste Water generated at depot is proposed to be collected at ETP & STP through separate sewer lines for treatment and recycled for horticulture work of the depot. About 64 KLD of treated waste water will be used for horticulture at Yamuna Vihar and Mukundpur Depots and 67 KLD at Kalindi Kunj Depot. The estimated cost of recycling of treated waste water is about Rs 4.1 million per plant. Hence total cost of recycling of treated waste water at all three depots is about Rs 12.3 million.

6.2.19 Training and Extension

The training and extension programmes need to be conducted by the Railway Staff College, for MRTS officers. The training for engineers and managers is imparted by DMRC on regular basis to implement the environmental protection clauses of the tender document and to implement the best environmental practices during the construction phase. The course content draws heavily from past experiences. These training programs are imparted through regular training workshops in which presentations are made on a variety of issues pertaining to environmental management so as to sensitise the participants and raise their awareness on environmental issues in general and conditions of contract on environment, in particular. These programmes could be extended for the local population for their active participation in the project implementation. Apart from training, such programme should include guidelines for safety, methods of disaster prevention, action required in case of emergency, fire protection, environmental risk analysis etc. Railways extension staffs are currently trained in railway operation and maintenance techniques. Additional training in above areas is required. The cost involved for such programme is presented in **Table 6.2.**

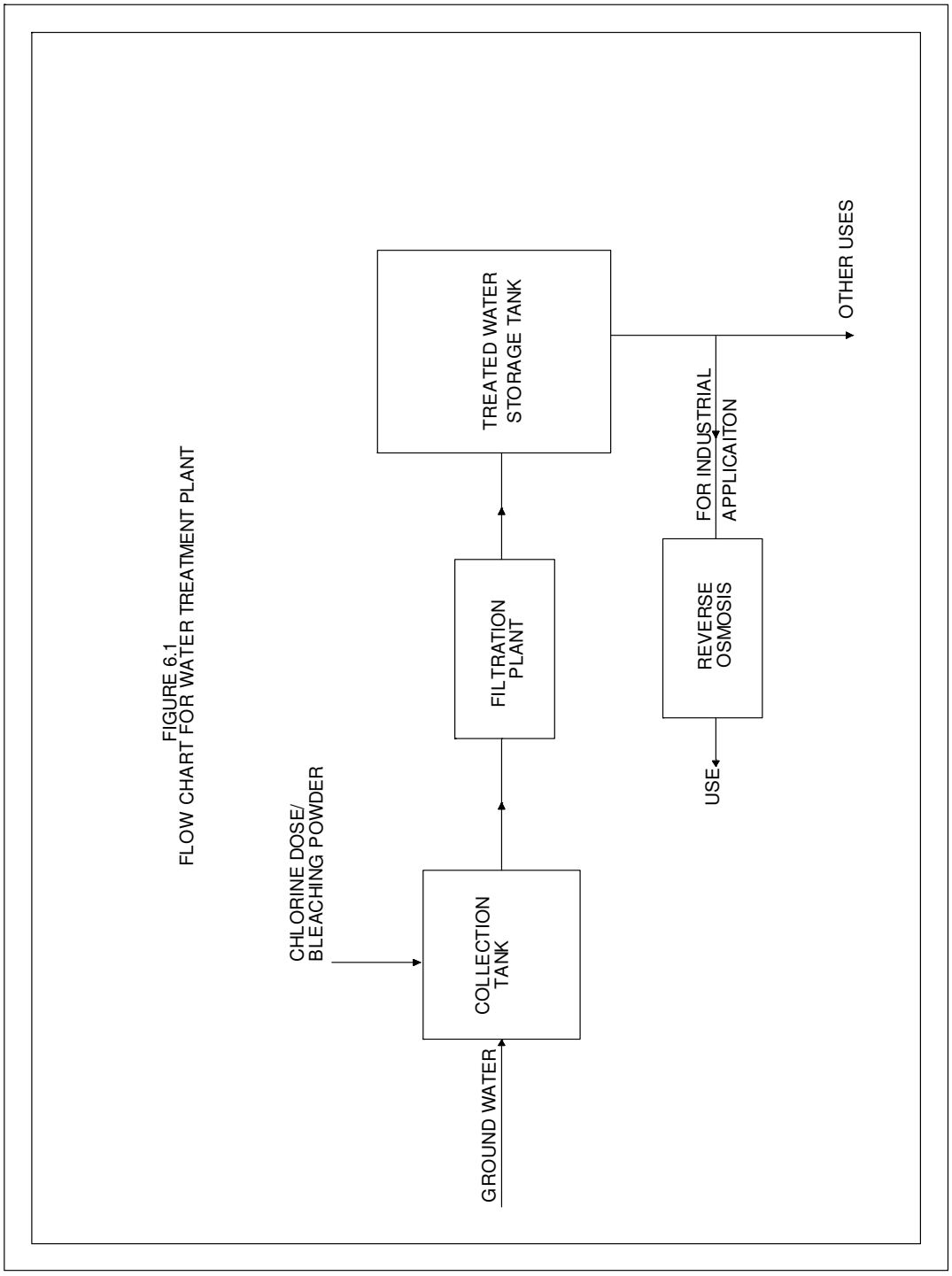


FIGURE 6.1
FLOW CHART FOR WATER TREATMENT PLANT

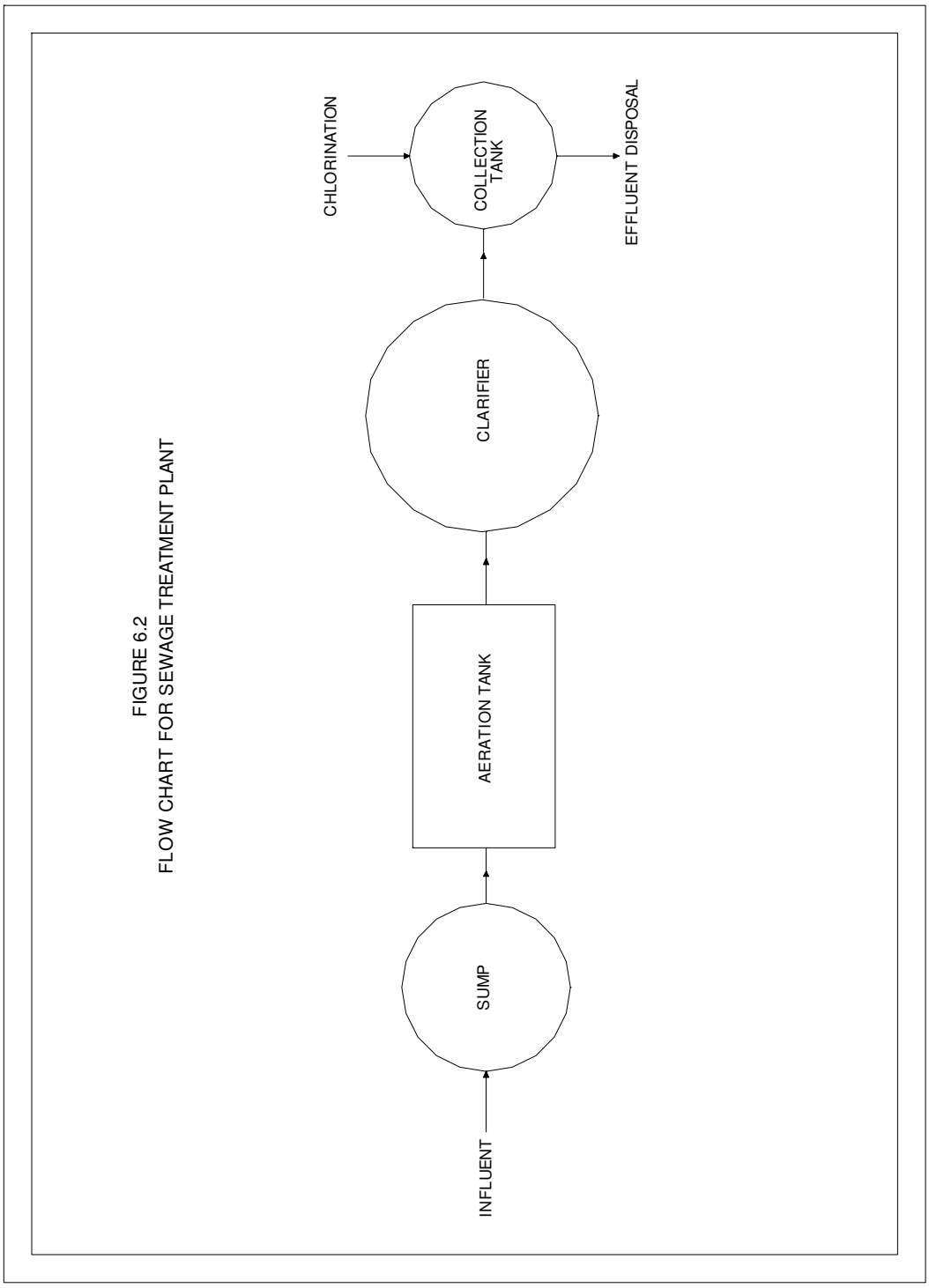


FIGURE 6.2
FLOW CHART FOR SEWAGE TREATMENT PLANT

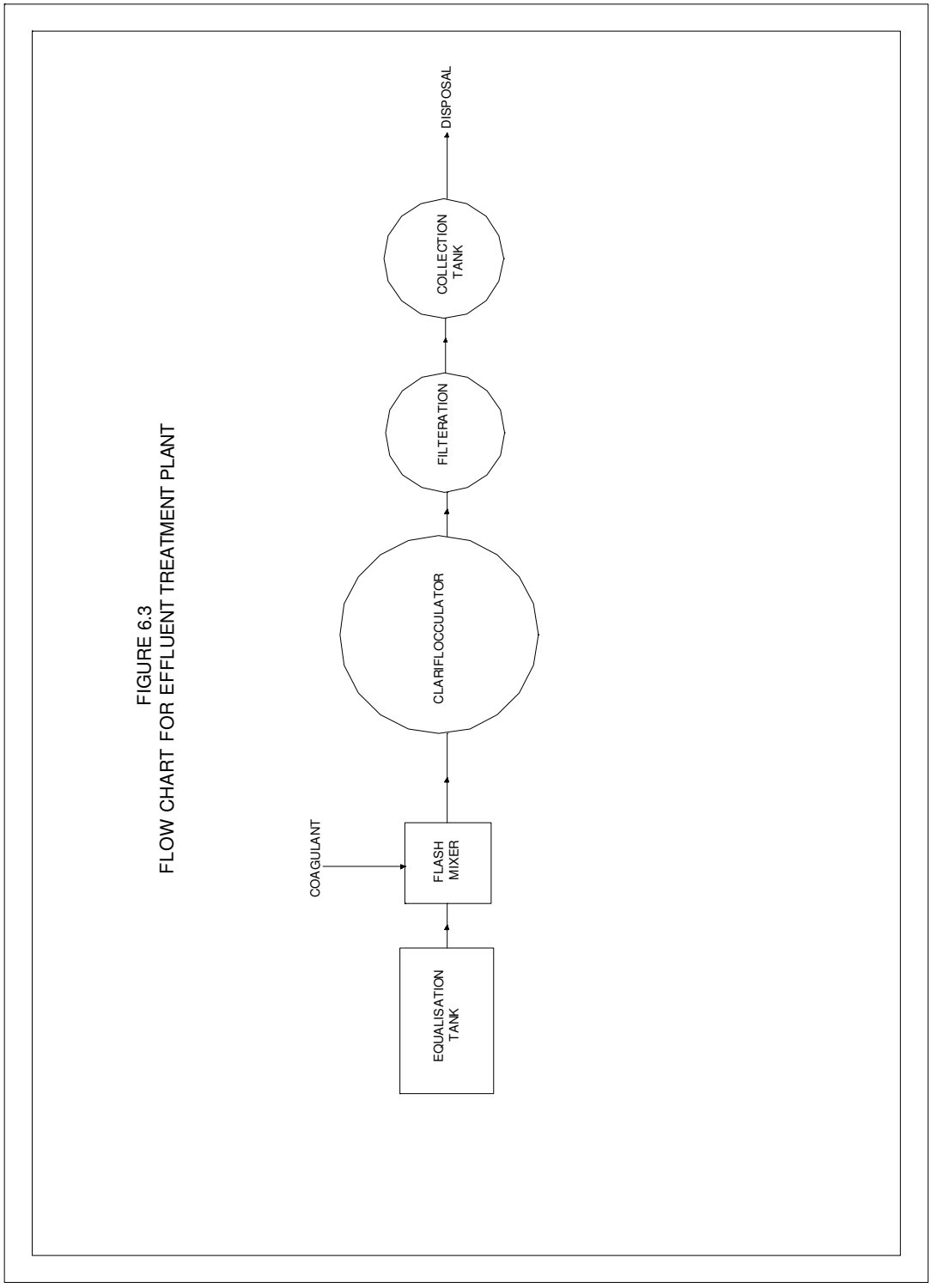


FIGURE 6.3
FLOW CHART FOR EFFLUENT TREATMENT PLANT

TABLE 6.2
COST FOR TRAINING PROGRAMME

S. NO	ITEM	COST (₹)
1.	Curriculum Development and course preparation 2 months Rs.30000/month	60,000
2.	10 Extension Officer (1year) Rs.25, 000/ month	30, 00,000
3.	Instructor 20 sessions of 10 days each	5, 00,000
4.	Demonstration/Presentation Aids	50,000
5.	Material etc	1,00,000
	Total	**37, 10,000**

6.3 DISASTER MANAGEMENT

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

6.3.1 Preventive Action

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

6.3.2 Reporting Procedures

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

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

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

6.3.3 Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More

often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and full proof communication system.

6.3.4 Emergency Action Committee

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

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

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

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

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

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

It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

6.4 EMERGENCY MEASURES

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

6.4.1 Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power to at least 25% of the lights at the station, platforms, tunnels/viaducts for a period of 2 hours. The underground station should have transformer at each end of the platform. Both the transformers need to be kept energized and should feed independently alternate rows of lights so that in case of failure of one transformer, there will not be complete darkness. The tunnels need to be provided with fluorescent incandescent lamps at a spacing of 20 m.

6.4.2 Fire Protection

The building materials should be of appropriate fire resistance standard. For underground structures the fire resistance period should be at least 4 hours, and 2 hours for surface or over head structures. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

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

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

All aspects of fire prevention and control will be dealt in close collaboration with the city fire fighting authority. Smoke control will be achieved by the following means:

- Downstand bulkheads of a minimum depth of 600 mm to provide smoke containment. These will be provided around openings for escalators, lifts and stairs in underground stations,

- In underground stations the ventilation system will be designed to extract smoke in the event of fire, and

- In enclosed public areas of above ground stations (e.g. a concourse located below a platform) arrangement for smoke extraction will be provided.

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

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

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

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

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

A. Fire Prevention and Safety Measures

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

i. Fire Prevention

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

ii. Safety

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

- Automatic sprinkler/detection system to be provided if floor area exceeds 750 sq.m
- One wet riser-cum-down comer per 1000 sqm floor area with static underground storage tank, overhead tanks and pumps of suitable capacity with hydrants, first-aid reel, etc.
- Portable fire non-aqueous extinguishers of Carbon di Oxide, chemical dry powder etc. at suitable places.
- Automatic smokes venting facilities.
- Two separate means of exit shall be provided, if more than 10 persons are working and the area exceeds 1400 sq.m
- Fire resisting doors shall be provided at appropriate places along the escape routes to prevent spread of fire and smoke.
- The travel distance for fire escape shall not exceed 20 m where escape is available in more than one direction; the distance could be upto 40 m.

B. Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Delhi Fire Services shall be provided through out each station and ancillary buildings

including entrance passageways, subways and adits etc. to give visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g. detector heads, linear heat detecting cables etc. The system shall be operated from 24 V DC Power sources.

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

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

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

C. Fire Control Measures

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

D. Access for Fireman

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

6.4.3 Ventilation Shafts

The Environmental Control system for underground stations requires ventilation openings between various plants, plant rooms and the atmosphere. Five independent shafts are required for exhaust air, fresh air intake and draft relief. The two shafts for Mukundpur –

Yamuna Vihar Corridor, two shaft for Kalindi Kunj – Jankpuri and one shaft for Central Secreteraiate – Kashmere Gate. The minimum cross-sectional area of each shaft will be 12 m^2. Total length of each ventilation shaft from the station box to the atmosphere should not exceed 60m.

6.4.4 Emergency Door

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

6.5 SUMMARY OF ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The environmental impacts stemming out of the proposed project can be mitigated with simple set of measures, dealing with careful planning and designing of the metro alignment and structures. Adequate provision of environmental clauses in work contracts and efficient contract management will eliminate or reduce significantly all possible problems. A common problem encountered during implementation of environmental management plans of such projects is lack of environmental awareness among engineers and managers concerned with day to day construction activities, which can be solved through regular environmental training programs. A set of preliminary EMP is presented in **Table 6.3,** 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.

TABLE 6.3
ENVIRONMENTAL MANAGEMENT ACTION PLAN (EMP)

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

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
	phase, wherever it is required to avid dust. Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.	construction		implementing agency
Air Pollution	Vehicles and machinery are to be regularly maintained so that emissions conform to National and State AAQ Standards.	Beginning with and continuing throughout construction	Contractor	PIU/EMP implementing agency
Equipment Selection maintenance and operation	Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures relevant air, noise, and discharge regulations are met.	During construction	Contractor	PIU/EMP implementing agency
Noise	Noise standard at processing sites, will be strictly enforced as per GOI noise standards. Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. At construction sites within 150m of sensitive receptors construction will be stopped from 22:00 to 06:00. Machinery of noise barriers (Stone walls and plantation) for silence zones including schools and hospitals.	Beginning and through construction	Contractor	PIU/EMP implementing agency
Vibration	The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak p velocity as given in article project SHE Manual	Beginning and through construction	Contractor	PIU/EMP implementing agency
WATER				
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into rivers and irrigation system	Throughout construction period	Contractor	PIU/EMP implementing agency
Wastage of water	Measures shall be taken to avoid misuse of water. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking purpose.	Beginning with and continuing throughout construction	Contractor	PIU/EMP implementing agency
Sewerage disposal during	A minimum distance of any sewage or toilet facility from water sources should be 200	Throughout construction	Contractor	PIU/EMP implementing

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

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

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
	rules may be adopted.			
SOCIAL				
Safety and noise disturbances	New buildings should be prohibited within 50 m of the edge of carriageway. No new schools and hospitals should be allowed within 200 m of carriageway.	Throughout and after project development period.	Planning Department /PIU	PIU/EMP implementing agency

Chapter –7

Environmental Monitoring Plan

CHAPTER - 7
ENVIRONMENTAL MONITORING PLAN

7.1 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,
- Environmental Sanitation and Waste Disposal
- Ecological Monitoring and Afforestation,
- Workers Health and Safety

Environmental monitoring during pre-construction phase is important to know the baseline data and to predict the adverse impacts during construction and operations phases. Pre-construction phase monitoring has been done for the proposed project for air, noise, water, soil quality and ecology. The results so obtained are documented in **Chapter 3**.

7.2 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 7.1** These number could be modified based on need when the construction actually commences.

7.2.1 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.

7.2.2 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.

7.2.3 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.

7.2.4 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.

7.2.5 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 7.1**

TABLE 7.1
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

7.3 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 7.2**. The monitoring program shall be conducted by an external agency certified by NABL under the supervision of DMRC. Project proponent (DMRC) is responsible for successful environmental monitoring of the proposed project during operation phase.

TABLE 7.2
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 7.1.** The monitoring locations of various parameters during construction and operation phases are presented at **Annexure 7.2 and Annexure 7.3** respectively.

7.4 ESTABLISHMENT OF AN ENVIRONMENTAL DIVISION

It is recommended that DMRC establishes an Environment Division at the initial stage of the project itself. The division should be staffed with an Environmental Engineer/Officer and a Technical Assistant (environment background). The task of the division would be to supervise and coordinate studies, environmental monitoring and implementation of environmental mitigation measures, and it should report directly to Chief Engineer (Environment) of the project authority. Organizational setups for Environmental Monitoring during construction and operation phase are shown in **Figure 7.1 and Figure 7.2**. Progress of the division should be reviewed by an Environmental Advisor once in a year. The environmental Advisor should be an experienced expert familiar with environmental management in similar projects. Costs for the first ten years (including 10% annual increase has been) given **Table 7.3**.

TABLE 7.3
ENVIRONMENTAL DIVISION COSTS

S. No	Particulars	In Rupees
Per Year		
1.	Environmental Engineer (1No.)	6,00,000
2.	Technical Assistant (1No.)	4,00,000
3.	Miscellaneous Expenditure	2,00,000
	Total Cost per One Year	**1,200,000**
	Total Cost for Ten Years with 10% annual increase	**19,124,910**

FIGURE 7.1
ORGANIZATIONAL SETUP DURING CONSTRUCTION PHASE

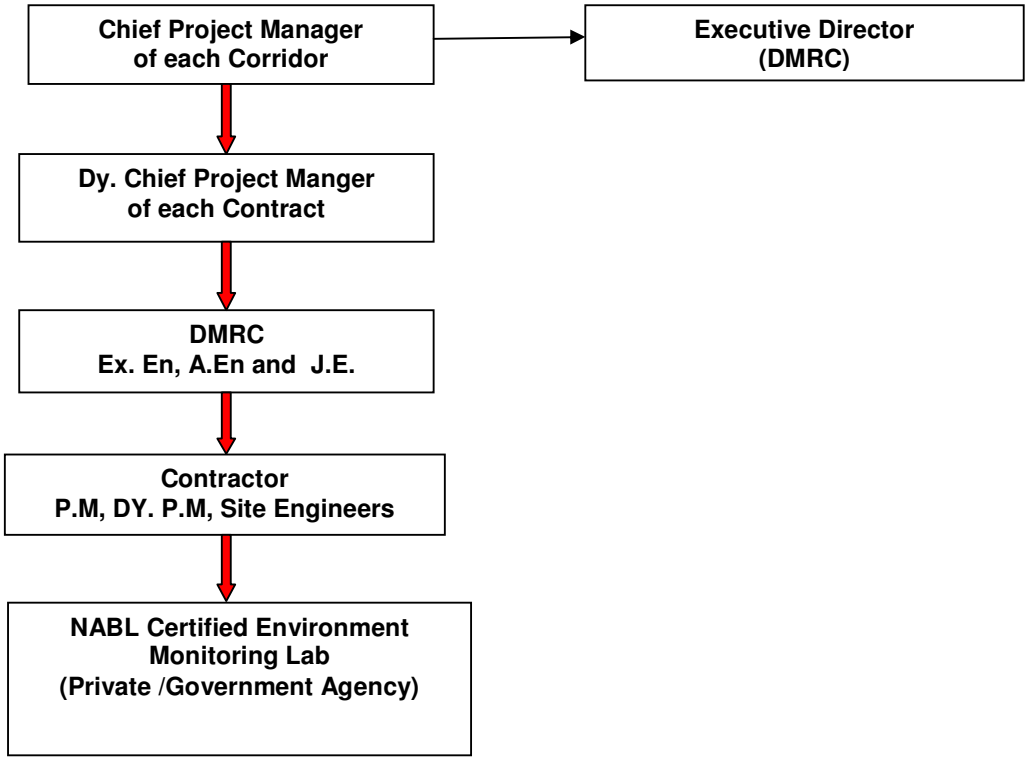
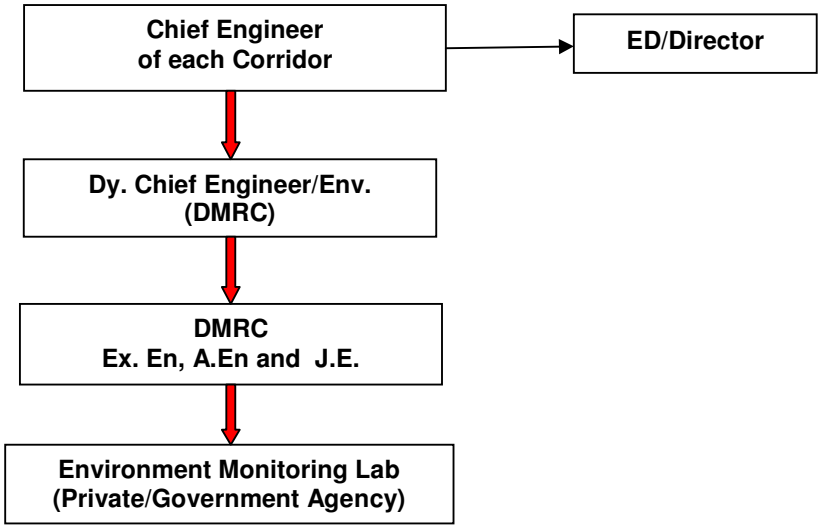


FIGURE 7.2
ORGANIZATIONAL SETUP DURING OPERATION PHASE



Chapter –8

Cost Estimates

CHAPTER-8
COST ESTIMATES

8.1 SUMMARY OF COSTS

All costs involved in Environmental mitigation and management and monitoring to be put on the account of Metro Project Phase III. These costs are computed in **Chapter 6** and **Chapter 7.** A summary of these is presented in **Table 8.1.**

TABLE 8.1
ENVIRONMENTAL COSTS

S. No.	ITEM	COST Rs.Million
1.	Compensatory Afforestation	465.052
2.	Water Supply Treatment	36.15
3.	Sewage Effluent Treatment	23.4
4.	Drainage	18.0
5.	Rain Water Harvesting In Depot Area	2.55
6.	Green Belt Development	12.0
7.	Recycling of treated waste water	12.3
8.	Air, Noise, vibration, Water, Waste Water, Solid waste, during construction and operation	48.38
9.	Ecological monitoring	10.00
10.	Establishment of Environment Division	19.12
11.	Training And Extension	3.71
	Total	**650.662**

The compensation for loss of land, fire control and information systems have been incorporated in project costs. Cost of Rehabilitation and Resettlement has been presented in Volume II.

