CHAPTER 1
INTRODUCTION

Background

Bangalore, the Capital of Karnataka is the Fifth Largest City in the Country and is growing at a rate, which is significantly higher than that of others. Due to the Growth in Economic Activities, the City is attracting migrants. To serve this Influx of Population, Residential Layouts are being developed. But adequate Transport Infrastructure Facilities such as Roads, Grade Separators, Subways, Mass Transit System, etc. to match this demand are conspicuously absent. The additional demand is to be catered by the already Saturated Road Network. Due to the Inherent Road Network in Bangalore, there are on the average 2 Major and 2 Minor Junctions per kilometer of Road Length. This has resulted in increase in Travel Time due to frequent Bottlenecks and Breakdowns.

1.1.2 The Urban Form of Bangalore is characterized by a Radio – Concentric System structured by Ring Roads, Five Major Radial Roads and Five Secondary Radial Roads. The Five Major Radial Roads are Mysore Road (SH – 17) in the South / South West, Old Madras Road (NH – 4) in the North / North East, Bellary Road in the North, Hosur Road (NH – 7) in the South – East and Tumkur Road in the North – West. Similarly, the Five Secondary Radial Roads include Magadi Road (SH – 17E) in the West, Kanakapura Road (NH – 209) in the South, Bannerghatta Road (SH – 86A) in the South, Varthur Road and Whitefield Road (SH – 56) in the East. The differentiated development of the City based on Geographical Sectors and the Star like Growth Array along the Major Roads, mark the change from a Concentric Spatial Growth to a Sectorial and Linear Radial Development.

1.1.3 The City had a population of 24.75 Lakh in 1981 and 65.00 Lakh in 2001. The extent of Developed Area has also increased considerably, in 1971 the Area was 174.7 Sq. km. and today it is about 800 Sq. km. In absence of Adequate Mass Transportation System, the use of personal motor vehicles for intra – city travel has increased substantially. This has resulted in growth of motor vehicles, which is four times the rate of population growth in the last two decades (1.91 Lakh vehicles in 1981 and 23 Lakh vehicles in 2005). The Public Transport System (Bus) is overstressed carrying about 50 Lakh Commuters in a daily basis. Congested Streets and Longer Route Length due to Urban Sprawl have only served to reduce Bus Frequencies further. In a recent study done by CRRI, it has been reported that annual traffic growth rates vary in the range of 2 – 4% in the central zone, 5 – 7% in the intermediate zone and 8 – 9% on the regional roads in Bangalore City. CRRI study also reported delays of 26.8 sec per km of travel and 9.9 seconds per minute of travel.

1.1.4 The combined effect of all these on the Road Network of Bangalore is Delay and Congestion beyond Tolerable Limits. Vehicular Conflicts at the Intersections are being eliminated by Traffic Signals but at the Expense of Delays and Long Queues. The Peak Hour has spread over a longer period of time, since there are no Perceptible Capacity Augmentation / Conflict Reduction Measures. Traffic related Problems have become Regular Phenomena on Bangalore Roads, due to the Vast Developments. This fact is substantiated by the Traffic Study Results at various Road Networks and Intersections of the City. Most of the Major Junctions of the Core City have crossed the mark of 10000 PCUs in the Peak Hour. Though number of Grade Separators have been constructed and

are being constructed, most of them are located in the Developed Part of the City and causing a Trigger of Congestion at adjacent Junctions. Traffic Management Measures such as One Way Systems, Parking Restrictions, Junctions Improvements, etc. are being implemented to ease the Congested Street Network. But the ever increasing Traffic is fast deteriorating the Limited Improvement in Level of Service these Traffic Management Measures can offer.

1.1.5 As a Comprehensive Development Programme for Improvement of Road Network, the Bruhat Bangalore Mahanagara Palike (BBMP) has planned Grade Separated Junction, Widening of Roads, Strengthening of Pavement Base and Sub – Base, Improvement to Pedestrian Facilities, Provision for Car Parking, etc. BBMP has constituted a separate cell to coordinate the Widening of Major Roads in Bangalore City in the face of Land Acquisition Challenges. This Response is the Answer to the severe strain on the Urban Infrastructure, which is inevitable due to the very rapid rate of growth in traffic. Travel Demands of Passengers have increased many folds in the last two decades. Unfortunately, Growth in the Infrastructure is not commensurate with the growing demands of traffic. There is an exigent need to effectively manage the Traffic and Transportation Systems to optimize the Solutions with Short Term and Long Term Measures.

1.1.6 One of the Practical Steps towards Optimal Solutions that will also give an Immediate Relief to Traffic Scenario is Capacity Augmentation. Capacity Augmentation is not possible without widening the high – density corridors. Increasing the capacity of important corridors is inescapable in the long run even if it entails Land Acquisition at high cost. The Land Acquisition is proposed through a Process of Conferring Development Rights (Transfer of Development Rights), by which the owner of the land who has surrendered the part of the land towards infrastructure projects would be allowed to carry out construction based on enhanced Floor Space Index (FSI) conferred by the TDRs.

1.1.7 The existing Road Network System of Bangalore is a major concern, both in terms of Conditions of Roads and the Structure of the Network. The Basic Structure is Radio – Concentric with about Ten Major Roads converging on the Centre. The Roads themselves are crowded and their Convergence creates Heavy Congestion. In order to ease the Traffic related Problems, the Bangalore Development Authority (BDA) constructed the Outer Ring Roads (ORR) connecting all Major Roads and Highways in and around Bangalore. The newly developed areas on the outer side of the Ring Road have caused much increase in Traffic across the Ring Road, which in turn is obstructing Flow of Traffic along the Ring Road and the ORR is currently heading towards a Saturated State of Flow, leading to Planning of New Road Infrastructure Development. With the introduction of Bruhat Bangalore Mahanagara Palike in January 2007, the City Development Area has increased considerably in the Outer Part of this Stretch of Ring Road and this in turn is increasing the Traffic Load in the Junctions.

1.1.8 The Project Corridor acts as an Important Link between Cantonment Area (Jayamahal, Shivaji Nagar, Benson Town, Cleveland Town, Cox Town, Cooke Town, Frazer Town, Ulsoor, etc.) and Eastern Part of the City (Domlur, Indira Nagar, Beniganahalli, K. R. Puram, White Field, etc). Before the Development of the Outer Ring Road, most part of

the Project Corridor was used for the Diversion of Heavy Traffic between NH – 4, i.e. between Tumkur Side and Krishna Raj Puram (K. R. Puram) Side. Presently, Traffic from well known Industrial Area like Peenya, Dasarahalli; from thickly developed Residential Areas in the Western Part of the City such as Malleshwaram, Yeshwanthapura, Mathikere; from well developed Colonial Residential Layout like Jayamahal, Shivaji Nagar, Benson Town, Cleveland Town, Cox Town, Cooke Town, Frazer Town, Ulsoor, Murphy Town; from well developed Commercial Hub like Indira Nagar, Domlur; uses this Corridor to reach Beniganahalli, K. R. Puram, ITPL, White Field, Kolar. The Study Corridor runs from the North Quadrant to the East Quadrant of the City. With the setting up of Software Industries (such as Oracle Software, Tata Consultancy Service, HCL Technologies, Bhoruka Tech Park, Brigade Tech Park, Google India Pvt. Ltd., RMZ Infinity Technology Park, etc.) in and around the Project Corridor, the growth of the techno polis has led to increase in traffic along the Corridor. The other main traffic attraction points along this Corridor are Fun World; Palace Ground; Doordarshan Kendra; Bangalore Cantonment Railway Station – the second major Railway Station in the City; various Educational Institutes; Shopping Malls like Gopalan Signature Mall, Big Bazaar; various Hospitals; Government Organisations like Indian Telephone Industry, Tin Factory; ABB Indian Corporate and Research Centre; high end Residential Apartments; BDA Complex at Indira Nagar; Ulsoor Lake; Sai Baba Ashram; Sathya Sai Super Speciality Hospital; etc. Further, with the spurt in the economy, the Land Use Patterns of this Part of the City Area have been changing at a very fast pace since 10 years. Many of the Residential Areas in and around this Corridor, such as Indira Nagar, Domlur, K. R. Puram, White Field, etc. are being converted into Partial Commercial Establishments. With this change in the Land Use Pattern, traffic along this Corridor has been increased considerably in last 10 years time. Apart from this, many large Residential Sites have been converted into Apartments / Flats along this Corridor and a site that would house either a family or two now will be able to house multiple number of families and with this the number of Vehicle / Traffic also has increased manifold in last 10 years. These being the Background, the Bruhath Bangalore Mahanagara Palike has proposed to construct Grade Separator using Pre Cast Element Technology at Major Junctions and to close Median at Minor Junctions with Appurtenant Link Improvements from Mekhri Circle to Hope Farm Junction via Old Madras Road covering a total of 29 Junctions (out of which, 20 Junctions have been taken for improvement) for a total length of 21 km in order to provide Uninterrupted, Seamless Traffic Flow and to Increase Level of Service along the Corridor.

1.2 Existing Junctions along the Project Corridor

The following Junctions are present along the Project Corridor.

- Mekhri Circle – Four Arm Junction.
- CIL Road Junction – Three ('T' Shaped) Arm Junction.
- Munireddy Palya Road Junction – Three ('Y' Shaped) Arm Junction.
- Jayamahal 5th Main Road Junction – Three ('T' Shaped) Arm Junction.
- Nandidurga Road Junction – Three ('Y' Shaped) Arm Junction.
- Junction near Cantonment Railway Station.
- Haines Road Junction – Five Arm Junction.
- Seppings Road Junction – Four Arm Junction.

- Kamaraj Road Junction – Four Arm Junction.
- Meanee Avenue Road Junction – Four Arm Junction.
- K. Venkatachala Circle – Three ('Y' Shaped) Arm Junction.
- Dhobighat Road Junction – Three ('Y' Shaped) Arm Junction.
- Thamarai Kannan Road Junction – Three ('Y' Shaped) Arm Junction.
- Murphy Road – Old Madras Road Junction – Three ('Y' Shaped) Arm Junction.
- Indira Nagar Double Road Junction – Three ('T' Shaped) Arm Junction.
- Indira Nagar 100 Feet Road Junction – Three ('T' Shaped) Arm Junction.
- Baiyyappanahalli Road Junction – Three ('Y' Shaped) Arm Junction.
- Indira Nagar 80 Feet Road Junction – Three ('T' Shaped) Arm Junction.
- Suranjan Das Road Junction – Four Arm Junction.
- N. G. E. F. Layout Road Junction – Three ('Y' Shaped) Arm Junction.
- Varthur Road Junction – Three ('Y' Shaped) Arm Junction.
- Beniganahalli Junction – Three ('Y' Shaped) Arm Junction.
- Krishna Raj Puram Junction – Three ('Y' Shaped) Arm Junction.
- Outer Ring Road – White Field Road Junction – Three ('Y' Shaped) Arm Junction.
- Junction near Hewlett Packard Office – Three ('T' Shaped) Arm Junction.
- Graphite Indian Road Junction – Three ('T' Shaped) Arm Junction.
- Hudi Main Road Junction – Four Arm Junction.
- Export Promotion Industrial Park (E. P. I. P.) Road Junction – Three ('T' Shaped) Arm Junction.
- Pattandur Agrahara Road Junction – Three ('T' Shaped) Arm Junction.
- Hope Farm Junction – Four Arm Junction.

1.3 Junctions proposed for Improvements

The following Junctions have been taken for the proposed Improvements.

- CIL Road Junction.
- Munireddy Palya Road Junction.
- Jayamahal 5th Main Road Junction.
- Nandidurga Road Junction.
- Haines Road Junction.
- Seppings Road Junction.
- Kamaraj Road Junction.
- Meanee Avenue Road Junction.
- K. Venkatachala Circle.
- Dhobighat Road Junction.
- Thamarai Kannan Road Junction.
- Murphy Road – Old Madras Road Junction.
- Indira Nagar Double Road Junction.
- Indira Nagar 80 Feet Road Junction.
- Suranjan Das Road Junction.
- Varthur Road Junction.
- Junction near Hewlett Packard Office.
- Hudi Main Road Junction.
- Export Promotion Industrial Park (E. P. I. P.) Road Junction.
- Pattandur Agrahara Road Junction.

- Hope Farm Junction.

Key Map of the Project Corridor proposed for Improvements is enclosed in **Annexure A.1.1**.

1.4 Contents of the Report

The Methodology, as detailed in the Project Proposal, has been followed for carrying out the necessary Investigations and Preparation of this Detailed Project Report.

This Report includes the following.

- Chapter 2: Objectives and Scope of Study
- Chapter 3: Study Corridor
- Chapter 4: Field Studies and Analysis
- Chapter 5: Planning and Design Considerations
- Chapter 6: Corridor Improvement Scheme
- Chapter 7: Design of Grade Separator
- Chapter 8: Traffic Management / Diversion and Traffic Engineering Schemes
- Chapter 9: Project Cost
- Chapter 10: Implementation Plan
- Chapter 11 Conclusion
- Chapter 12: Photographs
- Chapter 13: Drawings

CHAPTER 2
OBJECTIVE AND SCOPE OF STUDY

2.1 Objective

The Project has been taken up to address the Traffic related Problems on the Project Corridor. The Study Area spans from Mekhri Circle to Hope Farm Junction via Old Madras Road. This Stretch has been selected primarily keeping in mind that this is the Important Link providing connectivity between Cantonment Area (Jayamahal, Shivaji Nagar, Benson Town, Cleveland Town, Cox Town, Cooke Town, Frazer Town, Ulsoor, etc.) and Eastern Part of the City (Domlur, Indira Nagar, Beniganahalli, K. R. Puram, White Field, etc).

The Primary Objectives of the Study are

- To effectively and optimally manage Traffic on the Corridor.
- To conduct necessary Surveys and Investigations to arrive at Alignment Alternatives for Traffic Improvement along the Corridor.
- To suggest Optimal and Feasible Grade Separation Schemes and Appurtenant Link Improvement Measures to reduce travel time.
- To improve the existing Junctions to streamline Traffic Flow at Grade Level.
- To improve the Environmental Conditions of the Corridor by reducing Idle Time.
- To reduce the Vehicle Operation Cost of the Road Users.
- To reduce Traffic Accidents.

To summarise, the Main Objective of the Study of this Corridor is to offer to the Road Users commuting through this Corridor Comprehensive Connectivity, Convenience, Comfort, Affordability, Safety and Aesthetics.

2.2 Project Scope

The Scope of the Study to be carried out by the Consultant involves the following.

- Review of Available Data and Reports.
- Topographical Survey of the Corridor.
- Necessary Traffic Survey to obtain Data and its Analysis for the Concept Proposal.
- Geotechnical Investigation.
- Work out Traffic Management / Diversion and Traffic Engineering Schemes during Project Execution.
- Work out Land Acquisition Details.
- Engineering Designs along with Detailed Estimate of the approved Concept.
- To study the Environmental and Social Impacts that can be caused due to the Construction.
- Project Scheduling.
- Preparation of Bid Documents to finalise Execution Agency.

2.3 Approach Methodology

The Activities that are involved in the Preparation of Detailed Project Report for Signal Free Corridor from Mekhri Circle to Hope Farm Junction via Old Madras Road are briefed below.

2.3.1 Stage 1

- To define the Objective and Scope of Work.
- To plan Approach and Methodology, Data Collection.
- Carry out Field Reconnaissance Survey that includes Site Appreciation, Identification of Survey Locations and Site Constraints.

2.3.2 Stage 2

- Data Collection
  - Engineering Surveys and Investigations
    1. Classified Turning Traffic Volume Survey.
    2. Origin Destination Survey.
    3. Vehicular Delay and Accumulation Survey.
    4. Occupancy Survey.
    5. Topographic Survey.
    6. Geotechnical Investigation.
  - Secondary Data
    1. Economic Indicators affecting Traffic Growth.
    2. Past Accident Data.
    3. Details of on going Road Improvements, Junction Improvements, Grade Separator Schemes, Footpath Improvement Schemes and Metro Rail Alignment along the Project Stretch.

- Analysis of Traffic Volume Count in deciding the Alignment of Grade Separation Scheme and other Corridor Improvement Schemes.
- Analysis of Surface Level Improvements based on the Traffic Data and Proposed Grade Separation Scheme.
- Analysis of Traffic Circulation at Surface Level on Proposed Scheme.
- Design suitable Traffic Improvement Measures to reduce Conflicting Traffic Stream.
- Preparation of Layout Drawings and Longitudinal Sections of all the Proposals conceptualized.
- Work out Land Acquisition Details, if any, for the Proposed Alternatives.
- Costing based on Block / Line Estimate.
- Analysis of Traffic Diversion and Management Scheme during Project Execution.

2.3.3 Stage 3

- Engineering Designs, Drawings and Longitudinal Sections of the Approved Concept.
- Land Acquisition Details for the Approved Concept.
- Detailed Cost Estimate.
- Traffic Diversion and Management Scheme during project execution.

2.3.4 Stage 4

- Preparation of Tender and Contract Documents.

2.4 Design Philosophy

The Design Standards that will be adopted in the Design of Corridor Improvement Schemes shall be in accordance with the Codal Provisions of India as stipulated by the

Indian Road Congress (IRC), Indian Standard Specifications (IS) and the Ministry of Road Transport & Highways (MoRT&H). Deviations may be considered in planning parameters, if absolutely necessary, considering the Dense Urban Conditions from the present Codal Provisions. These Modifications in the Design shall be adopted based on Sound Engineering Practices.

The Designs and Drawings of the Approved Concept that will be presented as part of the Detailed Project Report shall be based on the Studies and Investigations carried out at Site, i.e. Traffic Data, Existing Utilities, Geotechnical Data, Soil Profile, etc.

CHAPTER 3
STUDY CORRIDOR

3.1 Study Corridor

The Study Corridor runs from the North Quadrant to the East Quadrant of the City. The Project Corridor acts as an Important Link between Cantonment Area (Jayamahal, Shivaji Nagar, Benson Town, Cleveland Town, Cox Town, Cooke Town, Frazer Town, Ulsoor, etc.) and Eastern Part of the City (Domlur, Indira Nagar, Beniganahalli, K. R. Puram, White Field, etc). It starts from Mekhri Circle on Jayamahal Road and ends at Hope Farm Junction near White Field. This Corridor consists of six stretches of roads i. e. Jayamahal Road (between Mekhri Circle and Cantonment Railway Station), Millers Road (between Cantonment Railway Station and Nandidurga Road Junction), St. John's Church Road (between Haines Road Junction and Meanee Avenue Road Junction), Kensington Road (between K. Venkatachala Circle and Dhobighat Road Junction), Murphy Road (between Dhobighat Road Junction and Murphy Road – Old Madras Road Junction), Old Madras Road (between Murphy Road – Old Madras Road Junction and K. R. Puram Junction) and White Field Road (between K. R. Puram Junction and Hope Farm Junction). The Metro Alignment is passing along the corridor from Indira Nagar 100 Feet Road Junction to Baiyyappanahalli Road Junction along Old Madras Road.

3.2 Salient Features of the Corridor

1. Total Length of the Corridor – 21 km.
2. Important Junctions along the Corridor
   - Mekhri Circle – Four Arm Junction.
   - CIL Road Junction – Three ('T' Shaped) Arm Junction.
   - Munireddy Palya Road Junction – Three ('Y' Shaped) Arm Junction.
   - Jayamahal 5th Main Road Junction – Three ('T' Shaped) Arm Junction.
   - Nandidurga Road Junction – Three ('Y' Shaped) Arm Junction.
   - Junction near Cantonment Railway Station – Four Arm Junction.
   - Haines Road Junction – Five Arm Junction.
   - Seppings Road Junction – Four Arm Junction.
   - Kamaraj Road Junction – Four Arm Junction.
   - Meanee Avenue Road Junction – Four Arm Junction.
   - K. Venkatachala Circle – Three ('Y' Shaped) Arm Junction.
   - Dhobighat Road Junction – Three ('Y' Shaped) Arm Junction.
   - Thamarai Kannan Road Junction – Three ('Y' Shaped) Arm Junction.
   - Murphy Road – Old Madras Road Junction – Three ('Y' Shaped) Arm Junction.
   - Indira Nagar Double Road Junction – Three ('T' Shaped) Arm Junction.
   - Indira Nagar 100 Feet Road Junction – Three ('T' Shaped) Arm Junction.
   - Baiyyappanahalli Road Junction – Three ('Y' Shaped) Arm Junction.
   - Indira Nagar 80 Feet Road Junction – Three ('T' Shaped) Arm Junction.
   - Suranjan Das Road Junction – Four Arm Junction.
   - N. G. E. F. Layout Road Junction – Three ('Y' Shaped) Arm Junction.
   - Varthur Road Junction – Three ('Y' Shaped) Arm Junction.
   - Beniganahalli Junction – Three ('Y' Shaped) Arm Junction.
   - Krishna Raj Puram Junction – Three ('Y' Shaped) Arm Junction.

- Outer Ring Road – White Field Road Junction – Three ('Y' Shaped) Arm Junction.
- Junction near Hewlett Packard Office – Three ('T' Shaped) Arm Junction.
- Graphite Indian Road Junction – Three ('T' Shaped) Arm Junction.
- Hudi Main Road Junction – Four Arm Junction.
- Export Promotion Industrial Park (E. P. I. P.) Road Junction – Three ('T' Shaped) Arm Junction.
- Pattandur Agrahara Road Junction – Three ('T' Shaped) Arm Junction.
- Hope Farm Junction – Four Arm Junction.

Key Map of the Study Corridor is enclosed in **Annexure A.1.1** and the Existing Views of the Junctions are enclosed in **Chapter 9 – Photographs**.

3. Two Way Movements with at least three lane are seen along this Corridor. Some Stretches are wider with Road Divider and Physical Separator (Island, Rotary). Footpath is present on either side throughout the Corridor.
4. The Study Area caters to considerable local and through amount of traffic commuting between Cantonment Area (Jayamahal, Shivaji Nagar, Benson Town, Cleveland Town, Cox Town, Cooke Town, Frazer Town, Ulsoor, etc.) and Eastern Part of the City (Domlur, Indira Nagar, Beniganahalli, K. R. Puram, White Field, etc). Further, with the setting up of Software Industries (such as Oracle Software, Tata Consultancy Service, HCL Technologies, Bhoruka Tech Park, Brigade Tech Park, Google India Pvt. Ltd., RMZ Infinity Technology Park, etc.) in and around the Project Corridor, the growth of the techno polis has led to increase in traffic along the Corridor. With the spurt in the economy, the Land Use Patterns of this Part of the City Area have been changing at a very fast pace since 10 years. Many of the Residential Areas in and around this Corridor, such as Indira Nagar, Domlur, K. R. Puram, White Field, etc. are being converted into Partial Commercial Establishments. With this change in the Land Use Pattern, traffic along this Corridor has been increased considerably in last 10 years time.
5. The Study Area is located in Thickly Developed Residential, Colonial Residential and Commercial Area and is surrounded by some of the well known establishments like Fun World; Palace Ground; Doordarshan Kendra; Bangalore Cantonment Railway Station – the second major Railway Station in the City; various Educational Institutes; Shopping Malls like Gopalan Signature Mall, Big Bazaar; various Hospitals; Government Organisations like Indian Telephone Industry, Tin Factory; ABB Indian Corporate and Research Centre; high end Residential Apartments; BDA Complex at Indira Nagar; Ulsoor Lake; Sai Baba Ashram; Sathya Sai Super Speciality Hospital; Software Industries such as Oracle Software, Tata Consultancy Service, HCL Technologies, Bhoruka Tech Park, Brigade Tech Park, Google India Pvt. Ltd., RMZ Infinity Technology Park, etc.
6. The Local Public Transportation is primarily being met by the Bangalore Metropolitan Transport Corporation (BMTC), originating at Majestic Bus Stand, Shivaji Nagar Bus Stand, Domlur Bus Stand and Indira Nagar Bus Stand and destined to Hebbal, Jayamahal, Benson Town, Vasant Nagar, Vivek Nagar, Ulsoor, Lingarajapuram, Indira Nagar, Domlur, Old Madras Road, Old Airport Road, Marathalli, Beniganahalli, Varthur, K. R. Puram, White Field.

7. This Corridor caters to the movement of Intra and Inter State Public Transport, originating at the Main Bus Stand (Kempe Gowda Bus Stand).
8. This Corridor caters to the movement of Private Software Company Vehicles.
9. This Corridor interfaces with Bellary Road (NH – 7) near Mekhri Circle, Outer Ring Road near Beniganahalli and White Field, State Highway – 35 near Hope Farm Junction.

3.3 Junction Details

3.3.1 Mekhri Circle

3.3.1.1 Physical Details

This Junction is located about 5.5 km away from the Kempegowda Bus Terminal. This is a typical four legged intersection in which Bellary Road forms North – South Axis and Road towards Jayamahal Road and Road towards C. V. Raman Road forms East – West Axis. Six lane divided bi directional Underpass is present along Bellary Road Axis.

3.3.2 C. I. L. Road Junction

3.3.2.1 Physical Details

This Junction is located about 920m away from the Mekhri Circle. This is a typical three legged ('T' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards C. I. L. Road Side of the Intersection

This part of the Road is divided bi directional with 0.30m wide Median. The Carriageway width varies between 9.7m and 13m near the Junction whereas the ROW of this Road varies between 15.8m and 17.8m. The Gradient is slopping away from the Junction. Either side of this Stretch is populated with well developed Commercial and Residential Establishments.

Arm towards Jayamahal 5th Main Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.25m wide Central Median. The Carriageway width varies between 12.9m and 11.5m near the Junction whereas the ROW of this Road varies between 18m and 20m. The Gradient is slopping away from the Junction. Palace Ground is present on western side of this stretch; Doordarshan Kendra, various Commercial and Residential Establishments are present on eastern side of this Stretch.

Arm towards Mekhri Circle Side of the Intersection

This part of the Road is divided bi directional with 0.15m wide Central Median. The Carriageway width varies between 10.8 and 11.5m near the Junction whereas the ROW of this Road varies between 21m and 25.8m. The Gradient is slopping towards the Junction. Palace Ground is present on western side of this stretch and Commercial and Residential Establishments are present on eastern side of this Stretch.

