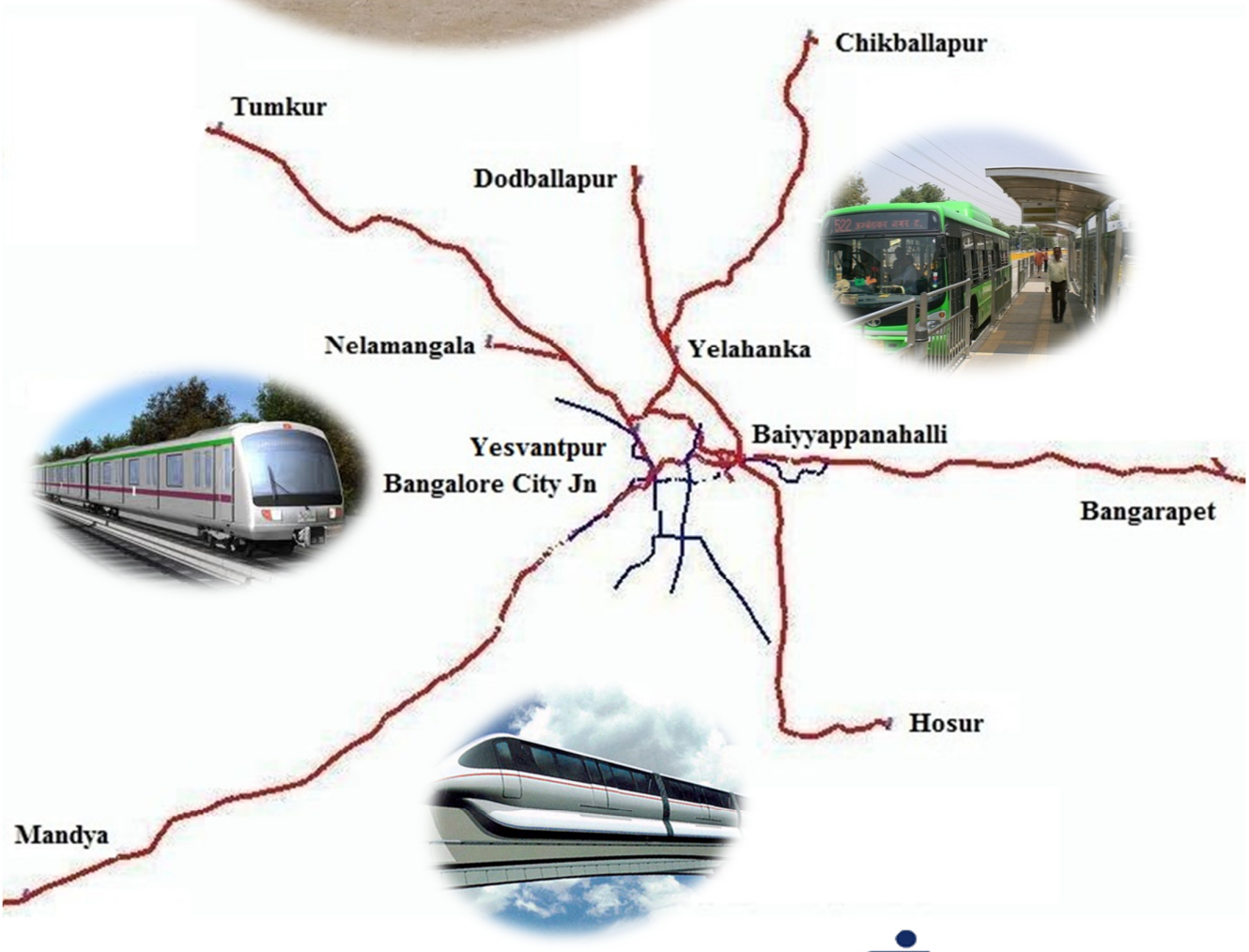
Directorate of Urban Land Transport
Government of Karnataka

Implementation of Commuter Rail System for Bangalore

Draft Report

June 2012



RITES
THE INFRASTRUCTURE PEOPLE

T&E Division Secunderabad

Directorate of Urban Land Transport
Government of Karnataka

Implementation of Commuter Rail System for Bangalore

Draft Report
June 2012

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Contents

1 Prologue.....1

2 City Development Plans and Transport Plans.....5

3 Conventional Rail System – Potential Untapped 17

4 Rail system: Integrated into Bangalore Commuter System.....26

5 Existing Rail Network – Capacity Enhancement Strategies 34

6 Extending Rail Network to new Geographical Areas.....67

7 Land – The Game Changer.....68

8. Demand Supply Assessment 73

9 Cost Estimates and Phasing of Investments 80

10 Return on Investment.....91

11 Financing & Implementation Plan 94

12 Recommendations and Roadmap further.....107

Detailed Contents

1 Prologue.....1

1.1 Back Drop.....1

1.2 Terms of Reference.....3

1.3 Approach and methodology adopted for this study.....4

2 City Development Plans and Transport Plans.....5

2.1 City Development plans.....5

2.2 Master plans / Development Plans/ Structure Plans for BMR.....6

2.3 BMR Revised Structure Plan (RSP), 2031.....7

2.4 Population Projections and allocation in BMR RSP 2031.....11

2.5 Existing Travel Patterns.....12

2.6 Appraisal of city transport plans.....13

2.7 Wilbur Smith Associates Plans for the BMR.....13

2.8 Where is plan for Commuter Rail?.....15

2.9 Costs of Overlap with CRS.....15

3 Conventional Rail System – Potential Untapped.....17

3.1 Leveraging the Strength of Indian Railways.....17

3.2 Potential in terms of Capacity.....18

3.3 Potential in terms of Dispersion.....19

3.4 Potential in terms of Cheapest Alternative.....21

3.5 Potential in terms of Existing Backbone.....23

3.6 Capacity Assessment: Metro Vs CRS.....23

3.7 Cost Assessment: Metro Vs CRS.....24

3.8 Comments and Suggestions.....25

4 Rail system: Integrated into Bangalore Commuter System.....26

4.1 The reality.....26

4.2 Extent of Commuter Rail System.....26

4.3 IR Network overlap with other modes.....27

4.4 Reverse Engineering.....29

4.5 Locating Commuter Rail Terminals: Enter City Core or Terminate at Outskirts 30

4.6 Modal Transits 32

4.7 Conclusions 33

5 Existing Rail Network – Capacity Enhancement Strategies 34

5.1 Backdrop 34

5.2 Terminal Strategies 34

5.2.1 Bangalore Terminal (SBC) 34

5.2.1.1 Over View 34

5.2.1.2 Platforms: 36

5.2.1.3 Lie-Overs and Engine Reversals 37

5.2.1.4 Lengths of various Lines: The Operational constraints 39

5.2.1.5 Interconnectivity of Lines 40

5.2.1.6 Yard Speeds 42

5.2.2 Yesvantpur Terminal 43

5.2.3 Additional Terminals 44

5.2.4 Binny Mill Land Terminal: An extension to SBC terminal 45

5.2.5 Baiyyappanahalli North: The Third Coaching Terminal 46

5.2.6 Yelahanka: EMU Terminal 47

5.2.7 Extension of Trains: Multi Terminals on MYS section 48

5.2.8 Hejjala 4th Coaching Terminal 48

5.2.9 Freight Terminals 49

5.3 Sectional Strategies 50

5.3.1 Unidirectional Traffic in Mornings and Evenings 50

5.3.2 Criss-Cross movements at BYPL: Avoid by Flyovers 51

5.3.3 Criss-Cross Movements at YPR 54

5.3.4 Other Criss-Cross Movements 55

5.3.5 Automatic Signalling 56

5.3.6 Speeds on Loop Lines 57

5.3.7 Electrification and Doubling 57

5.3.8 Minimizing goods trains on commuter lines 58

5.3.9 Level Crossings – The Speed Breakers of the System: 59

5.3.10 Quadrupling / Tripling 62

5.4 Station Strategies 63

5.4.1 Additional Lines and other facilities at CRS Stations 63

5.4.2 Additional halts on CRS 63

5.5 Directional Strategies for Terminating Trains 64

5.6 Rakes for commuter Trains 65

6 Extending Rail Network to new Geographical Areas 67

6.1 Enhancement – A continuous activity 67

6.2 Airport Connectivity: 67

7 Land – The Game Changer 68

7.1 Land – The major issue 68

7.2 Binny Mills Land at SBC yard 68

7.3 Military Land at YPR 68

7.4 Land for locating new terminal (4th coaching terminal) in SBC-MYS section 69

7.5 Land for SBC-WFD quadrupling 69

7.6 Land for various ROBs/RUBs construction 69

7.7 Land for developing stations – specially new halts on the CRS 70

7.8 Land for expansion of rail network to new geographical areas: 70

7.9 Land for Freight Terminals 70

7.10 Land for various proposals/measures suggested in this report 70

7.11 Land Acquisition: The Strategy 71

7.12 Bangalore Master Plan: Land for Railway use 72

8. Demand Supply Assessment 73

8.1 Demand for urban and suburban Rail services 73

8.1.1 Assumptions made for demand assessment 73

8.1.2 Suburban Demand in 3 scenarios 76

8.2 Urban and suburban rail services – Present supply position 77

8.3 Demand for Non-suburban and Freight Trains 78

8.4 Bridging Suburban Demand Supply gap 79

9 Cost Estimates and Phasing of Investments 80

9.1 Phasing philosophy 80

9.2 Phase 1 81

9.2.1 Phase 1A 82

9.2.2 Time frame for phase 1A 85

9.2.3 Phase 1B 86

9.3 Phase 2 87

9.3.1 Activities under this phase 87

9.3.2 Scenario at the end of phase 2 88

9.4 Costs of Phase 1 and 2 88

9.5 Phase 3 88

9.5.1 Extension of activity 88

9.5.2 Cost Estimates and Time frame for Phase 3 89

9.6 Care need to be exercised by S W Railway 90

10 Return on Investment 91

10.1 Financial Rate of Return 91

10.2 Economic Rate of Return 92

10.3 Surcharge 93

11 Financing & Implementation Plan 94

11.1 Financing by Indian Railways – The Traditional Model 94

11.2 Hyderabad – MMTS model 94

11.3 Mumbai – CIDCO Model 98

11.4 Mumbai - MRVC Model 99

11.5 Recommendations and Suggestions 100

11.6 Special Purpose Vehicle 102

11.6.1 Debt and Equity 102

11.6.2 Stake Holders 103

11.6.3 Projects Identification and Sanction 104

11.6.4 Execution of the Projects and O&M 104

11.6.5 Fare Structure and Sharing of Revenues 105

11.6.6 Land and Air Space 106

12 Recommendations and Roadmap further 107

12.1 Summing up 107

12.2 Action 1 108

12.3 Action 2 108

Tables

Table: 1.1 Population of Bangalore Metropolitan Region 1
Table: 1.2 Terms of Reference 3
Table: 2.1 Authorities functioning within BMR 5
Table: 2.2 Population projections and allocations 12
Table: 2.3 Share of various modes of transport 13
Table: 2.4 Phasing of Investments (WSA recommendations) 14
Table: 2.5 Total investment program for long term scheme (WSA recommendations) 14
Table: 2.6 Phasing of total investments (WSA recommendations) 14
Table: 2.7 Corridors suggested by RITES (2011) 15
Table: 2.8 Section overlap of other modes of transport with CRS 15
Table: 2.9 Value of overlap 16
Table: 3.1 Capacity comparison of different modes 18
Table: 3.2 Average trip length of suburban rail passengers in India 20
Table: 3.3 Comparison of station spacing in Mumbai and Bangalore Rail systems 21
Table: 4.1 CRS Network in Bangalore 26
Table: 4.2 Other modes of transport parallel to IR Network within 1 Km 27
Table: 4.3 Other modes of transport parallel to IR Network within 2 Km 27
Table: 4.4 Other modes of transport parallel to IR Network within 5 Km 28
Table: 4.5 IR Network parallel to other modes of transport 28
Table: 4.6 Consultant suggestions for Hyderabad MMTS 29
Table: 4.7 Existing travel pattern of Bangalore rail commuters 30
Table: 5.1 Major rail projects in Bangalore area in the past 34
Table: 5.2 Rakes lie over at SBC 37
Table: 5.3 Lines length of SBC yard 39
Table: 5.4 Interconnectivity of running lines at SBC 40
Table: 5.5 Trains being terminated short of SBC 41
Table: 5.6 Scenario of SBC yard after suggested remodelling 43
Table: 5.7 Likely scenario of BYPL (N) 3rd coaching terminal 47
Table: 5.8 Criss-cross movements of trains in BYPL area 52
Table: 5.9 Criss-Cross movements of trains at YPR 54
Table: 5.10 Criss-Cross movements of trains after YNK-YPR doubling 54
Table: 5.11 Comparison of Automatic Signalling and Absolute Block System 56
Table: 5.12 Electrification & Doubling projects 58
Table: 5.13 Average spacing of Level Crossings in CRS area 60
Table: 5.14 Number of Level Crossings & TVUs in CRS area 60
Table: 5.15 ROBs sanctioned in CRS area 61

Table: 5.16 Directional Convenience of Terminals 64
Table: 5.17 EMUs Vs Conventional Rakes 65
Table: 8.1 Population density in 2011 73
Table: 8.2 Assumed decadal growth rate of population 73
Table: 8.3 Split of each section district wise 73
Table: 8.4 Modal split of commuter traffic in Mumbai 74
Table 8.5 Modal share Vs trip lengths 74
Table: 8.6 The three scenarios 76
Table: 8.7 Assessed Commuter Rail Trips (Scenario: Low) 76
Table: 8.8 Assessed Commuter Rail Trips (Scenario: Medium) 76
Table: 8.9 Assessed Commuter Rail Trips (Scenario: High) 77
Table: 8.10 Suburban rail services – Supply position 78
Table: 8.11 Proposed services and their capacity 79
Table: 9.1 Costs of phase 1 & 2 88
Table: 10.1 Indian Railways earnings per vehicle Km 91
Table: 10.2 Indian Railways O & M Profit/Loss 92
Table: 10.3 Economic rate of return in terms of passenger carrying capacity 93
Table: 10.4 Assessment of Surcharge Accruals 93
Table: 11.1 Growth of Indian Railway Network 94
Table: 11.2 Patronage of Hyderabad MMTS 95
Table: 11.3 Projects under MMTS phase II 95

Figures

Figure: 2.1BBMP, BDA and BMR Boundaries 5
Figure: 2.2 LPAs in BMR 5
Figure: 2.3 Scenario 1 - Sprawl 8
Figure: 2.4 Scenario 2 – Investment led 8
Figure: 2.5 Scenario 3 – Green Network 8
Figure: 2.6 Scenario 4 - Cluster 8
Figure: 2.7 Preferred Scenario Map 9
Figure: 2.8 Land utilisation zoning 10
Figure: 2.9 Transport Network 11
Figure: 5.1 Binny Mill land towards Mysore end 37
Figure: 5.2 Connecting MYS line to grid one 42
Figure: 5.3 Utilisation of Binny Mill Land for Commuter terminal 45
Figure: 5.4 Baiyyappanahalli (north) 3rd coaching terminal 46
Figure: 5.5 Hejjala 4th coaching terminal 49
Figure: 5.6 Flyovers at BYPL area 53
Figure: 5.7 Connecting Dodballapur line with Chikballapur line 59
Figure: 5.8 EMU rake of MRVC 66

Annexures

Annexure: 1 Lie-Over at SBC yard 109
Annexure: 2 Criss-Cross movements that can be made seamless by Flyovers 113
Annexure: 3 Additional Halts suggested by voluntary organisations 115
Annexure: 4 Trains presently serving Bangalore commuters 118
Annexure: 5 Trains that can be replaced with DEMU/MEMU rakes 121
Annexure: 6 Phase wise Cost Estimates 123
Annexure: 7 Rakes Requirement Estimate 126

List of Abbreviations

BBMP	Bruhat Bangalore Maha Palike
BCRC	Bangalore Commuter Rail Corporation
BDA	Bangalore Development Authority
BEML	Bharath Earth Movers Limited
BIAL	Bangalore International Airport Limited
BMR	Bangalore Metro Railway
BMR RSP	Bangalore Metro Railway Revised Structure Plan
BMRDA	Bangalore Metro Regional Development Authority
BMTC	Bangalore Metro Transport Corporation
CIDCO	City and Industrial Development Corporation
CRS	Commuter Rail System
DEMU	Diesel Electrical Multiple Unit
EMU	Electrical Multiple Unit
FOB	Foot Over Bridge
GoAP	Government of Andhra Pradesh
GoI	Government of India
GoK	Government of Karnataka
GoM	Government of Maharashtra
GPS	Global Positioning System
HMDA	Hyderabad Metro Development Authority
IB	Intermittent Block
ICF	Integral Coach Factory
IR	Indian Railways
KRCL	Konkan Railway Corporation Limited
LCs	Level Crossings
LPA	Local Planning Authority
MEMU	Mainline Electrical Multiple Unit
MMTS	Multi Model Transport System
MoR	Ministry of Railways
MoU	Memorandum of Understanding
MRVC	Mumbai Rail Vikas Corporation
NICE	Nandi infrastructure corridor enterprises
O&M	Operations and Maintenance
ROB	Road Over Bridge
RUB	Road Under Bridge
SPV	Special purpose Vehicle
SWR	South Western Railway
TVUs	Train Vehicle Units
WSA	Wilbur Smith Associates

Alphabetical List of Stations

S. No	Code	Station Name
1	AEK	Anekal Road
2	AVT	Avatihalli H
3	BAND	Banaswadi
4	BAW	Chikbanavar
5	BFW	Byatrayanahalli
6	BID	Bidadi
7	BLRR	Belandur Road H
8	BNC	Bangalore Cantt
9	BNCE	Bangalore East
10	BNKH	Bhairanayakanahallli H
11	BWT	Bangarapet Jn
12	BYPL	Baiyyappanahalli Jn
13	CBP	Chikballapur
14	CPT	Channapatna
15	CRLM	Karmelaram
16	CSDR	Channasandra
17	DBL	Dodbele
18	DBS	Dobbspet H
19	DBU	Dodballapur
20	DHL	Devenahalli
21	DJL	Dodjala H
22	DKN	Devangonthi
23	GHL	Gollahalli
24	GNB	Jnana Bharthi H
25	HEB	Hebbal
26	HHL	Hirehalli
27	HJL	Hejjala
28	HLE	Heelalige
29	HNK	Hanakere
30	HSRA	Hosur
31	KDGH	Kodigehalli H

S. No	Code	Station Name
32	KGI	Kengeri
33	KHLL	Ketohalli H
34	KIAT	Kyatsandra
35	KJM	Krishnarajapuram
36	LOGH	Lottegollahalli H
37	MAD	Maddur
38	MDLL	Muddalinganahalli H
39	MLO	Malur
40	MWM	Malleswaram
41	MYA	Mandya
42	MZV	Maralahalli
43	NDV	Nidvanda
44	NDY	Nandi
45	NMGA	Nelamangala
46	NYH	Nayandahalli
47	NZH	Nidaghatta H
48	ORH	Oddarahalli
49	RMGM	Ramanagaram
50	RNN	Rajankunti
51	SBC	Bangalore City Jn
52	SDVL	Soldevanahalli H
53	SET	Settihalli
54	SGT	Satellite Goods Terminal
55	TCL	Tyakal
56	TK	Tumkur
57	TLS	Betthalsoor H
58	VTE	Venkatagiri Kote H
59	WFD	Whitefield
60	YNK	Yelahanka Jn
61	YPR	Yesvantpur Jn

1 Prologue

1.1 Back Drop

Bangalore, the capital of south Indian state Karnataka is India's fifth largest and a rapidly growing metropolis. It is known world over as India's Garden City and Silicon Valley. What started as a pensioner's paradise in post independent India transformed itself into a metropolis with presence of large public sector companies and educational institutions. Emergence of IT sector however, overshadowed other areas and metamorphosed the city into a global IT hub. It continues to attract India's best and brightest human capital given its undisputed status as the knowledge capital of India. In the last decade or so, a genial small city, dotted with breathtakingly beautiful gardens and dominated by large defence establishments and government funded labs transformed quickly in to a teeming metropolis which struggled to cope with its explosive growth. Its inadequate road infrastructure, lack of public transport, excessive reliance on private transportation due to surfeit of upper middle class citizens all combined to make local commute a nightmare.

Bangalore Metropolitan Region is spread over 3 districts namely Bangalore, Bangalore Rural and Ramanagara. Population of this region is:

Table: 1.1 Population of Bangalore Metropolitan Region

No	District	Area (Sq. Km)	Population		Decadal Growth Rate (%)		Density (per SqKm)	
			2001	2011[@]	(91-01)	(01-11)	2001	2011
1	Bangalore	2174	6537124	9588910	35.09	46.68	2985	4378
2	Bangalore Rural	2295	850968	987257	18.60	16.02	380	441
3	Ramanagara	3556	1030546	1082739	7.84	5.06	288	303
	Total →	8025	8418638	11658906		38.49		

Source: http://www.censusindia.gov.in/2011-prov-results/prov_data_products_karnatka.html

[@] Projected Population by 2031 : 180 Lakhs

The urban transport requirements have been reviewed in a number of studies, the prominent ones being, Wilbur Smith Associates (2011) and RITES (2011). Wilbur Smith draft report observed per capita trip rate for Bangalore populace is

observed as 1.28 in the region. Out of this, public transport is observed as 30%. That works out to about 4.5 million trips by public transport. BMTC daily ridership is about 4.5 million (*source: http:// www.bmtcinfo.com/ site/ BSBmtc At Glance.jsp*). Ridership of metro is presently about 25000 and ridership of Railways is about 150000. Thus, public transport commuting needs of Bangalore are met virtually by BMTC alone as on today!

With the kind of traffic congestion in Bangalore city today, BMTC can hardly increase its ridership any further (except on account of extensions to new geographical areas). Metro and Monorail are certainly going to provide some relief. But the relief is limited because of their limited spread in the city. But the demand growth is so huge that dependence on a particular mode of commuting will grossly under serve the public.

Bangalore has not yet actively involved in tapping the huge potential the Railway system has. Mumbai suburban and Chennai suburban trains' share of their city's public transport needs no figures. Bangalore (for that matter any growing urban agglomeration) should take Mumbai and Chennai as their role models and integrate the rail system into a part of their commuter system.

Towards this holy objective, many studies were conducted in the past by Southern Railway and RITES. However, the rail system in Bangalore did not undergo any major revamp towards serving commuters so far. It has been growing at its natural pace which is not targeted or intended for meeting urban transport needs.

Commuter traffic mainly originates at the suburban hamlets/towns and satellite cities situated at a distance ranging between 30 Km and 100 Km from the main hub Bangalore. These commuters should reach his/her work spot within about 1 to 1½ Hr. Such requirement cannot be met either by road or by mono rail or by metro (unless metro is spread in the entire region i.e. for about 400 km which is unthinkable at least now). Rail System has got all wherewithal's' to meet this holy demand.

Therefore, Commissioner of Urban land Transport Directorate retained RITES for quickly estimating the existing shortfall and the future requirement of commuter rail services for Bangalore region. Terms of reference of the study are:

1.2 Terms of Reference

Table: 1.2 Terms of Reference

No	Description
1	**Review City and Transport Plans** • Review of city master plans and future projections of growth • Review of city transport plans
2	**Assessment of current Rail traffic and projections for the next 20 years** • Review the demands for long and medium distance trains • Assess the current freight traffic and potential for future freight traffic under different scenarios • Assess the future demand for each stream of traffic for the next 20 years
3	**Assessment of Infrastructure requirements: Sectional and terminal requirements** • Assess the current capacity utilization over different sections • Review the current terminal availability and problems associated with the terminal operations • Assess the future capacity needs for the terminals • Suggest suitable measures to enhance the terminal capacity
4	**Suburban Rail traffic: Assessment of potential and evaluation of options** • Assess the demand for suburban commuter trains in consultation with various state government bodies and SWR • Projection of demand for the next 20 years • Evaluation of the services provided by SWR for suburban system compared to alternate options for the government of Karnataka. • Assess the feasibility of providing services and the infrastructure developments required to provide the services.
5	**Identification of optimal infrastructure utilization** • Assess the section capacity needs over different time periods by deploying Line Capacity Simulator jointly developed by IIT Bombay and RITES Ltd. • Identify possible combination of train running on different sections and identify suitable criterion for evaluating them • Assess the optimal combination for running trains by deploying the line capacity simulator developed by IIT Bombay.
6	**Infrastructure investment requirements** • Provide a phased plan for an estimate of broad costs for developing the infrastructure
7	**Institutional Management** • The Management, Operations and Maintenance of the Commuter Rail System • Identification of fare structure

1.3 Approach and methodology adopted for this study

1. Data collection and interaction with officials of Government of Karnataka (GoK) and S W Railway.
2. Estimating the demand for commuter services with specific reference to rail services.
3. Analysing the S W Railway network critically to identify the capacity constraints and make out appropriate proposals for capacity enhancement to serve commuters.
4. Providing block cost estimates for various proposals.
5. Analysing the alternative options for GoK for bringing commuter Rail System to Bangalore, suggesting implementation plans, phasing, funding options and institutional arrangements.

As number of base studies are completed earlier, present study has been limited to secondary data.

2 City Development Plans and Transport Plans

2.1 City Development plans

The Bangalore Metropolitan Region (BMR), the area of this study contains within itself, different planning and development units such as the BBMP, BDA, and many LPAs (Local Planning Areas).

Figure: 2.1BBMP, BDA and BMR Boundaries

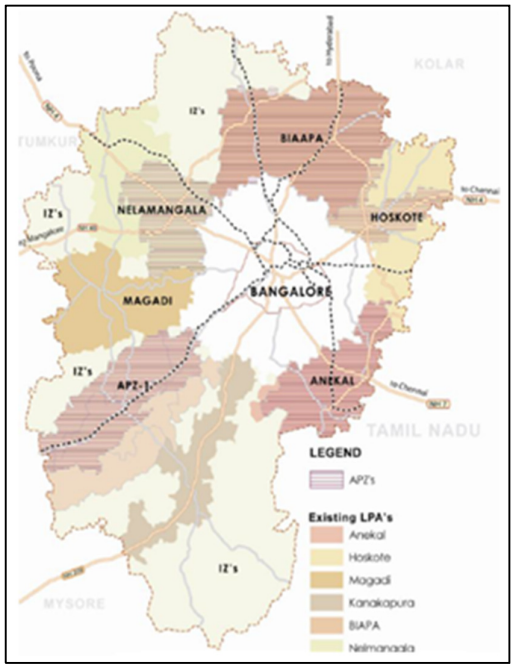

Figure: 2.2 LPAs in BMR

Table: 2.1 Authorities functioning within BMR

No	Authorities functioning within Bangalore Metropolitan Region [BMR]	Area in Sq. Km.
1	Bangalore Development Authority [BDA] (incl. of BBMP)	1219.50
2	Bangalore – Mysore Infrastructure Corridor Area Planning Authority [BMICAPA]	426.24
3	Ramanagaram-Channapatna Urban Development Authority[RCIDA]	63.06
4	Anekal Planning Authority [APA]	402.30
5	Nelamangal Planning Authority [NPA]	735.00

No	Authorities functioning within Bangalore Metropolitan Region [BMR]	Area in Sq. Km.
6	Magadi Planning Authority [MPA]	501.52
7	Hoskote Planning Authority [HPA]	535.00
8	Kanakapura Planning Authority [HPA]	412.78
9	Bangalore International Airport Area Planning Authority [BIAAPA]	792.00
10	Area Planning Zone-1 [APZ-1] (Excluding RDUDA & BMICAPA)	462.60
11	All Interstitial Zones in Bangalore Metropolitan Region [IZ's BMR]	2455.00
	Total	**8005.00**

2.2 Master plans / Development Plans/ Structure Plans for BMR

Draft Report 'Bangalore Metropolitan Region - Revised Structure Plan 2031' by BMRDA prepared in 2011 (the 'revised' is a reference to the BMR Structure Plan, 2011 which was prepared in 1998 and approved in 2005 by the Govt. of Karnataka.)

