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NATIONAL CAPITAL REGION PLANNING BOARD PROJECT

*Medium Term Strategic Evolution and
Borrowers Assessment*

REPORT ON SUB PROJECTS

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TABLE OF CONTENTS

SECTION 1 and 2 – PATAUDI WATER SUPPLY AND SEWARAGE PROJECTS

SECTION 3 – DEVELOPMENT OF MULTI-MODEL TRANSIT CENTRE AT ANAND VIHAR, NCTD

SECTION 4 – DEVELOPMENT OF MULTI-MODEL TRANSIT CENTRE AT SARAI KELA KHAN, NCTD

SECTION 5 – BADLI BYPASS

SECTION 6 – CONSTRUCTION OF VARIOUS ROADS IN SONEPAT DISTRICT

SECTION 7 – REHABILITATION OF 13 ROADS IN JHAJJAR DISTRICT

SECTIONS 1&2

PATAUDI WATER SUPPLY PROJECT PATAUDI SEWERAGE PROJECT

A. PATAUDI WATER SUPPLY PROJECT – TECHNICAL ASSESSMENT

1. INTRODUCTION – WATER SUPPLY PROJECT

1. This section provides a feasibility assessment of the sub-project on 'Augmentation of water supply for Pataudi town' as proposed by the PWD – Public Health Engineering Department (PWD – PHED), Govt. of Haryana (GoH) and submitted to the National Capital Region Planning Board (NCRPB) for financing. The DPR for this sub-project was prepared by M/s Lahmeyer International (India) Pvt. Ltd. in April 2009 and submitted to the NCRPB for appraisal.

2. PROJECT BACKGROUND – WATER SUPPLY PROJECT

2. Pataudi is a small Tehsil town in the Gurgaon District with current (2009) estimated population of around 22,000 (16,085 as per Census 2001). It is located on the Gurgaon – Rewari road at a distance of 25 km from Gurgaon and about 58 km from Delhi. Because of its proximity to the rapidly growing city of Gurgaon, being a part of the NCR, having good connectivity with other towns in the region, and expected growth on account of the upcoming special economic zone (SEZ), it assumes significance as an affordable option for absorbing future urban growth. In recognition of this potential of the town, the Government of Haryana has identified Pataudi for strengthening of, among others, water supply and wastewater management infrastructure and thereby to offer improved quality of life to the existing and prospective residents. Location of the town is shown in Figure 1.1
3. Besides the entire population of Pataudi, the project envisage coverage of another adjoining town of Haily Mandi and seven villages which fall en route the rising main. The total population for which the system has been designed is 1,12,380 which corresponds to year 2040 and a design period of 30 years. The system has been designed considering service levels of 135 litres/capita/day (lpcd) for the urban population and 70 lpcd for the rural population.
4. The present water supply systems for the towns of Pataudi and Hailey Mandi are entirely based on groundwater, which in recent years have been experiencing declining yields and deteriorating water quality. As per the available records of pumping stations, the average service level in Pataudi is determined to be 59 lpcd, which is as low as 43% of the prescribed level of 135 lpcd as per the Regional Plan-2021.

Figure 1.1: Location Map Of The Sub-Project Area



5. In this context, the sub-project has been proposed by the PWD – PHED, GoH with the objectives to:
 - (b) Improve infrastructural facilities and help create durable assets and quality oriented services in the identified towns.
 - (c) Provide potable water supply at the prescribed service level.
 - (d) Reduce or eliminate dependence on groundwater, and
 - (e) Introduce an effective water supply management system at the level of small towns.
6. The new system will draw raw water from the Gurgaon Canal which is part of the Western Yamuna Canal System and carries copious flows round the year. The system is designed for gross demand of 16.3 mld at the distribution end corresponding to the intermediate year of 2025 while the intake works and transmission system are designed for the gross demand of 19.3 mld corresponding to the ultimate design year of 2040 respectively. The total project cost is estimated to be Rs. 74.06 Crore (04/2009).

3. SITUATION ANALYSIS – WATER SUPPLY PROJECT

7. This section provides a detailed description of the existing situation and lays the basis for development of the sub-project for augmentation of water supply to Pataudi and Hailey Mandi and the adjoining 7 villages.

Population Growth Pattern and Projections

8. Over the last four census decades the two towns of Pataudi and Hailey Mandi have grown from average size villages to small towns with 2001 population of 16,085 and 17,081 respectively. The census data over this period reveals average compounded annual growth rates (CAGR) of 3.7% and 6.6% respectively. While the growth of Pataudi has been uniform, it is noted that Hailey Mandi recorded

unprecedented growth at a CAGR of over 16% during the 1971-81 decade, which subsequently declined to modest levels of around 2.7%.

9. Population projections have been made as per the 'declining growth rate' method evolved by the PWD-PHED which has considered an initial CAGR of 4% for the 9 year period of 2001-2010, followed by 2.7% and 1.2% for the subsequent two phases of 15 years each. The method assumes that the small towns can not continue to grow at historically determined rates along geometrical progression but will follow declining growth rates. Accordingly the populations estimates for the intermediate and ultimate design years have been made.

Table 1.1: Population Growth Pattern And Projections

Year	Pataudi		Hailey Mandi		Remarks
	Population	CAGR	Population	CAGR	
1961	3,788		1,340		
1971	6,045	4.8	2,252	5.3	
1981	8,422	3.4	10,140	16.2	Unprecedented growth recorded at Hailey Mandi
1991	11,278	3.0	13,263	2.7	
2001	16,085	3.6	17,081	2.6	3.7% and 6.6% of preceding 4 decades
2010	22,894	4.0	24,312	4.0	CAGR assumed @ 4%
2011	23,521	2.7	24,978	2.7	
2021	30,822	2.7	32,730	2.7	
2025	34,341	2.7	36,467	2.7	50% increase over 2010
2031	36,939	1.2	39,226	1.2	
2040	41,209	1.2	43,761	1.2	80% increase over 2010

10. In the case of the seven villages which are proposed to be included in the sub-project and which had a combined population of around 14,600 in census year 2001, the departmental approach adopts lower CAGRs of 2.5% for the first nine year period of 2001-2010, followed by 1.76% and 0.96% respectively for the subsequent two phases of 15 years each. As per this, the rural population is projected to go up to 23,755 by 2025 and to 27,400 by 2040. The design of the sub-project, is based on intermediate stage population of 94,500 and the ultimate stage population is 1,12,400 respectively.

Table 1.2 Population Projections For The Rural Areas

Village	Census year 2001	Base year 2010	Intermediate stage 2025	Ultimate stage 2040	Remarks
Jund Sarai	1,570	1,961	2,549	2,942	CAGRs '01-'10 : 2.5%; '10-'25 : 1.76%; '25-'40 : 0.96%
Babra Bakipur	1,445	1,805	2,347	2,708	
Johri	2,405	3,004	3,905	4,506	
Jamalpur	2,989	3,733	4,853	5,600	
Janaula	2,477	3,093	4,021	4,640	

Village	Census year 2001	Base year 2010	Intermediate stage 2025	Ultimate stage 2040	Remarks
Sampka	1,459	1,822	2,369	2,733	
Rampur	2,286	2,855	3,712	4,283	
Total	14,631	18,273	23,755	27,410	

Sources and Production

11. Currently both the urban areas and all of the rural habitations are dependent on ground water as the source of supply. In the case of Pataudi the system comprises 13 odd tube wells with combined yield of about 1.9 million litres per day (mld) considering 16 hours of pumping. In the case of Hailey Mandi the number of tube wells is 14 and the combined production is around 2 mld.
12. From the point of view of water quality, it is found that both in Pataudi and Hailey Mandi this is an area of increasing concern. Pataudi is experiencing increasing levels of dissolved solids. On the other hand, in several wells in Hailey Mandi, besides salinity, the hardness and fluoride levels are found to be almost at the rejection limits. However, groundwater is supplied without any treatment.
13. It is worth mentioning at this point that the Central Ground Water Board (CGWB) has declared Pataudi and the surrounding area as highly water scarce zone. In view of this deteriorating ground water quality, there is a need for developing alternate surface water based supply system for these towns.

Demand Supply Situation

14. Corresponding to the estimated population of 2010 and a service level of 135 lpcd, the gross net water demand (including 15% UAW, 20% floating population and fire demand) for the urban areas of Pataudi and Hailey Mandi are 4.75 mld and 5 mld respectively. With respect to these, the corresponding production values are only 40% indicating a grossly under-served community. The average net service level is determined to be around 58 lpcd which is around 44% of the prescribed level of 135 lpcd as per the CPHEEO Manual and Regional Plan 2021

Distribution System

15. There is one booster station at Motidungri which has one underground service reservoir of 1 million litres and an elevated service reservoir of 0.36 million litres capacity. However, the former is not in operation.
16. The distribution system in Pataudi comprises CI, AC and GI pipes of 80 – 300 mm diameter aggregating about 15 km in length. The pipes are more than 30 years old and as a result the distribution system is characterised by high leakages and high head losses, leading to low head at the point of supply. The leakages are estimated to be of the order of 30% of gross supply. The coverage through house connections said to be around 80% while the rest of the population comprising unauthorised settlements is dependent on either stand posts or private sources. The water is supplied for 3 hours in the morning and 3 hours in the evening every day.

17. As typically found in all urban areas, the production, transmission and distribution system is also characterised by total lack of metering at point of extraction, storage/transmission and the consumer end. As a result there is no reliable and authentic data on production and supply.
18. In this context, it is evident that the present system requires augmentation and strengthening to improve the service levels and the quality of life in the two towns.

FIGURE 1.2 : ELEVATED SERVICE RESERVOIR IN PATAUDI



Expenditure and Revenue Status

19. In view of the current practice of PWD – PHED of maintaining accounts on cash basis, the information on expenditure and revenue is not considered to be reliable. However, based on the available information, the broad expenditure and revenue situation on water supply in Pataudi and Hailey Mandi towns is as follows:

Expenditure

Table 1.3 Expenditure On Water Supply In The Sub-Project Towns

Particulars	Pataudi Expenditure, Rs. Lakh			Hailey Mandi Expenditure, Rs. Lakh		
	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09
Establishment costs	21.99	24.53	27.02	24.18	27.47	29.99
Electricity	31.24	34.54	13.34*	21.61	24.85	14.33*

Particulars	Pataudi Expenditure, Rs. Lakh			Hailey Mandi Expenditure, Rs. Lakh		
	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09
Consumables	2.38	2.68	3.91	2.18	3.11	3.55
Mechanical and electrical repairs	4.12	5.11	6.01	3.85	5.13	4.95
Miscellaneous	NA	NA	NA	NA	NA	NA
Total	59.73	66.86	50.28	51.82	60.56	52.82

20. It is noted that the expenditure on electricity as shown above for both the towns is corresponding to the actual payment made to the utility. However, the actual electricity cost of operation is estimated to be in the range of Rs. 3.6 Million and Rs. 2.7 Million respectively. This inconsistency arises due to the practice of cash accounting followed by the PWD-PHED. In view of this, the annual cost of operation in Pataudi and Hailey Mandi for 2008-09 is estimated to be in the range of Rs. 7.3 Million and Rs. 6.6 Million respectively.

Revenue

21. The tariff for domestic connections is charged at flat rate of Rs. 25/month, for commercial connections at a rate of Rs. 2/kilo litres and for industrial connections at a rate of Rs. 2.5/kilo litres.
22. The level of billing and collection is reported to be satisfactory. However, the annual revenue from water supply in both the towns is found to be under of Rs. 0.7 Million . The actual collection over the four year period of 2005-06 to 2008-09 is presented below.

Table 1.4 : Revenue Collection In The Sub-Project Towns

Financial year	Pataudi		Hailey Mandi	
	No. of connections	Revenue collected, Rs. Million	No. of connections	Revenue collected, Rs. Million
2005-06	1,773	0.7	NA	NA
2006-07	1,807	0.6	2,080	0.65
2007-08	1,849	0.7	2,208	0.85
2008-09	1,917	0.5	2,241	0.59

23. The revenue is found to be only around an average of 10% of the expenditure. The deficit is normally provided by the GoH under non-plan fund.

Institutional Arrangements

24. The entire responsibility of raw water abstraction/production and managing the distribution system is vested with the PWD – PHED. The department is also responsible for billing and revenue collection.
25. Water supply works are developed and managed/operated under the overall supervision of the Executive Engineer, Sohana Division. A Sub-Divisional Engineer, Pataudi is responsible for the day to

day activities at both Pataudi and Hailey Mandi. The latter is assisted by 3 Junior Engineers who manage various operations and logistics aspects for both the towns. Currently the team of engineers at Pataudi office is exclusively responsible for managing water supply operations, however in due course of time it will also be given the responsibility of implementation and managing operations of sewerage network and sewage treatment plant when work on another sub-project is commenced. In that regard, depending on the work load, if need be, additional posts for Junior Engineers would be created.

Issues to be Addressed

26. To improve the service levels and quality of life for the people of Pataudi and Hailey Mandi in particular, the following issues need to be addressed:

- Per capita supply level to be increased.
- Fraction of unaccounted for water needs to be reduced to 15% of total production.
- Quality of water supplied for domestic use needs to confirm to potable quality norms. Alternate sources, preferably surface water based need to be explored to address the problem of rising salinity, hardness and fluoride levels.
- The deficit between the expenditure and revenue from water supply needs to be brought to within a justifiable range which can then be financed reasonably through the non-plan funds of the GoH.
- Systems and practices for O&M of water supply scheme, data generation and storage corresponding to various stages of operation, billing and revenue collection need to be strengthened.
- Capacity building of the team of officials and staff in all aspects of management of the system.

4. SECTOR ROADMAP FOR THE WATER SUPPLY PROJECT AREA

Vision

27. As per the vision outlined in the DPR, the specific goals of the sub-project for augmenting water supply in Pataudi and Hailey Mandi in particular are to:

- Raise water supply service level at the consumer end from the present 58 lpcd to 135 lpcd.
- Eliminate dependence on groundwater as the only source of supply considering the concerns on deteriorating quality and declining yield.
- Strengthen and refurbishing existing distribution network to minimise UAW and chances of contamination during supply.
- Install bulk water meters at strategic locations to ensure measurements and effective management of the augmented water supply system.
- Encourage residents to install domestic water meters for gradual shift towards consumption based user charges and thereby increasing service quality.

28. Recognising the challenge faced by the residents of the adjoining town of Hailey Mandi and those of the seven villages which fall enroute the rising main(s), the sub-project adopts a regional perspective and an inclusive approach by incorporating the demands of the said communities.

Proposed Interventions

29. From the point of view of developing the hardware, the proposed interventions as presented in the schematic diagram in Exhibit ** comprise :
- Development of a dependable surface water source on the Gurgaon Canal.
 - Intake works, raw water pumping station and rising main.
 - Combined storage of 7 days to offset risk of disruption of supply during canal closure.
 - Treatment of raw water to potable quality and to ensure safety of public health.
 - Clear water pumping stations, rising mains and booster stations for various zones.
 - Strengthening and augmenting of distribution networks by installing new pipelines of DI pipes.

5. WATER SUPPLY SUB-PROJECT DESCRIPTION

Introduction

30. Based on the discussions with the PWD-PHED, Gurgaon, the coverage under the sub-project 'Augmentation of Water Supply for Pataudi Town' under the ADB funding was agreed upon. This section presents the feasibility analysis and prioritises the components for inclusion based on economic and financial analysis and integration of social and environmental safeguards.

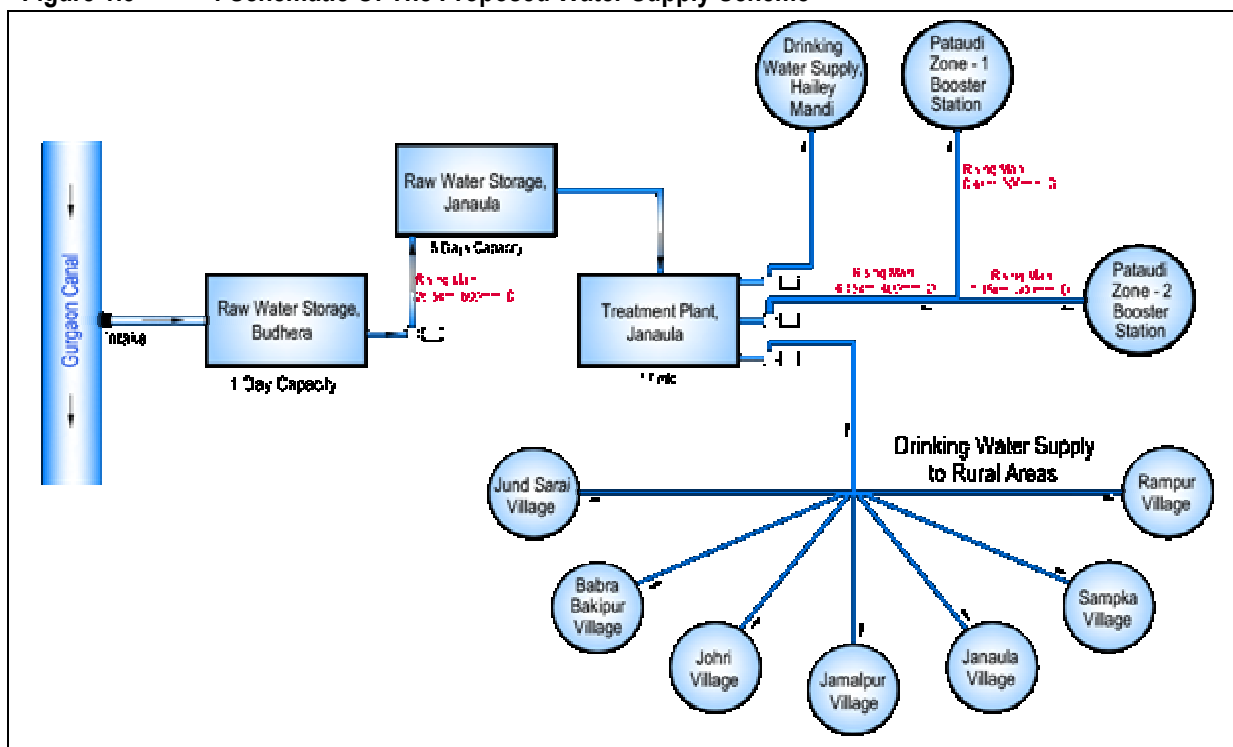
Coverage

31. The sub-project will cover the entire population of Pataudi, Hailey Mandi towns and seven adjoining village. Total population to be served in the ultimate stage of the project is of the order of 112,000.

Basis of Process Design

32. The sub-project takes 2010 as the base year and adopts a design period of 30 years which corresponds to 2040. Two phases of 15 years each are envisaged for development of the infrastructure corresponding to the demand forecast for 2025 and 2040 respectively.
33. A schematic of the overall project is presented in Figure 1.3 which comprises of raw water intake works, raw water storage for 1 day near the intake, raw water pumping station and rising main of 26km, raw water storage for 6 days at the treatment plant, a conventional treatment plant involving coagulation-flocculation, rapid sand filtration and chlorination, clear water pumping machinery and rising mains, and ground level service reservoirs and booster stations in various service zones. Raw water storage corresponding to 7 days of demand has been included considering typical annual canal closure.
34. Selected critical components e.g., intake works, rising mains, clariflocculator, etc. are designed corresponding to the ultimate design period while the rest of the components, e.g., pumping machinery, storage ponds, service reservoirs, etc. which can be implemented in a modular approach have been designed for the intermediate stage of 2025.

Figure 1.3 : Schematic Of The Proposed Water Supply Scheme



Design Population

35. Population projections have been made considering the departmental method which adopts a declining growth pattern over the period from 2001 until the design year 2040. For the urban areas, the CAGR until the base year years is 4% while for the subsequent two phases of 15 years each of the sub-project it is 2.7% and 1.2% respectively. The corresponding CAGRs for the rural areas are 2.5%, 1.76% and 0.96% respectively. The Table 1.5 below provides a summary of the population projections adopted for the design of the sub-project. As per this, the intermediate and ultimate stage populations for the entire sub-project area are estimated to be of the order of 95,000 and 112,000 respectively. Accordingly, the overall CAGR for the entire life of the sub-project corresponds to 1.82%.

Table 1.5 Population Estimates For The Sub-Project

	Population / Year				Remarks
	2001	2010	2025	2040	
Urban					
Pataudi	16,085	22,894	34,341	41,209	
Hailey Mandi	17,081	24,312	36,467	43,761	
Sub-total	33,166	47,206	70,808	84,970	
Rural, all 7 villages	14,631	18,273	23,755	27,410	
Total	47,797	65,479	94,563	112,380	

Water Demand

36. The water supply service levels for the urban and rural populations have been considered at 135 and 70 lpcd respectively. Total production demand for urban areas has been calculated considering 20% floating population, fire fighting requirements and 15% unaccounted for water (UFW). For the rural areas separate provision for only the UFW at 15% is made. The combined production demand estimates corresponding to various stages of the sub-project are presented in the table below.