3.3.3 Munireddy Palya Road Junction

3.3.3.1 Physical Details

This Junction is located about 520m away from the CIL Road Junction. This is a three legged ('Y' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards C. I. L. Road Side of the Intersection

This part of the Road is divided bi directional with 0.26m wide Median. The Carriageway width varies between 15.5m and 17m near the Junction whereas the ROW of this Road varies between 20.85m and 25.6m. The Gradient is slopping towards the Junction. Either side of this Stretch is populated with well developed Commercial and Residential Establishments.

Arm towards Jaichamaraja Nagar Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width varies between 9.41m and 13.96m near the Junction whereas the ROW of this Road varies between 11m and 20m. The Gradient is slopping away from the Junction. Well Developed Commercial and Residential Establishments are present on either side of this Stretch.

Arm towards Jayamahal 5th Main Road Side of the Intersection

This part of the Road is divided bi directional with 0.35m wide Central Median. The Carriageway width varies between 17.6 and 20.36m near the Junction whereas the ROW of this Road varies between 21m and 25m. The Gradient is slopping away from the Junction. Palace Ground is present on western side of this stretch and Commercial and Residential Establishments are present on eastern side of this Stretch.

3.3.4 Jayamahal 5th Main Road Junction

3.3.4.1 Physical Details

This Junction is located about 1.04 km away from the C. I. L. Road Junction. This is a typical three legged ('T' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards 5th Main Road Side of the Intersection

This part of the Road is divided bi directional with 0.4m wide Central Median. The Carriageway width of this stretch varies between 8.8m and 13.2m near the Junction whereas the ROW of this Road varies between 18m and 22.5m. Well developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Cantonment Railway Station Side of the Intersection

This part of the Road is divided bi directional with 0.25m wide Central Median. The Carriageway width of this stretch is 17.5m near the Junction whereas the ROW of this Road varies between 23m and 25.5m. The Gradient is slopping away from the Junction. Vacant land is present on western side of this stretch and Commercial Establishments are present on eastern side of this Stretch.

Arm towards C. I. L. Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.35m wide Central Median. The Carriageway width of this Stretch varies between 16m and 17m near the Junction

whereas the ROW of this Road varies between 19m and 24.3m. The Gradient is slopping towards the Junction. Vacant land is present on western side of this stretch and Commercial Establishments are present on eastern side of this Stretch.

3.3.5 Junction near Cantonment Railway Station

3.3.5.1 Physical Details

This Junction is located about 760m away from the Jayamahal 5th Main Road Junction. This is a typical four legged intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Jayamahal 5th Main Road Junction Side of the Intersection

This part of the Road is divided bi directional. The Carriageway width along this Stretch varies between 11.8m and 15m near the Junction whereas the ROW of this Road varies between 21.6m and 23.8m. The Gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Nandidurga Road Junction Side of the Intersection

This part of the Road is divided bi directional. The Carriageway width of this Stretch varies between 13m and 15.5m near the Junction whereas the ROW of this Road is 20m. The Gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Cantonment Railway Station Road Side of the Intersection

This part of the Road is divided bi directional. The Carriageway width along this Stretch varies between 10.5m and 15.5m near the Junction whereas the ROW of this Road varies between 13m and 18.5m. The Gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Millers Road Side of the Intersection

This part of the Road is divided bi directional with Physical Separator and Median. The Carriageway width along this Stretch varies between 50m and 63.5m whereas the ROW of this Road varies between 77m and 82m. The Gradient is slopping away from the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

3.3.6 Nandidurga Road Junction

3.3.6.1 Physical Details

This Junction is located about 560m away from Cantonment Railway Station. This is a typical three legged ('Y' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Cantonment Railway Station Road Side of the Intersection

This part of the Road is divided bi directional with 0.25m wide Median. The Carriageway width varies between 13m and 14.5m near the Junction whereas the ROW of this Road varies between 18m and 19m. The Gradient is slopping towards the Junction. Well

developed Commercial and Residential Establishments, Railway Offices and Quarters are present along this stretch of Road.

Arm towards Nandidurga Road Side of the Intersection

This part of the Road is divided bi directional. The Carriageway Width of this Stretch varies between 7.5m and 9m near the Junction whereas the ROW of this Road varies between 9.5m and 11.5m. The Gradient is gently slopping towards the Junction. This Stretch of Road passes through well developed Commercial and Residential Establishments.

Arm towards Haine's Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.80m wide Median. The Carriageway width varies between 15m and 16m near the Junction whereas the ROW of this Road varies between 18m and 20m. The Gradient is slopping away from the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

3.3.7 Haines Road Junction

3.3.7.1 Physical Details

This Junction is located about 600m away from the Nandidurga Road Junction. This is a typical five legged intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Nandidurga Road Junction Side of the Intersection

This part of the Road is divided bi directional with 2.20m wide Median. The Carriageway width along this Stretch varies between 20m and 24.5m near the Junction whereas the ROW of this Road varies between 26m and 29m. This Stretch of the Road passes through well developed Residential and Commercial Establishments.

Arm towards Tannery Road Side of the Intersection

This part of the Road is undivided uni directional. The Carriageway width of this Stretch varies between 7.50m and 12.5m near the Junction whereas the ROW of this Road varies between 11.5m and 16m. The Gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Seppings Road Junction Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 12.5m and 15m near the Junction whereas the ROW of this Road varies between 18.5m and 20m. This Stretch of Road passes through well developed Residential and Commercial Establishments.

Arm towards Haines Road Side of the Intersection

This part of the Road is undivided uni directional. The Carriageway width along this Stretch varies between 11.8m and 13.6m near the Junction whereas the ROW of this Road varies between 18.9m and 19.9m. The Gradient is sloping away from the Junction.

Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards New Bamboo Bazaar Side of the Intersection

This part of the Road is undivided uni directional. The Carriageway width along this Stretch of the Road varies between 6.5 and 7.5m near the Junction. ROW of this Road varies between 10.5m and 11m. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

3.3.7.2 Site Constraints

- Transformers are present near the Junction along arm towards Haines Road.

3.3.8 Seppings Road Junction

3.3.8.1 Physical Details

This Junction is located about 280m away from the Haines Road Junction. This is a typical four legged intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Haines Road Junction Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 18.8m and 20m near the Junction whereas the ROW of this Road varies between 27.5m and 31.8m. Well developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Saunders Road Side of the Intersection

This part of the Road is undivided uni directional. The Carriageway width along this Stretch varies between 9.5m and 14.5m near the Junction. ROW of this Road varies between 15.5 and 16.5m. The Gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Seppings Road Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 8m and 12.5m near the Junction. ROW of this Road varies between 14m and 15m. The Gradient is slopping away from the Junction. This Stretch of the Road passes through well developed Residential and Commercial Establishments.

Arm towards Kamaraj Road Junction Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 13.5m and 14.27m whereas the ROW of this Road varies between 19.5m and 20m. This Stretch of Road passes through well developed Educational Establishments and Religious Establishments.

3.3.9 Kamaraj Road Junction

3.3.9.1 Physical Details

This Junction is located about 500m away from the Seppings Road Junction. This is a typical four legged intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Seppings Road Junction Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 11m and 12m near the Junction whereas the ROW of this Road varies between 16m and 17m. The Gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Wheelers Road Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 12m and 13.5m near the Junction. ROW of this Road varies between 18m and 19.5m. The Gradient is slopping away from the Junction. This Stretch of Road passes through well developed Institutional Buildings, Religious Establishments, Residential and Commercial Establishments.

Arm towards Meanee Avenue Road Junction Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 12.5m and 20m near the Junction whereas the ROW of this Road varies between 16m and 21.50m. The Gradient is slopping away from the Junction. This Stretch of Road passes through well developed Institutional Buildings, Stadium, Residential and Commercial Establishments.

Arm towards Kamaraj Road Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 9m and 11.3m near the Junction whereas the ROW of this Road varies between 13.4m and 18.5m. Well developed Commercial and Residential Establishments, Institutional Buildings, Religious Establishments are present along this stretch of Road.

3.3.10 Meanee Avenue Road Junction

3.3.10.1 Physical Details

This Junction is located about 400m away from the Kamaraj Road Junction. This is a typical four legged intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Kamaraj Road Junction Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 13m and 15.5m near the Junction whereas the ROW of this Road varies between 15.5m and 18m. The Gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments, Institutional Buildings are present along this stretch of Road.

Arm towards Promenade Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.35m wide Central Median. The Carriageway width along this Stretch varies between 14m and 15m near the Junction whereas the ROW of this Road varies between 19.5m and 26m. The Gradient is slopping away from the Junction. Well developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards K. Venkatachala Circle Side of the Intersection

This part of the Road is divided bi directional with 0.7m wide Median. The Carriageway width along this Stretch varies between 18m and 23m near the Junction whereas the ROW of this Road varies between 23.5m and 29m. The Gradient is slopping away from the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road. Well known Ulsoor Lake is present very close to this Stretch of Road.

Arm towards St. John's Road Side of the Intersection

This part of the Road is divided bi directional with 0.6m wide median. The Carriageway width of this Stretch varies between 16.5m and 17.5m whereas the ROW of this Road varies between 23m and 24m. The Gradient is slopping towards the Junction. This Stretch of Road passes through well developed Commercial Establishments, Residential Apartments and Institutional Buildings.

3.3.11 K. Venkatachala Circle

3.3.11.1 Physical Details

This Junction is located about 280m away from the Meanee Avenue Road Junction. This is a typical three legged ('Y' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Meanee Avenue Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.6m wide Median. The Carriageway width along this Stretch varies between 20.5m and 33m near the Junction whereas the ROW of this Road varies between 24m and 42m. The Gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Kensington Road Side of the Intersection

This part of the Road is divided bi directional with 1.50m wide Central Median. The Carriageway width along this Stretch varies between 14m and 29.5m near the Junction whereas the ROW of this Road varies between 22m and 30.50m. Ulsoor Lake is present on southern and western side of this stretch with Commercial and Residential Establishments on northern and eastern side of this Stretch.

Arm towards Annaswamy Mudaliar Road Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 14m and 20.5m near the Junction whereas the ROW of this Road varies between 20.5m and 28m. Ulsoor Lake is present on eastern side of this stretch with Commercial and Residential Establishments, Institutional Buildings on western side of this Stretch.

3.3.12 Dhobighat Road Junction

3.3.12.1 Physical Details

This Junction is located about 610m away from the K. Venkatachala Circle. This is a typical three legged ('Y' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Kensington Road Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 9m and 11.5m near the Junction whereas the ROW of this Road varies between 14m and 15.5m. The Gradient is slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Thamarai Kannan Road Junction Side of the Intersection

This part of the Road is divided bi directional with 5.5m wide Physical Separator. The Carriageway width along this Stretch varies between 26m and 39.50m near the Junction whereas the ROW of this Road varies between 33m and 54.5m. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Murphy Road Side of the Intersection

This part of the Road is divided bi directional with 3.5m wide Physical Separator. The Carriageway width along this Stretch varies between 14.5m and 24.5m near the Junction whereas the ROW of this Road varies between 20m and 31m. The Gradient is slopping away from the Junction. Ulsoor Lake is present on the western side of this Stretch of Road.

3.3.13 Thamarai Kannan Road Junction

3.3.13.1 Physical Details

This Junction is located about 600m away from the Dhobighat Road Junction. This is a typical three legged ('Y' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Dhobighat Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.5m wide Central Median. The Carriageway width along this Stretch is 18m near the Junction whereas the ROW of this Road varies between 20m and 25m. The Gradient is gently slopping towards the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Murphy Road and Old Madras Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.7m wide Central Median. The Carriageway width along this Stretch varies between 17m and 19m near the Junction whereas the ROW of this Road varies between 20m and 27m. The Gradient is slopping away from the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Thamarai Kannan Road Side of the Intersection

This part of the Road is undivided uni directional. The Carriageway width along this Stretch varies between 7m and 12m near the Junction whereas the ROW of this Road varies between 12.5m and 19m. The Gradient is slopping away from the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

3.3.14 Murphy Road – Old Madras Road Junction

3.3.14.1 Physical Details

This Junction is located about 280m away from the Thamarai Kannan Road Junction. This is a typical three legged ('Y' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Thamarai Kannan Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.7m wide Central Median. The width of Carriageway varies between 18m and 19m near the Junction whereas the ROW of this Road varies between 23m and 27m. The Gradient is slopping towards the Junction. Well developed Commercial and Residential Establishments are present along this stretch of Road.

Arm towards Indira Nagar Double Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.2m wide Median. The width of Carriageway varies between 14m and 24m near the Junction whereas the ROW of this Road varies between 17.5m and 26m. Well developed Residential and Commercial Establishments are present along this stretch of Road.

Arm towards Old Madras Road Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 13m and 17m near the Junction whereas the ROW of this Road varies between 18m and 21m. The Gradient is gently slopping away from the Junction. Thickly developed Commercial and Residential Establishments are present along this stretch of Road.

3.3.15 Indira Nagar Double Road Junction

3.3.15.1 Physical Details

This Junction is located about 680m away from the Murphy Road – Old Madras Road Junction. This is a typical three legged ('T' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Murphy Road and Old Madras Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.22m wide Central Median. The width of Carriageway varies between 16.13m and 20.43m near the Junction whereas the ROW of this Road varies between 32.25m and 36.38m. Well developed Residential and Commercial Establishments are present along this stretch of Road. Binnamangala Lake is present on northern side of this Stretch of Road.

Arm towards Indira Nagar Double Road Side of the Intersection

This part of the Road is divided bi directional with 0.3m wide Central median. The width of Carriageway varies between 16m and 17m near the Junction whereas the ROW of this Road varies between 25.6m and 27m. Well developed Residential and Commercial Establishments are present on either side of this stretch of Road.

Arm towards Indira Nagar 100 Feet Road Side of the Intersection

This part of the Road is divided bi directional with 0.21m wide Central Median. The width of Carriageway varies between 17.18m and 18m near the Junction whereas the ROW of this Road varies between 24.7m and 26m. This Stretch of Road passes through Well Developed Residential and Commercial Establishments, Institutional and Office Buildings.

3.3.16 Indira Nagar 100 Feet Road Junction

3.3.16.1 Physical Details

This Junction is located about 360m away from the Indira Nagar Double Road Junction. This is a typical three legged ('T' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Indira Nagar Double Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.3m wide Central Median. The width of Carriageway of the Stretch varies between 14m and 15m near the Junction whereas the ROW of this Road varies between 17.5m and 32m. Well developed Residential and Commercial Establishments are present along this stretch of Road. Binnamangala Lake is present on northern side of this Stretch of Road.

Arm towards Indira Nagar 80 Feet Road Junction Side of the Intersection

This part of the Road is divided bi directional with 4.5m wide Physical Separator. The width of Carriageway of this Stretch varies between 21m and 22m near the Junction whereas the ROW of this Road varies between 28m and 40m. Well developed Residential Layouts, Commercial Establishments, Hospital are present along this stretch of Road.

Arm towards Indira Nagar 100 Feet Road Side of the Intersection

This part of the Road is undivided bi directional. The width of Carriageway of this Stretch varies between 19.2m and 26.5m near the Junction whereas the ROW of this Road varies between 31m and 46m. This Stretch of Road passes through well developed Residential Layout, Commercial Establishments and Institutional Buildings.

3.3.17 Indira Nagar 80 Feet Road Junction

3.3.17.1 Physical Details

This Junction is located about 520m away from the Indira Nagar 100 Feet Road Junction. This is a typical three legged ('T' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Indira Nagar 100 Feet Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.5m wide Central Median. The width of Carriageway of the Stretch is 22m near the Junction whereas the ROW of this Road

varies between 51m and 62m. This Stretch of Road passes through well developed Residential and Commercial Establishments.

Arm towards Suranjan Das Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.3m wide Median. The width of Carriageway of this Stretch varies between 18m and 22m near the Junction whereas the ROW of this Road varies between 47m and 62.5m. The Gradient is slopping towards the Junction. Well developed Commercial Establishments, Educational Institutes, Hospital are present along this stretch of Road.

Arm towards Indira Nagar 80 Feet Road Side of the Intersection

This part of the Road is divided bi directional with 0.9m wide Central Median. The width of Carriageway of this Stretch varies between 15.5m and 16.5m near the Junction whereas the ROW of this Road varies between 24m and 25.m. This Stretch of Road passes through well developed Residential and Commercial Establishments.

3.3.18 Suranjan Das Road Junction

3.3.18.1 Physical Details

This Junction is located about 340m away from the Indira Nagar 80 Feet Road Junction. This is a typical four legged intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Indira Nagar 80 Feet Road Side of the Intersection

This part of the Road is divided bi directional with 1m wide Central median. The Carriageway width along this Stretch varies between 19m and 20m near the Junction whereas the ROW of this Road varies between 24.5m and 29.9m. The Gradient is slopping away from the Junction. Vacant Land is present on northern side of this Stretch with Commercial Establishments on southern side of this Stretch.

Arm towards Baiyyappanahalli Layout Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 6m and 8.5m near the Junction. The Gradient is slopping away from the Junction. Vacant Land is Present on either side of this stretch.

Arm towards N. G. E. F. Layout Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.4m wide Median. The Carriageway width along this Stretch is 22m whereas the ROW of this Road varies between 28m and 30m. The Gradient is slopping towards the Junction. Vacant Land is present on Northern side of this Stretch with Engine Division of Hindustan Aeronautics Limited (HAL) on southern side of this Stretch.

Arm towards Suranjan Das Road Side of the Intersection

This part of the Road is divided bi directional with 0.5m wide median. The Carriageway width of this Stretch varies between 14m and 19m near the Junction whereas the ROW of this Road varies between 23m and 28m. The Property on the eastern side of this Stretch near the Junction belongs to HAL whereas the land on western side of this Stretch is populated with Institutional Buildings.

3.3.19 N. G. E. F. Layout Road Junction

3.3.19.1 Physical Details

This Junction is located about 360m away from the Suranjandas Road Junction. This is a typical three legged ('Y' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Suranjan Das Road Junction Side of the Intersection

This part of the Road is divided bi directional with 0.3m wide Central Median. The width of Carriageway varies between 23m and 30m near the Junction whereas the ROW of this Road varies between 31m and 32.7m. Vacant Land is present on Northern side of this Stretch with Engine Division of Hindustan Aeronautics Limited (HAL) on southern side of this Stretch.

Arm towards Varthur Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.5m wide Central Median. The width of Carriageway varies between 23m and 25.5m near the Junction whereas the ROW of this Road varies between 34m and 35m. Baiyyappanahalli Metro Terminal has been proposed on the northern side of this stretch whereas the Land on the southern side of this Stretch belongs to HAL.

Arm towards N. G. E. F. Layout Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 8.90m and 13.0m near the Junction whereas the ROW of this Road varies between 18m and 23m. The Gradient is slopping towards the Junction. Vacant Land is Present on either side of this stretch.

3.3.20 Varthur Road Junction

3.3.20.1 Physical Details

This Junction is located about 740m away from the N. G. E. F. Layout Road Junction. This is a typical three legged ('Y' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards N. G. E. F. Layout Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.3m wide Central Median. The width of Carriageway of the Stretch varies between 15.5m and 16.2m near the Junction whereas the ROW of this Road varies between 33m and 35m. The Gradient is slopping towards the Junction.

Arm towards Beniganahalli Junction Side of the Intersection

This part of the Road is divided bi directional with 1.5m wide Central Median. The width of Carriageway of this Stretch is 22m whereas the ROW of this Road varies between 33m and 43m. The Gradient is slopping away from the Junction. Public Service Building, well developed Commercial and Residential Establishments are present along this Stretch of Road.

Arm towards Varthur Road Side of the Intersection

This part of the Road is undivided bi directional. The width of Carriageway of this Stretch varies between 8m and 11m near the Junction whereas the ROW of this Road varies between 10m and 14.5m. The Gradient is slopping away from the Junction. The Property on the western side of this Stretch belongs to HAL whereas the Land on the eastern side of this Stretch is populated with well Developed Commercial and Residential Establishments.

3.3.21 Krishna Raj Puram Junction

3.3.21.1 Physical Details

This Junction is located about 2.315 km away from the Varthur Road Junction. This is a typical three legged ('Y' Shaped) intersection in which Old Madras Road and White Field Road form the axes. Four lane divided bi directional Cable Stayed Bridge is present along Old Madras Road Axis.

3.3.22 White Field Road – Outer Ring Road Junction

3.3.22.1 Physical Details

This Junction is located about 460m away from the K. R. Puram Junction. This is a typical three legged ('Y' Shaped) intersection in which White Field Road and Outer Ring Road form the axes. Two lane undivided uni directional Flyover is present along White Field Road and Outer Ring Road for the Traffic Movement from Old Madras Road Side to Outer Ring Road Side.

3.3.23 Junction near Hewlett Packard Office

3.3.23.1 Physical Details

This Junction is located about 1.12 km away from the White Field Road – Outer Ring Road Junction. This is a typical three legged ('T' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards White Field Road – Outer Ring Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.2m wide Central Median. The width of Carriageway of this Stretch varies between 15.5m and 16.2m near the Junction whereas the ROW of this Road varies between 25.8m and 27.8m. The Gradient is slopping towards the Junction. Well known Software Company like Hewlett Packard India Software Operation Private Limited, well developed Commercial and Residential Establishments are located along this Stretch of Road.

Arm towards Hudi Main Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.2m wide Central Median. The width of Carriageway of this Stretch varies between 16m and 17m near the Junction whereas the ROW of this Road varies between 31m and 29m. Thickly developed Commercial Establishments are present along this stretch of Road.

Arm towards Outer Ring Road Side of the Intersection

This part of the Road is undivided bi directional. The width of Carriageway of this Stretch varies between 8m and 9m near the Junction whereas the ROW of this Road varies

between 11m and 13.8m. This Stretch of the Road passes through well developed Residential and Commercial Establishments.

3.3.24 Hudi Main Road Junction

3.3.24.1 Physical Details

This Junction is located about 2.82 km away from the Junction near Hewlett Packard Office. This is a typical four legged intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Junction near Hewlett Packard Office Side of the Intersection

This part of the Road is divided bi directional with 1.1m wide Central Median. The width of Carriageway of this Stretch varies between 16m and 17m near the Junction whereas the ROW of this Road varies between 25.m and 29m. The Gradient is gently slopping towards the Junction. Thickly developed Commercial and Residential Establishments, Industrial Area are present along this stretch of Road.

Arm towards Hudi Main Road Side of the Intersection

This part of the Road is divided bi directional with 1.2m wide Central Median. The width of Carriageway of this Stretch varies between 10m and 18m near the Junction whereas the ROW of this Road varies between 18.5m and 23m. Well developed Commercial Establishments, Hospital, Educational Institutes are present along this stretch of Road.

Arm towards EPIP Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.0m wide Central Median. The width of Carriageway of this Stretch varies between 15.5m and 16.5m near the Junction whereas the ROW of this Road varies between 24.8m and 25.8m. The Gradient is slopping away from the Junction. Well developed Commercial Establishments, Industrial Area are present along this stretch of Road.

Arm towards Doddanekundi Industrial Area Side of the Intersection

This part of the Road is divided bi directional with 1m wide Central Median. The width of Carriageway of this Stretch varies between 15m and 16m near the Junction whereas the ROW of this Road varies between 24m and 26m. The Gradient is slopping towards the Junction. Thickly developed Commercial Establishments, Industrial Area are present along this stretch of Road.

3.3.25 Export Promotion Industrial Park (E. P. I. P.) Road Junction

3.3.25.1 Physical Details

This Junction is located about 1.78 km away from the Hudi Main Road Junction. This is a typical three legged ('T' Shaped) intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Hudi Main Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.3m wide Central Median. The width of Carriageway varies between 14.7m and 16.2m near the Junction whereas the ROW of this Road varies between 24.m and 25m. The Gradient is gently slopping away from the

Junction. Well developed Commercial Establishments are present along this stretch of Road.

Arm towards Pattandur Agrahara Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.25m wide Central Median. The width of Carriageway of this Stretch varies between 15.5m and 18.8m near the Junction whereas the ROW of this Road varies between 27m and 29m. The Gradient is slopping towards the Junction. Well developed Commercial Establishments, Software Companies are present along this stretch of Road.

Arm towards EPIP Road Side of the Intersection

This part of the Road is divided bi directional with 1.5m wide Central Median. The width of Carriageway of this Stretch varies between 15m and 18m near the Junction whereas the ROW of this Road varies between 29m and 36.8m. The Gradient is gently slopping towards the Junction. This Stretch of the Road passes through well developed Commercial Establishments on either side.

3.3.26 Pattandur Agrahara Road Junction

3.3.26.1 Physical Details

This Junction is located about 220m away from the EPIP Road Junction. This is a typical four legged intersection. The Details of the Arms forming this intersection are as follows.

Arm towards EPIP Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.25m wide Central Median. The width of Carriageway is 15m near the Junction whereas the ROW of this Road varies between 26m and 27.8m. The Gradient is slopping away from the Junction. Well developed Commercial Establishments are present along this stretch of Road.

Arm towards Shadarmangal Industrial Area Side of the Intersection

This part of the Road is undivided bi directional. The width of Carriageway varies between 8.2m and 10.6m near the Junction whereas the ROW of this Road varies between 15m and 16m. Well developed Commercial Establishments are present along this stretch of Road.

Arm towards Hope Farm Junction Side of the Intersection

This part of the Road is divided bi direction with 1.2m Wide Central Median. The Carriageway width along this Stretch varies between 13.5m and 17.3m near the Junction whereas the ROW of this Road varies between 27.8m and 29.8m. Well developed Commercial Establishments are present along this stretch of Road.

Arm towards Pattandur Agrahara Road Side of the Intersection

This part of the Road is undivided bi directional. The Carriageway width along this Stretch varies between 4m and 5.9m near the Junction whereas the ROW of this Road is 12m. The Gradient is gently slopping towards the Junction. Well developed Commercial Establishments are present on either side of this stretch of Road.

3.3.27 Hope Farm Junction

3.3.27.1 Physical Details

This Junction is located about 2.095 km away from the Pattandur Agrahara Road Junction. This is a typical four legged intersection. The Details of the Arms forming this intersection are as follows.

Arm towards Pattandur Agrahara Road Junction Side of the Intersection

This part of the Road is divided bi directional with 1.2m wide Median. The width of Carriageway varies between 16m and 19.5m near the Junction whereas the ROW of this Road varies between 25m and 31m. The Gradient is gently slopping towards the Junction. Well developed Commercial Establishments are present on either side of this stretch of Road.