1. IMPs (Intermediate Master Plans) for horizon year 2012 for the six LPAs (Local Planning Areas)
2. RMP (Revised Master Plan) 2015, Bangalore Development Authority, 2007 for the BDA Area
3. CDP (City Development Plan) for the BBMP in 2006

The Draft Report 'Bangalore Metropolitan Region - Revised Structure Plan 2031' by BMRDA prepared in 2011 is the latest Plan - incorporating reviews of the other plans. Unlike the other plans it is a plan for the entire BMR Area. Hence a review of this Structure Plan would be the most appropriate for purposes of looking at the future projections of growth envisaged in the BMR Area.

2.3 BMR Revised Structure Plan (RSP), 2031

In the introductory text, the BMR Revised Structure Plan (RSP), 2031 reviews the other plans for the different planning and development units in the area and concludes thus:

"An analysis of the various plans operational in this region reflect not only contrary development strategies but also certain inherent contradictions, and a lack of coordination and acceptance of the overall policy framework laid out by the BMR SP (Structure Plan) 2011. Rationalizing these contradictions emerged as the main objective of the BMR RSP 2031."

After a detailed spatial analysis of the land capability, demographic capability, transport accessibility, and industrial location, the following alternate development scenarios in the BMR were identified:

Scenario 1: Sprawl (along the existing road corridors)

Scenario 2: Investment led (major work / employment and residential centres)

Scenario 3: Green Network (conserving the existing environmentally sensitive areas)

Scenario 4: Cluster (dispersing and concentrating development away from the central city)

The above four scenario maps are illustrated in the images shown. These are followed by the map indicating the "preferred scenario" formulated in the RSP 2031, and which forms the basis for the proposed Structure Plan.

Figure: 2.3 Scenario 1 - Sprawl

Figure: 2.4 Scenario 2 – Investment led

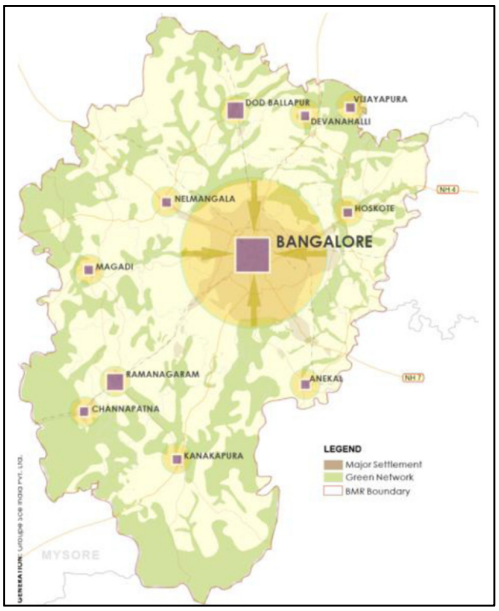

Figure: 2.5 Scenario 3 – Green Network

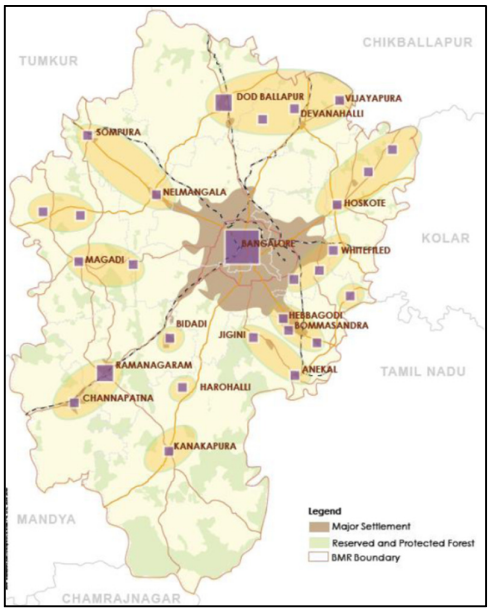

Figure: 2.6 Scenario 4 - Cluster

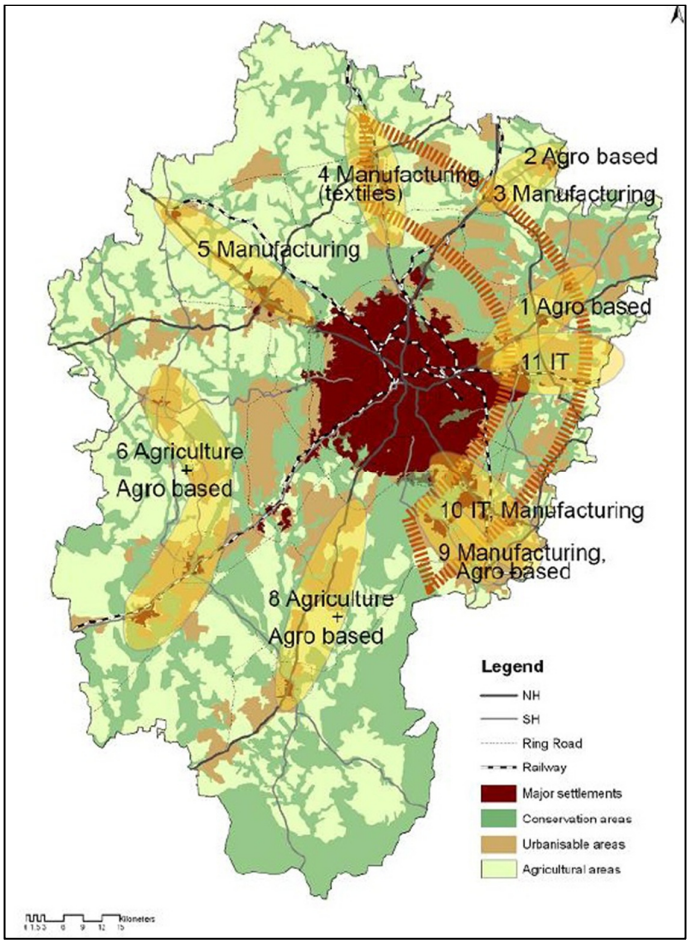

Figure: 2.7 Preferred Scenario Map

Based on this "preferred" scenario, proposed Land Utilization Zoning Plan is also shown here. This shows the predominance of "green" zones and the locations of growth clusters in the BMR. It will be observed that in locating the growth clusters, the focus is on roads rather than rail. It is only by coincidence that in two cases (the Mysore and Chikballapur corridors) the growth clusters fall on the rail axis, because they are close to the roads in the area. Also the proposed transport network that is supposed to support the land use zoning corroborates this focus on road based development proposed in the BMR RSP, 2031.

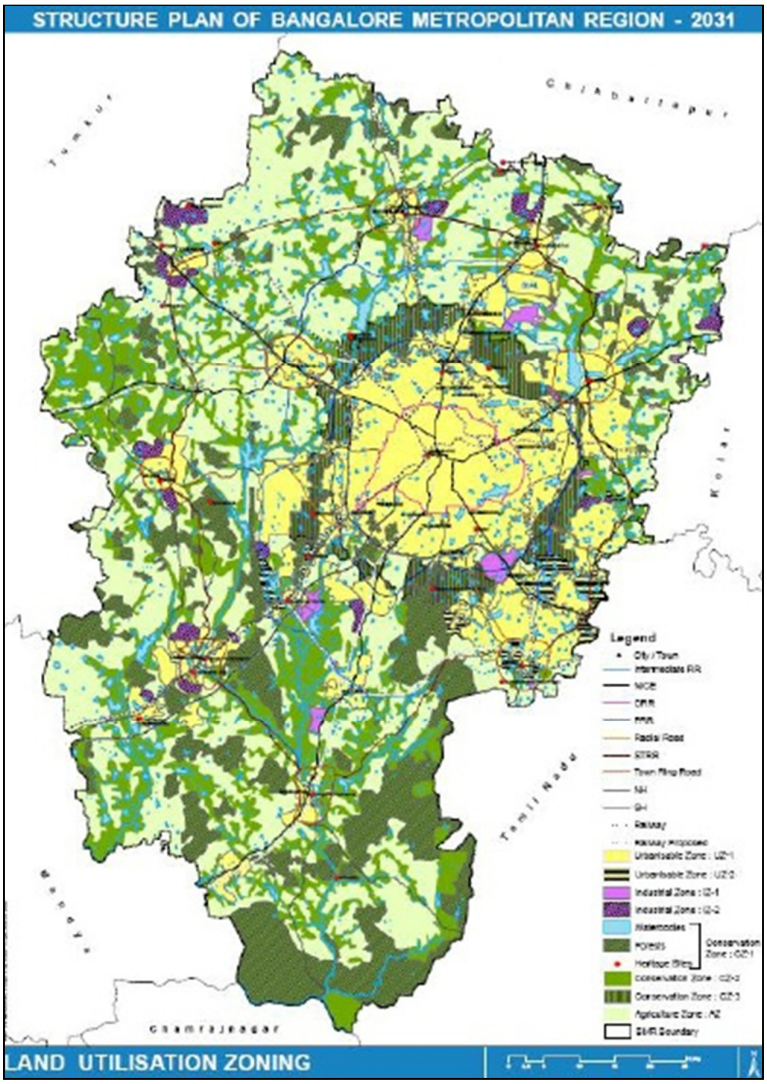

Figure: 2.8 Land utilisation zoning

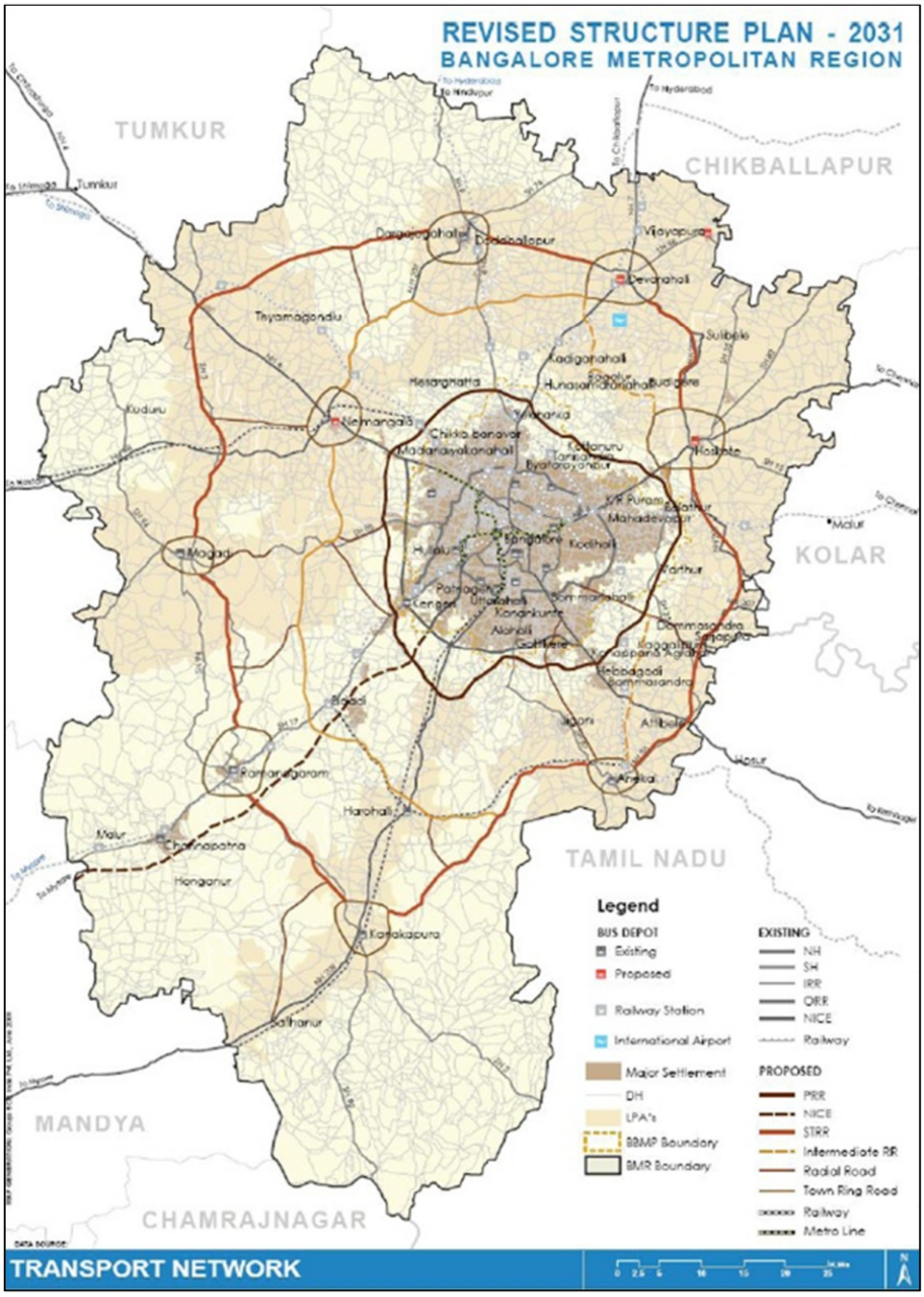

Figure: 2.9 Transport Network

2.4 Population Projections and allocation in BMR RSP 2031

Finally the land use zoning, transport plan and the growth clusters converge to the population projections and allocations detailed in the BMR RSP, 2031.

The RSP discusses three alternate scenarios for the population allocation in the BMR, with respect to the proportion of the population in the core and the rest of BMR. These three scenarios are for the 75:25; 70:30; and 60:40 proportions of population in the core and rest of BMR. The RSP states that the second alternative that is 70:30 share is the preferred population allocation. This particular table showing the population projections and allocation to different areas within the BMR is reproduced here.

Table: 2.2 Population projections and allocations

Alternative-2 : Core : Rest of BMR = 70:30

YEAR		2001	2011	2016	2021	2031
CAGR (%)		*1991-2001*	*2001-11*	*2011-16*	*2016-21*	*2021-31*
BMR (8005 sq.km.)						
Population		8.42	11.00	12.50	14.20	18.00
CAGR (%)		*2.61*	*2.71*	*2.59*	*2.58*	*2.40*
BBMP (800 sq.km.)						
Population		6.17	8.03	8.99	10.06	12.60
CAGR (%)		*3.68*	*2.67*	*2.28*	*2.28*	*2.28*
Density		*7713*	*10038*	*11234*	*12573*	*15750*
% of total BMR Pop		*73%*	*73%*	*72%*	*71%*	*70%*
BMP (Erstwhile - 226 sq.km.) : As per RMP-2015						
Population		4.30	5.14	5.35	5.35	5.35
CAGR (%)		*2.69*	*1.80*	*0.78*	*0.00*	*0.00*
Density		*19023*	*22737*	*23637*	*23637*	*23637*
BBMP Added area (574 sq.km.)						
Population		1.87	2.89	3.64	4.71	7.25
CAGR (%)		*6.44*	*4.46*	*4.75*	*5.29*	*4.41*
Density		*3254*	*5031*	*6345*	*8212*	*12641*
Rest of BMR (Outside BBMP- 7205 sq.km.)						
Population		2.25	2.97	3.51	4.14	5.40
CAGR (%)		*2.25*	*2.82*	*3.41*	*3.35*	*2.69*
Density		*312*	*412*	*488*	*575*	*749*
% of total BMR Pop		*27%*	*27%*	*28%*	*29%*	*30%*

Observation:

I. Steady and realistic CAGR for BBMP newly added areas.
II. CAGR outside BBMP for rest of the region is a little fluctuating but not unrealistic. However the increase in growth rate in rest of the region after 2011 needs to be justified and validated

2.5 Existing Travel Patterns

The Travel patterns of the city and the BMRDA region are analysed by various bodies based various reports and the latest is the one prepared by WSA associates for the BMRDA. The share of various modes of transport is given in the Table: 2.3.

Table: 2.3 Share of various modes of transport

S.No	Travel Mode	Share
1	Walk	34.0%
2	Bicycle	4.5%
3	Taxi	0.5%
4	Auto	4.6%
5	Maxi Cab	0.5%
6	Two Wheeler	21.4%
7	Car/Van	4.5%
8	Public Transport	30.0%
	Total	100%

Source: WilburSmith Associates, Final Draft Report, CTTS for Bangalore Metropolitan Region

2.6 Appraisal of city transport plans

Keeping the growing importance of the city, various projects were taken up the by different development agencies. Among this the important projects under execution are the NICE corridor project and the phase 1 of Bangalore metro project. In addition, the following projects are under different stages of sanction:

- Metro phase 2 including phase 1 extension
- High speed rail link to airport
- Different BRT corridors in the city

In addition, two master plans were prepared; one by RITES limited in 2011 and the other by Wilbur Smith Associates (WSA) in 2011. The RTIES report covers only the Bangalore Development Authority area and that of WSA covers the entire Bangalore Metropolitan Region (BMR). Since the CRS is in BMR, we review the WSA plans in greater detail.

2.7 Wilbur Smith Associates Plans for the BMR

WSA envisaged projects worth Rs.73,000 crores spread over 21 years.

Table: 2.4 Phasing of Investments (WSA recommendations)

Term	Phase-I	Phase-II	Phase-III	Total
Short	66	0	0	66
Medium	1529	847	0	2376
Long	15880	29543	25368	70791
Total	17475	30390	25368	73233

Table: 2.5 Total investment program for long term scheme (WSA recommendations)

Item	Unit	Assumed Unit Rate (Rs. In crores)	Quantity	Amount (Rs. In crores)
Metro	Km	250	95.7	23930
Mono Rail	Km	150	213.1	31964
BRT /High Density Dedicated Bus	Km	15	393.315	5900
Bus Corridor	Km	0.1	324.4	32.44
Road Upgradation	Km/lane	1.5	341.25	1507.35
New Roads	Km/lane	1.5	515.8	4642
Missing Links	Km/lane	1.5	529.1	1587
Transfer Stations	No.	25	17	425
Intermodal Transit Centers	No.	45	15	675
Truck Terminals	No.	10	8	80
Bus Terminals	No.	4	12	48
Total rounded off (Rs. In crores)				**70791**

Table: 2.6 Phasing of total investments (WSA recommendations)

Schemes	Phase 1 (2010 – 2015)	Phase 2 (2016 – 2021)	Phase 3 (2022 – 2031)	Total
Rs. In Crores				
Total	17475	30390	25368	73233
%	24%	41%	35%	100%

2.8 Where is plan for Commuter Rail?

In a massive plan worth about Rs.73,000 Crores envisaged by WSA, commuter rail system finds no place! Unfortunately, the report does not refer to the commuter rail system at all. It focused only on other modes of transport. But due to inherent advantages and large potential it has, rail system cannot be just ignored by any urban/suburban transport system. Potential of rail system is discussed in greater detail in subsequent chapters. The RITES report (2011) covers a commuter rail system and suggested to develop following corridors:

Table: 2.7 Corridors suggested by RITES (2011)

S.No	Corridor	Length Km
1	Kengeri – Ramanagaram	32.0
2	Baiyyappanahalli – Hosur	41.0
3	Yeshvantpur – Tumkur	64.0
4	Yelahanka – Dodballapur	24.0
	Total	**161.0**

Present study relooked the whole gambit of Rail Service in detail.

2.9 Costs of Overlap with CRS

- Costs associated with overlap is worked out section wise based on the following:
  - 80 % if the line has parallel alignment within < 1km of CRS
  - 60 % if the line has parallel alignment between 1 and 2 km of CRS
  - 40 % if the line has parallel alignment between 2 and 3 km of CRS
- Value of overlap is around Rs 19, 000crores (at least 12,000crores)

Table: 2.8 Section overlap of other modes of transport with CRS

No	From	To	Km	Within 3 Km from IR Network					
				BRT	Mono Rail	High Speed Rail Link	Metro Rail	Total Overlap	% overlap
									Rupees in Crores
1	SBC	MYA	92.88	36.63			12.20	48.83	52.57%
2	SBC	YPR	5.35			4.10	5.35	9.45	176.64%
3	YPR	TK	64.00	12.00			10.00	22.00	34.38%
4	YPR	YNK	12.45	3.64		9.30		12.94	103.94%
5	YNK	BYPL	19.23	11.42				11.42	59.39%

No	From	To	Km	Within 3 Km from IR Network					
				BRT	Mono Rail	High Speed Rail Link	Metro Rail	Total Overlap	% overlap
6	YPR	BYPL	16.12		14.00		6.00	20.00	124.07%
7	YNK	DUB	20.72	20.31				20.31	98.02%
8	YNK	CBP	46.05	14.00	9.41	12.90		36.31	78.85%
9	BYPL	HSRA	48.59				4.63	4.63	9.53%
10	SBC	BWT	70.21				15.00	15.00	21.36%
11	BYPN	VMN	2.00				2.00	2.00	100.00%
12	SVDL	NMGM	10.00					0.00	0.00%
Total			**407.60**	**98.00**	**23.41**	**26.30**	**55.18**	202.89	49.78%

Table: 2.9 Value of overlap

S.No	Less than 1 Km	1 to 2 Kms	2 to 3 Kms	Value of Overlapping Section		
				0 to 1	1 to 2	2 to 3
				80%	60%	40%
Metro Rail	29	49	55	5800	7350	5500
Mono Rail	14	23	23	1680	2070	1380
BRT	50	76	98	600	684	588
HSRL	7	11	26	1400	1650	2600
Total	100	159	202.00	9480	11754	10068

Value: Assumed by WilburSmith (in crores)	
Metro Rail	250
Mono Rail	150
BRT	15
HSRL	250

3 Conventional Rail System – Potential Untapped

3.1 Leveraging the Strength of Indian Railways

Potential of conventional rail system specially in commuter context can be better appreciated by the way the Mumbai Suburban rail is serving the public. Mumbai runs trains at 2 to 3 minutes frequency. This is the role model for any commuter system in India.

Mumbai's state of running trains at 2 to 3 minutes frequency is evolved over a period of time. Even today, the system is set to increase the capacity by quadrupling, 5th line, 6th line etc. In fact, capacity enhancement of any system should be a continues process. As technology changes and as the thinking process changes, more and more innovative solutions come up for increasing the capacity and meeting growing demand.

Indian Railways is a highly complex entity constituting various disciplines, various departments and various technologies. For example, it has got signalling systems ranging from conventional old mechanical type to semiconductor based signalling systems. Recently, a system of controlling signals from a lap top has also come up.

Any typical bureaucratic system is a vertical hierarchical system causing delays in decision making. Indian Railways is bureaucratic horizontally as well as vertically. This adds to the complexity of the system further.

Any capacity enhancements to the existing network become further more complex because the capacity enhancement is to be effected with no disturbance or least disturbance to the already running traffic.

It is this complexity that is making the modern infrastructure planners to go for costly alternatives like metro rail, dedicated corridors etc. without fully exploring the potential of existing rail network. Innovative methods of financing, execution, O&M, management etc. are being explored for these costly alternatives but not for rail network.

Capacity Enhancement of Indian Railways is by and large left solely to Indian Railways. No great intelligence is required to say that IR alone just cannot fully take up this holy job with its ever dwindling resources and complexity of its structure.

In fact, Indian Railways, the pride of the Nation runs un-interrupted services to move more than 30 million passengers and about 3 million tons of freight every day. It is an excellent rail operator and probably one of the world's best systems to run such a massive network without any hitch. Disaster management and crisis management systems of the Indian Railways are the best India can ever think of. Very big bridges washed out during floods are constructed in just a few hours or at the most a few days and such disasters are hardly felt by the travelling public.

IR has been enhancing capacity continuously with its limited resources. But such enhancement is very marginal and cannot match the ever growing demand. If the inability of IR to enhance capacity is supplemented by other means, IR's strengths can be well leveraged to cater to ever growing demand to a very large extent at much lesser costs.

3.2 Potential in terms of Capacity

Capacity of rail system can be better appreciated by the following comparison matrix:

Table: 3.1 Capacity comparison of different modes

	Rail	Metro	BRT
Average Speed (Kmph)	40 to 70 36 to 40[@]	25 to 55	25 to 50
Maximum Peak Throughput (passengers/Hr)	60000	40000	500
Investment in Lakhs of Rupees/Passenger Km / Hr / Direction	0.03	0.61	0.07

Source : Draft final report Jun '2010 of M/s Wilbur Smith Associates on Comprehensive Traffic and Transportation Study for Bangalore Metropolitan Region for BMRDA
[@]Indian Railways Year Book 10-11

The present commuter rail system of Bangalore runs at average speed more or less at its potential. But the present throughput is far below its potential (*about 2000 per hour – Taking 1 train of about 10 coaches per hour and 200 passengers per coach*) and can be exploited fully to its potential to serve the public. Capacity is high mainly because of the train length. Train length can go virtually up to 28 coaches which is just not possible with Metro or any other mode.

3.3 Potential in terms of Dispersion

Due to continuous growth of economic activity, urban agglomerations get overloaded with more population and more commuting. Urban planning should have mechanism to disperse the ever growing population and commuting to new and new geographical areas so that no location gets over dense beyond manageable levels. Undoubtedly, the first step of such dispersion is development of roads to new locations. Beyond certain trip lengths, road services become impracticable because they take unacceptably high journey times.

Namma Metro, Mono Rail, High Speed Rail to BIAL, rejuvenated BMTC services etc. which are top priority agenda items of GoK's transport plan cannot really address the key problem of commuters. A commuter should be able to travel a distance of about 70 Km (or even 100 Km) in about an hour or so. Then only growth centres like Hosur, Tumkur, Mandya, Bangarapet etc. get developed fast and pressure on main hub Bangalore shall be eased. The said agenda items (Namma Metro, Mono Rail etc.) shall at the most give some relief within the highly urbanized Bangalore city area leaving the larger commuter problem unaddressed because trip lengths of Metro are much less than the public needs.

IR has been able to disperse the commuter traffic as seen from the increase in average trip length of suburban rail passengers as under:

Table: 3.2 Average trip length of suburban rail passengers in India

Year	Average Lead of Suburban passengers	Average Annual Growth
1950-51	15.9	
1960-61	17.3	0.85%
1970-71	18.9	0.89%
1980-81	20.5	0.82%
1990-91	26.4	2.56%
2000-01	31.1	1.65%
2007-08	32.5	0.63%
2008-09	32.8	0.92%
2009-10	33.8	3.05%
2010-11	33.8	0.00%
Source : Indian Railways Year Book 2010-11		

Average trip lengths by public transport observed in Bangalore in 2009 is 10.8 Km (*Source : Draft final report Jun '2010 of M/s Wilbur Smith Associates on Comprehensive Traffic and Transportation Study for Bangalore Metropolitan Region for BMRDA*) because Bangalore is depending virtually on BMTC alone as on now. More the trip lengths, the better and effective is the dispersion of congestion.

From the above, it can be seen that IR has got potential to bring up the average trip length of Bangalore public transport system from the present 10.8 Km to as high as 33.8 Km. Such dispersion by Metro or Monorail or BMTC are nearly impossible because it is prohibitively expensive to extend Metro or Monorail to cover more locations.

Growth rate of this average trip length on IR is from 0.65% to 3% per annum. The increase since 1950-51 shown above is mostly by IR's internal resources. Only in the last decade, such increase is partly due to external support like MRVC etc. To maintain desired growth, local bodies and state governments should augment IR's resources.