Table 1.6 Estimates Of Water Demand At Production Stage

	Demand (million litres/day)			Remarks
	Present 2010	Intermediate 2025	Ultimate 2040	
Urban				
Pataudi	4.74	6.98	8.32	
Hailey Mandi	5.02	7.40	8.32	
Sub-total	9.76	14.38	16.64	
Rural, all 7 villages	1.47	1.91	2.21	
Grand total	11.23	16.29	19.35	

Table 1.7 Estimates Of Raw Water Requirement At Intake

Particulars	Unit	Production	Input to WTP	Withdrawal at intake
Losses	%		2	25
Demand (2025)	mld	16.29	16.62	20.77
	cumecs	0.19	0.19	0.24
Demand (2040)	mld	19.35	19.74	24.67
	cumecs	0.22	0.23	0.29

Note : cumecs – cum/sec computed considering 24 hour operations.

37. The ultimate stage raw water demand of the sub-project at the intake works is projected to be around 25 mld.

Source of Raw water

38. The Gurgaon Water Supply Channel (GWSC), an existing canal which is part of the Western Yamuna canal network has been identified as the raw water source for the sub-project. It is a 70 km long channel which takes off from the Delhi Branch at Kakroi in District Sonapat. It was constructed in 1993-94 as a dedicated source of supply for domestic and industrial water requirements of Gurgaon, Manesar industrial township and Bahadurgarh.
39. Present discharge capacity of GWSC is 331 mld (3.83 cumecs), however the Department of Irrigation GoH has proposed to augment its conveyance capacity in Phase II to 784 mld (9.07 cumecs) to serve the increasing demand in the above mentioned three areas as well as to meet the demands of various urban and rural schemes proposed by the PWD-PHED in Gurgaon and Jhajhar districts. PWD-PHED

had made budget allocation in the sub-project capital cost towards meeting the proportionate cost of capacity augmentation of the GWSC.

Figure 1.4 Location of the Proposed Intake Point on the Gurgaon Canal



Intake Works

40. Intake works will be located near village Budhera which is about 30 km from Pataudi and access from the Gurgaon Farukh Nagar road. The works will comprise intake pipe, road crossing, storage tank with 1 day detention capacity, suction well, raw water pumping station, staff quarters, boundary walls, internal roads etc. Provision towards the proportionate cost of construction of the Gurgaon Canal (capacity increase) to the extent of Rs. 9.3 Crore has been made under this line item.

41. Total land area required for construction of the intake work is 5 acres. This land is proposed to be acquired and budget provision to this effect has been made in line with the current policies of the GoH.

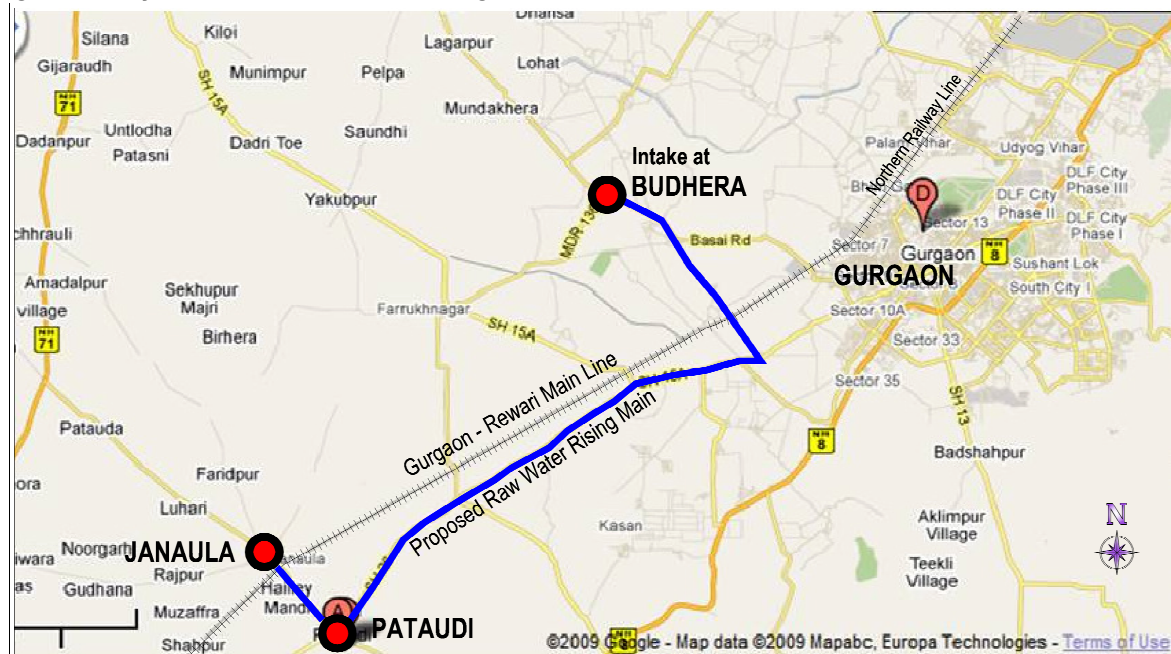
Figure 1.5: Site for the Proposed Intake Works, Budhera



Raw Water Transmission

42. Raw water transmission from Budhera intake works to the water works at Janaula will comprise a 26.5 km long, 600 mm diameter rising main. The pipeline will be laid underground and will follow the existing road alignment. The latter 3/4th part will be laid along the Gurgaon-Pataudi Road.
43. As per the original DPR the pipeline material specification was ductile iron. However, this item in particular and the long length of the rising main in general is found to be leading to significant increase in the overall cost of the sub-project. In order to optimise the cost, an alternate option of pre-stressed concrete rising main is recommended. This change of specification of rising main material will result in a reduction of about Rs. 6.5 Crore, which amounts to 20% of the cost of sub-works no. 2 and about 9% of the original sub-project cost.

Figure 1.6 Layout Plan of Raw Water Rising Main From Budhera to Janaula



Water Treatment Plant

44. Water works will be located near Janaula on the side of the Gurgaon-Pataudi Road which is about 3 km ahead of Pataudi town. It will comprise raw water storage corresponding to 6 days of average production demand, a conventional treatment plant involving clariflocculation, rapid sand filtration and chlorination, clear water storage and pumping arrangements, etc. The backwash from the rapid sand filters is proposed to be brought back into the raw water storage tanks, thereby avoiding the problem of its disposal into surface water bodies or on land. This is a progressive approach which has been adopted by PWD-PHEd in almost all its water works and which helps in conserving a substantial quantity (about 2-3%) of raw water.
45. From the process point of view, the original scheme has not provided for sludge drying beds which will be required for safe treatment and disposal of the sludge that will be generated in the clariflocculators. The capital cost estimates provided in this feasibility report have made adequate provisions for this component, however the same have to be incorporated in the DPR and the scheme of works need to be suitably adapted.
46. Other works comprise the usual internal roads, staff quarters, landscaping, plantation and construction of a boundary wall. Over and above these components proposed in the original DRP, it is recommended to include a water testing laboratory at the Janaula Water Works so as to provide means for quality control and assurance/monitoring. Provision to this effect is proposed in the subsequent TA loan component.

Bulk Transmission of Treated Water

47. The Original DPR has proposed clear water transmission to only Pataudi town. As per the design, the system comprises 4.15 km long rising main from Janaula Water Works to Zone-1 booster station at Pataudi which will be a ductile iron pipe of 400 mm dia. Another branch rising main out of the above line is 1.4 km long which will be a ductile iron pipe of 300 mm dia.
48. Besides these two rising mains, it is recommended to include additional rising mains for Hailey Mandi town and the seven villages in the overall scheme of the sub-project. Accordingly provision for the additional works has been made and the capital cost of the sub-project stands modified.

Treated Water Storage, Service Reservoirs and Booster Stations

49. Treated water storage will be provided at various locations. Two ground level service reservoirs (GLSR) with combined capacity of 9.7 million litres are proposed at the Janaula Water Works which corresponds to half day demand of the ultimate design year.
50. Besides the existing booster station at Motidungri, another booster station is proposed at Shamshanghat. The existing and proposed storage capacities of GLSRs and elevated service reservoirs (ESR) at the two booster stations in Pataudi is presented in the table 1.8 below. The capacities of GLSRs and ESRs correspond to half and one fourth the daily demand in the respective distribution zones.

Table 1.8 Existing and Proposed Storage Capacity at Booster Stations

Type of reservoir	Booster Station 1 (Moti Dungri) Million litres			Booster Station 2 (Shamshan Ghat) Million litres		
	Existing	Proposed	Total	Existing	Proposed	Total
GLSR	1.00	2.03	3.03	0	1.82	1.82
ESR	0.36*	0.64	1.00	0	1.08	1.08
Total	1.36	2.69	4.03	0	2.90	2.90

51. The existing ESR at Motidungri is presently dysfunctional and it is recommended to revive it so as to help in improving service levels in zone 1, particularly during power cuts.
52. At Hailey Mandi there are two existing underground water reservoirs of 0.5 and 0.35 million litre capacity respectively. These reservoirs and the installed pumping machinery will continue to serve the existing distribution system.

Water Metering

53. Electromagnetic flow meters are proposed at all key locations, e.g., outlets of the raw water pumping station, and the inlets and outlets of treatment plant, booster pumping stations, etc. All these meters will have data loggers which will be able to record flows on a continuous basis. The data thus collected will be downloaded to computers on a regular basis. As a part of this component under the sub-project PWD-PHED will procure necessary compatible hardware and software for managing and processing the data and will arrange for training of concerned staff.

54. From the point of view of moving towards volumetric billing and water conservation, PWD-PHED will encourage domestic and commercial consumers to install dry dial mechanical water meters of appropriate sizes. The cost is proposed to be borne by the consumers and therefore no provision on this account has been made in the sub-project capital cost.

Treated Water Distribution System

55. The distribution system has been designed for considering the demand of year 2040, a peak factor of 3 and tail end pressure of 17 m of water column.
56. It is proposed to lay about 22 km of distribution pipelines varying from 100 to 400 mm in diameter. With regard to the material of pipes, as per the GoH orders, the sub-project proposes to use only ductile iron pipes for the distribution network. This policy has been adopted in view of the past experience of using PVC pipes which were found to be prone to tempering for unauthorised connection, damage and intrusion of wastewater.
57. Evidently use of ductile iron pipes in distribution network, particularly in small towns is a rather expensive option. While the costs estimates presented hereunder correspond to this option, it is recommended to explore a cheaper alternative which is technically appropriate from the point of views of preventing tempering, damage and wastewater intrusion.

Power Supply

58. Power supply at the raw water intake works will be made from Makrola independent feeder which will take off from the existing Harsaru feeder. Power supply at the water treatment plant will be made from another independent feeder which will be tapped from Pataudi, involving a distance of 3 km. At both locations a substation, transformer, building, etc. will be provided. Adequate provision to this in the sub-project capital cost has been made.

Operation and Maintenance Arrangements

59. The raw water withdrawal, pumping and treatment operations will be on 24 hour basis while the supply to the consumers will be for four hours daily, 2 hours in morning and evening each. The supply arrangements will involve direct pumping into the distribution network as is the current practice. However, the proposed ESRs will also provide a back up support in case of power cuts.
60. One the whole, the Executive Engineer, Sohana Division of PWD-PHED will be responsible for supervising the operations of the entire water supply scheme. The entire system will be operated and maintained under the direct responsibility of the Sub-Divisional Engineer (Assistant Engineer) PWD-PHED, Pataudi. He will be assisted by 3 or more Junior Engineers for managing the daily operations.
61. The team at the intake works will comprise a supervisor and 9 regular staff including a pump operator, electricians, fitters, plumbers, helpers, etc. Five daily wage labours are proposed to be employed at this location.

62. At the water works at Janaula, the composition of the team will be on the same lines. However, it is also recommended to include a chemist for the water testing laboratory.
63. At each of the booster pumping stations the team will comprise one pump operator assisted by electricians, fitters and helpers, etc. One daily wage labour at each booster station will be engaged.
64. At the sub-division office level, besides the administrative staff the team will comprise an office superintendent, a head draftsman, an accountant and a store keeper. This staff will provide all the necessary administrative support to the Sub-Divisional Engineer including billing and revenue collection, etc. For managing the distribution network for each town a team of one key man, one patrol man, one beldar and one helper has been proposed.
65. Cost of all the above described staff and daily wage labour including those for the increased positions for Hailey Mandi has been included in the O&M cost of the sub-project which is presented in a subsequent section.
66. PWD-PHED will lay down a policy for taking new connection and specify an initial charge of Rs. 1000 for domestic consumers. It will also adopt the system of licensing fitters/plumbers who will be authorised to make new connections for various categories of consumers.
67. With regard to flow measurements, electromagnetic flow meters with data loggers are being proposed at critical locations. Concerned officials/ staff will trained in operating, inspecting these meters and downloading of data at regular intervals. The same staff will be given the responsibility of processing the data and generating reports on a regular interval which will be submitted to the Executive Engineer, Sohana.

Project Capital Cost Estimates

68. The base capital cost of the sub-project including the additional components of rising mains to Hailey Mandi and other seven enroute villages, land acquisition and R&R but excluding contingencies is estimated to be Rs. 794.6 Million. Component wise break up is presented in Table .1.9 below.

Table 1.9 Estimated Capital Cost of Sub-Project

Project component	Amount, Rs. Million
Raw water intake works and pumping station at Budhera	109.9
Raw water rising main from Budhera to Janaula	322.9
Water treatment plant at Janaula.	91.1
Clear water rising mains from Janaula to 2 boosting stations in Pataudi.	30.1
Clear water rising mains from Janaula to Hailey Mandi and other villages	70
Booster pumping station at Zone-I and Zone-II, Pataudi	29

Project component	Amount, Rs. Million
Augmentation and rehabilitation of the distribution system in Pataudi.	38.7
Procurement and installation of water meters and instrumentation works.	4.6
Provision for independent electric feeder connection.	6.7
Land acquisition	87.5
R & R cost	4.1
Base cost	794.6

69. It is to be noted that the cost of land acquisition is determined considering a rate of Rs. 25 Lakh per acre. However, this could change in view of the recent policy of the GoH which considers minimum floor rate for land in NCR region and payment of annuity at a rate of Rs. 15,000 per acre over a period of 33 years with annual increment of Rs. 500. The RP's define the process and schedule.
70. Furthermore, with the objective of optimising the capital costs, PWD-PHED has proposed changing specification for the raw water rising main from ductile iron to pre-stressed concrete (PSC), excluding the proportionate cost of construction of the Gurgaon Canal and the cost of land access to be paid to the forest department. In this way it is possible to reduce the capital cost of the sub-project by Rs. 157 Million. However, in view of quality and leakage concerns pertaining to PSC pipes, it is recommended that the specification for the raw water rising main should be retained to DI.
71. The sub-project does not include the components of augmenting the capacity of the existing booster stations and strengthening of the distribution network in Hailey Mandi. Apparently the existing system is considered to be adequate to meet the present requirements. Neither does it include the service storage and internal supply arrangements within the 7 villages. PWD-PHED proposes to take up these components separately at a later stage.

Project Operating Cost Estimates

72. The total annual cost of operation and maintenance of the entire water supply project is estimated to be Rs. 2272.4 Million. Over and above the original estimates provided in the DPR, additional costs correspond to :
- Chlorination at Janaula
 - Electrical cost for pumping clear water to Hailey Mandi and other seven villages
 - Corresponding increase in mechanical and electrical repairs cost, and
 - Manpower for managing distribution network in Haily Mandi
73. An itemised break-up of O&M costs is presented in Table 1.10

Table 1.10 Estimates Of O&M Costs For The Sub-Project

SL. NO.	Particulars	Annual costs, Rs. Million	Annual costs, Rs. Million
A.	Manpower		
1.	Regular staff	3.5	
2.	Daily wage labour	0.7	
	Sub-total		4.195
B.	Electrical charges		10.434
C.	Consumables		4.716
D.	Repairs (mechanical and electrical)		1.855
E.	Repairs (civil works)		1.524
	Total		22.724

Implementation Schedule

74. The sub-project will be implemented by the PWD-PHED over a period of 4 years from the date of release of loan. A detailed activity wise schedule of implementation/bar chart is presented in Appendix 21. The pre-project phase includes selection of 'project management consultant' and 'design and supervision consultant', preparation of revised DPR, land acquisition, rehabilitation of project affected people, preparation of bid documents, prequalification and selection of bidders for various construction packages and preparation of 'Shifting of Utilities Plan' and procuring of 'Letter of Approval for Shifting' from concerned agencies. This phase is expected to take around 10-12 months.
75. For the implementation phase, the bar chart shows activities according to the sub-works proposed in the DPR i.e., intake works, raw water rising main, treatment plant, clear water rising mains, booster stations at various locations, installation of bulk water meters and finally laying of distribution network. Under each sub-work, activities have been split along civil, electrical and mechanical works. Key components of this phase is expected to take between 24 month for completion and commissioning of water supply to Pataudi town. The components for Hailey Mandi and the seven villages will be implemented in the following 12 months.

Procurement Plan

76. The procurement plan for goods and works considers seven different packages as presented in Table 1.11 below. This is based on the current practice of PHED for clubbing works such that one contractor is responsible all the way from intake of raw water to its delivery at the water treatment plant; another contractor is responsible all the way from treatment to delivery at the booster stations; another contractor is responsible for booster stations and laying of distribution network. Considering special nature of work involved in construction of elevated service reservoirs, this has been proposed as a separate package. As per the current policy of PWD-PHED, procurement of DI pipes for all major pipeline components e.g.,

raw and clear water rising mains and distribution network is proposed to be carried out by the department as per the PWD/DGS&D procurement norms.

Table 1.11 Contract Packages For The Pataudi Water Supply Project

Package No.	Description	Cost		Remarks
		Rs. Million	US \$, million	
I	<p>Intake works at Budhera and raw water rising main including:</p> <ul style="list-style-type: none"> - All civil works, installation of pumping machinery, electrical fittings. - Laying and jointing of raw water rising main from Budhera to Janaula. - Procurement and installation of bulk water meters. 	49.658	1.06	<p>Cost of Sub-works No-1 less the proportionate cost of canal construction.</p> <p>Cost of Sub-works No-2 less land cost and pipe cost. Procurement cost of DI pipes for the raw water rising main is not included. If its specification is changed to PSC pipe then the package cost will have to be increased as pipe procurement will then be the responsibility of the contractor.</p>
II	Procurement of DI pipes by PWD-PHED for raw and clear water rising mains and the distribution network.	392.641	8.35	Based on cost of all DI pipes for the raw and clear water rising mains to Pataudi, Hailey Mandi and all seven villages. In case PSC pipe is used for raw water transmission, then it will be procured under Package I by the contractor and the costs of Package I increase and that of Package II will reduce accordingly.
III	<p>Water works at Janaula and the clear water rising mains to Pataudi including:</p> <ul style="list-style-type: none"> - All civil works. - Installation of clear water pumping machinery, electrical fittings, instrumentation, etc. - Laying and jointing of clear water rising mains to the two booster stations in Pataudi town. - Procurement and installation of bulk water meters. 	95.985	2.04	<p>Cost of Sub-works No.-3 plus laying and jointing of the two rising mains to Pataudi town.</p> <p>Pump house for Hailey Mandi and 7 villages is to be provided under this package while pumping machinery will be provided under package ** along with the rising mains.</p>

Package No.	Description	Cost		Remarks
		Rs. Million	US \$, million	
IV	Construction of booster pumping stations at Pataudi excluding elevated reservoirs but including all other civil works, installation of pumping machinery, electrical fittings, etc.; and including augmenting and strengthening of the distribution network in Pataudi town.	22.076	0.47	Sub work no. 5, less cost of elevated service reservoir. Sub work no. 6, less cost of procurement of DI pipes.
V	Construction of elevated service reservoirs at the two booster stations in Pataudi.	13.744	0.29	
VI	Installation of independent electric feeder connections at Budhera and Janaula.	6.720	0.14	Sub work no. 8
VII	Installation of pumping machinery and laying, jointing, etc. for clear water rising mains to Hailey Mandi and the seven villages, including procurement and installation of bulk water meters.	18.487	0.39	Cost of laying R/M to Hailey Mandi and 7 villages.
	Total	5993.11	12.75	

77. However, Procurement Specialist has expressed the following views:

- a. By splitting the entire sub-project works into seven packages, the average cost of a package is becoming rather low and therefore bigger size competent bidders would not show interest.
- b. More number of small contractors will lead to problems of project management during implementation, leading to delays.
- c. Procurement of DI pipes, as proposed to be done internally by the Department, will have to adhere to PWD/DGS&D or ADB procurement norms.
- d. However, departmental procurement of pipes will further reduce the cost of the respective packages and make them less interesting for a bigger contractors.
- e. Departmental procurement of pipes can also get delayed for a variety of factors e.g., limited suppliers, wide fluctuation in market rates, etc. which could in turn delay the implementation.
- f. The option of using PSC pipe for the raw water rising main is not preferred. The present specification of DI pipe is considered to be appropriate and should be retained.