Arm towards White Field Station Road (SH – 35) Side of the Intersection

This part of the Road is divided bi directional with 1.15m wide Median. The width of Carriageway of this Stretch varies between 14.5m and 15m near the Junction whereas the ROW of this Road varies between 26.5m and 27.5m. The Gradient is slopping away from the Junction. Well developed Commercial Establishments, Agricultural Land, Residential Layout are present along this stretch of Road.

Arm towards Chansandra Main Road Side of the Intersection

This part of the Road is undivided bi directional. The width of Carriageway of this Stretch varies between 7m and 9m near the Junction whereas the ROW of this Road varies between 10m and 11.5m. The Gradient is slopping away from the Junction. Plantation Land, Commercial Establishments are present on either side of this Stretch of Road.

Arm towards White Field Road (SH – 35) Side of the Intersection

This part of the Road is undivided bi directional. The width of Carriageway of this Stretch varies between 14m and 15m near the Junction whereas the ROW of this Road varies between 28m and 29.5m. The Gradient is slopping towards the Junction. Well developed Commercial Establishments, Residential Layout, Institutional Building are present along this stretch of Road.

3.3.27.2 Site Constraints

- A Temple is present at the Junction on White Field Road Side of the intersection.

Topographical Maps of all the above Junctions are enclosed in Chapter 13 – Drawings.

Vehicle Turning Movements at the Junctions are enclosed in Annexure A.3.1.
Existing Views of the Junctions are enclosed in Chapter 12 – Photographs.

3.4 Street Lighting Pattern

Road Side Street Lighting Arrangement along the Project Stretch is not adequate. Provision for the same will be incorporated in the Corridor Improvement Scheme.

3.5 Bus Stops

The presence of Bus Stops in the Carriageway on the Intersecting Arms of the Junctions hinders the smooth Traffic Movement along the Intersecting Arms of the Junctions.

3.6 Pedestrian Movement

The presence of Bus Stops, Well Developed Commercial Areas, Institutional Buildings, Recreational Facilities and their related activities in the vicinity of the Junctions leads to hazardous movement pattern of the Pedestrians across the Road, thus reducing the Safety Aspects. Further, presence of Trees and other Utilities, Commercial Activities on the Footpath reduces the Effective Width of the Footpath and in turn obstructs the Pedestrian Movement.

CHAPTER 4
FIELD STUDIES AND ANALYSIS

4.1 General

This chapter presents the various Studies (Reconnaissance Survey, Traffic Survey, Topographical Survey, Geotechnical Investigation, etc.) and thereafter the Data, obtained as a Result of these Studies, Analysis carried out by the Consultant. The Results of Analysis form Inputs for Planning and Design of Proposed Corridor Improvement Scheme, Traffic Forecast and Economic Analysis.

4.2 Reconnaissance Survey

Reconnaissance Survey has been carried out along the Corridor and at the Junctions and the Physical Characteristics of the Corridor and Junctions such as Road Geometrics, Pavement Structure, Traffic Controls (Signs, Signals, Road Markings and Parking Restrictions), Side Walks, Shoulders, Adjacent Land Use, Service Lines (For Example Water, Electricity, Telephone), Storm Water Drains and the Intensity of Non – Traffic Activities, which encroach upon Road Space (such as Hawkers, Builder's Materials, Market Stalls, etc.) have been studied. The Data recorded have been detailed out in **Chapter 3 – Study Corridor**.

4.3 Traffic Surveys

To establish the Vehicular Traffic Flow Characteristics such as Hourly variation, Composition, Peak Hour Flows along the Corridor and at the Junctions, Turning Movement Survey of Vehicles at Junctions has been conducted.

4.3.1 Methodology for Traffic Surveys

4.3.1.1 Turning Movement Survey of Vehicles at Junctions

24 hours Manual Traffic Counts have been conducted to cover all the Vehicular Movements at the Junction. The Vehicle Classification System adopted for the Study is given in **Table 4.1**.

Table 4.1
Vehicle Classification System

<table>
<tr><th colspan="2">Motorised Traffic</th><th>Non – Motorised Traffic</th></tr>
<tr><td colspan="2">2 – Wheelers, Auto Rickshaw, Passenger Car: Car, Taxi and Jeep</td><td rowspan="7">Bicycle, Cycle Rickshaw, Animal Drawn Vehicle, Hand Drawn Cart</td></tr>
<tr><td colspan="2">Utility Vehicle: Van and Tempo</td></tr>
<tr><td>Bus</td><td>Mini Bus
Standard Bus</td></tr>
<tr><td rowspan="2">Truck</td><td>Light Commercial Vehicle (LCV)</td></tr>
<tr><td>Heavy Commercial Vehicle (HCV)</td></tr>
<tr><td rowspan="2">Farm Vehicle</td><td>Agricultural Tractor (AgT)</td></tr>
<tr><td>Agricultural Tractor & Trailer (AgTT)</td></tr>
</table>

The Turning Movement Survey has been conducted to obtain Information on Mode wise and Direction wise Turning Movement of Traffic at the Intersection. The Survey has been conducted for 24 hours (0600 hrs. to 0600 hrs.) covering morning and evening peak hours.

Traffic Counting has been carried out manually in two twelve – hour shifts by trained enumerators, using hand tally. The Count Data have been recorded at 15 minute intervals using hand tallies and total per hour for each vehicle category has been computed. The Traffic Volume Count Data has been processed using the commonly used Spreadsheet Package. The processed Hourly Traffic Volume Data has been compiled Direction wise.

The Peak Hourly Directional Vehicular Movement Data has been used to plan and design the Improvement Scheme such as Grade Separation and At Grade Intersections with Traffic Signals.

4.4 Analysis of Traffic Study Data

The Data and Pertinent Information collected from the Traffic Surveys have been analysed using the Utility Software Packages (MS – EXCEL) to obtain the required Information concerning Traffic Characteristics at the Intersections in the Corridor. Findings and the brief Discussions thereon are presented in this Section.

4.4.1 Analysis of Turning Movement Count Data

Data have been processed on quarter hourly basis to establish the most appropriate Peak Hours. Data collected from Surveys have been computerised and analysed to study Hourly Variation of Traffic, Peak Hour Flows, Traffic Composition, etc. and are presented Junction wise below. The Counts have been classified by Category of Vehicles and by Direction of Movement. The various Vehicle Types having different Sizes and Characteristics have been converted into Equivalent Passenger Car Units. The Passenger Car Unit (PCU) Factors recommended by Indian Road Congress in "Guidelines for Capacity of Urban Roads in Plain Areas" (IRC: 106 – 1990) have been used. The same are detailed in **Table 4.2**.

Table 4.2

Recommended PCU Factors for Various Types of Vehicles in Urban Roads

Sl. No.	Vehicle Type	Equivalent PCU Factors	
		% Composition of Vehicle Type	
		Up to 10%	10% and above
A	Fast Vehicles		
1	Two wheelers, Motorcycle or Scooter, etc.	0.5	0.75
2	Passenger car, Pick – up Van	1.0	1.0
3	Auto Rickshaw	1.2	2.0
4	Light Commercial Vehicle	1.4	2.0
5	Truck or Bus	2.2	3.7
6	Agricultural Tractor Trailer	4.0	5.0
B	Slow Vehicles		
1	Cycle	0.4	0.5
2	Cycle Rickshaw	1.5	2.0
3	Tonga (Horse drawn vehicle)	1.5	2.0
4	Hand Cart	2.0	3.0

(Source: IRC: 106 – 1990)

4.5 Mekhri Circle

4.5.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.1**. The Hourly Traffic Volume observed at the Junction varied in the range of 997 – 11749 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (11749 PCU) and 1800 – 1900 hrs. in the evening (10545 PCU). This Junction handles more than 9000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Mekhri Circle is given in **Annexure A.4.1.**

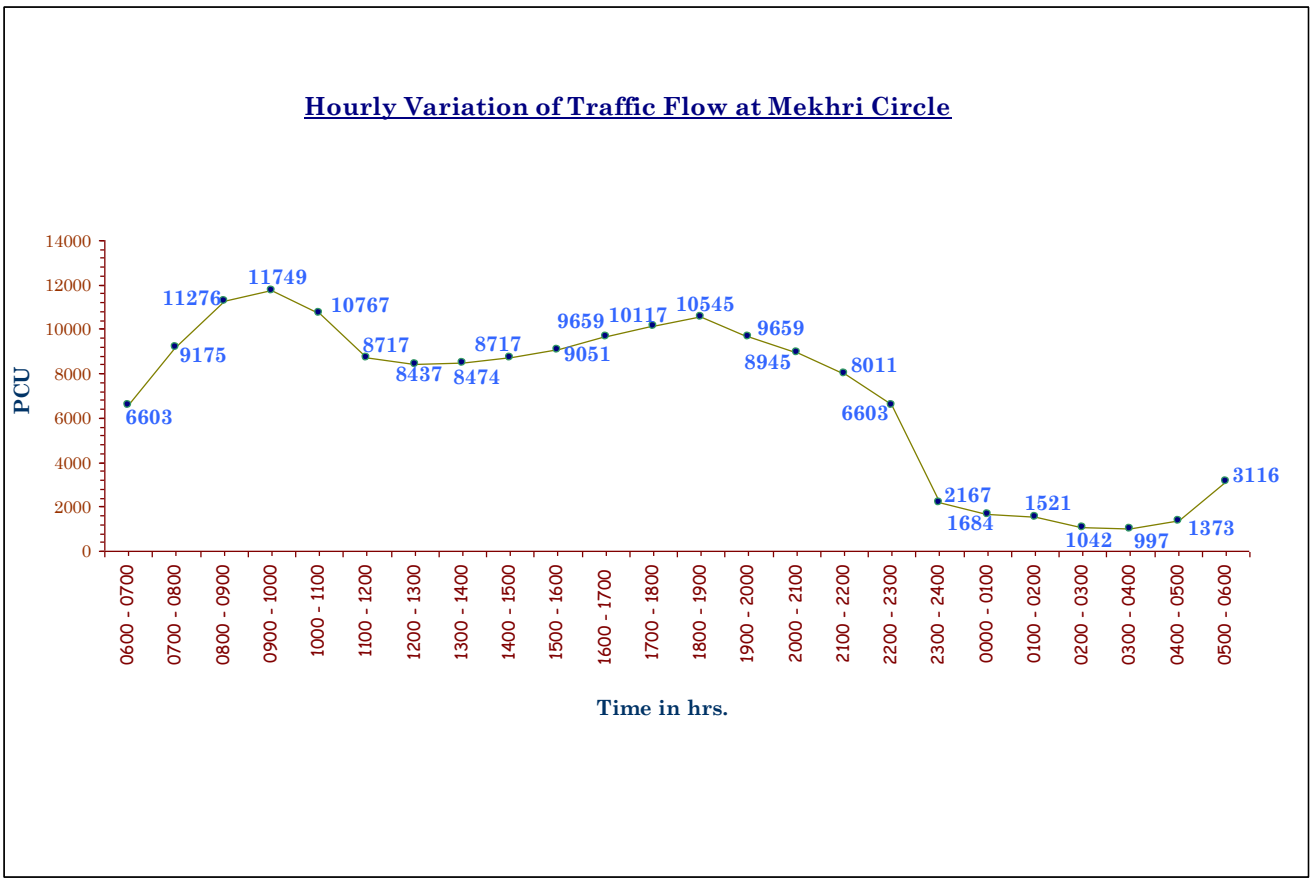

Fig. 4.1

4.5.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.2** for Mekhri Circle. The major flow is along Bellary Road in which current Peak Hour Flow is 6780 PCU, which amounts to 57.87% of Junction Volume.

4.6 CIL Road Junction

4.6.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.3**. The Hourly Traffic Volume observed at the Junction varied in the range of 506 – 8322 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (7648 PCU) and 1800 – 1900 hrs. in the evening (8322 PCU). This Junction handles more than 6000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at CIL Road Junction is given in **Annexure A.4.2.**

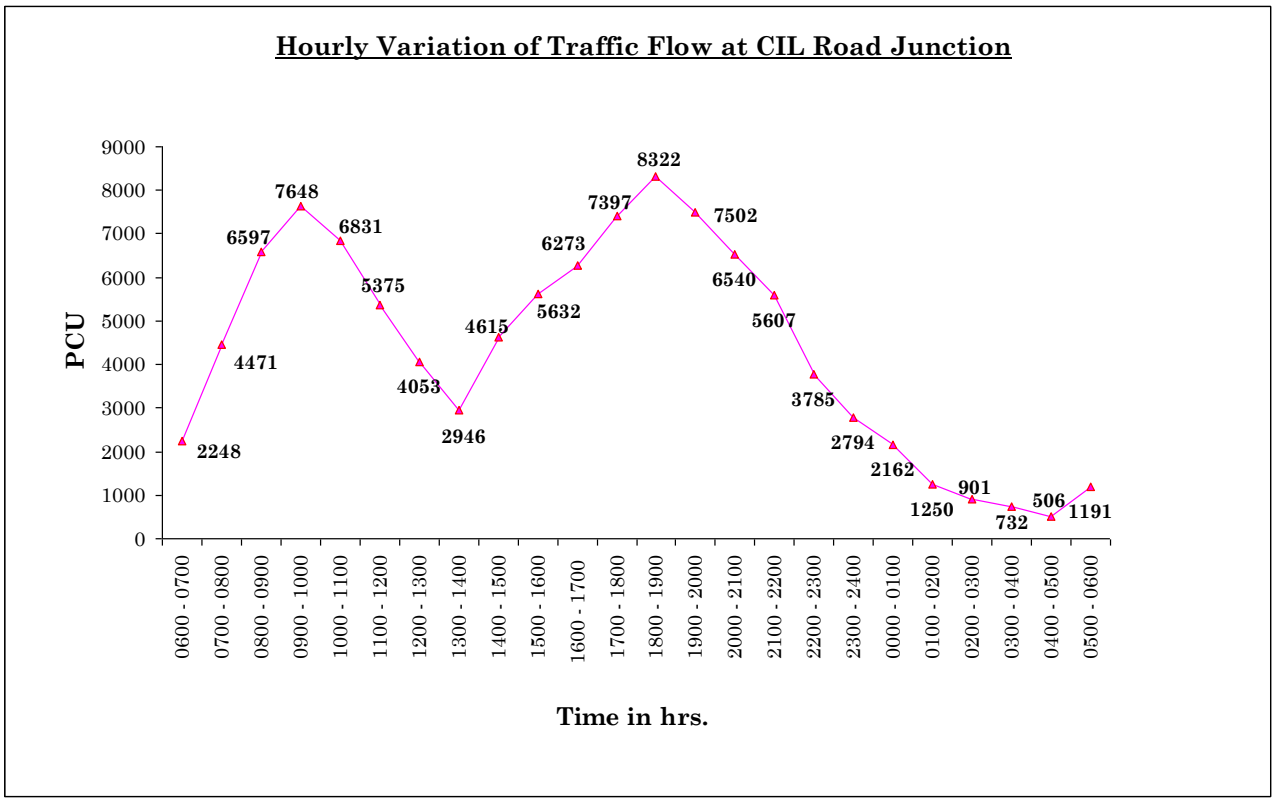

Fig. 4.3

4.6.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.4** for CIL Road Junction. The major flow is along Jayamahal Road in which current Peak Hour Flow is 3059 PCU, which amounts to 39.99% of Junction Volume.

4.7 Munireddy Palya Road Junction

4.7.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.5**. The Hourly Traffic Volume observed at the Junction varied in the range of 385 – 7404 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (6636 PCU) and 1800 – 1900 hrs. in the evening (7404 PCU). This Junction handles more than 5500 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow Munireddy Palya Road Junction is given in **Annexure A.4.3**.

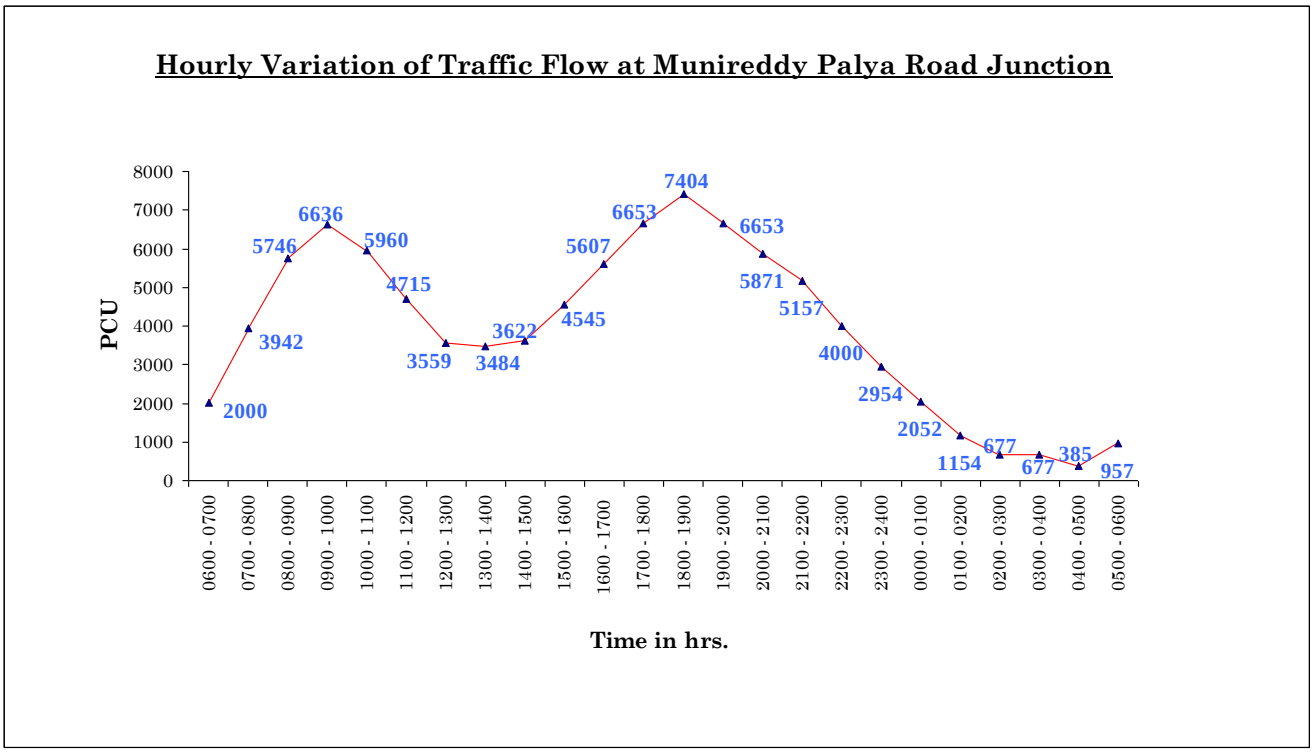

Fig. 4.5

4.7.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.6** for Munireddy Palya Road Junction. The major flow is along Jayamahal Road in which current Peak Hour Flow is 4668 PCU, which amounts to 63.04% of Junction Volume.

4.8 Jayamahal 5th Main Road Junction

4.8.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.7**. The Hourly Traffic Volume observed at the Junction varied in the range of 271 – 4875 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (4875 PCU) and 1800 – 1900 hrs. in the evening (4460 PCU). This Junction handles more than 4000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Jayamahal 5th Main Road Junction is given in **Annexure A.4.4**.

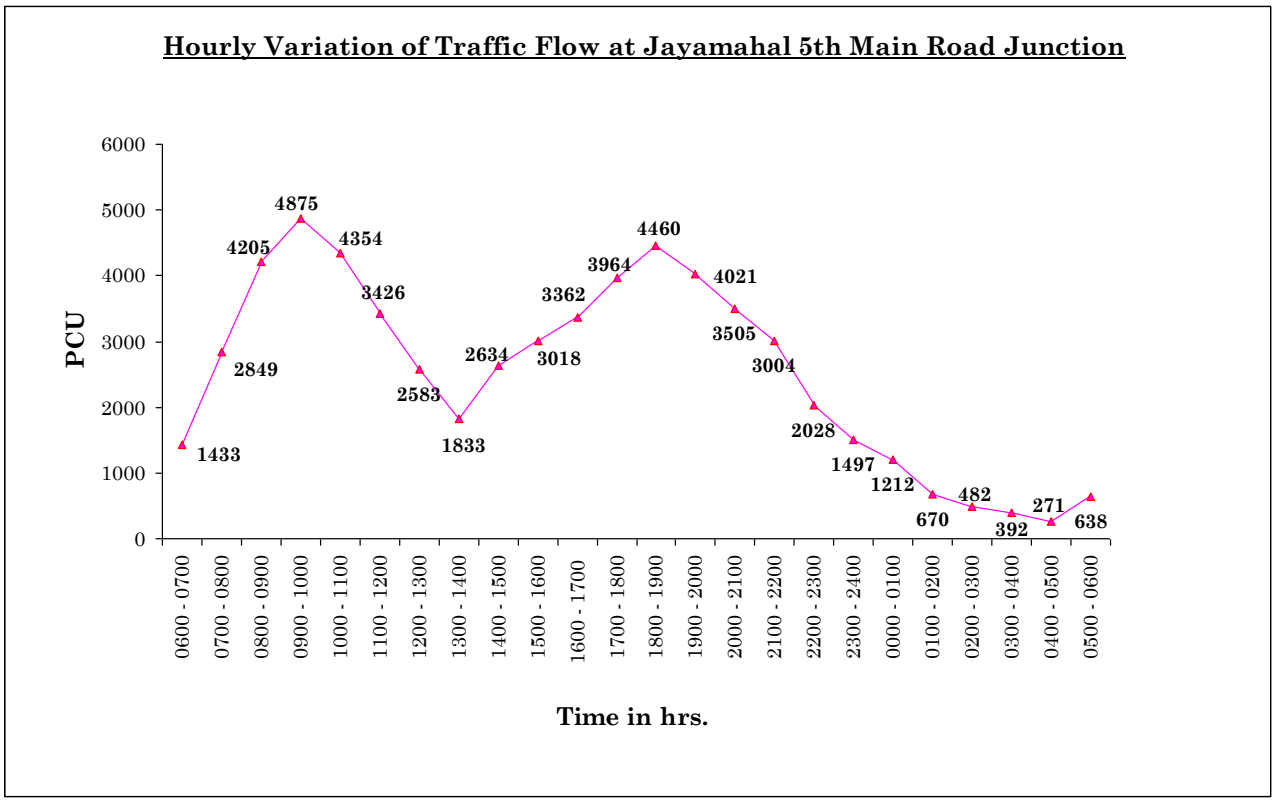

Fig. 4.7

4.8.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.8** for Jayamahal 5th Main Road Junction. The major flow is along Jayamahal Road in which current Peak Hour Flow is 5534 PCU, which amounts to 76.08% of Junction Volume.

4.9 Nandidurga Road Junction

4.9.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.9**. The Hourly Traffic Volume observed at the Junction varied in the range of 245 – 4857 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (4875 PCU) and 1800 – 1900 hrs. in the evening (4261 PCU). This Junction handles more than 4000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Nandidurga Road Junction is given in **Annexure A.4.5**.

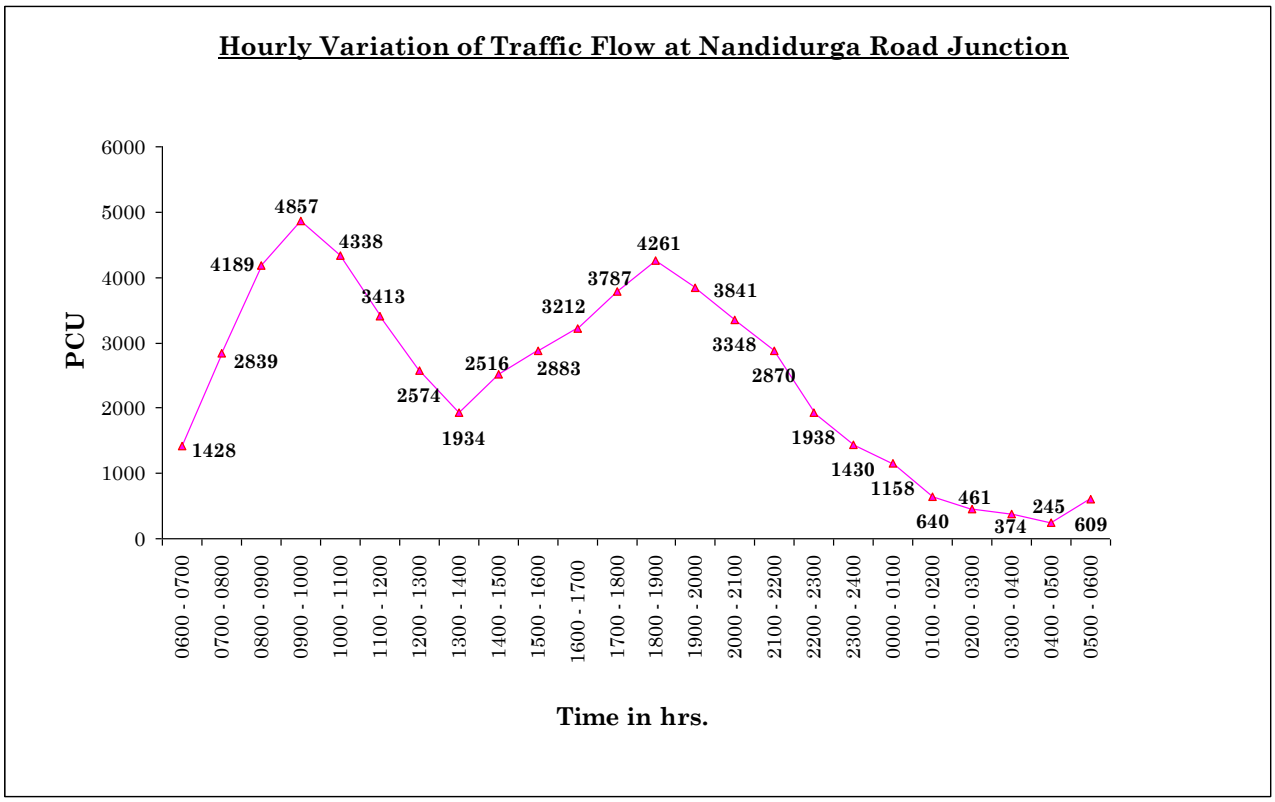

Fig. 4.9

4.9.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.10** for Nandidurga Road Junction. The major flow is along Millers Road in which current Peak Hour Flow is 3827 PCU, which amounts to 51.34% of Junction Volume.