Another measure of dispersion is stations spacing. Closer the spacing better is the dispersion. Stations spacing in Mumbai suburban rail system and Bangalore rail system are:

Table: 3.3 Comparison of station spacing in Mumbai and Bangalore Rail systems

Spacing of Stations	Stations in Quadruple lines with Automatic Signalling (Mumbai)	Stations in Double Line with Automatic Signalling (Mumbai)	Stations in Double Line with conventional Signalling (Bangalore CRS)	Stations in Single Line with conventional Signalling (Bangalore CRS)
Less than 1 Km	3 4%	3 4%	0 0%	0 0%
1 to 2 Km	21 29%	12 18%	1 2%	0 0%
2 to 3 Km	8 11%	9 14%	5 13%	2 9%
More than 3 Km	41 56%	42 64%	33 85%	20 91%
Total →	73 100%	66 100%	39 100%	22 100%

From the above, it can be seen that there is a lot of scope and potential to reduce the station spacing and increase dispersion in Bangalore. Measures like automatic signalling and doubling are required to bring about such dispersion.

3.4 Potential in terms of Cheapest Alternative

WSA (*Draft final report Jun '2010 of M/s Wilbur Smith Associates on Comprehensive Traffic and Transportation Study for Bangalore Metropolitan Region for BMRDA*) provides plans for investment of Rs 73300 Crores in phases up to 2031 (which does not include any investment on rail system). With just about 10% of such investment, rail system probably can meet half of Bangalore's public transport commuter demand.

With an Investment of about Rs 8000 Cr:

$$Passengers\ that\ can\ be\ handled = \frac{25 \text{ x } 405 \text{ x } 15 \text{ x } 200}{30} \text{ x } 2 = 2 \text{ Millions per day}$$

Broad assumptions in the above calculation:

- Costs are as per block cost estimates given in "Cost Estimates and Phasing of Investments" chapter.
- 25 commuter trains per direction in the entire CRS network of about 405 Km.
- Each train consists of 15 coaches with carrying capacity of 200 each.
- Average lead of each passenger is : 30 Km.
- Calculation is done for both directions (multiplied by 2).

The 2 million passengers capacity is about 45% of the present day public transport commuter demand of 4.5 million trips per day.

In fact, the 25 trains per direction taken in above calculation can be increased substantially with marginal additional investment. Train lengths also need not be 15 cars. It can be 20 or even 27 cars in future.

Metro Rail costs about 12000 Cr for 42.3Km to serve about 1 million passengers per day (as per phase-I of Namma Metro). Investment per passenger Km of rail will be much less than metro as seen above.

Thus, a CRS system for the same capacity as Metro (plus additional capacity for long distance passenger trains and freight trains) can be developed at much lesser cost than Metro.

Passenger fares of commuter rail start from Rs. 2/- onwards whereas BMTC fares start with Rs. 4/- and metro fares start with Rs. 10/-. The pricing per se does not really indicate the costs involved in creating the service or running the service. But it gives a very broad idea of costs of different modes of transport. In a broad sense, taking the subsidy component of each service as same, one can compare the fares of different modes to have reasonable comparison of costs of different modes.

This clearly shows that commuter rail is the most economical mode of public transport and it needs to be made an integral component of any commuting system.

3.5 Potential in terms of Existing Backbone

A strong and established IR network backbone is already available. No complicated modelling studies are required to fully exploit this network. The existing network can be studied for its bottlenecks and can be enhanced continuously to meet ever growing passenger demands. It is also easier to extend the backbone further to new geographical areas in all directions and also in the form of ring rail or so.

3.6 Capacity Assessment: Metro Vs CRS

As CRS will share space with other types of trains, frequency of trains, would necessarily be lower and thus most people assume that CRS will have lesser capacity. However, conventional rail systems can be designed to have the same capacity as metro systems being introduced in the country, it still have scope for running other trains in the same system.

Capacity, defined as passenger through put is a product of length, width and frequency. Width of metro coaches is 2.88 metres against 3.66 metres of a broad gauge rail coach making it 1.26 times wider. Thus, capacity is 26% more on account of width alone.

Length of metro coaches is fixed as 6 coaches in all the metro systems being built in the country. This limitation arises as elevated platforms are very costly and the increase of coach lengths increases the cost of the system disproportionately. However, in IR, as conventional trains run with 26 coaches, many of the station's mainline platforms are designed to accommodate trains of this length. In Mumbai suburban system, a historical legacy, progressively 12 coach trains have become the norm and a few services are run with 15 coaches also. Currently, suburban trains other than those in Mumbai are run in multiples of 4 coaches and thus we have option to run 8, 12 or 16 coach trains. In new suburban systems, as stations and platforms can be located relatively more flexibly compared to legacy systems, introduction of 16 coach trains would not be difficult. Thus, Capacity of a CRS train is 2.67 (16/6) times of a metro train on account of number of coaches.

Thus the capacity of a CRS train would be:

- 1 CRS Train = 3.3 metro trains (2.67 *1.26)

Next is the frequency of trains. A typical metro system is designed to achieve a peak frequency of 20 trains in hour. If a conventional train system can dedicate 6 train paths in an hour for commuter train, then the CRS will have the same capacity as a metro train system.

As seen earlier, in Mumbai Suburban system, Western Railway runs suburban or EMU trains with a 3 minute frequency and Central Railway with a 4 minute frequency. Even if we assume conservative figure of 4 minutes of Central Railway, to run 6 trains the total time taken up would be around 24 minutes in an hour. This leaves a gap of 36 minutes (or 60% of the time) for running non suburban (or conventional) trains or as spare to different exigencies. During the off peak hours, the time available for non-suburban trains will be higher.

Thus, by using 40 % of the capacity, a CRS system of the same capacity as compared to a metro system can be developed.

3.7 Cost Assessment: Metro Vs CRS

Cost of construction of a metro system per kilometre is around Rs. 250 Crores for an elevated system (as per WSA reports) and Rs. 350 – 400 Crores for an underground system. Compared to this, upgrading a conventional rail system to suburban needs would cost around Rs 15-20 crores per kilometre.

Thus, a metro train path during peak hour is worth around Rs 12.5 crores. As against this, a CRS train is worth around 41.2 crores (3.3*12.5 crores).

To summarise, investment on A CRS system is highly desirable and should be done on priority as it would create value for the following reasons:

- An investment of Rs 15-20 crores per kilometre on a CRS system would create capacity equivalent to a metro system with an investment requirement of Rs 250 crores per kilometre or more.

- It would also help in running more number of non-suburban trains more efficiently.

3.8 Comments and Suggestions

From the above, it can be appreciated that IR has very huge potential:

- To work as high density urban transit.
- To work as suburban commuter system.

With such a huge potential and advantages associated with it, no commuter system can be claimed to be “complete” or “satisfactory” without the appropriate mix of commuter rail.

It is only the Mumbai, Chennai (and Kolkata to some extent) that have tapped the potential to their maximum practicable levels and benefited immensely. They have been still tapping the potential further. Hyderabad also is now joining the league of coveted commuter rail systems of India with its MMTS. Bangalore should now take a leap forward to exploit the Railway’s potential and integrate the rail system with the city’s commuter system to satisfy the public needs.

4 Rail system: Integrated into Bangalore Commuter System

4.1 The reality

No single mode of commuting (say it rail or road or metro or mono rail or so) can fully satisfy the commuting needs of any city. Bus, rail, metro, mono rail etc. have got different applications associated with them. They are meant for different sections of commuters and different trip lengths. An optimal mix of different modes of public transport should be the strategy for any urban planning.

4.2 Extent of Commuter Rail System

From the trend of commuter ticket sales at various stations in and around Bangalore, and from interaction with various officials of South Western Railway and Government of Karnataka, IR network that can serve Bangalore commuters is identified as under:

Table: 4.1 CRS Network in Bangalore

S.No	From	To	Distance (Km)
1	Bangalore	Mandya	92.88
2	Bangalore	Yesvantpur	5.35
3	Yesvantpur	Tumkur	64.00
4	Yesvantpur	Yelahanka	12.45
5	Yelahanka	Baiyyappanahalli	19.23
6	Yesvantpur	Baiyyappanahalli	16.12
7	Yelahanka	Dodballapur	20.72
8	Yelahanka	Chikballapur	46.05
9	Baiyyappanahalli	Hosur	48.59
10	Bangalore	Bangarapet	70.21
11	Soldevanhalli	Nelamangala	10.00
		Total	405.60

4.3 IR Network overlap with other modes

This network is parallel to corridors of various other modes suggested (and under consideration) as a part of comprehensive transport plan for Bangalore (*Draft final report Jun '2010 of M/s Wilbur Smith Associates on Comprehensive Traffic and Transportation Study for Bangalore Metropolitan Region for BMRDA*) as under:

Table: 4.2 Other modes of transport parallel to IR Network within 1 Km

S.No	From	To	Distance (Km)	Within 1 Km from IR Network						
				BRT	Mono Rail	Bus Corridor	High Speed Rail Link	Metro Rail	Total Overlap (Km)	% Overlap
1	SBC	MYA	92.88	25.90				12.00	37.90	41%
2	SBC	YPR	5.35					5.35	5.35	100%
3	YPR	TK	64.00						0.00	0%
4	YPR	YNK	12.45	3.64			3.00		6.64	53%
5	YNK	BYPL	19.23						0.00	0%
6	YPR	BYPL	16.12		7.39			5.40	12.79	79%
7	YNK	DBU	20.72	20.31					20.31	98%
8	YNK	CBP	46.05				4.30		4.30	9%
9	BYPL	HSRA	48.59		6.68				6.68	14%
10	SBC	BWT	70.21					6.33	6.33	9%
11	SVDL	NMGA	10.00						0.00	0%
		Total	405.60						100.30	25%

Table: 4.3 Other modes of transport parallel to IR Network within 2 Km

S.No	From	To	Km	Within 2 Km from IR Network						
				BRT	Mono Rail	Bus Corridor	High Speed Rail Link	Metro Rail	Total Overlap (Km)	% Overlap
1	SBC	MYA	92.88	36.63				12.20	48.83	53%
2	SBC	YPR	5.35					5.35	5.35	100%
3	YPR	TK	64.00					3.50	3.50	5%
4	YPR	YNK	12.45	3.64			5.00		8.64	69%
5	YNK	BYPL	19.23	6.00					6.00	31%
6	YPR	BYPL	16.12		14.00			6.00	20.00	124%
7	YNK	DBU	20.72	20.31					20.31	98%
8	YNK	CBP	46.05	9.90			5.61		15.51	34%
9	BYPL	HSRA	48.59		9.41			4.63	14.04	29%
10	SBC	BWT	70.21					15.00	15.00	21%
11	SVDL	NMGA	10.00						0.00	0%
		Total	405.60						157.18	39%

Table: 4.4 Other modes of transport parallel to IR Network within 5 Km

S.No	From	To	Km	Within 5 Km from IR Network						
				BRT	Mono Rail	Bus Corridor	High Speed Rail Link	Metro Rail	Total Overlap (Km)	% Overlap
1	SBC	MYA	92.88	36.63				12.20	48.83	53%
2	SBC	YPR	5.35				4.10	5.35	9.45	177%
3	YPR	TK	64.00	12.00				10.00	22.00	34%
4	YPR	YNK	12.45	3.64			9.30		12.94	104%
5	YNK	BYPL	19.23	11.42					11.42	59%
6	YPR	BYPL	16.12		14.00			6.00	20.00	124%
7	YNK	DBU	20.72	20.31					20.31	98%
8	YNK	CBP	46.05	14.00			12.90		26.90	58%
9	BYPL	HSRA	48.59		9.41			4.63	14.04	29%
10	SBC	BWT	70.21	5.00				15.00	20.00	28%
11	SVDL	NMGA	10.00						0.00	0%
		Total	405.60						205.89	51%

Table: 4.5 IR Network parallel to other modes of transport

No	Mode	Length in Kms	Parallel to IR Network (Km)		
			Within 1 Km	Within 2 Km	Within 5 Km
1	Metro Rail	114.35	29.08 25%	48.68 43%	55.18 48%
2	BRT	393.3.00	49.85 13%	76.48 19%	103.00 26%
3	Mono Rail	213.20	14.07 7%	23.41 11%	23.41 11%
4	Bus Corridor	324.40	0.00 0%	0 0%	0.00 0%
5	High Speed Rail Link	35.00	7.30 21%	10.61 30%	26.30 75%
	Total	1080.25	100.30 9%	159.18 15%	207.89 19%

From the above, it can be seen that about 25% of commuter rail network is along the identified commuter corridors of different modes. This clearly gives an indication that the existing rail network is well in tune with the city's commuting needs and commuting plans.

If the overlap of CRS with other modes is very high, it only duplicates the service and is not desirable. If the overlap is too less, it is like a standalone system and serves only some captive commuters. If rail system crosses other

modes just at few locations, pressure on those inter modal transit hubs shall be very heavy and difficult to manage. Moderate overlap as seen above facilitates transhipment of commuters from one mode to other mode at different places and serves greater population in a meaningful way.

4.4 Reverse Engineering

Planning commuter systems in already developed geographical areas is very challenging. It is very expensive and also sometimes not feasible due to dense inhabitation and sky rocketing real estate prices. If a good commuting system is developed to a relatively less developed area, the economic activity gets automatically shifted from dense areas to these areas. Hyderabad MMTS is the latest beneficiary of such reverse engineering. In case of Hyderabad, their consultant studied the demand pattern of the city commuters and suggested to develop:

Table: 4.6 Consultant suggestions for Hyderabad MMTS

Priority	Timeframe	Sections
I	2006-2009	Medchal-Secunderabad, Ghatkesar-Moula Ali-Secunderabad
II	2009-2011	Secunderabad-Shamshabad, Lingampalli-Pattancheruvu
III	2011-2016	Lingampalli-Nampalli-Koti-Upppal

But, even much before the receipt of consultant's report (Feb '04), major part of priority-III (Lingampalli - Nampalli) section was commissioned (Aug '03). The reason behind giving priority III for this section by the consultant was clearly reflected in the poor patronage of the section initially. However, the patronage has shot up tremendously in this section and the real estate business in these sections also shot up and resulted in many new housing projects in this section. The priority II and III projects were subsequently sanctioned in MMTS phase-II.

Therefore, developing Bangalore commuter rail network of 405.6 Km is going to serve the commuting public both by conventional engineering as well as by reverse engineering.

Historically, dispersion of urbanisation by "Reverse Engineering" is possible only with rail network but not with any other mode (like metro, mono rail, road network or so).

4.5 Locating Commuter Rail Terminals: Enter City Core or Terminate at Outskirts

One of the strategies to address the commuter problems is locating rail terminals short of Bangalore station (say Baiyyappanahalli, Yeshvantpur, Kengeri or so) in each direction and connecting these terminals with metro rail for commuting towards busy Bangalore city area. To examine such proposition, existing travel pattern of rail commuters is shown as under:

Table: 4.7 Existing travel pattern of Bangalore rail commuters

		To →	Sectors									
From↓	Estimated Originating Commuters per Day ↓		SBC	YPR	BYPL	BWT	HEB	TK	MYA	HSRA	DBU	CBP
SBC	31500	21%	0%	1%	1%	**30%**	0%	**33%**	**32%**	1%	1%	1%
YPR sector	12000	8%	6%	1%	0%	2%	1%	**75%**	6%	3%	4%	2%
BYPL sector	12000	8%	9%	0%	3%	**76%**	0%	0%	4%	6%	0%	1%
BWT sector	34500	23%	**24%**	0%	10%	**64%**	0%	0%	1%	0%	0%	0%
HEB sector	1500	1%	11%	0%	0%	0%	0%	0%	0%	**60%**	29%	0%
TK sector	24000	16%	**64%**	13%	1%	1%	0%	**21%**	1%	0%	0%	0%
MYA sector	25500	17%	**39%**	2%	2%	2%	0%	2%	**54%**	0%	0%	0%
HSRA sector	4500	3%	**26%**	**25%**	14%	0%	15%	0%	0%	19%	0%	1%
DBU sector	3000	2%	**35%**	**34%**	0%	1%	11%	1%	3%	0%	15%	0%
CBP sector	1500	1%	**44%**	33%	17%	0%	0%	0%	0%	0%	0%	0%
Total	150000	100%										

- **YPR Sector:** Yesvantpur and Malleswaram
- **BYPL Sector**: Bangalore Cantt, Bangalore East, Baiyyappanahalli.
- **BWT Sector**: Krishnarajapuram, Satellite Goods Terminal, Whitefield, Devangonthi, Malur, Byatrayanahalli, Tyakal and Bangarapet.
- **HEB Sector**: Kodigehalli, Lottegollahalli, Hebbal, Banaswadi, and Channasandra.
- **TK Sector**: Tumkur, Kyatsandra, Hirehalli, Dobbspet, Nidvanda, Muddalinganahalli, Dodbele, Bhairanayakanahallli, Gollahalli, Nelamangala, Soldevanahalli, and Chikbanavar.
- **MYA Sector**: Mandya, Hanakere, Maddur, Nidaghatta, Settihalli, Channapatna, Ramanagaram, Ketohalli, Bidadi, Hejjala, Kengeri, Jnana Bharthi, and Nayandahalli.
- **HSRA Sector**: Hosur, Anekal Road, Heelalige, Karmelaram and Belandur Road.
- **DBU Sector**: Dodballapur, Rajankunti and Yelahanka.
- **CBP Sector**: Chikballapur, Nandi, Venkatagiri Kota, Avatihalli, Devenahalli, Dodjala and Betthalsoor.

Source: Actual Tickets sales data that could be collected has been modelled into this matrix.

- From the above, it can be seen that demand pattern is not supporting the proposition of locating commuter terminals short of Bangalore. From every sector, the demand pattern is to touch Bangalore.
- The traffic has two distinct patterns. First is the traffic within the sector. This traffic is expected to be high as people would be moving to nearby places more frequently. This traffic, however, would not be influenced by the location of terminals as they terminate their journeys short of the terminals.
- Another is the cross sector traffic. This traffic moves across the sectors and thus terminating traffic at suburban terminals will force a major transhipment. It can be observed from the above table that major portion of commuters move towards Bangalore terminal indicating predominant preference for it.
- Therefore, any attempt to locate terminals short of SBC is likely to result in artificial transhipment of commuters on big scale. To manage this level of avoidable transhipment, good amount of money need to be invested apart from causing inconvenience to commuting public.
- Suburban terminals like YPR, YNK, KGI and BYPL etc. cannot handle this break in service even with huge investments.
- As can be seen from the transport network, metro cannot provide complete alternate connectivity at these terminals. It does not serve the city at a number of places even after accounting for the proposed metro extensions. Further, network is such that people will be forced to have more than one transfer to reach the destination. For example, a person from BWT to reach YPR is forced to change to metro at BYPL, come to Majestic and from there take a metro to reach YPR. Similar, scenario can be visualised for a number of other origin destination points.
- If development of BMR is to happen in a seamless manner, seamless integration of outskirts and city core is necessary.

- Terminating the journeys at terminals in suburbs also reduces patronage to the CRS.
- Terminating trains short of SBC would reduce the capacity of rail system as trains are to be run for shorter distances.
- Such proposition becomes unavoidable only when no solution exists for enhancing capacity of rail network in Bangalore city core area. But as discussed in subsequent chapters, the core Bangalore area has got tremendous scope for additional capacity.

Therefore, it is recommended not to terminate the commuter trains short of Bangalore. Terminals need to be the farthermost stations in the CRS i.e. Tumkur, Mandya, Bangarapet and Hosur etc. All other stations including major stations like Bangalore City, Yesvantpur etc. need to be passing through stations. In fact, with EMUs, every station can act as terminal. The EMU gets terminated at a station, within 5 to 10 minutes, it can start journey in reverse direction. An additional line (or two) at every station (or at every alternate station or so) shall be handy to terminate the EMUs. This type of Omni Terminal system provides lot of flexibility in operations and the services can be tailor made as per the changing needs of travelling public. This also avoids congestion at any particular location.

4.6 Modal Transits

Commuters changing from one mode to another mode during the course of their trip is a big challenge in urban transport planning. All stations on CRS network act as modal transit locations because commuters normally come to station by bus or auto or so to take the train. All stations need to be developed accordingly to cater for this transit. With metro coming up, modal transit facilities need to be developed at locations like BYPL, SBC etc. Developing such arrangements are normally integrated into metro plans and as such not considered a part of CRS project.

4.7 Conclusions

Conventional rail system has grown to its present stage over a very very long period and is a part and parcel of common man's life whether for long distance travel or commuting. Unintentionally, it has become itself integrated into the commuting system of the city. It can itself become a mass rapid transport system and also it can also act as feeder system to other modes of transport. Therefore, exploiting its full potential gets automatically (and so naturally) integrated into the transport needs of the city. Such exploiting should be a continuous process (like in the case of MRVC) rather than discrete.

5 Existing Rail Network – Capacity Enhancement Strategies

5.1 Backdrop

The existing rail network in Bangalore area got developed over a period of time. The recent major rail projects for Bangalore area:

Table: 5.1 Major rail projects in Bangalore area in the past

Project	Year
Bangalore – Guntakal Gauge Conversion	1983
Bangalore – Mysore Gauge Conversion	1992
Bangalore – Tumkur Gauge Conversion	1993

Each of the above projects substantially altered the rail network scenario of Bangalore. But, the thrust in every project was to complete the project and give some connection to Bangalore. Scope of none of these projects had any means or provision to study the rail network in Bangalore area in a holistic and integrated view. With the result, Bangalore rail system became a cluster of small piecemeal systems rather than any holistic system. It is due to this legacy, the system is not geared up for suburban operations. This leaves lot of potential and opportunity to study and upgrade the system to serve larger public needs specially commuting needs. In fact, the system needs complete overhaul and redesign (but not incremental up gradations) to serve as good suburban rail system apart from serving long distance passenger traffic and freight traffic.

5.2 Terminal Strategies

5.2.1 Bangalore Terminal (SBC)

5.2.1.1 *Over View*

This is the main hub of Bangalore city. Almost every commuter of Bangalore wants to have direct link to this station from his/her place. Therefore, maximum number of trains should pass through this station for better service to the public. Today, SBC position is such that it cannot handle even one additional train. It is

not in a position to effectively handle a major delay in arrival or departure of even a single train. As already brought out above, SBC has evolved historically and needs radical redesign to serve commuters needs and aspirations. Tinkering is not going to help.

Presently Bangalore yard has 10 platform lines, 6 pit lines (maintenance lines), 8 stabling lines and a few other lines. Platform lines are meant for entraining and detraining passengers. Pit lines are meant for undertaking the repairs for each rake (train). These pit lines have necessary facilities for scheduled maintenance after each trip. Stabling lines are meant for stabling trains during their idle time or when they are waiting for their turn onto platform line or pit line.

Capacity of any terminal depends on:

- Number of platforms.
- Number of lines (platform lines, pit lines, stabling lines, shunting lines etc.).
- Length of each line. More the length of each line, higher is the capacity of the yard.
- Interconnectivity of all these lines. Ideally all platform lines should be universal i.e. train from/to any direction (BYPL or YPR or MYS) should be able to enter/exit any platform line.
- Connectivity of platform lines with pit lines, stabling lines and shunting lines etc. Ideally, all platform lines should have connection to all pit lines, shunting lines and stabling lines etc.
- Lie-Over i.e. time spent by each train in the yard (Lesser the lie-over, more is the capacity).
- Requirement of Engine Reversal for the train. More the trains which need engine reversals, lesser is the capacity of the yard.
- Type of Maintenance required for the train in the yard:
    - Primary Maintenance (Needs about 7 Hrs. minimum lie-over).

- Secondary Maintenance (Needs about 3 Hrs. minimum lie-over).
- No Maintenance (Needs no lie-over).

5.2.1.2 *Platforms:*

The 10 platforms present in SBC yard today are fully occupied and there is hardly any slot on any platform for dealing additional trains. SBC is catering to 3 directions i.e. YPR, BYPL and MYS. If commuter trains are to be dealt from 3 directions, SBC should have at least 2 platforms exclusively for commuter trains. With the present level of platform occupation, no platform can be exclusively earmarked for commuter train. In fact, hardly any additional train can be dealt on any of the existing platforms. Therefore, it is required to construct at least 2 additional platforms.

SBC yard has got 4 pit lines sandwiched between platform lines. These 4 pit lines can be conveniently converted into 2 platforms and they can be earmarked for commuters. However, the pit lines need to be relocated to accommodate platforms.

On MYS end of the yard, there is vacant land (Binny Mills Land) which can be conveniently used for constructing pit lines. This is the first and foremost requirement for introducing CRS trains in SBC.

Figure: 5.1 Binny Mill land towards Mysore end

Being in very prime location, Binny Mills Land may be difficult to get spared to Railways. Therefore, part of this land if not full can be spared to Railways so that possible number of pit lines can be constructed here. And to that extent, SBC can be provided with additional platforms for commuter trains.

5.2.1.3 *Lie-Overs and Engine Reversals*

Presently SBC yard is dealing 92 coaching trains (some of them are daily and some of them are non-daily). Close look at the trains being dealt at SBC shows:

Table: 5.2 Rakes lie over at SBC

	Trains that need no Maintenance (Lie-Over required : 5 Minutes)		Trains that need Secondary Maintenance (Lie-Over required: 3 Hrs.)		Trains that need Primary Maintenance (Lie-Over required: 7 Hrs.)	
Engine Reversal needed? → Lie-Over ↓	Yes	No	Yes	No	Yes	No
≤ 30 Minutes	8	23				
> 30 Mts ≤ 1 Hr	4	4				
> 1 Hr ≤ 2 Hr	6					
> 2 Hr ≤ 4 Hr		5				
> 4 Hr ≤ 6 Hr	1	1				

	Trains that need no Maintenance (Lie-Over required : 5 Minutes)		Trains that need Secondary Maintenance (Lie-Over required: 3 Hrs.)		Trains that need Primary Maintenance (Lie-Over required: 7 Hrs.)	
Engine Reversal needed? → Lie-Over ↓	Yes	No	Yes	No	Yes	No
> 6 Hr ≤ 8 Hr						
> 8 Hr ≤ 10 Hr	2				8	
> 10 Hr ≤ 12 Hr	3		2		3	
> 12 Hr ≤ 14 Hr	2		2		5	
> 14 Hr ≤ 16 Hr					2	
> 16 Hr ≤ 18 Hr					3	
> 18 Hr ≤ 20 Hr					1	
Total →	26	33	4		22	

Details at Annexure-1

From the above, it can be seen that:

- Very few trains only leave the yard within the minimum lie-over required. Majority of the trains are lying-over for more time than required (even more than 18 Hrs. in case of one train).
- 52 trains (out of 85) need engine reversals.

It is highly difficult for the yard to handle such massive lie-over and engine reversals. It is because of this reason, many empty rakes are being taken to Baiyyappanahalli marshalling yard, Krishnarajapuram, Whitefield and Bangalore Cantt just for stabling during their idle time. To stable these rakes and to bring back these rakes to SBC, light engines are also being moved. All these unproductive movements are badly eating away the capacity of SBC as well as SBC-WFD section which can otherwise be used productively to run more commuter services.

If such lie-over and engine reversals are eliminated (or minimised), capacity of the yard can be increased. The solution lies in making the SBC a pass through station from the present state of terminal station. Or terminal activities (maintenance of rakes) should be brought down to such a level that rakes do

not spend more time than required in the yard. Thus, all (or some) terminal activities should be shifted away from SBC to some other convenient location i.e. additional terminals should be developed. This creates enough capacity to deal more commuter trains and also to handle any additional long distance trains and freight trains.