Technical Analysis and Recommendations

78. On the whole, the sub-project is found to have been structured well and on the lines of the recommendations of CPHEEO Manual and the Regional Plan 2021. It has adopted a regional perspective by including adjoining urban and rural habitations and thereby avoiding any possibility of future conflict with under-served population in the surrounding areas. Population projections have been carried out based on the declining growth rate method which the department has validated internally on small towns over last three decades and found to be acceptable.
79. The domestic demand for urban and rural areas has been derived by considering service levels of 135 and 70 lpcd which are in conformity with the RP2021. The demands for production and raw water intake stages have been developed appropriately by considering losses at various stages and requirements for fire fighting and floating population in urban areas.
80. On the whole, the proposed source for raw water can be considered safe, reliable and dependable. Adequate allocation of water has been made by the concerned water resources department and the sub-project has proposed to make budgetary allocation towards its capacity augmentation. The source will also help in addressing the deteriorating groundwater quality issue, primarily salinity and fluorides.
81. With regard to the existing sources of water, i.e., the numerous tube wells located in and around both the towns and the pumping machinery, it is recommended that PWD-PHED must continue to operate and maintain them on a regular basis so that they can be used in emergency or as and when required. It is recommended that the revised DPR must provide a plan to this effect and make appropriate provision in the O&M cost.
82. On the whole the system comprising intake works, the storage ponds, the treatment scheme and the transmission and distribution system are found to be designed as per the established engineering practice and are in order. However it is noted that the following capital works have not been considered in the original DPR and it is recommended that provision to that effect should be included in the capital cost of the sub-project in the revised DPR:
- ⇒ A pumping station and a rising main (pre-stressed concrete) to Hailey Mandi town.
 - ⇒ Pumping machinery and rising mains to the seven villages envisaged to be covered in the project.
 - ⇒ Sludge drying beds at the Janaula Water Works to be linked to the clariflocculator.
83. Further, it is recommended to assess the requirements for augmenting the capacity of the two existing booster stations (including storage reservoirs) and strengthening of the distribution network in Hailey Mandi. This should be developed as a separate sub-project in due course of time.
84. It is recommended to retain the material specification for the raw water rising main to ductile iron considering its robustness and high reliability. The alternative of PSC pipes which was considered by the department should not be adopted in view of the quality and eventual leakage concerns.

85. To optimise the capital cost of the sub-project, PWD-PHED has proposed to exclude the proportionate cost of construction of the Gurgaon Canal and the cost of land access to be paid to the forest department. Although these two items will constitute a reduction of about Rs. 10.37 Crore, they are considered essential and would have to be paid in one way or another. Accordingly PWD-PHED must provide documentary evidence of alternate sources of financing or waivers before showing their exclusion in the revised DPR.
86. The DPR has made provision for installation of electromagnetic bulk water meters and domestic meters with the objective of bringing an element of measurement of supply at various levels. This is a progressive feature which will help in demonstrating good management practices for a small scale water supply system in the state and the region. This sub-work has to be spread over different packages. It is recommended that adequate training to operate data loggers, download the data and process the same, generate MIS reports, etc. must be provided to the concerned technical staff.
87. With regard to the cost estimates for operation and maintenance of the sub-project it is recommended to revalidate the original figure of Rs. 1.76 Crore which is quoted in the original DPR. Provision for following additional items must be incorporated:
- ⇒ Salaries and wages of site staff for distribution system in Hailey Mandi.
 - ⇒ Electrical costs for operation of pumping system (at Janaula) for Hailey Mandi and other seven towns.
 - ⇒ Repairs (mechanical and electrical) for the additional equipment to be included for the pumping system (at Janaula) for Hailey Mandi and other seven towns.
 - ⇒ Consumables towards chlorination of filtered water at Janaula water treatment works.
88. From the point of views of water quality control, quality assurance and monitoring, it is recommended to include a water testing laboratory at the Janaula Water Works. Although at this stage provision is not made in the cost estimates, the same will be provided in the subsequent TA loan component to be developed in due course.
89. It is recommended that PWD-PHED must develop a separate DPR on priority for augmenting the capacity of the existing booster stations and strengthening of the distribution network in Hailey Mandi; as well as creating adequate service storage and internal supply arrangements within the 7 villages.
90. The DPR does not provided a detailed implementation schedule for the sub-project covering procurement of goods, works and services, execution of works, etc. However, as per the fund requirement schedule it is determined that the entire project will be implemented over a period of 4 years. The revised DPR must include a realistic activity bar chart as presented in this report for ease in sub-project management and monitoring during execution.
91. Finally from the point of view of a decision maker, there is a need to restructure the DPR, streamline the content and develop focus on the issues of importance. The DPR can be strengthened by, among others, consolidating the information in relevant sections, including objectively verifiable information on water quality, current service levels, current and projected expenditure and revenue figures, etc.

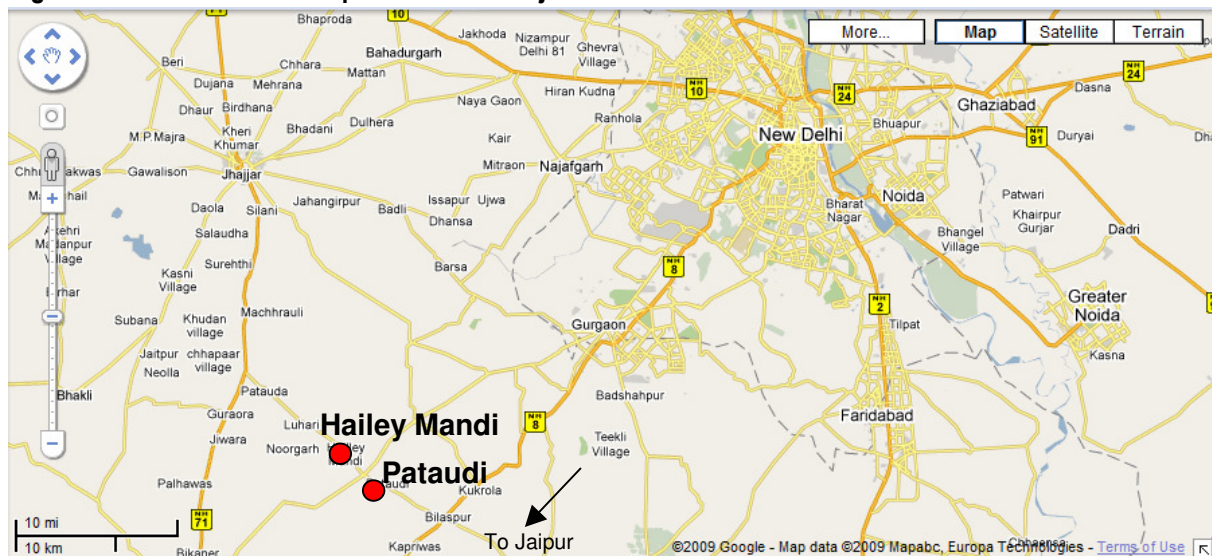
B. PATAUDI SEWERAGE PROJECT – TECHNICAL ASSESSMENT

6. SEWERAGE SUB-PROJECT BACKGROUND

92. Pataudi is a small Tehsil town in the Gurgaon District with current (2009) estimated population of around 22,000 (16,085 as per Census 2001). It is located on the Gurgaon – Rewari road at a distance of 25 km from Gurgaon and about 58 km from Delhi. Because of its proximity to one of the major growth centres of Gurgaon, being a part of the NCR, having good connectivity with other towns in the region, and expected growth on account of the upcoming special economic zone (SEZ), it assumes significance as an affordable option for absorbing future urban growth. In recognition of this potential of the town, the Government of Haryana has identified Pataudi for strengthening of, among others, water supply and wastewater management infrastructure and thereby to offer improved quality of life to the existing and prospective residents.

93. The sub-project also includes part of the adjoining town of Haily Mandi-Jatauli which is just about 4 km on north-west of Pataudi and due to its natural slope being towards the site proposed for sewage treatment plant (STP). The location of the sub-project area in relation to the major growth centres of Gurgaon and Delhi is shown in Figure 2.1.

Figure 2.1 Location Map Of The Sub-Project Area



94. This sub-project gains significance in the context of the Government of India's (GoI) policy on sanitation – both urban and rural areas. The GoI has been implementing a large Total Sanitation Campaign (TSC) for the rural areas across the country since 2003, and it brought out a policy on urban sanitation in 2008. Further, to improve infrastructure and services for, among others, water supply and wastewater management in small urban area, its has been providing financial assistance since 2004-05 under the

'Urban Infrastructure Development Scheme for Small and Medium Towns' (UIDSSMT). Based on these central policies, the Government of Haryana (GoH) has taken up in a major way implementation of TSC in rural areas and several sewerage schemes for improving wastewater / sewage management in smaller towns across the state. As a part of the Yamuna Action Plan it has implemented interception and diversion of sewage flows and treatment plant projects in several towns along the River Yamuna. Under the second phase of the YAP, similar works are being implemented in 6 additional cities in the Yamuna basin.

95. In recognition of the rapid urban growth in small towns, the consequent increase in wastewater volumes and the potential for adverse impact on the public health, the GoH places a high priority on creation of sewerage/ wastewater management infrastructure. In this regard, in order to encourage residents of smaller towns to take sewerage connection, it has also come out with a policy of exemption of sewer connection charge which was otherwise usually levied at a rate of Rs. 1000/- per household.

7. SITUATION ASSESSMENT – SEWERAGE PROJECT

96. This section provides a description of the existing situation and lays the basis for development of the sub-project for wastewater management in Pataudi and Hailey Mandi towns.

Profile of the Towns

97. Both Pataudi and Hailey Mandi are primarily close to rural habitations where agriculture and related activities are the main sources of livelihood for the majority of the population. Because of their relatively larger size, they have also evolved as trading and service centres for the agrarian hinterland in the region and therefore experience a fair level of traffic and floating population. However, there is very limited industrial activity in the vicinity of these towns.

Population Growth Pattern and Projections

98. Over the last four census decades the two towns of Pataudi and Hailey Mandi have grown from average size villages to small towns with 2001 population of 16,085 and 17,081 respectively. The census data over this period reveals average compounded annual growth rates (CAGR) of 3.7% and 6.6% respectively. While the growth of Pataudi has been uniform, it is noted that Hailey Mandi recorded unprecedented growth at a CAGR of over 16% during the 1971-81 decade, which subsequently declined to modest levels of around 2.7%.
99. Population projections have been made as per the 'declining growth rate' method evolved by the PWD-PHED which has considered an initial CAGR of 4% for the 9 year period of 2001-2010, followed by 2.7% and 1.2% for the subsequent two phases of 15 years each. The method assumes that the small towns can not continue to grow at historically determined rates along geometrical progression but will follow declining growth rates. Accordingly population projections up to year 2040 have been made.

Table 2.1 Population Growth Pattern And Projections

	Pataudi		Hailey Mandi		Remarks
Year	Population	CAGR	Population	CAGR	
1961	3,788		1,340		
1971	6,045	4.8	2,252	5.3	
1981	8,422	3.4	10,140	16.2	Unprecedented growth recorded at Hailey Mandi
1991	11,278	3.0	13,263	2.7	
2001	16,085	3.6	17,081	2.6	3.7% and 6.6% of preceding 4 decades
2010	22,894	4.0	24,312	4.0	CAGR assumed @ 4%
2011	23,521	2.7	24,978	2.7	
2021	30,822	2.7	32,730	2.7	
2025	34,341	2.7	36,467	2.7	50% increase over 2010
2031	36,939	1.2	39,226	1.2	
2040	41,209	1.2	43,761	1.2	80% increase over 2010

Water Supply Arrangements

100. Present water supply in Pataudi and Hailey Mandi is ground water based and the service level is estimated to be around 70 litres per capita per day (lpcd). PWD - Public Health Engineering Department of the GoH is responsible for construction and O&M of water supply. The supply is for about 2-3 hours in the morning and evening each and therefore almost every house also maintains a small storage. In addition, a number of houses and establishments have private bore wells.
101. The department has prepared a sub-project for augmenting water supply to both the towns to 135 lpcd and to this effect submission of a proposal for getting funding from NCRPB is under consideration. As a part of this TA, the water supply sub-project has also been appraised for possible financing and a separate feasibility report has been developed.

Current Sanitation Arrangements

102. Both the towns are characterized by the practice of on-site sanitation. Given the rural/ agrarian setting, it is also likely that a fair part of the population, especially the poorest may also be resorting to open defecation. Most households having latrines are connected to individual septic tanks and the overflow is let out into open road side drains. Very few houses have septic tanks connected to soak pits or drainage fields. The practice of direct discharge of wastewater into open drains is also prevalent, especially in those houses where space is limited and which are located along large open drains. In monsoon the wastewater from these drains overflows onto roads and at times enters residences, causing a serious threat to public health.

Figure 2.2 Current Arrangements For Wastewater Collection In Pataudi



103. Sullage is generally discharged into open road side drains, which along with the septic tank overflows is drained out of the habitation(s) into local depressions. One such disposal location is shown in Figure 2.1 which signifies lack of natural drainage for eventual disposal of wastewater. As a result of this, as shown in Figure 2.2, the wastewater stagnates in a depression outside the town. The location is right across the existing booster station (cum abstraction well) in Pataudi and is characterized by intensive eutrophication of water hyacinth.
104. In the case of Hailey Mandi, interceptor sewers were laid several years back to check wastewater discharges from open drains serving about 25% of the town area. However, in absence of maintenance support, these sewers have become dysfunctional and need to be restored or replaced. From wastewater management point of view the situation in Hailey Mandi-Jatauli is a bit complex because of the presence of a railway line which divides the two habitations. Hailey Mandi comprising 60% of the combined population is located on the southern side of the line while Jatauli comprising the balance 40% population is located on the northern side. The southern part drains southward towards Pataudi while the northern part drains northward.

Figure 2.3 Wastewater Disposal In Pataudi



Figure 2.4 Wastewater Disposal Near Water Supply Booster Station



Concerns on Public Health and the Environment

105. Open defecation and indiscriminate direct disposal or overflows from septic tanks joining open road side drains is an unhygienic and unsafe practice which often leads to spread of disease vectors, adversely affecting public health. Further, if septic tank-cum-soak pits are not constructed properly in shallow water-table areas, they can lead to contamination of groundwater. Disposal of untreated sewage/wastewater into local depressions as seen in Figure 2.3 and 2.4 above has the potential to contaminate groundwater over a larger area and especially the abstraction from wells located in vicinity e.g., at the booster station.

Justification for Intervention

106. Under the above setting, the quality of life in both the towns as determined by the water environment can be defined to be rather low. It is therefore evident that there is a need for making an appropriate intervention whereby the underlying cause, i.e., wastewater/ sewage disposal can be done safely. Moreover as the PHED plans to augment water supply to a level of 135 lpcd in the two towns (from an average of 2 mld to around 7.5 mld each) in a foreseeable future, there will be a need to provide adequate infrastructure for collection and disposal of increased volumes of wastewater.

Provision Of Sanitation Facilities to Slums

107. The sub-project does not include a component of sanitation for the poor in the form of community toilets, etc. Instead it envisages coverage of poor communities through the conventional sewerage network assuming existence of individual household latrines and willingness of the owners to pay for connectivity. However, given the nature of the two habitations there will be a need for providing adequate facilities and services to those households which can not afford to construct individual latrines. Accordingly, provision must be made for construction of community latrines which could then be connected to the sewer network.

8. SUB-PROJECT DESCRIPTION – SEWERAGE PROJECT

108. In response to the growing population, expected increase in water supply, rising aspirations of the residents for a better quality of life and to protect environment and public health, this sub-project has been developed for improving the level of sanitation in the towns of Pataudi and Hailey Mandi. As of now the towns are characterised by household discharge of sewage and sullage into road side open drains and final disposal of untreated sewage on the outskirts. The sub-project pertains to providing underground conventional sewerage and setting up a sewage treatment plant. Salient features of the sub-project are described in the paragraphs that follow.

Objectives

109. The sub-project for providing and strengthening infrastructure for wastewater/ sewage management in the two towns has been prepared with the objectives to (a) safeguard environment and public health, (b) offer an improved quality of life such that they can emerge as alternate urban growth

centres in the region, and thereby (c) reduce pressure of urbanisation in the larger cities e.g., Delhi and Gurgaon.

Design Period

110. The sub-project has adopted design period of 30 years and intermediate stage of 15 years. Considering 2010 as the base year, the ultimate design year is 2040 and the intermediate stage corresponds to 2025. Certain parts/components of the project such as civil works, etc will be designed corresponding to ultimate stage while others e.g., mechanical and electrical components will be designed for intermediate stage. Prospect of developing treatment capacity in two phases has also been explored. These aspects are further elaborated under the heading of phasing and implementation schedule later in this report.

Population Projections

111. The projected populations for the two towns corresponding to the intermediate and ultimate design stages of the sub-project are presented below. These projections have been made according to the 'declining growth rate' method usually followed by the PWD-PHED, GoH for small and medium towns.

Table 2.2 Projected Population For The Sub-Project

POPULATION				
Year	Pataudi	Hailey Mandi- Jatauli	Total	Remarks
2010	22,894	24,312	47,206	
2025	34,341	36,467	70,808	Intermediate stage
2040	41,209	43,761	84,970	Ultimate design stage

Coverage

112. The sub-project will cover entire population of Pataudi and about 63% population of Hailey Mandi-Jatauli which is residing on the southern side of the railway line and where the general slope of the ground is towards the proposed location of the sewage treatment plant. Although Hailey Mandi is about 3-4 km away, the sub-project has adopted the strategy of including part of its population in order to get the benefit of natural flow pattern and scale, and avoid difficult elements of intermediate pumping and a railway crossing. Accordingly the intermediate and ultimate stage populations used for design of various components are as follows:

Table 2.3 Design Population For The Sub-Project

DESIGN POPULATION				Remarks
Year	Pataudi	Hailey Mandi-Jatauli	Total	
2010	22,894	15,222	38,116	
2025	34,341	22,833	57,174	Intermediate stage
2040	41,209	27,400	68,609	Ultimate design stage

113. It is to be noted that the coverage as proposed in the DPR is only for the municipal areas. The areas which are to be developed as residential sectors, as per the proposal under the Development Plan prepared by the Dept. of Town and Country Planning, the sewerage infrastructure, among others, will be provided by Haryana Urban Development Authority (HUDA).

Components of the Sub-project

114. The sub-project will include (a) laying of branch sewers, laterals, mains and trunk sewers for the entire population of Pataudi, (b) a trunk sewer for the combined flows of the two towns, (c) a pumping station, (d) a sewage treatment plant (e) and a pumping station and outfall for final disposal of the treated sewage.

115. It is noted that under the sub-project the components of laying of sewer lines in the southern and northern parts of Hailey Mandi-Jatauli, outfall sewer from Hailey Mandi to Pataudi and construction of a treatment plant for the sewage flows being generated in the northern part are not included. These components are proposed to be developed under a separate sub-project which is being prepared by PWD-PHED.

116. Household Connections: The connection from the household will be made through the inspection chamber, which will be constructed outside the premises and will be funded under the sub-project. Such connections from 3-4 houses will be made in to a common inspection chamber which shall be connected to the manhole on the sewer on the road. Construction of inspection chambers will minimize road cutting while making house connections. As per the policy of the GoH while sewer connection charges are likely to be waived, the cost of labour and materials will be borne by the house owners.

The design period considered for various components is explained in the following table 2.4

Table 2.4 Design Periods For Various Components Of The Sub-Project

S. No.	Component	Recommended Design Period in years	Clarification
1	Collection System i.e. Sewer Network	30	The system should be designed for the prospective population of 30 years, as its replacement is not possible during its use.
2	Pumping Stations (Civil Works)*	30	Duplicating machinery within the pumping station would be easier/cost of civil works will be economical for full design period
3	Pumping Machinery**	15	Life of pumping machinery is generally 15 years
4	Sewage Treatment Plant	30	The construction may be in a phased manner as initially the flow may not reach the designed levels, and it will be uneconomical to build the full capacity plant initially
5	Effluent disposal and utilization	30	Provision of design capacities in the initial stages itself is economical

Sewerage Zones

117. The sub-project can be characterised to be broadly having two sewerage zones – one for the whole of Pataudi and the second for that part of Hailey Mandi-Jatauli which is on the southern side of the railway line and which is nearer to and sloping towards Pataudi. Zone one, i.e., entire area of Pataudi is predominantly sloping southward whereby all the sewage flows by gravity to one point without involving excessive depth of excavation and without entailing provision of intermediate pumping stations. However, this zone can be sub-divided into 5 or 6 sub-zones according to the existing pattern of the habitation. The population distribution over an area of 250 hectare is considered to be uniform, and the population densities for the present and the design year work out to be 91 and 165 persons/ha respectively.