4.10 Haines Road Junction

4.10.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.11**. The Hourly Traffic Volume observed at the Junction varied in the range of 569 – 9660 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (9660 PCU) and 1800 – 1900 hrs. in the evening (9351 PCU). This Junction handles more than 8000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Haines Road Junction is given in **Annexure A.4.6**.

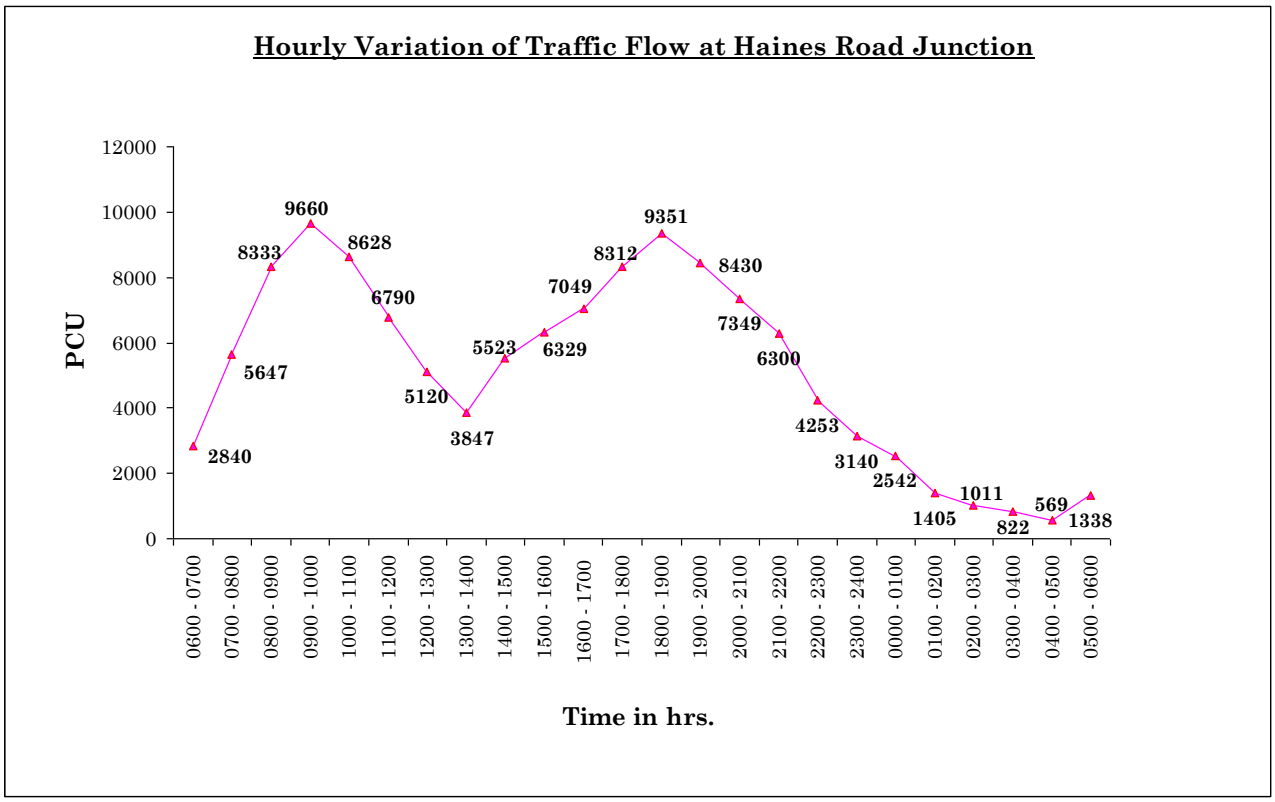

Fig. 4.11

4.10.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.12** for Haines Road Junction. The major flow is along Millers Road in which current Peak Hour Flow is 3349 PCU, which amounts to 34.66% of Junction Volume.

4.11 Seppings Road Junction

4.11.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.13**. The Hourly Traffic Volume observed at the Junction varied in the range of 455 – 8332 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (8332 PCU) and 1800 – 1900 hrs. in the evening (7909 PCU). This Junction handles more than 6500 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Seppings Road Junction is given in **Annexure A.4.7**.

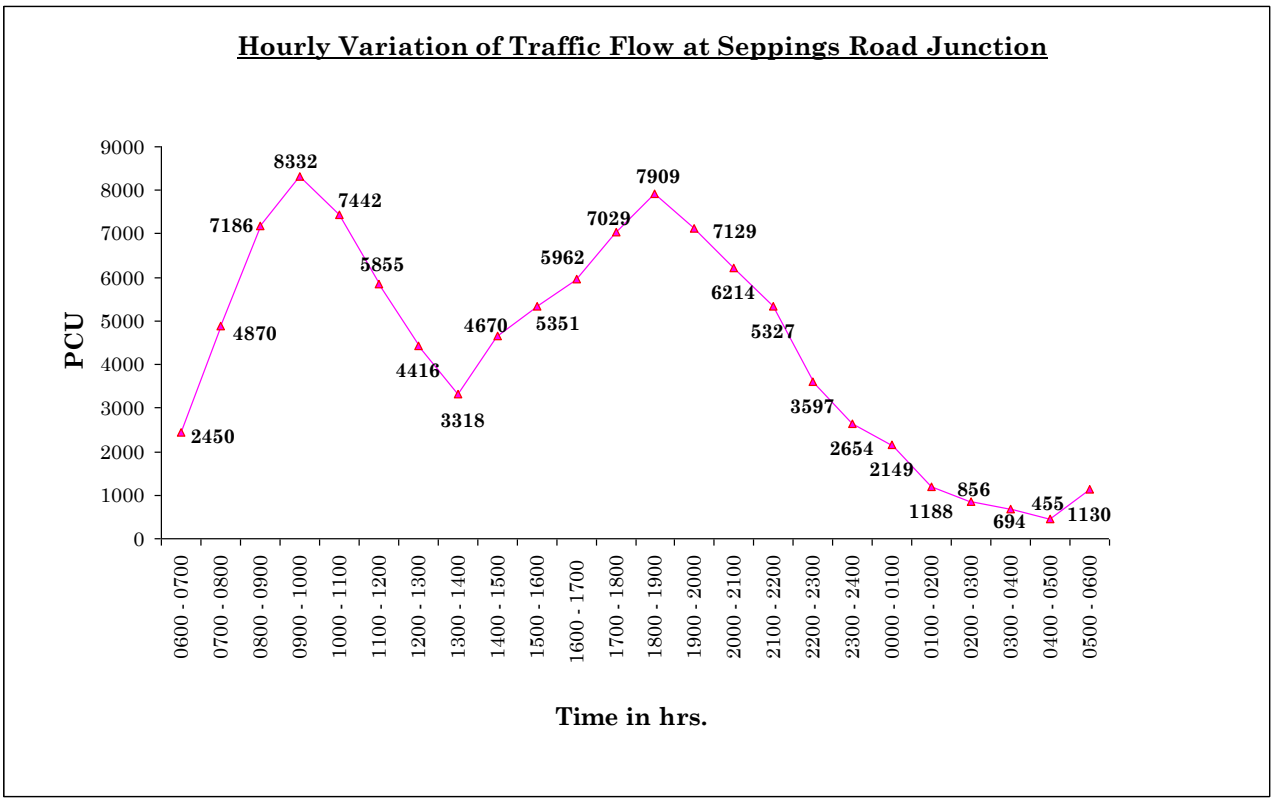

Fig. 4.13

4.11.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.14** for Seppings Road Junction. The major flow is along St. John's Road in which current Peak Hour Flow is 3556 PCU, which amounts to 44.96% of Junction Volume.

4.12 Kamaraj Road Junction

4.12.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.15**. The Hourly Traffic Volume observed at the Junction varied in the range of 399 – 7706 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (7706 PCU) and 1800 – 1900 hrs. in the evening (6945 PCU). This Junction handles more than 5000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Kamaraj Road Junction is given in **Annexure A.4.8**.

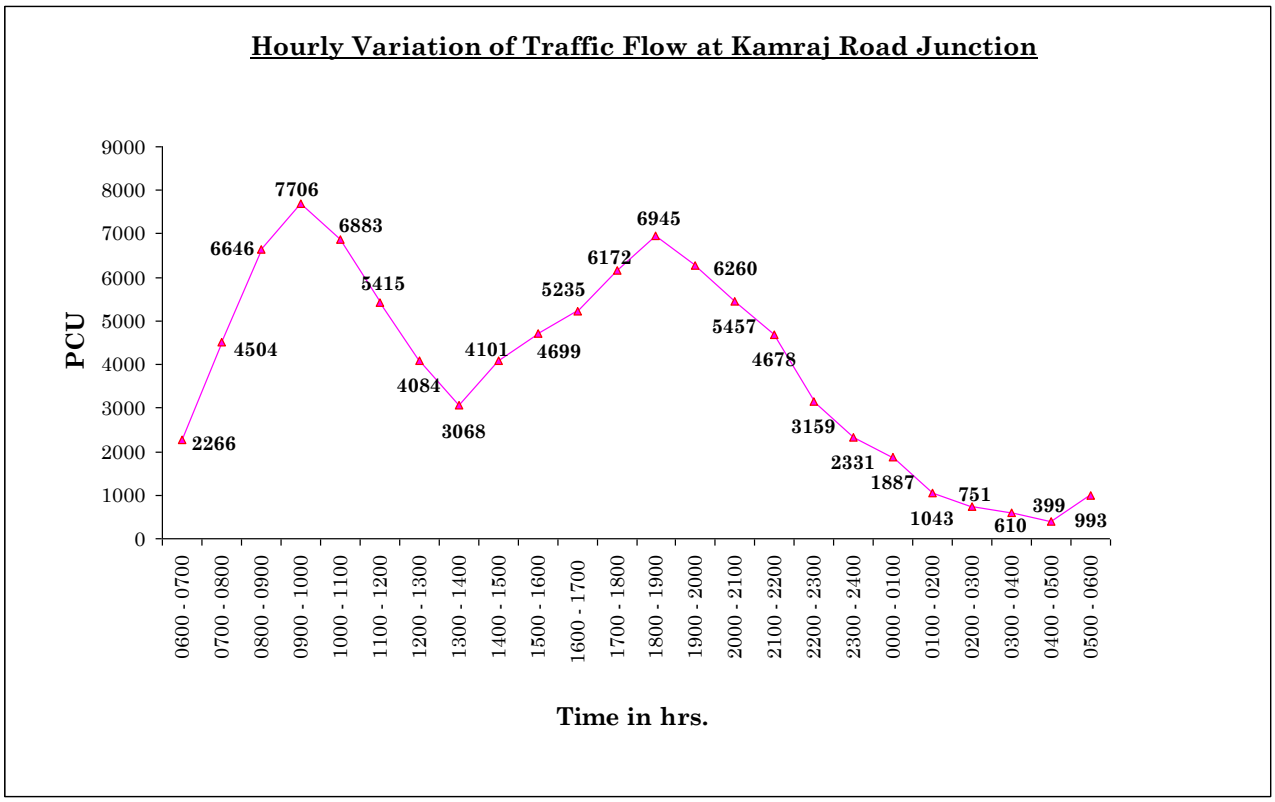

Fig. 4.15

4.12.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.16** for Kamaraj Road Junction. The major flow is along St. John's Road in which current Peak Hour Flow is 3254 PCU, which amounts to 42.22% of Junction Volume.

4.13 Meanee Avenue Road Junction

4.13.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.17**. The Hourly Traffic Volume observed at the Junction varied in the range of 417 – 7908 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (7908 PCU) and 1800 – 1900 hrs. in the evening (7255 PCU). This Junction handles more than 6000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Meanee Avenue Road Junction is given in **Annexure A.4.9**.

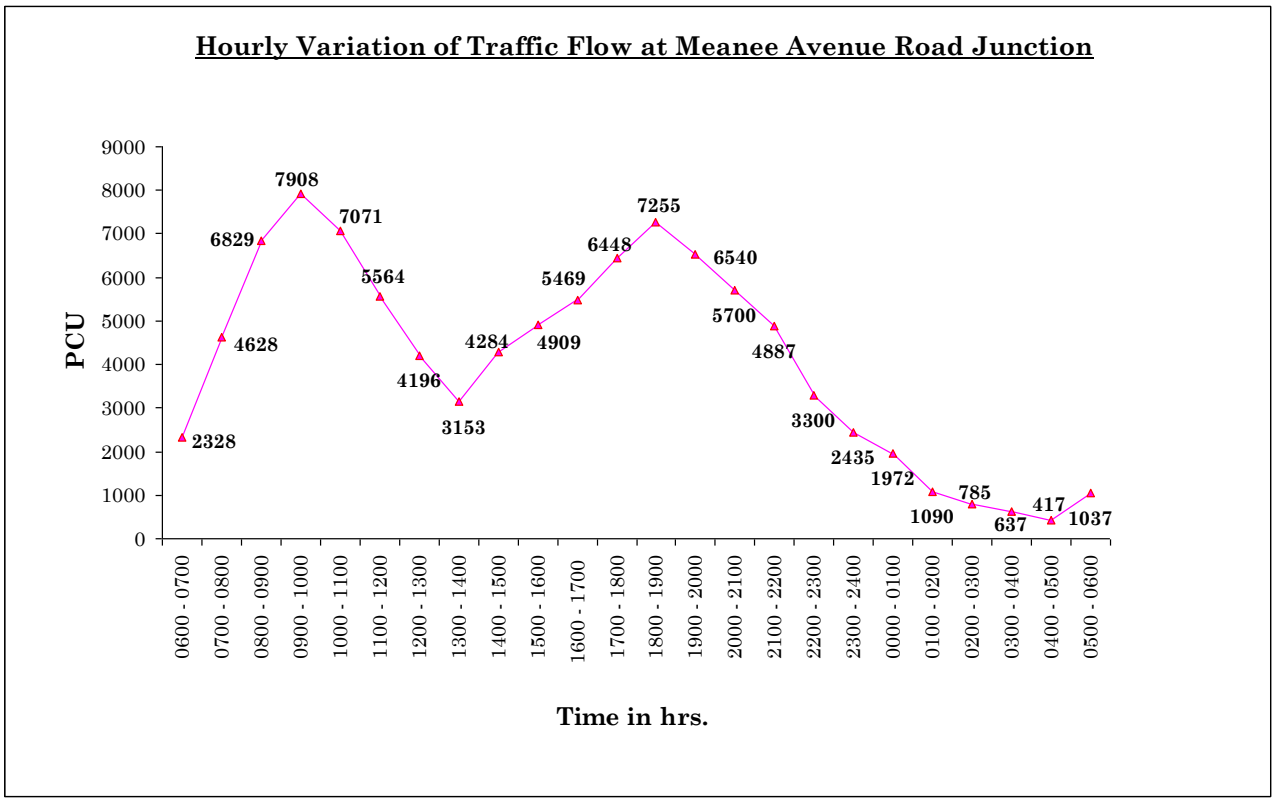

Fig. 4.17

4.13.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.18** for Meanee Avenue Road Junction. The major flow is along Meanee Avenue Road in which current Peak Hour Flow is 3293 PCU, which amounts to 41.64% of Junction Volume.

4.14 K. Venkatachala Circle

4.14.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.19**. The Hourly Traffic Volume observed at the Junction varied in the range of 368 – 6398 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (5966 PCU) and 1800 – 1900 hrs. in the evening (6398 PCU). This Junction handles more than 5000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at K. Venkatachala Circle is given in **Annexure A.4.10**.

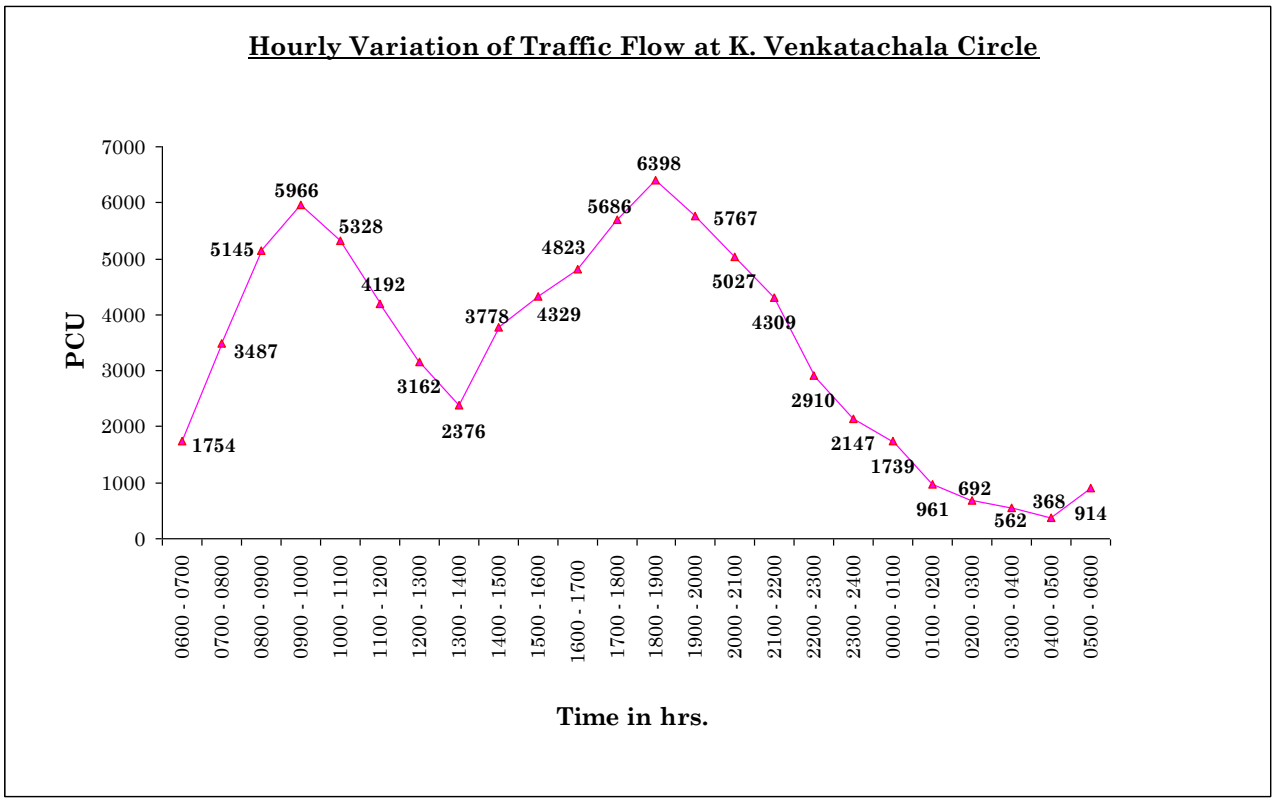

Fig. 4.19

4.14.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.20** for K. Venkatachala Circle. The major flow is along Meanee Avenue Road in which current Peak Hour Flow is 3342 PCU, which amounts to 52.23% of Junction Volume.

4.15 Dhobighat Road Junction

4.15.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.21**. The Hourly Traffic Volume observed at the Junction varied in the range of 417 – 7756 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1100 hrs. in the morning (7756 PCU) and 1800 – 1900 hrs. in the evening (7257 PCU). This Junction handles more than 6000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Dhobighat Road Junction is given in **Annexure A.4.11**.

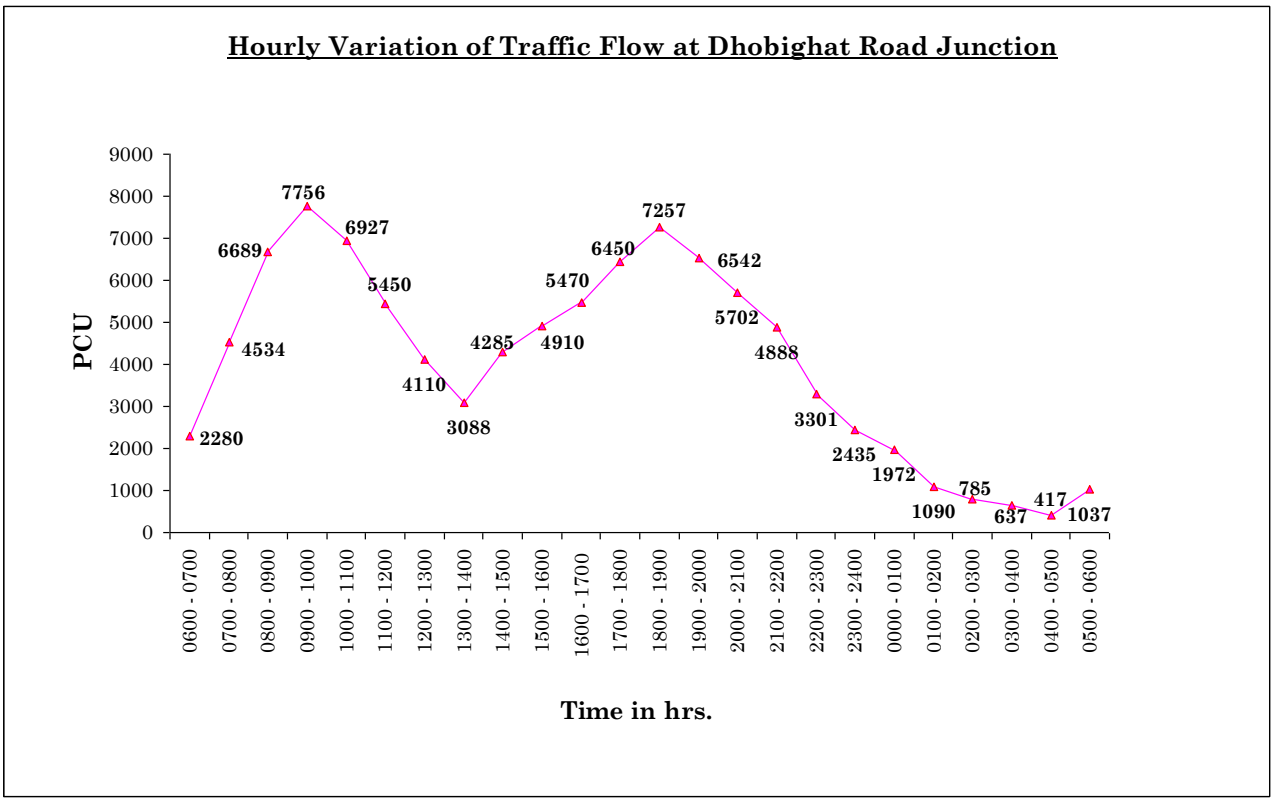

Fig. 4.21

4.15.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.22** for Dhobi Ghat Road Junction. The major flow is along Thamarai Kannan Road and Kensington Road in which current Peak Hour Flow is 5113 PCU, which amounts to 70.81% of Junction Volume.

4.16 Thamarai Kannan Road Junction

4.16.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.23**. The Hourly Traffic Volume observed at the Junction varied in the range of 402 – 7356 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (7356 PCU) and 1800 – 1900 hrs. in the evening (6991 PCU). This Junction handles more than 5500 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Thamarai Kannan Road Junction is given in **Annexure A.4.12**.

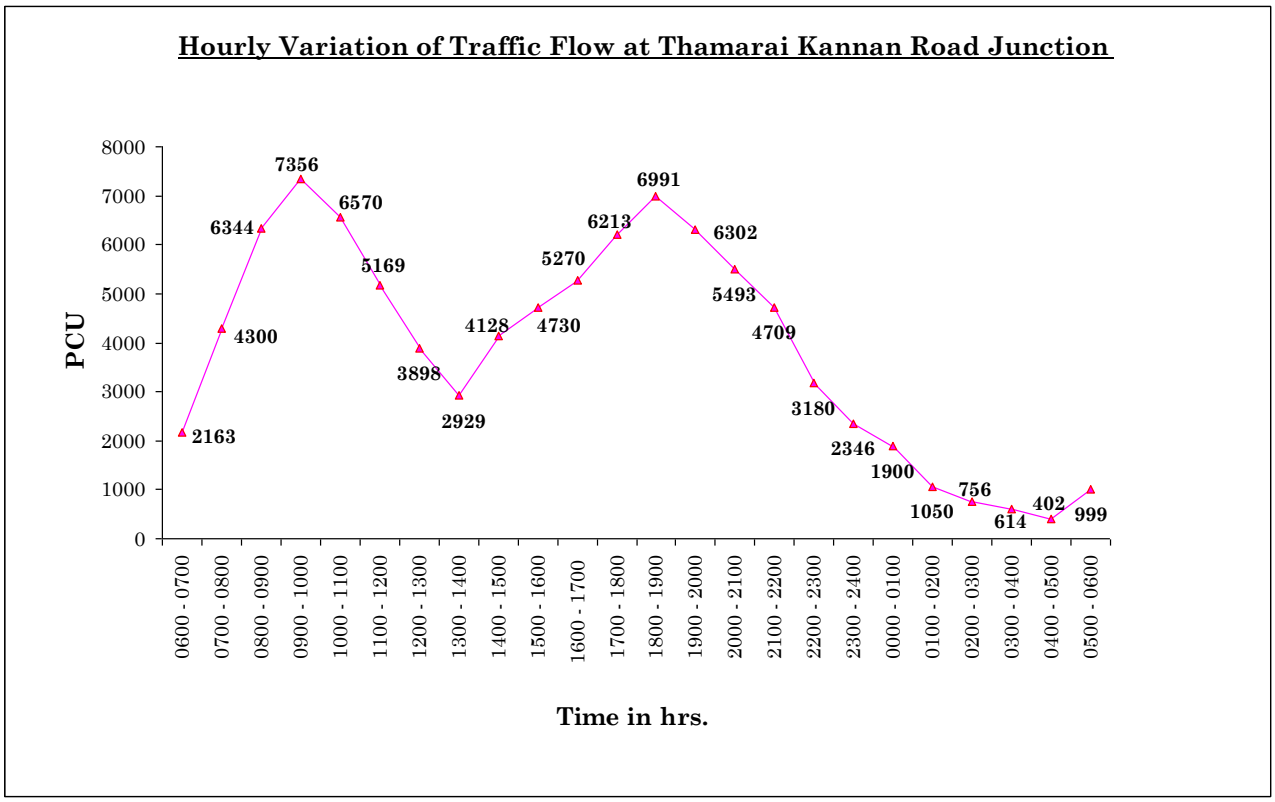

Fig. 4.23

4.16.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.24** for Thamarai Kannan Road Junction. The major flow is along Murphy Road in which current Peak Hour Flow is 5451 PCU, which amounts to 77.97% of Junction Volume.