5.2.1.4 *Lengths of various Lines: The Operational constraints*

Table: 5.3 Lines length of SBC yard

Line No	Type of Line	Length (in Metres)	Length (in Vehicles)	Present Utilisation
1	PF-1	659	26 Coaches	63%
2	PF-2	589	24 Coaches	100%
3	PF-3	572	24 Coaches	46%
4	PF-4	598	24 Coaches	71%
5	Stabling Line	476	19 Coaches	
6	Stabling Line	476	19 Coaches	
7	Stabling Line	559	24 Coaches	
8	PF-5	559	24 Coaches	63%
9	PF-6	495	20 Coaches	71%
10	PF-7	462	19 Coaches	45%
11	PF-8	570	23 Coaches	71%
12	PF-9	625	26 Coaches	42%
13	PF-10	602	25 Coaches	63%
	Pit Lines		3 Pit Lines : 24 Coaches Each 2 Pit Lines : 21 Coaches Each 1 Pit line : 18 Coaches	85% 92% 79% 60% 75% 75%
	Shunting Neck		At YPR End : 24 Coaches At BWT End : 26 Coaches	

With ever growing demand for more capacity, number of coaches get increased for more and more trains. Freight trains are normally full length trains (means 686 metres). Longer passenger trains and freight trains can be dealt only on very few lines in SBC yard as can be seen above. Inadequate length of lines coupled with absence of universal reception and despatch facilities for all the lines forces number of unproductive (shunt) movements in the yard and thus adversely affects the capacity of the SBC yard.

Thus, SBC needs to offload some of its terminal activities and also needs to increase in length of lines.

5.2.1.5 *Interconnectivity of Lines*

SBC yard has 10 platforms presently as under:

Table: 5.4 Interconnectivity of running lines at SBC

PF	Entry/Exit towards BYPL	Entry/Ext towards MYS end	Entry/Exit towards YPR end
1	Yes	No	No
2	Yes	No	No
3	Yes	No	No
4	Yes	No	No
5	Yes	Yes	No
6	Yes	Yes	No
7	Yes	Yes	No
8	No	Yes	Yes
9	No	Yes	Yes
10	No	Yes	Yes
Trains Arriving from this direction →	49	20	23

From the above, it can be seen that majority of the trains enter into SBC yard from BYPL side. Then can come only onto PFs 1 to 7. Out of these platforms, 4 platforms have no exit to other directions. Trains received onto these 4 platforms cannot go anywhere. Presently, trains received from BYPL are being disposed by:

- Reversing to BYPL side (to start as new train).
- Reversing to BYPL side (for stabling at stations like BNC or so).
- Placing onto stabling lines.
- Placing on pit lines.
- Keeping on the platform itself until it needs to be stared as new train (even for 6 to 8 hrs. or so).
- Despatching towards MYS.

All the above disposal schemes except the last one consumes lot of time. Engine also needs to be reversed. A few shunt movements (movements from one line to another within the yard) are also required. These shunt movements have to wait in between to give way for trains entering and leaving the yard

from/to different directions. In shunt movements alone, each train may need to spend a couple of hours bringing down the capacity of the yard drastically.

For the trains entering SBC from MYS or YPR, the situation is not this much critical. Trains from MYS can go either towards BYPL or YPR as seen from above table. Trains from YPR also can go towards MYS. However, if they are terminated at SBC, they are to be taken onto stabling lines or pit lines. Such terminal activities need lot of shunt movements and take away substantial capacity of SBC.

Due to above cited constraints coupled with heavy lie-over and inadequate line lengths, SBC is not able to use the platforms and pit lines to the full extant as seen in above tables.

It is for this reason, any new train announced by Ministry of Railways shall either run short of Bangalore (like YPR, BYPL or so) or it is accommodated by making some other existing train to terminate short of Bangalore. Trains which are ideally required to come to SBC but are presently terminated short of SBC are:

Table: 5.5 Trains being terminated short of SBC

Train No	From	To	Terminated	
			Station	Time
66533	BWT	KJM	KJM	19:10:00
66534	KJM	BWT	KJM	19:30:00
76506	KQZ	BNC	BNC	09:40:00
76507	BNC	BWT	BNC	11:00:00
76508	BWT	BNC	BNC	17:20:00
76505	BNC	KQZ	BNC	17:55:00

These trains are during peak commuter timings and they can serve commuters better if these trains can be brought up to SBC.

There should also be seamless movement of trains from YPR/BYPL side to MYS side for enhanced capacity of SBC.

- Trains from MYS side and getting terminated here should be able to go to pit lines or to BYPL side easily.
- Terminating trains should be taken onto stabling lines or pit lines without reversing the engine and without any shunt movements. This way, the

Figure: 5.2 Connecting MYS line to grid one

terminating train shall leave the yard within about 10 minutes.

To achieve these objectives, all the lines of SBC should have entry/exit to MYS side. However, this connection needs some Binny Mills land. Image showing typical arrangement of connection to MYS side is shown in figure 5.2 above.

5.2.1.6 *Yard Speeds*

Normally, trains move with 15 Kmph in yards. But with latest improvements in turnouts and signalling technology, speed in yard can be enhanced to 30 Kmph while redesigning the yard. In the above lines, SBC yard should be redesigned such that:

- Few platforms are exclusively nominated for commuter trains.
- All lines have universal R&D facilities from all directions (BYPL, YPR and MYS directions).
- All lines shall be of full length (i.e. full length freight train or coaching train).
- Other lines like shunting necks, pit lines (if provided) etc. also should be of full length.

- Speed in SBC yard is 30 Kmph

To make all these options feasible, a very meticulous and innovative detailing is required while redesigning the SBC yard.

If the yard is redesigned like this, SBC yard shall have:

- Purely passenger handling facilities.
- Almost nil terminal activities and shunting operations.
- Almost all lines with universal reception and despatch facilities.
- Almost all lines with full length.
- Speed of 30 Kmph.
- Capacity :

Table: 5.6 Scenario of SBC yard after suggested remodelling

	Present	Likely to be (if above cited measures are implemented)
Platforms	10 (different lengths and without universal R&D)	14 or 15 (More or less full length and universal R&D)
Capacity (commuters, long distance and freight)	60 pairs of trains per day	150 pairs of trains per day

5.2.2 Yesvantpur Terminal

YPR, the second coaching terminal of Bangalore is presently dealing with 89 passenger and express trains. It has got 6 platforms, 3 pit lines and 7 stabling lines and a few other lines. Capacity of YPR can be increased tremendously by additional pit lines. Work is presently in progress for providing 1 additional pit line. If 3 more pit lines are constructed, terminal capacity of YPR increases to about 60 pairs from the present 37 pairs of trains. However, land is a major constraint at YPR to develop additional pit lines. Possibility of acquiring military land for Railway operations at YPR need to be explored.

5.2.3 Additional Terminals

Presently, there are only 2 passenger terminals in Bangalore (SBC and YPR) as brought out above. These 2 terminals are fully busy with long distance trains and hardly can deal any more trains (commuter or otherwise). If at all CRS need to be introduced in Bangalore meaningfully, these 2 terminals are grossly inadequate and additional terminals need to be developed as brought out in above paragraphs. For locating additional terminals, the major criteria are:

- The locations should have enough land.
- The locations should be close to SBC.
- The locations should have seamless movement to SBC yard.
- The locations should be such that long distance and commuter trains do not conflict their interests each other but supplement each other.
- The location should have good road connectivity.

More the terminals, the better it is. More terminals facilitate more dispersion of congestion and also reduces load on any particular terminal. Thus, more capacity to run commuter trains. As per the preliminary studies and as per interactions with South Western Railway officials, it is felt necessary to develop terminals at 3 locations as under:

- Binny Mill Land just at MYS end of SBC yard.
- Railway Land at BYPL (adjoining NGEF land) where presently marshalling yard and stabling lines exist (about 11 Km from SBC).
- Yelahanka Terminal.

5.2.4 Binny Mill Land Terminal: An extension to SBC terminal

Figure: 5.3 Utilisation of Binny Mill Land for Commuter terminal

In fact, this is not a new terminal; But an extension of SBC terminal. As already discussed in above paragraphs, this area can be provided with a few pit lines so that additional platforms can be constructed exclusively for commuter trains. The above image shows the typical arrangement of pit lines etc. in Binny Mill Land. This arrangement can accommodate about 12 lines (pit lines or platform lines or any other line). Initially pit lines can be accommodated in this area. Subsequently, when the traffic in SBC yard becomes more and more, some platforms can also be added in this Binny Mills area. Feeder roads also can be developed easily for this terminal as this area is well connected by road network. This is also nearer to the metro station coming up nearby. Therefore, this proposition is very ideal and most of the problems of SBC can be solved in one go with this alternative. This arrangement needs about 29 acres of Binny Mill Land. This land shall make an excellent suburban terminal at SBC to deal commuter trains from all directions.

Binny Mill land is in very prime location and has lot of commercial value. In case it is not practicable to give this whole land to Railways, part of the land can also be spared to Railways so that just a few pit lines can be constructed

instead of 12 lines. Binny Mills land issue should be deliberated with open mind along with all stake holders. Depending on the extent of land that can be spared, plans can be made accordingly.

5.2.5 Baiyyappanahalli North: The Third Coaching Terminal

At Baiyyappanahalli, presently there is a marshalling yard (adjoining NGEF land). This yard is mostly being used for stabling passenger rakes of trains terminated at SBC due to non-availability of lines at SBC. This land can be effectively used to build about 20 to 25 lines. About 10 pit lines, 5 stabling lines, 6 R&D lines (for goods) and 5 platforms (for passenger trains) can be planned here. Image of the typical arrangements is also shown.

Advantages of this arrangement:

- Long distance Trains coming from North (YNK side), TK side and Bangarapet side can be terminated here. Thus, good number of trains (about 25 or so) presently getting terminated at SBC can be terminated at BYPL (North).
- A few commuter trains also can pass through this station and stop at this station.

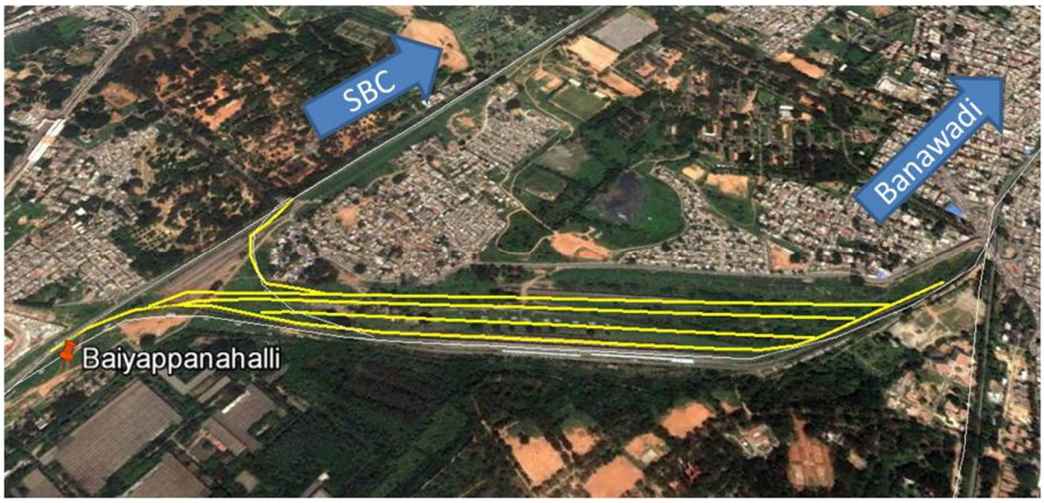

Figure: 5.4 Baiyyappanahalli (north) 3rd coaching terminal

- This area is presently in non-signalled territory of South Western Railway. Therefore, execution of work does not involve obstruction to running trains. In Railway's parlance, this is almost a green field project, thus making the execution easier and simpler.
- This terminal eases off the SBC yard to a very great extent and SBC can be improved to handle more commuter trains by providing more platforms and lengthier platforms with almost universal R&D facilities.
- This is very nearer to BYPL metro station. Long distance passengers can easily go to metro station from this BYPLN new terminal. A skywalk can also be planned in future to facilitate transhipment.
- Scenario of BYPLN (Baiyyappanahalli North) yard shall be:

Table: 5.7 Likely scenario of BYPL (N) 3rd coaching terminal

	Present	Likely scenario after the above measures are taken
Platforms	0	5
Capacity (commuter and long distance)	0	70 Pairs

5.2.6 Yelahanka: EMU Terminal

- Yelahanka is presently a pass through station and there are no terminal activities here.
- But with increasing demand, this station needs to be developed into a terminal.
- There is enough Railway land available in YNK for developing the terminal.
- This can be very well used to construct EMU maintenance shed (EMU terminal). In future, for Bangalore CRS, only EMUs shall be used. As on now, EMU maintenance facilities do not exist in SBC area. They cannot be maintained in normal pit lines as they need different maintenance facilities.

- Thus YNK terminal can be developed exclusively for EMUs.

5.2.7 Extension of Trains: Multi Terminals on MYS section

Number of trains getting terminated at SBC do not need any maintenance i.e. they do not need any terminal facilities like pit lines etc. These trains are lying over at SBC for durations as high as 11:55 hours (Details at Annexure-1). Good number of such trains can be extended into MYS section and can be terminated at Kengeri, Hejjala, Bidadi, Ramanagara, Channapatna, Maddur and Mandya. What is required at those stations is just one platform line which can be easily constructed. Even if one train is terminated at each of these stations, 7 to 10 trains can be terminated in SBC-MYS section. The relief it brings to SBC is just immense in terms of commuter capacity addition. The trains thus extended shall also serve as commuter trains from SBC up to that terminal.

5.2.8 Hejjala 4th Coaching Terminal

Mumbai has got many terminals like CSTM, Dadar, LTT, Kalyan, Mumabi Central, Thane etc. Unless so many terminals are planned like this, dispersion of traffic shall be a big problem

Developing an exclusive 4th coaching terminal in MYS section is strategically important to disperse the sub-urban traffic effectively and for seamless functioning of CRS. Trains coming from BYPL side can be conveniently taken onto MYS section and can be terminated at Hejjala.

- Between Kengeri and Hejjala of Mysore section, there is some Railway land available at about Km 20-21.
- In this land, about 6 pit lines can be easily constructed.
- All these lines can be connected to Hejjala station.
- This land is very strategically located near the track and can be best used for enhancing the capacity of overall rail system of Bangalore.
- This can be fully developed into coaching terminal and some trains can be terminated here.
- This is about 20 km from SBC.

- The land available can facilitate a small terminal. If some more land can be acquired adjacent to the available land, this terminal also can be developed for a capacity like SBC or BYPL (North) or YPR.

Image showing typical arrangement is as under:

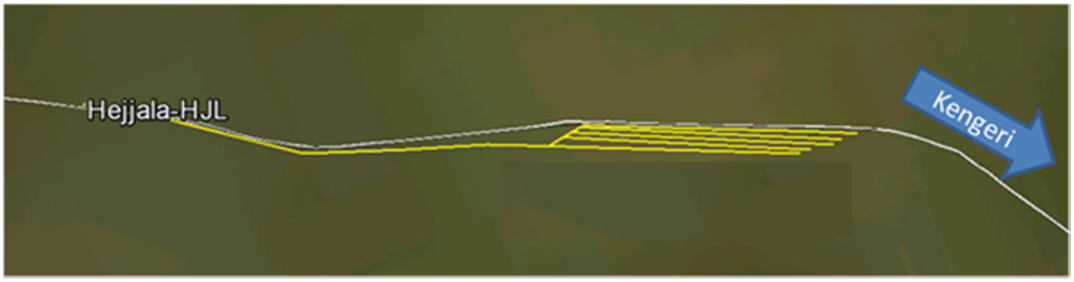

Figure: 5.5 Hejjala 4th coaching terminal

It is highly recommended to develop all the four terminals (Binny Mill, BYPLN, YNK and Hejjala) discussed above. .

5.2.9 Freight Terminals

On date, there exists only one freight terminal (SGT) near Whitefield on Bangalore CRS. For the present level of freight traffic, existing facilities are good enough. However, as the freight traffic increases, movement of freight trains from all direction to SGT badly occupies the sections and net capacity for commuter trains shall come down. Therefore, some more freight terminals need to be developed in Bangalore area in future. Probably, one freight terminal in the north will be required first in DBU area. Then some more freight terminals in south and west can be planned depending on growth in freight traffic. The new freight terminals should be developed as multimodal logistic hubs providing one stop logistic solutions to customers. On date, Bangalore City does not have such terminals.

However, additional freight terminals are not warranted now to introduce CRS trains.

5.3 Sectional Strategies

5.3.1 Unidirectional Traffic in Mornings and Evenings

In the morning time, long distance trains keep arriving Bangalore. During that time Down line (Bangalore Cantonment to SBC) is fully occupied and there will be hardly any slot left over to run commuter trains. This is the time where commuter trains also need to be run in this direction. During this time, trains in opposite direction are comparatively less and thus the Up line is underutilised. The situation becomes reverse in evenings when long distance trains start from SBC and commuter trains also are to start from SBC. This phenomenon causes hurdle to commuter trains as well as long distance trains. Any small hitch anywhere hits series of trains. To address this issue:

- Signalling system should be changed in SBC-BNC. Conventional up line and down line system should be replaced by twin single line system so that both lines can deal trains of both directions.
- Presently Bangalore Cantt – Baiyyappanahalli block section is 6.46 km length. A train can be dispatched from BNC towards BYPL only after previous train reaches BYPL. This 6.46 km block section can be converted into 3 blocks of 2 Km each by providing automatic block signalling. Similarly, K R Puram – Whitefield 9.32 Km block section also should be converted into 4 blocks by changing the signalling to automatic signalling. There appears to be some gradient problems in these sections to introduce automatic signalling. In case condo nation of these gradient problems is not feasible, at least one IB (Intermittent Block) signal can be provided in each of these block sections to split it into 2 block sections each. When providing IB also is not allowed on technical grounds, certain restrictions may be imposed for operating IB; Like: When freight train is passed in the section, entire block section shall be considered as one only without considering IB. IB shall split the block section into two only for coaching trains. If such solution is also not

feasible, twin single line arrangements should be developed in this section (SBC-WFD).

The above cited solutions effectively tackle the morning and evening rush of unidirectional traffic so that commuter trains do not get affected due to the unidirectional rush.

Same unidirectional traffic congestion is experienced in SBC-YPR section also. In the morning, many long distance trains keep coming from TK side to SBC and these trains have to go in opposite direction in the evening. To tackle this problem, SBC-YPR block section is already provided with twin single line system. Even with this arrangement also, handling peak time rush is posing operational problems to S W Railway. This problem can be solved by providing IB (Intermittent Block) signals in both the lines of SBC-YPR for both up and down directions. After this option is also explored, probably next alternative would be tripling of SBC-YPR to tackle unidirectional morning and evening rush.

5.3.2 Criss-Cross movements at BYPL: Avoid by Flyovers

BYPL area of Bangalore CRS has very peculiar arrangement. Trains from 5 different directions join here, from Bangarapet, Bangalore, Yelahanka, Hebbal and Hosur. This type of multi directions at a single area affects the train operations very badly. This being in heart of urbanisation, commuter trains take a severe hit in this area. Some trains get more priority at the cost of other trains. But, in this area all the directions are more or less equally important from commuter's point of view. Basic motto of any commuter system is that public should be able to reach their work places situated at about 70 to 100 Km within 1 hour. With the type of criss-cross movements at BYPL area, the basic motto of the commuter system just cannot be thought of. Train movements in this area criss-cross as under:

Table: 5.8 Criss-cross movements of trains in BYPL area

To → From ↓	Bangarapet	Bangalore	Yelahanka	Hosur	Hebbal
Bangarapet	-	Main Line	Infringes Bangalore-Bangarapet trains. Flyover required	No Connection	Infringes Bangalore-Bangarapet trains. Flyover required
Bangalore	Main Line	-	Direct Connection.	Infringes Bangarapet-Bangalore trains. Flyover required	Direct Connection
Yelahanka	Direct Movement	Infringes Bangalore-Bangarapet trains. Flyover required (via Channasandra)	-	No Connection.	No Connection
Hosur	No Connection	Direct Movement	No Connection	-	Fly over exists
Hebbal	Direct Connection	Direct Connection	Direct Connection	Already Fly over exists	-

From the above it can be seen that to avoid criss-cross movements and for seamless movement of trains in this area, 4 flyovers are required. These flyovers in order of priority are:

1. Bangalore – Hosur flyover.
2. Bangarapet-Yelahanka Flyover.
3. Bangarapet-Hebbal Flyover.
4. Yelahanka – Bangalore Flyover.

Doubling is in progress in Yelahanka – Baiyyappanahalli section. Bangalore – Bangarapet is already double line. In future, YPR-BYPL and Banaswadi-Hosur Doublings will come up. Automatic Signalling is also contemplated for any commuter rail system. Advantage of these doublings and automatic signalling goes waste to a large extent in this criss-cross movement area unless these flyovers are constructed. This is to say that full advantage of the doublings and automatic signalling cannot be realised without these flyovers.

As per the preliminary feasibility study undertaken, it appears that flyovers at Serial Number 1, 2 and 3 are prima facie feasible. Flyover at serial number 4 appears to be not feasible due to the presence of another 2 flyovers (one road fly over connecting Kasturi Nagar and Tin Factory area and another rail flyover connecting Banaswadi to Hosur).

Presently, 34 trains are making criss-cross movements in BYPL area (Details at Annexure-2). Out of these, about 25 trains are criss-crossing during commuter

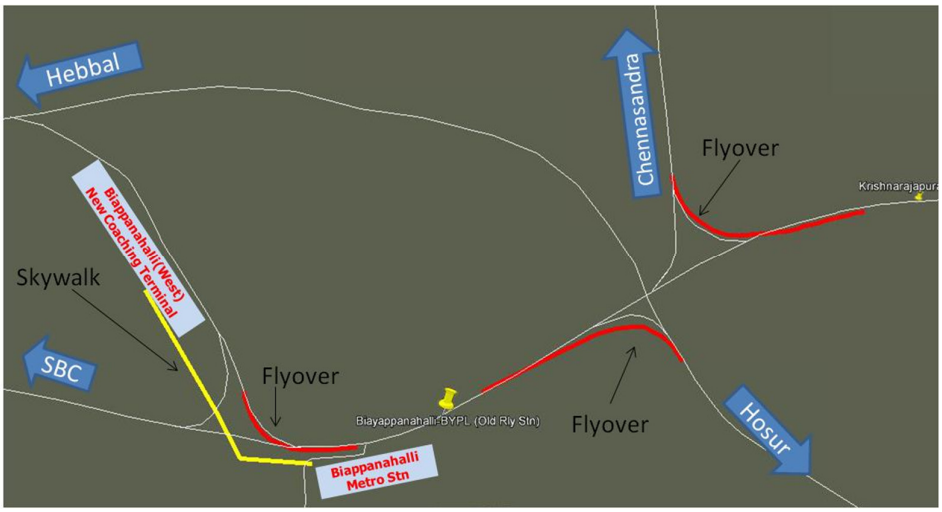

Figure: 5.6 Flyovers at BYPL area

train timings (0500 Hrs. to 2100 Hrs.). In addition, number of un scheduled trains (goods trains, Light Engines and Departmental Trains etc.) also cross the main line. With 25 to 35 trains criss-crossing in this area in commuter timings, it can be imagined how the commuter trains are hit. With the proposed 3 flyovers, 24 out of 34 trains will pass smoothly without any need to regulate trains on other lines. Balance 10 trains necessitate flyover No 4 which is prima facie found not feasible. However, as can be seen in Annexure-2, most of these 10 trains can be terminated at YPR instead of SBC so that criss-cross movements are avoided at BYPL.

This tremendously boosts up the capacity of the system. In other words, more commuter trains can be run in all the directions. These types of flyover arrangements already exist in systems like Mumbai Suburban. Typical

arrangement of flyovers at BYPL area along with skywalk is shown in the image.

Innovative engineering solutions need to be worked out to construct these flyovers and skywalk.

5.3.3 Criss-Cross Movements at YPR

At YPR also, criss-cross movements are badly eating away the capacity of the system. Trains criss-cross in this area are as under:

Table: 5.9 Criss-Cross movements of trains at YPR

To → From ↓	Yesvantpur	Tumkur	Yelahanka	Hebbal
Yesvantpur	-	Direct Connection	Direct Connection	Direct Connection
Tumkur	Direct Connection	-	Direct Connection.	Infringes YPR-HEB line
Yelahanka	Direct Connection	Infringes TK-YPR line	-	No Connection exists
Hebbal	Direct Connection	Infringes YPR-YNK line and TK-YPR line	No connection exists	-

Presently, YPR-LOGH-YNK doubling is in progress. During doubling, both block sections (YPR-LOGH and LOGH-YNK) should be provided with Twin Single Line system duly making LOGH as a block station (existing is halt station) for operational flexibility and increase of capacity. When such a doubling is done, criss-cross scenario at YPR shall be like:

Table: 5.10 Criss-Cross movements of trains after YNK-YPR doubling

To → From ↓	Yesvantpur	Tumkur	Yelahanka	Hebbal
Yesvantpur	-	Direct Connection	Direct Connection	Direct Connection
Tumkur	Direct Connection	-	Direct Connection.	Direct Connection
Yelahanka	Direct Connection	Infringes TK-YPR line	-	No Connection exists
Hebbal	Direct Connection	Infringes TK-YPR line	No connection exists	-

Above cited infringements can be avoided by constructing one flyover. Feasibility of constructing this flyover can be explored with innovative engineering solutions by engaging experts.

However, criss-cross movements get generated at LOGH. Depending on the congestion after doubling, necessity and feasibility of flyovers at LOGH should also be explored in future.

5.3.4 Other Criss-Cross Movements

Apart from Criss-Cross movements at BYPL and YPR area discussed above, due to presence of Goods Terminal at White Field and Diesel shed in K R Puram area, so many criss-cross movements take place. After a train is terminated at SBC, Locomotive comes to diesel shed. After attention, again it goes to SBC. Similarly, freight trains entering into Bangalore area have to necessarily come to Goods Terminal at Whitefield for maintenance. All these cause lot of criss-cross movements in this area.

That means, the trains are subjected to so many obstructions at BYPL, KJM and WFD and trains virtually crawl from SBC-WFD. If at all any train does not crawl, it is at the cost of many trains in other directions.

Whitefield and K R Puram areas also need to be analysed thoroughly and arrangements like flyovers should be planned for seamless movement of trains in CRS.

In the long run, when the existing rail network's potential is fully tapped (or when Mumbai suburban like situation comes), the goods terminal may need relocation to some distant place. Or some more goods terminals may need to be developed in DBU side or TK side or MYS side or so. Similarly, when the entire area is changed to electrified territory and diesel traction is totally done away with, the diesel shed needs re-design and/or probably relocation. Therefore, proposals like flyovers etc. in K R Puram – Whitefield should be planned in the changed scenario and therefore not contemplated in the present study.

5.3.5 Automatic Signalling

Automatic Signalling allows movement of more trains as seen from:

Table: 5.11 Comparison of Automatic Signalling and Absolute Block System

	Absolute Block Signalling (Existing system)	Automatic Signalling
Signals spacing along the track	4 to 6 Km (Distance from one station to another)	2 Km or even less
Train can start	After previous train reaches the next station	After previous train passes the signal ahead
Operation of Signal	Operated by staff as soon as train passes the signal	Gets automatically operated as soon as train passes the signal

From the above, it can be seen that how automatic block signalling boosts up the capacity of rail system. Mumbai, Chennai and Hyderabad are able to run local trains because they have automatic signalling. Thus, automatic signalling is a must to introduce commuter rail system in Bangalore.