The Environmental management plan should be implemented in phases so that optimum benefit could be achieved and should be synchronized with the construction schedules.

Annexure 1.1 -1.6

Annexure 1.1

NUMBER OF REGISTERED VEHICLES IN DELHI

S.No.	Type of Vehicle	Numbers
Private Vehicles		
1.	Invalid Carriage	264
2.	L.M.V. (Car)	1,979,631
3.	L.M.V. (Imp.)	8,013
4.	L.M.V. (Jeep)	69,050
5.	L.M.V. (Van)	74,757
6.	Moped	80,638
7.	Motor Cycle	1,978,138
8.	Motor Cycle (Imp.)	193
9.	Motor Cycle With Side Car	5
10.	Scooter	2,262,930
11.	Scooter With Side Car	601
	Sub Total	**6,454,220**
Commercial Vehicles		
12.	Ambulance	2,445
13.	Ambulance(Imp.)	30
14.	Bus	31,979
15.	Cab Scheme	2,142
16.	Eco Friendly Sewa	628
17.	Economy Radio Taxi	449
18.	Gramin Sewa	4,891
19.	Heavy Goods Vehicle	53,692
20.	Light Goods Vehicle	135,648
21.	Light Pass. Vehicle	15,989
22.	Local Taxi	9,572
23.	Maxi Cab	121
24.	Maxi Cab-(School Cab)	5,849
25.	Medium Goods Vehicle	9,140
26.	Medium Pass. Vehicle	1,470
27.	Motor Cab-(School Cab)	689
28.	Motor Cycle Rikshaw	2
29.	Others	4,637
30.	Phatphat Sewa	375
31.	Radio Taxi	4,672
32.	T.S.R	55,436
33.	Three Wheeler (Passenger)	20,809
34.	Tourist Taxi	21,886
35.	Tourist Taxi Deluxe	1,906
36.	Tractor	5,105
37.	Trailer/Side Car	99
38.	Utility Van	633
	Sub Total	**390,294**
	Grand Total	**6,844,514**

Annexure 1.2

DRINKING WATER QUALITY STANDARDS (IS 10500:1991)

S. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable limit	Permissible limit in the absence of alternate source
Essential Characteristics				
1	Colour, Hazen units, Max	5	Above 5, consumer acceptance decreases	25
2	Odour	Unobjectionable	-	-
3	Taste	Agreeable	-	-
4	Turbidity NTU, max	5	Above 5, consumer acceptance decreases	10
5	pH Value	6.5 to 8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	No relaxation
6	Total Hardness (as $CaCO_3$) mg/l, Max	300	Encrustation in water supply strucute and adverse effects on domestic use	600
7	Iron (as Fe) mg/l, max	0.3	Beyond this limit taste/appearance are affected, has adverse affect on domestic uses and water supply structures and promotes iron bacteria	1.0
8	Chloride (as Cl) mg/l, Max	250	Beyond this limit, test, corrosion and palatability are affected	1000
9	Residual free Chlorine, mg/l, Min	0.2	-	-
10	Fluoride (as F) mg/l, Max	1.0	Fluoride may be kept as low as possible. High fluoride may cause florosis	1.5
11	Dissolved solids mg/l, Max	500	Beyond this palatability decreases and may cause gastro intestinal irrigation	2000
12	Calcium (as Ca) mg/l, Max	75	Encrustation in water supply structure and adverse effects on domestic use	200
13	Magnesium (as Mg) mg/l, Max	30	Encrustation in water supply structure and adverse effects on domestic use	100
14	Copper (as Cu) mg/l, Max	0.05	Astringent taste, discoloration and corrosion of pipes fitting and utensils will be caused beyond this	1.5
15	Manganese (as Mn) mg/l, Max	0.1	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures	0.3

S. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable limit	Permissible limit in the absence of alternate source
Essential Characteristics				
16	Sulphate (as SO_4) mg/l, Max	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are present	400
17	Nitrate (as NO_2) mg/l, Max	45	Beyond this methaemoglobinemia takes place	100
18	Phenolic compounds (as C_6H_5OH) mg/l, Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002
19	Mercury (as Hg) mg/l, Max	0.001	Beyond this, the water become toxic	No relaxation
20	Cadmium (as Cd), mg/l, Max	0.01	Beyond this the water become toxic	No relaxation
21	Selenium (as Se), mg/l, Max	0.01	Beyond this the water become toxic	No relaxation
22	Arsenic (as As), mg/l, Max	0.05	Beyond this the water become toxic	No relaxation
23	Cyanide (as CN), mg/l, Max	0.05	Beyond this the water become toxic	No relaxation
24	Lead (as Pb), mg/l, Max	0.05	Beyond this the water become toxic	No relaxation
25	Zinc (as zn), mg/l, Max	5	Beyond this limit it can cause astringent taste and an opalescene in water	15
26	Anionic detergents (as MBAS), mg/l, Max	0.2	Beyond this limit it can cause a light froth in water	1.0
27	Chromium (as Cr^{+6}) mg/l, Max	0.05	May be carcinogenic above this limit	No relaxation
28	Plynuclear aromatic hydrocarbons (as PAH) g/l, Max	-	May be carcinogenic	-
29	Mineral oil mg/l Max	0.01	Beyond this undesirable and odour chlorination place	0.03
30	Pesticides mg/l Max	Absent	Toxic	0.001
31	Radioactive materials a) Alpha emitters Bq/l max b) Beta emitters pci/l, Max	 - -	 - -	 0.1 1
32	Alkalinity mg/l Max	200	Beyond this limit taste becomes unpleasant	600
33	Aluminium (as Al), mg/l Max	0.03	Cumulative effect is report to cause demntia	0.2
34	Boron, mg/l, mg/l Max	1	-	5

Annexure 1.3

EFFLUENT DISCHARGE STANDARDS (INLAND SURFACE WATER)

S.No.	Parameter	Unit	Standards
1	Colour & Odor	--	All efforts should be made to remove colour and unpleasant odor as far as practicable.
2	Suspended Solids Max.	mg/l	100
3	Particle size of Suspended Solids	--	Shall pass 850 micron IS Sieve
4	pH value	--	5.5 to 9.0
5	Temperature, Max.	^{o}C	Shall not exceed 5°C above the receiving water temperature
6	Oil and grease, Max.	mg/l	10
7	Total residual Chlorine, Max.	mg/l	1.0
8	Ammonical Nitrogen (as N), Max.	mg/l	50
9	Total Kjeldah Nitrogen (as N), Max.	mg/l	100
10	Free Ammonia (as NH_3), Max.	mg/l	5
11	Biochemical Oxygen Demand (5 days at 20°C), Max.	mg/l	30
12	Chemical Oxygen Demand Max.	mg/l	250
13	Arsenic (as As), Max.	mg/l	0.2
14	Mercury (as Hg), Max.	mg/l	0.01
15	Lead (as Pb), Max.	mg/l	0.1
16	Cadmium (as Cd), Max.	mg/l	2.0
17	Hexavalent Chromium (as Cr^{+6}), Max.	mg/l	0.1
18	Total Chromium (as Cr) Max.	mg/l	2.0
19	Copper (as Cu), Max.	mg/l	3.0
20	Zinc (as Zn), Max.	mg/l	5.0
21	Selenium (as Se), Max.	mg/l	0.05
22	Nickel (as Ni), Max.	mg/l	3.0
23	Cyanide (as CN), Max.	mg/l	0.2
24	Fluorides (as F), Max.	mg/l	2.0
25	Dissolved phosphates (as P), Max.	mg/l	5.0
26	Sulphides (as S), Max.	mg/l	2.0

S.No.	Parameter	Unit	Standards
27	Phenolic compounds (as C_6H_5OH), Max.	mg/l	1.0
28	Radioactive Materials α Emitters, µcurie/ml, Max. β Emitters, µcurie/ml, Max.	mg/l	 10^{-7} 10^{-6}
29	Bio-assay test	mg/l	90% survival of fish after 96 hours in 100% effluent
30	Manganese (as Mn)	mg/l	2.0
31	Iron (as Fe)	mg/l	3.0
32	Vanadium (as V)	mg/l	0.2
33	Nitrate Nitrogen	mg/l	10.0

Annexure 1.4

TOLERANCE LIMITS FOR INLAND SURFACE WATER QUALITY

Characteristic	Designated Use Class of Inland Waters				
	A	B	C	D	E
pH value	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.0 to 8.5
Dissolved Oxygen, mg/l, Min.	6	5	4	4	-
Biochemical Oxygen Demand (5 days at 20^0C), mg/l	2	3	3	-	-
Total coliform organisms, MPN/100 ml. Max.	50	500	5000	-	-
Colour Hazen units	10	300	300	-	-
Chlorides (as Cl), mg/l Max.	250	-	600	-	600
Sodium Adsorption ratio Max.	-	-	-	-	26
Boron (as B), mg/l. Max.	-	-	-	-	2
Sulphates (as SO_4), mg/ l	400	-	400	-	1000
Nitrates (as NO), mg/l Max.	20	-	50	-	-
Free Ammonia (as NH_3), mg/l	-	-	-	1.2	-
Conductivity at 25° C microhm / cm Max.	-	-	-	1000	2250
Arsenic (as As), mg/l. Max.	0.05	0.2	0.2	-	-
Iron (as Fe), mg/l	0.3	-	50	-	-
Fluorides (as F), mg/l	1.5	1.5	1.5	-	-
Lead (as Pb), mg/l. Max.	0.1	-	0.1	-	-
Copper (as Cu), mg/l	1.5	-	1.5	-	-
Zinc (as Zn) mg/l/ Max.	1.5	-	1.5	-	-
Manganese (as Mn), mg/l	0.5	-	-	-	-
Total Dissolved Solids, mg/l	500	-	1500	-	2100
Total Hardness ($CaCO_3$), mg/l	300	-	-	-	-
Magnesium (as Mg), mg/l	100	-	-	-	-
Chlorides (as Cl), mg/l	250	600	-	-	600
Cyanides (as CN), mg/l	0.05	0.05	0.05	-	-

A: Drinking Water Source without conventional treatment but after disinfections;
B: Outdoor bathing organized;
C: drinking water source with conventional treatment followed by disinfections;
D: propagation of wildlife and fisheries;
E: irrigation, industrial cooling, controlled waste disposal.
Source: Central Pollution Control Board

Annexure 1.5

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), μm^3	Annual 24 Hours**	50 80	20 80
Nitrogen Dioxide as NO_2, μm^3	Annual 24 Hours**	40 80	30 80
Particulate Matter (size less than 10μm) or PM_{10} μm^3	Annual 24 Hours**	60 100	60 100
Particulate Matter (size less than 2.5μm) or PM2.5 μm^3	Annual * 24 Hours**	40 60	40 60
Ozone (O3) μm^3	8 hours** 24 Hours**	100 180	100 180
Lead (Pb) μm^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) μm^3	Annual * 24 Hours**	100 400	100 400
Benzene (C_6H_6) μm^3	Annual *	05	05
Benzo (a) pyrene (BaP)particulate phase only nm^3	Annual *	01	01
Arsenic (AS) μnm^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 1.6

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 and Courts. Use of vehicle horn, loudspeaker and bursting of crackers is banned in these zones.*

Annexure 2.1 -2.2

ANNEXURE 2.1

STATION DETAILS

S.No.	Station Name	Station Type
Mukundpur to Yamuna Vihar		
1)	Mukundpur	At Grade
2)	Azadpur	Underground
3)	Shalimar Bagh	Elevated
4)	Netaji Subash Place	Elevated
5)	Shakurpur	Elevated
6)	Punjabi Bagh West	Elevated
7)	ESI Hospital	Elevated
8)	Rajouri Garden	Elevated
9)	Maya Puri	Elevated
10)	Naraina 2	Elevated
11)	Naraina 1	Elevated
12)	Delhi Cantonment	Elevated
13)	Dhaula Kuan	Elevated
14)	Moti Bagh	Elevated
15)	Bhikaji Cama Place	Underground
16)	Sarojini Nagar	Underground
17)	INA	Underground
18)	South extension	Underground
19)	Lajpath Nagar	Underground
20)	Srinivaspuri	Underground
21)	Ashram	Underground
22)	Hazrat Nizamuddin	Underground
23)	Mayur Vihar	Elevated
24)	Mayur Vihar Pocket 1	Elevated
25)	Trilokpuri	Elevated
26)	Vinod Nagar	Elevated
27)	IP Extension	Elevated
28)	Anand Vihar	Elevated
29)	Jagatpuri	Elevated
30)	Arjun Nagar	Elevated
31)	Bhola Nath Nagar	Elevated
32)	Welcome	Elevated
33)	Jaffrabad	Elevated
34)	Maujpur	Elevated

S.No.	Station Name	Station Type
35)	Yamuna Vihar	Elevated
Janakpuri to Kalindi Kunj		
1)	Janakpuri west	Elevated
2)	Janakpuri C2B	Elevated
3)	Dabri Mor	Elevated
4)	Dhasrathpuri	Elevated
5)	Palam	Underground
6)	I G D Airport	Underground
7)	Vastant Vihar	Underground
8)	Munirka	Underground
9)	R.K. Puram	Underground
10)	IIT	Underground
11)	Hauz Khas	Underground
12)	Panchsheel Park	Underground
13)	Chirag Delhi	Underground
14)	G.K. Enclave – I	Underground
15)	Nehru Place	Underground
16)	Kalkaji	Underground
17)	Okhla Phase III	Elevated
18)	Ishwar Nagar	Elevated
19)	Jamia Nagar	Elevated
20)	Okhla Vihar	Elevated
21)	Jasola Vihar	Elevated
22)	Kalindi Kunj	Elevated
Central Secretariat – Kashmire Gate		
1)	Janpath	Underground
2)	Mandi House	Underground
3)	ITO	Underground
4)	Delhi Gate	Underground
5)	Jama Masijid	Underground
6)	Lal Quila	Underground
7)	Kashmire Gate	Underground
Jahangirpuri – Badli		
1)	Shalimar Place	Elevated
2)	Rohini sector 18	Elevated
3)	Badli	Elevated

ANNEXURE 2.2

TELECOMMUNICATION SYSTEM

S.No.	System	Standards
1	Transmission Media	Optical Fibre System as the main bearer for bulk of the telecommunication network
2	Telephone exchange	EPABX of minimum 48 ports equipped is to be provided at each station
3	Train Radio System	Digital Train radio (TETRA) communication between motorman of moving cars, stations, maintenance personnel and central control.
4	Train Destination indicator system	LED/LCD based boards with adequately visibility to be provided bilingual visual indication of the status of the running trains, and also special message in emergencies .
5	Centralise clock system	Accurate display of time trough a synchronisation system of slave clocks driven from a master clock at the OCC and sub-master clock in station. This shall also be used for synchronisation other systems.
6	Passenger Announcement system	Passenger Announcement system covering all platform and concourse areas with local as well as central announcement.
7	Redundancy (Major System)	Redundancy on Radios' in the Base Stations. Path redundancy for optical fibre cable by provisioning in ring configuration.
8	Environmental conditions	All equipment rooms to be air conditioned
9	Maintenance Philosophy	System to have, as far as possible, automatic switching facility to alternate routes/circuits in the event of failure Philosphy of preventive checks for maintenance to be followed. System networked with NMS for diagnosing faults and co-ordination. Card/module level replacement shall be done in the field and repairs undertaken in the central laboratory/manufacture's premise

Annexure 3.1 -3.7

ANNEXURE 3.1

WATER QUALITY STATUS OF RIVER YAMUNA

S.No.	Locations	pH	COD (mg/l)	BOD (mg/l)	DO (mg/l)
	Water Quality Criteria (C Class)	6.0-9.0	-	3 (max)	4 (min)
1	River Yamuna at Palla	7.8	20	2.8	9.0
2	Surghat (Down stream of Wazirabad Barrage)	8.3	48	9.5	7.0
3	River Yamuna at Khajori Paltoon Pool (Downstream Najafgarh Drain)	7.6	176	50	Nil
4	River Yamuna at Kudesia Ghat	7.5	84	28	Nil
5	River Yamuna at ITO Bridge	7.5	124	37	Nil
6	River Yamuna at Nizamudin Bridge	7.0	140	34	Nil
7	Agra Canal (Okhla)	7.4	76	13	Nil
8	River Yamuna after meeting Shahdara Drain (Downstream Okhla Barrage)	7.6	112	38	Nil
9	Agra Canal (Jaitpur)	7.5	80	20	Nil

Source http:Delhi pollution control committee

ANNEXURE 3.2

GROUND WATER QUALITY AT VARIOUS PLACES IN DELHI

S.No.	Location/Parameter	pH	TDS	Cl	Hardness as $Caco_3$	Ca as Ca	So_4	Turbidity (NTU)	Nitrate	F	Zn	Fe	Pb	Cu	Cr	Ni	Cd
Desirable Limit for Drinking Water		*6.5-8.5*	*500*	*250*	*300*	*75*	*200*	*5.0*	*45*	*1.0*	*5.0*	*0.3*	*0.05*	*0.05*	*0.05*		*0.01*
1.	Paschim Vihar	7.8	930	140	680	37	43	1	0.7	2.3	1.2	0.5	ND	ND	ND	ND	ND
2.	Meera Bagh	7.7	2580	995	1370	128	52	1	0.6	2.4	1.8	2.2	ND	ND	ND	ND	ND
3.	Mangolpuri	7.5	3620	1525	1630	360	60	ND	0.6	1.9	2.3	2.0	ND	ND	ND	ND	ND
4.	Rohini	7.8	1420	165	780	133	56	ND	0.8	0.7	1.5	1.8	ND	ND	ND	ND	ND
5.	Shalimar Bagh	7.9	940	120	550	125	52	ND	0.6	1.7	1.9	0.7	ND	ND	ND	ND	ND
6.	Adash Nagar	8.4	730	105	450	133	43	3	0.4	0.9	1.3	1.0	ND	ND	ND	ND	ND
7.	Perhladpur	8.2	2680	810	1230	205	53	ND	1.8	0.7	2.0	0.9	ND	ND	ND	ND	ND
8.	Moti Bagh – I	8.1	590	100	330	64	36	1	0.07	1.2	1.1	0.8	ND	ND	ND	ND	ND
9.	R. K. Puram	8.6	660	110	270	48	35	ND	0.15	1.4	1.7	2.0	ND	ND	ND	ND	ND
10.	Nauroji Nagar	8.0	580	85	270	62	45	1	0.22	1.3	1.5	1.9	ND	ND	ND	ND	ND
11.	Kondli	8.2	700	105	440	83	37	ND	0.9	1.7	0.8	1.3	ND	ND	ND	ND	ND
12.	Mandawali	8.1	990	125	600	149	37	1	1.4	2.1	2.0	0.8	ND	ND	ND	ND	ND
13.	Shanti Vihar	7.4	370	75	210	46	56	ND	0.2	1.8	0.9	0.5	ND	ND	ND	ND	ND
14.	Nand Nagri	8.3	850	140	230	43	20	ND	0.3	1.5	0.5	0.4	ND	ND	ND	ND	ND
15.	Yamuna Vihar	8.0	960	960	550	56	57	1	0.2	1.4	1.6	0.7	ND	ND	ND	ND	ND
16.	Karawal Nagar	7.6	1180	305	750	136	49	1	1.4	1.2	1.9	0.7	ND	ND	ND	ND	ND
17.	Dariya Gunj	8.0	640	95	400	67	45	2	0.3	0.9	1.0	0.4	ND	ND	ND	ND	ND
18.	Vasant Kunj	8.3	520	60	360	37	32	ND	0.4	0.8	1.1	0.2	ND	ND	ND	ND	ND
19.	Meharauli	8.4	610	85	450	41	8.2	ND	0.6	0.8	0.7	0.3	ND	ND	ND	ND	ND
20.	Dwarka	8.4	790	300	370	70	32	ND	0.6	2.6	1.2	0.6	ND	ND	ND	ND	ND
21.	Tilak Nagar	8.2	1390	220	640	93	24	2	0.9	1.0	1.5	0.7	ND	ND	ND	ND	ND
22.	Wazipur	8.0	2640	305	1600	336	42	2	0.3	2.8	1.3	0.9	ND	ND	ND	ND	ND
23.	Lawrence Road	8.6	670	205	260	45	36	ND	0.04	3.0	1.9	0.8	ND	ND	ND	ND	ND
24.	Badli	8.2	870	120	670	82	57	ND	1.5	1.6	1.5	0.5	ND	ND	ND	ND	ND
25.	Rajpura Road	8.4	930	180	590	69	50	ND	0.08	1.0	1.7	1.3	ND	ND	ND	ND	ND
26.	Inderpuri	8.3	620	160	250	57	27	3	0.2	1.6	0.8	0.4	ND	ND	ND	ND	ND
27.	Moti Nagar	8.4	620	110	420	51	44	1	1.0	0.7	1.0	0.5	ND	ND	ND	ND	ND
28.	Rana Pratap Bagh	7.9	1930	280	910	182	61	ND	0.06	1.1	1.4	0.7	ND	ND	ND	ND	ND
29.	Paharganj	8.3	420	190	144	59	42	ND	0.5	1.0	1.1	0.6	ND	ND	ND	ND	ND
30.	Karol Bagh	8.4	830	125	520	112	39	1	0.02	1.4	0.8	0.4	ND	ND	ND	ND	ND
31.	Patel Nagar	8.5	860	200	400	96	31	ND	0.5	2.2	1.0	0.7	ND	ND	ND	ND	ND
32.	Janak Puri	8.4	1920	535	890	185	35	1	0.07	1.6	1.9	0.6	ND	ND	ND	ND	ND

Source: Delhi Pollution Control Committee

ANNEXURE 3.3

WIND DIRECTION AND WIND SPEED

	WIND DIRECTION AND WIND SPEED AT 8:30 (2005)																								
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC		
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Speed km/hr
1	C	0	W	8	NW	2	WNW	6	ESE	7	NW	10	S	10	ESE	12	W	10	W	4	C	0	W	2	
2	C	0	W	6	WNW	4	W	10	E	8	WNW	6	SE	12	SE	12	C	0	W	8	C	0	NW	2	
3	SW	4	W	4	NW	4	W	8	E	6	WNW	14	SE	8	E	6	C	0	W	12	S	4	W	4	
4	WSW	6	C	0	S	6	WSW	4	W	4	W	8	C	0	C	0	ESE	4	W	12	C	0	W	8	
5	WNW	6	C	0	E	6	C	0	NW	16	WSW	8	SE	8	C	0	S	6	W	8	C	0	W	12	
6	W	4	E	4	C	0	SE	14	C	0	E	4	E	12	NNW	8	SE	6	NW	6	C	0	C	0	
7	NW	6	E	10	C	0	ESE	10	C	0	C	0	E	14	WNW	14	SE	12	W	10	W	2	C	0	
8	W	10	E	6	C	0	NNE	8	N	6	W	6	SE	2	WNW	12	SE	6	W	8	C	0	C	0	
9	C	0	ESE	8	NNE	12	C	0	NNW	4	W	8	C	0	W	12	C	0	W	8	W	4	W	6	
10	W	2	NW	2	N	10	W	20	WNW	8	W	8	NNE	2	WNW	18	NNW	4	W	6	W	8	W	6	
11	W	2	C	0	NW	8	NW	10	W	4	C	0	SE	12	WNW	24	C	0	C	0	W	10	C	0	
12	WNW	10	C	0	C	0	NW	8	WNW	12	NW	10	C	0	NW	14	SE	10	C	0	C	0	C	0	
13	SW	6	NW	6	W	2	NW	12	W	12	NNW	8	C	0	W	16	C	0	C	0	W	4	W	2	
14	WSW	4	NW	8	W	4	W	2	E	8	W	22	SE	6	WNW	14	E	16	C	0	WNW	12	W	10	
15	NW	4	S	6	WSW	4	C	0	C	0	W	8	SE	10	WNW	12	E	8	C	0	W	10	C	0	
16	NW	2	C	0	C	0	NNW	4	WSW	10	WSW	10	E	8	ESE	6	NE	26	C	0	W	12	C	0	
17	C	0	ESE	6	S	8	NW	6	C	0	W	14	C	0	C	0	N	8	C	0	W	12	C	0	
18	NW	2	SE	8	WNW	6	WSW	10	NNE	14	W	8	C	0	NW	2	C	0	C	0	W	12	C	0	
19	W	4	W	6	C	0	WNW	6	S	6	W	4	W	6	WNW	14	C	0	C	0	C	0	C	0	
20	WNW	6	NNW	4	ESE	4	C	0	E	4	C	0	WSW	12	SW	10	C	0	C	0	C	0	C	0	
21	SW	4	NW	12	ENE	22	C	0	E	8	C	0	W	14	W	8	E	2	C	0	W	4	C	0	
22	SE	6	NW	10	S	8	W	6	C	0	C	0	C	0	W	18	SE	16	W	2	C	0	C	0	
23	C	0	NW	4	W	2	C	0	NE	12	SE	12	C	0	W	18	E	8	W	16	C	0	C	0	
24	SW	2	W	6	C	0	N	4	N	4	SW	6	C	0	W	24	C	0	C	8	C	0	WNW	8	
25	WNW	2	NNW	10	NW	6	E	4	WNW	2	E	12	SE	4	WSW	12	NW	10	C	0	C	0	WNW	4	
26	W	4	W	10	W	10	NE	10	C	0	C	0	NNE	4	W	14	WNW	16	C	10	C	0	WSW	4	
27	C	0	WNW	12	SW	2	WNW	5	NE	8	C	0	SE	10	W	10	W	10	C	16	C	0	C	0	
28	E	2	NW	4	NNW	2	E	4	NW	6	C	0	ESE	16	NW	10	WNW	18	C	10	C	0	C	0	
29	C	0			W	6	W	6	W	12	S	12	ESE	8	WNW	6	W	6	W	18	C	0	C	0	
30	C	0			WNW	10	NW	6	NW	4	SE	6	C	0	C	0	W	8	W	6	C	0	C	0	
31	NW	2			NW	10			NNW	14			C	0	W	8			C	8			C	0	

ANNEXURE 3.3 Contd..