118. As mentioned earlier, primary sewerage network for zone two, representing Hailey Mandi-Jatauli area is not included in the sub-project. In due course of time the combined sewage flows generated in this area will be routed through an outfall sewer into the proposed sewer network in Pataudi at junction point X/10. The depth of excavation at this point is determined to be 5.7m which makes it feasible to convey the combined flows of the two towns to the treatment plant site by gravity without entailing excavation deeper than 8m.

Design Criteria

119. The design criteria for the sewerage network and sewage pumping station are summarised in Table 2.5 as follows.

Table 2.5 Design Criteria Adopted For The Sewerage Network.

Parameter	Criteria
Average flow	80% of water supply level which is considered to be 135 lpcd.
Infiltration	As per CPHEEO recommendation.
Peak factor	3
Velocity friction formula	Manning's formula : $V = (1/n) \times R^{2/3} \times S^{1/2}$
Value of Manning's 'n'	0.015
Depth of flow at peak flow in all size sewers	0.8 D
Minimum pipe diameter	200 mm.
Velocity in sewers	0.6 m/s in initial years and 0.9 at ultimate stage peak flow.
Pipe material	
- Diameter < 400 mm	Salt glazed stone ware pipes
- Diameter > 400 mm	RCC NP3 pipes
Maximum depth of excavation	8 m.

Note: The criteria is as per the recommendations of the Manual on sewerage and sewage treatment (second edition), CPHEEO, Ministry of Urban Development, Govt. of India, 1993.

Table 2.6 Design Criteria Adopted For The Sewage Pumping Station

Parameter	Criteria
Detention time in wet well	5 minutes.
Number of pumps	5 working + 1 standby.
Type of pumps	Centrifugal horizontal assembly in dry well.
Screen	Manually operated coarse screen of 40 mm openings ahead of the pumping station.

Sewerage Network Components

120. Total length of the sewerage network as per the available design lay out for the Pataudi town alone works out to close to 31 km. Out of this, almost 91% length comprises pipes of least diameter i.e., 200 mm which are generally used as primary branch sewers and laterals. Balance 9% length comprises pipes of various sizes ranging from 250 mm to 700 mm. The depth of excavation varies from less than 1m to up to 8 m, however almost 85% of this will be under 3m and less than 10% involves excavation from 5 to 8m depth. A break up of sewer lengths according to sizes and depth of excavation is presented in the table 2.7 below and a layout in presented in Figure 2.5.

Table 2.7 Sewer Lengths For The Proposed Pataudi Sewerage Network

Diameter (mm)	Average depth of excavation (m)								Total	%
	1	1-2	2-3	3-4	4-5	5-6	6-7	7-8		
200	1,790	18,385	5,485	1,880	520	30			28,090	91
250				230		330	150		710	2
300					85		110		195	1
350							295		295	1
400								375	375	1
500						165		170	335	1
600								510	510	2
700								380	380	1
Combined length of all diameter sewers									30,890	100
%	6	60	18	7	2	2	2	5	100	

121. All the sewers less than or equal to 400mm in diameter will be salt glazed stone ware pipes while all other large diameter sewers will be RCC NP3 pipes. The laterals shall be of 200 mm to 400 mm and would be connected through manholes or connecting chambers. All laterals shall have inner cement mortar lining.
122. Sewage flows from Hailey Mandi will join at the junction point no. X/10 on the western side of Pataudi. From there on the combined sewage will flow through RCC pipes of 500-700mm upto the sewage pumping station. The depth of excavation in the tail end of this stretch is in the range of 7-8m. The pumping station is to be constructed at the same site where the sewage treatment plant is proposed and therefore the length of the rising main will be very small. The rising main comprise 300mm dia K9 class DI pipes.
123. All necessary appurtenances such as manholes, ventilating shafts, intercepting chambers shall be provided as per the standard practice of sewer construction. Manholes-cum-connecting chambers will be constructed on the sewer lines to facilitate house connections as well as inspection of sewer lines. Manholes will be provided at every junction, change of diameter, and for house connections. The manholes will be of Brick Masonary with SR cement mortar and plaster at all places except in water logged area and RCC (with SR cement) cast-in-situ structures for water logged area. It is however advised that looking to the limitations of time for execution, pre-cast manholes should be considered under the sub-project.

Flushing in Upper Ends

124. The upper ends of the sewerage network are expected to face the problem of low flows and therefore chance of deposition of solids/sludge. In this regard, it is understood that PWD-PHED has already procured a sewer cleaning cum rodding machine for its operations in Sohana town where a sewerage network has been recently commissioned. The same machine will be used on a fortnightly basis for flushing of branch sewers in areas where such problems are expected to be encountered.

Sewage Volumes

125. The estimates of sewage flows for the present period and the intermediate and ultimate design stages are presented in table 2.8 below. The estimate for the present stage is determined considering supply level of 70 lpcd while those for the intermediate and ultimate design stages are determined considering supply rate of 135 lpcd. Sewage generation ratio is considered 80%. However, these estimates do not consider contribution from floating population and ground water infiltration, etc. Further, the peak flows for determining the installed capacity for pumping and to cross check hydraulic loading on the treatment plant are determined by considering a relatively lower peak factor of 2.25.

Table 2.8 Estimates Of Sewage Volumes Expected At The Treatment Plant

Year	Contributing population		Average/Dry weather flow		Peak flow
	Pataudi	HM-J	MLD	cum/sec	cum/sec
2010	22,894	15,222	2.1	0.02	0.06
2025	34,341	22,833	6.2	0.07	0.16
2040	41,209	27,400	7.4	0.09	0.19

126. It is to be noted that the present water supply rate is very low which is resulting in very low volumes of sewage generation, almost one third of the intermediate stage estimates. However, after the implementation of a new water supply scheme which is under consideration (and for which a sub-project proposal is structured), the sewage volumes are expected to increase in 3-4 years.

Phasing of Capacity Creation

127. In view of the large difference of 250% between the present and the ultimate design stage dry weather flows (DWF), it is decided to create sewage pumping capacity and treatment capacity in two phases. This approach will prevent under-loading of the system and help optimize investments. Moreover considering that there isn't much difference between the intermediate stage and ultimate stage design flows, and the uncertainty in water supply levels, it is proposed to adopt first phase capacity for only 50% of the ultimate stage DWF and then take up implementation of the second phase as and when the first phase works are found to be fully loaded. Works for the second phase may therefore have to be taken up earlier than 2025.

128. In accordance with the above considerations, the pumping and treatment capacities will be created in two phases of 3.75 mld each. The DWF for the first and second phases will be taken as 3.75 mld and 7.5 mld respectively.

Sewage Pumping Station

129. The sewage pumping station is required at the tail end of the sewerage network and just ahead of the sewage treatment plant. It will essentially work as a lift station as its main objective is to take the combined sewage from a depth of around 8 m and put it in the inlet chamber of the treatment plant.

130. The pump configuration is proposed to comprise five working pumps and one standby pump, each having discharge capacity of 0.5 dry weather flow (DWF) (=75 m³/hr). In normal period only two pumps will operate which will provide a discharge capacity of 1 DWF. In times of diurnal peak flow, all five working pumps will operate, offering a discharge capacity of 2.5 DWF and thereby adequately taking care of the increased hydraulic loads. The pumps will work against a total head of 16 m of water column.

Table 2.9 Configuration Of The Sewage Pumping Machinery

Pump No.	Unit	Working pumps					Stand-by
		1	2	3	4	5	
Disc. Capacity	DWF	0.5	0.5	0.5	0.5	0.5	0.5
Cumulative discharge cap	DWF	0.5	1.0	1.5	2.0	2.5	-
	m ³ /hr	75	150	225	330	375	-

131. The rising main is proposed to be of 300 mm diameter K9 DI pipe. In view of the location of the pumping station being within the treatment plant complex, the length of the rising main will also be very limited.

Quality of Wastewater and the Discharge Standards

132. As per the sampling carried out in the month of October 2009, the quality of raw sewage as found at the existing outfall is presented in the following table. The corresponding wastewater quality discharge standards as per the Environment Protection Act, 1986 are also presented alongside.

Table 2.10 Quality Of Raw Sewage And Effluent Discharge Standard.

Sl. No.	Parameter	Unit	Raw sewage	Discharge standards	
				Water body	land
1.	pH	-	6.82	7 - 8.5	7 - 8.5
2.	Total suspended solids (TSS)	mg/l	213	< 50	< 200
3.	Biological Oxygen Demand (BOD)	Mg/l	196	< 30	< 100
4.	Chemical Oxygen Demand (COD)	Mg/l	410	< 100	-
5.	Faecal Coliforms (restricted irrigation)	MPN/100 ml			
	- Desirable		NA	-	1,000
	- Max. permissible		NA	-	10,000

133. Note : Faecal coliform norms correspond to treated effluent to be used for irrigation of edible crops which are usually not eaten raw.

134. In view of large difference between the quality of raw sewage and the discharge standards and to comply with the requirements of the pollution control authority, it is essential to provide for treatment of sewage and accordingly this component has been included in the overall scheme under the sub-project. Further, although the treated wastewater is proposed to be used for irrigation for most part of the year, it will also have to be disposed of directly into a water body during monsoon and therefore the treatment scheme will have to conform to a comparatively stringent criteria as provided in the Table 2.10 above. The subsequent section deals with the relevant aspects of treatment, available technology options, etc.

Treatment Technology Options

135. Seven different available and proven technology options for sewage treatment have been evaluated on a rigorous criteria involving diverse parameters e.g., process performance/efficiency, stability, liability of sludge treatment and disposal, level of mechanisation, energy consumption, land requirement, skill requirement, capital and operating costs, etc. The options comprise (a) conventional activated sludge process (b) UASB followed by a polishing pond (c) extended aeration (d) conventional trickling filter (e) waste stabilisation pond (f) facultative aerated lagoon, and (g) 'Moving Bed Bio-reactor' (MBBR). This comparison is presented in Table 2.11.

Table 2.11: Comparison Of Available Sewage Treatment Technology Options

Parameter	ASP	UASB +FPU	Ex. Aeration	FAL	Trickling filter	WSP	MBBR
Foot print (ha/mld)	0.2	0.3	0.15	0.3	0.3	2.8	0.1
Treatment efficiency (%)	85-92	< 75	> 95	85	90	90	>95
Power consumption (Lakh units/mld/yr)	1.2	0.05	1.8	1.2	0.7	0	0.9
Sludge liability	High	Low	Low	Low	Medium	Low	Low
Skill required	High	Medium	Medium	Low	High	Low	Medium
Life cycle cost (Rs. Lakh/mld)	141	78	155	141	129	173	113

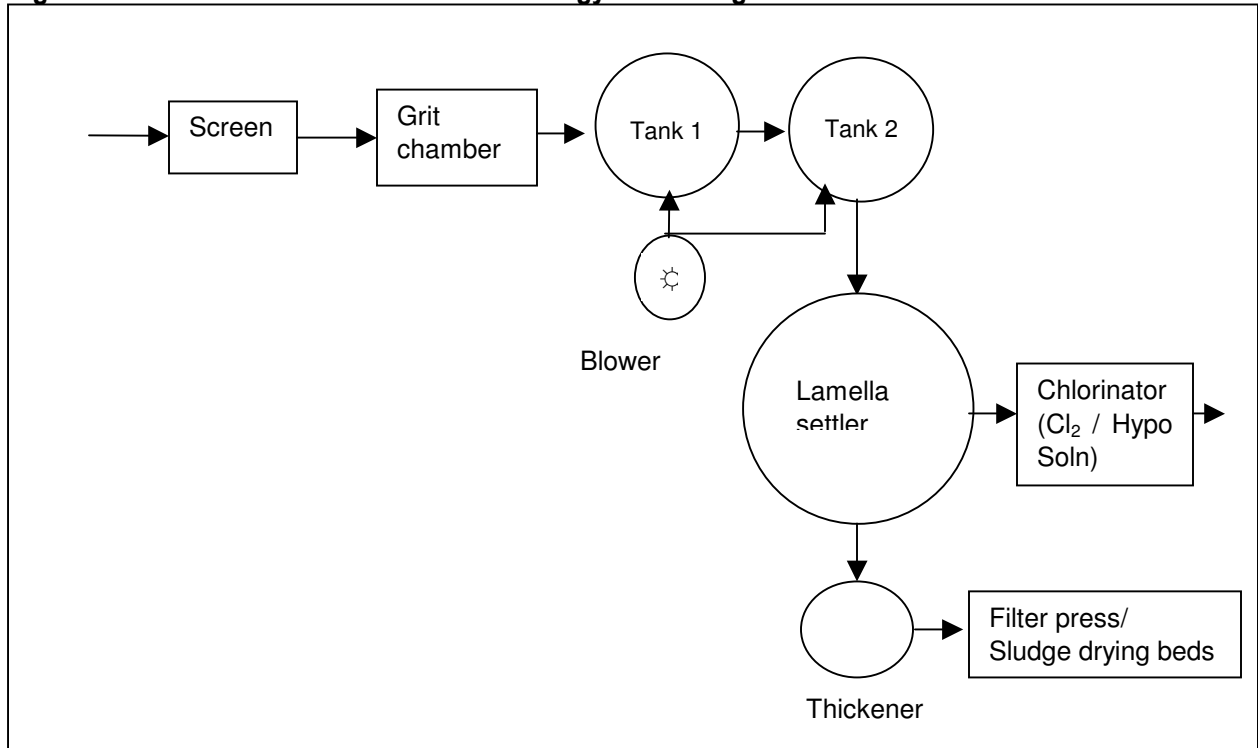
136. Based on this evaluation, the sub-project has decided in favour of MBBR, a compact system which offers the key advantages of low foot print, relatively lower power requirement, least liability of sludge treatment (no digestion required) and disposal, significantly higher treatment efficiency, high process flexibility, stability and robustness, simple and reliable operation, absence of odour and emission of corrosive gases, improved aesthetics, and finally the second lowest life cycle costs. The key deciding aspect has been the low foot print entailing lower land acquisition and lower land costs.

Treatment Scheme

137. MBBR is a hybrid technology which involves maintaining a very high population of active bacteria in attached and suspended form in the reactor. The bacteria are kept attached on small plastic rings and the bed of rings is kept in fluidized form / suspension through vigorous mixing of compressed air. As a result of this arrangement while the technology does not require sludge recirculation but at the same time it enables operation on a very low 'food to micro-organism' (F/M) ratio.

138. As shown in the process flow sheet above, the treatment scheme will comprise preliminary treatment in the form of screening at two stage i.e., prior to pumps and then after the pumps and a grit chamber. The scheme does not involve primary sedimentation, instead the wastewater will be directly let into MBBR reactor for biological treatment. There are two such reactors in series, each with a detention time of 45 minutes. On account of operation on low F/M ratio, the sludge that is produced is stabilized/digested and therefore the scheme also does not require the step of sludge digestion. The process design parameters / loading criteria are provided in Table 2.12 below.

Figure 2.5 Flowsheet Of MBBR Technology For Sewage Treatment



139. The technology is proven and available in common domain as there are several providers in north India alone. Thus the selection of this technology is found to be appropriate under the given situation.

Process Design Criteria For 'Moving Bed Bio-Reactor Sewage Treatment Technology Option

Parameter	Unit	Value
Organic loading	kg. BOD/m ³	1.2
Media surface area	m ² / m ³	250
Media loading rate	gm. BOD/m ²	20
Oxygen supplied	kg/ kg. BOD	1.2

140. Subsequent step involves clarifier which will help in removal of the bio-flocks. Typically a tube settler is provided because of its low foot print and high efficiency. Tertiary treatment will only involve chlorination so as to ensure compliance with the discharge norms on faecal coliforms.

Capacity and Phasing of the Treatment Plant

141. As described in a preceding section on flow estimates, the capacity of the sewage treatment plant in the first phase is kept at 3.75 mld. Although the intermediate design stage is considered as 2025, but depending on the growth of population, water consumption and sewage generation, the second module of equal capacity can be created earlier to meet the increased loads.

142. Based on these considerations, the STP will be constructed in two modules/phases, while the land acquisition will correspond to the full requirement. As explained earlier, the pumping capacity will also be developed in phases.

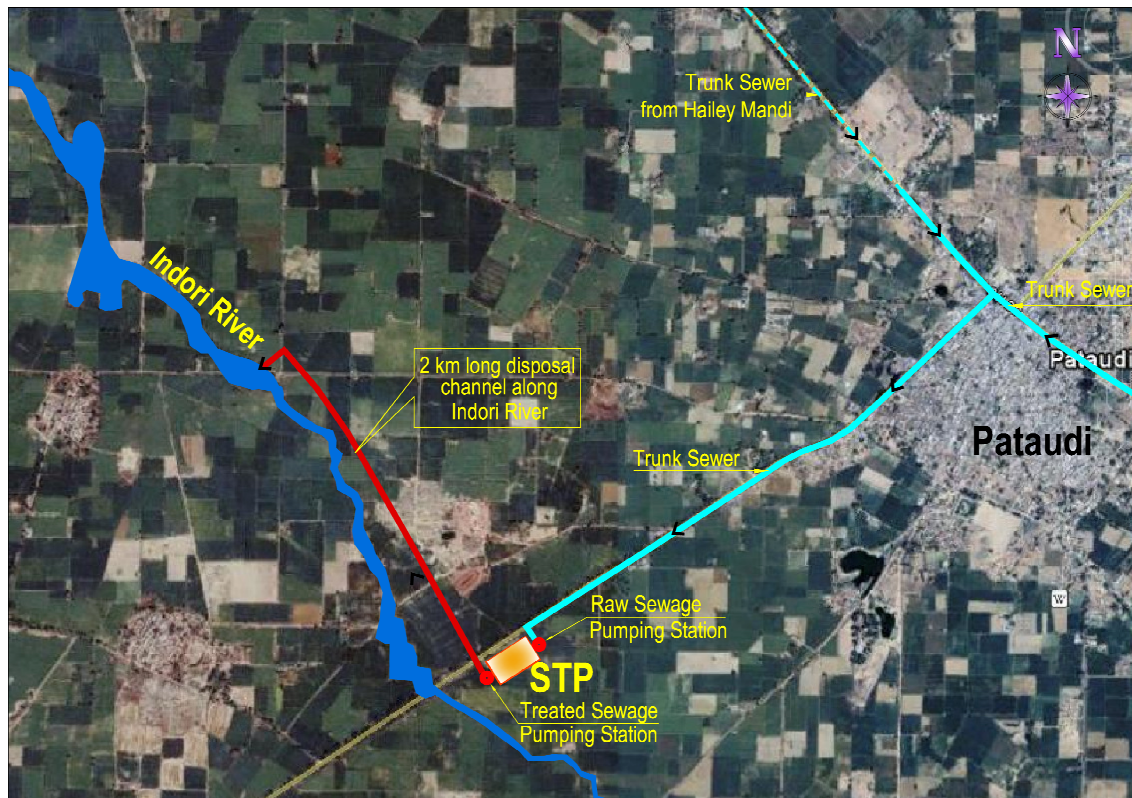
Siting of the Treatment Plant

143. The STP is proposed to be located within 2 km from Pataudi town on the Gurgaon-Rewari Road. As shown in Figure 2.8 the proposed site is an agriculture field which is on the side of the road and also close to a local rivulet called Indori River. This rivulet eventually joins Sahibi river which is a tributary of River Yamuna and joins the latter in the Delhi stretch via the Najafgarh drain. The sub-project involves acquisition of about 2.04 hectare of land for construction of STP and pumping station.

Disposal of Treated Sewage

144. The treated sewage will be discharged either into the Indori River or used for irrigation in the agriculture fields in the vicinity. PWD-PHED proposes to auction the rights for use of treated wastewater on an annual basis. Past experience shows that farmers prefer to use treated effluent during dry season and are typically prepared to pay a price of Rs. 100 per million litre. In view of this possible use, it becomes all the more necessary to include chlorination as the final treatment step.
145. In order to help dispose off the treated effluent to agriculture fields in the vicinity, the sub-project includes the component of a final pumping station after the STP and a short channel for 17 mld upto the Indori Drain, approximately 60m long. However, based on field investigations it is perceived that the Indori Drain does not have adequate discharge capacity at or near the proposed point of disposal and it can lead to formation of a lagoon near the culvert/road embankment and inundation of adjoining agriculture fields.
146. However as shown in the Figure 2.9 the Indori River is found to widen about 2 km on downstream and offers fairly adequate discharge capacity. In view of this, it is suggested to consider inclusion of additional works viz., (a) a pond of 6 hour holding capacity within the STP compound (b) a small overflow weir, and (c) a channel of about 2 km until it joins wider section of the drain downstream. These measures will completely address the concern on inadequate discharge capacity of Indori River on one hand while enabling use of water for irrigation as well as contribute to natural recharge.