As already discussed above, in Bangalore – Whitefield area is full of criss-cross movements. Added to this, there is rush of unidirectional traffic in morning and evening peak hours. Therefore, trains in this section virtually crawl. Capacity of this section needs to be increased on top most priority by automatic signalling or IB signals or Twin Single Line system as already discussed.

Subsequently, the automatic signalling should be extended to all other sections also as under:

1. Bangalore – Whitefield
2. Whitefield – Bangarapet
3. Bangalore-Mysore (along with full doubling and electrification)
4. Yeshvantpur – Tumkur (along with electrification)
5. Baiyyappanahalli – Yelahanka – Dodballapur (along with doubling)
6. Banaswadi – Hosur (along with doubling and electrification)

5.3.6 Speeds on Loop Lines

Traditionally, trains are run with 15 Kmph on loop lines. But, IR has identified it as mission area to increase speed to 30 Kmph on all loop lines. Wherever it is not yet increased to 30 Kmph, it should be done on top priority.

5.3.7 Electrification and Doubling

Commuter system cannot serve the public meaningfully with single line. All the sections of the CRS should necessarily be double lines. Also the tracks should be electrified. Diesel traction adds to the already polluted urban environment. Partly diesel and partly electric traction imposes severe restrictions on operations and seamless movement of trains is not possible. Without full electrification, EMUs cannot be introduced in all sections. Maintenance of diesel locomotives and electric locomotives need different facilities. Maintenance of DEMUs and EMUs also need different facilities. Therefore, with full electrification, lot of duplication of maintenance infrastructure and operational infrastructure can be avoided. Such saved infrastructure shall be better used for increasing capacity of CRS.

Number of electrification projects and doubling projects are already sanctioned by Indian Railways in CRS area and they are in different stages of execution. Still number of sections needs sanction of doublings and electrification to make the CRS fully electrified double lines. Details are:

Table: 5.12 Electrification & Doubling projects

Doubling		Electrification	
Sanctioned (in order of priority for execution)	To be sanctioned (in order of priority)	Sanctioned (in order of priority for execution)	To be sanctioned (in order of priority)
1. Yeshvantpur – Yelahanka (13 Km) 2. Yelahanka – Channasandra (14 Km) 3. Ramanagara- Mysore (94 Km)	1. Yelahanka – Dodballapur (22 Km) 2. Yeshvantpur – Baiyyappanahalli (18 Km) 3. Banaswadi – Hosur (54 Km) 4. Yelahanka – Chikballapur (47 Km) 5. Soldevanhalli – Nelamangala (10 Km)	1. Kengeri – Mysore (126 Km) 2. Yeshvantpur – Yelahanka (13 Km) 3. Yelahanka – Channasandra (14 Km) 4. Yelahanka – Dodballapur (22 Km) 5. Yeshvantpur - Chikbanavar (8 Km)	1. Yeshvantpur – Yelahanka (12 km) 2. Bangalore - Yeshvantpur - Tumkur (70 Km). 3. Soldevanhalli – Nelamangala (10 Km) 4. Yeshvantpur - Banaswadi – Hosur (along with doubling) (67 Km) 5. Yelahanka – Chikballapur (along with doubling) (47 Km)

The sanctioned projects should be executed as per the priority and new projects also should be taken up for introducing commuter trains in Bangalore.

5.3.8 Minimizing goods trains on commuter lines

If running one goods train is reduced in any section, more than 3 additional commuter trains can be run on that section. That is the kind of resources a goods train consumes. To the possible extant, goods trains are not normally run during commuter timings. However, running goods trains in commuter timings cannot be totally avoided. These unscheduled trains hamper the running of commuter trains as well as long distance trains. Therefore, to minimize the effect of goods trains on CRS routes, the following recommendations are made:

- A by-pass line (about 25 Km) before YNK: Trains coming from Dodballapur going to Jolarpettai can go to Chikballapur, Kolar and Bangarapet. (Chikballapur – Kolar gauge conversion is in progress). Train need not touch YNK or BYPL or SBC-BWT line at all. If the traffic so warrants, such bypass can also be replaced by a flyover after DBU side and CBP side doublings are done.

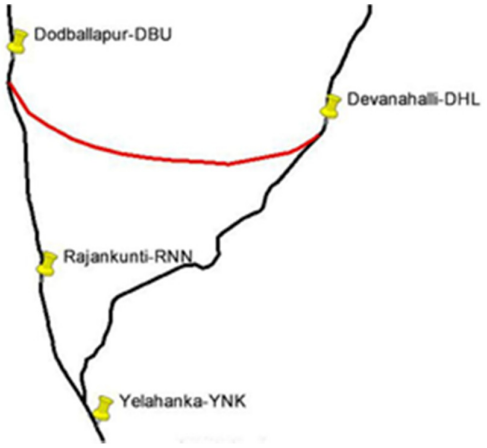

Figure: 5.7 Connecting Dodballapur line with Chikballapur line

- A line connecting YNK to HEB line. This facilitates direct movement for goods trains from YNK to HSRA which are presently being taken to YPR and engine is being reversed. This area is heavily built up area. Alignment should be fixed carefully and meticulously so that relocation of structures shall be least. Until such bypass line comes, LOGH should be made as junction station with some loop lines so that trains from YNK need not go to YPR for engine reversals.
- Freight train movements on CRS should be planned only during off peak hours especially during nights. In fact, South Western Railway has been already adopting this strategy to some extent or other.

5.3.9 Level Crossings – The Speed Breakers of the System:

Trains have to observe the signals at Level Crossings and stop if required. When running a train at every 10 minutes or even less is contemplated, level crossings become seriously critical in the system. They need to be eliminated by ROBs/RUBs or so. More the manned Level Crossings in a section, more the running time of the trains. Average spacing of manned level crossings in CRS area are:

Table: 5.13 Average spacing of Level Crossings in CRS area

Section	Length (Kms)	Average spacing of manned Level Crossings (Kms)
YPR-YNK	12.45	1.78
YPR-BYPL	16.11	1.79
YNK-DBU	20.72	1.88
SBC-MYA	92.88	2.32
BYPL-HSRA	48.59	2.56
YNK-BYPL	16.12	2.69
YNK-TK	64.00	2.78
YNK-CBP	46.05	4.61
SBC-YPR	5.35	5.35

Apart from spacing of manned level crossings, traffic at each of these level crossings also affect the train operations. More the TVUs (Train Vehicle Units), more is the average running time of the trains. TVUs of LCs in CRS area can be appreciated as under:

Table: 5.14 Number of Level Crossings & TVUs in CRS area

Section		Distance (Kms)	Manned Level Crossings with TVUs							Total
From	To		Greater than 4 lakh	Between 3 to 4 lakhs	Between 2 to 3 lakhs	Between 1 to 2 lakhs	Between 50000 and 1 lakh	Between 25000 and 50000	Less than 25000	
SBC	BWT	70.21	2	3	1	2		1	4	13
SBC	MYA	92.88	2		1	4	4	3	26	40
SBC	YPR	5.35					1			1
YPR	TK	64.00	1			3	5	2	12	23
YPR	YNK	12.45	1		1	3	1	1		7
YPR	BYPL	16.11					1	3	5	9
YNK	DBU	20.72	1			1	1	6	2	11
YNK	CBP	46.05			1	1		1	7	10
YNK	BYPL	16.12	1			1	2	1	1	6
BYPL	HSRA	48.59				3	3	4	9	19
		Total →	8	3	4	18	18	22	66	139

Level crossing becomes unmanageable and severely affects the train as well as road operations if the TVU exceeds about 100000. How a train will be able to maintain its speed with the level crossings with heavy TVUs and with less average spacing as seen above is anybody's guess. Suburban trains should be run at 5 to 10 minute frequency. How can a gate with 4 Lakh TVUs be opened and closed once in 5 to 10 minutes? It is difficult even to think of. In commuter train operations, every minute counts. Even a couple of minutes early/late

matters for the commuters. Therefore, these manned level crossings should be replaced by ROB/RUBs on top most priority in the interest of commuter train operations. By replacing the level crossings with ROB/RUBs, commuters travelling by roads also save lot of time.

Unmanned level crossings per se do not affect train operations. Unmanned level crossings are to be eliminated on safety considerations rather than speed considerations. Indian Railways have already identified elimination of unmanned level crossings as their mission area.

Present arrangement of replacing level crossings by ROB/RUB is very age old arrangement. Railway executes the portion near to the track and the approaches get executed by local bodies. Due to co-ordinating problems and due to land problems, construction is taking too long time. ROBs sanctioned in CRS area on date are:

Table: 5.15 ROBs sanctioned in CRS area

Year of Sanction	No of LCs
00-01	3
06-07	2
07-08	1
09-10	8
10-11	3
11-12	1
12-13	6
Total →	24

The snail pace of ROB's execution deters the planners to sanction new ROB projects. At this pace, elimination of more than 100 Level crossings in CRS area just cannot be thought of. A few things worth noting are:

- Jharkhand government entrusted the work of construction of 14 Road Over Bridges including the work of approaches to the Railways. Railways awarded the entire work to KRCL on turnkey basis (Estimated Cost: Rs. 163 Crores) in 2003-04. Though KRCL faced delays on account of delay in handing over of land free of encumbrances, removal

of encroachments, relocation of utilities and adverse law and order situation etc., the works on all the ROBs were completed in 2009-10 (*Source : http://www.konkanrailway.com/node/610*).

- Indian Railways proposed to set up a Special Purpose Vehicle (SPV) named Rail-Road Grade Separation Corporation. (*Source : Hon'ble Minister for Railways Sri Dinesh Trivedi's 12-13 Railway Budget Speech*).

The above issues are brought out here just to reiterate the seriousness of the issue of level crossings. Like Jharkhand Government, GoK also may consider entrusting ROBs execution to one agency.

5.3.10 Quadrupling / Tripling

With the above cited measures, on all commuter sections (double line sections), trains can be run at 10 minutes frequency during peak hours. However, such running can be made comfortable and also enhanced further (to 5 minutes frequency or so), by having an exclusive corridor for commuters. If lines are quadrupled, one set (of 2 lines) can be exclusively earmarked for commuter trains. If quadrupling is not feasible due to land problems or so, at least tripling should be done. In such case, one line can be earmarked for commuter trains. Priorities of Quadrupling / Tripling:

1. SBC - White field (from congestion point of view).
2. BYPL-HSRA (as this section constitutes about $^{1}/_{3}$ of commuter demand of Bangalore area).
3. SBC-YPR-Tumkur
4. SBC-MYS
5. White Field – Bangarapet.

5.4 Station Strategies

5.4.1 Additional Lines and other facilities at CRS Stations

With the implementation of CRS, every station has to cater for stoppage of more number of trains. With EMUs, every station can act as terminal. Ideally, an exclusive platform should be nominated for commuter trains at every station. Therefore, 1 or 2 additional lines and platforms should be provided at each of the CRS stations. One of the platforms can be even dead end platform so that it will be earmarked exclusively to terminate/originate EMUs. Other facilities like foot over bridges, ticketing windows, vending stalls, parking space etc. should be created (or upgraded) at each station.

5.4.2 Additional halts on CRS

More the halts in CRS, the better it will serve the public. Ideally:

- Every 1 Km, there should be a halt within city core i.e. for about 15 to 20 Km from SBC.
- Every 2 Km beyond the city core.
- Every 3 to 4 Km in the suburbs i.e. near MYA, TK, HSRA, BWT etc.

However, provision of more halts has limitations as under:

- Single Line cannot provide more halts. Line should necessarily be a double line to provide more halts.
- Absolute block system of signalling (present system of Bangalore CRS) cannot provide more halts. Automatic signalling facilitates more halts.
- EMU rakes take very less time for acceleration, deceleration and also for passengers to entrain/detrain. With normal passenger rakes, more halts is not feasible. All rakes should be made EMU rakes before increasing number of halts.

- Additional halts reduce the average speed of the trains. Hence all activities to boost average speeds should be completed before additional halts are introduced.
- Provision of adequate length of platforms, FOBs, ticketing counters, parking space etc. should be feasible at these halts.
- Feeder roads should be feasible and should be developed for every halt.

Presently there are about 60 halts in the CRS area of about 405 Km. As felt necessary by public and various voluntary organisations, another about 45 halts are required in the CRS area (List at Annexure - 3). However, the list does not cover the additional halts of full CRS area. These additional halts and even more can be made possible provided the issues brought out above are addressed and a detailed field survey is done for possibility of feeder roads etc.

5.5 Directional Strategies for Terminating Trains

Existing terminals SBC and YPR have got certain natural convenience to deal trains of particular direction as shown under:

Table: 5.16 Directional Convenience of Terminals

Trains from (direction)	Convenient Terminal
DBU	YPR
BWT	SBC
HSRA	YPR and SBC
MYS	SBC
TK	YPR
CBP	YPR

If a train from DBU is terminated at SBC instead of YPR, extra time taken is about 15 to 25 minutes. Similarly, if a train from BWT side is taken to YPR instead of SBC, it takes about 15 to 25 minutes extra. Presently, no such rationalisation exists in the trains time table. With the result, both the terminals are dealing trains from virtually all directions. If the time table is changed making the terminals strictly as per the above cited directions:

- Running time of most of the long distance trains come down by 15 to 25 minutes.

- So many criss-cross movements specially at BYPL area can be avoided and number of additional paths can be created in all sections to facilitate running additional trains.

5.6 Rakes for commuter Trains

Presently, commuter trains are being run in Bangalore using 4 MEMU/DEMU rakes and 10 normal passenger rakes. Features of these rakes:

Table: 5.17 EMUs Vs Conventional Rakes

	EMU rakes	Normal Passenger Rakes
Average Speed (KMPH)[@]	40.2	36.8
Engine Reversal	Not Required	Required
Terminal Detention	5 to 10 minutes	30 minutes to 1 Hr or even more
Rake Design	Made especially for commuter travel	They are made for normal long distance travel. Toilets, arrangements for luggage, lying down etc. are available.
Entrain / Detrain	Wider entries and passengers can entrain and detrain very fast	Narrow entries and very uncomfortable if more passengers need to entrain/detrain at a time
Capacity	Normal sitting : 100 Over Crowding : 200 or even more	Normal Sitting : 80 Over Crowding : Very uncomfortable for standing
[@]*Source : Indian Railways Year Book 2010-11*		

It can be seen from above that commuter trains should only be EMU rakes. Mumbai, Chennai, Hyderabad etc. use EMU rakes only for their local train operations. All existing rakes (passenger rakes and DEMU rakes) should be replaced with EMU rakes and new additional rakes also should be of EMUs. Typical photographs of an EMU rake of MRVC are as under:

Figure: 5.8 EMU rake of MRVC

Maintenance facilities required for EMU rakes and normal passenger rakes are different. Therefore, apart from procuring rakes, maintenance facilities are to be developed for these rakes. Therefore, EMU maintenance facilities are suggested to be provided at Yelahanka as discussed in above paragraphs.

6 Extending Rail Network to new Geographical Areas

6.1 Enhancement – A continuous activity

Capacity enhancement of existing rail network has been brought out in detail in the previous chapter. However, the mission of commuter rail shall not stop there. It is a continues process to enhance capacity and to extend the rail network to new geographical areas.

MRVC in its phase II and phase III plans, made proposals to extend the network to new areas which Indian Railways cannot do with its resources.

- Now, new line work of Chikbanavar – Satyamangalam is in progress. Commuter services should be planned and extended for about 70Km in this direction also.
- Baiyyappanahalli – Vimanpura abandoned line can also be restored for running commuter services.

Suggesting alignments and locations for rail network to new areas need lot of physical survey specially details about road network, demand pattern and land availability. Broadly speaking, ring rail should be developed one at 40 Km radius and another at 60 to 70 Km radius from SBC so that entire Bangalore city area gets covered by rail system.

6.2 Airport Connectivity:

The rail network passes close to the airport and it is very easy to connect airport. By extending this by about 5-6 Km, the CRS system can be connected to the airport. Assuming that around 50% of the line will be at grade and another 50 % will be elevated that system would cost around 800 crores to provide the connectivity. This will replace the high speed rail link proposed between the city and the airport. Hyderabad MMTS phase-II provides for a rail link to Shamshabad Airport just by extending the rail network by about 6 Km.

7 Land – The Game Changer

7.1 Land – The major issue

In any highly urbanized area, land definitely is a major issue. All big plans and projects may get struck up when it comes to "land".

In the context of CRS Bangalore, land issues that can change the game need special attention by GoK.

7.2 Binny Mills Land at SBC yard

If at all there exists one single most important issue that can bring CRS to Bangalore, it is Binny Mills Land in SBC yard. This land is just a natural extension of SBC yard and therefore, can be connected to SBC and other rail network very easily. This also facilitates construction of additional platforms at SBC exclusively for commuters duly relocating existing pit lines to Binny Mills Land. Easy connection of SBC yard to MYS side and thus making all lines of SBC universal for receipt/dispatch from/to any direction is also possible with this land. This land can also help for locating lines, platforms, FOBs etc. to deal exclusively commuter trains so that load on over saturated SBC get relieved which in turn help to run more and more commuter trains in the entire CRS.

It is highly recommended that this land entirely should be made available for Railways for bringing best CRS to Bangalore. In exceptional difficulties, if part of this land is spared to Railways, other scaled down options can be explored wherein capacity additions also shall be accordingly less.

7.3 Military Land at YPR

As of now, no major changes are contemplated in YPR, the 2nd coaching terminal. However, when SBC and 3rd coaching terminal BYPLN are exploited fully as recommended in this report, for further enhancement of Bangalore rail system, YPR needs very critical review. At that time, the military land available

near YPR need to be spared to Railways for expansion of YPR terminal activities.

7.4 Land for locating new terminal (4th coaching terminal) in SBC-MYS section

Developing an exclusive 4th coaching terminal in MYS section is strategically important for seamless functioning of CRS. The land should be ideally within about 20 – 25 Km from SBC. It can be near to any of the existing stations or even away from station so that it can be connected easily to any of the stations. It is suggested in this report to make use of Railway land available at Hejjala to develop 4th coaching terminal. However, the land available is not enough to terminal on big scale (like SBC or YPR or BYPLN). Either additional land should be acquired adjacent to available land or land at alternate location should be identified to develop coaching terminal in this section.

7.5 Land for SBC-WFD quadrupling

When CRS gets developed duly implementing phases 1 and 2 recommended in this report, lines need quadrupling to enhance it further to the level of Mumbai Suburban rail. SBC-WFD is the first and foremost section that needs quadrupling. Keeping the importance of this section, this quadrupling was sanctioned by Indian Railways in 1997 itself. But it has not yet taken off due to various issues including the land acquisition issues. In fact, if automatic signalling, IB signals, twin single line options are not feasible, SBC-WFD needs immediate quadrupling or at least tripling in phase 1A itself.

7.6 Land for various ROBs/RUBs construction

Importance of ROB/RUBs for rail as well as road users needs no emphasis. Many ROB works get held up due to land related problems like in the case of ROB works near Baiyyappanahalli – Krishnarajapuram areas and near Military gate at Yesvantpur.

7.7 Land for developing stations – specially new halts on the CRS

To serve more public, more stations need to be developed in the CRS. For every such station, land for platforms, ticketing, parking, commercial space etc. is required. Land is also required to develop the feeder roads to the new stations.

7.8 Land for expansion of rail network to new geographical areas:

Rail network should continuously be expanded to new geographical areas to meet the ever growing passenger needs specially commuting needs. For geography like Bangalore, ring rail (one at 40 Km radius and another at about 60 to 70 Km radius from SBC) is an ideal proposition. Fortunately, land is said to have been already earmarked in master plan for ring rail adjacent to outer ring road.

7.9 Land for Freight Terminals

On date, there exists only one freight terminal (SGT) near Whitefield on CRS. For the present level of freight traffic, existing freight facilities are good enough. However, as the freight traffic increases, movement of freight trains from all direction to SGT badly occupies the sections and net capacity for commuter trains shall come down. Therefore, in future, some more freight terminals need to be developed in Bangalore area. Probably, one freight terminal in DBU area and one in TK area will be required.

7.10 Land for various proposals/measures suggested in this report

Land is required for doublings, flyovers etc. suggested in this report. Detailed field study should be undertaken to assess the total land requirement, land available with Railways and state government and private land requirement.

7.11 Land Acquisition: The Strategy

Land Acquisition especially in urban area is highly complex and unfortunately no universally acceptable strategies exist. One thing that can be said for sure is: Serious and fully dedicated organisational setup exclusively meant for land acquisition for CRS should be put in place. Managerial as well as administrative solutions should be found on case to case basis to make land acquisition faster. A few news items are brought out here for appreciation:

An Extract from RTI's success story
The state government is a 49 per cent partner in MRVC, the rest being held by ministry of railways. The government's twin nominees on the board of directors are MMRDA commissioner Dr T Chandrasekhar and principal secretary (Urban development) Ramanand Tiwari. The problem, MRVC officials say, is that both are very busy officers and do not get time to devote to MRVC. Due to this most MRVC projects were stuck because of problems in land acquisition or encroachments. While Chandrasekhar is in charge of rehabilitation, Tiwari's department deals with land acquisition.
Source: http://right2information.wordpress.com/category/rti-success-stories/page/3/

How a Land Acquisition Problem was tackled by Delhi Metro
After having land acquisition problems in acquiring three plots for construction, DMRC felt to skip the Chhatarpur station. But the gap between the two stations on either side of Chhatarpur would have been 2.7 km which is too long for a MRTS system. Then, DMRC decided to construct the station using a special design costing an additional 30 to 50% expense to construct the station within the time frame. The construction work of the station was delayed as the land for the building of the station was acquired by DMRC in October 2009 after prolonged litigation. The elevated station was constructed using a unique method using special pre-fabricated/structural steel as the conventional construction technique by concrete would have taken at least 18 to 24 months. The steel structures were fabricated in a factory in Gurgaon in advance, brought to site after land acquisition and got assembled.


7.12 Bangalore Master Plan: Land for Railway use

Vision of any city comes from its master plan. If master plan is made with due care and vision, probably city development, particularly the transport problems do not pose serious problems. Bangalore Development Authority is contemplating to make City Master Plan for 2035. In fact, it has also called for suggestions from public in this regard. South Western Railway should be actively associated to identify future land requirements for Railway use. Land requirement for all the above cited railway uses should be thoroughly studied (by engaging a professional consultant if required) and analysed and land should be clearly earmarked in the master plan for railway use. It is worth noting that Hyderabad Metropolitan Development Authority (HMDA) earmarked land for future Railway passenger terminal at Manoharabad and Edulanagulapalli, freight terminal at Ravulapalli and passenger-cum-freight terminal at Timmapur and Bhongir in the Hyderabad draft master plan published in 2010 (*source: http://www.thehindu.com/todays-paper/tp-national/article2297287.ece*).

Identifying land for railway use needs physical survey and series of deliberations with various stake holders. In fact, it is a separate study by itself. Therefore, specific locations (for earmarking the land for railway use) are not suggested in this report.

8. Demand Supply Assessment

8.1 Demand for urban and suburban Rail services

8.1.1 Assumptions made for demand assessment

- Population on either side of rail network (within 1 Km, 2 Km and 5 Km catchment) is assessed based on geographical area and population densities. Population density in 2011 is assumed as:

Table: 8.1 Population density in 2011

Area	Density (per Sq. Km)
BBMP	10592.5
Bangalore District	4378
Bangalore Rural District	441
Ramanagara District	303
Mandya District	365
Tumkur District	253
Kolar District	384
Chikballapur District	298
Source: http://www.censusindia.gov.in/2011-prov-results/prov_data_products_karnatka.html	

- Decadal growth rate of population is assumed as:

Table: 8.2 Assumed decadal growth rate of population

Area	BMR	BBMP	Rest of the Area
2011 – 2021	29.14%	25.29%	39.43%
2021 – 2031	26.77%	25.29%	30.40%

- Distance of each section is split into various districts as under

Table: 8.3 Split of each section district wise

No	From	To	Distance in various Districts (Kms)							
			BBMP	Bangalore	Bangalore Rural	Ramanagara	Mandya	Tumkur	Kolar	Total Distance (Kms)
1	SBC	MYA	12.3	11		46	23.58			92.88
2	SBC	YPR	5.35							5.35
3	YPR	TK	7.9	13	31.1			12		64

No	From	To	Distance in various Districts (Kms)							
			BBMP	Bangalore	Bangalore Rural	Ramanagara	Mandya	Tumkur	Kolar	Total Distance (Kms)
4	YPR	YNK	12.45							12.45
5	YNK	BYPL	19.23							19.23
6	YPR	BYPL	16.12							16.12
7	YNK	DBU	3.8	10.92	6					20.72
8	YNK	CBP	2.2	13.8	30.05					46.05
9	BYPL	HSRA	13.4	35.19						48.59
10	SBC	BYPL	10.76							10.76
11	BYPL	BWT	10.9		18				30.55	59.45
12	SDVL	NMGA		10						10

- Typical modal split of commuter traffic in Mumbai

(Source: *http:// essay 535. blogspot.in / 2008/03/some-reflections-on-transport-problems.html*)

Table: 8.4 Modal split of commuter traffic in Mumbai

Mode	Trips (Millions)	Share
Rail	6.5	46%
Bus	4.7	34%
Autos etc.	1.4	10%
Personal Cars etc.	0.7	5%
Walk	0.7	5%
Total	14.0	100%

- Modal share is influenced mostly by trip lengths as seen under

Table 8.5 Modal share Vs trip lengths

Trip Length	Bus	Car	Two Wheeler	Three Wheeler	Cycle	Walk	Total
0 – 2	0%	0%	20%	0%	8%	72%	100%
02-05	12%	3%	50%	29%	5%	0%	100%
05-10	11%	13%	60%	14%	2%	0%	100%
10-15	68%	7%	15%	9%	0%	0%	100%
15 – 20	68%	7%	15%	9%	0%	0%	100%
20 – 35	83%	4%	11%	1%	0%	0%	100%
> 35	85%	12%	0%	3%	0%	0%	100%
Total	42%	7%	29%	12%	2%	8%	100%
Average Trip Length	14.99	11.59	8.02	8.59	3.88	1.01	10.57

Source: RITES report, Comprehensive Traffic and Transportation Plan for Bengaluru 2011

- In Bangalore, presently, rail network caters for about 0.18 million trips out of about 9 million trips i.e. about 2%.
- Trip lengths that can attract CRS are normally beyond about 10 to 15 Kms. Thus, CRS mostly captures the traffic from Bus.
- Considering all the above, CRS is assumed to attract up to 30% of commuters within 1 to 5 Km catchment on either side of the railway line. Depending on its success, this can be increased to even beyond 5 Km on either side of railway line and also up to 50% of commuters in future. However, demand in city core area may not be 30% and also catchment will be less due to presence of competing modes like Metro etc.
- Accordingly, Demand for urban/suburban rail traffic is assessed in 3 scenarios:
    - Low Patronage Scenario: Basic CRS services with very low multimodal integration at stations: 1 Km catchment area and 10% modal share of total trips.
    - Medium Patronage Scenario: Full-fledged CRS services but with low multimodal integration: 2 Km catchment area and 20% modal share of total trips.
    - High Patronage Scenario: Full-fledged CRS services but with good multimodal integration: 5 Km catchment area and 30% modal share of total trips.