	WIND DIRECTION AND WIND SPEED AT17:30 (2005)																							
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC	
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr
1	ESE	2	NW	10	N	10	WNW	16	WNW	16	ESE	10	NE	6	ESE	12	NNW	6	NW	4	C	0	C	0
2	W	2	NW	10	NNW	4	NNW	14	NNW	14	E	12	SE	8	E	8	N	8	NNW	6	SE	8	C	0
3	NW	6	NW	2	N	4	NNW	16	NNW	16	NNE	6	SE	8	ESE	8	NNW	8	NNW	6	E	8	WNW	2
4	WNW	8	ESE	6	NE	8	NW	18	NW	18	SE	4	ENE	12	E	4	ESE	6	C	0	C	0	NW	10
5	C	0	NE	4	S	10	N	6	N	6	NW	16	E	4	C	0	E	6	NNW	4	C	0	W	4
6	NW	6	NE	4	NNE	8	NNE	8	NNE	8	NW	12	E	12	WNW	8	ESE	10	NW	2	NW	4	C	0
7	NW	14	SE	10	ESE	10	NNE	18	NNE	18	NNE	10	SE	4	C	0	ESE	12	NW	4	C	0	C	0
8	NW	8	SE	12	SE	8	S	6	S	6	NNW	6	NW	4	C	0	E	2	C	0	C	0	C	0
9	NW	2	SE	8	NE	10	W	12	W	12	NW	18	NNE	6	NNW	8	N	14	C	0	C	0	C	0
10	NW	4	NE	12	NW	14	NW	22	NW	22	NW	28	E	10	NW	12	C	0	NW	4	C	0	C	0
11	NNW	6	SE	8	NW	14	NW	16	NW	16	NW	12	E	8	NW	6	NE	8	C	0	C	0	C	0
12	NW	4	W	6	NW	8	NW	22	NW	22	NW	16	C	0	NW	10	NNW	2	C	0	C	0	C	0
13	NW	8	NW	18	NNW	8	WNW	16	WNW	16	SE	6	S	4	NW	4	C	0	C	0	NW	12	C	0
14	NW	12	NW	10	NNW	8	C	0	C	0	NE	4	C	0	NNW	10	ESE	22	C	0	NW	6	C	0
15	NNW	4	SE	16	NNW	10	NNE	4	NNE	4	WNW	16	E	20	E	8	NNE	4	C	0	NW	10	C	0
16	C	0	NNW	4	NW	6	NW	20	NW	20	NW	12	C	0	C	0	NE	26	E	4	NW	4	C	0
17	NNE	12	NE	18	NE	4	NW	10	NW	10	E	8	C	0	C	0	N	10	C	0	NW	0	NW	6
18	NW	12	SE	16	ESE	2	NW	20	NW	20	NE	4	C	0	NNW	2	C	0	C	0	C	0	C	0
19	NW	1	WNW	10	WNW	14	C	0	C	0	NW	4	NW	12	NW	9	NNW	2	C	0	C	0	C	0
20	NW	12	NW	18	NNE	6	N	2	N	2	NNW	4	WNW	4	NW	8	W	4	ESE	4	C	0	C	0
21	S	6	NNW	12	ESE	14	NW	12	NW	12	NW	10	W	6	NNW	4	SE	12	C	0	C	0	C	0
22	E	8	NNW	12	NW	12	C	0	C	0	NE	6	NW	4	NNW	8	ESE	8	NW	6	C	0	C	0
23	NW	8	NNW	8	NW	10	W	12	W	12	NNE	12	NNE	4	NNW	4	ESE	4	NNW	4	C	0	NW	8
24	WNW	6	WNW	14	NW	12	C	0	C	0	NNW	12	C	0	WNW	10	NE	10	C	0	C	0	WNW	8
25	NW	6	NW	18	NW	16	NW	6	NW	6	NW	12	SE	6	NNW	4	NNW	10	C	0	C	0	NW	4
26	NW	6	NNW	20	NW	12	NW	12	NW	12	NE	2	E	8	W	8	C	0	C	0	C	0	NW	14
27	SE	8	NNW	18	NE	10	NNE	8	NNE	8	NNE	6	ESE	12	W	10	WNW	4	C	0	C	0	C	0
28	NW	12	N	12	NNW	16	NW	4	NW	4	NW	24	ESE	12	NW	8	WNW	10	N	4	C	0	C	0
29	NNW	4			N	10	WNW	14	WNW	14	C	0	ENE	6	NNW	12	NW	8	C	0	C	0	C	0
30	NNW	6			NNW	16	SE	12	SE	12	NNW	6	W	12	NNW	10	NW	8	C	0	NW	4	C	0
31	NW	6			N	18					NW	16	S	4	NW	12	NW	12	NE	4			C	0

ANNEXURE 3.3 Contd..

	WIND DIRECTION AND WIND SPEED AT 8:30 (2006)																							
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC	
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr
1	C	0	C	0	W	12	C	0	WNW	4	NNE	4	C	0	ESE	22	E	12	C	0	C	0	WNW	6
2	SE	14	WNW	8	C	0	C	0	C	0	S	2	ESE	4	S	6	C	0	C	0	C	0	WNW	6
3	NW	4	W	10	C	0	C	0	WNW	8	C	0	ESE	12	C	0	C	0	C	0	C	0	WSW	2
4	NW	12	W	6	C	0	WNW	12	C	0	ESE	4	SE	10	ESE	12	NW	2	C	0	C	0	C	0
5	WNW	12	W	12	C	0	NW	8	C	0	SW	4	ESE	14	ESE	18	E	2	C	0	WSW	4	C	0
6	WNW	10	C	0	C	0	WNW	10	C	0	W	12	SE	14	ESE	16	SE	8	W	12	C	0	C	0
7	WNW	4	C	0	C	0	WNW	8	C	0	NW	8	W	12	ESE	10	SE	10	W	8	C	0	WNW	4
8	WNW	6	C	0	C	0	C	0	SE	8	W	12	W	28	ESE	8	WSW	10	WNW	14	C	0	NW	4
9	WNW	6	C	0	NNW	10	S	4	SE	4	NW	4	W	18	E	12	WNW	12	W	8	C	0	C	0
10	WNW	4	C	0	C	0	C	0	SE	6	WNW	14	C	0	ESE	12	WNW	14	W	4	C	0	C	0
11	WSW	8	C	0	SE	4	C	0	S	12	W	12	SE	2	ESE	8	W	10	WNW	10	C	0	C	0
12	C	0	C	0	C	0	NW	8	ESE	10	W	14	NW	6	SE	8	WNW	12	W	6	C	0	WNW	8
13	WSW	10	C	0	WSW	10	NNW	4	E	4	WNW	16	C	0	SE	4	WNW	8	C	0	C	0	W	12
14	WNW	14	C	0	SW	22	N	4	SE	12	W	6	WNW	6	C	0	W	6	C	0	C	0	W	6
15	C	0	W	12	C	0	C	0	C	0	WSW	10	C	0	E	8	C	0	W	2	C	0	NW	10
16	ESE	6	C	0	C	0	C	0	SE	12	C	0	C	0	SE	4	C	0	WSW	4	C	0	C	0
17	ESE	2	W	10	NW	14	W	4	ENE	12	C	0	E	4	ESE	2	C	0	C	0	C	0	NW	4
18	C	0	W	12	WNW	12	ESE	14	WSW	2	C	0	ESE	14	SE	16	ESE	2	C	0	C	0	NW	4
19	W	1	WNW	10	WSW	10	ESE	8	WNW	18	NE	8	NNE	2	E	12	C	0	ESE	10	WNW	4	C	0
20	C	0	WSW	6	C	0	SE	10	S	2	SE	6	C	0	SE	8	SE	6	C	0	W	6	C	0
21	W	14	C	0	W	20	SW	4	C	0	E	8	ESE	4	SE	6	SE	8	C	0	C	0	C	0
22	WSW	10	WSW	8	NNW	14	W	6	SE	10	C	0	SE	12	WNW	6	C	0	ESE	4	NE	6	C	0
23	C	0	W	16	W	6	C	0	C	0	SE	8	SE	14	C	0	NW	4	C	0	NW	4	W	6
24	W	10	W	10	C	0	C	0	C	0	SE	4	E	4	W	12	NW	4	C	0	W	6	C	0
25	W	10	WSW	6	W	10	C	0	SW	10	ESE	4	C	0	WNW	14	W	4	C	0	W	4	C	0
26	C	0	C	0	C	0	WNW	8	ESE	8	SE	4	C	0	W	22	WSW	8	C	0	WNW	4	C	0
27	W	10	WNW	6	W	4	WNW	10	SE	10	N	10	SW	4	W	18	WSW	4	C	0	WSW	6	W	10
28	W	4	WSW	6	W	8	ESE	4	SE	12	C	0	SE	4	W	10	WNW	4	C	0	C	0	WSW	6
29	C	0			NNW	8	S	8	ESE	6	ESE	10	ESE	8	W	12	C	0	C	0	C	0	WSW	2
30	WSW	8			W	8	N	16	SE	6	E	4	ESE	6	E	6	C	0	C	0	W	2	C	0
31	C	0			WSW	4			SE	4			E	10	E	10			C	0			C	0

ANNEXURE 3.3 Contd..

	WIND DIRECTION AND WIND SPEED AT 17:30 (2006)																							
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC	
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr
1	C	0	NNW	10	NW	18	NNE	4	E	6	NNW	12	SE	14	ESE	12	NNW	6	NW	4	C	0	C	0
2	C	0	NW	12	NNE	14	WNW	12	C	0	NW	12	SE	14	ESE	8	N	8	NNW	6	SE	8	C	0
3	NNW	12	NW	22	NNW	6	NW	10	C	0	S	8	ESE	12	ESE	8	NNW	8	NNW	6	E	8	WNW	2
4	NW	10	NW	22	N	6	NW	14	ESE	12	NW	8	C	0	ESE	4	ESE	6	C	0	C	0	NW	10
5	NW	12	NW	12	N	2	NW	22	ENE	4	WNW	16	E	4	C	0	E	6	NNW	4	C	0	W	4
6	NW	14	NW	6	ESE	12	NNW	12	NNE	20	N	20	C	0	WNW	8	ESE	10	NW	2	NW	4	C	0
7	NW	10	SE	4	NE	4	WNW	12	C	0	WNW	16	C	0	C	0	ESE	12	NW	4	C	0	C	0
8	NW	4	SE	8	ESE	18	NNW	4	ESE	8	NW	12	SE	14	C	0	E	2	C	0	C	0	C	0
9	NW	6	WNW	2	S	8	NNE	18	SE	8	NW	8	ESE	12	NNW	8	N	14	C	0	C	0	C	0
10	NW	4	WNW	16	ESE	6	NW	8	E	2	NNW	8	ESE	10	NW	12	C	0	NW	4	C	0	C	0
11	NW	4	NW	2	C	0	NW	4	NE	2	ESE	10	SE	8	NW	6	NE	8	C	0	C	0	C	0
12	NW	6	C	0	W	16	NNW	8	ESE	8	SE	6	WNW	6	NW	10	NNW	2	C	0	C	0	C	0
13	NW	1	NW	4	W	8	NNW	10	E	6	SE	4	C	0	NW	4	C	0	C	0	NW	12	C	0
14	NW	16	C	0	ESE	18	NW	8	C	0	ESE	10	NW	6	NNW	10	ESE	22	C	0	NW	6	C	0
15	ESE	8	WNW	6	NNW	8	NNW	4	NNW	10	C	0	E	4	E	8	NNE	4	C	0	NW	10	C	0
16	SE	12	NW	10	C	0	NNE	8	ESE	4	NE	2	NNW	4	C	0	NE	26	E	4	NW	4	C	0
17	SE	4	NW	20	NW	14	NW	4	C	0	C	0	NW	12	C	0	N	10	C	0	NW	4	NW	6
18	NW	6	WNW	16	NW	16	NE	6	C	0	C	0	NW	14	NNW	2	C	0	C	0	C	0	C	0
19	NW	8	NW	14	NW	12	SE	12	NNE	2	C	0	NW	20	NW	9	NNW	2	C	0	C	0	C	0
20	NW	8	NNW	10	ESE	12	E	4	N	10	NNE	4	W	10	NW	8	W	4	ESE	4	C	0	C	0
21	NW	20	NW	12	NW	22	NW	4	W	6	E	6	S	8	NNW	4	SE	12	C	0	C	0	C	0
22	NW	14	NW	8	NW	22	NW	12	N	10	ESE	10	E	1	NNW	8	ESE	8	NW	6	C	0	C	0
23	NW	20	NNW	12	NW	10	NNE	8	N	4	SE	10	C	0	NNW	4	ESE	4	NNW	4	C	0	NW	8
24	NW	24	NNW	12	SE	16	N	2	C	0	ESE	8	NNW	8	WNW	10	NE	1	C	0	C	0	WNW	8
25	NW	10	W	14	NNW	6	NNW	8	C	0	E	2	C	0	NNW	4	NNW	10	C	0	C	0	NW	4
26	NW	12	NNE	16	NW	10	WNW	8	NW	18	NW	10	NW	16	W	8	C	0	C	0	C	0	NW	14
27	WNW	14	NW	18	WNW	12	WNW	12	NNE	16	NW	10	WNW	12	W	10	WNW	4	C	0	C	0	C	0
28	WNW	2	NW	12	NW	12	C	0	ESE	8	NNE	8	NNE	6	NW	8	WNW	10	N	4	C	0	C	0
29	WNW	10			NW	8	N	2	C	0	ESE	10	C	0	NNW	12	NW	8	C	0	C	0	C	0
30	WNW	6			NNW	8	NW	10	W	8	SE	8	SE	4	NNW	10	NW	8	C	0	NW	4	C	0
31	NE	4			NNW	8			N	8			NW	8	NW	12			NE	4			C	0

ANNEXURE 3.3 Contd..

	WIND DIRECTION AND WIND SPEED AT 8:30 (2007)																							
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC	
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr
1	C	0	C	0	W	12	C	0	WNW	4	NNE	4	C	0	ESE	22	E	12	C	0	C	0	WNW	6
2	SE	14	WNW	8	C	0	C	0	C	0	S	2	ESE	4	S	6	C	0	C	0	C	0	WNW	6
3	NW	4	W	10	C	0	C	0	WNW	8	C	0	ESE	12	C	0	C	0	C	0	C	0	WSW	2
4	NW	12	W	6	C	0	WNW	12	C	0	ESE	4	SE	10	ESE	12	NW	2	C	0	C	0	C	0
5	WNW	12	W	12	C	0	NW	8	C	0	SW	4	ESE	14	ESE	18	E	2	C	0	C	0	C	0
6	WNW	10	C	0	C	0	W	10	C	0	W	12	SE	14	ESE	16	SEP	8	W	12	C	0	C	0
7	WNW	4	C	0	C	0	WNW	8	C	0	NW	8	W	12	ESE	10	SEP	10	W	8	C	0	WNW	4
8	WNW	6	C	0	C	0	C	0	SE	8	W	12	W	28	ESE	8	WSW	10	WNW	14	C	0	NW	4
9	W	6	C	0	NNW	10	S	4	SE	4	NW	4	W	18	E	12	WNW	12	W	8	C	0	C	0
10	WNW	4	C	0	C	0	C	0	SE	6	WNW	14	C	0	ESE	12	WNW	14	W	4	C	0	C	0
11	WSW	8	C	0	SE	4	C	0	S	12	W	12	SE	2	ESE	8	W	10	WNW	10	C	0	C	0
12	C	0	C	0	C	0	NW	8	ESE	10	W	14	NW	6	SE	8	WNW	12	W	6	C	0	WNW	8
13	WSW	10	C	0	WSW	10	NNW	4	E	4	WNW	16	C	0	SE	4	WNW	8	C	0	C	0	W	12
14	WNW	14	C	0	SW	22	N	4	SE	12	W	6	WNW	6	C	0	W	6	C	0	C	0	W	6
15	C	0	W	12	C	0	C	0	C	0	WSW	10	C	0	E	8	C	0	W	2	C	0	NW	10
16	ESE	6	C	0	C	0	C	0	SE	12	C	0	C	0	SE	4	C	0	WSW	4	C	0	C	0
17	E	2	W	10	NW	14	W	4	ENE	12	C	0	ESE	4	ESE	2	C	0	C	0	C	0	NW	4
18	C	0	W	12	WNW	12	ESE	14	WSW	2	C	0	ESE	14	SE	16	ESE	2	C	0	C	0	NW	4
19	W	`0	WNW	10	WSW	10	ESE	8	WNW	18	NE	8	NNE	2	E	12	C	0	ESE	10	WNW	4	C	0
20	C	0	WSW	6	C	0	SE	10	S	2	SE	6	C	0	SE	8	SE	6	C	0	WNW	6	C	0
21	W	`4	C	0	W	20	SW	4	C	0	E	8	ESE	4	SE	6	SE	8	C	0	C	0	C	0
22	WSW	10	WSW	8	NNW	14	W	6	SE	10	C	0	SE	12	WNW	6	C	0	ESE	4	NE	6	C	0
23	C	0	W	16	W	6	C	0	C	0	SE	8	SE	14	C	0	NW	4	C	0	NW	4	W	6
24	W	10	W	10	C	0	C	0	C	0	SE	4	E	4	W	12	NW	4	C	0	W	6	C	0
25	W	10	WSW	6	W	10	C	0	SW	10	ESE	4	C	0	WNW	14	W	4	C	0	W	4	C	0
26	C	0	C	0	C	0	WNW	8	ESE	8	SE	4	C	0	W	22	WSW	8	C	0	WNW	4	C	0
27	W	10	WNW	6	W	4	WNW	10	SE	10	N	10	SW	4	W	18	WSW	4	C	0	WSW	6	W	10
28	W	4	WSW	6	W	8	ESE	4	SE	12	C	0	SE	4	W	10	WNW	4	C	0	C	0	WSW	6
29	C	0			NNW	8	S	8	ESE	6	ESE	10	ESE	8	W	12	C	0	C	0	C	0	WSW	2
30	WSW	8			W	8	N	16	SE	6	E	4	ESE	6	E	6	C	0	C	0	W	2	C	0
31	C	0			WSW	4			SE	4			E	10	E	10			C	0			C	0

ANNEXURE 3.3 Contd..

	WIND DIRECTION AND WIND SPEED AT 17:30 (2007)																							
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC	
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr
1	C	0	NNW	10	NW	18	NNE	4	NW	8	C	0	N	4	SE	10	SE	14	C	0	C	0	NW	10
2	C	0	NW	12	NNE	14	WNW	12	NNE	10	C	0	E	6	SE	6	E	6	NE	4	C	0	NW	4
3	NNW	12	WNW	22	NNW	6	NW	10	NNW	12	ESE	6	E	10	C	0	NW	2	C	0	C	0	C	0
4	NW	10	NW	22	N	6	NW	14	NW	15	S	8	SE	8	ESE	12	C	0	NNW	4	C	0	C	0
5	NW	12	NW	12	N	2	NW	22	NNW	6	WNW	6	E	14	ESE	14	E	4	NW	10	C	0	E	4
6	NW	14	NW	6	ESE	12	NNW	12	NNW	13	NNW	12	ESE	8	ESE	6	C	0	NW	4	C	0	NW	4
7	NW	10	SE	4	NE	4	WNW	12	NW	8	NW	12	NW	8	ESE	12	NNE	8	NW	8	C	0	C	0
8	NW	4	SE	8	ESE	18	NNW	4	ESE	4	NW	14	NNE	8	ESE	10	W	8	NW	4	C	0	NW	6
9	NW	6	WNW	2	S	8	NNE	18	E	4	NNW	14	ESE	4	SE	10	NW	4	NW	10	C	0	C	0
10	NW	4	WNW	16	ESE	6	NW	8	C	0	NW	12	C	0	E	10	NW	8	NW	8	C	0	C	0
11	NW	4	NW	2	C	0	NW	4	C	0	WNW	4	NW	2	ESE	8	C	0	NW	8	C	0	WNW	8
12	NW	6	C	0	W	16	NNW	8	C	0	NNE	8	NW	6	E	8	NW	4	C	0	C	0	WNW	8
13	NW	10	NW	4	W	8	NNW	10	E	6	NNW	12	ESE	2	NE	20	C	0	C	0	C	0	NW	4
14	NW	16	C	0	E	18	NW	8	C	0	NW	10	NNW	2	C	0	C	0	NW	4	C	0	WNW	4
15	ESE	8	WNW	6	NNW	8	NNW	4	SE	8	WNW	36	NNW	4	NE	10	C	0	NW	4	C	0	NW	4
16	SE	12	NW	10	C	0	NNE	8	SE	12	NW	6	NW	4	SE	16	C	0	C	0	C	0	WNW	4
17	SE	4	NW	20	NW	14	NW	4	ENE	40	NNW	4	ESE	4	ESE	6	C	0	C	0	C	0	NW	6
18	NW	6	WNW	16	NW	16	NE	6	NW	8	NW	10	S	4	E	6	C	0	C	0	NNW	6	C	0
19	NW	8	NW	14	NW	12	SE	12	NNW	2	NE	8	E	4	SE	20	C	0	SE	12	NW	6	ESE	2
20	NW	8	NNW	19	ESE	12	E	4	C	0	S	10	ESE	4	SE	16	C	0	E	2	WNW	4	ESE	4
21	NW	20	NW	12	NW	22	NW	4	NNE	13	ESE	2	E	14	S	4	C	0	C	0	C	0	C	0
22	NW	14	NW	8	NW	22	NW	12	E	2	C	0	ESE	8	C	0	S	8	E	4	C	0	NW	2
23	NW	20	NNW	12	NW	19	NNE	8	NW	4	ESE	2	SE	4	C	0	C	0	C	0	NW	8	C	0
24	NW	24	NNW	12	SE	16	N	2	NNW	2	SE	4	ESE	10	NW	6	NW	4	C	0	NW	4	NNW	4
25	NW	10	WNW	14	NNW	6	NNW	8	C	0	C	0	NNE	4	WNW	10	NW	4	C	0	NW	6	WNW	4
26	NW	12	NNE	16	NW	10	WNW	8	C	0	SE	12	NNE	4	W	12	NW	8	C	0	NW	4	NE	8
27	WNW	14	NW	18	WNW	12	WNW	12	SE	8	C	0	ESE	2	NNE	4	NNW	4	C	0	C	0	WNW	6
28	WNW	2	NW	12	NW	12	C	0	ESE	16	SE	6	ESE	12	C	0	NNW	6	C	0	C	0	WNW	6
29	WNW	10			NW	8	N	2	ESE	10	C	0	SE	8	C	0	NW	8	C	0	NNW	4	WNW	4
30	WNW	6			NNW	8	NW	10	C	0	N	6	E	12	E	14	C	0	C	0	NW	8	C	0
31	NE	4			NNW	8			ENE	4			E	14	ESE	6			C	0			C	0

ANNEXURE 3.3 Contd..