4.17 Murphy Road and Old Madras Road Junction

4.17.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.25**. The Hourly Traffic Volume observed at the Junction varied in the range of 591 – 10275 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (9996 PCU) and 1800 – 1900 hrs. in the evening (10275 PCU). This Junction handles more than 7500 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Murphy Road and Old Madras Road Junction is given in **Annexure A.4.13**.

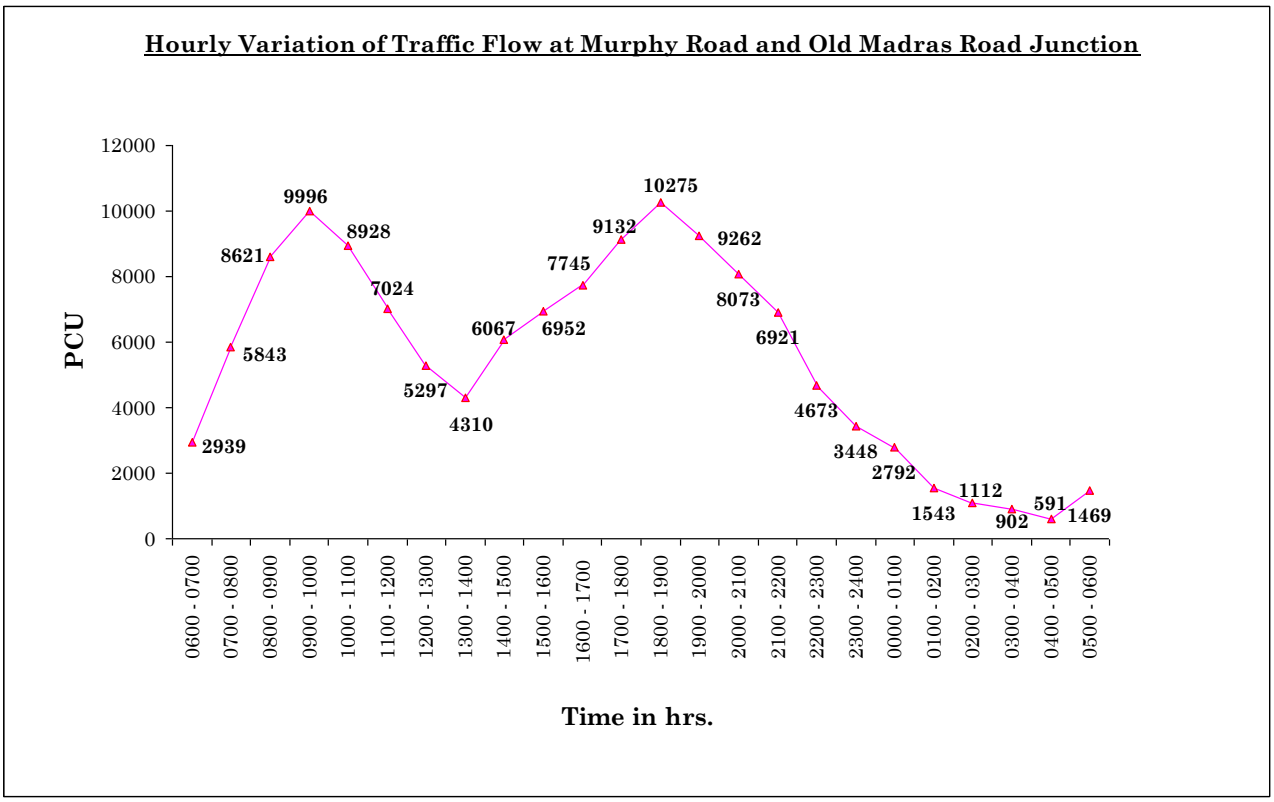

Fig. 4.25

4.17.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.26** for Murphy Road and Old Madras Road Junction. The major flow is along Old Madras Road in which current Peak Hour Flow is 5423 PCU, which amounts to 53.0% of Junction Volume.

4.18 Indira Nagar 100 Feet Road Junction

4.18.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.27**. The Hourly Traffic Volume observed at the Junction varied in the range of 550 – 10777 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (10777 PCU) and 1800 – 1900 hrs. in the evening (9565 PCU). This Junction handles more than 8000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Indira Nagar 100 Feet Road Junction is given in **Annexure A.4.14**.

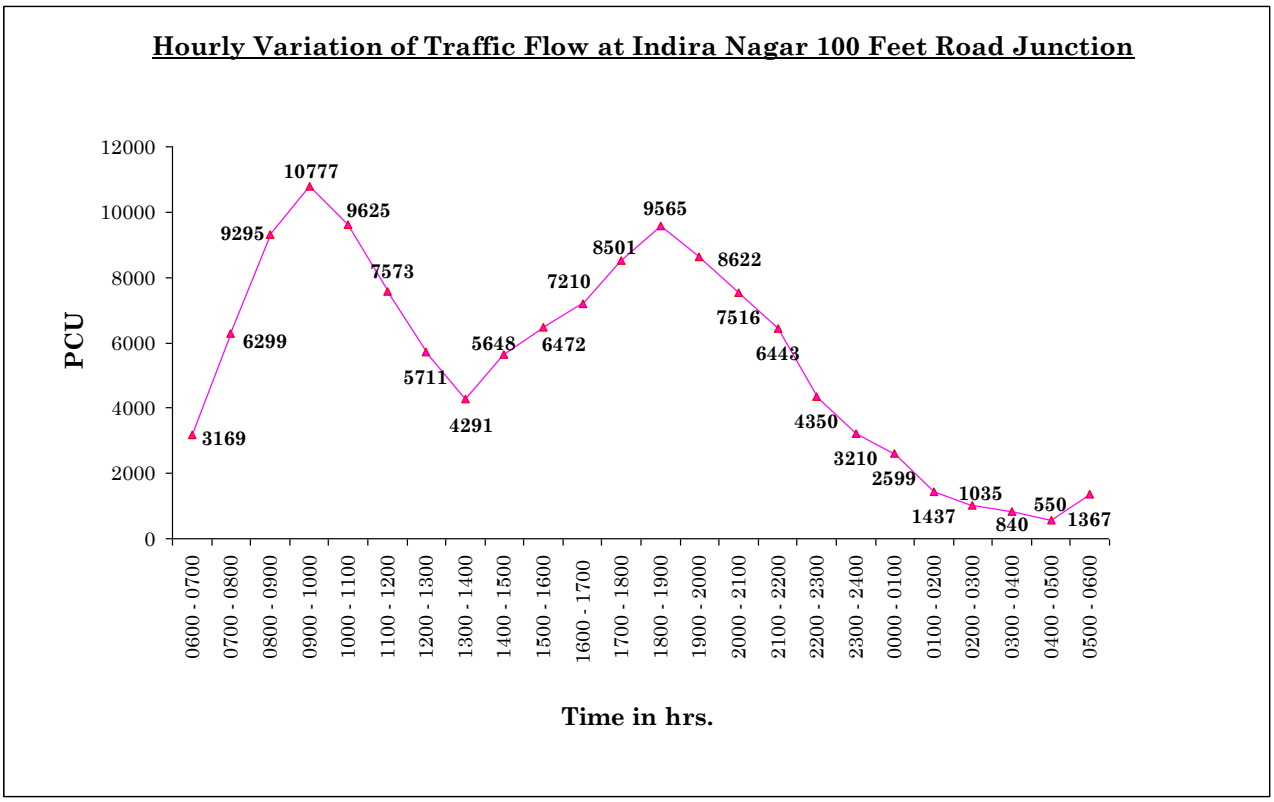

Fig. 4.27

4.18.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.28** for Indira Nagar 100 Feet Road Junction. The major flow is along Old Madras Road in which current Peak Hour Flow is 6148 PCU, which amounts to 57.04% of Junction Volume.

4.19 Indira Nagar 80 Feet Road Junction

4.19.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.29**. The Hourly Traffic Volume observed at the Junction varied in the range of 540 – 10257 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (10257 PCU) and 1800 – 1900 hrs. in the evening (9384 PCU). This Junction handles more than 8000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Indira Nagar 80 Feet Road Junction is given in **Annexure A.4.15**.

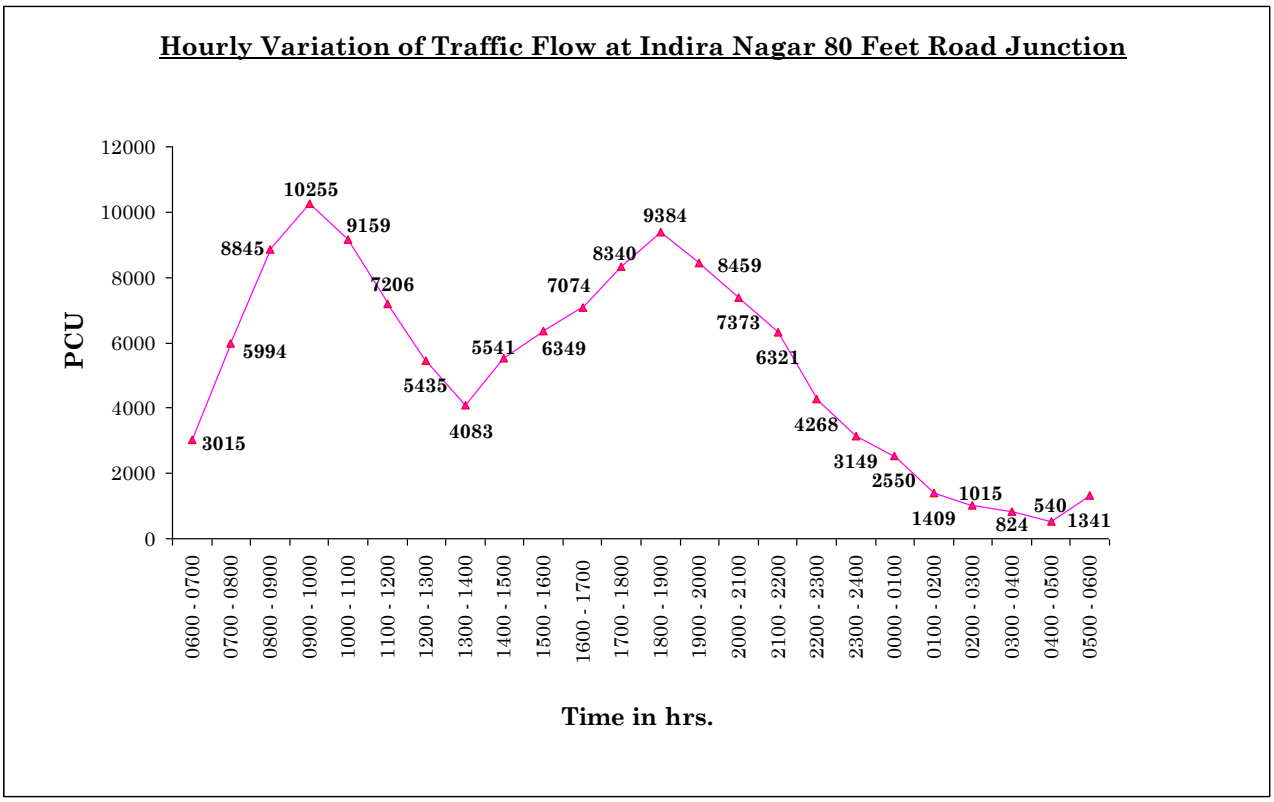

Fig. 4.29

4.19.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.30** for Indira Nagar 80 Feet Road Junction. The major flow is along Old Madras Road in which current Peak Hour Flow is 5673 PCU, which amounts to 55.31% of Junction Volume.

4.20 N. G. E. F. Layout Road Junction

4.20.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.31**. The Hourly Traffic Volume observed at the Junction varied in the range of 501 – 9376 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (9376 PCU) and 1800 – 1900 hrs. in the evening (8713 PCU). This Junction handles more than 7000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at N. G. E. F. Layout Road Junction is given in **Annexure A.4.16**.

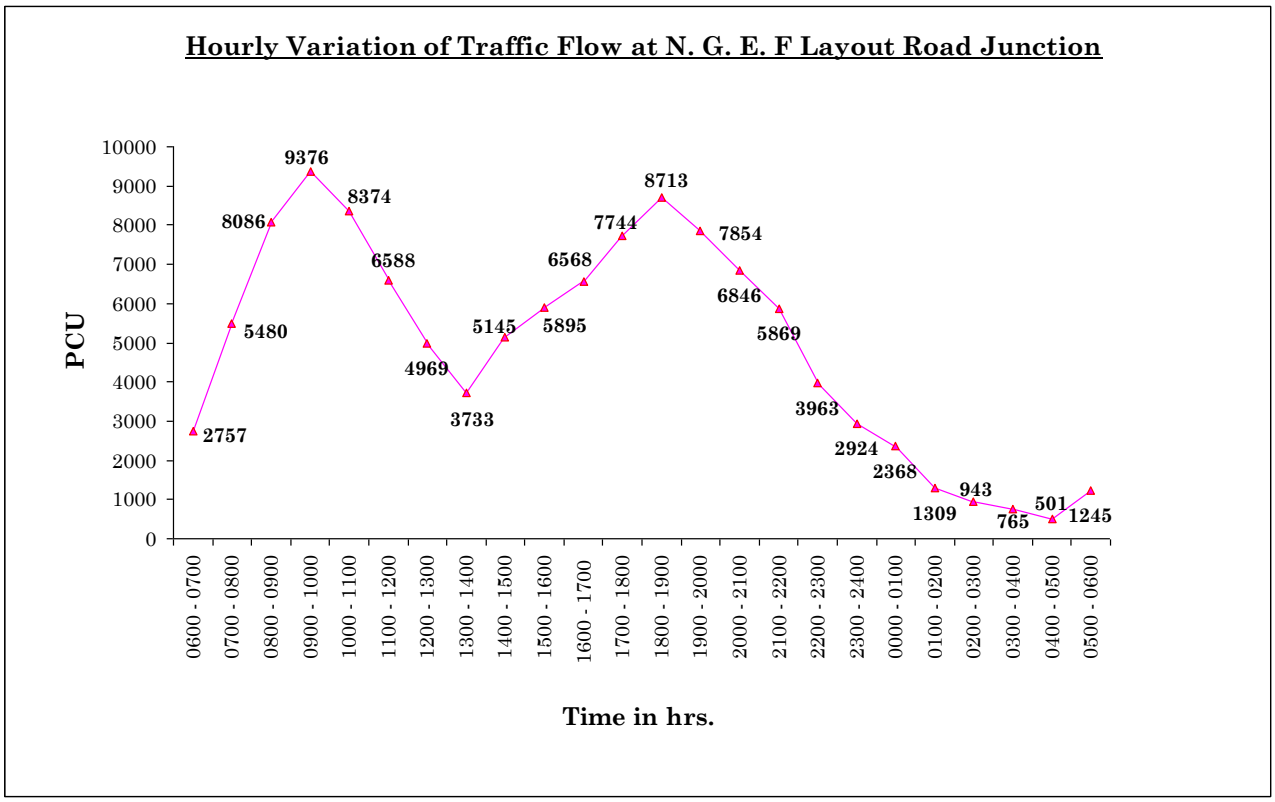

Fig. 4.31

4.20.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.32** for N. G. E. F. Layout Road Junction. The major flow is along Old Madras Road in which current Peak Hour Flow is 7453 PCU, which amounts to 79.49% of Junction Volume.

4.21 Varthur Road Junction

4.21.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.33**. The Hourly Traffic Volume observed at the Junction varied in the range of 472 – 9040 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (9040 PCU) and 1800 – 1900 hrs. in the evening (8211 PCU). This Junction handles more than 7000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Varthur Road Junction is given in **Annexure A.4.17**.

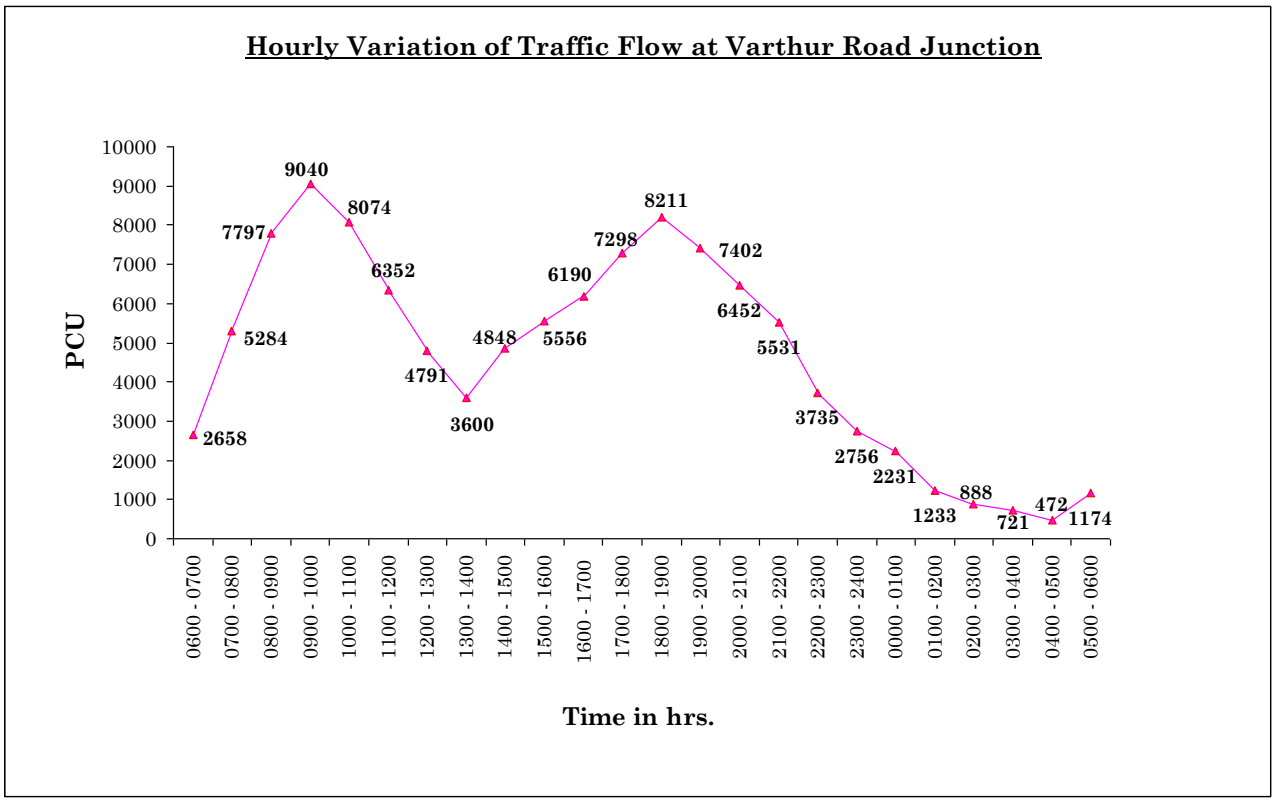

Fig. 4.33

4.21.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.34** for Varthur Road Junction. The major flow is along Old madras Road in which current Peak Hour Flow is 7322 PCU, which amounts to 80.99% of Junction Volume.

4.22 Junction near Hewlett Packard Office

4.22.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.35**. The Hourly Traffic Volume observed at the Junction varied in the range of 401 – 7758 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (7758 PCU) and 1800 – 1900 hrs. in the evening (6974 PCU). This Junction handles more than 6000 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Junction near Hewlett Packard Office is given in **Annexure A.4.18**.

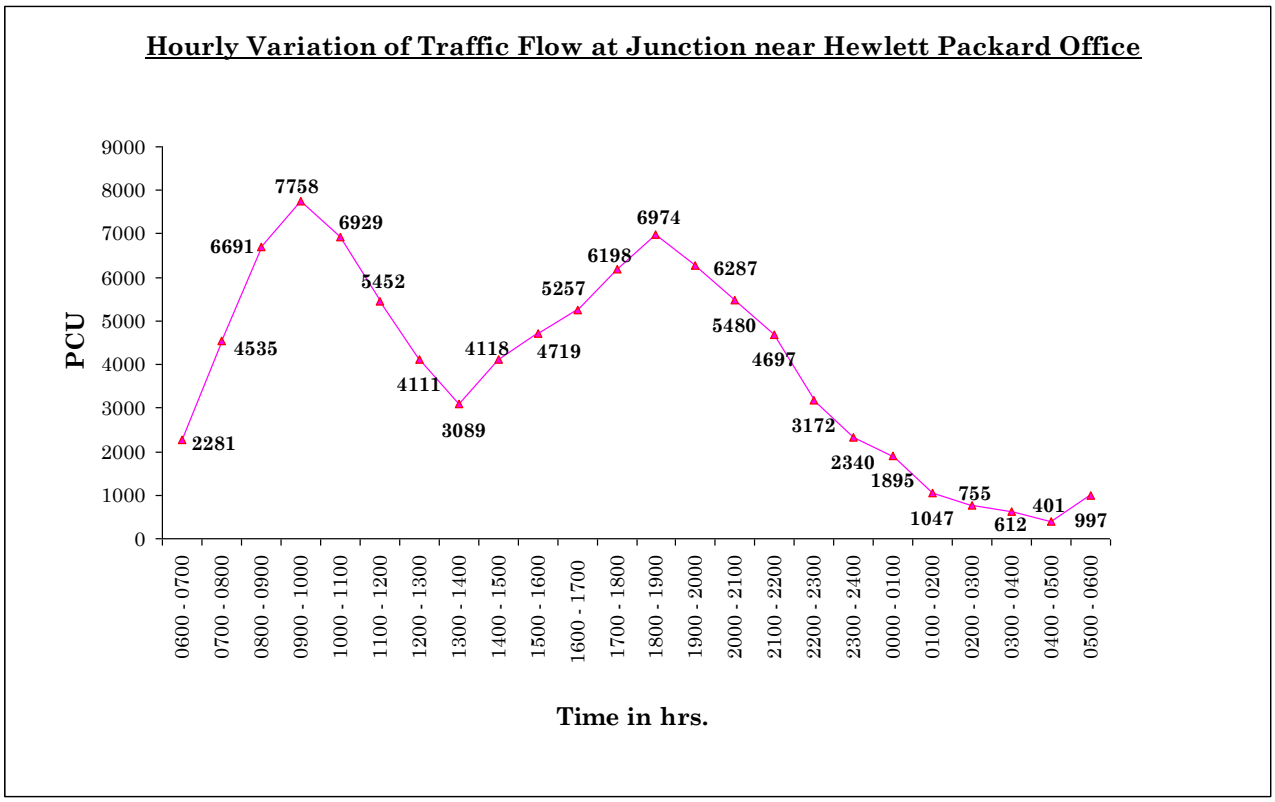

Fig. 4.35

4.22.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.36** for Junction near Hewlett Packard Office. The major flow is along White Field Road in which current Peak Hour Flow is 5108 PCU, which amounts to 65.84% of Junction Volume.

4.23 Hudi Main Road Junction

4.23.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.37**. The Hourly Traffic Volume observed at the Junction varied in the range of 459 – 8570 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (8570 PCU) and 1800 – 1900 hrs. in the evening (7985 PCU). This Junction handles more than 6500 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Hudi Main Road Junction is given in **Annexure A.4.19**.

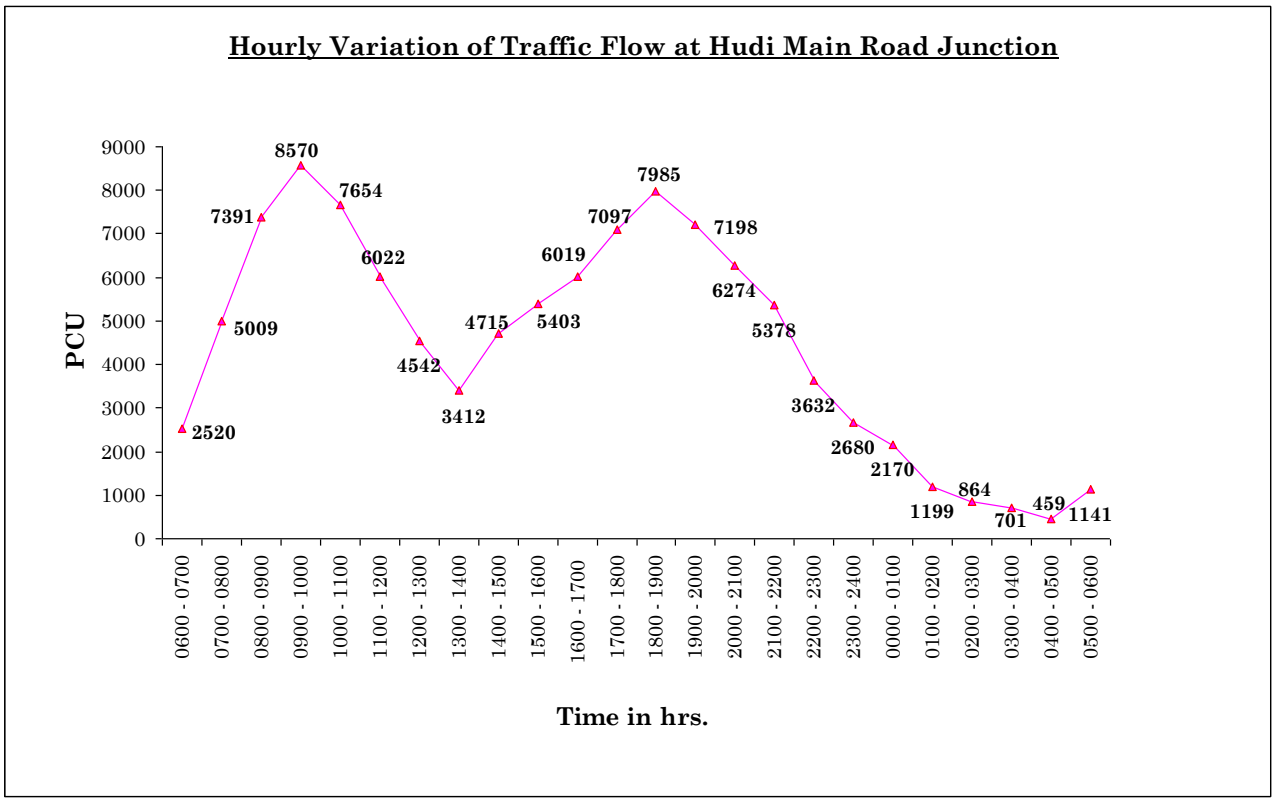

Fig. 4.37

4.23.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.38** for Hudi Main Road Junction. The major flow is along White Field Road in which current Peak Hour Flow is 2844 PCU, which amounts to 33.18% of Junction Volume.