- The three scenarios in brief are as under

Table: 8.6 The three scenarios

		Low				Medium				High			
		BBMP		Other Area		BBMP		Other Area		BBMP		Other Area	
Year	Per Capita Trip Rate[$]	Catchment	Modal Share of CRS	Catchment	Modal Share of CRS	Catchment	Modal Share of CRS	Catchment	Modal Share of CRS	Catchment	Modal Share of CRS	Catchment	Modal Share of CRS
2011	1.00	1 Km	10%	1 Km	10%	1 Km	10%	2 Km	20%	1 Km	10%	5 Km	30%
2021	1.10	1 Km	10%	1 Km	10%	1 Km	10%	2 Km	20%	1 Km	10%	5 Km	30%
2031	1.28	1 Km	10%	1 Km	10%	1 Km	10%	2 Km	20%	1 Km	10%	5 Km	30%

[$] *PCTR for 2011 and 2031 is adopted from Draft final report Jun '2010 of M/s Wilbur Smith Associates on Comprehensive Traffic and Transportation Study for Bangalore Metropolitan Region for BMRDA. However, for 2021 it is assumed as 1.10.*

8.1.2 Suburban Demand in 3 scenarios

Table: 8.7 Assessed Commuter Rail Trips (Scenario: Low)

No	From	To	Distance in Kms	Assessed Demand (Scenario : Low) (Commuter Rail Trips)			Share
				2011	2021	2031	
1	SBC	MY	92.88	40198	57600	85264	13%
2	SBC	YPR	5.35	11334	15620	22772	3%
3	YPR	TK	64.00	31469	45662	67915	10%
4	YPR	YNK	12.45	8050	11095	16175	2%
5	YNK	BYPL	19.23	40739	56146	81853	13%
6	YPR	BYPL	16.12	34150	47065	68615	10%
7	YNK	DBU	20.72	18141	26571	39659	6%
8	YNK	CBP	46.05	19394	29021	43654	6%
9	BYPL	HSRA	48.59	59200	86382	128747	19%
10	SBC	BYPL	10.76	22795	31416	45800	7%
11	BYPL	BWT	59.45	27025	37858	55551	8%
12	SDVL	NMGA	10.00	8756	13429	20378	3%
			Total →	321251	457865	676383	100%

Table: 8.8 Assessed Commuter Rail Trips (Scenario: Medium)

No	From	To	Distance in Kms	Assessed Demand (Scenario : Medium) (Commuter Rail Trips)			Share
				2011	2021	2031	
1	SBC	MYA	92.88	82620	122663	183992	14%
2	SBC	YPR	5.35	11334	15620	22772	2%
3	YPR	TK	64.00	75668	113451	170779	13%
4	YPR	YNK	12.45	8050	11095	16175	1%
5	YNK	BYPL	19.23	40739	56146	81853	6%
6	YPR	BYPL	16.12	34150	47065	68615	5%
7	YNK	DBU	20.72	48413	73001	110111	8%
8	YNK	CBP	46.05	63595	96813	146523	11%
9	BYPL	HSRA	48.59	151637	228155	343875	25%
10	SBC	BYPL	10.76	22795	31416	45800	3%
11	BYPL	BWT	59.45	38827	55958	83017	6%

No	From	To	Distance in Kms	Assessed Demand (Scenario : Medium) (Commuter Rail Trips)			Share
				2011	2021	2031	
12	SDVL	NMGA	10.00	35024	53717	81511	6%
			Total →	612852	905100	1355023	100%

Table: 8.9 Assessed Commuter Rail Trips (Scenario: High)

No	From	To	Distance in Kms	Assessed Demand (Scenario : High) (Commuter Rail Trips)			Share
				2011	2021	2031	
1	SBC	MYA	92.88	117298	175851	264700	13%
2	SBC	YPR	5.35	11334	15620	22772	1%
3	YPR	TK	64.00	120125	181636	274242	14%
4	YPR	YNK	12.45	8050	11095	16175	1%
5	YNK	BYPL	19.23	40739	56146	81853	4%
6	YPR	BYPL	16.12	34150	47065	68615	4%
7	YNK	DBU	20.72	53290	80481	121462	6%
8	YNK	CBP	46.05	97865	149374	226279	11%
9	BYPL	HSRA	48.59	280955	426493	644835	32%
10	SBC	BYPL	10.76	22795	31416	45800	2%
11	BYPL	BWT	59.45	67576	100051	149924	8%
12	SDVL	NMGA	10.00	35024	53717	81511	4%
			Total →	889201	1328945	1998168	100%

From the above tables, it can be seen that most important sections from commuter's consideration are:

- BYPL-HSRA (constitutes 32% of demand).
- YPR-TK (constitutes 14% of demand).
- SBC-MYA (constitutes 13% of demand).
- YPR-CBP (constitutes 11% of demand).

But all these sections are non-electrified sections and/or mostly single line sections. For introducing CRS, these sections should be made double line electrified sections on top priority. Accordingly, these proposals are included in phase 1A.

8.2 Urban and suburban rail services – Present supply position

As per the present services being run, supply is assessed as under:

Table: 8.10 Suburban rail services – Supply position

S.No	Sector	From	To	Distance (Km)	No of [@] Commuter Services at present	Total Coaches being run at present	Passengers Capacity (@ 150 per coach)	Passenger Km being Run	No of passenger trips being served [#]
1	MYA	SBC	MYA	92.88	10	114	17100	1588248	46990
2	YPR	SBC	YPR	5.35	18	204	30600	163710	4843
3	TK	YPR	TK	64	14	164	24600	1574400	46580
4	HEB	YPR	YNK	12.45	6	18	2700	33615	995
5	HEB	YNK	BYPL	19.23	2	16	2700	51921	1365
7	DBU	YNK	DBU	20.72	4	48	7200	149184	4414
8	CBP	YNK	CBP	46.05	4	30	4500	207225	6131
9	HSRA	BYPL	HSRA	48.59	6	62	9300	451887	13369
10	BYPL	SBC	BYPL	12	24	242	36300	435600	12888
11	BWT	BYPL	BWT	58	18	181	28350	1644300	46757
			Total		106	1079	163350	6300090	184332[$]

[#] Assuming average trip length as 33.8 Km as taken from Indian Railways Year Book 10-11
[$] This tallies with the ridership assessment of 150000 made from ticket sales analysis.
[@] List of present commuter services is at Annexure - 4

From the above table, it can be seen that present supply is able to cater for about 30% of commuter demand (medium scenario).

8.3 Demand for Non-suburban and Freight Trains

In every Railway budget, a few extra-long distance trains are announced. It is reasonable to assume an increase of about 2 to 3 long distance trains per annum on the system.

Bangalore area is predominantly a passenger intensive area i.e. number of freight trains dealt in the system are much less compared to passenger trains handled. These freight trains load (per day) on the system can be reasonably assumed to grow at 1 or 2 trains per annum.

Before introducing any long distance train, Indian Railways assesses the capacity of the system. If there is need to enhance certain facilities, Railways themselves plan such facilities and allot necessary funds. Similarly, for enhancing the freight capacity also, necessary facilities are developed by Indian Railways with their own funds depending on the requirement.

Measures suggested in phases 1 and 2 in this report are aimed at running trains at 5 to 10 minutes frequency. These 2 phases can be implemented in about 6

years from the date of approval by competent authority. These 2 phases are very much enough to take care of the above cited quantum of increase in long distance trains and freight trains apart from meeting the commuter requirement.

Therefore, long term growth of long distance passenger trains and freight trains should not be a cause of concern while planning the commuter services.

8.4 Bridging Suburban Demand Supply gap

Various measures suggested in phases 1A, 1B and 2 are to be implemented religiously to bridge Suburban demand supply gap. Services proposed to be run and the capacity generated are as under:

Table: 8.11 Proposed services and their capacity

						Commuter Services proposed to be run after phase			Commuter Trips generated after phase		
S.No	Sector	From	To	Distance (Km)	Commuter Services at present @	1A	1B	2	1A	1B	2
1	MYA	SBC	MYA	92.88	10	20	24	30	164876	217636	296776
2	YPR	SBC	YPR	5.35	18	26	30	36	12346	15670	20514
3	TK	YPR	TK	64	14	22	28	34	124970	174959	231763
4	HEB	YPR	YNK	12.45	6	10	12	16	11050	14586	21217
5	HEB	YNK	BYPL	19.23	2	6	20	34	10241	37550	69638
6	HEB	YPR	BYPL	16.12	0	0	0	34	0	0	58375
7	DBU	YNK	DBU	20.72	4	4	22	38	7356	44505	83861
8	CBP	YNK	CBP	46.05	4	4	22	40	16349	98912	196189
9	HSRA	BYPL	HSRA	48.59	6	14	34	82	60378	161296	424372
10	BYPL	SBC	BYPL	12	24	28	30	36	29822	35148	46012
11	BWT	BYPL	BWT	58.21	18	22	26	30	113664	147764	185996
12	NMGA	SDVL	NMGA	10	0	0	20	50	0	19527	53254
			Total	405.6	106	156	268	460	551052	967553	1687967

Average trip length is assumed as 33.8 Km

Each rake assumed as 15 car EMU and each car is assumed to carry 200 (1A), 220 (1B) and 240 (2). As the services get improved, patronage and overcrowding is also assumed to go up.

@ List of present commuter services is at Annexure-4

From the above table, it can be seen that, after phase 2, capacity of the system will be able to carry 2021 commuter demand of High scenario. Phases 1A and 1B and 2 can be easily implemented by that time (time frame is about 6 to 8 years as brought out in next chapter).

9 Cost Estimates and Phasing of Investments

9.1 Phasing philosophy

Phasing of investments should be such that it starts giving service at the earliest. As already discussed in this report, Bangalore rail system is so congested that it can hardly run any additional service.

However, capacity of existing services can be substantially enhanced by replacing the existing rakes with DEMU/MEMU rakes. As all sections are not electrified, DEMU rakes should be introduced in some sections while MEMU can be run in electrified sections. About 18 pairs of trains can be replaced with DEMU/MEMU rakes of 16 coaches each (List of trains at Annexure-5).

Presently, these trains are being run with an average of 10 coaches per train. Therefore, capacity increase in terms of coaches alone will be 60%. Considering capacity of each DEMU/MEMU coach as 30% more than normal coach, total capacity addition shall be about 100% i.e. the present capacity of 1.8 lakh trips shall get increased to about 3.6 lakh trips.

This proposal costs about Rs 650 Cr (8 rakes cost about 500 Cr and pit lines and DEMU maintenance facilities cost about 150 Cr).

Though this proposal appears very fast yielding, it is considered too rudimentary to adopt because:

- It is only one time activity and there is nothing in this proposal which can create additional capacity on a continuous and sustainable basis.
- Commuter demand of Hosur section is more than $^{1}/_{3}^{rd}$ of city's CRS demand. This proposal gives just one pair of commuter train to Hosur. That means, crux of CRS problem is not touched at all.
- Rakes procurement shall take in about 2 years. During this period, many improvements can be done to the rail system to substantially enhance the commuter capacity to facilitate continuous addition of capacity on sustainable basis.

- DEMU/MEMUs are not meant for mass transit. They are medium transit systems. EMU is specially designed for mass transit system. EMU capacity is theoretically 20% more than DEMU/MEMUs. Practically, their capacity is even 50% more considering standing commuters, overcrowding etc. Ultimately, any mass transport urban system has to switch over to EMUs.
- Mumbai MRVC is using EMUs. Even Hyderabad MMTS, initially planned for MEMUs. Later on, realising the limitations of MEMU/DEMUs, they switched over to EMUs. This change in planning resulted in some infructuous expenditure.
- Electrification of all the sections is only a matter of time. Once all the sections are electrified, DEMUs in electrified sections becomes a mismatch and maintaining DEMU maintenance facilities will be additional burden to the system.
- Processing time of even this simple proposal is same with Railways. Formal proposal has to be sent to Railway Board. Railway Board has to approve the proposal and place order for MEMU/DEMUs.

Therefore, the above cited simple proposal is not recommended. Instead, considering the procurement time of DEMU/MEMUs as 2 years, it is felt appropriate and wise to make use of this 2 years time to increase the inherent capacity of the rail system to introduce more services at the end of 2 years and to cater for more commuter demand on continuous and sustainable basis.

Accordingly, different measures are suggested in different phases in subsequent paragraphs.

9.2 Phase 1

- This phase is framed such that:
- Implementing the phase does not pose major technical challenges.
- This phase is recommended again in sub phases 1A and 1B so that they can be taken up depending on the funds availability. If funds position permit, both phase 1A and 1B can be started simultaneously.

9.2.1 Phase 1A

- SBC, the main hub of the city should be provided with 2 additional platforms exclusively for dealing commuter trains. These additional platforms should be constructed in place of existing pit lines duly shifting the pit lines to Binny Mills land area.
- Presently 28 pairs of trains are serving Bangalore commuters. They are being run with 7 to 21 coaches (average 10.5 coaches). Out of these, 78% coaches are normal passenger coaches and 22% are DEMU/MEMU coaches. If all these rakes are replaced by 15 car EMU rakes, capacity increase in terms of coaches alone is 43%. If capacity of EMU coach is taken as about 50% more than normal passenger coach, total capacity increase shall be up to almost 100%.
- These EMU rakes can be run more or less in the same paths being run now. Therefore, sectional capacity constraints of S W Railway are not violated this way. However, time table need to be redrawn a little because some of the present passenger trains serving commuters are travelling even beyond CRS area.
- In fact, turnaround of EMUs is faster compared to passenger rakes as no engine reversals are required and acceleration/deceleration are high. This creates additional capacity in the sections and terminals and thus few more additional paths get generated and few more services can be run.
- However, this strategy has to address the following issues:
    - Presently no facilities exist for EMU rakes maintenance in SBC area. EMU services cannot be introduced unless EMU shed is developed. As brought out in this report, this shed is recommended to be developed near Yelahanka. EMU shed should be planned for about 60 rakes of 24 cars each. However, in this phase, facilities for maintaining 15 rakes (of 15 cars each) shall be developed.
    - EMU rakes (15 rakes) need to be procured for replacing the existing services as well as to run some additional services.

- Additional platforms are to be constructed at SBC to handle EMUs. Pit lines need to be constructed in Binny Mill land of SBC yard and in BYPL and to enhance terminal capacities. Pit lines at BYPL should fit into overall scheme of developing BYPL as full-fledged 3rd coaching terminal. Pit lines at Binny Mills land should fit into overall scheme of complete remodelling of SBC yard with about 15 or 16 platforms with all lines universal R&D facilities etc. With these pit lines, maintenance in SBC shall be offloaded to some extent and it shall be in a position to handle more commuter trains.
- Along with providing pit lines in Binny Mills Land, give entry from all lines of SBC to MYS side (SBC remodelling – phase 1A). This facilitates movement of more trains to Mysore end and to terminate trains (which do not need any pit line attention) at different stations of MYS section. This greatly relieves SBC and increases commuter capacity of SBC.
- Due to morning and evening rush of unidirectional traffic and due to meeting of lines from different directions at BYPL, and due to presence of SGT and diesel sheds at WFD and KJM area, trains movement from SBC to WFD is very critical. Also, some rakes need to be brought to pit lines at BYPL from SBC. After maintenance, they should be taken back to SBC. SBC – BYPL section is presently over saturated and cannot handle even one additional train. Therefore, twin single line arrangements from SBC to BNC and automatic signalling from BNC to WFD are to be provided so that SBC-BYPL section capacity is enhanced. In case automatic signalling is not possible due to gradient considerations etc., IB (intermittent block) signals should be provided in BNC-BYPL-KJM-WFD. If IB is also not feasible, twin single line from SBC-WFD should be introduced. If that is also not feasible, tripling should be done.

- Due to morning and evening rush of unidirectional traffic, commuter trains may not get paths in YPR-SBC section. This needs additional capacity in SBC-YPR. This block section is already provided with Twin Single Line arrangements. This section should be further provided with IB (Intermittent block) signals for both lines for both directions so that this section capacity almost doubles.
- Running EMUs need electrified sections. Therefore, non electrified sections (YPR-BYPL-HSRA , SBC-YPR-TK, YPR-YNK-CBP) need electrification. Commuter demand in these 3 sections constitutes 63% (36%, 15% and 12% respectively) of total CRS demand. With such a huge demand, these sections cannot serve commuters meaningfully without doubling and electrification. Therefore, doubling (except TK section as it is already double) and automatic signalling should be taken up simultaneously in these sections along with electrification. Also at every station one additional line should be constructed during doubling exclusively to deal commuter trains.
- For EMU rakes, no steps exist for passengers to entrain/detrain. PF floor level and EMU floor level are almost same. Therefore, platforms levels at all existing halts should be checked up and raised wherever required. PF lengths should not be a problem because already longer trains are stopping at these halts. However, PF lengths should also be checked and increased wherever required.
- Facilities at terminals i.e. BWT, MYA, TK, HSRA, DBY, CBP, YPR and YNK should be upgraded (like parking area, waiting area, platforms, FOBs etc.).
- This phase 1A is likely to enhance the capacity of commuter rail system to about 500000 trips from the present level of 180000 trips.

- SBC yard modifications need Binny Mills Land. If this phase is attempted without this land, capacity enhancement will be on lower than what is indicated above due to absence of dedicated platforms for commuter trains at SBC.

9.2.2 Time frame for phase 1A

- Apart from getting Binny Mill Land, EMUs procurement is the most long lead item and critical item of this phase. All other activities should be planned in such a way that their completion/commissioning is synchronised with these critical activities.
- ICF, BEML and 2 private players (Titagarh Wagons Ltd/Kolkata and Jessop & Co Ltd/Kolkata) make EMUs in India.
- Among all, ICF is the major player. Hyderabad MMTS and Mumbai MRVC got their EMUs from ICF.
- Through series of deliberations, MRVC and ICF improved so many features of EMUs. EMU design adopted for phase I project is further improved in their phase II project.
- ICF is likely to deliver present MRVC orders by 2015.
- If MRVC's latest design (stainless steel coaches with 3 Phase AC motors) is straight away adopted, Bangalore CRS can save lot of time.
- ICF has capacity of about 1500 coaches per annum which include all varieties i.e. EMUs, sleeper class coaches, guard coaches, AC coaches etc. Railway Board approves and conveys the annual production program (i.e. quantity of each type of coach to be manufactured within this 1500) to ICF.
- Once Railway Board approves the program, ICF can start delivering EMUs after about 8 to 12 months. Their supply rate shall be normally about 3 EMU rakes per month.
- Therefore, from the date of formal understanding between GoK and MOR, EMUs arrival to Bangalore is likely to take 2 years.
- All activities proposed in this phase can comfortably be completed in this 2 years (i.e. by the time EMUs arrive) provided Binny Mills Land issue is

sorted out and very tight scheduling and monitoring is done for various activities.

9.2.3 Phase 1B

- This phase need not be taken up after Phase 1A. If funds position permits, this phase can be taken up on simultaneously along with phase 1A.
- Once the phase 1A is implemented, commuter traffic starts picking up in all the sections. To take care of increased traffic, existing stations need upgradations like providing more waiting area, parking area, ticketing area, foot over bridges etc. Also, feeder road system to these stations should be improved.
- All other sections should be provided with double line and automatic signalling (WFD-BWT, YNK-DBU, YPR-BYPL and SDVL-NMGA). While doing so, additional line/platform should be provided at each of the stations to deal commuters.
- Fully develop Baiyyappanahalli (North) (BYPLN) third coaching terminal in place of the existing marshalling yard duly making use of the existing additional land. Coaching terminal at this location can have 5 platforms, 10 pit lines and 11 stabling lines/running lines along with facilities like shunting neck, signalled entry to all sides (SBC side, BYPL side, HEB side etc.). Once this is fully developed, number of long distance trains (20 to 30 trains) presently being terminated at SBC can be shifted and terminated at BYPLN. This gives substantial relief to SBC yard. Such a relief to SBC is a prerequisite to undertake major revamp of SBC yard (increasing number of platforms, providing universal reception and despatch facilities, increasing length of few lines etc.) which will increase the capacity of CRS phenomenally. Long distance passengers getting down at BYPLN can go to other parts of the city by the BYPL metro station. Presence of metro station nearby makes the BYPLN third coaching terminal an ideal location. In future, a skywalk can also be planned to connect metro station and BYPLN coaching terminal.

- Some more enhancements should be done to SBC yard (phase 1B).
- To run additional services, additional EMUs (9 rakes) should be procured and EMU maintenance facilities at YNK should also be enhanced to maintain these additional rakes.
- Phase 1B is likely to enhance the capacity of commuter system to about 10 lakh trips per day.
- Time frame for this phase is: 2 Years provided very close follow up is done.

9.3 Phase 2

9.3.1 Activities under this phase

- Complete the SBC yard remodelling. After remodelling, SBC should have:
  - A few pit lines etc. in Binny Mills Land.
  - Entry to MYS side from all the lines.
  - Universal reception and despatch facilities to almost all lines.
  - About 15 platforms in place of present 10 platforms.
  - Full length shunting necks and stabling lines and pit lines (if any).
  - Solid State Interlocking.
  - Increased platforms length.
  - Improved passenger facilities like shelters, train information boards, toilets, waiting area etc.
- Construct 3 flyovers at BYPL area (connecting SBC-HSRA, BWT-YNK, BWT-HEB) and 1 flyover at YPR (connecting HEB/YPR side to TK side).
- Construct bypass line at YNK connecting DBU line and CBP line.
- These measures phenomenally enhance the capacity of all the sections.
- To make use of the enhanced capacity, develop additional halts on CRS to serve more and more public.
- To run additional services, additional EMUs (15 rakes) should be procured and EMU maintenance facilities at YNK should also be enhanced.

- After this phase, capacity is likely to get enhanced to more than 25 lakhs trips per day.
- Time frame for this phase: 3 Years.

9.3.2 Scenario at the end of phase 2

After implementing phases 1A, 1B and 2 i.e. by about 2021, CRS capacity will be more than 25 lakhs trips per day. (This capacity can be substantially increased further by simply increasing length of each rake and procuring additional rakes and lengthening the platforms). By that time, total load on Bangalore public transport system shall be about 60 lakh trips. Thus CRS shall cater for at least 40% of public transport needs of the city which is a very healthy indication for any urban/suburban transport system.

9.4 Costs of Phase 1 and 2

The above cited measures under each phase are estimated to cost:

Table: 9.1 Costs of phase 1 & 2

Phase wise Costs in Crores of Rupees			
1A	1B	2	Total
3433	2363	2550	8346
Block Cost Estimates at Annexure-6 Rakes Requirement estimate at Annexure-7			

9.5 Phase 3

9.5.1 Extension of activity

Once the above phases are completed, to increase the capacity of the system further, it will be required to remove final bottlenecks. Also it is required to extend the CRS to new geographical areas. Activities suggested in this phase:

a. Chikbanavar – Satyamanagalam new line construction is in progress now. Commuter Rail services should be extended in this direction for about 70 Km or so. This line is in Bangalore (urban) district and population density is heavy. Probably, this section needs doubling to introduce meaningful commuter services.

b. Restoration of abandoned line in Baiyyappanahalli – Vimanpura area and introducing commuter services in that.
c. Constructing a line to facilitate direct entry of train from YNK to HEB without touching YPR (bypass at LOGH).
d. Introducing longer EMUs (up to 27 car EMUs) and fast (limited halts) services.
e. Quadrupling / Tripling of SBC-WFD, BYPL-HSRA, SBC-TK, SBC-MYS and other sections (in the same order).
f. Elimination of all Level Crossings with ROBs/RUBs in CRS area.
g. Skywalk connecting Baiyyappanahalli North 3rd coaching terminal to Baiyyappanahalli Metro Station.
h. 4th Coaching Terminal at Hejjala in SBC-MYS section.
i. Presently, SGT (Satellite goods terminal) near Whitefield is handling all freight terminal activities. In the first 2 phases, all the enhancements are suggested without tinkering with freight operations. After phase 2, probably the freight terminals may need to be relocated to enhance the CRS capacity further. Or additional freight terminals need to be developed in different directions (MYS side, TK side and DBU side) so that freight trains need not enter into whitefield area unnecessarily and eating away commuter capacity.
j. Extension of rail services to new areas or extending CRS to some more length on existing rail network i.e. beyond HSRA, TK, and MYA etc.
k. Ring Rail around the city to cover greater public (One at 40 Km radius and another at 60-70 Km radius from SBC) is to be developed.
l. Construction of Air Link Rail.

9.5.2 Cost Estimates and Time frame for Phase 3

Activities under Phase 3 are proposed as a natural extension of CRS capacity on a continues basis. Attempting to workout time frame or estimates of these activities at this stage is considered too early and hence not assessed in this report.

9.6 Care need to be exercised by S W Railway

Planning capacity enhancement is a continues activity on the Railway. While planning so, care need to be taken to fit the activities into the overall long term scheme of SBC, YPR, YNK and BYPLN etc. Especially at SBC, activities like extension of existing pit lines etc. should not be attempted as they will bring down capacity of SBC. Also, the land available at Hejjala should be strategically earmarked for capacity building (developing 4th coaching terminal) and not to be used for activities like building construction.

10 Return on Investment

10.1 Financial Rate of Return

Rate of return depends on the demand and pricing. For a commuter rail project, especially for a system like Bangalore, demand is not an issue. Demand is normally much more than the project can offer. But, the pricing is very tricky. Any business model adopts scientific pricing model like demand-supply model (price is fixed such that demand equals to supply) or cost plus profit model. As is well known, Commuter train fares are not decided based on any of these scientific methods. Fares are decided based on popular considerations without concerning about the costs incurred to produce the service. Therefore, it is too much of an optimism to think in terms of recovery of capital costs or even running costs from a commuter project.

In this context, costs and returns scenario of Indian Railways is worth looking at. Indian Railways accounting system is not in the form of a typical profit and loss statement which normally any corporate entity maintains. It is in the form of various indices and comparisons to previous years. Most of the assets (Track, Signals, Locomotives, and Stations etc.) are used for all trains i.e. commuter trains, long distance trains, freight trains etc. Therefore, it is practically not possible to bifurcate various O & M costs into different categories. However, certain parameters of Indian Railways are given below to give an idea of Indian Railways financial returns.

Table: 10.1 Indian Railways earnings per vehicle Km

Segment	Vehicle Km (in Millions)	Earnings (in Crores of Rupees)	Earnings (Rupees per Vehicle Km)
Sub-Urban Passenger Service (EMUs only)	1438.50	1792.59	12.46
Other Passenger Service	18207.00	24000.04	13.18
Freight Service	17749.00	62844.72	35.41
All together	37394.50	88637.35	23.70
Source: Indian Railways Year Book 2010-11			

Truly speaking, costs incurred by IR for one vehicle Km of freight and passenger service are not same. As detailed data is not maintained by Indian Railways, for the purpose of broad discussion, it is assumed that both are same. From the above table, it can be seen that the earnings (per vehicle km) from passenger service is much lower than freight earnings. Even in passenger segment, earnings of sub-urban service are much lower than other passenger earnings on vehicle Km basis.

Indian Railways operating Ratio is 94.59% (*Source: Indian Railways Year Book 2010-11*). That means, IR spends 94.59% of its revenues for operations and maintenance (O&M) leaving about 5% operating surplus. This is again a notional figure and does not truly reflect the real operating ratio. Expenditure is normally limited to the budget allotment and does not really reflect real requirement of expenditure. Therefore, it cannot be taken for granted that operating ratio is less than 100%.

This operating ratio is for total services i.e. freight as well as passenger service. As can be seen from above, passenger earnings per vehicle Km is far less than freight earnings per vehicle Km. Thus, operating ratio of IR passenger service (more so in case of commuter passenger service) shall be much more than 100%.

In the absence of detailed account available, O&M costs are broadly analysed as under:

Table: 10.2 Indian Railways O & M Profit/Loss

Earnings per vehicle Km (overall)	Rs 23.70
Expenditure per vehicle Km (taking operating ratio as 94.59%	Rs 22.42
Earnings per Vehicle Km for EMU	Rs 12.46
Operating Loss per Vehicle Km (EMU)	Rs 9.96
Operating Loss of EMUs in percentage	44.4%

If interest on capital and depreciation of assets is also considered, the financial rate of return shall be a loss more than 60%.