	WIND DIRECTION AND WIND SPEED AT 8:30 (2008)																							
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC	
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr
1	C	0	W	4	C	0	N	10	W	10	WNW	8	S	8	ESE	8	C	0	C	0	SW	6	C	0
2	C	0	C	0	E	4	C	0	NW	12	C	0	NE	6	ESE	8	SW	6	C	0	W	8	C	0
3	C	0	SE	4	ESE	4	W	16	WSW	22	C	0	WNW	4	SE	8	SW	8	C	0	C	0	C	0
4	NW	4	ESE	4	C	0	SE	4	W	14	C	0	SSW	8	E	4	S	4	C	0	C	0	C	0
5	NW	4	NW	8	C	0	C	0	E	22	NE	4	SW	12	SE	6	SSW	6	ESE	4	C	0	C	0
6	C	0	C	0	C	0	N	6	SW	8	ESE	6	S	12	C	0	N	4	ENE	8	C	0	WSW	4
7	C	0	C	0	SE	10	W	10	SE	4	ESE	12	NE	8	W	10	C	0	SE	8	C	0	W	2
8	C	0	NW	4	W	6	W	8	C	0	ESE	4	NE	6	W	14	C	0	C	0	C	0	C	0
9	C	0	WNW	4	C	0	WNW	14	WSW	14	E	12	ESE	8	C	0	NNW	4	C	0	C	0	C	0
10	C	0	WNW	8	WNW	12	WNW	10	W	18	ESE	12	E	8	C	0	C	0	C	0	C	0	C	0
11	NW	4	C	0	WNW	12	W	12	C	0	C	0	E	12	ESE	8	C	0	C	0	C	0	WNW	2
12	NW	6	NW	6	WSW	16	C	0	C	0	ESE	10	NE	6	ESE	18	C	0	C	0	C	0	C	0
13	WNW	4	W	8	W	4	C	0	SW	6	W	10	NW	8	ESE	6	ESE	8	C	0	C	0	C	0
14	NW	6	WNW	4	C	0	C	0	C	0	SW	8	W	12	SE	4	ENE	4	C	0	C	0	NW	4
15	NW	8	C	0	W	14	NNW	4	C	0	SW	4	SW	8	C	0	C	0	NNE	14	C	0	W	8
16	W	8	W	8	W	10	WNW	4	W	14	C	0	W	18	C	0	C	0	NNE	6	C	0	C	0
17	C	0	W	8	C	0	NW	8	W	14	C	0	W	12	NW	4	NE	12	W	4	C	0	C	0
18	S	4	C	0	SSW	12	NNW	10	NE	12	E	10	W	8	W	18	C	0	C	0	C	0	W	4
19	C	0	C	0	E	10	WSW	8	NE	18	SE	8	WNW	10	SW	16	NNE	8	C	0	C	0	NW	12
20	NW	4	C	0	C	0	W	8	NNE	4	SE	10	ENE	8	W	18	WNW	8	W	4	E	10	SE	6
21	NW	4	C	0	WNW	8	W	20	WNW	8	NW	6	W	4	C	0	ENE	8	C	0	W	10	NW	12
22	C	0	SE	4	W	8	SSW	10	ESE	16	W	8	WNW	12	C	0	SW	8	C	0	W	8	NW	8
23	W	4	SE	4	WNW	8	WSW	8	C	0	W	8	SW	12	C	0	C	0	C	0	C	0	W	6
24	C	0	C	0	W	8	WSW	8	C	0	SW	8	W	14	C	0	WSW	8	C	0	W	6	W	4
25	C	0	NW	4	W	10	C	0	SSE	6	C	0	C	0	C	0	W	10	C	0	C	0	C	0
26	C	0	WNW	6	NW	8	C	0	NNE	12	S	4	ESE	10	C	0	SW	14	C	0	C	0	C	0
27	NW	6	W	4	W	20	W	10	WNW	8	NNW	4	SE	12	C	0	SW	14	C	0	C	0	C	0
28	W	8	WNW	2	NW	6	W	6	WNW	2	C	0	SE	8	WNW	22	W	12	C	0	C	0	C	0
29	W	4	C	0	NNW	8	NW	4	NW	6	ESE	10	E	12	WSW	14	W	12	C	0	W	8	C	0
30	C	0			C	0	WNW	4	W	8	C	0	SE	12	WSW	33	C	0	W	4	C	0	WNW	4
31	W	4			SW	8			SW	10			SE	8	SW	2			NW	8			NW	6

ANNEXURE 3.3 Contd..

	WIND DIRECTION AND WIND SPEED AT 17:30 (2008)																							
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC	
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr
1	c	0	WNW	8	NW	4	E	8	NNW	12	C	0	E	8	NE	8	W	10	C	0	NW	6	C	0
2	c	0	SE	4	SE	4	E	8	WNW	22	NE	12	NW	4	SE	8	WNW	14	C	0	C	0	C	0
3	W	2	ESE	10	NW	6	W	16	NW	12	E	6	SE	12	C	0	WNW	8	C	0	C	0	C	0
4	C	0	S	6	NW	4	N	4	NW	10	C	0	W	18	C	0	W	8	C	0	C	0	C	0
5	C	0	NW	8	NW	12	E	18	SE	8	SSW	10	SSW	8	E	4	NE	6	C	0	C	0	C	0
6	C	0	NW	8	ENE	10	WNW	10	W	16	E	4	C	0	C	0	SE	8	SE	6	C	0	C	0
7	NW	4	NW	8	ESE	8	NW	12	SW	4	E	12	NNE	10	WNW	14	E	4	WNW	6	C	0	C	0
8	C	0	NW	16	NW	4	NW	24	SSW	14	C	0	SW	8	C	0	N	2	WNW	4	C	0	C	0
9	C	0	WNW	16	NNW	14	NW	28	WNW	12	E	10	SE	10	NW	8	NW	6	C	0	C	0	C	0
10	NW	2	WNW	14	NW	20	NW	14	WNW	12	ESE	8	E	8	WNW	4	NW	4	NW	4	C	0	C	0
11	NW	16	NW	10	NW	24	NNW	12	N	6	SW	6	ESE	14	SE	12	NE	2	WNW	8	C	0	NW	4
12	NW	12	NW	20	NW	16	NNE	4	NE	6	ENE	2	SW	8	ESE	10	C	0	C	0	C	0	C	0
13	NNW	12	NW	14	SSW	8	W	10	NNE	8	C	0	C	0	NE	8	C	0	WNW	4	C	0	C	0
14	NW	16	NW	4	NNW	12	W	8	S	8	WSW	12	NNW	8	S	8	E	8	C	0	C	0	C	0
15	NW	20	NW	8	WNW	18	S	8	NW	10	E	6	W	12	ENE	4	C	0	ESE	8	C	0	W	8
16	NW	14	NW	18	WNW	18	N	12	W	12	C	0	W	14	NNW	4	C	0	C	0	C	0	NW	10
17	C	0	NW	4	NNW	10	NW	14	NW	4	SSW	14	WSW	8	C	0	ENE	18	WNW	4	C	0	C	0
18	NW	12	NW	8	NW	12	WNW	18	NE	6	E	8	SW	10	W	2	NW	18	C	0	C	0	NW	2
19	NW	4	NNW	4	NE	12	NW	20	S	8	SE	8	WNW	10	WNW	14	NNE	4	C	0	C	0	WSW	8
20	NW	12	WNW	2	NNE	4	NW	20	C	0	SW	8	ESE	8	W	14	W	6	C	0	C	0	NW	10
21	NW	8	SE	8	NW	16	WNW	14	E	4	C	0	NW	4	SW	8	SSE	6	C	0	NW	6	WNW	8
22	C	0	SE	8	N	8	WNW	12	NE	10	NW	12	NW	8	C	0	W	8	C	0	C	0	C	0
23	NNW	8	WNW	4	NW	10	WNW	14	E	4	WNW	8	NW	10	C	0	NW	6	C	0	NW	6	C	0
24	NNW	8	NW	12	N	10	W	14	WNW	10	NW	8	C	0	C	0	NW	12	C	0	C	0	C	0
25	NNW	8	NW	22	NW	8	NW	12	NNE	18	SW	10	E	4	C	0	WNW	16	C	0	C	0	C	0
26	NW	8	NW	22	NW	12	WNW	14	C	0	E	6	SW	12	C	0	WNW	8	C	0	C	0	C	0
27	NW	10	WNW	20	W	14	NW	14	WNW	14	E	12	ESE	4	NNW	4	NW	8	C	0	C	0	C	0
28	NW	8	NW	12	N	10	WNW	12	SSW	6	C	0	E	12	NW	8	W	8	C	0	C	0	C	0
29	WNW	12	NW	6	N	10	N	10	SW	22	ESE	10	ESE	12	W	8	WNW	4	C	0	C	0	NW	4
30	NNW	8			N	8	W	12	W	12	N	8	ESE	10	C	0	C	0	C	0	C	0	C	0
31	WNW	10			N	20			SW	28			E	8	NNW	4			WNW	6			WNW	10

ANNEXURE 3.3 Contd..

	WIND DIRECTION AND WIND SPEED AT 8:30 (2009)																							
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC	
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr
1	W	8	W	14	NNW	14	NW	8	W	4	W	6	ESE	6	W	18	C	0	C	0	C	0	C	0
2	C	0	W	8	NW	6	C	0	W	8	W	4	C	0	WNW	20	C	0	C	0	C	0	C	0
3	C	0	C	0	C	0	WNW	8	SSE	18	W	10	C	0	W	14	ESE	4	ESE	6	C	0	W	8
4	C	0	C	0	C	0	NW	14	N	10	NW	10	C	0	WNW	12	C	0	S	4	C	0	C	0
5	W	2	C	0	WNW	6	NW	8	N	14	WNW	10	C	0	W	20	NE	6	E	4	C	0	C	0
6	C	0	C	0	W	4	C	0	WNW	12	C	0	C	0	W	16	WNW	8	C	0	C	0	C	0
7	C	0	W	4	S	4	C	0	NNW	14	WNW	8	ESE	4	W	24	NNW	4	S	6	C	0	C	0
8	C	0	C	0	C	0	S	18	WNW	8	WNW	4	ESE	12	WNW	10	E	8	C	0	C	0	C	0
9	C	0	C	0	C	0	E	12	NW	4	WNW	4	ESE	20	WNW	10	N	6	C	0	C	0	C	0
10	C	0	C	0	C	0	NW	15	SW	4	W	6	ESE	12	WNW	6	NE	8	C	0	C	0	C	0
11	NW	4	NW	14	W	8	NW	6	SSE	18	C	0	ESE	6	C	0	NE	4	C	0	C	0	C	0
12	NNW	6	NW	12	NW	8	W	8	SE	8	C	0	C	0	C	0	C	0	C	0	C	0	W	4
13	C	0	WNW	4	C	0	W	10	SE	14	WNW	6	SE	4	W	10	W	4	C	0	E	6	C	0
14	C	0	C	0	C	0	W	8	SE	12	NW	12	C	0	SW	10	C	0	C	0	C	0	C	0
15	C	0	W	4	C	0	C	0	ESE	16	WNW	20	C	0	C	0	WSW	10	C	0	C	0	C	0
16	C	0	W	8	C	0	NNW	12	SE	15	WNW	18	C	0	NE	8	WSW	10	NW	6	C	0	C	0
17	W	8	W	4	C	0	NNW	8	S	4	WNW	8	SE	12	NW	6	W	6	WSW	10	NNE	6	C	0
18	ESE	10	WNW	10	C	0	WNW	20	C	0	NW	12	SE	12	WSW	15	W	6	W	6	C	0	C	0
19	WNW	10	NW	10	C	0	NNW	14	ESE	4	NW	8	WNW	6	N	14	C	0	C	0	WNW	4	C	0
20	WNW	14	NW	4	W	4	W	6	E	4	NW	8	WNW	8	C	0	C	0	C	0	W	8	C	0
21	NW	18	W	6	WNW	6	N	4	SE	6	WNW	12	C	0	WSW	8	SE	4	W	4	C	0	W	2
22	NW	4	W	4	C	0	N	6	C	0	NW	10	E	34	WNW	8	C	0	WSW	4	C	0	W	6
23	NW	10	C	0	C	0	W	14	ESE	12	NW	14	ESE	14	W	8	C	0	WSW	4	C	0	C	0
24	NW	10	C	0	C	0	C	0	ESE	6	NW	18	ESE	20	SW	4	WNW	8	C	0	WNW	6	C	0
25	ENE	4	W	8	ESE	6	W	10	C	0	C	0	C	0	C	0	WNW	10	W	6	C	0	W	8
26	C	0	WNW	4	C	0	WNW	12	SSW	4	WNW	8	W	10	ESE	8	WNW	6	C	0	C	0	C	0
27	C	0	WNW	10	C	0	NW	8	C	0	WNW	10	W	18	C	0	C	0	W	4	WNW	4	C	0
28	W	8	NNW	8	C	0	W	8	C	0	W	22	C	0	E	6	WNW	6	W	6	C	0	C	0
29	C	0			C	0	W	16	SSE	14	E	6	W	12	ESE	14	NW	4	C	0	C	0	C	0
30	C	0			NW	6	W	6	E	4	C	0	WNW	16	E	4	C	0	WNW	10	C	0	C	0
31	NW	8			WNW	14			SW	4			WNW	14	ESE	4			W	6			WSW	8

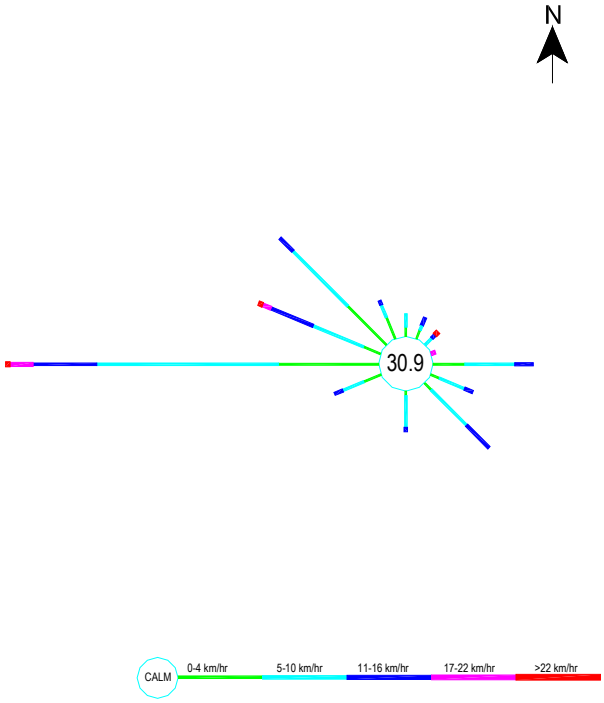
ANNEXURE 3.3 Contd..

	WIND DIRECTION AND WIND SPEED AT 17:30 (2009)																							
	JAN		FEB		MARCH		APRIL		MAY		JUNE		JULY		AUG		SEP		OCT		NOV		DEC	
DATE	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr	Dir	Speed km/hr
1	C	0	WNW	15	NE	15	NW	18	W	12	NNW	8	WSW	4	C	0	C	0	C	0	C	0	C	0
2	C	0	C	0	NW	8	C	0	N	6	WNW	18	C	0	WNW	4	E	4	ESE	6	C	0	C	0
3	C	0	C	0	ESE	10	NW	8	ESE	12	NW	18	C	0	WNW	12	ESE	16	C	0	C	0	C	0
4	C	0	C	0	NW	6	N	14	SE	18	WNW	14	S	12	WNW	4	ENE	6	E	10	C	0	C	0
5	C	0	ESE	4	NW	18	WNW	26	N	14	C	0	NE	8	C	0	NNW	4	ESE	4	C	0	C	0
6	C	0	NNW	10	NW	4	ESE	8	NW	16	NW	6	NNE	8	SE	6	NNW	4	C	0	C	0	C	0
7	C	0	NW	11	NW	12	C	0	WNW	16	NW	14	C	0	NW	4	NNW	4	C	0	WNW	6	C	0
8	C	0	NNW	6	NW	12	ESE	18	NNW	8	WNW	10	E	4	NW	8	ENE	14	C	0	C	0	C	0
9	C	0	NNE	8	N	8	N	14	WNW	14	NW	8	E	12	NW	6	WNW	8	C	0	C	0	C	0
10	NW	8	SE	8	NW	12	NW	14	SE	16	NE	14	N	6	C	0	NNE	8	C	0	C	0	C	0
11	W	6	NNW	6	NW	22	NW	18	C	0	SW	37	S	18	C	0	ENE	10	C	0	C	0	C	0
12	C	0	NW	12	NW	18	NW	12	C	0	N	24	C	0	C	0	WNW	6	C	0	WSW	6	C	0
13	C	0	NW	8	SE	8	NW	13	C	0	C	0	SE	4	NE	6	NW	4	C	0	C	0	C	0
14	C	0	NW	8	NE	6	W	4	C	0	C	0	NW	14	WSW	8	WNW	12	C	0	C	0	NW	4
15	C	0	NW	12	NW	6	NW	4	ESE	8	C	0	C	0	C	0	C	0	C	0	NW	4	C	0
16	C	0	NW	10	C	0	N	8	C	0	NW	14	ESE	8	C	0	WNW	6	C	0	WNW	4	C	0
17	C	0	NW	12	NW	8	WNW	22	C	0	NW	12	ESE	18	E	4	WNW	4	C	0	C	0	C	0
18	C	0	NNW	16	N	6	NW	22	C	0	N	18	S	12	WNW	12	C	0	C	0	C	0	NW	4
19	NW	19	NW	18	NNE	8	NW	28	C	0	NW	20	C	0	NNE	10	C	0	C	0	C	0	C	0
20	NW	18	NNW	6	ESE	4	NW	18	SW	28	NNW	18	C	0	SW	10	C	0	C	0	C	0	C	0
21	NW	14	NW	12	NNE	8	WNW	14	E	4	NW	22	C	0	C	0	C	0	C	0	C	0	W	4
22	NNW	16	NW	10	NNE	8	NW	6	ENE	12	NW	18	C	0	WNW	4	C	0	C	0	C	0	WNW	6
23	NW	23	W	6	NW	10	NW	18	E	4	NNW	20	NE	6	WNW	6	NNW	6	WNW	6	C	0	C	0
24	NW	19	NW	6	NNW	6	NNW	10	C	0	WNW	10	SSE	20	NW	6	NW	6	C	0	C	0	C	0
25	ESE	4	NW	12	N	10	WNW	14	SE	6	N	8	SW	8	C	0	NW	4	C	0	C	0	WNW	4
26	W	6	NNW	12	NW	8	NNW	12	NNW	16	N	12	C	0	C	0	WNW	4	C	0	C	0	NW	4
27	NNW	10	NNW	8	ENE	6	NW	22	C	0	NNW	12	W	6	E	4	NNW	4	C	0	C	0	C	0
28	NW	18	NNW	28	ENE	10	NW	16	NE	4	C	0	C	0	ESE	8	WNW	6	C	0	C	0	C	0
29	WNW	14			SW	8	NW	14	SW	14	C	0	C	0	E	14	NNW	4	C	0	C	0	C	0
30	NNW	10			W	19	NW	12	E	12	WSW	12	NW	6	C	0	C	0	W	4	C	0	WNW	4
31	NW	10			NW	20			ESE	4			W	8	SSW	6			C	0			C	0