4.24 Export Promotion Industrial Park (E. P. I. P.) Road Junction

4.24.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.39**. The Hourly Traffic Volume observed at the Junction varied in the range of 395 – 7463 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (7463 PCU) and 1800 – 1900 hrs. in the evening (6877 PCU). This Junction handles more than 5500 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at E. P. I. P. Road Junction is given in **Annexure A.4.20**.

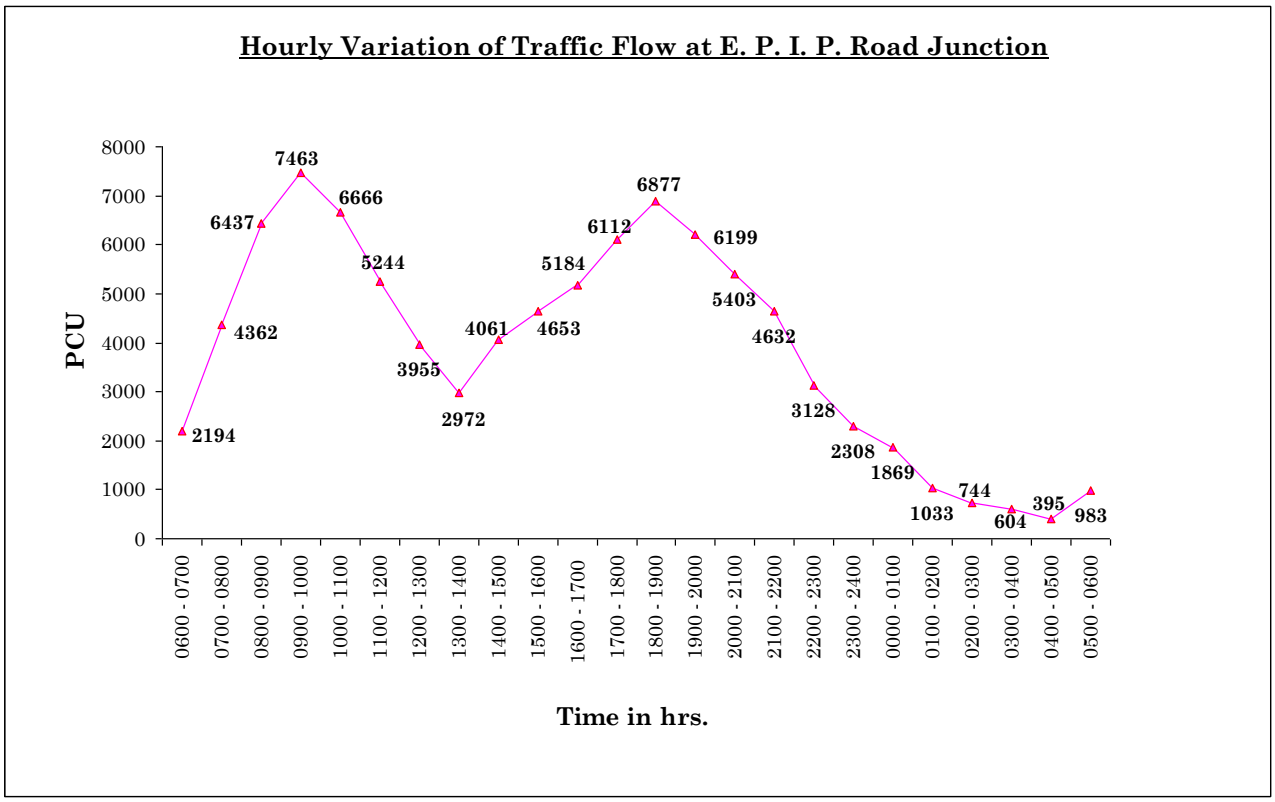

Fig. 4.39

4.24.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.40** for E. P. I. P Road Junction. The major flow is along White Field Road in which current Peak Hour Flow is 3956 PCU, which amounts to 53.00% of Junction Volume.

4.25 Hope Farm Junction

4.25.1 Hourly Variation of Traffic

Hourly Variation of Traffic Flow is presented in **Fig. 4.41**. The Hourly Traffic Volume observed at the Junction varied in the range of 380 – 7285 PCUPH (Passenger Car Unit per Hour). Peak Hour Flows are observed during 0900 – 1000 hrs. in the morning (7285 PCU) and 1800 – 1900 hrs. in the evening (6605 PCU). This Junction handles more than 5500 PCU / hr. for most part of the day (0800 – 2000 hrs.). This is due to prolonged congestion, which has "forced" the Peak Hour Flows over several hours giving Near Peak Flow for more periods of the day. The Detailed Direction wise Traffic Flow at Hope Farm Junction is given in **Annexure A.4.21**.

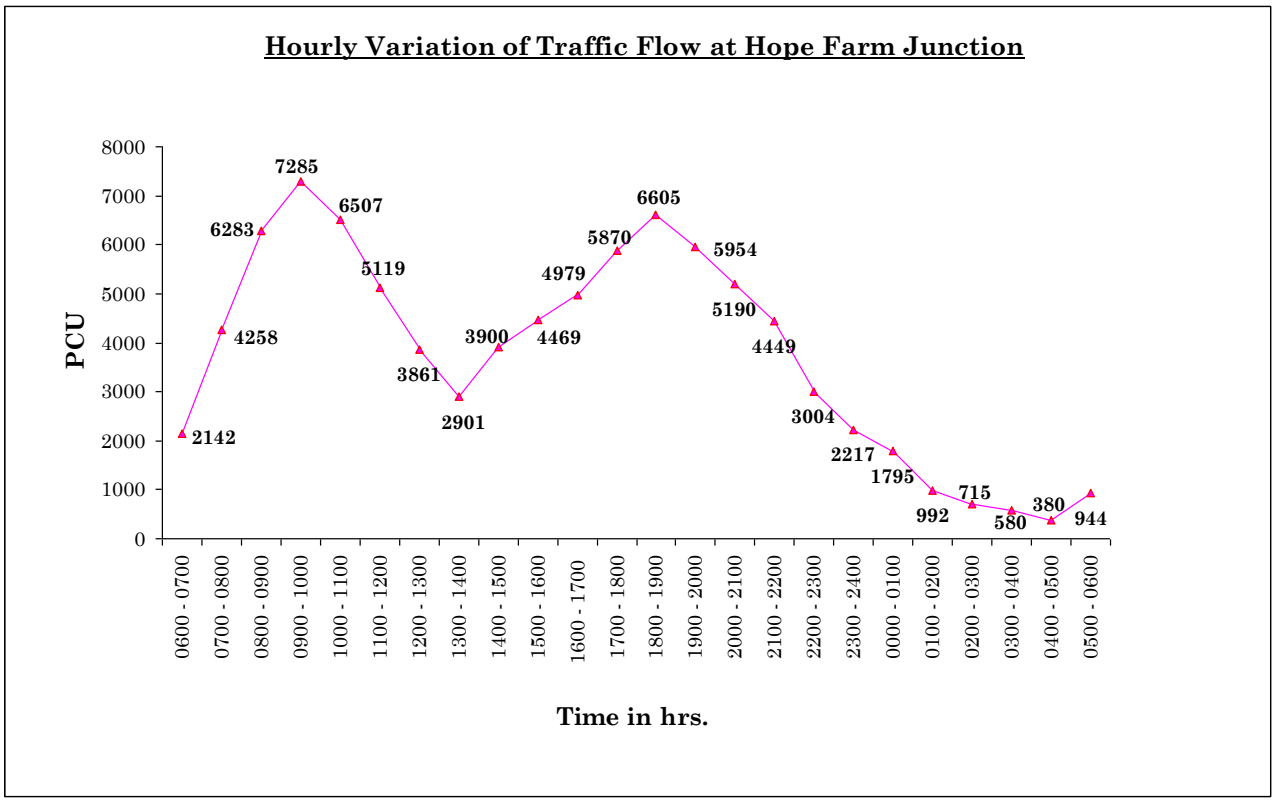

Fig. 4.41

4.25.2 Direction wise Traffic

Peak Hour Direction wise Flow is presented in **Fig. 4.42** for Hope Farm Junction. The major flow is along White Field Road and Chanasandra Main Road in which current Peak Hour Flow is 1644 PCU, which amounts to 22.56 % of Junction Volume.

4.26 Topographic Survey

A Comprehensive Topographic Survey has been conducted all along the Corridor using Total Station Equipment to accurately map the Area and obtain the Present Information on Road Width, Adjoining Land Use, Building Offsets and Levelling Data using Auto Level. The GTS Bench Mark has been transferred to the Site by carrying out Fly Leveling and the Bench Marks have been established at Site. The entire Levelling has been carried out using GTS Bench Mark. The Profiles and Levels of the Road Network within the Study Area have been also captured by taking Longitudinal and Cross Section Levels. The Extent of Survey has been limited to 100m beyond the Battery Limit on both the sides of the Corridor and to 200m on all the Cross Roads joining with the Corridor. The Details have been captured adequately for Planning and Designing of proposed Corridor Improvement Scheme. The Data captured is in 3 – D Format, which have been directly downloaded to Computers and is compatible for Modern Design Softwares. Topographical Map is given in **Chapter 13 – Drawings**.

The Existing Site Features collected during Topographical Survey are enumerated in **Chapter 3 – Study Corridor.**

4.27 Geotechnical Investigation

Geotechnical Investigation has been carried out with the Primary Objective of establishing the Ground Condition at the Site for Major Junctions coming along the Corridor and evaluating the Bearing Pressure and other Engineering Design Parameters through the Field and Laboratory Tests.

Geotechnical Investigation Reports for each of the following Junctions are enclosed in **Annexure A.4.22**.

- CIL Road Junction.
- Munireddy Palya Road Junction.
- Jayamahal 5th Main Road Junction.
- Nandidurga Road Junction.
- Haines Road Junction.
- Seppings Road Junction.
- Kamaraj Road Junction.
- Dhobighat Road Junction.
- Thamarai Kannan Road Junction.
- Murphy Road – Old Madras Road Junction.
- Indira Nagar Double Road Junction.
- Indira Nagar 100 Feet Road – Old Madras Road Junction.
- Baiyyappanahalli Road – Old Madras Road Junction.
- Indira Nagar 80 Feet Road – Old Madras Road Junction.
- Suranjan Das Road Junction.
- Varthur Road Junction.
- Junction near Hewlett Packard Office.
- Hudi Main Road Junction.
- E. P. I. P. Road Junction.
- Pattandur Agrahara Road Junction.
- Hope Farm Junction.

CHAPTER 5
PLANNING AND DESIGN CONSIDERATIONS

5.1 General

Planning and Design of Grade Separated Facility comprising of Grade Separator, Surface Level Roads, At Grade Junction, Pedestrian Facilities, etc. are essentially based on the Design Standards as stipulated in relevant IRC Standards and MoRT&H Specifications. Whenever, the Codes / Standards are silent on some of the Aspects, the same will be planned / designed based on Sound Engineering Practices. Design Standards relevant to the Project Corridor along with the Broad List of Design Parameters and the relevant IRC Codes / Specifications have been detailed in **Table 5.1**.

Design Standards (as appropriate) have been further elaborated under the following heads:

- Geometric Design.
- Drainage.
- Road Furniture and Appurtenances.
- Grade Separated Structure.

5.2 Factors Considered in Planning

The Important Factors considered in the Planning of Grade Separated Facility are detailed below.

- Grade Separated Facility has been planned in such a way that it blends well with the existing Transport Infrastructure Facilities in the City.
- Grade Separated Facility has been planned in such a way that it not only provides Traffic Relief but also enhances the Capacity of the Junctions.
- Grade Separated Structure should have no / minimum Impact on the existing environment and its surroundings. It should not mask the Buildings of Historical Importance.
- Layout of Grade Separated Facility and the Shape / Size of its Components will be harmonized so that to result in Aesthetically Pleasing Structure.
- Drainage and Illumination of the Grade Separated Facility and the Surface Level Roads have been properly planned as per Relevant Provisions of IRC / IS Codes and
- Distance between Expansion Joints would be kept at about 60 – 75m to provide Better Riding Comfort.

5.3 Design Standards Related to Geometric Design

Design Standards related to Road Geometric along with the suggested Design Values / Standards and Recommended Values based on Site Conditions and Data Analysis are detailed in **Table 5.1**.

Table 5.1
Geometric Design Standards

Sl. No.	Design Parameters	Reference Code / Design Values
1.	Design Speed	IRC: 69 – 1977 – "Space Standards for Roads in Urban Areas". IRC: 86 – 1983 – "Geometric Design Standards for Urban Roads in Plains". IRC: 92 – 1985 – "Guidelines for the Design of Interchanges in Urban Areas".
2.	Geometric Design Standards	
	• Median	1m
	• Footpath at grade level	2.5m
	• Camber (Bi – directional)	2.5% for Paved Carriageway
	• Super elevation	Limited to 5% (1 in 20).
	• Horizontal Curves	IRC: 38 – 1988 – "Guidelines for Design of Horizontal Curves for Highways and Design Tables" (First Revision).
	• Vertical Curves	IRC: SP: 23 – 1983 – "Vertical Curves for Highways"
	• Gradient	Entry and Exit Ramps – 5% (1 in 20) Minimum Permissible Gradient for Drainage – 0.5% (lined) and 1% (unlined)
	• Vertical Clearance	4.5m, 5.5m.
	• At – grade junction	IRC: SP: 41 – 1994 – "Guidelines on Design of At Grade Intersections in Rural and Urban Areas".
3.	Road Traffic Signal	IRC: 93 – 1985 "Guidelines on Design and Installation of Road Traffic Signals".

5.4 Design Standards Related to Drainage

Drainage of Storm Water collected in / on Grade Separator and on Surface Level Roads are essentially based on the Guidelines given in IRC: SP: 42 – 1994 – "Guidelines on Road Drainage" and in IRC: SP: 50 – 1999 – "Guidelines on Urban Drainage". The Suggested Design Values / Standards and Recommended Values based on Site Conditions are detailed in **Table 5.2**.

Table 5.2
Design Standards Related to Drainage

Design Parameters	Reference Code / Design Values
• Camber	2.5% (bi – directional) for carriageway
• Longitudinal Gradient	Minimum 0.3% for satisfactory drainage
• Drain Type	RCC Box Drain covered with Precast RCC Slab

5.5 Design Standards Related to Road Furniture and Appurtenances

Utility and Importance of the Grade Separated Facility (Grade Separator, Surface Level Roads and Junction) is greatly enhanced by installing Road Furniture and Appurtenances

at appropriate locations, which ensures Improved Safety. Planning and Design of Road Furniture and Appurtenances are as per the Guidelines stipulated in IRC. Detailing of each of these Components has been done so that to integrate the same with the Grade Separator Scheme. The Suggested Design Values / Standards are detailed in **Table 5.3**.

Table 5.3
Design Standards Related to Road Furniture and Appurtenances

Sl. No.	Design Parameters	Reference Code / Design Values
1	Road Markings	IRC: 35 – 1997 – "Code of Practice for Road Markings (with Paints)".
2	Road Signs	IRC: 67 – 2001 – "Code of Practice for Road Signs".
3	Road Delineators	IRC: 79 – 1981 –"Recommended Practice for Road Delineators"
4	Pedestrian Facilities *	IRC: 103 – 1988 – "Guidelines for Pedestrian Facilities".

(*– Footpath, Pedestrian Crossing, Zebra Crossing, etc.)

5.6 Design Standards Related to Grade Separated Structure

The Design Standards and Loading considered for Grade Separated Structure have been as stipulated in latest IRC Codes / Special Publications supplemented by appropriate MoRT&H Circulars and / or IS Codes.

5.7 Lighting

The Preparation of Lighting Scheme, Installation and Maintenance of Street Lights in / on the Grade Separator and at Surface Level are essentially based on IS: 1994 (Part I and II) – 1970.

CHAPTER 6
CORRIDOR IMPROVEMENT SCHEME

6.1 General

Due to the Land Constraint, the Scope of the Corridor Improvement Scheme has been limited to only Junction Improvements by proposing Grade Separator using Pre Cast Element Technology at Major Junctions and closing of Median at Minor Junctions. Link Improvement in terms of Widening of Roads has been proposed only near Indira Nagar Double Road and other Improvements such as Improvements to Footpath, Median, Drainage System; Provision of Effective Illumination, etc. have been accommodated in the Project Proposal for the entire stretch of the Project Corridor.

The Concept proposed for each Project Junction has been presented to the Technical Advisory Committee (TAC), BBMP and based on the suggestion / instruction by the TAC, the Concepts for each Junction has been finalised and accordingly approved by the TAC. The Approved Concept for each Junction is briefly explained below.

6.2 CIL Road Junction

At this Junction, a two lane uni directional Underpass has been proposed along Jayamahal Road for Traffic Movement from Mekhri Circle Side to Munireddy Palya Junction Side with 5.5m wide Slip Road and 2.5m wide Footpath on Eastern Side at grade level. To facilitate the Traffic Flow from Munireddy Palya Junction Side to Mekhri Circle Side, 7.5m wide Carriageway with 2.5m wide Footpath has been proposed at grade level.

Following are the Salient Features of the Underpass at CIL Road Junction.

- Total Length of Underpass 275.43m
- Number of Lane 2 lane uni directional
- Carriageway Width 7.5m
- Length of Covered Portion 30m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Mekhri Circle 134.85m
- Length of Approach Ramp towards Munireddy Palya Jn. 110.58m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 3390.63 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / CILRJ / GAD / 302**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / CILRJ / LA / 304**.

6.3 Munireddy Palya Road Junction

At this Junction, a two lane uni directional Underpass has been proposed along Jayamahal Road for Traffic Movement from CIL Road Junction Side to Jayamahal 5th

Main Road Junction Side with 5.5m wide Slip Road and 2.5m wide Footpath on Eastern Side at grade level. To facilitate the Traffic Flow from Jayamahal 5th Main Road Junction Side to CIL Road Junction Side, 7.5m wide Carriageway with 2.5m wide Footpath has been proposed at grade level.

Following are the Salient Features of the Underpass at Munireddy Palya Junction.

- Total Length of Underpass 333.73m
- Number of Lane 2 lane uni directional
- Carriageway Width 7.5m
- Length of Covered Portion at J C Nagar Road Jn. 30m
- Length of Covered Portion at Nandidurga Road Jn. 30m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards CIL Road Junction 124.98m
- Length of Approach Ramp towards 5th Main Road Jn. 108.93m
- Length of Integrated Ramp Portion 39.82m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 4071.15 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / MRPRJ / GAD / 402**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / MRPRJ / LA / 404**.

6.4 Jayamahal 5th Main Road Junction

At this Junction, a two lane uni directional Underpass has been proposed along Jayamahal Road for Traffic Movement from Munireddy Palya Junction Side to Nandidurga Road Junction Side with 5.5m wide Slip Road and 2.5m wide Footpath on Eastern Side at grade level. To facilitate the Traffic Flow from Nandidurga Road Junction Side to Munireddy Palya Junction Side, 7.5m wide Carriageway with 2.5m wide Footpath has been proposed at grade level.

Following are the Salient Features of the Underpass at Jayamahal 5th Main Road Junction.

- Total Length of Underpass 270.09m
- Number of Lane 2 lane uni directional
- Carriageway Width 7.5m
- Length of Covered Portion 25m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Munireddy Palya Road Junction 157.29m
- Length of Approach Ramp towards Nandidurga Road Junction 87.8m

- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 3871.15 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / J5thMRJ / GAD / 502**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / J5thMRJ / LA / 504**.

6.5 Nandidurga Road Junction

At this Junction, a two lane uni directional Underpass has been proposed along Millers Road for Traffic Movement from Jayamahal 5th Main Road Junction Side to Haines Road Junction Side with 5.5m wide Slip Road and 2.5m wide Footpath on Eastern Side at grade level. To facilitate the Traffic Flow from Haines Road Junction Side to Jayamahal 5th Main Road Junction Side, 7.5m wide Carriageway with 2.5m wide Footpath has been proposed at Grade Level.

Following are the Salient Features of the Underpass at Nandidurga Road Junction.

- Total Length of Underpass 270m
- Number of Lane 2 lane uni directional
- Carriageway Width 7.5m
- Length of Covered Portion 38m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Jayamahal 5th Main Road Junction 155.19m
- Length of Approach Ramp towards Haines Road Junction 76.76m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 4624.27 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / NRJ / GAD / 702**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / NRJ / LA / 704**.

6.6 Haines Road Junction and Seppings Road Junction

A four lane divided bi directional Flyover has been proposed along the Corridor by integrating both Haines Road Junction and Seppings Road Junction with 5.5m wide Slip Road and 2.5m wide Footpath on either Side at grade level.

Following are the Salient Features of the Integrated Flyover at Haines Road Junction and Seppings Road Junction.

- Total Length of Integrated Flyover 606.238m
- Number of Lane 4 lane divided bi directional

- Carriageway Width 7.5m X 2
- Length of Obligatory Span at Haines Road Junction 40m
- Length of Obligatory Span at Seppings Road Jn. 30m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Nandidurga Road Jn. 124.471m
- Length of Approach Ramp towards Kamaraj Road Jn. 155.76m
- Length of Integrated Via Duct 256.0m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 6419.36 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / HR&SRJ / GAD / 902A**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / HR&SRJ / LA / 904**.

6.7 Kamaraj Road Junction and Meanee Avenue Road Junction

As per the suggestion / instruction by the TAC, no Grade Separator Scheme has been proposed at these two Junctions. A One Way Loop has been incorporated by making St. John's Church Road One Way from Meanee Avenue Road Junction to Kamaraj Road Junction and Promenade Road One Way from T.R.A Thumboo Chetty Circle to Meanee Avenue Road Junction

Concept Plan is presented in **Drawing No. MC / BBMP / KRJ&MARJ / CP / 1102**.

6.8 K. Venkatachala Circle

At this Junction, the Circumference of the existing Rotary has been reduced to widen the Carriageway along all the three arms of the Junction.

Concept Plan is presented in **Drawing No. MC / BBMP / KVC / CP / 1202**.

6.9 Dhobighat Road Junction

At this Junction, a two lane uni directional Underpass has been proposed across the Project Corridor i.e. along Murphy Road for Traffic Movement from Murphy Road Side to Thamarai Kannan Road Junction Side.

Following are the Salient Features of the Underpass at Dhobighat Road Junction.

- Total Length of Underpass 235.3m
- Number of Lane 2 lane uni directional
- Carriageway Width 7.5m
- Length of Covered Portion 24m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Murphy Road 90.4m
- Length of Approach Ramp towards Thamarai Kannan Road Junction 120.9m

- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 438.60 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / DGRJ / GAD / 1302**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / DGRJ / LA / 1304**.

6.10 Thammarai Kannan Road Junction and Murphy Road – Old Madras Road Junction

A two lane uni directional Underpass has been proposed along the Corridor by integrating both these Junctions for the Traffic Movement from Old Madras Road Side to Murphy Road Side with 5.5m wide Slip Road and 2.5m wide Footpath on the southern side at grade level.

Following are the Salient Features of the Integrated Underpass at Thamarai Kannan Road Junction and Old Madras Road Junction

.

- Total Length of Underpass 551.3m
- Number of Lane 2 lane uni directional
- Carriageway Width 7.5m
- Length of Covered Portion at Thamarai Kannan Road Junction 20m
- Length of Covered Portion at Old Madras Road Junction 40m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Dhobighat Road Junction 120.39m
- Length of Approach Ramp towards Old Madras Road 102.89m
- Length of Integrated Ramp 268m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 3547.84 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / TKR&MRJ / GAD / 1402**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / TKR&MRJ / LA / 1404**.

6.11 Indira Nagar Double Road Junction

At this Junction, a two lane uni directional Flyover has been proposed along the Corridor for the Traffic Movement from Indira Nagar 80ft. Road Junction Side to Murphy Road – Old Madras Road Junction Side with 5.5m wide Slip Road and 2.5m wide Footpath on Southern Side at grade level.

Following are the Salient Features of the Flyover at Indira Nagar Double Road Junction.

- Total Length of Flyover 303.89m
- Number of Lane 2 lane uni directional
- Carriageway Width 7.5m
- Length of Obligatory Span 35m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Murphy Road – Old Madras Road Junction 158.79m
- Length of Approach Ramp towards Indira Nagar 80ft Road Junction 110.1m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 3652.38 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / INDRJ / GAD / 1502A**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / INDRJ / LA / 1504**.

6.12 Indira Nagar 80ft. Road Junction

At this Junction, a two lane uni directional Underpass has been proposed along Old Madras Road for the Traffic Movement from Suranjan Das Road Junction Side to Indira Nagar Double Road Junction Side with 5.5m wide Slip Road and 2.5m wide Footpath on Southern Side at grade level.

Following are the Salient Features of the Underpass at Indira Nagar 80ft. Road Junction.

- Total Length of Underpass 234.98m
- Number of Lane 2 lane uni directional
- Carriageway Width 7.5m
- Length of Covered Portion 35m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Indira Nagar Double Road Junction 80.12m
- Length of Approach Ramp towards Suranjan Das Road Junction 119.86m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 517.74 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / IN80ftRJ / GAD / 1702**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / IN80ftRJ / LA / 1704**.

6.13 Suranjan Das Road Junction

At this Junction, a four lane divided bi directional Flyover has been proposed along Old Madras Road with 5.5m wide Slip Road and 2.5m wide Footpath on either Side at grade level.

Following are the Salient Features of the Flyover at Suranjan Das Road Junction.