Figure 2.6 Position Of Indori River In Relation To The Stp



Difficulties Anticipated in Implementation

147. Pataudi being a small town with rural and agrarian background, some of the areas are going to be congested and unplanned. In such areas, excavation of trenches and laying of sewer lines can be difficult. In very small stretches the depth of excavation is seen to be relatively deep, going as much as 7 to 8 m. In all these cases appropriate methods and scheduling will have to be adopted to avoid inconvenience to the residents or disrupt commercial or other usual activities in the town. All additional expenses to be incurred towards such working conditions have been taken in to consideration while estimating the cost of project.
148. Slow pace during monsoon season: work is expected to proceed at a slow pace during the monsoon season, which is spread from June to September. This will be applicable for both, the sewer laying as well as construction of treatment plant.
149. Interception of sewage flows from Hailey Mandi : In absence of a conventional sewerage network in Hailey Mandi, it likely that the estimated sewage volumes from this town may not be reaching the STP and the latter may remain under-loaded. A separate sub-project for providing sewerage network in Hailey Mandi needs to be developed to maximize achievement of the objectives of protecting public health.

150. Land acquisition for the STP could be a long drawn process and could delay the implementation. However, given the new policy of the GoH which offers liberal compensation, there will be less resistance in giving the land.

Cost Estimates

151. The cost of the sub-project is estimated to be Rs. 120.6 Million / US\$ 2.57 Million. A break up of various components is provided in the Table 2.11 below. This cost estimate is arrived at after carrying out a detailed appraisal of the original proposal, discussions with the PWD-PHED officials and consultants and reflect the changes that have been suggested by the TA consultant. This cost estimate therefore represents the revised estimate.

Table 2.11 Capital Costs Of The Sub-Project

Component	Total	
	Rs., Million	US \$, Million
Sewers in Pataudi and common trunk sewers up to the sewage treatment plant	55.60	1.18
Sewage Pumping Station	9.90	0.21
Sewage Treatment Plant and all associated works including independent electric feeder.	15.70	0.33
Utilities at the STP	4.80	0.10
Land acquisition	26.10	0.56
Disposal works	8.5.0	0.18
Total	120.60	2.57

152. Costs of an independent power feeder, a standby generator set; and disposal works comprising a sump of 6 hour holding capacity, on overflow weir and a 2 km long drainage channel are included. However, the above estimate does not include the costs of laying sewer lines in Hailey Mandi and an outfall sewer upto Pataudi. These and the components for the northern part of the Hailey Mandi-Jatauli town will be taken up under a separate sub-project.

Operating and Maintenance Cost Estimates

153. The total annual cost of operation and maintenance of the entire scheme comprising sewerage network, pumping stations and the sewage treatment plant is estimated to be Rs. 5.48 Lakh. An itemized break-up is presented in Table 2.12

Table 2.12: Abstract Of The Operation And Maintenance Cost

SL. NO.	Particulars	Annual costs, Rs. Million
A.	Manpower	1.69
B.	Electrical charges	2.07
C.	Consumables	0.75
D.	Repairs & Maintenance	0.00
	- Civil works	0.30
	- Mechanical and electrical	0.52
	- Sewerage network	0.14
	Total	5.47

Prioritisation

154. At the very outset and upon approval of the project, the process of acquisition of land for the STP and the disposal works will commence. Laying of sewer lines in habitations will be taken up on priority according to sub-zones. Work of trunk sewers will be taken up in parallel and in accordance with laying of branch sewers and laterals. In the mean time, the PWD-PHED will mobilize the local municipal council to pass a local by-law/resolution for all residents to connect to the sewerage network. In this regard, it is reiterated that the GoH had already adopted the policy of waiving connection charges.
155. Work of sewage pumping station and the treatment plant will be taken up towards the later part of the sub-project. The disposal works e.g., a pond, a weir and an outfall channel will be implemented in parallel towards the later phase of implementation of STP.

Implementation Schedule

156. The sub-project will be implemented by the PWD-PHED over a period of 3 years from the date of release of loan. A detailed activity wise schedule of implementation/bar chart is presented in Appendix 21. The pre-project phase includes selection of 'project management consultant' and 'design and supervision consultant', preparation of revised DPR, land acquisition, rehabilitation of project affected people, preparation of bid documents, prequalification and selection of bidders for various construction packages and preparation of 'Shifting of Utilities Plan' and procuring of 'Letter of Approval for Shifting' from concerned agencies. This phase is expected to take around 10-12 months.
157. For the implementation phase, the bar chart shows activities according to the sub-works proposed in the DPR i.e. sewer lines, raw sewage pumping station and sewage treatment plant. Two relatively larger items of independent electric feeder and effluent disposal works are also shown separately for ease in project planning and execution.

Procurement Plan

158. As shown in Table 2.13 the procurement plan for goods and works considers only two packages, first for laying of the sewer network and second for the construction of sewage treatment plant and all related works. It is proposed that the contractor / technology provide who will carry out turn key execution of the treatment plant package will also be given the responsibility of trial run, commissioning and operation and maintenance of the STP for at least two years. The corresponding costs are included in the Package II.

Table 2.13 Procurement Packages For Goods And Works

Package No.	Description	Cost		Remarks
		Rs. Lakh	US \$, million	
I	Laying of sewer lines in Pataudi town including branch, lateral and trunk sewers and all appurtenances.	55.60	1.18	Sewer lines in Hailey Mandi will be taken up under a separate sub-project.
II	Construction of sewage treatment plant including raw and treated sewage pumping stations, electric feeder line and disposal works (pond, weir and disposal channel), M&E components, etc.; trial runs, commissioning and; two years of operation and maintenance.	76.10	1.62	A ball park estimate for the annual O&M cost for the entire scheme is Rs. 54.85 Lakh/ US\$ 0.12 Million.
	Total	131.00	2.80	

159. In addition, there will be two separate procurement packages for services viz., engagement of a project management consultant (PMC) and a design and supervision consultant respectively. A detailed procurement plan for all packages is provided in Appendix 28.

Technical Analysis and Recommendations

160. This section provides a set of comments and observations based on an appraisal of the original DPR which was submitted by the PWD-PHED to the NCRPB. These comments and observations have already been discussed with the PWD-PHED and appropriate modifications in the technical design of the sub-project have been incorporated. The scheme described in the preceding sections and the cost estimates correspond to the modified design after incorporating all the suggested changes. However, for the sake of completeness and for ease in revision of the original DPR, the comments and observations are reproduced in the paragraphs that follow.

161. The original DPR is rather comprehensive from technical and costing point of views. However based on a rapid appraisal of the DPR it is determined that additional information is required to strengthen the proposal and establish a case for the project. The required information is elucidated in the paragraphs that follow.

Design Period

162.

Design period for sewerage network, pumping station and sewage treatment plant is considered as 30 years. A longer design period of this order is acceptable for sewerage network, however the same is not justified for the pumping station and the sewage treatment plant, especially when the ultimate design population is not more than 100,000.

163. In the case of pumping station, ideally the civil works should correspond to full 30 years while the pumping machinery at the outset should be for 15 years. In the case of sewage treatment plant in such a small town, generally a modular design approach should be adopted wherein the first module is for an intermediate period of 15 years and second module for an equal period is provided in the second phase. This modular/phased approach will ensure reasonably adequate hydraulic loading of the STP and also offer economy in resource deployment. However, it should be noted that land acquisition should correspond to ultimate requirement.

164. In view of the above arguments, it is recommended that the design of sewage treatment plant, the pumping station and the corresponding cost estimates should be revised considering 15 year period for Phase-I.

Flow Estimates

165. The estimated sewage flows which are based on the assumption of water being available at a rate of 135 litre/capita/day (lpcd) must be justified, while the current water supply level is reported to be only 70 lpcd.

166. Based on the available data it is estimated that the present flow will be only about 28% of the proposed capacity of STP. In order to assess the risk of low hydraulic loading and establish case for construction in two phases, an analysis of the average and peak sewage flows for the present year, intermediate (15) year and the design (30) year should be provided.

167. The DPR must explain how the cost of sewer connection and the connection deposit will be met. It must bring out the latest policy of the GOH which offers a waiver in small towns for connection deposit. The DPR must also provide a quarterly schedule of connections and time frame by when 100% household could be expected to be covered.

Schematic key Diagram

168. An index map showing locations of the three towns relative to New Delhi, Gurgaon and nearest highway, etc. must be provided. This will provide a synoptic view and proper perspective of the project to the decision makers. Similarly a schematic diagram on an A4 sheet showing connectivity of sewerage networks of Pataudi and Haily Mandi, location of sewage pumping station, STP, channel for disposal of treated sewage, receiving water bodies, potential areas for irrigation with treated sewage, etc. and other geographical features of the area should be provided..

Pumping Station and Rising Main

169. Engineering design calculations for the sewage pumping station and the rising main must be provided. The DPR has arbitrarily taken size of 350 mm for the rising main.
170. The pump assembly should ideally be reconfigured corresponding to the dry weather flow (DWF) projections for 15 year period and according to the recommendations of the CPHEEO manual. According to the latter, an ideal pump assembly would comprise 1 pump each of 1DWF, 2DWF and 3DWF respectively with one standby of 1 DWF corresponding to an intermediate stage in year 2025.

Final Disposal of Treated Sewage

171. A map showing the location of the receiving water body and the fields which will utilise treated sewage for irrigation should be provided in the DPR.

Figure 2.7 : Sewage Network

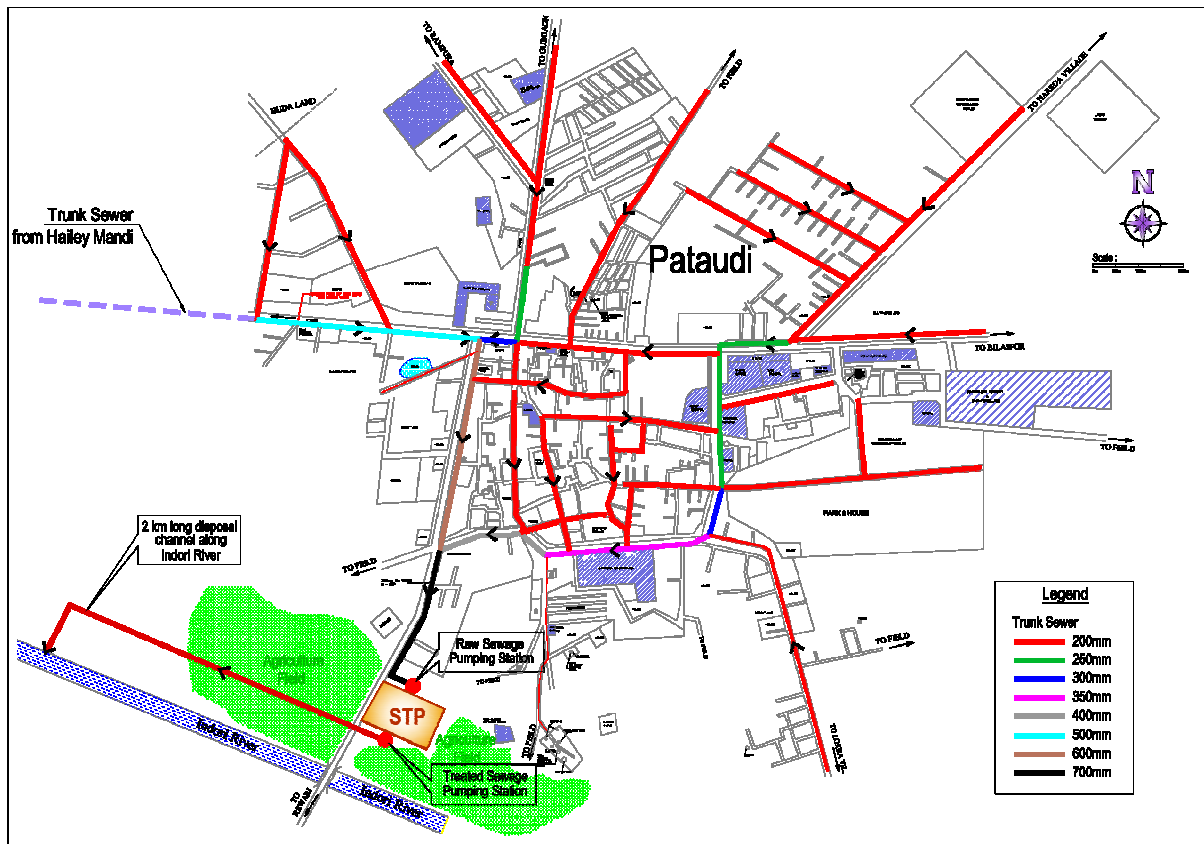
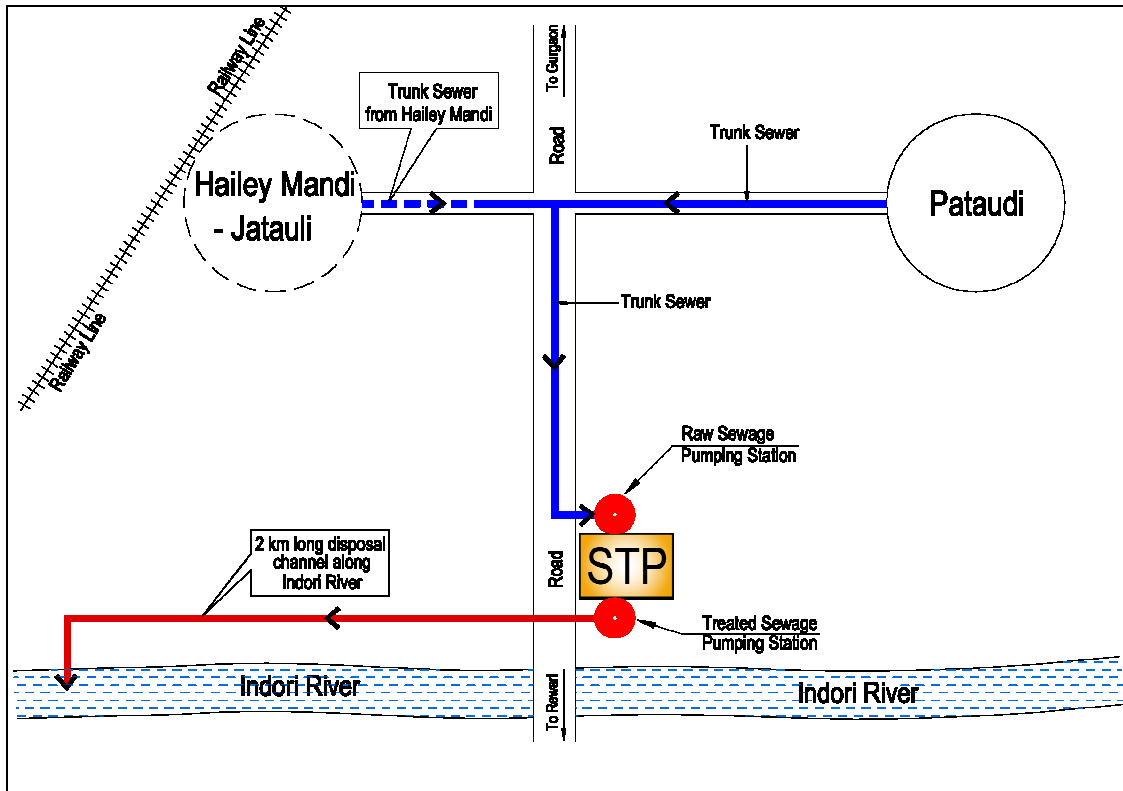


Figure 2.8 Layout Plan For Disposal Of Treated Sewage To Indori River



172. The DPR must categorically specify the level of key water quality parameters e.g., BOD, suspended solids (SS), COD and DO to which the sewage will be treated. For discharge into Indori nalla/river, the treated stream should correspond to discharge standards for disposal into an inland water body. If the treated effluent is to be used exclusively for irrigation, then it should comply with discharge standards corresponding to disposal on land, which entails much lesser degree of treatment.

173. In order to avoid the possibility of stagnation of treated effluent near the culvert/road embankment and inundation of adjoining agriculture fields, it is recommended to include additional works of (a) a pond of 6 hour holding capacity within the STP compound (b) a small overflow weir, and (c) a channel of about 2 km until it joins wider section of the Indori River downstream. These measures will make it convenient for the farmers in the vicinity to lift the treated effluent for irrigation.

Technology for Sewerage Network

174. The DPR proposes conventional sewerage technology, which is a norm of sort. Conventional sewerage requires minimum flow velocity and involves deep excavation. In view of the uncertainty involved in water supply service levels and sewage flows that could be available, large difference between the initial and ultimate stage flows, the minimum velocity of flow in small towns such as Pataudi may not be assured all the time. From that point of view, the DPR should either make provision for equipment that may be required for flushing of sewer lines in the upper end of the network; or it should clearly state availability of such equipment with the PHED.

175. The DPR must address current weakness in the area of solid waste management which can adversely affect performance of the sewerage network. An independent component on SWM by the local municipality addressing some of the related issues would enhance sustainability of the proposed system.

Technology for Sewage Treatment

176. The DPR must establish reasons for not considering the simple sewage treatment technology of waste stabilisation ponds and availability of the selected option of MBBR technology in the common domain. A broad design criteria of the MBBR technology should be provided and measures to overcome the problem of unreliable power supply must be explained.

Exclude Tertiary Treatment

177. It is also noted that a tertiary treatment component is included in the detailed cost estimates of the STP which are provided in the annexure part the report, however it is not described or justified in the main section where the project component or strategy are covered.

178. In view of the stated disposal options of treated sewage either going in to a natural rivulet or used for irrigation, a tertiary treatment component (comprising coagulation and rapid sand filter) represents an 'over design'. A tertiary component represents a rather advanced level of treatment which is usually required for very high end reuse application (e.g., industrial) or when the receiving water body demands very high quality effluent because of its sensitive nature. Evidently under the given setting neither of these considerations applies and therefore the tertiary component is not necessary. Accordingly it is recommended that STP capital cost should be reduced by Rs. 7.5 million.

Institutional Aspects

179. The DPR must establish that the sewerage charges will be collected by PHED from both the towns toward meeting the operating costs of the STP.
180. Experience of the department in construction of STPs and particularly the operation experience of MBBR technology based plants must be elaborated and established. Also provide PHED experience of O&M of sewerage networks and explain how it will take care of this component.
181. An organisation structure of PHED at the circle and division levels should be provided to establish availability of required expertise for construction, supervision and O&M of the STP. In addition, the DPR must explain possible institutional risks to the project, e.g., availability of budget for O&M of the sewerage network, pumping station, STP, etc.

Project Costs and Financial Matters

182. The information on capital cost of the project, O&M cost related to sewage treatment plant, financing arrangement, and available options for revenue generation, etc. is presented at different places in the DPR. There is a need to consolidate this information from the point of view of the decision makers.

Capital costs

183. With regard to the cost of land, the DPR must elaborate on the current policy of the GOH for acquisition and establish the rates which have been used in the estimates. There is a need to justify the rate adopted for land acquisition which is noted to be Rs. 860/sqm.

184. The capital cost estimates of the sub-project need to be revised in view of the comments made in the preceding paragraphs, i.e.,:

- ⇒ Reduced capacity of the STP and sewage pumping station corresponding to the first phase of 15 years.
- ⇒ Exclusion of the tertiary treatment component.

185. Further, the DPR must consider total cost of all works proposed under the sub-project and should not request funding for only that part of the cost that is apportioned to Pataudi while excluding the cost apportioned to Hailey Mandi. By adopting the apportioning approach, the implementing agency will not be able to complete the critical works e.g., pumping station and STP, etc.

O&M costs

186. Information on the O&M costs provided in the main report is incomplete and needs to be quality assured in relation to what has been provided in the annexure on STP cost estimates. The O&M cost computations provided as sub-work 6 in the referred annexure cover expenses related to establishment/manpower, energy, consumables and repairs and maintenance. Total O&M cost is estimated to be Rs. 5.48 million per annum. Although the original DPR has made a provision of two years of O&M costs for funding, the latter must be excluded and a separate proposal to that effect must be made or it must be arranged from internal resources.