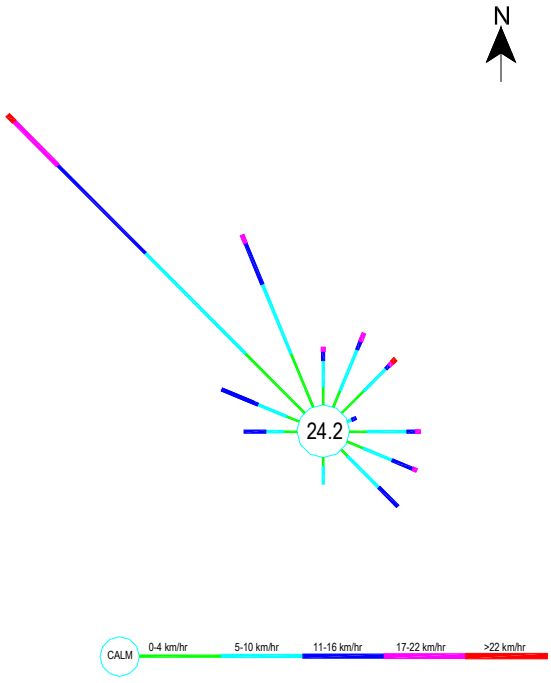
Annexure 3.4

WINDROSE DIAGRAMS

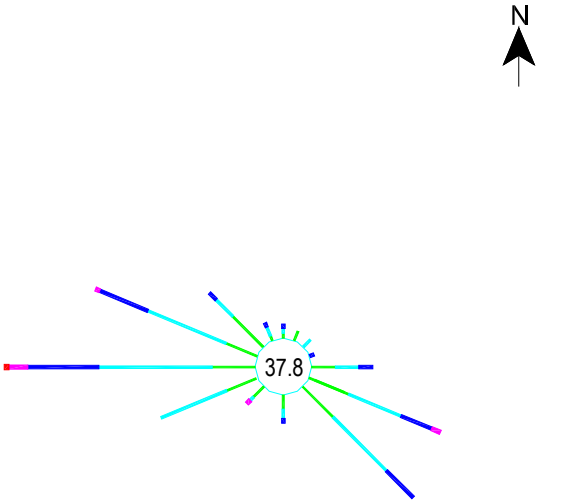
WINDROSE DIAGRAM FOR 2005 AT 8:30 HRS



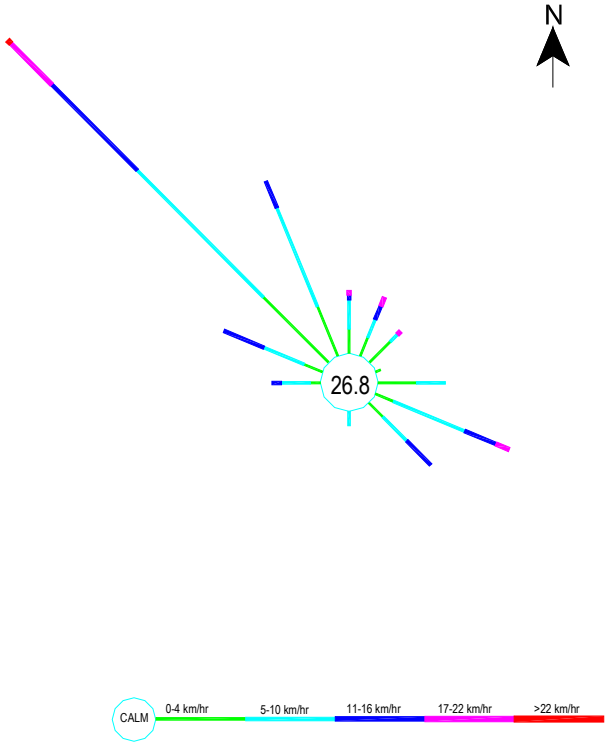
WINDROSE DIAGRAM FOR 2005 AT 17:30 HRS



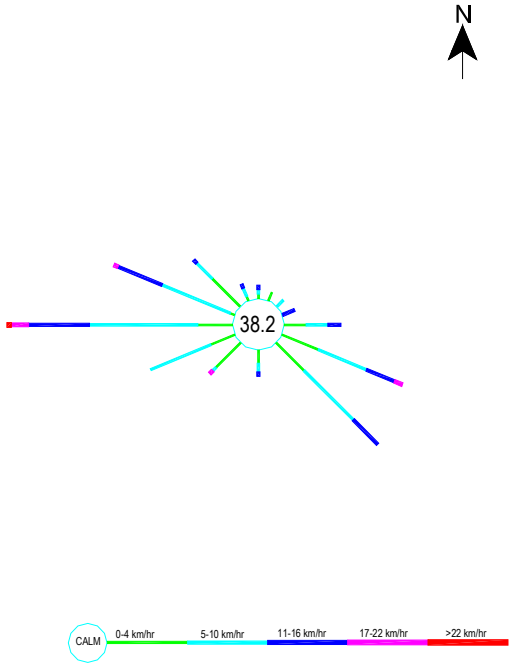
WINDROSE DIAGRAM FOR 2006 AT 8:30 HRS



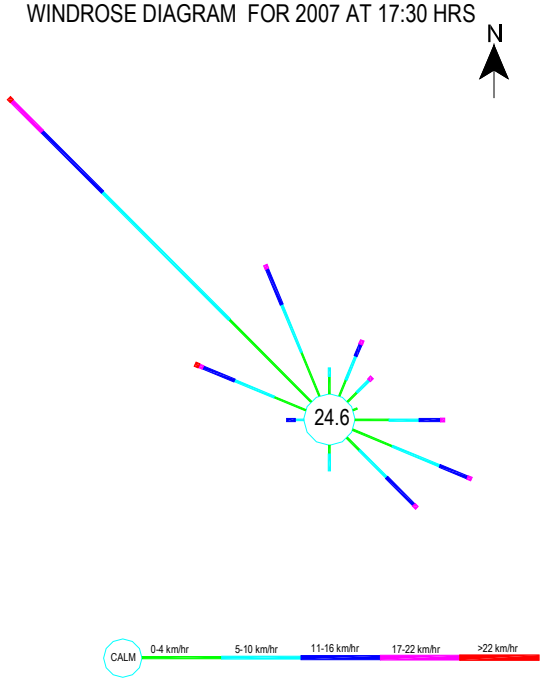
WINDROSE DIAGRAM FOR 2006 AT 17:30 HRS



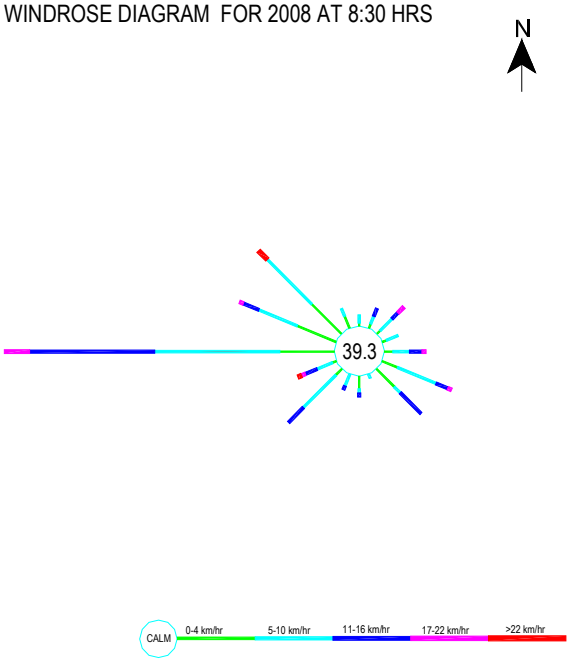
WINDROSE DIAGRAM FOR 2007 AT 8:30 HRS



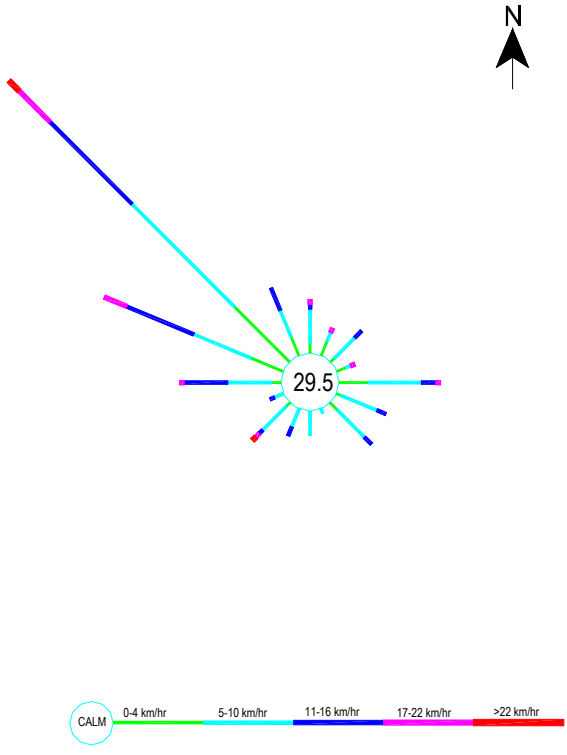
WINDROSE DIAGRAM FOR 2007 AT 17:30 HRS



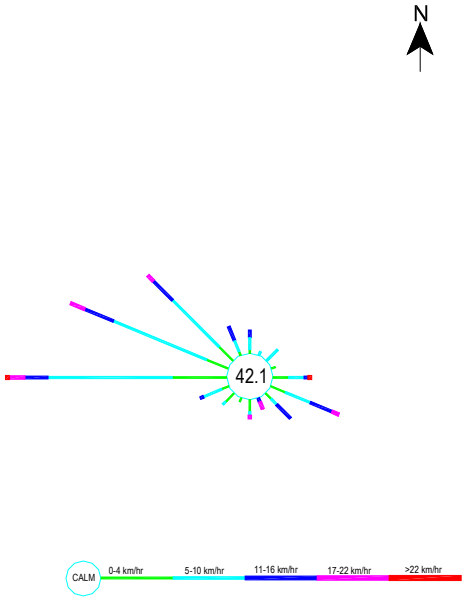
WINDROSE DIAGRAM FOR 2008 AT 8:30 HRS



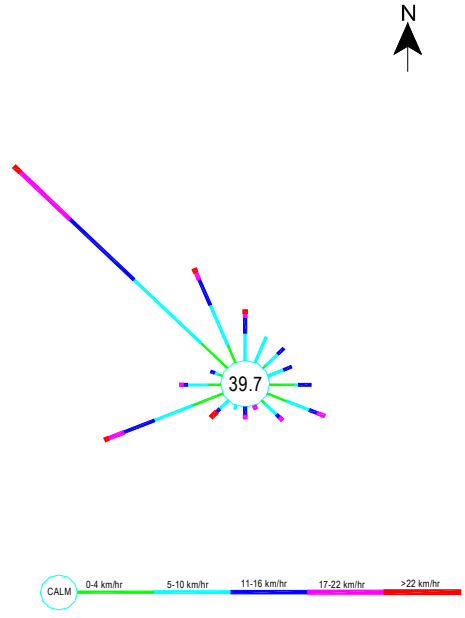
WINDROSE DIAGRAM FOR 2008 AT 17:30 HRS



WINDROSE DIAGRAM FOR 2009 AT 8:30 HRS



WINDROSE DIAGRAM FOR 2009 AT 17:30 HRS



ANNEXURE 3.5

AIR QUALITY DATA OF DELHI

CONCENTRATION OF SPM AT DIFFERENT LOCATIONS IN DELHI

S.No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sep. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May. (2009)	June. (2009)
1	**Adarsh Nagar**	463	532	305	292	352	412	396	371	453	358	**313**	340	369	297	302
2	**Anand Vihar**	766	672	492	362	411	552	492	521	572	499	543	598	542	388	375
3	**Ashok Vihar**	454	474	312	268	312	547	437	465	511	463	468	514	466	275	266
4	**Badli**	537	585	288	270	**239**	601	569	**612**	**681**	522	568	578	502	**269**	277
5	**Braham Puri**	728	666	403	380	429	598	439	465	530	455	511	558	507	355	368
6	**Daryaganj**	528	594	376	313	523	513	465	403	509	410	435	406	440	424	368
7	**Defence Colony**	364	403	321	273	309	444	470	432	554	439	484	450	420	317	285
8	**Dwaraka**	572	520	392	308	326	**343**	336	313	444	352	446	491	463	315	312
9	**Greater Kailash**	437	519	382	346	311	449	414	485	511	491	491	458	467	345	330
10	**Inder Puri**	491	441	278	254	305	387	**336**	**301**	**414**	326	352	384	414	271	262
11	**Janak Puri**	376	461	303	327	413	476	431	476	554	466	519	562	486	283	305
12	**Karawal Nagar**	**938**	**859**	453	487	509	**765**	573	611	666	618	**620**	**679**	**624**	419	408
13	**Karol Bagh**	514	607	376	350	402	608	435	498	571	469	486	533	486	338	344
14	**Kondli**	577	591	290	252	303	587	520	604	618	575	558	610	546	298	275
15	**Lajpat Nagar**	444	549	341	335	419	451	476	421	529	406	358	**337**	**348**	285	309
16	**Lawrence Road**	517	586	365	310	291	564	588	527	660	546	590	551	567	344	327
17	**Mandavali**	522	570	453	394	366	514	550	514	557	505	549	606	610	385	370
18	**Mangol Puri**	622	568	349	341	400	478	532	562	553	577	577	630	574	332	337
19	**Meera Bagh**	560	544	402	308	333	510	448	424	540	385	363	399	371	342	325
20	**Mehrauli**	433	505	286	281	315	489	423	490	619	515	530	581	512	323	302
21	**Moti Bagh**	674	463	330	303	361	488	419	392	446	416	433	474	494	314	309
22	**Moti Nagar**	469	493	345	364	325	567	518	513	481	478	537	591	551	298	337
23	**Mukherji Nagar**	494	534	401	318	405	524	470	456	591	484	510	614	443	367	343
24	**Nand Nagri**	630	594	378	240	388	478	415	429	504	446	434	512	505	373	332
25	**Naraouji Nagar**	524	445	**258**	**236**	402	389	449	428	487	440	453	497	475	278	**257**
26	**New Friends Colony**	482	427	276	291	362	397	408	395	508	371	423	408	387	374	339

S.No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sep. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May. (2009)	June. (2009)
27	**Pahar Ganj**	750	534	409	382	501	449	499	536	627	528	552	601	532	396	389
28	**Paschim Vihar**	695	710	352	320	365	537	452	438	510	439	407	424	398	333	327
29	**Patel Nagar**	632	615	422	386	439	502	444	524	539	523	543	595	542	369	378
30	**Prehladpur**	496	569	387	332	401	555	487	535	637	514	529	580	571	391	363
31	**R.K. Puram**	467	442	316	286	321	401	398	404	433	422	412	453	407	334	311
32	**Rajpura Road**	**273**	**389**	344	372	422	387	406	419	477	434	425	405	384	284	299
33	**Rana Pratap Bagh**	582	509	386	353	296	512	467	435	483	448	445	427	411	336	344
34	**Rohini**	608	561	355	311	273	587	478	476	527	458	432	413	439	390	353
35	**Sarita Vihar**	768	804	**492**	**523**	**685**	723	**656**	608	624	564	596	544	508	**460**	391
36	**Shalimar Bagh**	541	606	388	403	512	603	479	455	529	466	521	572	514	387	396
37	**Shanti Vihar**	590	574	359	312	276	523	460	421	483	483	417	457	411	362	335
38	**Tilak Nagar**	289	521	423	451	381	498	445	429	533	443	482	529	470	417	394
39	**Tughlakabad**	**	**	**	**	**	**	341	**	576	399	410	379	412	313	**417**
40	**Vasant Kunj**	918	768	388	427	359	488	473	451	508	429	435	476	416	411	396
41	**Yamuna Vihar**	637	597	338	313	291	512	396	424	469	432	435	480	447	403	364
	Min	**273**	**389**	**258**	**236**	**239**	**343**	**336**	**301**	**414**	**326**	**313**	**337**	**348**	**269**	**257**
	Max	**938**	**859**	**492**	**523**	**685**	**765**	**656**	**612**	**681**	**618**	**620**	**679**	**624**	**460**	**417**
	Average	**559**	**560**	**363**	**334**	**376**	**510**	**461**	**467**	**537**	**463**	**478**	**505**	**474**	**346**	**337**

Source: http://dpcc.delhigovt.nic.in/

All values in µgrams/m^3

ANNEXURE 3.5 Contd..

CONCENTRATION OF RSPM AT DIFFERENT LOCATIONS IN DELHI

S. No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sep. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May (2009)	June (2009)
1	**Adarsh Nagar**	261	231	187	168	192	215	197	210	214	237	210	231	246	180	189
2	**Anand Vihar**	399	305	287	223	205	290	237	259	265	**310**	**313**	**344**	288	**225**	216
3	**Ashok Vihar**	304	277	176	149	155	278	241	215	235	210	240	264	238	174	162
4	**Badli**	429	308	169	142	**136**	290	259	263	306	300	310	337	**290**	159	162
5	**Braham Puri**	339	319	229	198	179	364	234	201	231	191	228	248	251	195	206
6	**Daryaganj**	280	259	272	173	239	275	248	199	234	239	254	235	228	243	237
7	**Defence Colony**	325	234	194	154	172	263	247	204	229	217	198	182	**161**	156	173
8	**Dwaraka**	235	196	231	205	172	**189**	187	172	194	198	196	214	209	174	180
9	**Greater Kailash**	262	243	287	248	189	217	200	185	222	194	186	**171**	198	191	216
10	**Inder Puri**	320	188	**159**	140	162	211	**163**	**154**	**184**	173	185	207	210	155	149
11	**Janak Puri**	226	271	190	202	231	232	209	212	239	191	198	214	216	168	185
12	**Karawal Nagar**	338	382	319	280	277	358	272	**281**	301	301	299	321	279	**297**	**288**
13	**Karol Bagh**	218	276	227	198	219	298	251	227	257	230	235	260	203	213	206
14	**Kondli**	254	289	195	146	162	315	237	263	282	258	282	312	264	182	166
15	**Lajpat Nagar**	313	301	203	184	233	279	254	199	239	223	211	193	167	184	197
16	**Lawrence Road**	378	359	257	238	155	312	286	208	**328**	256	284	262	259	207	196
17	**Mandavali**	266	312	279	266	188	289	271	226	226	207	225	248	254	223	238
18	**Mangol Puri**	**485**	**419**	255	209	205	316	255	236	236	259	271	295	256	181	197
19	**Meera Bagh**	301	243	269	177	142	283	250	202	240	190	182	198	179	197	193
20	**Mehrauli**	252	264	177	148	144	309	222	215	304	224	242	268	222	173	180
21	**Moti Bagh**	272	231	213	172	177	237	220	192	228	212	233	256	240	177	186
22	**Moti Nagar**	343	235	206	182	159	282	281	240	236	190	189	205	235	160	169
23	**Mukherji Nagar**	305	213	234	208	222	274	244	209	273	219	228	248	218	207	198
24	**Nand Nagri**	323	319	257	**139**	229	266	220	201	238	259	227	245	224	209	193

S. No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sep. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May (2009)	June (2009)
25	**Naraouji Nagar**	307	241	184	142	186	235	212	198	233	194	192	208	189	169	169
26	**New Friends Colony**	250	246	213	160	179	217	208	191	225	218	200	187	185	218	203
27	**Pahar Ganj**	301	273	263	211	221	314	277	258	288	266	301	327	275	202	211
28	**Paschim Vihar**	339	402	251	187	175	354	272	198	246	218	219	203	200	207	204
29	**Patel Nagar**	404	372	219	207	244	334	238	230	258	273	260	283	264	212	215
30	**Prehladpur**	209	305	257	189	192	333	277	237	279	241	240	265	248	223	216
31	**R.K. Puram**	**168**	211	181	153	159	245	201	202	229	**170**	156	180	167	188	174
32	**Rajpura Road**	194	**172**	192	142	191	220	195	190	207	218	184	172	168	**148**	**145**
33	**Rana Pratap Bagh**	318	243	216	211	161	289	259	217	235	236	225	209	184	176	188
34	**Rohini**	403	323	223	179	154	303	256	222	249	241	246	232	235	203	202
35	**Sarita Vihar**	362	375	**322**	**316**	**305**	**371**	**325**	276	280	282	267	291	238	252	260
36	**Shalimar Bagh**	428	383	291	277	243	345	292	205	236	244	249	274	245	219	233
37	**Shanti Vihar**	347	303	241	183	177	279	247	218	242	206	**140**	197	176	212	203
38	**Tilak Nagar**	425	291	286	303	211	273	258	191	256	208	186	209	201	276	284
39	**Tughlakabad**	**	**	**	**	**	**	177	**	251	188	195	187	195	163	179
40	**Vasant Kunj**	280	321	222	251	202	287	254	235	253	218	188	215	193	220	233
41	**Yamuna Vihar**	351	268	217	176	145	295	218	194	209	190	233	267	256	220	199
	Min	**168**	**172**	**159**	**139**	**136**	**189**	**163**	**154**	**184**	**170**	**140**	**171**	**161**	**148**	**145**
	Max	**485**	**419**	**322**	**316**	**305**	**371**	**325**	**281**	**328**	**310**	**313**	**344**	**290**	**297**	**288**
	Average	**313**	**285**	**231**	**196**	**192**	**283**	**240**	**216**	**247**	**227**	**227**	**241**	**223**	**198**	**200**

Source: http://dpcc.delhigovt.nic.in/

All values in µgrams/m^3

ANNEXURE 3.5 Contd..

CONCENTRATION OF SO_2 AT DIFFERENT LOCATIONS IN DELHI

S. No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sept. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May. (2009)	June (2009)
1	**Adarsh Nagar**	9.1	12.60	7.00	6.00	9.20	12.10	10.70	10.90	24.00	14.9	16.3	18.00	18.20	5.60	6.1
2	**Anand Vihar**	13.6	15.30	7.10	6.20	9.40	9.10	8.50	11.20	34.20	14.5	17.7	20.10	22.60	5.70	5.5
3	**Ashok Vihar**	5	5.00	5.00	5.00	6.60	11.40	10.10	9.80	17.90	10.5	13.2	14.40	12.90	6.50	5.8
4	**Badli**	9.6	**22.50**	9.10	8.00	11.40	13.60	14.50	11.80	29.70	15.6	16.6	17.30	16.60	7.10	7.1
5	**Braham Puri**	6.8	16.80	7.45	6.80	9.40	9.10	8.50	9.50	17.90	**9.5**	13.5	15.40	16.80	**12.40**	9.9
6	**Daryaganj**	5	9.60	7.09	6.40	9.10	8.20	8.70	8.90	20.20	14.3	15.8	14.70	16.60	10.20	8.1
7	**Defence Colony**	5.3	5.00	5.00	5.00	5.00	8.20	9.70	8.70	**12.20**	13.7	12.6	14.20	15.50	5.50	**5.2**
8	**Dwaraka**	10	5.00	5.00	5.00	6.90	8.40	8.30	10.00	22.40	11.7	14.8	14.90	13.90	5.30	5.4
9	**Greater Kailash**	5	5.00	7.30	6.20	9.00	9.10	9.90	9.60	19.60	12.2	16.3	13.50	14.30	6.40	6.2
10	**Inder Puri**	6.8	6.30	6.55	6.00	7.60	11.10	10.90	9.40	28.50	13.9	15.1	17.20	16.00	**5.10**	5.3
11	**Janak Puri**	5	19.20	**15.13**	**12.60**	**16.70**	**19.50**	16.20	9.60	22.10	12.4	13.8	15.50	14.40	7.20	8.1
12	**Karawal Nagar**	5.1	8.40	9.80	8.40	10.30	14.20	13.20	12.00	25.80	19.5	19.4	22.30	20.50	9.70	9.2
13	**Karol Bagh**	5	12.30	10.80	9.60	12.50	13.30	11.50	11.50	31.00	17.7	14.2	16.10	14.90	6.10	7.1
14	**Kondli**	5	5.00	5.00	5.00	9.00	10.80	12.00	13.70	34.50	19.2	20.6	23.50	21.20	7.80	8
15	**Lajpat Nagar**	7.6	5.00	5.00	5.00	5.90	7.30	11.50	10.60	22.00	15.6	12.7	11.90	12.70	6.80	7.1
16	**Lawrence Road**	5	5.00	6.40	5.00	7.10	9.60	11.80	10.10	14.60	15.5	16.2	15.10	19.40	5.80	5.6
17	**Mandavali**	5.6	5.00	5.00	7.20	9.40	13.30	10.70	13.40	29.90	20.7	17.7	20.20	21.70	5.70	5.9
18	**Mangol Puri**	6	6.90	8.80	7.40	10.50	11.60	9.30	12.40	23.40	15.4	13	14.80	17.90	9.70	8.3
19	**Meera Bagh**	5	9.60	8.50	5.00	**5.00**	8.90	**7.10**	**6.60**	15.30	10	**10.3**	**8.30**	11.30	7.10	6.5
20	**Mehrauli**	8	5.00	5.00	10.60	14.00	14.00	11.20	15.20	29.70	19.8	18.6	21.20	19.80	5.50	7.1
21	**Moti Bagh**	5	7.80	11.60	9.80	12.40	15.30	12.30	10.30	19.80	15.3	13.4	15.00	14.00	5.90	6.6
22	**Moti Nagar**	7.3	9.60	10.00	9.60	12.80	11.70	11.80	9.70	13.70	14.9	13.1	13.00	14.30	6.10	6.7
23	**Mukherji Nagar**	17	12.30	11.20	5.00	8.40	8.40	11.10	12.60	16.80	20.3	17.2	19.40	21.10	5.70	5.4
24	**Nand Nagri**	7.8	5.00	5.00	5.00	6.40	7.00	9.80	10.40	18.30	16.4	16.1	16.50	18.20	7.30	6.6
25	**Naraouji Nagar**	5	**5.00**	5.00	5.00	7.70	10.00	8.40	9.70	18.00	14.5	13.9	14.10	12.80	12.30	8.6
26	**New Friends Colony**	5	5.00	5.00	5.00	7.50	13.50	10.80	9.40	18.70	13.6	15.7	14.80	17.40	5.40	5.5
27	**Pahar Ganj**	5	5.00	5.00	5.00	8.20	7.00	12.30	**15.70**	25.90	**22.1**	**21.3**	**24.20**	**26.00**	10.30	8.8
28	**Paschim Vihar**	5	9.20	9.30	9.00	9.10	9.10	8.30	7.90	22.00	11.7	12.6	11.70	13.20	7.60	7.7

S. No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sept. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May. (2009)	June (2009)
29	**Patel Nagar**	9.6	8.40	8.00	7.80	14.70	11.50	9.70	9.20	13.60	12.5	11.8	13.40	13.80	5.50	6.3
30	**Prehladpur**	5	5.00	5.00	6.90	11.40	**13.70**	13.50	12.30	25.20	14.4	15.7	17.70	19.80	6.20	6.1
31	**R.K. Puram**	6.8	5.00	**5.00**	**5.00**	6.90	6.60	9.50	8.40	35.70	11.4	11.4	12.90	13.80	5.40	5.5
32	**Rajpura Road**	5	6.30	7.20	5.00	5.00	9.10	8.30	11.10	38.20	13.6	12.9	10.30	11.10	5.60	5.3
33	**Rana Pratap Bagh**	5	6.90	8.80	7.80	11.50	11.90	10.50	8.70	25.30	16.6	12.3	11.50	12.20	6.50	6.4
34	**Rohini**	12.3	7.80	8.00	5.00	8.10	11.10	9.70	7.10	31.10	9.7	14.3	13.40	17.40	6.20	5.9
35	**Sarita Vihar**	5	11.40	8.60	11.20	15.20	17.20	**18.60**	11.80	24.40	13.2	13.6	12.40	15.80	11.50	**10.8**
36	**Shalimar Bagh**	8.6	12.30	9.50	7.20	11.30	11.90	9.50	10.80	21.80	14.3	16.7	18.90	17.90	5.40	5.8
37	**Shanti Vihar**	6.3	9.30	11.00	9.80	13.00	15.30	12.30	14.50	34.50	21.9	16.6	18.80	17.70	6.60	7.7
38	**Tilak Nagar**	8.6	6.30	8.20	8.20	9.00	11.60	9.90	8.90	16.70	10.6	10.4	11.70	16.00	5.50	5.9
39	**Tughlakabad**	**	**	**	**	**	**	9.20	**	**38.20**	15.5	11.3	11.60	**9.00**	5.50	7.1
40	**Vasant Kunj**	5	12.60	8.00	10.80	15.60	13.30	12.10	10.20	13.80	12.7	15.7	18.00	19.40	6.50	7.4
41	**Yamuna Vihar**	5	6.30	10.00	9.20	12.90	13.20	10.60	8.90	22.70	14.7	14.2	16.10	18.70	7.30	5.8
	Min	**5**	**5**	**5**	**5**	**5**	**6.6**	**7.1**	**6.6**	**12.2**	**9.5**	**10.3**	**8.3**	**9**	**5.1**	**5.2**
	Max	**17**	**22.5**	**15.13**	**12.6**	**16.7**	**19.5**	**18.6**	**15.7**	**38.2**	**22.1**	**21.3**	**24.2**	**26**	**12.4**	**10.8**
	Average	**7**	**9**	**8**	**7**	**10**	**11**	**11**	**11**	**24**	**15**	**15**	**16**	**17**	**7**	**7**

Source: http://dpcc.delhigovt.nic.in/

All values in µgrams/m^3

ANNEXURE 3.5 Contd..