• Total Length of Flyover	331.76m
• Number of Lane	4 lane divided bi directional
• Carriageway Width	7.5m X 2
• Length of Obligatory Span at Suranjan Das Road	35m
• Length of Obligatory Span near Railway Track	20m
• Length of Obligatory Span near the Proposed Road	30m
• Vertical Clearance	4.5m
• Gradient	5% (1 in 20)
• Length of Solid Ramp towards NGEF Layout Jn.	59.54m
• Length of Viaduct towards NGEF Layout Jn.	40m
• Length of Solid Ramp towards Indira Nagar 80ft. Road Junction	87.22m
• Length of Viaduct towards Indira Nagar 80ft. Road Jn.	60m
• Width of Slip Road	5.5m
• Width of Footpath	2.5m
• Land Acquisition	1017.28 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / SRJ / CP / 1802A**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / SRJ / LA / 1804**.

6.14 Varthur Road Junction

At this Junction, a two lane uni directional Underpass has been proposed along Old Madras Road for Traffic Movement from Krishna Raj Puram Side to Suranjan Das Road Junction Side with 7.5m wide Slip Road and 2.5m wide Footpath for Traffic Movement from Varthur Road to Old Madras Road at grade level.

Following are the Salient Features of the Underpass at Varthur Road Junction.

• Total Length of Underpass	307.88m
• Number of Lane	2 lane uni directional
• Carriageway Width	7.5m
• Length of Covered Portion	30m
• Vertical Clearance	4.5m
• Gradient	5% (1 in 20)
• Length of Approach Ramp towards Suranjan Das Road Junction	200.56m
• Length of Approach Ramp towards K. R. Puram	77.32m

- Width of Slip Road 7.5m
- Width of Footpath 2.5m
- Land Acquisition 40.47 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / VRJ / GAD / 2002**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / VRJ / LA / 2004**.

6.15 Junction near Hewlett Packard Office

At this Junction, a two lane uni directional Underpass has been proposed along White Field Road to facilitate the Traffic Flow from White Field Road Side to Old Madras Road Side with 5.5m wide Slip Road and 2.5m wide Footpath for the Traffic Movement from Hewlett Packard Office Side to Old Madras Road Side at grade level.

Following are the Salient Features of the Underpass at Junction near Hewlett Packard Office.

- Total Length of Underpass 315.98m
- Number of Lane 2 lane uni directional
- Carriageway Width 7.5m
- Length of Covered Portion 20m
- Vertical Clearance 5.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Old Madras Road 166.32m
- Length of Approach Ramp towards Hudi Main Road Junction 129.66m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 1602.96 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / JNHPO / GAD / 2302**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / JNHPO / LA / 2304**.

6.16 Hudi Main Road Junction

At this Junction, a four lane divided bi directional Underpass has been proposed along Hudi Main Road i.e. across the Corridor and a four lane divided bi directional Flyover has been proposed along the Corridor with 5.5m wide Slip Road and 2.5m wide Footpath on either side at grade level.

Following are the Salient Features of the Underpass at Hudi Main Road Junction.

- Total Length of Underpass 357.08m
- Number of Lane 4 lane divided bi directional
- Carriageway Width 7.5m X 2

- Length of Covered Portion 80m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards ITPL Main Road 195.24m
- Length of Approach Ramp towards Hudi Main Road 81.83m
- Width of Slip Road 5.5m
- Width of Footpath 2.5.

Following are the Salient Features of the Flyover at Hudi Main Road Junction.

- Total Length of Flyover 459.889m
- Number of Lane 4 lane divided bi directional
- Carriageway Width 7.5m X 2
- Length of Obligatory Span 60m
- Vertical Clearance 4.5m
- Gradient 5% (1 in 20)
- Length of Solid Ramp towards Hewlett Packard Jn. 125.132m
- Length of Solid Ramp towards EPIP Road Junction 274.756m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 6714.73 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / HMRJ / GAD / 2402A**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / HMRJ / LA / 2404**.

6.17 Export Promotion Industrial Park (E. P. I. P.) Road Junction and Pattandur Agrahara Road Junction

A four lane divided bi directional Underpass has been proposed along White Field Road by integrating these two Junctions with 5.5m wide Slip Road and 2.5m wide Footpath on either side at grade level.

Following are the Salient Features of the Integrated Underpass at E. P. I. P. Road Junction and Pattandur Agrahara Road Junction.

- Total Length of Underpass 495.53m
- Number of Lane 4 lane divided bi directional
- Carriageway Width 7.5m X 2
- Length of Covered Portion at E. P. I. P. Road Junction 30m
- Length of Covered Portion at Pattandur Agrahara Road Junction 30m
- Vertical Clearance 5.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Hudi Main Road Junction 117.12m

- Length of Approach Ramp towards Hope Farm Junction 141.04m
- Length of Integrated Ramp 177.38m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 3225.3 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / EPIP&PARJ / GAD / 2502**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / EPIP&PARJ / LA / 2504**.

6.18 Hope Farm Junction

At this Junction, a four lane divided bi directional Underpass has been proposed along SH – 35 for Traffic Movement along the State Highway – 35 with 5.5m wide Slip Road and 2.5m wide Footpath on either side at grade level.

Following are the Salient Features of the Underpass at Hope Farm Junction.

- Total Length of Underpass 334.66m
- Number of Lane 4 lane divided bi directional
- Carriageway Width 7.5m X 2
- Length of Covered Portion 35m
- Vertical Clearance 5.5m
- Gradient 5% (1 in 20)
- Length of Approach Ramp towards Northern Side of the Junction 96.96m
- Length of Approach Ramp towards Southern Side of the Junction 202.69m
- Width of Slip Road 5.5m
- Width of Footpath 2.5m
- Land Acquisition 2699.09 Sqm

Layout Plan and Longitudinal Section are presented in **Drawing No. MC / BBMP / HFJ / GAD / 2602**. Land Acquisition Details are presented in **Drawing No. MC / BBMP / HFJ / LA / 2604**.

6.19 Pedestrian Crossing

The Pedestrian Crossing across the Study Corridor is considerable and the No. is quite significant almost at all the Junctions. This is due to the presence of well developed Institutional Buildings, Public Offices, Apartments, Hospitals, Industrial Buildings, Recreational Facilities, etc. along the Project Corridor. But, due to Land Constraint, no separate facility has been proposed for Pedestrian Movement in this Corridor Improvement Scheme. Hence, Pedestrian Crossing has been proposed to be managed by Signalled Zebra Crossing.

CHAPTER 7
DESIGN OF GRADE SEPARATOR

7.1 Planning and Investigations

The Corridor Improvement Scheme has been discussed in detail in Chapter 6. Diversion of the Underground Services like Water, Sewer, Electricity, etc., which will affect the Construction Activities will be programmed prior to the Excavation Work.

7.2 General Arrangement

Care has been taken while designing so that the structure generally fulfills the following requirements.

- The Soundness of the Structure and its Durability are of the highest standards.
- Aesthetics is in harmony with the surroundings.
- Speedy and Practicable Construction.
- Economy in Construction.

7.3 Design Loads

1. Live Load

Class 70R Loading has been considered.

2. Wind Force

Wind Forces have been considered in the following two ways. The design shall be governed by the one producing the worst effect.

- Full wind force at right angles to the superstructure.
- 65% of wind force as calculated above acting perpendicular to the superstructure and 35% acting in traffic direction.

The appropriate wind force on 10m high Lighting Poles @ 30m c/c. has been considered in the design.

3. Seismic Force

The Grade Separator has been designed for the Seismic Force as per the provisions of IS: 1893 (Latest Edition).

4. Earth pressure

- The Soil Properties for Embankment like Dry Density of Soil 1.85 t / cum.; Saturated Density 2.00 t / cum.; $\Phi = 30^0$ and c = 0 have been considered for Estimation Purpose.
- Saturated Density of the Backfill (minimum 2 t / cum) has been considered for calculating Active Earth Pressure for Estimation Purpose.

5. Temperature Range

- For Design of Structure, to account for temperature, the following Formula has been considered.

$(DL) = \alpha Lt,$

The value of "t" shall be ±17^{0}C.

Where α = Coefficient of expansion or contraction

L = Length of the member

(DL) = Expansion / Contraction due to Temperature Variation in appropriate units.

The Superstructure has been designed for Effects of Distribution of Temperature across the Deck Depth as per the relevant Codal Provisions. For Calculation, Thermal Force Effect (E) of 50% of the Insulation Value has been considered so that to account for Effect of Creep on Thermal Strain.

7.4 Design of Underpass

7.4.1 General

The Length of the Underpass has been determined based on the Depth of Deck Slab, where a minimum Vertical Clearance of 4.5m has to be provided. By considering the Economy of the Project, Open Cut System has been considered both for Ramp and Covered Portion of the Underpass. Based on the Economy of the Project and Site Condition, the Covered Portion of the proposed Underpass has been designed as Precast RCC Closed Box Section. For Approaches, Open Box and Conventional RCC Retaining Structure have been adopted. The Drawings for Covered and Open Portions of the Underpass at respective Junctions are enclosed in **Chapter 13 – Drawings**.

7.4.2 Foundation

a) Retaining Walls

The Retaining Walls for the Approaches have been proposed to be of RCC appropriate with the Site Conditions. The Depth of the Foundation has been determined based on the Soil Investigation Report. Maximum Settlement allowed is 10mm. Adequate Protection has been given to Reinforcement against Corrosion.

b) Underpass

Closed and Open Portions of the Underpass including Retaining Walls shall be of minimum M35 grade Ready Mix Concrete.

7.5 Design of Flyover

7.5.1 General

The length of the Flyover has been determined by the depth of the superstructure of the Obligatory Span, where a minimum vertical clearance of 4.5m has to be provided. The roads in the project area have a number of underground services like water, sewer, electricity, etc. and diverting these service lines are not so easy and hence the foundation has been designed in such a way that there will be minimum obstruction for executing the work. Hence, Open Foundation, though economical is not considered, as it requires shoring as well as temporary support to service lines in addition to prolonged time of construction. Further, diversions of these services have been programmed to carry out prior to the execution work.

The depth of pile has been taken as 15m in the cost estimate upon the cut off level. The boreholes shall be taken at the time of execution one at each pier and one at each

abutment prior to the commencement of the work. The termination level of the borehole shall be determined by conducting SPT tests. Three consecutive SPT tests at an interval of 1.5m each with 'N' values greater than 100 shall be carried out before termination. If rock is encountered, drilling shall continue upto 3m in rock with rock samples taken for testing. All the soil / sub soil investigations shall be strictly in accordance with the relevant code provisions.

While checking the stresses at the base of foundations it has to be ensured that under the worst combination of forces no tension is permitted. The safe bearing capacity at the foundation level shall be verified during construction so that to ensure that the stresses imposed on the foundation strata are within permissible limits.

7.5.2 Foundation

With the presence of underground services and foundation of adjoining existing structures, Open Foundation is not permitted considering the time for execution, importance from traffic point of view and location of the Flyover. Pile Foundation is considered for speedy construction and minimum traffic disruption. As far as possible, the Piles will be installed by bypassing the underground services and the Pile Caps will be constructed below the ground level at a minimum depth of 0.75m form the surface. The piles are of bored cast – in – situ type and resting on hard strata, where 'N' values are more than 100. The construction of pile foundation design has been done as per the relevant specifications of IS: 2911.

The Piles are essentially end bearing and are socketed into the hard strata at least to a depth equal to 1.5 times the diameter of the pile. The presence of hard strata shall be established by conducting SPT Tests in the pile bore. On ascertaining the hard strata through SPT, further chiseling shall be done for socketing. The number of drops of a given chisel falling at a constant fall for a specific depth of penetration shall be noted and these chiseling criteria (in terms of number of drops) shall be used to ascertain hard strata in the surrounding bores. Based on the available soil data for the area, a pile length of 15m has been assumed for the purpose of estimation. The capacity has to be derived by working out the actual load capacity of a laterally supported, freestanding column. However, the Construction Agency shall submit the Design Calculation for Pile Load Capacity to the Engineer on the basis of the results of initial load test on piles. The test piles shall be installed as directed by the Engineer.

Metal Casings with thickness not less then 6mm has been proposed to support the unstable sides at the top of the borehole.

- **Minimum Length of the Embedment**
  A minimum depth of embedment of 9m (including socket length) in soil has been proposed to be maintained where the pile cannot be driven any further. However, the termination level of the pile shall be as per specific instructions of the Engineer – in – Charge or his authorized representative. In the event of presence of rock or very hard strata at a shallow depth, the Construction Agency shall be advised by the Engineer regarding the termination level and the same shall be in conformity with the code provisions.

- **Pile Diameters**

  1200mm dia Piles have been proposed for Obligatory Span and 1000mm dia Piles for Standard Spans. Pile groups with 10 nos. of piles for abutments and 4 to 6 nos. of piles for pier locations have been proposed.

  The grade of concrete for the pile is M35. The cement content for pilling work has been assumed as 400 kg/m3 with Ordinary Portland Cement of grade 43. However, the Pile Foundations shall satisfy the following requirements.

  - Only bored cast in situ piles will be accepted.
  - The pile foundations shall be designed as per the requirements of IS: 2911 (Part I / Section – 2) – Latest Revision.
  - The design capacity assumed for the piles shall be verified by the initial load testing of test piles in non working areas, in the vicinity of the flyover site. These piles shall be tested for 2.0 times the design load and number of such tests shall be done for each diameter of pile. Additional one pile for each diameter, which is actually going to be used for piers and abutments, shall be tested for 1.5 times the design load.
  - Annular Piles filled or unfilled shall not be accepted.
  - Design with single row of piles shall not be accepted.
  - Design shall ensure that no pile is subjected to tension.
  - Concreting shall be done by Tremie Method after ensuring proper tip zone cleaning by flushing only.
  - The top of concrete in piles shall be brought above the cut off level by minimum 750mm to permit removal of all laitance and week concrete before pile is laid.

7.5.3 Ramps / Retaining Walls

The adoption of Reinforced Earth Wall is economical and the construction can be faster compared to Conventional Retaining Walls. Hence, Solid Ramp Portion of the Flyover has been proposed to be constructed with Reinforced Earth Retaining Structure. This Work consists of reinforced soil structures as per Terramesh Reinforced Soil Wall with Concrete Panel / Segmental Block Fascia comprising of Mechanically Woven Double Twisted Hexagonal shape, (Zn + PVC) Coated Wire Mesh as per detailed specifications.

The work is generally done in conformity to the MORT&H Specification / BS: 8006 Specifications. The detailed design and drawings of the work have been done in accordance with the MORT&H Specification and Guidelines contained in the IRC. Patentee's Specifications has been incorporated wherever relevant.

The Materials shall be procured from the supplier of the Reinforced Soil Technology approved by the Engineer. The Designs and Drawings shall be got approved from BBMP before execution of work.

7.5.4 Substructure

The Substructure shall satisfy the following Requirements.

- **Dimensions**
  - Dimension of any Element of Substructure shall not be less than 300mm.
  - All RCC Piers shall be of solid type.
  - The height of pedestals on pier cap supporting bearings shall not be more than 300mm.

- **Layout and Design**
  - All Bearings shall be supported directly on Pier Stem. However, bearings resting on overhangs are acceptable provided the differential deflection of pier cap is accounted in the transverse analysis of superstructure.
  - Scope for accessibility for inspection of bearings and arrangement for lifting of the superstructure for future replacement of bearings shall be provided in the design of Substructure and Superstructure.

7.5.4.1 Abutments

The Abutments and Returns have been designed for live load surcharge equivalent to earthfill of 1.2m height. The minimum density of filling for calculations of Surcharge Pressure has been considered as 2 T / cum. The Surcharge Effect has been considered for the purpose of evaluating Earth Pressure and not for Vertical Loads.

7.5.4.2 Piers

The Piers considered for design is of two types. One type is for Standard Spans and other type is for Obligatory Span. The Design has been based on the Combination of Design Loads producing the worst effect. One span dislodged condition has also been taken into consideration while designing the piers.

7.5.5 Superstructure

The choice of Superstructure mainly depends on the Span and the Aesthetic Importance. The Spans are determined based on the Superstructure and feasibility of transporting long span Precast Girders. It is advisable that construction of superstructure proceeds with surface level construction like pier or abutment construction.

For standard spans, Precast Pre Tensioned I girders of 16.75m with Cast – in – Situ Concrete Deck Slab have been adopted. Geometrical Variation like Curvature of the Deck can be easily constructed with Concrete Decks using Straight Precast Girders.

The Selection of the type of Obligatory Span depends on Availability of Space, Curvature and Aesthetic Importance. The minimum thickness of 200mm for Deck Slab has been proposed to be maintained.

7.5.5.1 Prestressed Concrete Girder and Slab

For ease and speed of construction, Precast Concrete Superstructure has been proposed to be adopted for the Standard Span. While designing such element / structure, Aspects of Durability and Minimum Maintenance have been kept in view. Precast Panel Slab Deck /

Girders and Cast – in – Situ Slab Construction shall be designed as Composite Construction.

Concrete Girder and Slab Type Superstructure shall satisfy following stipulations.

- Minimum Thickness of Slab shall be 200 mm.
- Minimum Thickness of Web shall be 250 mm.
- Where Prestressed Cables pass through the webs, the thickness shall be same as that stipulated for Webs of Box Girder.

The Components shall be designed for Lifting and Erection Loads and Stresses. Proper Lifting Arrangements shall be arranged by the Construction Agency for handling the Precast Unit.

7.5.5.2 Post Tensioned PSC Box Girder

For Obligatory Span Box Girder has been proposed. The following Method has been adopted for Analyzing and Designing the Box Girder.

- Calculate the Main Girder Moments, Shear Forces and Torsional Moments for a single beam for all loading conditions.
- Also add to above, the Forces due to the Restraint of Warping Torsion at the ends.
- In addition, calculate the Bending Moments in the Roadway Slab considering the Slab, the Web and Soffit Slab as a closed frame.
- Reinforcement in the Slabs and Webs due to the Transverse Moments shall be provided in addition to the Steel, which is required for Shear or Torsion in the Box as a Main Girder.
- Distortion of Box Girder due to Transverse Moment can be neglected if minimum numbers of Diaphragms are provided.
- In the absence of Rigorous Analysis (A) for the Torsional Moment (B) for Forces due to Restraints of Warping Torsion at ends, the Design Live Load Moments and Shear Force in the Longitudinal Direction shall be increased by 20% and Transverse Reinforcement Steel be increased by 5%.
- For Prestressed Concrete Structure, where Cables pass through Webs, minimum Web Thickness shall be greater of 150mm + outer dia of Duct or 250mm whichever is greater.
- The Cross Diaphragms shall be minimum one number at each support and at ends of cantilever, if any. In addition, for Abrupt Change in Soffit Geometry, Stiffening Frame or Diaphragm shall be provided to cater to Forces arising out of Change in Direction.
- Minimum Thickness of Diaphragms at Supports shall be 500mm and those of other Locations shall be 300mm.
- Minimum Untensioned Reinforcement shall be as per Clause 15 of IRC: 18 – 2000. The Spacing of the Bars shall not exceed 200mm c/c. The Minimum Diameter of Bars to be used is 10mm.
- No Tension under Full Permanent Design Load is allowed.

7.5.5.3 Precast Pretensioned Girders

These Girders are not specifically covered in IRC Specification. The Preliminary Design carried out herein follows AASHTO Specification. Some of the important Guidelines are given below.

- Pretensioned Girders shall be designed as Simple Span Girders for Positive Moments, without regard to Live Load Continuity. The Girders shall be designed to account for Live Load Continuity for Shear and Negative Moment Design. The Girders are assumed to be continuous because they are embedded into the Continuity Diaphragm that is poured in place with the Deck Slab. Additional Reinforcement Steel shall be placed in the cast – in – place Deck Slab to resist the Continuous Live Load Negative Moments.
- The Temporary Tension Stress in the Top Fibre near the ends of the Prestressed Girders shall be deduced as much as possible by debonding.
- A future Wearing Surface of 600N / m^2 in Dead Load shall be added to the Clear Roadway Width for Design.

7.5.6 Bearing below Superstructure

Bearing controls the Transfer of the Forces from Superstructure to Substructure. Bearings under superstructure shall be within the external line of the Pier / Abutment. The Bearings shall be provided below the Diaphragm at Suitable Locations.

- The Type of Bearing generally allowed is as below.

Span	Type of Bearing
For effective spans upto 20m	Restrained Elastomeric / POT cum PTFE / POT
For effective spans more than 20m	POT cum PTFE / POT

- The Bearing shall be easily accessible for Inspection / Maintenance.
- Scope for Lifting the Superstructure for Future Replacement of Bearing shall be provided in the Design of Bearing. The Scheme of Lifting shall be indicated on the Drawing to be submitted along with the Technical Bid.
- Inspection of Bearing by Director General of Supplies and Disposal (DGSD) during manufacturing is essential. The Construction Agency shall have to produce necessary Certificate and Inspection Marks from the DGSD at his own cast.
- The bearing shall conform to the requirements of the MoRT&H Specifications.
- The Dimensions of Top Plate of Bearing shall be such that the Contact Surface of the Superstructure projects beyond the Edge of Bearing Plate by a minimum distance of 50mm at any location.

7.5.7 Expansion Joints

Elastomeric Strip Seal Type Expansion Joint conforming to Clause 2607 of MoRT&H Specifications has been considered. Calculations for the Adequacy of the Expansion Extent for which the Joint is selected by the Engineer shall be submitted along with the Name of Manufacturer and their Technical Details. During installation of these Joints,

Manufacturer's Engineer shall be required to supervise the same including the Thermal Presetting, if required.

7.6 Crash barriers

Concrete Crash Barriers shall conform to Clause 809 of MoRT&H Specifications. The Height of the Concrete Crash Barrier is 1000mm above the Finished Road Level. It has been designed to resist an Impact of 30t Axle Loads.

7.7 Wearing Coat

Wearing Coat conforming to Clause 2702.1 of MoRT&H Specifications for Road and Bridge Works (latest edition) has been provided for Smooth Riding Surface.

7.8 Approach Slab

The Approach Slab conforming to Clause 2704 of MoRT&H Specifications for Road and Bridge Works (Latest Edition) has been provided.

7.9 Durability

From the Durability Consideration, the following minimum Grades of Concrete are to be considered for Plain Cement Concrete (PCC) and Reinforced Cement Concrete (RCC).

a) Minimum Grade of Concrete shall be as below.

PCC for Levelling Course	M15
RCC for Open Foundation, Substructure and Superstructure	M35

b) Minimum Cement Content, Diameter of Bar and Cover Requirements
For PCC and RCC, the value given below regarding minimum Cement Content and maximum Water Cement Ratio shall be followed.

PCC		RCC	
Minimum cement Content Kg / cum.	Maximum Water Cement Ratio	Minimum cement Content Kg / cum.	Maximum Water Cement Ratio
360	0.45	400 / 400	0.45 / 0.40

The minimum Nominal Diameter of Reinforcement is 10 mm.

7.10 Drainage

Drainage of Storm Water collected in / on the Grade Separator and at Surface Level Roads are essentially based on
IRC: SP: 42 – 1994 – "Guidelines on Road Drainage".
IRC: SP: 50 – 1999 – "Guidelines on Urban Drainage".

The Drainage Spouts conform to Clause 2705 of MoRT&H Specifications.

7.11 Traffic Signs, Markings and other Road Appurtenances

Traffic Signs, Markings and other Road Appurtenances shall conform to Clause 800 of the MoRT&H Specifications for Road and Bridges (latest edition). Road Markings shall conform to IRC: 35 – 1997 and Road Signs shall confirm to IRC: 67 – 2001.

7.12 Medians, Kerbs and Footpaths

Medians, Kerbs and Footpaths shall conform to Clause 407, 408 and 409 of the MoRT&H Specifications for Road and Bridges (latest edition).

7.13 Lighting

The Lighting within the Covered and Open Portion of Underpass, Service Roads, Junction at Surface Level above the Underpass, etc. has been provided as per relevant Codal Provisions. The Illumination proposed is an average 125 lux through out.

7.14 Specification and Design Codes

The Designs of Structural Components have been in conformation to the Criteria laid down in the Latest Editions of the following Codes of Practice and Standard Specifications.

a. IRC Standard Specifications and Code of Practice for Road Bridges with amendments issued upto the Date of Issue of Tender Notice.

IRC: 5	General Features of Design
IRC: 6	Loads and Stresses
IRC: 18	Design Criteria for Prestressed Concrete Road Flyovers (Post Tensioned Concrete). This Code will also be applicable to Continuous Structures with Pertinent Particulars.
IRC: 21	Cement Concrete (Plain and Reinforced)
IRC: 35	Code of Practice for Road Markings
IRC: 78	Foundation and Substructure
IRC: 83 (All Parts)	Standard Specifications and Code of Practice for Road Bridges – Bearings
IRC: 92	Guidelines for the Design of Interchanges in Urban Areas
IS: 875 (Part 3)	Code of Practice for Design Loads (Wind Load)
IS: 1893	Criteria for Earthquake Resistant Design of Structures
IS: 2911 (All Parts)	Pile Foundations

b. IRC – SP: 33 Guidelines on Supplemental Measures for Design, Detailing and Durability of Important Bridge Structures (if applicable).
c. Specification for Roads and Bridge Works (Latest Edition), published by IRC, New Delhi on behalf of Govt. of India, Ministry of Shipping, Road Transport and Highways.

7.15 Boring Data and Soil Investigation at Site

The Details of Boring Data and Soil Investigation Report have been enclosed in **Chapter 4**.

CHAPTER 8
TRAFFIC MANAGEMENT / DIVERSION DURING CONSTRUCTION AND TRAFFIC ENGINEERING SCHEMES

8.1 General

Traffic Management / Diversion during construction of Grade Separation Scheme is essential for smooth flow of traffic. Traffic Diversion / Management during Construction has been planned so that not to cause inconvenience for Traffic Movement and the Width of Carriageway available for Traffic Movement during Construction is adequate.

8.2 Traffic Management during Construction

Work on the entire length of the Grade Separator for each Junction has been planned continuously for 6 months in case of Underpass and 12 months in case of Flyover and the Construction of Grade Separator at each Junction has been planned to tackle separately, phase wise. Wherever land is available for the proposed Slip Road, the available land will be strengthened to allow the traffic. Otherwise alternative routes have been worked out for the diversion of traffic and the Details are enclosed in **Chapter 13 – Drawings**. The proposed scheme shall ensure the smooth flow of traffic during the entire Construction Period. During the entire Construction Period, Street Parking on all the approach arms of the junction shall be strictly prohibited.