10.2 Economic Rate of Return

Economic rate of return in terms of passenger carrying capacity created is as under:

Table: 10.3 Economic rate of return in terms of passenger carrying capacity

Phase	Investment (in Crores of Rupees)	No of commuter trips that can be generated per day (Cumulative)
0	0	185000
1A	3433	550000
1B	2363	1000000
2	2550	1700000

Each commuter trip contributes:

- Savings in journey time because rail is going to capture the traffic which is presently being served by bus or private transport etc.
- Reduction in fuel consumption (trains are more fuel efficient than busses).
- Reduction in pollution of atmosphere (Electrical trains emit no smoke into atmosphere).
- Extra comfort to commuters.

Established modelling techniques can be used to quantify each of these benefits in terms of rupees to work out economic rate of return. Such modelling exercise is normally done when the financial appraisal of the proposal need to be submitted to lending agencies.

10.3 Surcharge

Indian Railways or Government of Karnataka may like to impose some surcharge on commuter tickets to recover part of the costs and to keep the CRS expansion on. Amounts that can accrue by way of surcharge is assessed as under:

Table: 10.4 Assessment of Surcharge Accruals

Phase	Investment (in Crores of Rupees)	No of commuter trips that can be generated	Surcharge that can accrue per annum (for about 30 years) (in Crores of Rupees)
0	0	185000	0
1A	3433	550000	32
1B	2353	1000000	58
2	2500	1700000	99
Normally for shorter trip lengths, surcharge is not levied. On weekends, commuter trips will be less. Also, surcharge on season tickets shall be much less than normal ticket. Therefore, per annum surcharge accrual is worked out as 80% of 365 days surcharge.			

For a lead of about 25 Km, present IR fare is Rs 7/-. Considering surcharge of about 25%, surcharge of Rs 2/- per ticket is assumed.

11 Financing & Implementation Plan

11.1 Financing by Indian Railways – The Traditional Model

All Railway projects (new or enhancement to existing assets) are traditionally financed by Indian Railways themselves. Through this traditional model of financing, growth of IR network since independence is:

Table: 11.1 Growth of Indian Railway Network

Year	Route Km in India	Track Km in India[@]
1950[#]	53596	77609
2010[$]	64460	113994
Average Annual Growth Rate	0.31%	0.64%

[#]Source: Indian Railways Year Book 2002-03
[$]Source: Indian Railways Year Book 2010-11
[@] Includes all track like double line track, station lines, sidings etc.

Route KMs indicate expansion of railway network to new geographical areas, Track KMs indicate the enhancement of facility like converting a single line into double line, making extra platform lines in a station etc.

From the above, we can reasonably assume that commuter rail system in Bangalore shall continue to grow at a rate of 0.64% per annum under this financing model which is nowhere nearer to the growth of demand (or growth of population). Hence this model of financing is not suggested. In fact, if this model of financing is to be adopted, probably this study by RITES is not warranted at all.

11.2 Hyderabad – MMTS model

Feasibility study was got done by GoAP to develop mass rapid transport plan for Hyderabad. This feasibility study and further follow up by Government of Andhra Pradesh (GoAP) led to signing of MOU between MOR and GoAP on 25th Sep '2000. The MOU was basically to develop commuter rail services on existing rail network in HYB/SC-Lingampalli (28.1 KM) and SC-Falaknuma (14.54 KM) sections. As per the MOU, Cost has to be shared at 50%-50% with

a provision for levy of at least 25% surcharge to be retained by IR. The costs were estimated as 69.96 Cr for infrastructure and 84 Cr for 20 MEMU rakes. Work was sanctioned by MOR in Oct '01 and work completed in Feb '04 at a cost of 98.75 Cr for up gradation and Rs 60.88 Cr for Rolling Stock. Patronage of MMTS phase-I is:

Table: 11.2 Patronage of Hyderabad MMTS

Description	Originating passengers per day [@]
Initially projected during project appraisal	336000
03-04	13104
04-05	25486
05-06	35770
11-12	Over 150000[#]

[@] *Source :* http://www.cag.gov.in/html/reports/railways/2007_6_peraud/chap_4.pdf
[#] *Source*: http://www.thehindu.com/news/cities/Hyderabad/article2981025.ece

Govt. of Andhra Pradesh mooted the proposals for Phase-II even when Phase-I was under execution. However, Railways decided (in 2006) that Phase-II would not be taken up until phase-I becomes financially viable. Finally Phase-II was sanctioned by Railways in 2012 with financing by GoAP (66.67%) and MOR (33.33%). MOR also proposed to set up a SPV for commercial management of MMTS leaving the O&M to IR for rapid growth of MMTS and to meet public aspirations. (Source: 12-13 budget speech of Hon'ble MR). While the South Central Railway started making all planning for execution, the SPV is yet to take shape. The scope of the project under MMTS phase-II is:

Table: 11.3 Projects under MMTS phase II

Section	Activity	Length (KM)	Estimate (Cr)
Falaknuma – Umdanagar	Doubling	20	85
New Line to Shamshabad Airport	New Line		
Telapur – Patancheru	Restoration of abandoned Line	9	32
Secunderabad – Bolaram	Electrification & Stations Remodelling	14	30
Sanatnagar – Maulali doubling	Doubling	22	170
Moula-Ali – Malkajgiri- Seethapalmandi	Doubling and Electrification	10	25
Bolaram – Medchal	Doubling and Electrification	28	74
Moula-Ali – Ghatkesar	Quadrupling	12	120

Section	Activity	Length (KM)	Estimate (Cr)
Passenger Amenities	Platforms, Station Buildings etc.		20
EMU Rakes	Rakes		85
	Total →	115	641
Expected Capacity : 3 Lakh Originating Passengers per day			
Source : http://www.thehindu.com/news/cities/Hyderabad/article2981025.ece, http://www.exclventures.com/News/Newslink-11324.asp and http://www.thehansindia.info/News/Article.asp?category=1&subCategory=2&ContentId=42711			

From MMTS-Hyderabad model, it is worth noting:

- In 2000-01 period, the then ruling party of AP was the most key ally of the then ruling party at the centre. Therefore, the project (Phase-I) got sanctioned and got executed expeditiously.
- Phase-I was basically making use of the potential available in certain sections of the existing IR network by minimal changes. The project includes provision of Automatic Signalling, electrification of missing patches, construction of platforms, station buildings etc., procurement of EMU rakes and developing maintenance facilities for EMUs. No significant inputs were given to track. Bangalore has got no such spare capacity available in the existing network, therefore capacity enhancement need to be planned.
- As per MOU, state government shall provide land free of cost wherever required for development of stations and concerned facilities like roads etc.
- In phase-II, the major thrust is to enhance the capacity of already saturated sections by doublings, construction of new lines etc. Therefore, this phase-II takes more time for execution. Coupled with the financial crunch being faced by IR and GoAP and political uncertainty prevailing in the states and the centre, phase-II may take more time than expected.
- Sanction of phase-II took almost 9 years. AP mooted proposals in 2003 itself. But the project was sanctioned only in 2012 as the proposal goes through lengthy process of sanction which includes reference to Planning Commission also.

- In the first year of sanction i.e. 2012-13, Railway allotted about Rs 100 Cr budget for the phase-II project whereas Government of AP has not allotted any funds so far. In fact, first year of sanction normally goes for planning, survey, tendering etc. and not much budget grant will be spent. Success of this project depends on how Railway and GoAP allot the funds in subsequent years.
- Today, the finance crunch being faced by Railway is probably the worst ever. Therefore, GOI agreeing for cost sharing of Bangalore CRS (whether 33% or 25% or so) is anybody's guess.
- IR has to incur operating losses as commuter service is a loss making business (more details in "Return on Investments" chapter). IR should also plan additional resources specially the manpower recruitment and training to run additional services. With virtual ban prevalent in IR for addition of manpower, IR weighs many factors to sanction the commuter rail project for Bangalore, even if GoK comes forward to bear 100% costs.
- Except some review meetings especially at political level, there is practically no monitoring mechanism to decide the priorities of various activities and to ensure expeditious completion of the projects.
- While the system (phase-I) was expected to cater for more than 3 lacs passengers per day, patronage even today is about 1.6 lacs per day. This is mostly due to non-development of feeder roads to MMTS stations. There is no institutional mechanism to plan and monitor the development of feeder roads. The patronage has been increasing not because some additional facilities were created to the public (like feeder roads etc.). It is simply due to its low cost. Even without proper feeder roads, public is taking all pains to make use of this cheaper service.
- GoAP has virtually no say in the services being run. IR decides on their own the number of services, their direction, timings etc. IR is under no obligation to run certain number of services etc.

- Surcharge if at all levied, accrues to IR and not to GoAP as per the MOU (phase-I). Levy of surcharge (or otherwise) shall be mostly decided by IR themselves and GoAP does not have any say.
- Debt financing, exploitation of commercial space etc. do not form a part of the scheme.
- Once the identified projects are completed (like phase-I), to execute further enhancement projects (like phase-II) the whole process need to be virtually started afresh. There is no arrangement to undertake continues expansion/increase of network/infrastructure (or even services).

11.3 Mumbai – CIDCO Model

- CIDCO (City and Industrial Development Corporation of Maharashtra Ltd) was formed in Mar '1970 to plan and create environment-friendly, model urban settlements with full-fledged physical and social infrastructure to meet residential, commercial and industrial needs of population.
- In Nov '1986, MOU was entered by CIDCO with IR for provision of rail connectivity to Navi Mumbai.
- Cost of the construction of railway line, station buildings, commercial area etc. was shared between CIDCO (67%) and IR (33%).
- Rolling Stock was provided by IR.
- Ownership of the land and line remains with IR.
- O & M is IR's responsibility. O & M costs are borne by IR. Operational losses are also borne by IR. However, non-operational maintenance costs are to be borne by CIDCO.
- IR levied surcharge of Re 1/- per ticket and the same was transferred to CIDCO.
- CIDCO had the right to commercialize the air space and other parts of the station area.
- Under this model, The Mankhurd to Belapur new line (27 Km) was commissioned in 1993.

- As a next phase, CIDCO and IR agreed in 1996 to construct Belapur – Seawoods – Uran line at a cost of Rs 494 Crores. However, this project is pending before High Court on environmental grounds.
- In essence, CIDCO model and Hyderabad MMTS model are more or less same except the share of the respective parties, provisions about commercial utilisation and bearing non-operational maintenance costs.

11.4 Mumbai - MRVC Model

MRVC came into existence in Jul '99 with equity of Rs 25 Cr (GOI: GOM = 51%: 49%). The corporation executes the identified projects and also plans development of Mumbai Suburban Rail System on a continuous basis. The mandate of the entity is:

- Integrate suburban rail capacity enhancement plans with urban development plan for Mumbai and propose investments.
- Implement rail infra projects in Mumbai.
- Commercially develop Railway land and airspace in Mumbai to raise funds for suburban railway development.
- Rehabilitation and Resettlement of project affected households.

Where direct involvement of running trains and signals is involved, works are entrusted by MRVC to IR for execution. Works like station buildings, circulating areas etc. which need not involve disturbance to train operations are executed by MRVC directly. Procurement of EMU rakes is also done by MRVC. Phase-I costs about Rs 4200 Cr. The funding mechanism:

- Budgetary Support from GoM and IR in the form of equity.
- Revenue from commercial development of railway land and air space.
- Borrowings to be decided by mutual consent of GoM and IR.
- Surcharge to be levied on commuters from a date to be mutually agreed by GoM and IR.

Phase-I is expected to increase the number of train services by 25% and vehicle KMs by 33%. Phase-I is almost completed now. MRVC planned for

further enhancing the capacity of sub-urban trains of Mumbai and rolled out plans for phase-II and III.

Works taken up in Phase-II are:

- Optimisation of existing network (Western Railway, Central Railway and Harbour Lines).
- Procurement of EMUs.
- Developing maintenance facilities and stabling lines for EMUs.
- AC to DC conversion of certain sections.
- Quadrupling and 5^{th} & 6^{th} lines in certain sections.
- Rehabilitation of affected households.

11.5 Recommendations and Suggestions

1. Rail system undisputedly needs to be an integral part of any urban commuter system like Bangalore.
2. Therefore, it needs continues implementation (not one project implementation) mechanism for up gradations and enhancements to keep in pace with ever growing transport needs of the public.
3. Therefore, an arrangement like MRVC is ideal to roll out plans continuously to integrate rail system with commuter system.
4. Process of bringing BCRC (Bangalore Commuter Rail Corporation) into existence involves:
    a. Identifying and freezing the list of projects that should form initial mandate of BCRC.
    b. Doing techno-economic survey of these projects. This stage involves preliminary field survey and making preliminary technical specifications of the project and making preliminary estimate.
    c. Drafting the constitution and structure of SPV, its scope, role of different constituents of SPV, equity share holding etc.
    d. Making out a formal proposal to GOI.
    e. Holding series of meetings with GOI until the SPV becomes reality.

5. The above process is a long drawn process. Making a formal proposal itself may take a year or so. Therefore, a very optimistic assessment of the time frame to realize the SPV is about 2 years. Thereafter, execution of the identified projects takes few more years.
6. Therefore, to derive early service to the public and expedite the entire process, an interim measure as under is suggested.
    a. Identify certain projects which can be taken up immediately and which can give immediate benefit to the public. These projects should be a subset of the whole scheme.
    b. These projects should be 100% financed by GoK.
    c. Make out a formal proposal accordingly to GOI.
    d. GOI should not have any reservations on accepting this proposal in principle. However, GOI may refer the proposal to South Western Railway for their comments and remarks. GOI may at the most think about O&M because IR only should bear the O&M costs and operating losses. Also, they have to plan for additional manpower recruitment and training. Considering the public cause involved and considering the just marginal increase in operating costs on all India basis, agreeing for the proposal in principle by IR is not considered a major issue.
    e. Proposal of GOK should also have some provisions for:
        - Provisions for some assured number of commuter services. Services proposed at the end of each phase are given in Demand Supply Assessment Chapter.
        - Time frame for commissioning the projects.
        - Features desired for EMUs like good interiors, GPS based information system, AC EMUs etc.
        - Levy of surcharge for about 30 years and review of surcharge by GoK and transferring it to GoK (or its entity).

    These issues shall form a part of discussion and negotiations with GOI.

f. Projects under phae-1A and 1B can be executed under this model.

If GoK approaches GOI with a simple proposal without details like preliminary survey report, preliminary estimates or without draft constitution of SPV etc., GOI refers the projects to S W Railway for survey and appoints a committee to design a SPV. This phase itself takes lot of time. To cut short such time, it is recommended to carry out preliminary survey and draft SPV before approaching GOI. However, while undertaking preliminary survey, S W Railway should be taken into confidence and Ministry of Railways also should be kept formally informed.

11.6 Special Purpose Vehicle

As brought out in earlier, constituting a SPV (in the lines of MRVC) is essential to effectively integrate rail network into Bangalore commuting system and effectively address the commuting challenges. A brief basic frame work to build the BCRC (Bangalore Commuter Rail Corporation) is discussed here.

11.6.1 Debt and Equity

Initially the equity shall need to be in the order of about 2000 Cr (considering the cost of projects identified initially as about 8000 Cr). Equity share holders should be basically Government of India and Government of Karnataka. It can be 50% - 50% equity share holding or 51% (GOI): 49% (GOK) like in the case of MRVC.

Equity can be provided either directly by the government or through their entities like IDD or K-RIDE or so. Normally no infrastructure project can take off purely with equity. Some debt component is a must for the success of the entity. However, debt component should be such that debt servicing can be met from operating surplus. If this aspect is not given due consideration, interest on debt itself becomes a big operating expense. In KRCL (Konkan Railway Corporation Ltd), the debt component was so high that the interest burden itself was making the organisation running into operating losses.

Ultimately, GOI had to enhance its equity to avoid KRCL going into red. Then KRCL started showing operating profits.

MRVC projects are financed by World Bank Loans. Namma Metro is financed by loans from financial institutions. Similarly, BCRC also shall have provision to get loans from various National and International financial institutions.

Private Equity can be attracted only in case of viable projects. Therefore, commuter rail business per se does not attract private equity. Therefore, some options that need to be explored to attract private equity:

- Provide alternate income sources like real estate exploitation etc. (apart from commuter fares) to investors.
- Provide VGF (Viability Gap Funding) by BCRC.
- Design and evolve standalone projects with different fare structure (different from IR fare structure) so that private equities can flow into these projects.

11.6.2 Stake Holders

Officials need to be on the Board of the SPV:

- Principal Secretary (Infra) / GoK.
- Other officials from Government of Karnataka (through IDD or K-RIDE).
- General Manager / South Western Railway.
- Divisional Railway Manager / Bangalore Division / South Western Railway.
- Nominee of Bangalore Metro Transport Corporation.
- Nominee of Bangalore Metro Rail Corporation.

Apart from above cited independent directors, BCRC shall also have full time functional directors (of course a MD) as under:

- Director (Planning): To continuously interact with various stake holders and roll out new projects and get them approved by GoK and GOI.
- Director (Projects): To execute the works directly or get them executed by S W Railway or by some state agency as the case may be. He is responsible for Railway projects as well as feeder road projects, ROB/RUBs etc. so that CRS stations get well connected by Road.
- Director (Finance).

11.6.3 Projects Identification and Sanction

- Projects initially mandated to BCRC are already discussed in this report.
- Projects identification should be a continues process. Processing each phase of the project is very long lead item. Its lead can be as big as execution. If phase-I takes 3 years for completion, by the time phase-I is completed, proposals should be ready along with financial closure for phase-II. BCRC should have exclusive planning wing to identify projects and process them until they are ready for execution.
- BCRC should have final say in rolling out new projects. The projects shall be proposed keeping in view the total transport plan of the city. Projects proposed by BCRC shall be formally approved by IR and GoK. This will also help IR to plan the necessary arrangements for O & M of such projects (for manpower recruitment, training etc.).

11.6.4 Execution of the Projects and O&M

- BCRC shall be Chief Project Manager i.e. it is project implementing agency responsible and accountable for satisfactory completion of its projects. It is responsible for arranging finances also to the projects.
- BCRC shall divide each project into logical and meaningful packages. Packages which directly affect running trains, track and

signalling systems shall be handed over to South Western Railway for execution. Feeder road projects can be entrusted to state government agencies. Packages which can be executed free of running trains/track etc. can be executed by BCRC itself. To this extent, BCRC should have competent engineering team to execute the projects. Dependence purely on Indian Railways is not recommended to have flexibility of execution in the long run.

- Specially works like road connectivity for CRS stations should be planned and executed by BCRC itself.
- All assets created shall be handed over to Indian Railways for O & M. O & M costs and O & M profits / losses shall be borne by IR.
- However, flexibility to decide O & M of green field projects should be retained with BCRC.

11.6.5 Fare Structure and Sharing of Revenues

- Working out O&M costs by IR is easier said than done. IR's accounting system does not facilitate bifurcation of O&M costs into various heads like freight, commuter rail, long distance trains etc. Moreover, IR takes entire South Western Railway as one unit (not even Bangalore Division) while working out O&M costs. Then working out O&M costs for commuter rail that too only for Bangalore area alone is very complex and not feasible with IR's accounting system. Therefore, any model to share O&M costs (or profits/loss) is not practicable. Instead, simple surcharge model is easy to implement.
- Fare is decided by Ministry of Railways and BCRC shall not have any control over it.
- However, an option to impose surcharge on IR fare should be available with BCRC.
- There should also be a provision for revision of surcharge from time to time.

- The surcharge should totally accrue to BCRC. This shall be used to meet working expenses of the organisation and to part finance future projects.
- Concession period shall be about 33 years (i.e. surcharge shall accrue to BCRC for 33 years) from the date of commissioning of each project.
- Commercial publicity rights of stations and premises of existing IR stations shall continue to be with IR. Commercial publicity rights of new stations developed and commissioned by BCRC shall need to be with BCRC. Also commercial publicity rights in all EMU rakes shall also need to be with BCRC.

11.6.6 Land and Air Space

- Available Railway land shall be used for commuter rail projects and the same shall continue to be Indian Railways' property. Also, land belonging to GoK if required for the projects shall also be handed over to Railways free of cost.
- Private Land if required for commuter rail projects shall be acquired by BCRC. However, as the assets will be ultimately handed over to IR for maintenance, land acquired also shall be handed over to IR and the same shall be Indian Railway's property.
- Vacant Railway land and vacant GoK's lands along the commuter lines shall be given on nominal lease to BCRC. BCRC shall have rights to exploit the land to get some revenue.
- Even vacant air space (of IR as well as GoK) available along commuter lines shall be given on nominal lease charges to BCRC for commercial exploitation.
- In case of standalone new line constructions, the line along with the land shall be BCRC's property. It will only lease the line to IR for running trains with their coaches and locomotives.

12 Recommendations and Roadmap further

12.1 Summing up

A commuter should be able to travel a distance of about 70 Km (or even 100 Km) in about an hour so that areas like Hosur, Tumkur, Mandya, Bangarapet etc. get developed fast and pressure on main hub Bangalore shall be eased. Namma Metro, Mono Rail, High Speed Rail to BIAL, rejuvenated BMTC services etc. cannot really provide this type of solution. They only provide some relief in a limited extent to very highly urbanised Bangalore area. Commuter rail has got all wherewithals to effectively provide solution to this problem.

Any commuter transport plan (rather any transport plan) shall be incomplete, if it does not integrate rail system into it apart from other modes.

In case of roadways, KSRTC's mandate is for long distance bus services. It cannot cater for commuter traffic. Another entity BMTC exists for this purpose. Similar way, IR cannot be expected to take care of the commuter rail services. Its mandate is long distance travel and not urban transport.

Therefore, to tap the full potential of Railway network and to effectively integrate rail network into commuter system of Bangalore, Government of Karnataka has to take the lead (rather, an extra lead). Structure of Indian Railways is very complex and it needs a great deal of time and energy to push through the issue.

CRS development is not a onetime activity. It is a continuous process. For metro rail, there is an entity BMRCL. For roads, there is BMTC. Similarly, for commuter rail, an exclusive entity BCRCL (Bangalore Commuter Rail Corporation Ltd) should come into existence. Then only CRS will get upgraded continuously in tune with demand.

An SPV coming into existence and start delivering services to the public is a long drawn process. Therefore, it is recommended that GoK should initiate 2 parallel actions simultaneously:

12.2 Action 1

Finance phase 1 (sub phases 1A and 1B) activities fully i.e. 100%. Make out a proposal to Ministry of Railways duly bringing out the scope of the projects along with abstract estimates, techno economic survey reports etc. While making the proposal, GoK should clearly indicate that certain number of additional services should be run on CRS network. Against this investment, GoK should not expect any further returns like share of revenues, say in fare policy, say in day to day O & M, ownership of newly created assets etc. Ownership of the newly created assets (though 100% financed by GoK) shall remain with Indian Railways.

This model is suggested just to get immediate consideration of the proposal by Ministry of Railways and get immediate relief to Bangalore commuter woes. Moreover, the investments required for this phase are virtually pittance compared to the GoK's investments in Metro Rail, Mono Rail, High Speed Rail to BAIL, BMTC etc. But the benefits are just immense.

12.3 Action 2

Propose an SPV and write to Ministry of Railways. The proposal should clearly bring out details like projects (Phase 2) to be taken up, their abstract estimates, techno economic survey reports of the projects, proposed equity, proposed share holding pattern, O & M arrangements, fare policy, revenue sharing policy, policy for commercialising air spaces, proposed structure of the SPV, arrangements to take up future projects etc.

Projects under phase 2 and 3 indicated in this report are to be taken up by the SPV.

Proposals under Action 1 are likely to get sanctioned by Indian Railways within about 3 to 6 months. SPV formation may likely to take shape in about 2 years' time, provided it is closely followed up.