CONCENTRATION OF NO_X AT DIFFERENT LOCATIONS IN DELHI

S. No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sept. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May. (2009)	June (2009)
1	**Adarsh Nagar**	24.6	**15.4**	**8.7**	33.8	40.1	44.5	37	31.6	40.5	42.9	40.2	45.1	46.8	**11.8**	**24.2**
2	**Anand Vihar**	204	22.3	13.8	56.7	59.1	64.2	49.7	41.4	49.5	45.8	42.9	57.9	52.8	12.2	29.8
3	**Ashok Vihar**	83.1	69.8	44.4	40.8	35.6	31.2	27.3	32.5	46.6	41.4	46.1	52.1	41.8	48.2	43.1
4	**Badli**	29.6	86.3	51.6	33.7	46.6	49.4	43	39.6	48.9	54.9	52.5	59.5	53.6	41.7	37.7
5	**Braham Puri**	157.8	**178.4**	124.2	77.3	61.6	57.5	48.3	41	54.2	50.9	54.3	61.6	57.1	**115.4**	65.7
6	**Daryaganj**	157	121.8	80.9	66.9	57.5	60.3	50.4	41.8	49.6	46.7	52.3	48.2	54.1	70.2	68
7	**Defence Colony**	176	51.7	36.9	42.2	33.1	39.3	35.7	38.8	47.9	48.3	42.6	48.1	47.1	33.5	33.3
8	**Dwaraka**	67	41	29.9	**26.8**	35.8	32.1	26.2	30.4	39.6	40.4	36.9	42	35.4	28	24.2
9	**Greater Kailash**	113	72.6	67.3	47.6	53.3	51.4	41.5	35.4	44.4	43.3	44.7	41	39.1	47.6	49.5
10	**Inder Puri**	43.1	58.3	31.8	27.2	**25.9**	32.5	28	36	46.3	51.5	49.4	56.1	51.1	25	25.3
11	**Janak Puri**	56.3	78.2	59.4	63.8	60.5	65.2	51.8	42.9	51.3	49.2	54.4	63.3	46.5	58.5	56.7
12	**Karawal Nagar**	71.8	159.7	110.7	82.5	74.1	65.4	49.6	52	58.4	60.7	53.6	61.2	64.7	72.4	62.4
13	**Karol Bagh**	38.6	62.3	31.7	46.5	55.1	61.8	49.3	41	51.7	55.9	48.3	54.7	60.2	33.9	34
14	**Kondli**	82.5	111.6	83.8	67.6	78.2	80.5	62.5	54.7	51.3	47.2	46.9	53.2	48.9	83.7	68.9
15	**Lajpat Nagar**	50.6	87.1	66.2	42.4	39.8	45.4	36.8	28.5	36	**35.2**	**31.1**	**28.5**	**32.5**	56.2	46.7
16	**Lawrence Road**	49	63.4	44.9	38.8	45.0	40.4	31.7	**24.9**	**36.5**	40	49	45.1	47.4	43.9	38.4
17	**Mandavali**	130	107.2	60.5	58.2	73.2	68	51.7	43.3	50.8	60	53.8	59.9	52.8	56.6	51
18	**Mangol Puri**	147	67.4	**139**	108	88.6	90.4	**85.5**	59.5	60.3	53.5	65.6	74.7	67.6	108.3	64.8
19	**Meera Bagh**	18.6	39.9	96	61.3	70.9	64.5	67.8	53.8	63.1	63	64.9	72.9	54.6	67.4	55.6
20	**Mehrauli**	195	73.2	34.5	27.7	45.3	40.5	31.6	39	41.7	45.8	48.2	54.6	52.4	34.5	30.2
21	**Moti Bagh**	197	45.5	38.2	40.2	35.5	60.2	46.8	37.7	47.8	48.4	49.1	55.4	52.6	34.7	32.6
22	**Moti Nagar**	66	69.2	57.4	43.5	33.8	38.2	32	38.1	48.3	56.3	45.1	51.1	48	42.5	37.5
23	**Mukherji Nagar**	151	111.9	43	36.2	45.9	37.3	29.6	33.4	40.4	42.8	36.2	40.8	45.7	35.4	31.5
24	**Nand Nagri**	89.3	79.6	66.8	40.9	56.6	46.3	35.2	41.8	47.5	42.4	48.3	54.6	46.9	69.5	50.1
25	**Naraouji Nagar**	69	51	112.1	69.8	57.3	48.2	39.9	30.8	39.1	46.9	36.5	41.4	38.5	92.3	**72.5**
26	**New Friends Colony**	87	38.9	53.5	37.3	37.8	46.4	34.9	29	59.5	57.4	60.3	55.8	51.5	39.6	34.4
27	**Pahar Ganj**	86.1	71.3	80.4	70.4	**105.1**	**106**	69.7	55.6	66.8	**77.4**	**72**	**81.9**	**73.5**	63.4	59.8

S. No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sept. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May. (2009)	June (2009)
28	**Paschim Vihar**	129.7	97.2	86.1	46.2	57.4	51.5	41.5	31.5	41.2	44.4	48	44.6	42	71.9	54.4
29	**Patel Nagar**	75.3	60.3	44.9	37.4	42.4	37.2	32.6	29.1	39.7	43.8	39.3	44.5	41.3	37.7	33.4
30	**Prehladpur**	24.3	85.6	59.9	72.8	89.3	76.3	54.7	**61**	**68.3**	61	67.8	75.9	62.1	51.1	54.3
31	**R.K. Puram**	69.5	54.3	38.7	38.6	44.9	49.2	40.9	38.2	45.8	47.3	46	52	49.6	35.9	32.8
32	**Rajpura Road**	77	33.2	37.6	45.5	36.3	30.1	25.7	29.9	41.8	42	36.8	33.9	32.6	32.4	33.7
33	**Rana Pratap Bagh**	99	81.2	65.9	40.9	35.4	**28.3**	**25.5**	31.2	38.2	42.9	42.5	39.2	38.9	47.7	41.3
34	**Rohini**	34.1	58.8	52.3	61.2	50.4	56.9	46.8	49.9	56.4	59.3	56.2	52	48.9	49.6	47.9
35	**Sarita Vihar**	126	109.2	84	**108.6**	80.3	71.4	67.5	51.9	60.4	53.6	49.4	65	58	72	54
36	**Shalimar Bagh**	25.5	41.3	38.6	43.2	39.7	44	33.3	38.7	50.7	54.2	49.9	55.6	58.3	35.7	34.6
37	**Shanti Vihar**	100	81.9	69.4	50.8	40.3	35.5	37.5	39.4	43.9	52.8	52	58.3	53.8	59	48.7
38	**Tilak Nagar**	59.6	39.6	29.9	33.4	58.8	49.3	43.3	40.2	50.4	52.6	59.2	66.5	65.6	26.3	26.5
39	**Tughlakabad**	**	**	**	**	**	**	25.2	**	66.8	42.7	38.2	39	41.2	32.5	34.5
40	**Vasant Kunj**	169	61.6	55.9	78.1	60.4	52.6	44.2	49.2	48.9	49.8	54.8	62.2	61.6	56	54.2
41	**Yamuna Vihar**	131	110.5	86.6	56.9	50.1	45.9	36.2	40	45.2	43.4	43.6	49.4	45.2	75.9	56.2
	Min	**18.6**	**15.4**	**8.7**	**26.8**	**25.9**	**28.3**	**25.2**	**24.9**	**36**	**35.2**	**31.1**	**28.5**	**32.5**	**11.8**	**24.2**
	Max	**204**	**178.4**	**139**	**108.6**	**105.1**	**106**	**85.5**	**61**	**68.3**	**77.4**	**72**	**81.9**	**73.5**	**115.4**	**72.5**
	Average	**94**	**74**	**60**	**53**	**53**	**52**	**43**	**40**	**49**	**50**	**49**	**54**	**50**	**51**	**45**

Source: http://dpcc.delhigovt.nic.in/

All values in µgrams/m^3

ANNEXURE 3.5 Contd..

CONCENTRATION OF CO AT DIFFERENT LOCATIONS IN DELHI

S.No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sept. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May (2009)	June (2009)
1	**Adarsh Nagar**	1200	1425	1190	1370	1330	**1305**	1183	1051	1134	1331	**985**	1177	1182	996	992
2	**Anand Vihar**	1000	1240	1090	1150	1190	1153	1217	1147	1239	1350	1362	1465	1312	1025	1013
3	**Ashok Vihar**	900	1020	890	870	860	**785**	**658**	**723**	1091	1218	1170	1328	1207	860	870
4	**Badli**	500	990	675	760	775	874	908	1000	1426	1462	1460	1291	1171	765	747
5	**Braham Puri**	800	1105	820	720	850	863	768	834	1170	1168	1148	1307	1101	834	720
6	**Daryaganj**	1200	1250	780	975	1000	918	962	878	1203	1369	1193	1300	1319	1034	996
7	**Defence Colony**	900	890	700	710	735	948	733	916	1278	1388	1289	1329	1160	778	710
8	**Dwaraka**	500	660	610	650	715	883	748	847	1143	1118	1203	1294	1148	760	753
9	**Greater Kailash**	700	805	720	690	675	882	736	781	1085	1088	1047	1107	1134	923	760
10	**Inder Puri**	600	680	595	635	690	938	788	757	1038	1056	1196	1321	1258	667	**635**
11	**Janak Puri**	900	1025	900	1100	910	940	1114	**1227**	**1659**	1689	**1592**	**1467**	1232	748	860
12	**Karawal Nagar**	1300	1660	1020	1210	1075	1128	938	814	1143	1266	1176	1334	1285	1044	1006
13	**Karol Bagh**	1400	1820	1080	825	1210	1148	995	960	1147	1446	1325	1423	1280	1177	1210
14	**Kondli**	600	725	730	860	875	924	828	835	1161	1171	1237	1356	1204	865	825
15	**Lajpat Nagar**	600	755	750	895	865	892	1037	956	1247	1442	1185	1048	1023	1048	936
16	**Lawrence Road**	1200	990	960	1080	900	1078	903	1048	1336	1335	1393	1293	1301	910	895
17	**Mandavali**	900	1025	945	970	1080	957	878	889	1151	1300	1145	1331	1318	938	963
18	**Mangol Puri**	800	820	840	710	1110	1008	797	804	1117	1366	1151	1285	1150	812	944
19	**Meera Bagh**	700	710	740	765	855	950	920	740	**964**	1069	1200	1353	1223	804	745
20	**Mehrauli**	600	885	890	890	855	1034	898	838	1108	1359	1081	1281	1143	891	838
21	**Moti Bagh**	1300	1495	1260	665	880	956	730	858	1115	1497	1147	1299	1238	1078	946
22	**Moti Nagar**	600	805	775	990	680	933	843	737	1002	1123	1096	1243	1118	872	888
23	**Mukherji Nagar**	900	1105	1095	920	1275	1112	900	1023	1415	1322	1223	1386	1235	1015	987
24	**Nand Nagri**	1100	1240	860	1075	1025	1107	977	883	1162	1203	1131	1264	1222	773	792
25	**Naraouji Nagar**	1000	1205	920	920	1095	1030	855	896	1212	1272	1137	1288	1305	953	945
26	**New Friends Colony**	2100	1220	800	1325	895	998	832	858	1133	1344	1057	**967**	995	795	788
27	**Pahar Ganj**	1600	**1850**	**1480**	880	**1375**	1202	1138	973	1292	1348	1313	1428	1293	**1363**	**1325**
28	**Paschim Vihar**	800	905	790	790	895	1051	949	884	1134	1208	1146	1053	1002	861	846

S.No.	Locations	Dec. (2007)	April (2008)	May (2008)	June (2008)	July (2008)	Aug. (2008)	Sept. (2008)	Oct. (2008)	Nov. (2008)	Dec. (2008)	Jan. (2009)	Feb. (2009)	Mar. (2009)	May (2009)	June (2009)
29	**Patel Nagar**	700	815	640	925	755	1023	945	814	1141	1258	1232	1302	1116	780	748
30	**Prehladpur**	500	910	715	720	1135	1124	978	953	1258	1487	1224	1370	**1383**	841	827
31	**R.K. Puram**	1000	865	710	735	785	999	778	788	1052	1322	1124	1233	1082	743	732
32	**Rajpura Road**	700	610	600	650	715	963	758	778	1012	1208	1151	1058	**973**	**652**	661
33	**Rana Pratap Bagh**	800	625	555	880	755	946	800	829	1096	1107	1103	1016	999	707	719
34	**Rohini**	700	975	780	**1525**	960	1043	1004	946	1285	1524	1329	1189	1123	874	898
35	**Sarita Vihar**	2200	1740	1340	835	1310	1209	**1318**	1012	1353	1397	1299	1278	1173	1181	1058
36	**Shalimar Bagh**	700	1020	790	**510**	945	1041	855	818	1050	1315	1126	1438	1326	755	775
37	**Shanti Vihar**	600	**560**	**530**	785	**645**	1010	869	925	1209	1248	1082	1197	1088	714	756
38	**Tilak Nagar**	700	785	650	820	810	1023	1154	1092	1290	1346	1273	1418	1257	883	850
39	**Tughlakabad**	**	**	**	**	**	**	725	**	1043	1310	1268	1278	1201	909	925
40	**Vasant Kunj**	800	625	630	610	940	1007	882	948	1160	1431	1351	1208	1148	737	771
41	**Yamuna Vihar**	500	580	580	720	745	1058	888	935	1205	1341	1109	1196	1096	850	888
	Min	**500**	**560**	**530**	**510**	**645**	**785**	**658**	**723**	**964**	**1056**	**985**	**967**	**973**	**652**	**635**
	Max	**2200**	**1850**	**1480**	**1525**	**1375**	**1305**	**1318**	**1227**	**1659**	**1689**	**1592**	**1467**	**1383**	**1363**	**1325**
	Average	**915**	**1010**	**836**	**878**	**929**	**1011**	**907**	**900**	**1182**	**1307**	**1206**	**1273**	**1184**	**883**	**867**

Source: http://dpcc.delhigovt.nic.in/

All values in µgrams/m^3

ANNEXURE 3.6

NOISE QUALITY DATA OF DELHI Leq dB(A)

S.No.	Locations	June(2008)		July (2008)		August (2008)		Sep. (2008)		Oct. (2008)		Nov. (2008)		Dec. (2008)		Jan. (2009)	
		Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)
1	**Adarsh Nagar**	62.3	53.0	61.6	52.2	62.9	52.4	62.7	55.1	63.4	55.8	59.1	**47.1**	61.2	52.5	60.5	51
2	**Anand Vihar**	63.1	57.5	62.5	55.9	63.0	56.0	64.3	54.4	62.7	53.9	62.0	56.0	61.6	52.7	60.4	53.3
3	**Ashok Vihar**	61.7	52.6	61.3	62.2	60.2	51.5	61.4	55.1	**	**	61.3	50.9	60.4	51.9	60.1	50.1
4	**Badli**	58.7	49.1	**57.1**	50.9	57.4	50.6	63	55.8	**	**	61.4	57.2	59.6	51	60.6	54
5	**Braham Puri**	59.6	54.0	57.7	53.6	**56.6**	51.5	**59**	54.2	**	**	59.6	52.2	60.4	54.6	59.9	53.7
6	**Daryaganj**	64.0	57.4	62.3	52.5	63.7	56.8	62.2	53.4	**	**	62.1	52.5	62.8	56.2	60.6	55.8
7	**Defence Colony**	60.1	53.8	60.9	55.2	60	54.3	63	57.1	**64**	**57.4**	61.6	55.6	60.3	54.3	59.8	53.7
8	**Dwaraka**	60.9	52.3	59.2	51.3	61.2	52.1	62.9	55.9	**	**	59	51.1	59.3	55.8	58.1	54.5
9	**Greater Kailash**	63.1	**62.2**	61.8	56	63.9	**62.6**	62.7	57	61.5	55.9	61.7	53.1	62.8	55.5	59.2	49.7
10	**Inder Puri**	59.4	55.9	59.1	53.8	59.6	54.6	62	57.9	**	**	60.6	55.2	61.7	53.3	60.2	53.1
11	**Janak Puri**	62.7	55.1	61.9	55.6	61.2	53.9	62.9	56.1	**	**	62.5	**60.5**	62.8	57.6	59.4	53.1
12	**Karawal Nagar**	62.2	53.2	62.4	52.9	61.4	52.5	63.9	57.7	62.9	56.3	60.5	54.7	63	**61.2**	61.2	**60.8**
13	**Karol Bagh**	62.9	61.3	62.4	60.6	62	61	62.9	54.4			61.8	56.4	62.8	54.9	64	57.4
14	**Kondli**	60.0	50.3	60.1	51.1	60.4	54.2	62.4	56.8	62.2	54.7	62.2	54	**64.4**	54	60.8	48.3
15	**Lajpat Nagar**	63.6	61.8	64.6	**62.3**	63.6	61.5	62.5	55.9	61.9	55.5	63.1	53.1	61.3	55.1	61.2	51.9
16	**Lawrence Road**	59.0	50.9	59.7	52.2	59.1	52.6	62.4	53.2	**	**	61.4	56.8	62.3	56.5	62.4	49
17	**Mandavali**	61.7	56.5	63.2	56.6	62.4	55.1	62	57.2	61.6	54.2	63	56.9	59.3	51.3	60.9	52.7
18	**Mangol Puri**	62.8	56.2	61.6	55.9	62.5	55.9	63.6	56.8	**	**	61.4	56.8	61.3	54.3	62.6	57.6
19	**Meera Bagh**	60.0	52.00	59.4	51.60	60.2	52.0	61.4	54.8	**	**	61.0	56.9	62.8	56.2	60.5	52.5
20	**Mehrauli**	61.3	55.1	62.3	58	62.7	53.4	63.9	54.3	**61.1**	51.2	60.5	56.8	60.9	57.8	62.7	55.4
21	**Moti Bagh**	59.3	52.4	58.2	52.2	58.7	51.8	62.1	53	61.6	52.9	62.4	51.3	58.7	52.2	58.6	47.7
22	**Moti Nagar**	61.2	57.8	60.9	54.2	61.9	57.9	61	52.5			62.9	54.8	62.9	54.8	59.5	53.5
23	**Mukherji Nagar**	61.7	55.5	61	56.2	62.2	55.9	64.8	56.4	61.6	**50.7**	61.8	53.8	61.1	55.6	62.8	56.2

S.No.	Locations	June(2008)		July (2008)		August (2008)		Sep. (2008)		Oct. (2008)		Nov. (2008)		Dec. (2008)		Jan. (2009)	
		Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)	Noise (Day Time)	Noise (Night Time)
24	**Nand Nagri**	60.6	55.8	59.7	55	60.3	55.4	61.9	53.9	61.4	56.1	62.4	55.7	60.6	55.8	59.4	55.9
25	**Naraouji Nagar**	60.5	52.6	60.5	55.6	60.9	53.7	61.9	56.1	62.6	51.6	62.9	56.6	60.7	52.8	59.6	51.6
26	**New Friends Colony**	60.1	53.2	62.8	56.5	62.2	53.5	62.9	55.2	63.1	55.6	61.8	56.7	61.3	56.2	59.2	53.5
27	**Pahar Ganj**	63.6	60.4	63.1	57.6	67.0	59.1	63.8	59.2	**	**	61.9	55.4	62.7	60.1	62.6	57.6
28	**Paschim Vihar**	**57.4**	51.7	57.9	54.1	59.2	51.8	61.3	53.9	**	**	62.2	54.7	57.8	51.4	59.9	48.4
29	**Patel Nagar**	57.6	**48.7**	59.6	52.3	58	48.6	61.7	55.4	**	**	62.1	55.5	**56.8**	48.3	60.2	50.5
30	**Prehladpur**	63.0	59.1	59.4	54.5	62.4	57	61.9	56.1	61.6	52.9	62.8	52.8	60.5	57.6	61.7	56.5
31	**R.K. Puram**	60.2	55.7	60.4	57.1	60.6	55.5	62	55.6	63.1	55	**59**	51.6	59.6	53.4	58.7	49.1
32	**Rajpura Road**	62.1	52.5	60.2	52.3	62.4	52.8	63.8	57.2	63.3	53	59.2	52.7	60.2	51.6	**57.6**	48.7
33	**Rana Pratap Bagh**	61.0	51.4	60.3	50.8	61.8	52.9	63.6	56.8	**	**	62.4	52.1	60.6	51.2	59.3	52.4
34	**Rohini**	64.0	54.3	61.1	53.5	62.3	53.4	63.5	54.7	**	**	61.7	56.8	63.3	53.9	**64**	57.4
35	**Sarita Vihar**	**69.0**	59.1	60.4	51.7	**67.2**	58	62.8	54.3	63.3	56.5	63	55.5	60.5	52	63.6	54.3
36	**Shalimar Bagh**	62.6	57.6	63.3	57.6	61.7	54.8	63.8	54.3	**	**	62	54.8	62.4	55.2	61.7	55.7
37	**Shanti Vihar**	61.3	55.1	**65.9**	56.0	59.7	**48.3**	63.1	**59.2**	**	**	63.0	55.5	58.6	**47.7**	59.1	**47.5**
38	**Tilak Nagar**	62.1	54.9	61.5	54.5	62.2	54.9	**65**	55.6	**	**	60.5	53.9	59.4	53.5	59.2	48.4
39	**Tughlakabad**	**	**	**	**	**	**	**	**	**	**	62.2	52.6	61	52.5	61.3	48.5
40	**Vasant Kunj**	62.9	58.6	63.5	58.9	61.7	56.6	61.8	56.8	61.6	55.2	63.5	58.9	61.9	54.9	59.5	55.8
41	**Yamuna Vihar**	59.6	51.6	59.9	51.3	60.1	52.5	62.7	**51.8**	63	53.9	**63.8**	51.3	58.6	51.2	59.9	51.1
	Min	**57.4**	**48.7**	**57.1**	**50.8**	**56.6**	**48.3**	**59**	**51.8**	**61.1**	**50.7**	**59**	**47.1**	**56.8**	**47.7**	**57.6**	**47.5**
	Max	**69**	**62.2**	**65.9**	**62.3**	**67.2**	**62.6**	**65**	**59.2**	**64**	**57.4**	**63.8**	**60.5**	**64.4**	**61.2**	**64**	**60.8**
	Average	**61.473**	**54.96**	**61.02**	**54.81**	**61.413**	**54.47**	**62.6625**	**55.53**	**62.38**	**54.42**	**61.69**	**54.5**	**60.9**	**54.1**	**60.54**	**60.54**

****Data not available**

Source: http://dpcc.delhigovt.nic.in/noise-diwali.html

Annexure 3.7

LIST OF COMMON TREES AND SHRUBS IN DELHI

S.No.	Botanical Name	Local Name
1	*Aegle marmelos*	Bael
2	*Albizia lebbeck*	
3	*Alstonia scholaris*	Chhataun
4	*Azadirachta Indica*	Neem
5	Barringtonia acutangula	
6	*Bishchoefia javanica*	
7	*Callistemon lanceolatus*	Bottle Brush
8	*Cassia fistula*	Amaltas
9	*Cassia javanica*	
10	*Cassis fistula*	Amaltas
11	*Cedrela Toona*	Tun
12	*Chukarassia tabularis*	
13	*Cinnamomum camphora*	Camphor
14	*Cochlospermum gossypium*	
15	*Delonix regia*	Gulmohar
16	*Erythrina suberosa*	
17	*Ficus Glomerata*	Gular
18	*Ficus infectoria*	Pilkhan
19	*Ficus religiosa*	Pipal
20	*Grevillea robusta*	Silver oak
21	*Hollarrhena pubescens*	
22	*Jacaranda mimosaefolia*	Jacaranda
23	*Kigelia pinnata*	
24	*Koelreuteria apiculata*	
25	*Lagerstroemia indica*	Pride of India
26	*Lagerstroemia speciosa*	Pride of India
27	*Lagerstroemia thorelli*	Pride of India
28	*Michelia champaca*	
29	*Mimusops elengii*	Maulsari
30	*Nyctanthes arbortristis*	
31	*Peltaforum species*	
32	*Pistacia integerrima*	
33	*Polyalthia longifolia*	Asoka
34	*Pongamia glabra*	Papari

S.No.	Botanical Name	Local Name
35	*Pterospermum acerifolium*	Kanak Champa
36	*Putranjiva roxburghii*	Jiya pota
37	*Samania saman*	
38	*Sapium sebiferum*	Makhan tree
39	*Sarraca asoka*	Sita Asoka
40	*Schleichera oleosa*	Kusum
41	*Schleichera trijuga*	Kusum
42	*Sterculia alata (*Var. diversifolia)	
43	*Swietenia mahogany*	Mahagony
44	*Syzygium cumuni*	Jamun
45	*Syzygium spp.*	Jamun
46	*Terminalia arjuna*	Arjan
47	*Terminalia balerica*	Bahera
48	*Terminalia Chebula*	Harar
49	*Acalypha*	
50	*Azardirachta indica*	Neem
51	*Cassia fistula*	Amaltas
52	*Cassia glauca*	
53	*Cestrum nocturnum*	Rat ki Rani
54	*Gardenia florida*	Gandhraj
55	*Hamelia patens*	
56	*Hibiscus*	Gurhal
57	*Lagerstroemia indica*	
58	*Lausonia indica*	Mehndi
59	*Murraya*	Kashipatta
60	*Nerium oleander*	
61	*Poinciana pulcherrima*	
62	*Polyalthia longifolia*	Ashok
63	*Tabernaemontana coronaria*	Chandni

Annexure 5.1-5.2

Annexure 5.1

QUESTION FOR PUBLIC CONSULTATION

S.No.	Questions	Yes	No
1.	Are the project Details were explained to you?		
2.	Was the mode of presentation useful?		
3.	Were the Positive Impacts due to project explained to you?		
4.	Were the Negative Impacts due to project explained to you on water quality, air quality, noise, structure/monuments, tree/forest/ecology etc.		
5.	were the mitigation measure that will be taken for negative impacts were communicated		
6.	Are you satisfied with the discussion on the project		
7.	Do you have any objection to the Environmental Management Plan? (please fill below)		
8.	Do you have any suggestions for improvement ? (please fill below)		
Objections			
Suggestion			

Name

Signature

Address

Mobile No.