Traffic Management and Diversion Scheme during Execution are given in **Chapter 13 – Drawings**.

8.3 Necessary Improvements

For Effective Implementation of Traffic Diversion Scheme, Diversion Routes shall be kept in Traffic Worthy Condition (Free from Pot Holes, Ruts, Undulation, etc.) during the entire Construction Period.

Necessary Signboards for guiding the Road Users shall be located as per IRC Norms. The Traffic Management Scheme and Traffic Diversion Plans proposed shall be discussed with Police Authorities before Implementation. All the Necessary Improvements and Location of Signboards shall be finalized during Implementation in discussion with Police Authorities.

8.4 Traffic Engineering Schemes Components

Design of At Grade Junction is essential for proper dispersion of traffic retained at Surface Level in the Post Grade Separator Scenario. The Various Components of At Grade Junction and in the Grade Separator that need to be Planned, Designed and Built Integrally in the Grade Separation Scheme are detailed in Table 8.1. Planning and Design of these Components are as per the Guidelines stipulated in IRC.

Table 8.1
Components of At Grade Junction and Grade Separation Scheme

Sl. No.	Components	Description	Standards
1.	Traffic Signals	Fully Automatic Traffic Signal with Timer (Solar)	IRC: 93 – 1985
2.	Road Markings	On Grade Separator and at Surface Level Roads	IRC: 35 – 1997
3.	Road Signs	On Grade Separator and at Surface Level Roads	IRC: 67 – 1977 & IRC: SP – 31 – 1992
4.	Road Delineators	On Grade Separator and at Surface Level Roads	IRC: 79 – 1981
5.	Geometrics	Surface Level Roads	IRC: 86 – 1983
6.	Geometrics	Junction	IRC: SP – 41 – 1994
7.	Pedestrian Facilities	At Surface Level Roads and near the Junction (Footpaths, Railing & Zebra Crossing)	IRC: 103 – 1988

The Drawings for the proposed Traffic Signage and Road Marking for the Post Grade Separator Scenario are enclosed in **Chapter 13 – Drawings**.

CHAPTER 9
PROJECT COST

9.1 Rate Analysis

As part of the Detailed Project Report (DPR), Rate Analysis of each of the item has been prepared by adopting PW, P & IWTD SR 2009 – 10, Bangalore Circle and NHSR 2009 – 10, National Highways Circle, Bangalore. The Rates as given in PW, P & IWTD SR are to be enhanced by 6% for additional weightages for the Works to be executed under Extra Ordinary Conditions for Bangalore Metropolitan Limits. Items not covered in NHSR / PW, P & IWTD SR have been based on Market Rates.

9.2 Detailed Cost Estimate

As part of DPR, Detailed Cost Estimate has been prepared for the Grade Separated Structure and Surface Level Roads based on Detailed Engineering Design.

9.3 Project Cost

The Rates of the various Items of Works analysed keeping in view of the basic rates as per SR and their respective lead.

To accommodate the proposed Corridor Improvement Scheme, 46032.96 Sqm. of Land needs to be acquired. The Process of Land Acquisition has been initiated by BBMP and this will be carried out by Transfer of Development Rights (TDR) Scheme. No existing structure needs to be demolished completely.

The Abstract of the Project Cost is detailed in **Table 9.1**. For the proposed Corridor Improvement Scheme, total Cost of the Project has been worked out as **Rs. 269.375 Crore**. Further, the Abstract of the Junction wise Project Cost is detailed in **Table 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, 9.9, 9.10, 9.11, 9.12, 9.13, 9.14, 9.15, 9.16 and 9.17** respectively.

The Detailed Cost Estimate is presented in **Annexure A.9.1**.

Table 9.1

Abstract of Project Cost

Sl. No.	Particulars	Cost in Rs.
1.	Proposed Construction of Vehicular Underpass at CIL Road Junction	104870000.00
2.	Proposed Construction of Vehicular Underpass at Munireddy Palya Road Junction	147000000.00
3.	Proposed Construction of Vehicular Underpass at Jayamahal 5th Road Junction	112610000.00
4.	Proposed Construction of Vehicular Underpass at Nandidurga Road Junction	107050000.00
5.	Proposed Construction of Integrated Flyover at Haines Road and Seppings Road Junction	347500000.00
6.	Proposed Junction Improvement at K. Venkatachala Circle	7760000.00
7.	Proposed Construction of Vehicular Underpass at Dhobi Ghat Road Junction	85850000.00
8.	Proposed Construction of Integrated Vehicular Underpass at Thamarai Kannan Road Junction and Murphy Road – Old Madras Road Junction	210500000.00
9.	Proposed Construction of Flyover at Indira Nagar Double Road Junction	187000000.00
10.	Proposed Construction of Vehicular Underpass at Indira Nagar 80ft. Road Junction	93540000.00
11.	Proposed Construction of Flyover at Suranjan Das Road Junction	230500000.00
12.	Proposed Construction of Vehicular Underpass at Varthur Road Junction	108620000.00
13.	Proposed Construction of Vehicular Underpass at Junction near Hewlett Packard Office	120050000.00
14A.	Proposed Construction of Vehicular Underpass at Hudi Main Road Junction	163860000.00
14B.	Proposed Construction of Flyover at Hudi Main Road Junction	228500000.00
15.	Proposed Construction of Integrated Vehicular Underpass at E. P. I. P. Road Junction and Pattandur Agrahara Road Junction	289400000.00
16.	Proposed Construction of Vehicular Underpass at Hope Farm Junction	149140000.00
	Total	2693750000.00

Table 9.2

Abstract of Project Cost for CIL Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 4.5m X 1.0m	9660000.00
2.	Lowering the Segments and other Allied Works	4650000.00
3.	Construction of Retaining Wall	24360000.00
4.	Formation of Service Road, Concreting of Ramps	22280000.00
5.	Providing Drainage Facility to Underpass	12040000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	10480000.00
	Sub Total	83470000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1252050.00
8.	Add for Utility Shifting Charges @ 20%	16694000.00
9.	Add Cost for Topographical Survey	40000.00
10.	Add Cost for Soil Investigation	120000.00
11.	Add Cost for Electrical Works	3270000.00
		104846050.00
12.	Miscellaneous and Rounding Off	23950.00
	Total	104870000.00

Table 9.3
Abstract of Project Cost for Munireddy Palya Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 4.5m X 1.0m	19300000.00
2.	Lowering the Segments and other Allied Works	9070000.00
3.	Construction of Retaining Wall	29870000.00
4.	Formation of Service Road, Concreting of Ramps	36490000.00
5.	Providing Drainage Facility to Underpass	10280000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	11680000.00
	Sub Total	116690000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1750350.00
8.	Add for Utility Shifting Charges @ 20%	23338000.00
9.	Add Cost for Topographical Survey	80000.00
10.	Add Cost for Soil Investigation	240000.00
11.	Add Cost for Electrical Works	4880000.00
		146978350.00
12.	Miscellaneous and Rounding Off	21650.00
	Total	147000000.00

Table 9.4

Abstract of Project Cost for Jayamahal 5th Main Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 4.5m X 1.0m	8050000.00
2.	Lowering the Segments and other Allied Works	3910000.00
3.	Construction of Retaining Wall	27640000.00
4.	Formation of Service Road, Concreting of Ramps	22250000.00
5.	Providing Drainage Facility to Underpass	15260000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	12670000.00
	Sub Total	89780000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1346700.00
8.	Add for Utility Shifting Charges @ 20%	17956000.00
9.	Add Cost for Topographical Survey	40000.00
10.	Add Cost for Soil Investigation	120000.00
11.	Add Cost for Electrical Works	3330000.00
		112572700.00
12.	Miscellaneous and Rounding Off	37300.00
	Total	112610000.00

Table 9.5
Abstract of Project Cost for Nandidurga Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 4.5m X 1.0m	12230000.00
2.	Lowering the Segments and other Allied Works	5590000.00
3.	Construction of Retaining Wall	26950000.00
4.	Formation of Service Road, Concreting of Ramps	23230000.00
5.	Providing Drainage Facility to Underpass	7440000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	10400000.00
	Sub Total	85840000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1287600.00
8.	Add for Utility Shifting Charges @ 20%	17168000.00
9.	Add Cost for Topographical Survey	40000.00
10.	Add Cost for Soil Investigation	120000.00
11.	Add Cost for Electrical Works	2570000.00
		107025600.00
12.	Miscellaneous and Rounding Off	24400.00
	Total	107050000.00

Table 9.6

Abstract of Project Cost for Integrated Flyover at Haines Road Junction and Seppings Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Site Clearance and Dismantling	2140578.00
2.	Surface Level Roads / Slip Roads	29251143.00
3.	Drain Works	
	a. For Road Side Drains	7405013.00
	b. For Culvert	1618571.00
4.	Footpath, Median, Kerb and Compound	8368755.00
5.	Road Furniture and other Works	4553204.00
6.	Flyover Works	222361418.00
7.	Electrical Works for Flyover	4127650.00
	Construction Cost	279826332.00
8.	Utility Shifting Charges	55965266.00
9.	Add Cost for Topographical Survey and Soil Investigation	250000.00
10.	Add Cost for Landscaping Works	2500000.00
11.	Contingencies (@ 3% of Construction Cost)	8394790.00
	Sub Total	346936388.00
12.	Miscellaneous and Rounding Off	563612.00
	Total	347500000.00

Table 9.7

Abstract of Project Cost for Dhobi Ghat Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 4.5m X 1.0m	7730000.00
2.	Lowering the Segments and other Allied Works	3790000.00
3.	Construction of Retaining Wall	22830000.00
4.	Formation of Service Road, Concreting of Ramps	20930000.00
5.	Providing Drainage Facility to Underpass	7870000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	5460000.00
	Sub Total	68610000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1029150.00
8.	Add for Utility Shifting Charges @ 20%	13722000.00
9.	Add Cost for Topographical Survey	40000.00
10.	Add Cost for Soil Investigation	120000.00
11.	Add Cost for Electrical Works	2300000.00
		85821150.00
12.	Miscellaneous and Rounding Off	28850.00
	Total	85850000.00

Table 9.8

Abstract of Project Cost for Integrated Vehicular Underpass at Thamarai Kannan Road Junction and Murphy Road – Old Madras Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 4.5m X 1.0m	19300000.00
2.	Lowering the Segments and other Allied Works	9070000.00
3.	Construction of Retaining Wall	78700000.00
4.	Formation of Service Road, Concreting of Ramps	34910000.00
5.	Providing Drainage Facility to Underpass	19810000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	7160000.00
	Sub Total	168950000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	2534250.00
8.	Add for Utility Shifting Charges @ 20%	33790000.00
9.	Add Cost for Topographical Survey	80000.00
10.	Add Cost for Soil Investigation	240000.00
11.	Add Cost for Electrical Works	4880000.00
		210474250.00
12.	Miscellaneous and Rounding Off	25750.00
	Total	210500000.00

Table 9.9

Abstract of Project Cost for Indira Nagar Double Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Site Clearance and Dismantling	1783722.00
2.	Surface Level Roads / Slip Roads	26639376.00
3.	Drain Works	
	a. For Road Side Drains	5170566.00
	b. For Culvert	377479.00
	c. For Storm Water Drain across Ring Road and Retaining Wall	42085777.00
4.	Footpath, Median, Kerb and Compound	5486022.00
5.	Road Furniture and other Works	3272867.00
6.	Flyover Works	58861629.00
7.	Flyover Approaches	4712518.00
8.	Electrical Works for Flyover	2105340.00
	Construction Cost	150495296.00
9.	Utility Shifting Charges	30099059.00
10.	Add Cost for Topographical Survey and Soil Investigation	250000.00
11.	Add Cost for Landscaping Works	1500000.00
12.	Contingencies (@ 3% of Construction Cost)	4514859.00
	Sub Total	186859214.00
13.	Miscellaneous and Rounding Off	140786.00
	Total	187000000.00

Table 9.10

Abstract of Project Cost for Indira Nagar 80ft. Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 4.5m X 1.0m	11270000.00
2.	Lowering the Segments and other Allied Works	5190000.00
3.	Construction of Retaining Wall	20260000.00
4.	Formation of Service Road, Concreting of Ramps	17800000.00
5.	Providing Drainage Facility to Underpass	11370000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	8260000.00
	Sub Total	74150000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1112250.00
8.	Add for Utility Shifting Charges @ 20%	14830000.00
9.	Add Cost for Topographical Survey	40000.00
10.	Add Cost for Soil Investigation	120000.00
11.	Add Cost for Electrical Works	3270000.00
		93522250.00
12.	Miscellaneous and Rounding Off	17750.00
	Total	93540000.00

Table 9.11
Abstract of Project Cost for Suranjan Das Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Site Clearance and Dismantling	2267343.00
2.	Surface Level Roads / Slip Roads	16775376.00
3.	Drain Works	
	a. For Road Side Drains	5296456.00
	b. For Culvert	1097898.00
4.	Footpath, Median, Kerb and Compound	5987919.00
5.	Road Furniture and other Works	3393045.00
6.	Flyover Works	132082521.00
7.	Flyover Approaches	9319527.00
8.	Electrical Works for Flyover	2273650.00
	Construction Cost	178493735.00
9.	Utility Shifting Charges	44623434.00
10.	Add Cost for Topographical Survey and Soil Investigation	250000.00
11.	Add Cost for Landscaping Works	1500000.00
12.	Contingencies (@ 3% of Construction Cost)	5354812.00
	Sub Total	230221981.00
13.	Miscellaneous and Rounding Off	278019.00
	Total	230500000.00

Table 9.12
Abstract of Project Cost for Varthur Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Procurement of Pre Cast RCC Box Segments of Size 7.5m X 4.5m X 1.0m	9660000.00
2.	Lowering the Segments and other Allied Works	4560000.00
3.	Construction of Retaining Wall	33610000.00
4.	Formation of Service Road, Concreting of Ramps	22690000.00
5.	Providing Drainage Facility to Underpass	7560000.00
6.	Construction of Approach Road to Underpass and Other Allied Works	8890000.00
	Sub Total	86970000.00
7.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1304550.00
8.	Add for Utility Shifting Charges @ 20%	17394000.00
9.	Add Cost for Topographical Survey	40000.00
10.	Add Cost for Soil Investigation	120000.00
11.	Add Cost for Electrical Works	2770000.00
		108598550.00
12.	Miscellaneous and Rounding Off	21450.00
	Total	108620000.00

Table 9.13
Abstract of Project Cost for Junction near Hewlett Packard Office

Sl. No.	Particulars	Cost in Rs.
1.	Construction of Covered Portion of Underpass	6420000.00
2.	Construction of Retaining Wall	45490000.00
3.	Construction of Ramp and Formation of Service Road	28150000.00
4.	Providing Drainage Facility to Underpass	8700000.00
5.	Construction of Approach Road to Underpass and Other Allied Works	7640000.00
	Sub Total	96400000.00
6.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1446000.00
7.	Add for Utility Shifting Charges @ 20%	19280000.00
8.	Add Cost for Topographical Survey	40000.00
9.	Add Cost for Soil Investigation	120000.00
10.	Add Cost for Electrical Works	2740000.00
		120026000.00
11.	Miscellaneous and Rounding Off	24000.00
	Total	120050000.00

Table 9.14
Abstract of Project Cost for Hudi Main Road Junction – Underpass

Sl. No.	Particulars	Cost in Rs.
1.	Construction of Covered Portion of Underpass	50170000.00
2.	Construction of Retaining Wall	30780000.00
3.	Construction of Ramp and Formation of Service Road	34540000.00
4.	Providing Drainage Facility to Underpass	8320000.00
5.	Construction of Approach Road to Underpass and Other Allied Works	9300000.00
	Sub Total	133110000.00
6.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1996650.00
7.	Add for Utility Shifting Charges @ 20%	26622000.00
8.	Add Cost for Topographical Survey	40000.00
9.	Add Cost for Soil Investigation	120000.00
10.	Add Cost for Electrical Works	1946000.00
		163834650.00
11.	Miscellaneous and Rounding Off	25350.00
	Total	163860000.00

Table 9.15
Abstract of Project Cost for Hudi Main Road Junction – Flyover

Sl. No.	Particulars	Cost in Rs.
1.	Site Clearance and Dismantling	1777705.00
2.	Surface Level Roads / Slip Roads	13454838.00
3.	Drain Works	
	a. For Road Side Drains	6524720.00
	b. For Culvert	455974.00
4.	Footpath, Median, Kerb and Compound	6530402.00
5.	Road Furniture and other Works	4391300.00
6.	Flyover Works	148651835.00
7.	Electrical Works for Flyover	2300650.00
	Construction Cost	184087424.00
8.	Utility Shifting Charges	36817485.00
9.	Add Cost for Topographical Survey and Soil Investigation	250000.00
10.	Add Cost for Landscaping Works	1500000.00
11.	Contingencies (@ 3% of Construction Cost)	5522623.00
	Sub Total	228177532.00
12.	Miscellaneous and Rounding Off	322468.00
	Total	228500000.00

Table 9.16

Abstract of Project Cost for Integrated Vehicular Underpass at E. P. I. P. Road Junction and Pattandur Agrahara Road Junction

Sl. No.	Particulars	Cost in Rs.
1.	Construction of Covered Portion of Underpass	70340000.00
2.	Construction of Retaining Wall	82600000.00
3.	Construction of Ramp and Formation of Service Road	53190000.00
4.	Providing Drainage Facility to Underpass	17200000.00
5.	Construction of Approach Road to Underpass and Other Allied Works	12300000.00
	Sub Total	235630000.00
6.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	3534450.00
7.	Add for Utility Shifting Charges @ 20%	47126000.00
8.	Add Cost for Topographical Survey	80000.00
9.	Add Cost for Soil Investigation	240000.00
10.	Add Cost for Electrical Works	2770000.00
		289380450.00
11.	Miscellaneous and Rounding Off	19550.00
	Total	289400000.00

Table 9.17
Abstract of Project Cost for Hope Farm Junction

Sl. No.	Particulars	Cost in Rs.
1.	Construction of Covered Portion of Underpass	23060000.00
2.	Construction of Retaining Wall	41620000.00
3.	Construction of Ramp and Formation of Service Road	37680000.00
4.	Providing Drainage Facility to Underpass	9040000.00
5.	Construction of Approach Road to Underpass and Other Allied Works	8420000.00
	Sub Total	119820000.00
6.	Add for Consultancy Charges for DPR Preparation, PMC and Quality Assurance Charges @ 1.5%	1797300.00
7.	Add for Utility Shifting Charges @ 20%	23964000.00
8.	Add Cost for Topographical Survey	40000.00
9.	Add Cost for Soil Investigation	120000.00
10.	Add Cost for Electrical Works	3370000.00
		149111300.00
11.	Miscellaneous and Rounding Off	28700
	Total	149140000.00

CHAPTER 10
IMPLEMENTATION PLAN

The entire Project Period for each Junction has been divided into two parts viz.

1. **Tendering Stage and Finalisation of Contract.**
2. **Execution of the Project including Utility Shifting.**

The 1st Part will entail a period of **45 Days** whereas the 2nd Part will entail a period of **180 Days** in case of Underpass and **365 Days** in case of Flyover.

Further, each Junction will be tackled in Phase wise so that not to cause inconvenience to the Flow of Traffic throughout the Corridor.

The Total Time to handover the Project for each Junction to the BBMP will thus be **225 Days** in case of Underpass and **410 Days** in case of Flyover from the Date of Notice Inviting Tender.

The Detailed Implementation Plans for all the Project Junctions are attached in **Annexure A.10.1**.

CHAPTER 11
CONCLUSION

11.1 The Project Corridor acts as an Important Link between Cantonment Area (Jayamahal, Shivaji Nagar, Benson Town, Cleveland Town, Cox Town, Cooke Town, Frazer Town, Ulsoor, etc.) and Eastern Part of the City (Domlur, Indira Nagar, Beniganahalli, K. R. Puram, White Field, etc). Before the Development of the Outer Ring Road, most part of the Project Corridor was used for the Diversion of Heavy Traffic between NH – 4, i.e. between Tumkur Side and Krishna Raj Puram (K. R. Puram) Side. Presently, Traffic from well known Industrial Area like Peenya, Dasarahalli; from thickly developed Residential Areas in the Western Part of the City such as Malleshwaram, Yeshwanthapura, Mathikere; from well developed Colonial Residential Layout like Jayamahal, Shivaji Nagar, Benson Town, Cleveland Town, Cox Town, Cooke Town, Frazer Town, Ulsoor, Murphy Town; from well developed Commercial Hub like Indira Nagar, Domlur; uses this Corridor to reach Beniganahalli, K. R. Puram, ITPL, White Field, Kolar. The Study Corridor runs from the North Quadrant to the East Quadrant of the City. With the setting up of Software Industries (such as Oracle Software, Tata Consultancy Service, HCL Technologies, Bhoruka Tech Park, Brigade Tech Park, Google India Pvt. Ltd., RMZ Infinity Technology Park, etc.) in and around the Project Corridor, the growth of the techno polis has led to increase in traffic along the Corridor. The other main traffic attraction points along this Corridor are Fun World; Palace Ground; Doordarshan Kendra; Bangalore Cantonment Railway Station – the second major Railway Station in the City; various Educational Institutes; Shopping Malls like Gopalan Signature Mall, Big Bazaar; various Hospitals; Government Organisations like Indian Telephone Industry, Tin Factory; ABB Indian Corporate and Research Centre; high end Residential Apartments; BDA Complex at Indira Nagar; Ulsoor Lake; Sai Baba Ashram; Sathya Sai Super Speciality Hospital; etc. Further, with the spurt in the economy, the Land Use Patterns of this Part of the City Area have been changing at a very fast pace since 10 years. Many of the Residential Areas in and around this Corridor, such as Indira Nagar, Domlur, K. R. Puram, White Field, etc. are being converted into Partial Commercial Establishments. With this change in the Land Use Pattern, traffic along this Corridor has been increased considerably in last 10 years time. Apart from this, many large Residential Sites have been converted into Apartments / Flats along this Corridor and a site that would house either a family or two now will be able to house multiple number of families and with this the number of Vehicle / Traffic also has increased manifold in last 10 years. These being the Background, the Bruhath Bangalore Mahanagara Palike has proposed to construct Grade Separator using Pre Cast Element Technology at Major Junctions and to close Median at Minor Junctions with Appurtenant Link Improvements from Mekhri Circle to Hope Farm Junction via Old Madras Road covering a total of 29 Junctions (out of which, 20 Junctions have been taken for improvement) for a total length of 21 km in order to provide Uninterrupted, Seamless Traffic Flow and to Increase Level of Service along the Corridor.

11.2 Existing Junctions along the Project Corridor

The following Junctions are present along the Project Corridor.

- Mekhri Circle – Four Arm Junction.
- CIL Road Junction – Three ('T' Shaped) Arm Junction.

- Munireddy Palya Road Junction – Three ('Y' Shaped) Arm Junction.
- Jayamahal 5th Main Road Junction – Three ('T' Shaped) Arm Junction.
- Nandidurga Road Junction – Three ('Y' Shaped) Arm Junction.
- Junction near Cantonment Railway Station.
- Haines Road Junction – Five Arm Junction.
- Seppings Road Junction – Four Arm Junction.
- Kamaraj Road Junction – Four Arm Junction.
- Meanee Avenue Road Junction – Four Arm Junction.
- K. Venkatachala Circle – Three ('Y' Shaped) Arm Junction.
- Dhobighat Road Junction – Three ('Y' Shaped) Arm Junction.
- Thamarai Kannan Road Junction – Three ('Y' Shaped) Arm Junction.
- Murphy Road – Old Madras Road Junction – Three ('Y' Shaped) Arm Junction.
- Indira Nagar Double Road Junction – Three ('T' Shaped) Arm Junction.
- Indira Nagar 100 Feet Road Junction – Three ('T' Shaped) Arm Junction.
- Baiyyappanahalli Road Junction – Three ('Y' Shaped) Arm Junction.
- Indira Nagar 80 Feet Road Junction – Three ('T' Shaped) Arm Junction.
- Suranjan Das Road Junction – Four Arm Junction.
- N. G. E. F. Layout Road Junction – Three ('Y' Shaped) Arm Junction.
- Varthur Road Junction – Three ('Y' Shaped) Arm Junction.
- Beniganahalli Junction – Three ('Y' Shaped) Arm Junction.
- Krishna Raj Puram Junction – Three ('Y' Shaped) Arm Junction.
- Outer Ring Road – White Field Road Junction – Three ('Y' Shaped) Arm Junction.
- Junction near Hewlett Packard Office – Three ('T' Shaped) Arm Junction.
- Graphite Indian Road Junction – Three ('T' Shaped) Arm Junction.
- Hudi Main Road Junction – Four Arm Junction.
- Export Promotion Industrial Park (E. P. I. P.) Road Junction – Three ('T' Shaped) Arm Junction.
- Pattandur Agrahara Road Junction – Three ('T' Shaped) Arm Junction.
- Hope Farm Junction – Four Arm Junction.

11.3 Junctions proposed for Improvements

The following Junctions have been taken for the proposed Improvements.

- CIL Road Junction.
- Munireddy Palya Road Junction.
- Jayamahal 5th Main Road Junction.
- Nandidurga Road Junction.
- Haines Road Junction.
- Seppings Road Junction.
- Kamaraj Road Junction.
- Meanee Avenue Road Junction.
- K. Venkatachala Circle.
- Dhobighat Road Junction.
- Thamarai Kannan Road Junction.
- Murphy Road – Old Madras Road Junction.
- Indira Nagar Double Road Junction.
- Indira Nagar 80 Feet Road Junction.

- Suranjan Das Road Junction.
- Varthur Road Junction.
- Junction near Hewlett Packard Office.
- Hudi Main Road Junction.
- Export Promotion Industrial Park (E. P. I. P.) Road Junction.
- Pattandur Agrahara Road Junction.
- Hope Farm Junction.

11.4 For the proposed Corridor Improvement Scheme, total Cost of the Project has been worked out as **Rs. 269.375 Crore** with Implementation Period for each Junction as **225 Days** in case of Underpass and **410 Days** in case of Flyover from the Date of Notice Inviting Tender.

11.5 To keep pace with the High Density of Traffic, it is Techno Economically Feasible to take up this Project along the mentioned stretches from Mekhri Circle to Hope Farm Junction via Old Madras Road.