Annexure: 1 Lie-Over at SBC yard

No	Rake Arrival				Rake Departure				Lie-Over	Maintenance Type	Engine needs Reversal?
	Train	Origin	Direction	Time	Train	Destination	Direction	Time			
1	12683	ERS	BYPL	4:20	12684	ERS	BYPL	17:15	12:55	N/A	Yes
2	22607	ERS	BYPL	4:20	22608	ERS	BYPL	17:15	12:55	N/A	Yes
3	12785	KCG	BYPL	6:25	12786	KCG	BYPL	18:20	11:55	N/A	Yes
4	12678	ERS	BYPL	19:50	12677	SBC	BYPL	6:15	10:25	N/A	Yes
5	16322	TVC	BYPL	8:35	16321	TVC	BYPL	18:50	10:15	N/A	Yes
6	16316	KCVL	BYPL	8:35	16315	KCVL	BYPL	17:15	8:40	N/A	Yes
7	16215	MYS	MYS	9:40	16216	MYS	MYS	18:15	8:35	N/A	Yes
8	56242	YPR	YPR	10:45	56227	ASK	YPR	16:45	6:00	N/A	Yes
9	56228	ASK	YPR	11:20	56230	MYS	MYS	16:25	5:05	N/A	No
10	56229	MYS	MYS	12:10	56241	YPR	YPR	16:05	3:55	N/A	No
11	56263	MYS	MYS	4:00	56510	MKM	BYPL	7:00	3:00	N/A	No
12	12613	MYS	MYS	13:30	16201	SMET	YPR	16:30	3:00	N/A	No
13	16557	MYS	MYS	19:40	16592	UBL	BYPL	22:00	2:20	N/A	No
14	16591	UBL	BYPL	6:10	16558	MYS	MYS	8:15	2:05	N/A	No
15	18463	BBS	BYPL	12:05	18464	BBS	BYPL	14:00	1:55	N/A	Yes
16	56914	UBL	YPR	20:40	56911	UBL	YPR	22:15	1:35	N/A	Yes
17	16519	JTJ	BYPL	8:00	56262	AJJ	BYPL	9:20	1:20	N/A	Yes
18	56912	UBL	YPR	5:15	56913	UBL	YPR	6:30	1:15	N/A	Yes
19	12639	MAS	BYPL	13:20	12640	MAS	BYPL	14:30	1:10	N/A	Yes
20	16202	SMET	YPR	11:55	12725	DWR	YPR	13:00	1:05	N/A	Yes
21	56237	MYS	MYS	18:00	56238	MYS	MYS	19:00	1:00	N/A	Yes
22	12726	DWR	YPR	14:05	12614	MYS	MYS	15:00	0:55	N/A	No
23	56261	MAS	BYPL	18:45	16522	MKM	BYPL	19:35	0:50	N/A	Yes
24	16228	SMET	YPR	4:30	56233	MYS	MYS	5:15	0:45	N/A	No
25	17210	CCT	BYPL	12:35	17209	CCT	BYPL	13:20	0:45	N/A	Yes
26	56234	MYS	MYS	22:30	16227	SMET	YPR	23:15	0:45	N/A	No

No	Rake Arrival				Rake Departure				Lie-Over	Maintenance Type	Engine needs Reversal?
	Train	Origin	Direction	Time	Train	Destination	Direction	Time			
27	16222	MAS	BYPL	4:10	16222	MYS	MYS	4:50	0:40	N/A	No
28	56226	TK	YPR	17:40	56223	ASK	YPR	18:20	0:40	N/A	Yes
29	56222	TK	YPR	13:10	56225	TK	YPR	13:40	0:30	N/A	Yes
30	12692	SSPN	BYPL	22:30	1692	MAS	BYPL	23:00	0:30	N/A	Yes
31	22818	MYS	MYS	3:00	22818	HWH	BYPL	3:30	0:30	N/A	No
32	16209	AII	YPR	4:00	16209	MYS	MYS	4:30	0:30	N/A	No
33	12648	NZM	BYPL	1:00	12648	CBE	BYPL	1:30	0:30	N/A	Yes
34	16521	BWT	BYPL	23:25	56264	MYS	MYS	23:55	0:30	N/A	No
35	56509	MKM	BYPL	17:00	16520	JTJ	BYPL	17:30	0:30	N/A	Yes
36	11013	LTT	BYPL	21:50	11013	CBE	BYPL	22:15	0:25	N/A	Yes
37	16731	TN	BYPL	6:40	16731	MYS	MYS	7:00	0:20	N/A	No
38	22817	HWH	BYPL	1:40	22817	MYS	MYS	2:00	0:20	N/A	No
39	56214	TPTY	BYPL	7:10	56214	CMNR	MYS	7:30	0:20	N/A	No
40	56224	ASK	YPR	9:10	56232	MYS	MYS	9:30	0:20	N/A	No
41	11014	CBE	BYPL	15:05	11014	LTT	BYPL	15:25	0:20	N/A	Yes
42	16232	MYS	MYS	18:45	16232	NV	BYPL	19:05	0:20	N/A	No
43	16210	MYS	MYS	21:40	16210	AII	YPR	21:55	0:15	N/A	No
44	16221	MYS	MYS	23:30	16221	MAS	BYPL	23:45	0:15	N/A	No
45	22681	MYS	MYS	22:45	22681	MAS	BYPL	23:00	0:15	N/A	No
46	12691	MAS	BYPL	5:25	12691	SSPN	BYPL	5:40	0:15	N/A	Yes
47	12647	CBE	BYPL	23:00	12647	NZM	BYPL	23:15	0:15	N/A	Yes
48	56213	CMNR	MYS	20:15	56213	TPTY	BYPL	20:30	0:15	N/A	No
49	12975	MYS	MYS	12:55	12975	JP	BYPL	13:05	0:10	N/A	No
50	12976	JP	BYPL	12:55	12976	MYS	MYS	13:05	0:10	N/A	No
51	16559	MYS	MYS	16:50	16559	YPR	YPR	17:00	0:10	N/A	No
52	22682	MAS	BYPL	5:30	22682	MYS	MYS	5:40	0:10	N/A	No
53	56231	MYS	MYS	9:10	56221	TK	YPR	9:20	0:10	N/A	No
54	16231	MV	BYPL	5:50	16231	MYS	MYS	6:00	0:10	N/A	No

No	Rake Arrival				Rake Departure				Lie-Over	Maintenance Type	Engine needs Reversal?
	Train	Origin	Direction	Time	Train	Destination	Direction	Time			
55	12008	MYS	MYS	16:15	12008	MAS	BYPL	16:25	0:10	N/A	No
56	12007	MAS	BYPL	10:50	12007	MYS	MYS	11:00	0:10	N/A	No
57	16732	MYS	MYS	21:10	16732	TN	BYPL	21:20	0:10	N/A	No
58	16518	CAN	MYS	7:05	16518	YPR	YPR	7:10	0:05	N/A	No
59	17303	MYS	MYS	15:05	17303	YPR	YPR	15:10	0:05	N/A	No
60	12430	NZM	BYPL	6:40	12429	NDLS	YPR	20:20	13:40	Secondary	Yes
61	12577	DBGA	BYPL	20:50	12578	DBGA	BYPL	10:10	13:40	Secondary	Yes
62	12591	GKP	BYPL	4:50	12592	GKP	BYPL	16:50	12:00	Secondary	Yes
63	12510	GHY	BYPL	11:50	12509	GHY	BYPL	23:30	11:40	Secondary	Yes
64	16505	GIM/JU	YPR	4:00	16537	NCJ	BYPL	23:05	19:05	Primary	Yes
65	16507	GIM/JU	YPR	4:00	16506	GIM	YPR	21:55	17:55	Primary	Yes
66	16507	YPR	YPR	4:00	16508	JU	YPR	21:55	17:55	Primary	Yes
67	16593	NED	YPR	6:10	16594	NED	YPR	23:00	16:50	Primary	Yes
68	16525	CAPE	BYPL	6:55	16526	CAPE	BYPL	21:40	14:45	Primary	Yes
69	12657	MAS	BYPL	5:10	12627	NDLS	BYPL	19:20	14:10	Primary	Yes
70	12494	NZM	BYPL	6:40	12493	NZM	YPR	20:20	13:40	Primary	Yes
71	16590	KOP	YPR	7:35	16589	KOP	YPR	21:15	13:40	Primary	Yes
72	16501	YPR	YPR	4:50	16532	AII	YPR	17:20	12:30	Primary	Yes
73	12296	PNBE	BYPL	20:40	12295	PNBE	BYPL	9:00	12:20	Primary	Yes
74	56513	NCR	BYPL	19:00	56514	NCR	BYPL	7:15	12:15	Primary	Yes
75	12609	MAS	BYPL	20:05	12610	MAS	BYPL	8:00	11:55	Primary	Yes
76	56516	CTA	YPR	20:00	56515	CTA	YPR	7:50	11:50	Primary	Yes
77	16529	CSTM	BYPL	8:50	16530	CSTM	BYPL	20:10	11:20	Primary	Yes
78	16538	NCJ	BYPL	4:00	16502	ADI	YPR	13:30	9:30	Primary	Yes
79	12027	MAS	BYPL	22:30	12028	MAS	BYPL	6:00	9:30	Primary	Yes
80	56524	HUP	YPR	9:25	56523	HUP	YPR	18:40	9:15	Primary	Yes
81	12628	NDLS	BYPL	13:40	12658	MAS	BYPL	22:45	9:05	Primary	Yes
82	56507	MKM	BYPL	9:15	56508	MKM	BYPL	18:05	8:50	Primary	Yes

No	Rake Arrival				Rake Departure				Lie-Over	Maintenance Type	Engine needs Reversal?
	Train	Origin	Direction	Time	Train	Destination	Direction	Time			
83	12607	MAS	BYPL	21:35	12608	MAS	BYPL	6:30	8:45	Primary	Yes
84	12080	UBL	YPR	21:25	12079	UBL	YPR	6:00	8:35	Primary	Yes
85	56526	CBP	YPR	9:45	56525	CBP	YPR	18:00	8:15	Primary	Yes
86	76512	MKM	BYPL	10:30	76511	MKM	BYPL	12:20	1:50	Primary (Only on Sunday, Non Running Day)	No (DEMU/MEMU)
87	56910	HDT	YPR	5:15	56913	SBC	YPR	6:30	1:15	Primary (Only on Sunday, Non Running Day)	No (DEMU/MEMU)
88	56918	SMET	YPR	21:10	56909	UBL	YPR	22:15	1:05	Primary (Only on Sunday, Non Running Day)	No (DEMU/MEMU)
89	66531	BWT	BYPL	14:25	66532	BWT	BYPL	14:55	0:30	Primary (Only on Sunday, Non Running Day)	No (DEMU/MEMU)
90	76552	CBP	BYPL	18:00	76553	DPJ	BYPL	18:30	0:30	Primary (Only on Sunday, Non Running Day)	No (DEMU/MEMU)
91	76554	DPJ	BYPL	8:10	76551	CBP	BYPL	8:40	0:30	Primary (Only on Sunday, Non Running Day)	No (DEMU/MEMU)
92	66529	BWT	BYPL	9:30	66530	BWT	BYPL	9:50	0:20	Primary (Only on Sunday, Non Running Day)	No (DEMU/MEMU)

Annexure: 2 Criss-Cross movements that can be made seamless by Flyovers

No	Train No.	Origin	Destination	Time at BYPL	Direction of Train	Flyover No
1	12648	NZM	CBE	00:20:00	YNK-SBC	4
2	12648	NZM	CBD	01:42:00	SBC-HSRA	1
3	12778	KCVL	UBL	03:50:00	BWT-HEB	3
4	12835	THE	YPR	04:00:00	BWT-HEB	3
5	12889	TATA	YPR	04:10:00	BWT-HEB	3
6	12292	MAS	YPR	05:03:00	BWT-HEB	3
7	16591	UBL	SBC	05:46:00	YNK-SBC	4
8	12785	KCG	SBC	05:56:00	YNK-SBC	4
9	12863	HWH	YPR	06:18:00	BWT-HEB	3
10	12677	SBC	ERS	06:37:00	SBC-HSRA	1
11	16614	CBE	RJT	07:32:00	BWT-YNK	2
12	56514	SBC	SA	07:44:00	SBC-HSRA	1
13	12254	BGP	YPR	07:53:00	BWT-HEB	3
14	16529	CSTM	SBC	08:16:00	YNK-SBC	4
15	12845	BBS	YPR	09:37:00	BWT-HEB	3
16	15228	MFP	YPR	10:19:00	BWT-HEB	3
17	15902	DBGR	YPR	10:27:00	BWT-HEB	3
18	18642	BBS	SBC	11:23:00	YNK-SBC	4
19	12976	JP	MYS	12:23:00	YNK-SBC	4
20	12628	NDLS	SBC	12:56:00	YNK-SBC	4
21	12245	HWH	YPR	15:28:00	BWT-HEB	3

No	Train No.	Origin	Destination	Time at BYPL	Direction of Train	Flyover No
22	12540	LKO	YPR	15:44:00	BWT-HEB	3
23	22601	MAS	SNSI	16:04:00	BWT-YNK	2
24	76552	CBP	SBC	17:34:00	YNK-SBC	4
25	76553	SBC	DPJ	18:55:00	SBC-HSRA	1
26	16232	SBC	MV	19:33:00	SBC-HSRA	1
27	22618	TYTY	YPR	20:08:00	BWT-HEB	3
28	12544	TYTY	YPR	20:21:00	BWT-HEB	3
29	17311	MAS	VSG	20:40:00	BWT-HEB	3
30	11013	LTT	CBE	21:16:00	YNK-SBC	4
31	12692	SSPN	MAS	21:44:00	YNK-SBC	4
32	16332	TVC	CSTM	21:45:00	BWT-YNK	2
33	16732	MYS	TN	21:48:00	SBC-HSRA	1
34	11013	LTT	CBD	22:40:00	SBC-HSRA	1

Annexure: 3 Additional Halts suggested by voluntary organisations

S.No	Sector	Inter Distance		S.No	Sector	Inter Distance
1	Yesvantpur- Baiyyappanahalli			6	Yesvantpur – Tumkur	
	Yeshvantpur	0.00			Yeshvantpur	0.00
	Gokula Extension	4.10			HMT	3.20
	Lottegollahalli	1.40			Jalahalli West (Near Jalahalli Main Rd)	1.80
	RMV Extn (D Rajagopal Rd)	1.60			Chikbanavar	2.90
	Hebbal	1.30			Soldevanahalli	2.90
	Guddadahalli	1.10			Gollahalli	9.90
	Kanakanagar	1.30			Bhairanayakanhalli	6.60
	Nagavara Main rd	1.40			Dodbele	4.40
	Kadugondhalli	1.10			Muddalingahalli	6.90
	Banaswadi	1.30			Nidvanda	4.40
	Kamanahalli Rd (IOC Flyover)	1.00			Dobbspet	1.00
	Kasturinagar (near SAIL)	1.50			Hirehalli	8.50
	Benniganahalli	1.20			Kyatsandra	6.10
	Baiyyappanahalli				Vijaynagar (Siddaganga)	2.80
2	Baiyyappanahalli - Hosur				Tumkur	2.60
	Benniganahalli	0.00		7	Yesvantpur - Yelahanka	
	Kaggadasapura (near Railway Cross)	2.10			Yeshvantpur	0.00
	Karthik Nagar (east of ORR)	2.60			Gokula Extension	4.10
	Varthur Rd (Marathalli bridge)	1.80			Lottegollahalli	1.40
	Belandur Rd	2.50			Kodigehalli	1.60
	Karmelaram	3.30			Jakkur West (Allalasandra main rd)	1.60
	Sarjapur Rd (just past level crossing)	1.10			Yelahanka south (NH7 /Level crossing)	1.70

S.No	Sector	Inter Distance		S.No	Sector	Inter Distance
	Heelalige	10.90			Yelahanka Jn	2.00
	Anekal road	10.50		8	Baiyyappanahalli - Bangarapet	
	Hosur	13.40			Benniganahalli	0.00
3	Yelahanka– Chikballapur				KR Puram	1.60
	Yelahanka Jn	0.00			Hoodi (Main rd cross)	4.70
	Kenchanhalli East	2.20			Sadarmangal (Kodigehalli rd cross)	2.00
	MVIT /Ganganahalli	4.10			Whitefield	2.60
	Betthalsoor	2.10			Devangonthi	7.80
	Dodjala	4.30			Malur	12.20
	NH-7 /BIAL trumpet Interchange	3.70			Byatrayanahalli	8.80
	Devenahalli	7.10			Tyakal	6.00
	Avatihalli	6.80			Maralahalli	5.80
	Venkatagiri kote	3.00			Bangarapet Jn	6.20
	Nandi Hills	6.50		9	Yesvantpur – Bangalore City	
	Chikballapur south (SJCIT)	2.80			Yeshvantpur	0.00
	Chikballapur	3.60			Subramanyanagar (Milk colony)	1.70
4	Baiyyappanahalli- Yelahanka				Malleswaram	2.70
	Benniganahalli	0.00			Bangalore City	2.70
	Channasandra	2.20		10	Bangalore City - Mandya	
	Horamavu (near main rd)	1.80			Bangalore city	0.00
	Hennur	1.80			Binnypet (Bus stand)	2.30
	Bagalur rd cross	1.80			Chord Road	2.20
	Thanisandra	2.10			Nayandahalli	2.90
	Jakkur East	3.00			Jnana Bharati (BU)	1.40

S.No	Sector	Inter Distance
	Nehru Nagar (NH-7 Jn)	2.00
	Yelahanka Jn	1.40
5	Yelahanka – Dodballapur	
	Yelahanka Jn	0.00
	Kenchanhalli West	2.20
	Naganahalli	1.60
	Rajankunte	5.00
	Dodballapur Ind Area (middle)	8.30
	Dodballapur	3.20

S.No	Sector	Inter Distance
	Rajarajeshwari nagar (RVCE)	2.30
	Kengeri	1.20
	NICE Rd (Southwest)	1.80
	Kumbalgodu (Rajarajeswari Dentl /Engg)	4.10
	Hampapura (WonderLa)	3.20
	Hejjala	1.90
	Bidadi	6.40
	Ketohalli	8.30
	Ramanagaram	6.50
	Channapatna	6.90
	Settihalli H	6.12
	Nidaghatta H	5.23
	Maddur	9.06
	Hanakere	10.11
	Mandya	7.78

Annexure: 4 Trains presently serving Bangalore commuters

S.No	Train	Type	From	Departure	To	Arrival	Sectors passing through									
							MYA	YPR	TK	HEB (YP-YNK)	HEB (YNK-BYPL)	DBU	CBP	HSRA	BYPL	BWT
1	56213	Pass	CMNR	15:00	TPTY	05:35	Y								Y	Y
2	56214	Pass	TPTY	20:55	CMNR	12:50	Y								Y	Y
3	56221	Pass	SBC	09:20	TK	11:05		Y	Y							
4	56222	Pass	TK	11:20	SBC	13:10		Y	Y							
5	56223	Pass	SBC	18:20	ASK	22:45		Y	Y							
6	56224	Pass	ASK	05:00	SBC	09:10		Y	Y							
7	56225	Pass	SBC	13:40	TK	15:25		Y	Y							
8	56226	Pass	TK	15:50	SBC	17:40		Y	Y							
9	56227	Pass	SBC	16:45	SMET	23:55		Y	Y							
10	56228	Pass	SMET	04:00	SBC	11:20		Y	Y							
11	56229	Pass	MYS	08:20	SBC	12:10	Y									
12	56230	Pass	SBC	16:25	MYS	20:05	Y									
13	56231	Pass	MYS	05:50	SBC	09:10	Y									
14	56232	Pass	SBC	09:30	MYS	13:35	Y									
15	56233	Pass	SBC	05:15	MYS	08:55	Y									
16	56234	Pass	MYS	18:50	SBC	22:25	Y									
17	56237	Pass	MYS	14:25	SBC	18:00	Y									
18	56238	Pass	SBC	19:00	MYS	22:40	Y									
19	56241	Pass	SA	05:20	YPR	10:45					Y			Y		

S.No	Train	Type	From	Departure	To	Arrival	Sectors passing through									
							MYA	YPR	TK	HEB (YP-YNK)	HEB (YNK-BYPL)	DBU	CBP	HSRA	BYPL	BWT
20	56242	Pass	YPR	16:05	SA	21:25					Y			Y		
21	56261	Pass	AJJ	08:00	SBC	18:45									Y	Y
22	56262	Pass	SBC	09:20	AJJ	20:50									Y	Y
25	56503	Pass	YPR	08:00	BZA	05:40				Y		Y				
26	56504	Pass	BZA	20:50	YPR	17:10				Y		Y				
27	56507	Pass	MKM	06:20	SBC	09:15									Y	Y
28	56508	Pass	SBC	18:05	MKM	20:35									Y	Y
29	56509	Pass	MKM	14:00	SBC	17:00									Y	Y
30	56510	Pass	SBC	07:00	MKM	09:35									Y	Y
31	56513	Pass	SA	13:30	SBC	19:00								Y	Y	
32	56514	Pass	SBC	07:15	SA	12:50								Y	Y	
33	56515	Pass	SBC	07:50	UBL	20:20		Y	Y							
34	56516	Pass	UBL	07:15	SBC	20:00		Y	Y							
35	56523	Pass	SBC	18:40	HUP	21:35		Y		Y		Y				
36	56524	Pass	HUP	06:30	SBC	09:25		Y		Y		Y				
37	56525	Pass	SBC	18:00	CBP	19:50		Y		Y			Y			
38	56526	Pass	CBP	07:55	SBC	09:45		Y		Y			Y			
42	56913	Pass	SBC	06:30	UBL	17:45		Y	Y							
43	56914	Pass	UBL	09:45	SBC	21:10		Y	Y							
44	56917	Pass	SBC	06:30	SMET	13:15		Y	Y							
45	56918	Pass	SMET	13:50	SBC	21:10		Y	Y							

S.No	Train	Type	From	Departure	To	Arrival	Sectors passing through									
							MYA	YPR	TK	HEB (YP-YNK)	HEB (YNK-BYPL)	DBU	CBP	HSRA	BYPL	BWT
46	66529	MEMU	BWT	07:30	SBC	09:30									Y	Y
47	66530	MEMU	SBC	09:50	BWT	12:05									Y	Y
48	66531	MEMU	BWT	12:40	SBC	14:25									Y	Y
49	66532	MEMU	SBC	14:55	BWT	16:25									Y	Y
50	66533	MEMU	BWT	18:00	KJM	19:10										Y
51	66534	MEMU	KJM	19:30	BWT	20:40										
52	76505	DEMU	BNC	17:55	KQZ	20:20									Y	Y
53	76506	DEMU	KQZ	07:15	BNC	09:40									Y	Y
54	76507	DEMU	BNC	11:00	BWT	12:50									Y	Y
55	76508	DEMU	BWT	15:30	BNC	17:20									Y	Y
56	76511	DEMU	SBC	12:20	MKM	15:15									Y	Y
57	76512	DEMU	MKM	08:00	SBC	10:30									Y	
58	76551	DEMU	SBC	08:40	CBP	10:50							Y		Y	
59	76552	DEMU	CBP	15:55	SBC	18:00							Y		Y	
60	76553	DEMU	SBC	18:30	DPJ	21:40								Y	Y	
61	76554	DEMU	DPJ	05:00	SBC	08:10								Y	Y	
Total Services in each sector -->							10	18	14	6	2	4	4	6	24	18

Annexure: 5 Trains that can be replaced with DEMU/MEMU rakes

No	Train	Type	From	Departure	To	Arrival	DEMU	MEMU
1	56221	Pass	SBC	09:20	TK	11:05	Y	
2	56222	Pass	TK	11:20	SBC	13:10	Y	
3	56225	Pass	SBC	13:40	TK	15:25	Y	
4	56226	Pass	TK	15:50	SBC	17:40	Y	
5	56229	Pass	MYS	08:20	SBC	12:10		Y
6	56230	Pass	SBC	16:25	MYS	20:05		Y
7	56231	Pass	MYS	05:50	SBC	09:10		Y
8	56232	Pass	SBC	09:30	MYS	13:35		Y
9	56233	Pass	SBC	05:15	MYS	08:55		Y
10	56234	Pass	MYS	18:50	SBC	22:25	Y	
11	56237	Pass	MYS	14:25	SBC	18:00		Y
12	56238	Pass	SBC	19:00	MYS	22:40		Y
13	56507	Pass	MKM	06:20	SBC	09:15		Y
14	56508	Pass	SBC	18:05	MKM	20:35		Y
15	56509	Pass	MKM	14:00	SBC	17:00		Y
16	56510	Pass	SBC	07:00	MKM	09:35		Y
17	56523	Pass	SBC	18:40	HUP	21:35	Y	
18	56524	Pass	HUP	06:30	SBC	09:25	Y	
19	56525	Pass	SBC	18:00	CBP	19:50	Y	
20	56526	Pass	CBP	07:55	SBC	09:45	Y	
21	66529	MEMU	BWT	07:30	SBC	09:30		Y
22	66530	MEMU	SBC	09:50	BWT	12:05		Y
23	66531	MEMU	BWT	12:40	SBC	14:25		Y
24	66532	MEMU	SBC	14:55	BWT	16:25		Y

No	Train	Type	From	Departure	To	Arrival	DEMU	MEMU
25	66533	MEMU	BWT	18:00	KJM	19:10		Y
26	66534	MEMU	KJM	19:30	BWT	20:40		Y
27	76505	DEMU	BNC	17:55	KQZ	20:20	Y	
28	76506	DEMU	KQZ	07:15	BNC	09:40	Y	
29	76507	DEMU	BNC	11:00	BWT	12:50		Y
30	76508	DEMU	BWT	15:30	BNC	17:20		Y
31	76511	DEMU	SBC	12:20	MKM	15:15		Y
32	76512	DEMU	MKM	08:00	SBC	10:30	Y	
33	76551	DEMU	SBC	08:40	CBP	10:50	Y	
34	76552	DEMU	CBP	15:55	SBC	18:00	Y	
35	76553	DEMU	SBC	18:30	DPJ	21:40	Y	
36	76554	DEMU	DPJ	05:00	SBC	08:10	Y	
						Total	16	20

Annexure: 6 Phase wise Cost Estimates

Phase	No	Item	Nos	Unit	Rate (Cr)	Amount Cr)
1A	a	Construction of pit lines at Binny Mills Land area of SBC	4	Pit Lines	8	32
1A	b	Construction of pit lines at BYPLN (Baiyyappanahalli North)	4	Pit Lines	8	32
1A	c	EMU Maintenance shed for 15 rakes at YNK (Plan should be for 60 rakes of 24 cars. In this phase, facilities for 15 rakes of 15 cars should be developed)	1	Each Shed	200	200
1A	d	Procurement of EMU rakes	15	Each Rake	60	900
1A	e	SBC Yard Remodelling phase 1A (Provision of additional PFs, Entry to MYS side)	1	Each	60	60
1A	f	Changing SBC-BNC section into twin single line system	1	Each Block Section	12	12
1A	g	Automatic Block Signalling or IB signals or twin single line system in BNC-WFD	20	Km	1.5	30
1A	l	Introduction of IB for both lines in both directions of SBC-YPR twin single line section	1	Each	5	5
1A	h	Electrification and Automatic Signalling for SBC-YPR-TK	70	Km	2	140
1A	i	Doubling, Electrification and Automatic Signalling for YPR-BYPL-HSRA	70	Km	15	1050
1A	j	Doubling, Electrification and Automatic Signalling for YPR-YNK-CBP	48	Km	14	672

Phase	No	Item	Nos	Unit	Rate (Cr)	Amount Cr)
1A	k	Raising and/or lengthening of platforms at various stations	60	No of Stations	3	180
1A	l	Developing Terminals (BWT, MYA, TK, HSRA, DBU and CBP, YPR and YNK) by upgrading parking area, waiting area, FOBs, PFs etc.)	8	No of Stations	15	120
1B	a	Improvements to stations like providing waiting area, parking area, foot over bridges etc.	60	Each Station	10	600
1B	b	Automatic Block Signalling in WFD-BWT	50	Km	0.7	35
1B	c	YNK-DBU Doubling along with electrification and automatic signalling	22	Km	14	308
1B	d	YPR-BYPL Doubling along with electrification and automatic signalling	20	Km	14	280
1B	e	SDVL-NMGA Doubling along with electrification and automatic signalling	10	Km	14	140
1B	f	Developing new coaching terminal at Baiyyappanahalli West	1	Terminal	350	350
1B	g	SBC Yard Remodelling phase 1B	1	Each	60	60
1B	h	Procurement of EMU rakes	9	Each Rake	60	540
1B	i	Enhance the capacity of EMU shed at YNK	1	Each	50	50
2	a	SBC Yard Remodelling - Final phase	1	Each	250	250
2	b	Flyovers in BYPL area	3	Km	100	300
2	c	Flyover in YPR area	1	Km	100	100
2	d	Bye Pass Line at YNK (Connecting DBU and CBP lines)	25	Km	12	300
2	e	Developing additional halt stations	70	Each Halt Station	10	700

Phase	No	Item	Nos	Unit	Rate (Cr)	Amount Cr)
2	f	Procurement of EMU rakes	15	Each rake	60	900

Note : Cost of Binny Mills land is not included in these estimates

Phase wise Costs in Crores of Rupees			
1A	1B	2	Total
3433	2363	2550	8346

Annexure: 7 Rakes Requirement Estimate

S.No	Sector	From	To	Distance (Km)	No of Commuter Services				Train Km Required for phase		
					At Present	After phase 1A	After Phase 1B	After Phase 2	1A	1B	2
1	MYA	Bangalore	Mandya	92.88	10	20	24	30	1857.60	2229.12	2786.40
2	YPR	Bangalore	Yesvantpur	5.35	18	26	30	36	139.10	160.50	192.60
3	TK	Yesvantpur	Tumkur	64.00	14	22	28	34	1408.00	1792.00	2176.00
4	HEB	Yesvantpur	Yelahanka	12.45	6	10	12	16	124.50	149.40	199.20
5	HEB	Yelahanka	Baiyyappanahalli	19.23	2	6	20	34	115.38	384.60	653.82
6	HEB	Yesvantpur	Baiyyappanahalli	16.12	0	0	0	34	0.00	0.00	548.08
7	DBU	Yelahanka	Dodballapur	20.72	4	4	22	38	82.88	455.84	787.36
8	CBP	Yelahanka	Chikballapur	46.05	4	4	22	40	184.20	1013.10	1842.00
9	HSRA	Baiyyappanahalli	Hosur	48.59	6	14	34	82	680.26	1652.06	3984.38
10	BYPL	Bangalore	Baiyyappanahalli	12.00	24	28	30	36	336.00	360.00	432.00
11	BWT	Baiyyappanahalli	Bangarapet	58.21	18	22	26	30	1280.62	1513.46	1746.30
12	NMGA	Soldevanhalli	Nelamangala	10.00	0	0	20	50	0.00	200.00	500.00
			Total	405.60	106	156	268		6208.54	9910.08	15848.14
Rakes Required (@ 500km per day) -->									12.42	19.82	32.00
Add 20% for Maintenance buffer -->									2.48	3.96	6.40
Rakes Required-->									15	24	39

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