PRESENTATION

ON

Environmental Impact Assessment and Management Plans

for

Phase III Corridors of Delhi Metro

July 19-20, 2011

RITES
THE INFRASTRUCTURE PEOPLE

(A Government of India Enterprise)

GURGAON – 122 001

Annexure 5.2

ABOUT THE PROJECT: SALIENT FEATURES

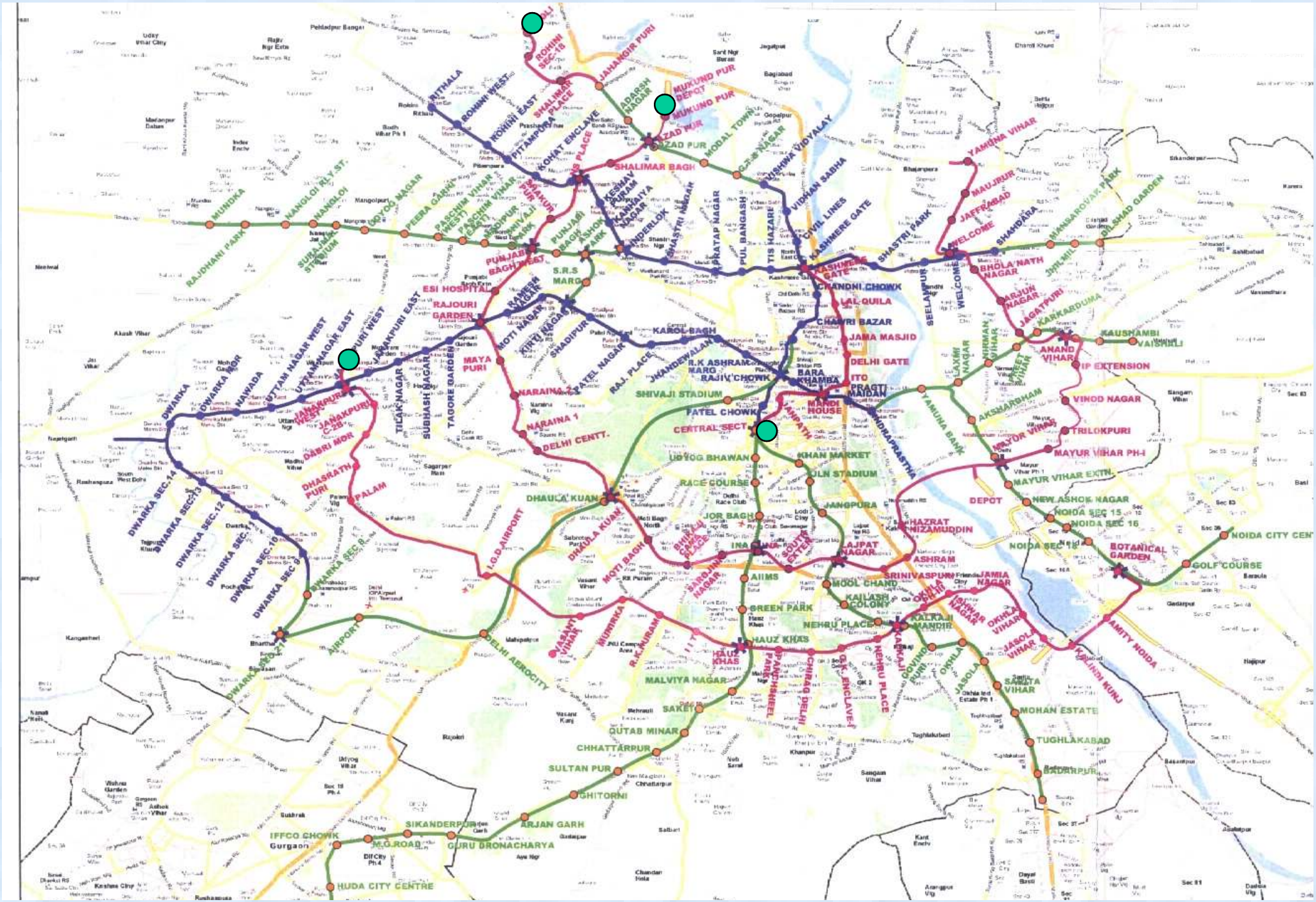
- There are 4 Corridors for the Delhi Metro Phase III

Corridor	Under-ground (km)	Elevated/ at Grade (km)	Total Length (km)	Stations (Nos)		
				Under-ground	Elevated/ At Grade	Total
Mukundpur-Yamuna Vihar	14.386	41.311	55.697	9	26	35
Janakpuri West- Kalindi Kunj	17.288	16.206	33.494	12	10	22
Central Sectt.-Kashmiri Gate	9.370	0	9.370	7	0	7
Jhangirpuri Badli		4.489	4.489	0	3	3
Total	**41.044**	**65.5**	**103.05**	**28**	**39**	**67**

- There will be 3 Depots in this Phase at Yamuna Vihar, Mukundpur and Kalindi Kunj.

INDEX PLAN OF MRTS NETWORK

Annexure 5.2



ENVIRONMENTAL CLEARANCE FOR THE PROJECT

- As per EIA Notification 2006; Metro Rail Projects do not fall in the category of projects that need Environment Clearance.
- However, DMRC is committed to protect and conserve environment
- It has therefore prepared EIA report for the project which also meets funding institutions guidelines such as those of JICA.

ENVIRONMENT STATUS

Annexure 5.2

WATER QUALITY: 15 Ground Water Samples were collected from al
ne four corridors. Most of the parameters are within limits.

SOIL QUALITY: 15 Number of Soil samples were collected from al
ne four corridors. It is observed that soil is tending to become alkaline
Soil is high in nitrogen and the carbon contents at most of the places
However phosphors and potassium content is low. At all places the soi
exture is of sandy silt

AIR QUALITY AND NOISE QUALITY: Air and Noise monitoring i
arried out at 16 Locations near the proposed corridors;Th
oncentration of PM_{10} and $PM_{2.5}$ exceeds the standards at all location
whereas other parameters are within permissible limits at all th
ocations. The noise levels at all the 16 sites are more than the limi
rescribed for residential areas.

TREES: 16609 Trees are coming along the four alignment.

ENVIRONMENTAL ISSUES IN PROJECT CYCLE

Annexure 5.2

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
IMPACTS DUE TO PROJECT LOCATION				
i.	Displacement of People	■		
ii.	Change of Land use And Ecology	■		
iii.	Loss of Cultural and Religious Structures		▭	
iv.	Drainage & Utilities Problems	■		

ENVIRONMENTAL ISSUES IN PROJECT CYCLE

Annexure 5.2

IMPACT DUE TO PROJECT DESIGN

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
i.	Platforms - Inlets and Outlets			
ii.	Ventilation and Lighting			
iii.	Railway Station Refuse			
iv.	Risk due to Earthquakes			

ENVIRONMENTAL ISSUES IN PROJECT CYCLE

Annexure 5.2

IMPACT DUE TO PROJECT CONSTRUCTION				
S. No.	Parameter	Negative Impact	No Impact	Positive Impact
i.	Soil Erosion, Pollution and Health risk			
ii.	Traffic Diversions and Risk to Existing Buildings			
iii.	Problems of Soil Disposal and Seepage Risk			

ENVIRONMENTAL ISSUES IN PROJECT CYCLE

Annexure 5.2

IMPACT DUE TO PROJECT OPERATION				
S. No.	Parameter	Negative Impact	No Impact	Positive Impact
i.	Oil Pollution			
ii.	Noise			
iii.	Water Demands			
iv.	Pedestrian Issues			
v.	Visual Impacts			

Annexure 5.2

ENVIRONMENTAL ISSUES IN PROJECT CYCLE

IMPACT DUE TO PROJECT OPERATION				
S. No.	Parameter	Negative Impact	No Impact	Positive Impact
vi	Employment Opportunity			
vii.	Enhancement of Economy			
viii.	Mobility			
ix.	Safety			
x.	Traffic Congestion Reduction			

Annexure 5.2

ENVIRONMENTAL ISSUES IN PROJECT CYCLE

IMPACT DUE TO PROJECT OPERATION				
S.No.	Parameter	Negative Impact	No Impact	Positive Impact
xi	Less fuel Consumption			
xii	Less Air Pollution			
xiii	Carbon dioxide Reduction			
xiv	Reduction in Buses			
xv	Reduction in Infrastructure			

Annexure 5.2

DUE TO PROJECT LOCATION

Number of Family Affected

LINE	TITLE HOLDER	NON TITLE HOLDERS	TOTAL
Mukundpur to Yamuna Vihar (Line No. 7)	217	119	336
anakpuri West – Kalindi Kunj (Line No. 8)	98	94	192
Central Secretariat – Kashmiri Gate (Line No. 6) Extension	4	18	22
ahangirpuri – Badli (Line No.) Extension	0	28	28
Total	**319**	**259**	**578**

POSITIVE ENVIRONMENTAL IMPACTS

- **Employment Opportunities :**

  About **10,000** people are like to work during peak construction perio and **3726** persons will be employed during operation.

- **Saving In Passenger Time:**

  Average passenger time saved will be about **32.51** minutes.

- **Safety:**

  There will reduction in number of accidents due to less vehicles o road.

- **Less Fuel Consumption:**

Due to shift of passengers from road to Metro about **Rs 3,058** millio will be saved in 2016 and **Rs 4348** million in 2025

- **Less Air Pollution**

  Due to less vehicles on road due to Metro, Pollution will be com down in Delhi

- **Reduction in Number of Vehicles**

1760 buses will be reduce in 2025 with a capital cost of Rs **4682**

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

PRE-CONSTRUCTION /DESIGN STAGE

- **Compensatory Plantation:** Ten trees will be planted for each tre
ut.

- **Precaution For Natural Disaster**: Suitable seismic coefficient will b
dopted in the design of structure as per IS: 1893-2002. Station shall b
esigned for the 50-year flood level

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Annexure 5.2

CONSTRUCTION STAGE

- **Soil Disposal***:* Soil collection will be in containers from which soil shoul ot spill during disposal. The disposal site will be first cleaned and the reated so that leached water does not contaminate the ground water.

- **Utility Restoration***:* The utilities will be maintained in working condition uring different stages of construction, by temporary/ permanent diversion r by supporting in position.

- **Traffic Management:** This will be done through road widening, traffi egregation, one way movement, affic diversion on influence area oad, and utilization of service oads for traffic

CONSTRUCTION STAGE

Soil Erosion Control: Through bank protection and management

Air Pollution Control Measures:

- Transportation of construction material during non-peak hours.
- Use of ready mix concrete and pre-cast panels.
- Optimize operation time of construction machinery.
- Silent DG sets will be used and other machinery will be fitted with pollution control device.
- Sprinkling of roads daily to avoid dust.
- All dusty material will be properly covered during transportation.
- All Transportation equipments will be washed.

Air Pollution Control Measures:

Annexure 5.2

- Wheel washing/ manual cleaning of vehicles.
- During rains, the stockpile will be covered to prevent run-off.
- Dust control activities will be continue even during wor stoppages.

Water Pollution:

- Temporary drainage works at construction depots and batching plants .
- Sedimentation tank to be provided before discharge into the drain.
- Temporary storage sites for excavated material.
- Wastewater to be discharged to sewer after taking prior approval.
- Oil separator/inceptors will be installed at batching plant and construction depot.
- Construction work will be programmed to minimize soil excavation works in rainy season.

Waste Management

General refuse will be segregated and stored in enclosed bins.

Office waste will be reduced though recycling of paper

Disposal of chemical waste will be via a licensed waste collecto
uly authorized by MoEF or DPCB

The waste containers will be at least 50L/100L

Noise Control: Noise Control Will Be Achieved By:

- Use of silent generator.
- Job rotation, Automation, Noise barriers, and noise absorption material.
- Mounting of under frame equipments on anti-vibration pad,
- Provision of poly-carbonate sheets on the via-duct fo elimination of noise transmission.

ENVIRONMENTAL SANITATION

Annexure 5.2

ENVIRONMENTAL MONITORING

❖**Environment Monitoring Will Be Done For Both During Construction and Operation for:**

- Rehabilitation and Resettlement Programme,
- Ecology,
- Water Quality and Public Health,
- Air and Noise quality, and
- Soil Conservation

RESPONSE TO PUBLIC COMPLAINTS

THREE EXAMPLES

- Quality of Roads:
- Barricading/Traffic Management
- Noise and Vibrations

Inadequate Barricading of Road

Inadequate Barricading of Road

Improved Barricading of Road

SILENT VIBRO HAMMER

ENVIRONMENTAL MONITORING & COST

❖Environmental Cost

Total Environmental Cost for the project will be Rs 62.87 crores and Rehabilitation and Resettlement cost will be about 182.50 crores

THANK YOU

RITES
THE INFRASTRUCTURE PEOPLE

(A Government of India Enterprise)
Consultants - Concept To Commissioning

Annexure 7.1-7.3

Annexure 7.1

MONITORING FORMAT

1. Air Quality (Emission Gas/Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
PM_{10}						

2. A. Ground Water Quality (BIS : 10500)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
As per BIS 10500						

2. B. Water Quality (effluent / Wastewater / Ambient Water Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH						
TSS						
BOD						
COD						
Oil / Grease						
DO						

3. Noise / Vibration

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise level	dB(A					
Vibration level	dBV					

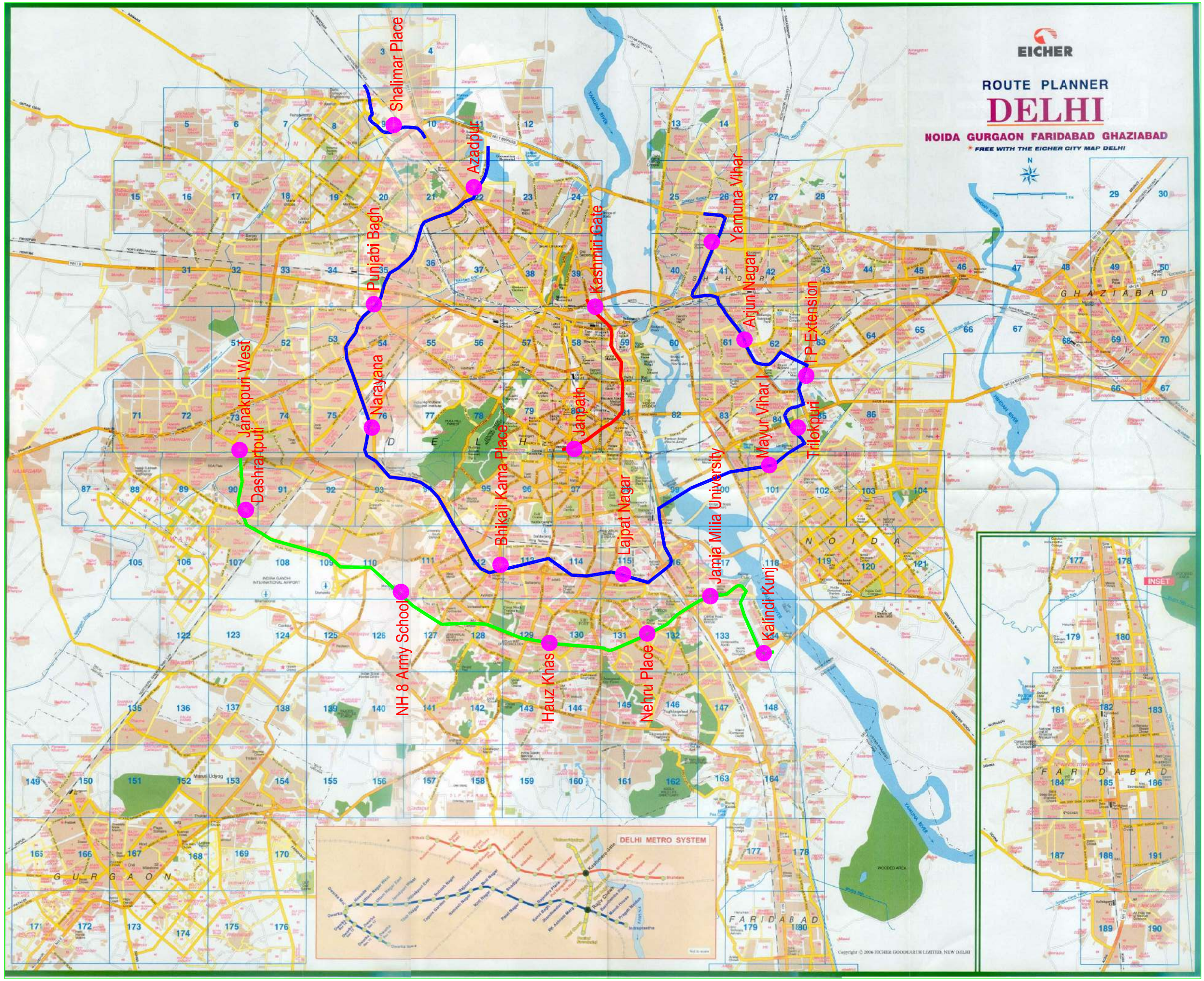
4. Solid Waste

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH						
Total Phenols						
lead						
cadmium						
chromium-VI						
Copper						
Nickel						
Mercury						
Zinc						
Fluoride						
Cyanide						
Calorific value						
Total Volatile						
Moisture						
Organic matter						
Total Ash						
Bulk Density						

5 Format for Flora Monitoring Report

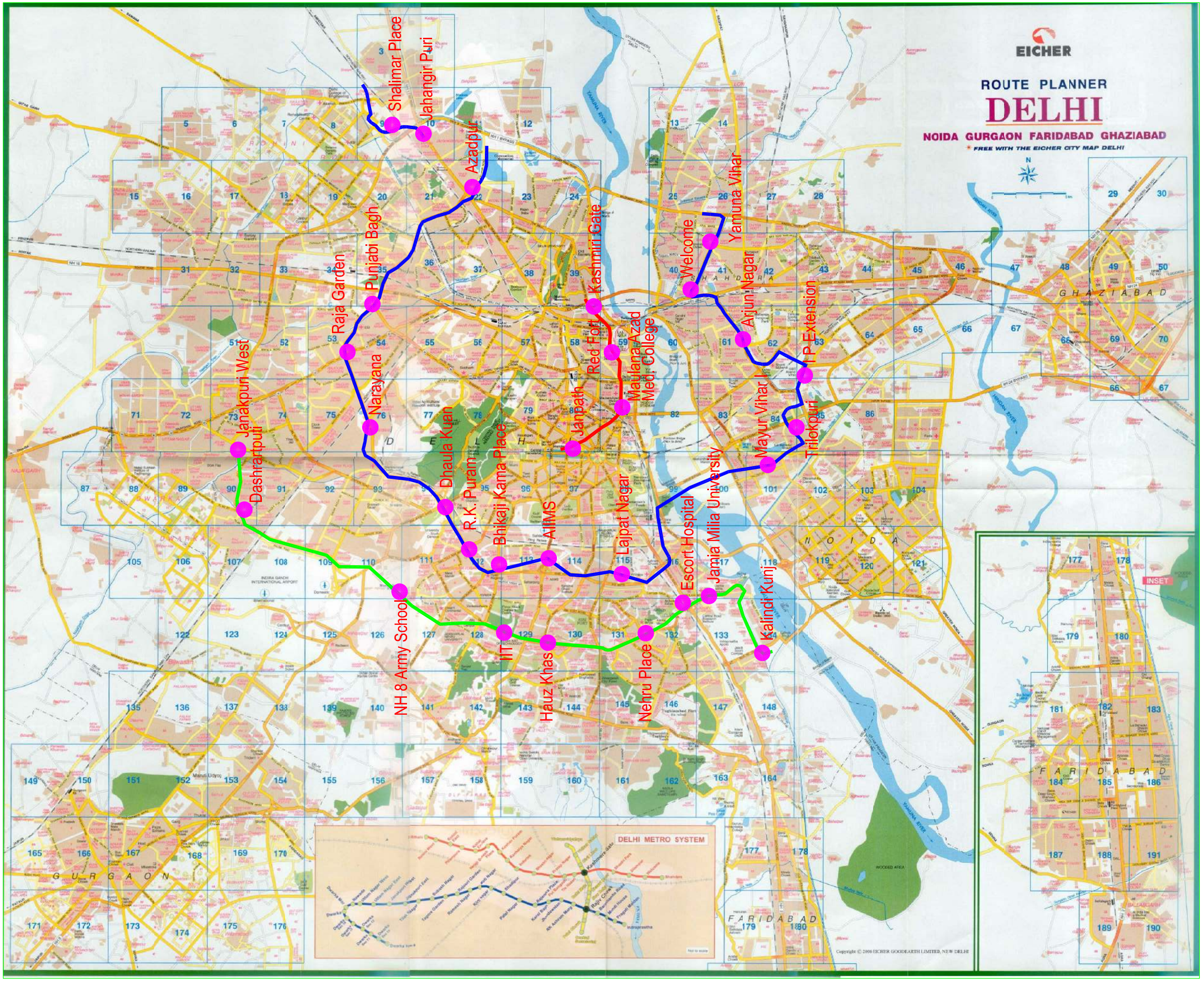
Local Name of Species	Scientific Name of the species	Location	Height (m)	Girth (cm)	Quantity (No.)	Storage Detail

AIR MONITORING LOCATIONS (CONSTRUCTION)

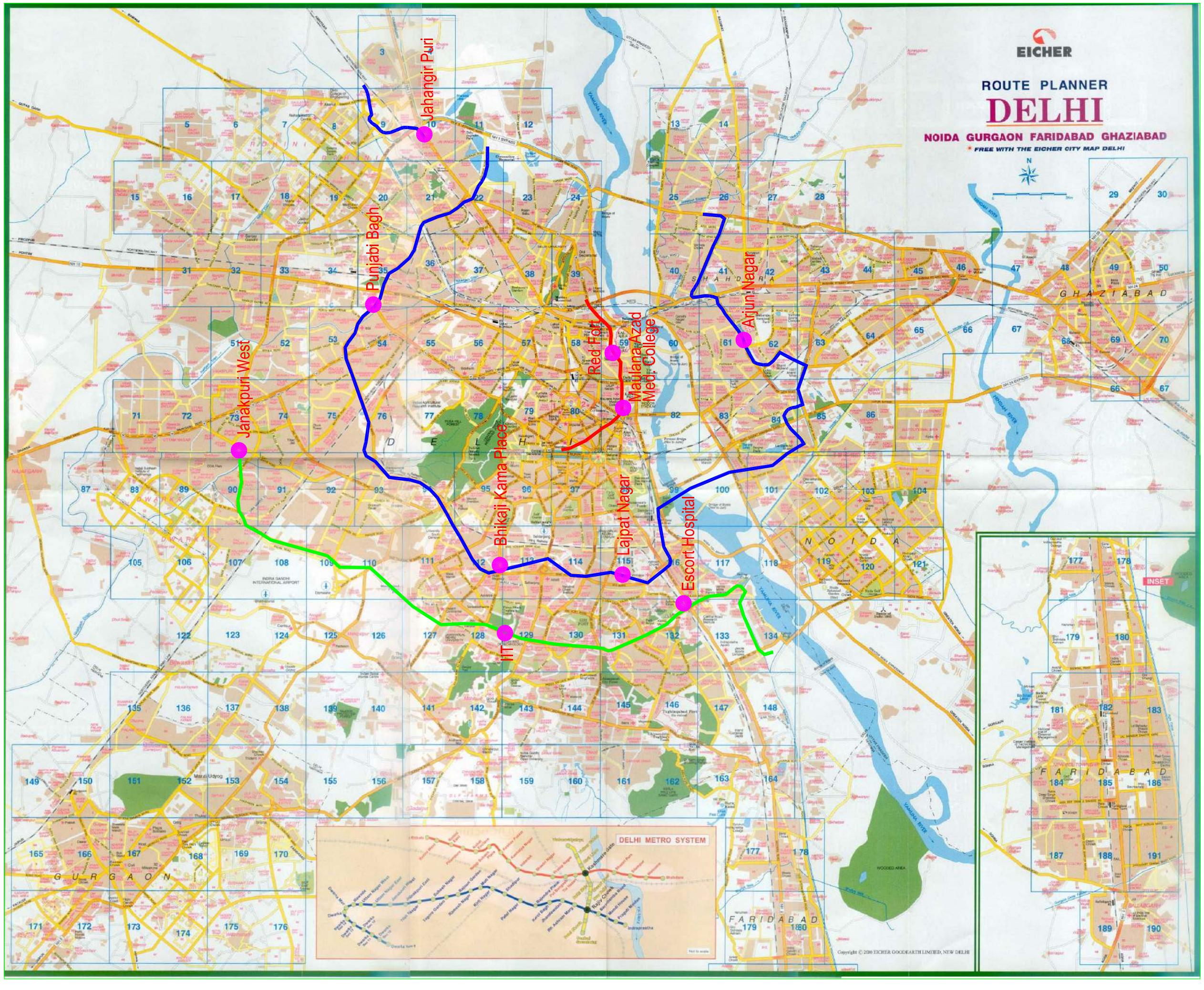


NOISE MONITORING LOCATIONS (CONSTRUCTION PHASE)