Replacement costs

187. The DPR does not discuss the crucial issue of replacement cost for mechanical and electrical equipment which in sewage pumping and treatment works is typically incurred every 8-10 years on account of wear and tear and corrosion. The financial analysis needs to take these costs into account and suitable provisions would need to be made to sustain the plant operation over the entire duration of the design period. The sources of fund for meeting the replacement costs must be explained.

Revenue generation

188. Revenue projection has been carried out for the 30 year design period, however the analysis covers only the population of Pataudi town while the STP will also be serving almost 60% population of Haily Mandi and Jatauli towns.
189. The revenue analysis considers possible income from sale of sludge (@ Rs. 1/kg), treated sewage as irrigation water (@ Rs. 0.1/ kilo litre) and user charges (@ Rs. 6/ water closet). It is determined that the annual revenue from all these sources is very low compared to the annual O&M costs and the DPR makes the case for levying of sewerage charges at a rate of 70-80% of the water charges, however it does not comment on willingness on the part of the users and feasibility to implement this measure. The difficulty in increasing revenue from such streams is acknowledged which makes the case for budgetary allocation for O&M costs from the state government.
190. The DPR must provide a feasibility analysis of the option of selling treated sewage for irrigation and establish willingness of farmers in the vicinity of the STP site to use the treated sewage for irrigation and pay for the facility at an assumed rate of Rs. 0.1 per kilo litre.

Phasing

191. The rational of phasing expenditure/fund requirements in the ration of 27%, 48% and 25% over the three year period must be explained and adequately justified.

Implementation plan

192. The DPR must provide assumptions, qualifying remarks and explanations about feasibility and / or risks of completion of the project in a period of 33 months, highlighting critical items. It must provide a quarterly programme of laying pipelines and upon completion a programme of giving connections to residents.

C. ECONOMIC AND FINANCIAL ANALYSIS

9. ECONOMIC ANALYSIS

Review of Macroeconomic Context. – Water Supply Project

City / Town Profile

193. Pataudi is a small Tehsil town in the Gurgaon District with current (2009) estimated population of around 22,000 (16,085 as per Census 2001). It is located on the Gurgaon – Rewari road at a distance of 25 km from Gurgaon and about 58 km from Delhi.

194. Besides the entire population of Pataudi, the project envisage coverage of another adjoining town of Haily Mandi and seven villages which fall en route the rising main. The total population for which the system has been designed is 112,380 which correspond to year 2040 and a design period of 30 years. The system has been designed considering service levels of 135 litres/capita/day (lpcd) for the urban population and 70 lpcd for the rural population.

195. Major Economic Activity. Both Pataudi and Hailey Mandi are primarily rural habitations where agriculture and related activities are the main sources of livelihood for the majority of the population. Because of their relatively larger size, they have also evolved as trading and service centers for the agrarian hinterland in the region and therefore experiences a fair level of traffic and floating population. However, there is very limited industrial activity in the vicinity of these towns.

196. Its importance in the NCR. Because of its proximity to the rapidly growing city of Gurgaon, being a part of the NCR, having good connectivity with other towns in the region, and expected growth on account of the upcoming special economic zone (SEZ), it assumes significance as an affordable option for absorbing future urban growth. In recognition of this potential of the town, the Government of Haryana has identified Pataudi for strengthening of, among others, water supply and wastewater management infrastructure and thereby to offer improved quality of life to the existing and prospective residents.

Economic Policy

197. Implication on Town's growth. Good water supply service calls for three important benchmarks, viz: a) 'Sufficient Quantity & continuous supply,' b) 'Adequate Water Pressure' and c) 'Potable, Aesthetically Satisfying Water Quality'. Because the state is moderately endowed with water resources and there appear to be more constraints on utilising these resources for water supply. The Millennium Development Goals (MDGs) (Goal No.7) enjoin upon the signatory nations requiring them "to halving the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015" and 100 percent access by 2025. This implies extending coverage to households which are

- presently without improved sanitation, and providing proper sanitation facilities in public places to make cities open-defecation free
198. National Urban Sanitation Policy. National Water Policy approved by the Government of India in April 2002 recommended the following:
- Adequate safe drinking water facilities should be provided to the entire population both in urban and in rural areas. Irrigation and multipurpose projects should invariably include a drinking water component, wherever there is no alternative source of drinking water.
 - Drinking water needs of human beings and animals should be the first charge on any available water.
199. Subsequent national programs like Rajiv Gandhi Rural Drinking Water Mission, Jawaharlal Nehru National Urban Renewal Mission (JNNURM) etc are focusing to improve the water supply situations in rural and urban areas to achieve the goals set in the National Water Policy. The vision of the policy is that all Indian cities and towns become totally sanitized, healthy and livable and ensure and sustain good water supply for all their citizens with a special focus on hygienic and affordable water supply for the urban poor and women.
200. Haryana has 100 percent coverage urban water supply schemes. However, the main problems comprise of intermittent water supply resulting in in-adequate terminal pressures, contamination in distribution network, high amount of UFW and poor customer care. Also unplanned use of ground water sources is resulting in many environmental issues.
201. Eleventh Five Year Plan of Gol with the support of states including Haryana have identified action program to achieve 100 per cent population coverage for better water supply in urban areas.

Review of Sector Context – Water Supply Project

Present Status

202. Despite the increasing importance of the town in the economic growth of the national capital region, the urban infrastructure is not adequate.
203. The water supply system of Pataudi is facing several problems at present. A low level of service in terms of low per capita water supply rate, short hours of supply, insufficient terminal pressure in the outlying areas, and non-uniform spatial supply rate are among these problems. Most of the unauthorized colonies do not receive municipal water supply. These problems affect the water consumption patterns in the following ways:
- Those colonies not receiving municipal water supply use ground water extensively to meet drinking and non-drinking needs of water.
 - Areas connected to the municipal water supply system but located at the tail of service area, use ground water to supplement the municipal supply due to low rate of supply and low

terminal pressure.

- Small household industries and commercial enterprises (dying, dairies, hotels, nursing homes, and hospitals) continue to rely heavily on ground water to meet their demands.

204. Therefore, the inadequacy in provision of water supply is likely to be the major constraint to the potential economic growth in the National Capital Region. Reduction of disparities through targeting less developed areas was a core element of the Government of India's 10th Five Year Plan (2002-2007). The objective of the 11th Five Year Plan is 'faster and more inclusive growth,' citing the issues on inequitable share of growth, which was seen as increasing disparities among states, and regions within states, between urban and rural areas, and between various sections of the community. In order to realize the Five Year Plans, investment into sewerage sector in Pataudi town is necessary.

Justification for Government Intervention to Sector – Water Supply Project

205. The basic urban services include water supply, sewerage, drainage and solid waste management (SWM). All of them are the mandatory functions of urban local bodies (ULB) under the 74th Constitutional Amendment Act (CAA). Unfortunately, immediate transfer of functions from the states to ULB is highly impractical due to the inadequate technical and financial strength of the ULB. Consequently, many of the state governments take initiative on capital investment and operation of water supply and sewerage while delegating SWM to ULB, which require less technical and financial strength than water supply and sewerage. In some states, the state governments take initiative on capital investment on water supply and sewerage projects. On completion of the construction they will be maintained by themselves like in Haryana State and also handed over to the ULBs for operation and maintenance in some states, similar to UP. In Haryana, generally Haryana PWD(WSSD) will develop the sewage project and maintain themselves and this will be applicable to the Pataudi Water Supply scheme also.

206. In addition to being a constitutional obligation, provision of these services has economic rationales for government intervention for the following reasons: (i) many of the services (especially wastewater treatment, drainage and solid waste management) are natural monopolies unsuited to unregulated private investment, and hence justify government intervention at least in regulation; (ii) environmental sanitation improvement (a) protects a public good such as a hygienic environment, and (b) prevents a negative situation arising from pollution; and (iii) poverty alleviation programs minimize the inefficiency in economic growth in the urban areas. The economic rationale for government intervention is therefore sound.

207. As per the vision outlined in the DPR, the specific goals of the sub-project for augmenting water supply in Pataudi and Hailey Mandi in particular are to:

- Raise water supply service level at the consumer end from the present 58 lpcd to 135 lpcd.
- Eliminate dependence on groundwater as the only source of supply considering the concerns on deteriorating quality and declining yield.

- Strengthen and refurbishing existing distribution network to minimise UAW and chances of contamination during supply.
- Install bulk water meters at strategic locations to ensure measurements and effective management of the augmented water supply system.
- Encourage residents to install domestic water meters for gradual shift towards consumption based user charges and thereby increasing service quality.

208. Recognising the challenge faced by the residents of the adjoining town of Hailey Mandi and those of the seven villages which fall enroute the rising main(s), the sub-project adopts a regional perspective and an inclusive approach by incorporating the demands of the said communities.

Demand Analysis – Water Supply Project

209. The water supply service levels for the urban and rural populations have been considered at 135 and 70 lpcd respectively. Total production demand for urban areas has been calculated considering 20% floating population, fire fighting requirements and 15% unaccounted for water (UFW). For the rural areas separate provision for only the UFW at 15% is made. The combined production demand estimates corresponding to various stages of the sub-project are presented in the Table 2.14 below.

Table 2.14 **Estimates Of Water Demand At Production Stage**

	Demand (million litres/day)		
	Present 2010	Intermediate 2025	Ultimate 2040
Urban			
Pataudi	4.74	6.98	8.32
Hailey Mandi	5.02	7.40	8.32
Sub-total	9.76	14.38	16.64
Rural, all 7 villages	1.47	1.91	2.21
Grand total	11.23	16.29	19.35

Water Supply Situation in Pataudi

210. Currently both the urban areas and all of the rural habitations are dependent on ground water as the source of supply. In the case of Pataudi the system comprises 13 odd tube wells with combined yield of about 1.9 million litres per day (mld) considering 16 hours of pumping. In the case of Hailey Mandi the number of tube wells is 14 and the combined production is around 2 mld.

211. From the point of view of water quality, it is found that both in Pataudi and Hailey Mandi this is an area of increasing concern. Pataudi is experiencing increasing levels of dissolved solids. On the other hand, in several wells in Hailey Mandi, besides salinity, the hardness and fluoride levels are found to be almost at the rejection limits. However, groundwater is supplied without any treatment.

212. It is worth mentioning at this point that the Central Ground Water Board (CGWB) has declared Pataudi and the surrounding area as highly water scarce zone. In view of this deteriorating ground water quality, there is a need for developing alternate surface water based supply system for these towns.

213. Proposed water supply project in Pataudi and Haily Mandi Towns including 7 villages is aimed to increase the supply level of 58 lpcd and 50% coverage in 2009 to 135 lpcd and 100% coverage by the year 2040.

Table 2.15 Per Capita Consumption Forecast – Pataudi, Haily Mandi water Supply

City/Town	Current Consumption	Supplied by Piped Water*	Target Consumption	Year	Supplied by piped water in Target Year (2040)
Pataudi Town	100 lpcd	58 lpcd	2040		135 lpcd

*- Only 50% of the population in Pataudi only covered under the piped water supply.

Effective Demand for Water Supply

214. The socio-economic baseline survey¹ was aimed at understanding the perception of the public towards the existing urban civic infrastructure and their service levels including their opinion towards the improvement of these services and their willingness to pay for assessing the 'effective demand'. Though this survey had covered the 'willingness to pay' aspect, it was not given specific focus so as to amend the results to statistical framework.

Identification of project rationale.

215. The present water supply system covers only part of the town area and is with more deficiencies in service delivery.

- Lack of coverage and
- Inefficient functioning of the existing system

Identification of Project Alternatives – Water Supply Project

216. Alternative designs were assessed on three aspects, namely, cost-effectiveness, operation and maintenance capacity of the states governments and ULB, and safety to beneficiaries. The proposed design of the project incorporates that (i) service coverage are limited to municipal area, (ii) selected optimum network with least cost options including size and material for pipes (iii) decision on rehabilitation of the existing system (iv) selection of WTP locations (v) selected optimum technology for WTP operation (vi) selected technologies meet geographical restrictions and can be operated and maintained by the asset owners with minor training, and (vii) materials and equipments are locally available and incur least cost during construction and maintenance, but are internationally accepted as health hazard free. These Assessments are discussed in the design section of this DPR.

¹ conducted as part of the present project (2009) in Pataudi Town (with 0._% sample size with stratified sampling approach giving representation to all administrative wards and all notified slums)

Identification and Comparison of Project Costs and Benefits – Water Supply Project

Economic Cost – Water Supply Project:

217. From the cost estimate discussed in Section of this report, the 'base' project financial cost is estimated to Rs. 794.6 million. Considering the contingency and allowances of additional 10% for Physical contingency, the total project financial cost was worked out to Rs 874 million and this is phased during the three year construction period as follows:

- 2010-11 – 20%
- 2011-12 – 60%
- 2012-13 – 20%

218. For the analysis purpose the tax element of 12% included in the above financial cost has been excluded. Considering the standard procedures recommended for economic feasibility analysis, the above financial cost was converted into economic cost for the analysis.

Project Benefits – Water Supply Project:

219. The main project rationale lies for the rehabilitation of the water supply system for Pataudi Town in filling the demand – supply gap resulted from

- Lack of coverage and
- Inefficient functioning of the existing system

220. Incremental Benefit: This component has a positive effect on the total consumption due to the proposed subproject. The benefit has been evaluated by using the willingness to pay (WTP) for additional consumption in the present analysis².

221. Non-incremental Benefit / (Loss). This is evaluated by the differential price paid by the new households, presently drawing water from other sources of water and standposts, availing the water service connection. Other non-increment benefit in the form of resource cost savings are: (a) tanker water purchase cost saving; (b) storage tank cost saving; (c) water purification cost saving; and (d) time savings. Time savings resulting from water collection, which is more acute in the dry season and is quantified using the opportunity cost of unskilled urban women laborers. Valuation of resource cost savings time savings; water purification cost saving, storage tank cost saving and tanker water purchase cost saving was done by using data and information available for a) time taken to fetch water; b) amount spent on purification of water; c) cost of storage tank and d) amount paid for purchasing water through tanker from the Socio-Economic survey, secondary data and physical enquiries was used.

² The survey adopted Contingent Valuation method to elicit the willingness to pay of the households on water supply and sewerage services since the households are not exposed to the type of services proposed. The samples were distributed in both the municipalities and a few villages. The population was stratified based on income levels of people with input from PHED officials and within each strata samples were chosen randomly proportion to the size of the strata.

222. Exclusions. The following benefits of water supply project have not been quantified for want of adequate data and quantification techniques. These qualitative benefits along with the quantifiable benefits discussed above, the proposed water supply system will tend to provide better living condition in the project town.

- (i) Public cost of treating water borne diseases due to poor environmental sanitation;
- (ii) Effects on businesses and industries, such as aquaculture and fisheries, agriculture and washing; and
- (iii) Effects on tourism and tourist-related businesses.

Economic Feasibility Analysis – Water Supply Project

Analysis Period – Water Supply Project

223. The analysis period of the project is taken as 24 years from the base year 2009-10 for different sections of the project road as follows:

- Base Year 2009-10
- Construction period – 2010-11 to 2012-13
- Project opened start year – 2013-14
- End of the analysis period – 2032-33

Number of operating years after project improvement, considered for economic analysis – 20 years. Thus, 20 years of operation, in effect, from the operation start of the proposed project i.e. 2013-14, has been considered for economic evaluation for the project road.

Economic Feasibility criteria– Water Supply Project:

224. The cost – benefit analysis is carried out by using the discounted cash flow (DCF) technique to obtain the economic internal rate of return (EIRR) and economic net present value (ENPV) for the proposed investments and the likely quantified project benefits linked with the project during the defined project analysis period

Economic Opportunity Cost of Capital (EOCC) – Water Supply Project.

225. Given the complexity of estimating country-specific economic opportunity cost of capital (EOCC), a discount rate of 12% in constant economic prices is generally used as a proxy for EOCC in the economic analysis of ADB-financed projects. The EIRR must be compared with the economic opportunity cost of capital, for interpretation purpose of project feasibility. Results of the analysis are presented in Table 2.16.

Table 2.16 **Economic Cost-Benefit Analysis for Water Supply Component, Pataudi Town**

Details	Present Value (Rs. million) a/
Costs	
Capital costs	484
O&M costs	121
Economic cost for alternate use of water for irrigation purpose	2
Total costs	607
Benefits	
Total Resource Cost Benefits	435
Time savings	291
Incremental Benefits	79
Total benefits	805
Economic Return Measures	
Net present value (Rs. Million)	198
EIRR (%)	15.4

a/ In 2009-10 prices. Discounted to 2009-10 at 12% real discount rate.

Source: Analysis

Sensitivity Analysis – Water Supply Project

226. Sensitivity analysis was carried out to their economic feasibility results for the following scenarios:

- Capital cost increase by 20%
- O&M costs increased by 20%
- Target beneficiaries reduced by 20%
- Delay in accrual of benefit by 1 year
- Combined adverse condition

227. Results of the sensitivity analysis for the proposed project are summarized below in Table 2.17. Detailed calculations are given in Annex 1.

Table 2.17 **Sensitivity Analysis for Water Supply Component (EIRR)**

Details	EIRR	Switching Value c/
Main Evaluation (Base Case) a/	15.4%	
Capital Cost Overrun b/	13.2%	70.8%
O&M Cost Overrun d/	15.0%	431.9%
Decrease in Project Benefits e/	12.6%	54.7%
One Year Delay in Implementation	15.2%	
All Four Tests Combined	10.4%	

a/ From table 2.16

b/ 20% increase in capital cost estimates.

c/ Calculated as the percentage change in a variable required for EIRR to reduce to 12%.

d/ 20% increase in O&M cost.

e/ 20% decrease in project benefits

Source: Analysis

228. Of the four sensitivity scenarios (cost overrun, O&M cost increase, reduced beneficiaries, delay in implementation) reduced benefits is the most vulnerable to EIRR, followed by cost overrun. Considering the more sensitiveness of these variables, following implementation arrangements need to be focused more so as minimize the project risk:

- Ensuring adequate project coverage of beneficiaries through advance commitment from HHs for individual connections or making mandatory for all individual connections through project design;
- Timely implementation of the project through appropriate procurement method in which incentive for early completion may be included;
- Adequate focus for LA and utility shifting related project components so as to avoid project delay

ECONOMIC ANALYSIS - Sewerage Project

Current sanitation arrangements

229. Both the towns are characterized by the practice of on-site sanitation. Given the rural/ agrarian setting, it is also likely that a fair part of the population, especially the poorest may also be resorting to open defecation. Most households having latrines are connected to individual septic tanks and the overflow is let out into open road side drains. Very few houses have septic tanks connected to soak pits or drainage fields. The practice of direct discharge of wastewater into open drains is also prevalent, especially in those houses where space is limited and which are located along large open drains. In monsoon the wastewater from these drains overflows onto roads and at times enters residences, causing a serious threat to public health.

Coverage – Sewerage Project

230. The sub-project will cover entire population of Pataudi and about 63% population of Hailey Mandi-Jatauli which is residing on the southern side of the railway line and where the general slope of the ground is towards the proposed location of the sewage treatment plant. Although Hailey Mandi is about 3-4 km away, the sub-project has adopted the strategy of including part of its population in order to get the benefit of natural flow pattern and scale, and avoid difficult elements of intermediate pumping and a railway crossing. Accordingly the intermediate and ultimate stage populations used for design of various components are as follows:

Economic Cost – Sewerage Project:

231. From the cost estimate discussed in Section of this report, the 'base' project financial cost is estimated to Rs. 120.6 million. Considering the contingency and allowances of additional 10% for

Physical contingency, the total project financial cost was worked out to Rs 133 million and this is phased during the three year construction period as follows:

- 2010-11 – 10%
- 2011-12 – 55%
- 2012-13 – 35%

232. For the analysis purpose the tax element of 12% included in the above financial cost has been excluded. Considering the standard procedures recommended for economic feasibility analysis, the above financial cost was converted into economic cost for the analysis.

Project Benefits – Sewerage Project

233. The survey results indicate that the potential beneficiaries are prepared to pay for the improved services of Sewerage services. The economic benefits considered are:

- Savings in septic tank capital cost;
- Savings in septic tank maintenance cost;
- Savings in days lost due to sickness;
- Reduction in household expenditure on treatment of water borne diseases both considered based on discussions with PHED and Government of Haryana officials and other similar projects;
- Savings in cost of flooding (covering population in Haily Mandi including Jatauli town); and
- User charges

234. **Avoided Economic Cost:** The Socio Economic Survey collected information from sample households and the information collected from secondary sources are used to estimate the economic costs that would be avoided with improved infrastructure services for the project beneficiaries and they include: expenditure on disposing of wastewater; expenditure on treating environmental sanitation related diseases.

235. Exclusion for non-availability of adequate data - the benefits arising out of reduced pollution, reduction in the incidence of diseases and morbidity, improved environment due to cleaner city and the like are not included in this analysis as these could not be quantified and valued.

Economic Feasibility Analysis – Sewerage Project

Analysis Period – Sewerage Project

236. The analysis period of the project is taken as 24 years from the base year 2009-10 for different sections of the project road as follows:

- Base Year 2009-10
- Construction period – 2010-11 to 2012-13
- Project opened start year – 2013-14

- End of the analysis period –2032-33

237. Number of operating years after project improvement, considered for economic analysis – 20 years. Thus, 20 years of operation, in effect, from the operation start of the proposed project i.e. 2013-14, has been considered for economic evaluation for the project road.

Economic Feasibility criteria – Sewerage Project:

238. The cost – benefit analysis is carried out by using the discounted cash flow (DCF) technique to obtain the economic internal rate of return (EIRR) and economic net present value (ENPV) for the proposed investments and the likely quantified project benefits linked with the project during the defined project analysis period

Economic Opportunity Cost of Capital (EOCC) – Sewerage Project

239. Given the complexity of estimating country-specific economic opportunity cost of capital (EOCC), a discount rate of 12% in constant economic prices is generally used as a proxy for EOCC in the economic analysis of ADB-financed projects. The EIRR must be compared with the economic opportunity cost of capital, for interpretation purpose of project feasibility. Results of the analysis are presented in Table 2.18.

Table 2.18 **Economic Cost-Benefit Analysis for Sewerage Project, Pataudi Town**

Details	Present Value (Rs. million) a/
Costs	
Capital costs	
Sewerage	96
O&M costs	
Sewerage	29
Total costs	125
Benefits	
Total Resource Cost Benefits	128
Time savings	4
Incremental Benefits	22
Total benefits	154
Economic Return Measures	
Net present value (Rs. Million)	29
EIRR (%)	15.9

a/ In 2009-10 prices. Discounted to 2009-10 at 12% real discount rate.

Source: Analysis

Sensitivity Analysis – Sewerage Project

240. Sensitivity analysis was carried out to their economic feasibility results for the following scenarios:

- Capital cost increase by 20%
- O&M costs increased by 20%
- Target beneficiaries reduced by 20%
- Delay in accrual of benefit by 1 year
- Combined adverse condition

241. Results of the sensitivity analysis for the proposed project are summarized below in Table 2.19. Detailed calculations are given in Annex 2.

Table 2.19 **Sensitivity Analysis for Sewerage Project (EIRR)**

Details	EIRR	Switching Value c/
Main Evaluation (Base Case) a/	15.9%	
Capital Cost Overrun b/	13.0%	54.0%
O&M Cost Overrun d/	15.1%	228.9%
Decrease in Project Benefits e/	11.7%	32.8%
One Year Delay in Implementation	15.8%	
All Four Tests Combined	8.9%	

a/ From Table 2.18

b/ 20% increase in capital cost estimates.

c/ Calculated as the percentage change in a variable required for EIRR to reduce to 12%.

d/ 20% increase in O&M cost.

e/ 20% decrease in project benefits

242. Of the four sensitivity scenarios (cost overrun, O&M cost increase, reduced beneficiaries, delay in implementation) reduced benefits is the most vulnerable to EIRR, followed by cost overrun. Considering the more sensitiveness of these variables, following implementation arrangements need to be focused more so as minimize the project risk:

- Ensuring adequate project coverage of beneficiaries through advance commitment from HHs for individual connections or making mandatory for all individual connections through project design;
- Timely implementation of the project through appropriate procurement method in which incentive for early completion may be included;

243. Adequate focus for LA and utility shifting related project components so as to avoid project delay

Distribution of Project Benefits

244. Distributional analysis, which leads into calculation of the Poverty Impact Ratio (PIR) i.e., the proportion of project net benefits accruing to the poor, is presented in Table 2.19A.

245. Assumptions followed in the analysis include:

- The financial effects statement for the water supply and sewerage subprojects has been adjusted by non-monetized outputs and resource cost savings. Appropriate factors for converting financial prices of resource cost savings and user charge revenue to economic prices have been used (to adjust to taxes, unskilled labour wage rate and shadow exchange rate);
- Economic values have been expressed in domestic price;
- The effect of subproject financing has been excluded;
- The effects of loss of access and other types of disruption to residents and business due to works during the construction have been excluded; and
- All values are presented in the net present value (NPV) at 12 percent discount rate and calculated for the year 2009-10.

246. Main features of the distribution analysis for Pataudi Town are presented in Table and indicate;

- The financial effect statement indicates that the financial results for the Project are with a net gain of Rs. 298 million in NPV terms;
- The economic effect statement indicates that the economic results for the subproject are with a net gain of Rs. 231 million in NPV terms;
- The net economic benefits of the sub project exceeded the net financial benefits by Rs. 298 million in NPV terms;
- The main beneficiaries of the subproject are Households in Pataudi (Rs. 294 million in net present value terms discounted at 12 percent).
- Other gainers are unskilled laborers engaged during construction and maintenance (Rs. 19 million, in net present value terms discounted at 12 percent).

247. The assumptions used to estimate the poor proportion of each group identified in the Table are detailed in footnotes to the table. Poor households have been defined in terms of those living Below Poverty Line (BPL) and Poor. The analysis shows that the Poverty Impact Ratio (PIR) for the subproject in Pataudi is 65 percent.

Conclusion – Sewerage Project

248. The main evaluation has indicated that the proposed water supply sub project for Pataudi, Haily Mandi Town including seven villages and sewerage sub project for Pataudi Town and Haily Mandi (63% population connected to Trunk Sewer) town was found to be economically viable, with the calculated EIRR values exceeding the economic opportunity cost of capital. The sensitivity analysis has demonstrated the robustness of this result.

249. Furthermore, for the proposed water supply subproject, the calculated EIRR value is considered minimum estimates of economic return, as there are a number of economic benefits of reduced water pollution related issues, improvement in sanitation, tourism benefits and a cleaner city that have not been quantified.

Table 2.19A Distribution of Project Benefits and Calculation of Poverty Impact Ratio (Present Value at 12% Discount Rate)

Details	Financial Effects	Million) Conversion Factor	- Subprojects, Economic Effects	Economic minus Financial	Distribution of Project				
					Households	Unskilled labour	ULB	Government	Total
Benefits									
Non-monetised Outputs ^{b/}			294	294	294				294
Resource Cost Savings ^{c/}	563	0.94 ^{e/}	530	(34)				(34)	(34)
User Charges	101	1.00	101						
Total	664		925	261					-
Costs									-
Capital Cost - Unskilled labour	67	0.72 ^{f/}	48	(19)		19			19
Capital Cost - Land									
Capital Cost - Other costs	514	0.97	499	(15)				15	15
O&M - Unskilled labour		0.72 ^{f/}	-	-		-			-
O&M - Other costs	150	0.98	147	(3)				3	3
Total	731		694	(37)					-
Net Benefits^{f/}	(67)		231	298					-
Gains & Losses^{g/}					294	19	-	(15)	298

Calculation of Poverty Impact Ratio

Percentage of Poor ^{h/}	46%	100%	46%	18%
Benefits to poor	134	19	-	(2.7)
Total benefits to				150
Total project				231
Poverty Impact Ratio				65%

Notes:

a/ 12% for Water Supply and Sewerage Components.

b/ Collection time savings

c/ Resource cost savings from overhead tank capital cost and non-incremental benefit

d/ Adjusts for taxes (12%) for local costs.

e/ Adjusts for taxes at local costs and shadow wage rate.

f/ Calculated as Total Benefits - Total Costs.

g/ Calculated as sum of gains and losses

h/ Considers only Poor of Socio-economic categories whose monthly HH income is less than Rs 2500

Annex 1

Pataudi Water Supply Project

		Benefit				Total	Investment	OM	Cost		Total	Net	Sensitivity			Worst Scenario (all combined)	One Year Delay	
		Labor cost saved (stand post user)	Storage tank cost saved	Saved Cost of Water Purchased	Saved Purification Cost				Incremental Benefit	Economic Cost of alternate use of water			Capital Cost Over-run by 20 %	O&M Over-run by 20%	Benefits reduced by 20%			
1	2010	0	0	0	0	0	144,887	0	0	144,887	-144,887	(173,865)	(144,887)	(144,887)	(173,865)	-72,444		
2	2011	0	0	0	0	0	434,662	0	0	434,662	-434,662	(521,595)	(434,662)	(434,662)	(521,595)	-72,444		
3	2012	0	0	0	0	0	144,887	0	0	144,887	-144,887	(173,865)	(144,887)	(144,887)	(173,865)	-434,662		
4	2013	45,680	9,996	48,231	18,991	16,616	139,514	0	22,724	362	23,086	116,428	116,428	111,883	88,525	83,980	-144,887	
5	2014	46,895	266	49,514	19,492	10,826	126,993	0	22,724	362	23,086	103,907	103,907	99,362	78,508	73,964	116,428	
6	2015	48,735	403	51,457	20,215	11,571	132,382	0	22,724	362	23,086	109,295	109,295	104,750	82,819	78,274	103,907	
7	2016	50,602	408	53,428	20,949	12,328	137,716	0	22,724	362	23,086	114,629	114,629	110,085	87,086	82,541	109,295	
8	2017	52,495	414	55,427	21,694	13,097	143,126	0	22,724	362	23,086	120,040	120,040	115,495	91,415	86,870	114,629	
9	2018	54,413	420	57,453	22,450	13,877	148,613	0	22,724	362	23,086	125,526	125,526	120,982	95,804	91,259	120,040	
10	2019	56,358	426	59,506	23,217	14,668	154,175	0	22,724	362	23,086	131,089	131,089	126,544	100,254	95,709	125,526	
11	2020	57,620	276	60,838	23,746	15,213	157,693	0	22,724	362	23,086	134,607	134,607	130,062	103,068	98,523	131,089	
12	2021	58,876	275	62,164	24,274	15,758	161,347	0	22,724	362	23,086	138,261	138,261	133,716	105,991	101,447	134,607	
13	2022	60,125	273	63,484	24,803	16,303	164,989	0	22,724	362	23,086	141,902	141,902	137,358	108,905	104,360	138,261	
14	2023	61,369	272	64,797	25,331	16,848	168,617	0	22,724	362	23,086	145,531	145,531	140,986	111,808	107,263	141,902	
15	2024	62,606	271	66,103	25,860	17,394	172,233	0	22,724	362	23,086	149,147	149,147	144,602	114,700	110,155	145,531	
16	2025	63,259	143	66,793	26,185	17,729	174,109	0	22,724	362	23,086	151,023	151,023	146,478	116,201	111,656	149,147	
17	2026	63,906	142	67,476	26,510	18,064	176,097	144,887	22,724	362	167,974	8,123	8,123	3,579	(27,096)	(31,641)	151,023	
18	2027	64,546	140	68,151	26,835	18,399	178,071	0	22,724	362	23,086	154,985	126,008	150,440	119,371	85,849	8,123	
19	2028	65,179	138	68,820	27,160	18,734	180,031	0	22,724	362	23,086	156,945	156,945	152,400	120,939	116,394	154,985	
20	2029	65,805	137	69,480	27,485	19,069	181,976	0	22,724	362	23,086	158,890	158,890	154,345	122,495	117,950	156,945	
21	2030	66,423	135	70,133	27,810	19,405	183,905	0	22,724	362	23,086	160,819	160,819	156,274	124,038	119,493	158,890	
22	2031	67,034	134	70,778	28,135	19,740	185,819	0	22,724	362	23,086	162,733	162,733	158,188	125,569	121,025	160,819	
23	2032	67,637	132	71,414	28,460	20,075	187,717	-1,564,824	22,724	362	-1,541,738	1,729,456	1,729,456	1,724,911	1,691,912	1,687,367	162,733	
							0						0	0	0	0	0	0
Total		1,179,563	14,801	1,245,446	489,599	325,714	3,255,123	-695,500	454,480	7,244	-233,775	3,488,899	3,315,034	3,398,003	2,837,874	2,573,113	3,488,899	
	NPV @ 12%	290,729	7,791	306,967	120,452	78,914	804,854	484,639	120,814	1,926	607,379	197,475	77,906	173,312	36,504	-107,227	169,387	
	EIRR											15.4%		SV				
													SI	SV				
												12%	13.2%	1.4	70.8%			
												12%	15.0%	0.2	431.9%			
												12%	12.6%	1.8	54.7%			
												12%	10.4%					
													15.2%					

Annex 2

Pataudi Sewerage Project

		Benefit					Cost			Sensitivity								
		Saved disability days	Saved medical cost	Septic tank capital cost saved	Septic tank OM cost saved	Saved cost of flooding	Incremental Benefit (user charges + conn fees)	Total	Investment	OM	Total	Net	Capital Cost Over-run by 20 %	O&M Over-run by 20%	Benefits reduced by 20%	Worst Scenario (all combined)	One Year Delay	
1	2010	0	0	0	0	0	0	13,428	0	13,428	-13,428	-16113.7	-13428.1	-13428.1	-16113.7	-6,714		
2	2011	0	0	0	0	0	0	73,855	0	73,855	-73,855	-88625.5	-73854.6	-88625.5	-88625.5	-6,714		
3	2012	0	0	0	0	0	0	46,998	0	46,998	-46,998	-56398.1	-46998.4	-56398.1	-56398.1	73,855		
4	2013	343	389	62,500	2,023	2,107	6,850	74,212	5,483	79,695	68,729	67632.3	53886.5	52789.9	-46,998			
5	2014	405	459	11,194	2,385	2,155	2,451	19,049	0	19,049	5,483	13,566	13565.7	12469.1	8659.4	68,729		
6	2015	466	529	11,194	2,747	2,203	2,678	19,818	0	19,818	5,483	14,335	14334.6	13238.0	10371.1	9274.5		
7	2016	528	598	11,194	3,109	2,251	2,908	20,589	0	20,589	5,483	15,106	15105.8	14009.2	10988.0	9891.4		
8	2017	589	668	11,194	3,471	2,299	3,143	21,365	0	21,365	5,483	15,882	15882.1	14785.5	11609.1	10512.5		
9	2018	651	738	11,194	3,834	2,346	3,382	22,145	0	22,145	5,483	16,662	16662.1	15565.5	12233.1	11136.5		
10	2019	712	807	11,194	4,196	2,394	3,624	22,928	0	22,928	5,483	17,445	17445.2	16348.6	12859.6	11763.0		
11	2020	774	877	11,194	4,558	2,442	3,844	23,690	0	23,690	5,483	18,207	18206.9	17110.3	13488.9	12372.3		
12	2021	835	947	11,194	4,920	2,490	4,070	24,457	0	24,457	5,483	18,974	18974.5	17877.9	14083.0	12966.4		
13	2022	897	1,016	11,194	5,283	2,538	4,290	25,218	0	25,218	5,483	19,735	19735.2	18638.6	14691.6	13595.0		
14	2023	958	1,086	11,194	5,645	2,586	4,516	25,986	0	25,986	5,483	20,503	20503.0	19406.4	15305.8	14209.2		
15	2024	1,020	1,156	11,194	6,007	2,634	4,743	26,754	0	26,754	5,483	21,271	21271.1	20174.5	15920.3	14823.7		
16	2025	1,081	1,226	11,194	6,369	2,682	4,973	27,526	0	27,526	5,483	22,043	22042.9	20946.3	16537.8	15441.2		
17	2026	1,143	1,295	11,194	6,732	2,712	5,204	28,290	0	28,290	5,483	22,797	22797.5	21700.9	17141.4	16044.8		
18	2027	1,204	1,365	11,194	7,094	2,743	5,435	29,036	26,856	55,892	32,339	-3,303	-8674.7	-4400.0	-9110.6	15578.4		
19	2028	1,266	1,435	11,194	7,456	2,773	5,667	29,792	0	29,792	5,483	24,309	24308.9	23212.3	18350.5	17253.9		
20	2029	1,282	1,453	11,194	7,551	2,804	4,988	20,995	0	20,995	5,483	15,512	15512.2	14415.6	11313.1	10216.5		
21	2030	1,298	1,471	11,194	7,645	2,834	5,054	21,220	0	21,220	5,483	15,737	15737.1	14640.5	11493.1	10396.5		
22	2031	1,314	1,489	11,194	7,740	2,865	5,120	21,446	0	21,446	5,483	15,963	15962.5	14865.9	11673.4	10578.5		
23	2032	1,330	1,507	11,194	7,834	2,895	5,187	21,671	-155,448	-133,777	5,483	-149,965	171,636	202725.7	170539.5	167301.8	197294.8	
Total		14,157	16,043	233,333	83,381	42,158	88,129	526,177	5,690	531,867	109,660	115,350	410,828	409,690	388,896	305,592	282,522	410,828
	NPV @ 12%	3,757	4,257	89,203	22,125	12,689	21,721	153,751	96,341	249,092	29,151	125,491	28,259	8,991	22,429	-2,491	-27,589	24,589
	EIRR												15.9%					
														SI	SV			
													12%	13.0%	1.9	54.0%		
													12%	15.1%	0.4	228.9%		
													12%	11.7%	3.0	32.8%		
													12%	8.9%				
														15.8%				

10. FINANCIAL ANALYSIS – SUB PROJECTS

General

250. Detailed financial analyses were conducted to examine the financial viability of the revenue generating subprojects. The analyses were undertaken in accordance with *ADB's Framework for the Economic and Financial Appraisal of Urban Development Sector Projects*. Financial Internal Rates of Return and Average Incremental Financial Costs were calculated and sensitivity analyses were carried out for each subproject. The proposed tariff levels were assessed to ascertain their affordability to the beneficiaries, in particular the low-income group and poor households, i.e. those below the poverty line. PHED of Government of Haryana will implement the Water Supply and Sewerage projects in Pataudi. Financial projections for the PHED division were also performed to determine the financial capability of the MC to implement and operate the subprojects on a sustainable basis.

Assumptions Used in Financial Projections

251. Water and sewerage are currently the responsibility of the Public Health Engineering Department (PHED), Government of Haryana. During the project implementation period until the actual transfer of responsibility, KSUDP and KWA will build the capacity of MC staff in water supply and sewerage asset planning and management. Additionally, KWA in coordination with the MC will identify and map the assets within the MC jurisdiction, conduct asset condition survey and valuation and transfer the assets to the MC.

252. Financial projections performed for the division of PHED consist of projected revenue receipts and revenue expenditures during the assumed implementation period (FY 2010-11 to FY 2012-13) plus 20 years after project completion. The projected revenue receipts include water and sewerage connection and user charges. Government of Haryana (GoH) will provide grants-in-aid in case of shortfall in revenue. The projected revenue expenditures include all recurrent expenditures, including those of the subprojects, to be met from revenue receipts. The financial projections also include the PHED's (GoH's) assumed equity contribution to be met from its own resources in accordance with the financing plan.

Cost Recovery

Water Supply

253. Under the existing tariff, PHED operation is highly subsidized by the State Government. The revenues collected from water sales represent only about 15% of operation and maintenance cost.

254. Water tariff increase proposed in volumetric basis from end of project implementation year @ Rs. 15 per KL in FY 2014. Further 20% increase has been proposed in FY2019 and thereafter every four years. The analysis shows that the average tariff, for the water supply fully cover incremental O&M costs with their average tariffs higher than AIFC for O&M. Minimum tariff required to recover the full O&M cost is INRs.1.5/KL (at 2009 prices) in FY2014. Under recovery of cost due to constraints in increasing tariff will have to be subsidised by GoH.

Sewerage

255. Presently, PHED levies monthly charge of Rs. 6 per closet seat wherever sewerage system is present. This is too low to cover the operation cost of operations. Proposed sewerage is @30% surcharge on water charges and a connection fee of Rs. 2250 per connection. Like water supply, sewerage operation is subsidized by the State Government. In Pataudi and Haily Mandi towns there is no sewerage system and hence no revenue.

Financial Internal Rate of Return

256. The financial viability of a subproject is assessed by comparing the subproject's Financial Internal Rate of Return (FIRR) with the Financial Opportunity Cost of Capital (FOCC). As proxy for the FOCC, the Weighted Average Cost of Capital (WACC) of the subprojects in real terms is used. FIRR is the discount rate that equalizes the present values of costs and revenues over the subproject life while the WACC represents the cost incurred by the MC to implement the subprojects.

257. The WACC of the subprojects is 5% (real terms). The calculation of the WACC is shown in Table 2.20.

Table 2.20 Weighted Average Cost of Capital

Particulars	Loan	Equity	Total
Weight (%)	75.00%	25.00%	100.00%
Nominal Cost (%)	9.00%	10.00%	
Tax Rate (%)	0.00%	0.00%	
Tax Adjusted Nominal Cost (%)	9.00%	10.00%	
Inflation Rate (%)	5.00%	5.00%	
Real Cost (%)	3.81%	4.76%	
Weighted Component of WACC (%)	2.86%	1.19%	4.05%
Weighted Average Cost of Capital (Real)			4.05%

258. FIRR was calculated for the revenue generating water supply and sewerage projects. The assumptions and approach used in the calculation of the FIRR include: i) all revenues and costs are stated at constant November 2009 prices; ii) all revenues and costs are calculated on an incremental basis, i.e. difference between "with project" and "without project" situations; iii) project capital expenditures are recognized at the time they are incurred; and iv) equipment replacement costs have been included every 15 years.