Annexure 7.2

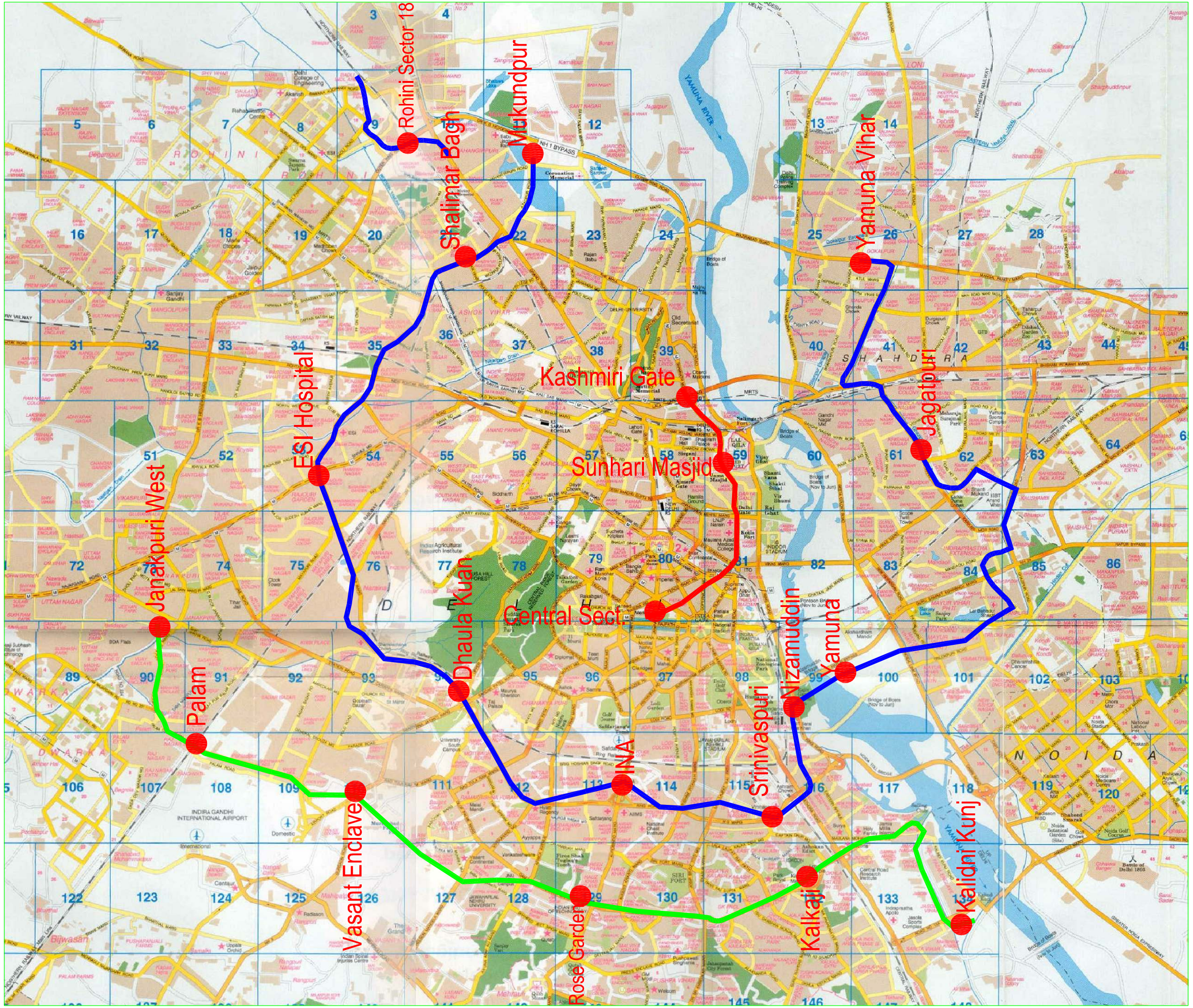


VIBRATION MONITORING LOCATIONS (CONSTRUCTION PHASE)

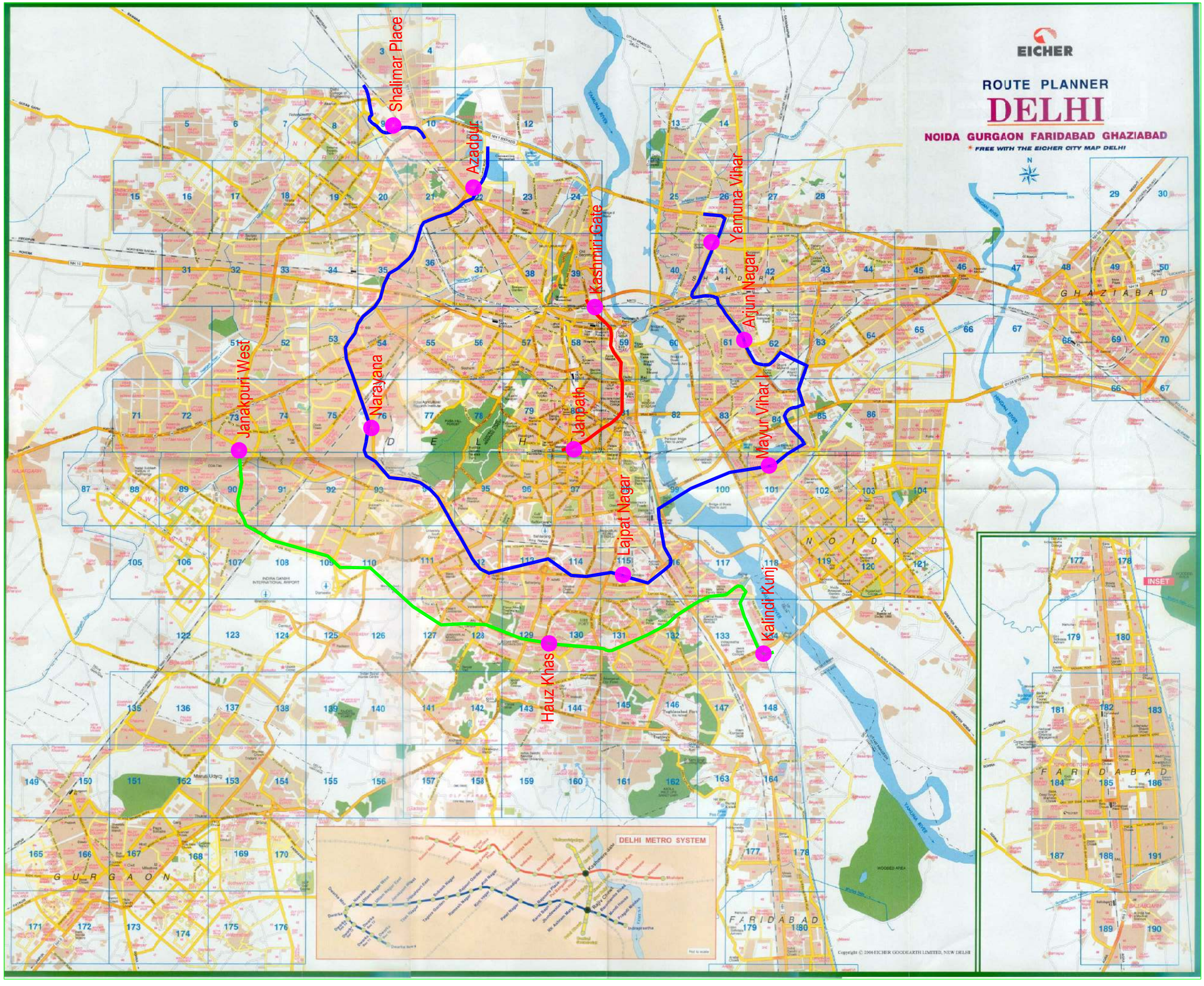


WATER MONITORING LOCATION (CONSTRUCTION PHASE)

Annexure 7.2

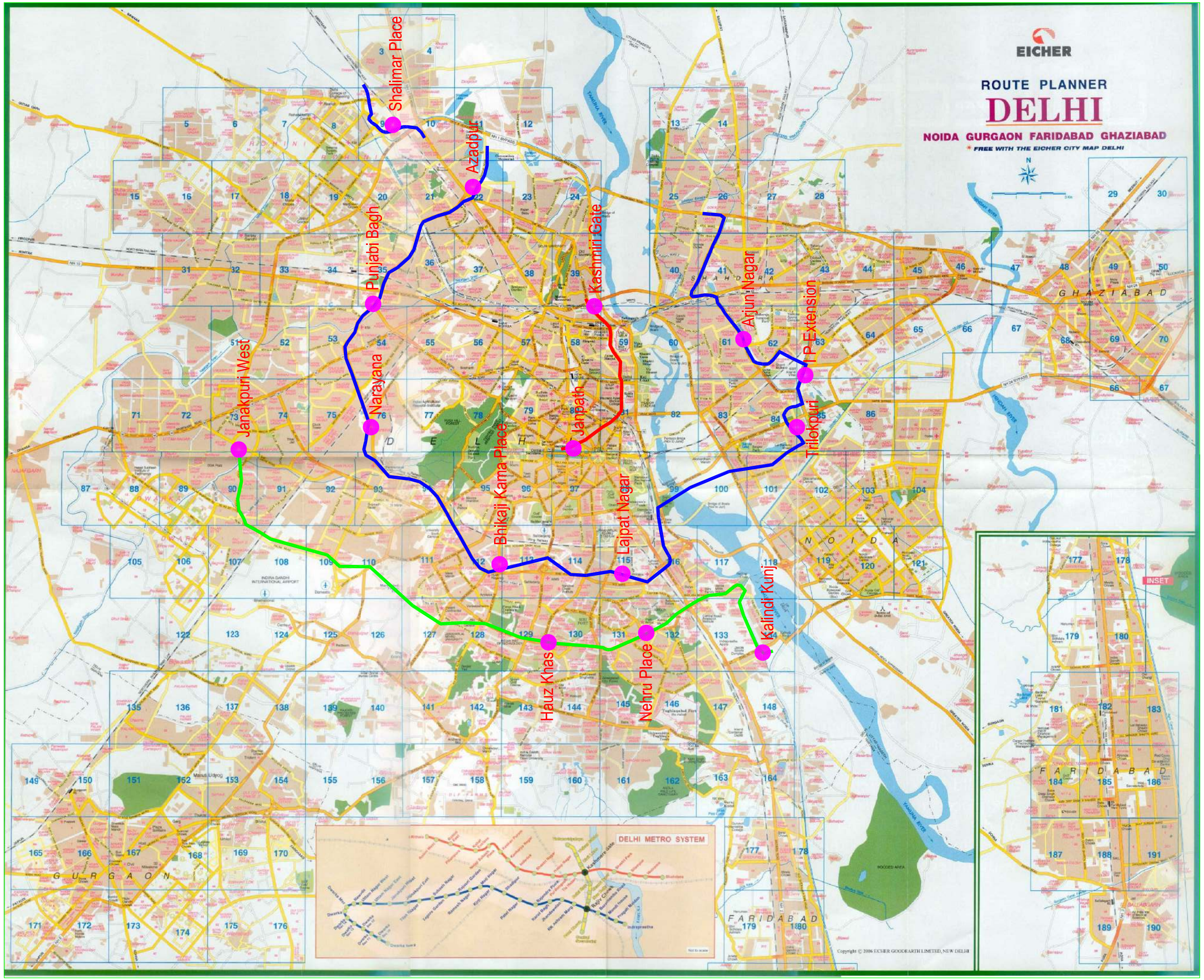


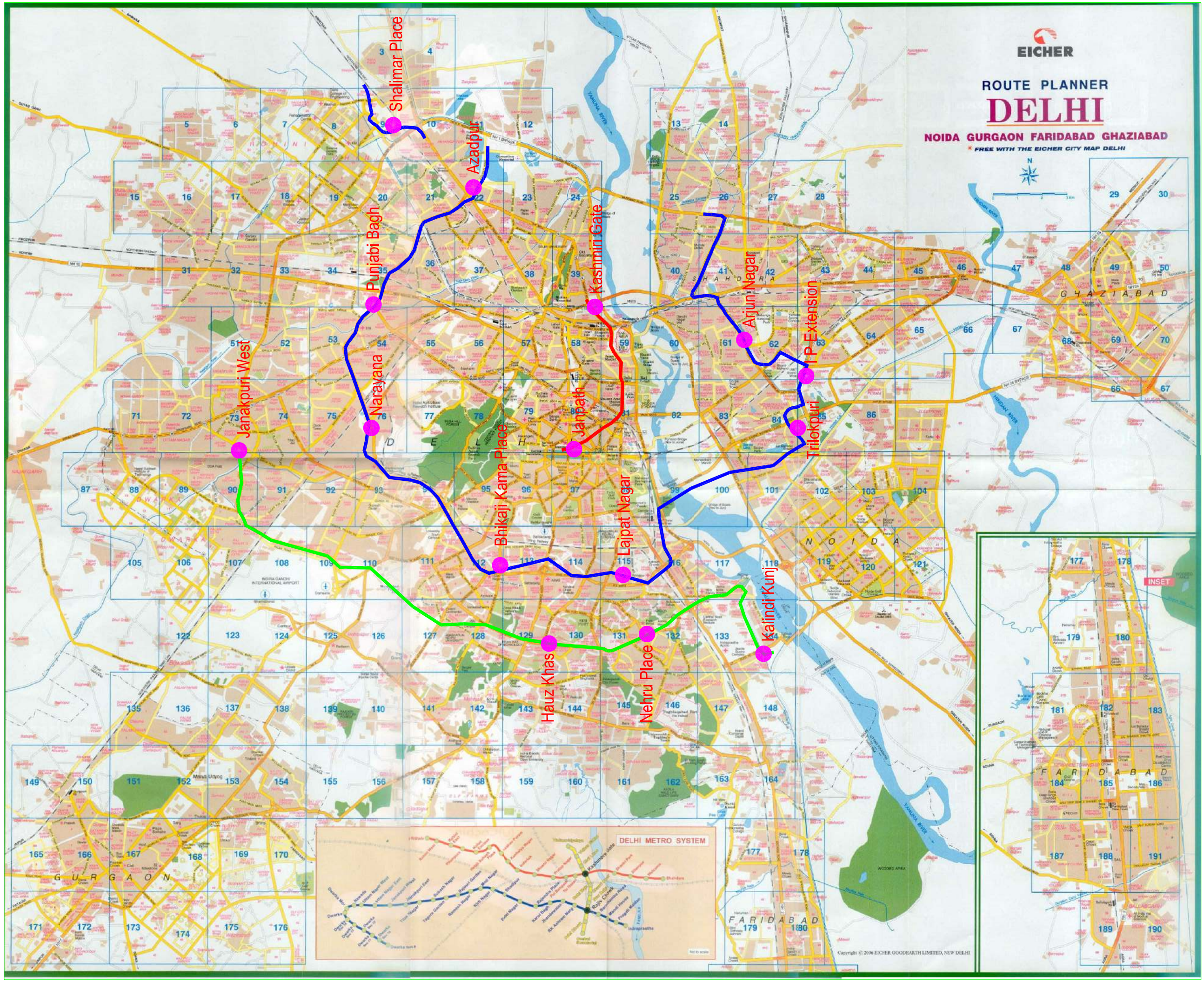
AIR MONITORING LOCATIONS (OPERATION PHASE)



NOISE MONITORING LOCATIONS (OPERATION PHASE)

Annexure 7.3

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Lajpat Nagar
Kalindi Kunj
Hauz Khas
Nehru Place
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INSET
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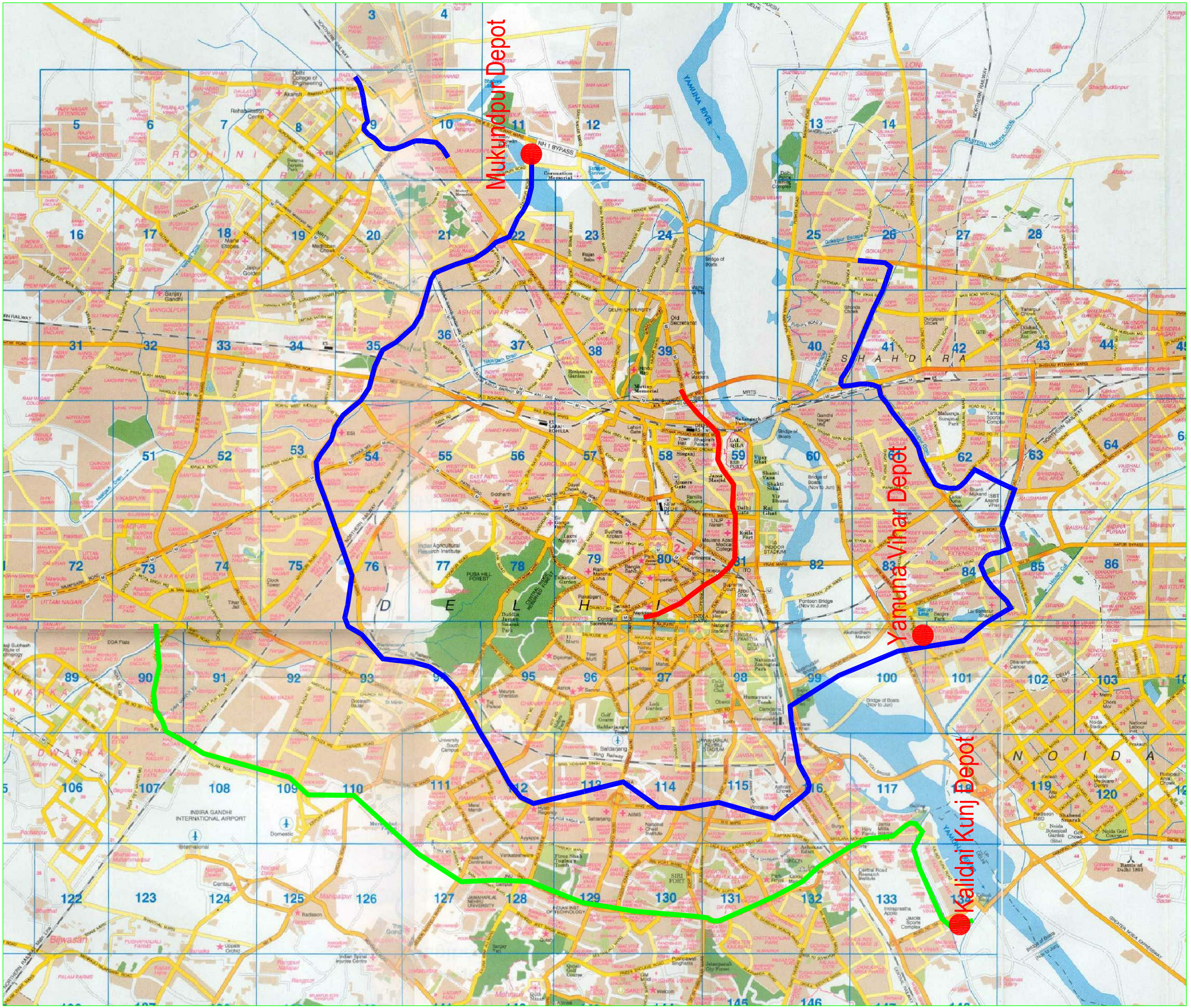
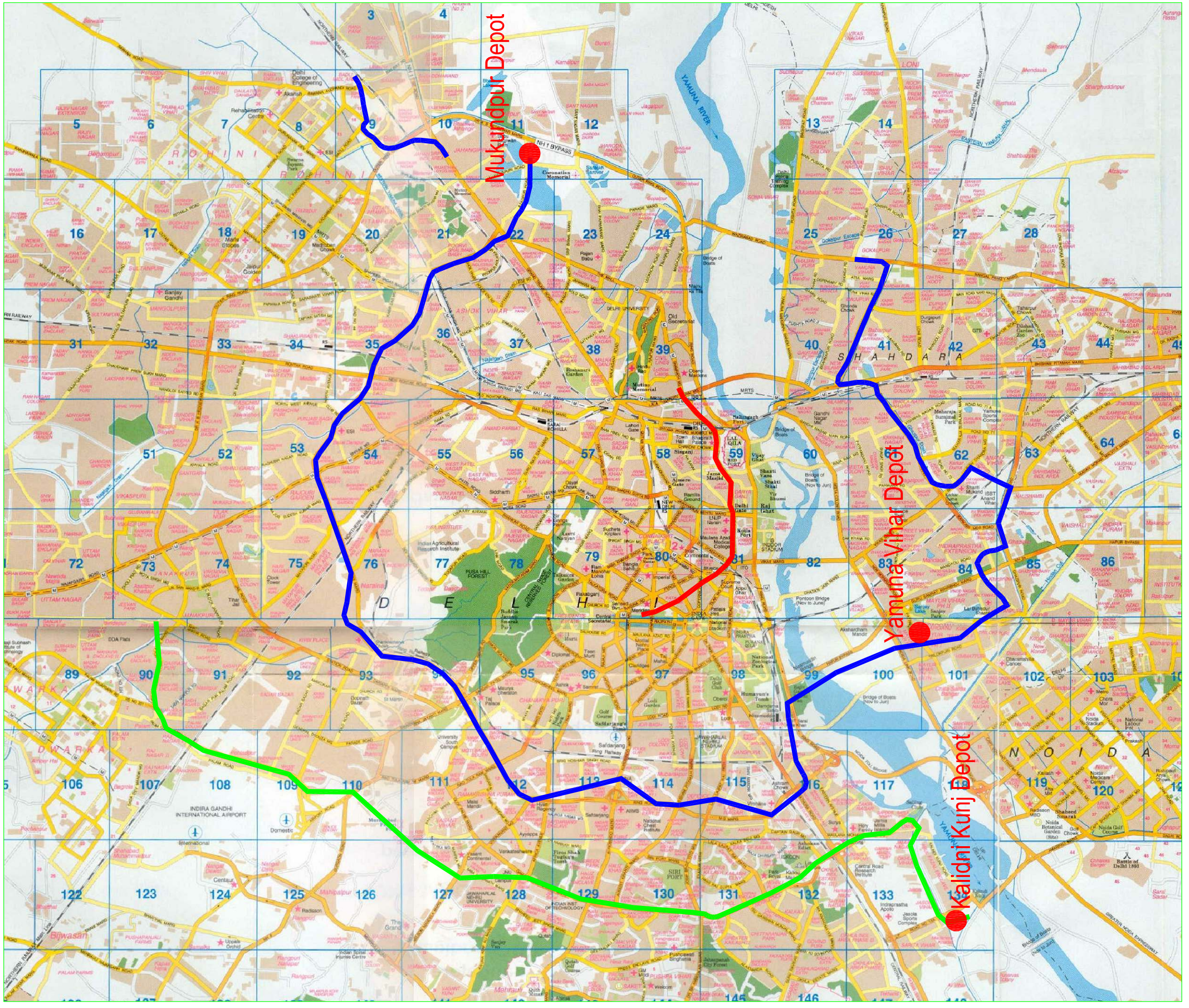
WATER MONITORING LOCATION (OPERATION PHASE)

Annexure 7.3



WASTE WATER MONITORING LOCATION (OPERATION PHASE)



SOLID WASTE MONITORING LOCATION (OPERATION PHASE)

Annexure 7.3