259. Sensitivity analyses were also carried out to determine the possible effects of adverse changes on the subprojects. The adverse changes are: i) 10% increase in capital costs; ii) 10% increase in O&M costs; iii) 10% decrease in revenues; and iv) one year delay in benefits.

260. The results of the FIRR calculation and sensitivity analyses are summarized in the table below. The details of the calculation and analyses are in Annex 3 to 5

Table 2.21 Summary of Financial Evaluation

Component	NPV @ 4% Rs. Million	FIRR, SI & SV	Base Case	Capital Costs 10%	+ O&M Costs 10%	+ Revenues 10%	- Benefits Delay by One Year
Water	247.5	FIRR (%)	6.3	5.4	6.1	5.1	4.2
				1.6	0.4	2.4	
		SV (%)		61	253	41	
Sewerage	(14.5)	FIRR (%)	3.2	2.4	2.7	1.9	2.3
		SI		3.1	1.5	6.6	
		SV (%)		33	66	15	
Water and Sewerage	233.0	FIRR (%)	5.9	4.7	5.4	4.7	5.3
				2.5	1.0	2.7	
		SV (%)		41	99	38	

NPV = Net Present Value

SI = Sensitivity Indicator (ratio of percentage change in NPV to the percentage change in a variable)

SV = Switching Value (percentage change in a variable required for the NPV to become zero)

Average Incremental Financial Cost and Subsidy

261. In setting the tariff, the appropriate target level to achieve subproject financial adequacy and sustainability is the long run marginal (LRM) cost which includes both the incremental investment and O&M costs. The Average Incremental Financial Cost (AIFC) is regarded as an approximation of the LRM cost. The AIFC for each project was calculated by dividing the present value of the incremental subproject costs streams (capital and O&M) by the present value of the incremental volume of wastewater flow. The costs and quantity streams were both discounted at the WACC of 4%.

262. The following table summarizes the calculation of the AIFC, its relation with the average tariff and the resultant financial subsidy.

Table 2.22: Average Incremental Financial Cost

Particulars	Water	Sewerage	Water + Sewerage
PV of Project Costs @ 4% (Rs. Million)	1,166.46	200.23	1,343.58
PV of Project Revenues @ 4% (Rs. Million)	802.96	193.24	1,443.71
PV of Quantity* @ 4%	33	17.31	28.66
AIFC**	35.56	11.57	46.88
AIFC (Rs./KL) for O&M	9.61	4.30	10.59
Average Tariff**	24.48	11.17	50.38
Financial Surplus (Subsidy)**	(11.08)	(0.40)	3.49
AIFC Recovery (%)	69%	97%	107%

263. The average tariff of the sewerage subproject could not cover fully all its costs.

Beneficiary Affordability

264. The survey indicated a low willingness to pay among the poor and a bit higher willingness to pay from the non-poor for obvious financial reason. The low willingness to pay for improved services among the poor is largely due to: i) relative satisfaction with the present water supply and sanitation services; ii) use of water from street tap, which is the major source of water among the poor, is currently free of charge; and iii) respondents' view that government has the responsibility to provide the services to its residents.

Affordability Analysis

265. An analysis was undertaken to determine if the beneficiaries, in particular the LIG and poor households, could afford the proposed tariff charges. The generally accepted guideline is that the combined charges for water supply and sanitation should not exceed 5% of household income. The average household income gathered in the socio-economic survey (November 2009) and the assumed water usage in 2013-14 were used in the analysis. The analysis tested the projected tariffs that would prevail in 2013-14, with new tariffs introduced in 2013-14. Proposed increase in tariff in FY 2014 is well within the affordability levels and ranges from 2.1 to 2.7% of income for different income group. Meter and connection costs, if included in the BPL/poor group, then it crosses the affordable limit. Under the subproject, cost of meters / connections has been proposed for poor.

Table 2.23 Household Affordability Analysis

Income Group	HH Income*	Mean	Water Usage	in	Water Charge in 2013 at 2009 Price	Sewerage Charge in 2013 at 2009 Price
	Rs./Year.	Rs./Year.	KL/Year.		Rs./Year.	% of Income
HIG	150,000	482	2,910	1.9%	873	0.6%
MIG	84,000	365	1,890	2.3%	567	0.7%
LIG	60,000	243	1,050	1.8%	315	0.5%
UP	30,000	180	630	2.1%	189	0.6%

* Source: November 2009 survey

266. The results of the analysis show that the proposed tariff charges are within the 5% affordability limit. If the poor households would want to continue sourcing their water from the street tap, their monthly charges would even be less since water from street tap would remain to be provided free of charge. No affordability problems therefore are foreseen for the proposed tariff charges.

Project Sustainability

267. The projected financial position of Pataudi Water Supply & Sewerage (WSS) division of PHED is given in Annex 6.

268. Based on proposed tariff increases (introduction of volumetric tariff @ Rs. 15 / KL in FY2014 and 20% in FY2019 and 20% every four years thereafter), WSS division will be able to fully recover its existing plus incremental operation and maintenance. However financial support will be needed from

GoH for meeting the full debt service obligation. WSS division will continue to depend on GoH subsidy till tariffs are substantially revised to ensure O&M cost recovery.

Financial Performance of Government of Haryana

269. As PHED is a department and dependent on State Funds for sustaining its operations till the time proposed tariff increases materialises, the financial performance of GoH has also been reviewed. The past financials of Haryana state is given in Table 2.24. A snap shot of the past financial position of the state government from 2004-05 to 2008-09 reflects growth in both revenues as well as expenditure. The compounded annual growth rate (CAGR) of revenue income from 2004-05 to 2007-08 is 15.37% and revenue expenditure is 9.86%. Thus the rate of growth of revenue income is more than the growth of revenue expenditure, facilitating reduction in revenue deficits from Rs. 24925.4 Million in the year 2004-05 to Rs. 1219.0 Million in the year 2007-08. However this positive trend was reversed in 2008-09 when revenues were affected by the economic slowdown, whereas revenue expenditure went up dramatically. It is hoped that this is a temporary aberration and the state will revert to its trajectory of fiscal prudence. The CAGR of capital receipts from 2004-05 to 2006-07 is 24.20%. The capital receipt growth is compared only for three years as there is an exceptional negative trend in the year 2007-08. The CAGR for capital expenditure for same three year period is 33.22% (35.38% for four years). It may be observed that the CAGR for capital expenditure is more than the capital receipt, which shows that the state is allocating more resources for plan expenditure.

270. The financial performance of the state governments has also been analysed based on 12th Finance Commission, recommendations and compared with NCR states and the national average. The 12th Finance Commission, as part of restructuring of public finances, has recommended certain measures to improve the long term financial sustainability of Centre and state governments. The suggested indicators suggested by the 12th finance commission include the following:

- The Tax to GDP ratio should be improved to 17.6 % by 2009-10
- Debt to GDP ratio to be brought down to 75% by 2009-10
- Fiscal deficit to GDP should be less than 3%
- There should not be any revenue deficit by 2008-09
- Interest payment to revenue receipts to be brought down to 15% in case of state government

271. The above ratios were computed for all four NCR states namely Haryana, Delhi, Uttar Pradesh and Rajasthan and the comparison is shown in Table 2.25.

272. The analysis shows that Haryana has achieved most of the targets in 2008-09 except the revenue deficit and fiscal deficit which has slipped marginally. However due to the slow down in the economy the deficit has increased in the year 2008-09. Even the Centre in its budget has relaxed the norms of gross fiscal deficit by 0.5% for 2008-09 and further 0.5% for 2009-10 to extend the fiscal stimulus to accelerate the growth in economy. Further all other recommendations given by 12th finance commissions have been achieved by the state. The growth rate of gross state domestic product at nominal rates is about 9.35% and 8.02% in the year 2007-08 and 2008-09 respectively. On the whole, Haryana has demonstrated better economic and fiscal management.

Table 2.24 Government of Haryana's Fiscal Indicators

Particulars	Norms	Haryana	
		FY08	FY09
Revenue deficit/GSDP	Zero by FY09	0.12%	2.04%
fiscal deficit/ GSDP	<3%	3.46%	5.39%
Debt/GSDP	<75% by FY10	27.50%	28.61%
Interest payment/ revenue receipts	<15%	11.88%	10.81%
Tax Income/ GSDP	>17.6% by FY10	12.72%	14.41%
GSDP Growth at nominal rates		9.35%	8.02%

Source: RBI Annual report 2008-09 and respective Government website

Table 2.25 Haryana state financials

		2004-05	2005-06	2006-07	2007-08	2008-09
	<i>All in Rs. Million</i>	Actual				Revised Estimates
I	Revenue Receipts					
1	Tax Revenue	80,600	102,800	122,230	132,520	162,230
2	Non-Tax Revenue	30,900	35,740	57,290	64,990	55,480
	Total Revenue Receipts(a) = (1)+(2)	111,490	138,530	179,520	197,510	217,710
II	Capital Receipts					
3	Recoveries of Loans	1570	2900	22,010	2140	3780
4	Misc.Capital Receipts				100	140
5	Public Debt. (Net)	14,600	22,410	8980	30	34,030
	Total Capital Receipts (b) = (3)+(4)+(5)	16,170	25,310	30,990	2270	37,950
	Total Receipts (c) = (a)+(b)	127,660	163,840	210,510	199,770	255,660
III	Revenue Expenditure					
	Non-Plan Expenditure	98,070	107,220	139,990	146,260	176,460
6	On Revenue Account	99,540	106,250	139,080	143,510	172,200
7	Interest Payments	22,350	21,000	22,650	23,460	23,540
	Plan Expenditure					
8	On Revenue Account	14,530	20,150	24,540	31,760	44,950
	Total Revenue Expenditure (d) = (6)+(7)+(8)	136,420	147,400	186,270	198,730	240,700
IV	Capital Expenditure					
	Non-Plan Expenditure					
9	On Capital Account	-1470	970	910	2750	4260
	Plan Expenditure					
10	On Capital Account	12,520	16,920	25,210	34,370	37,300
	Total Capital Expenditure (e) = (9)+(10)	11,050	17,890	26,120	37,120	41,560
	Total Expenditure (f) = (d)+(e)	147,470	165,290	212,400	235,840	282,250
11	Revenue Surplus(+)/Deficit(-) (g) = (a)-(d)	-24,930	-8860	-6750	-1220	-22,990
12	Fiscal Surplus(+)/Deficit(-) (h) = (c)-(5)-(f)	-34,400	-23,860	-10,860	-36,100	-60,630

Source: Haryana state budgets

Annex 3

Water Supply										
Year	Capital Cost	Incremental O&M Cost	Total Outflow	Incremental Revenue	Total Inflow	Net Cash Flow	Capital Cost increased by 10%	O & M Cost increased by 10%	Incremental Revenue Decreased by 10%	One Year Delay
2011	174.9		174.9			(174.9)	(192.3)	(174.9)	(174.9)	
2012	524.6		524.6			(524.6)	(577.0)	(524.6)	(524.6)	(174.9)
2013	174.9		174.9			(174.9)	(192.3)	(174.9)	(174.9)	(524.6)
2014		22.7	22.7	69.8	69.8	47.1	47.1	44.8	40.1	(174.9)
2015		22.7	22.7	61.5	61.5	38.7	38.7	36.5	32.6	47.1
2016		22.7	22.7	63.7	63.7	41.0	41.0	38.7	34.6	38.7
2017		22.7	22.7	65.7	65.7	43.0	43.0	40.7	36.4	41.0
2018		22.7	22.7	68.0	68.0	45.2	45.2	43.0	38.4	43.0
2019		22.7	22.7	84.6	84.6	61.9	61.9	59.6	53.4	45.2
2020		22.7	22.7	105.2	105.2	82.5	82.5	80.2	72.0	61.9
2021		22.7	22.7	107.0	107.0	84.3	84.3	82.0	73.6	82.5
2022		22.7	22.7	109.5	109.5	86.7	86.7	84.5	75.8	84.3
2023		22.7	22.7	111.5	111.5	88.8	88.8	86.5	77.6	86.7
2024		22.7	22.7	137.2	137.2	114.4	114.4	112.2	100.7	88.8
2025		22.7	22.7	140.2	140.2	117.5	117.5	115.2	103.4	114.4
2026		22.7	22.7	142.1	142.1	119.3	119.3	117.1	105.1	117.5
2027		22.7	22.7	144.2	144.2	121.5	121.5	119.2	107.1	119.3
2028	174.9	22.7	197.6	176.1	176.1	(21.5)	(39.0)	(23.8)	(39.1)	121.5
2029		22.7	22.7	178.7	178.7	156.0	156.0	153.7	138.1	(21.5)
2030		22.7	22.7	181.4	181.4	158.7	158.7	156.4	140.5	156.0
2031		22.7	22.7	183.1	183.1	160.4	160.4	158.1	142.1	158.7
2032		22.7	22.7	223.6	223.6	200.9	158.1	142.1	178.5	160.4
2033		22.7	22.7	226.9	226.9	204.2	142.1	158.7	181.5	200.9
Total	1,049.1	454.5	1,503.6	2,579.9	2,579.9	1,076.3	866.5	931.1	818.3	510.9

NPV @ 4.05%	935.1	307.5	1166.3	1592.7	1471.1	247.6	115.4	179.3	106.2	165.6
			FIRR	SI	SV					
Base Case			6.30%							
Capital Costs Increased by 10%		10%	5.08%	2.38	42%					
O&M Costs Increased by 10%		10%	5.75%	0.95	105%					
Incremental Revenue Decreased by 10%		10%	5.06%	2.44	41%					
One Year Delay			4.19%							

Annex 4

Sewerage											
Year	Capital Cost	Incremental O&M Cost	Total Outflow	Incremental Revenue	Total Inflow	Net Cash Flow	Capital Cost increased by 10%	O & M Cost increased by 10%	Incremental Revenue Decreased by 10%	One Year Delay	
2011	13.3		13.3			(13.3)	(14.6)	(13.3)	(13.3)		
2012	73.0		73.0			(73.0)	(80.3)	(73.0)	(73.0)	(13.3)	
2013	46.4		46.4			(46.4)	(51.1)	(46.4)	(46.4)	(73.0)	
2014		5.5	5.5	9.4	9.4	3.9	3.9	3.4	3.0	(46.4)	
2015		5.5	5.5	5.2	5.2	(0.3)	(0.3)	(0.9)	(0.8)	3.9	
2016		5.5	5.5	5.8	5.8	0.3	0.3	(0.3)	(0.3)	(0.3)	
2017		5.5	5.5	6.4	6.4	0.9	0.9	0.3	0.2	0.3	
2018		5.5	5.5	7.0	7.0	1.5	1.5	0.9	0.8	0.9	
2019		5.5	5.5	9.0	9.0	3.5	3.5	2.9	2.6	1.5	
2020		5.5	5.5	11.5	11.5	6.0	6.0	5.5	4.9	3.5	
2021		5.5	5.5	12.5	12.5	7.0	7.0	6.4	5.7	6.0	
2022		5.5	5.5	13.3	13.3	7.8	7.8	7.3	6.5	7.0	
2023		5.5	5.5	14.1	14.1	8.6	8.6	8.1	7.2	7.8	
2024		5.5	5.5	17.8	17.8	12.3	12.3	11.8	10.5	8.6	
2025		5.5	5.5	18.8	18.8	13.4	13.4	12.8	11.5	12.3	
2026		5.5	5.5	19.9	19.9	14.4	14.4	13.9	12.4	13.4	
2027		5.5	5.5	21.0	21.0	15.5	15.5	14.9	13.4	14.4	
2028	26.5	5.5	32.0	26.3	26.3	(5.7)	(8.4)	(6.3)	(8.4)	15.5	
2029		5.5	5.5	27.6	27.6	22.1	22.1	21.5	19.3	(5.7)	
2030		5.5	5.5	27.4	27.4	21.9	21.9	21.3	19.1	22.1	
2031		5.5	5.5	27.9	27.9	22.4	22.4	21.9	19.7	21.9	
2032		5.5	5.5	33.9	33.9	28.5	28.5	27.9	25.1	22.4	
2033		5.5	5.5	34.4	34.4	29.0	29.0	28.4	25.5	28.5	
Total	159.2	109.7	268.9	349.2	349.2	80.3	64.4	69.3	45.4	51.3	

NPV @ 4.05%	140.7	74.2	200.2	209.1	193.2	-14.5	-28.0	-21.1	-33.1	-26.2
			FIRR	SI	SV					
Base Case			3.16%							
Capital Costs Increased by 10%		10%	2.42%	3.06	33%					
O&M Costs Increased by 10%		10%	2.74%	1.50	66%					
Incremental Revenue Decreased by 10%		10%	1.90%	6.62	15%					
Worst Scenario			0.75%							
One year delay			2.28%							

Annex 5

Water + Sewerage											
Year	Capital Cost	Incremental O&M Cost	Total Outflow	Incremental Revenue	Total Inflow	Net Cash Flow	Capital Cost increased by 10%	O & M Cost increased by 10%	Incremental Revenue Decreased by 10%	One Year Delay	Year
2011	188.1		188.1			(188.1)	(206.9)	(188.1)	(188.1)		
2012	597.5		597.5			(597.5)	(657.3)	(597.5)	(597.5)	(188.1)	
2013	221.3		221.3			(221.3)	(243.4)	(221.3)	(221.3)	(597.5)	
2014		28.2	28.2	79.2	79.2	51.0	51.0	48.2	43.1	(221.3)	
2015		28.2	28.2	66.6	66.6	38.4	38.4	35.6	31.8	51.0	
2016		28.2	28.2	69.5	69.5	41.3	41.3	38.5	34.3	38.4	
2017		28.2	28.2	72.1	72.1	43.9	43.9	41.1	36.7	41.3	
2018		28.2	28.2	74.9	74.9	46.7	46.7	43.9	39.2	43.9	
2019		28.2	28.2	93.6	93.6	65.4	65.4	62.6	56.0	46.7	
2020		28.2	28.2	116.7	116.7	88.5	88.5	85.7	76.9	65.4	
2021		28.2	28.2	119.5	119.5	91.2	91.2	88.4	79.3	88.5	
2022		28.2	28.2	122.8	122.8	94.6	94.6	91.8	82.3	91.2	
2023		28.2	28.2	125.6	125.6	97.4	97.4	94.6	84.9	94.6	
2024		28.2	28.2	155.0	155.0	126.8	126.8	123.9	111.3	97.4	
2025		28.2	28.2	159.0	159.0	130.8	130.8	128.0	114.9	126.8	
2026		28.2	28.2	162.0	162.0	133.8	133.8	130.9	117.6	130.8	
2027		28.2	28.2	165.2	165.2	137.0	137.0	134.2	120.5	133.8	
2028	201.4	28.2	229.6	202.4	202.4	(27.2)	(47.4)	(30.1)	(47.5)	137.0	
2029		28.2	28.2	206.3	206.3	178.1	178.1	175.3	157.5	(27.2)	
2030		28.2	28.2	208.8	208.8	180.6	180.6	177.7	159.7	178.1	
2031		28.2	28.2	211.0	211.0	182.8	182.8	180.0	161.7	180.6	
2032		28.2	28.2	257.5	257.5	229.3	186.6	170.0	203.6	182.8	
2033		28.2	28.2	261.4	261.4	233.2	171.0	187.1	207.0	229.3	
Total	1,208.3	564.1	1,772.5	2,929.1	2,929.1	1,156.6	930.9	1,000.4	863.7	923.5	

NPV @ 4.05%	1027.7	338.8	1366.5	1599.5	1599.5	233.0	87.4	158.2	73.1	139.5
			FIRR	SI	SV					
Base Case			5.9%							
Capital Costs Increased by 10%		10%	4.7%	2.5	41%					
O&M Costs Increased by 10%		10%	5.4%	1.0	99%					
Incremental Revenue Decreased by 10%		10%	4.7%	2.7	38%					
One year delay			5.3%							

Annex 6

Pataudi PHED											
Particulars	Projections in Rs. Million										
	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2023-24	2029-30	2032-33
A. Pataudi PHED (Project Account)											
Opening Balance		(96.3)	(417.4)	(534.2)	(493.5)	(464.7)	(434.7)	(403.8)	(36.3)	654.6	1,122.0
<u>Sources of Fund</u>											
Debt Drawdown	144.5	481.7	187.1								
Water Supply											
- Income - Existing	1.1	1.1	1.1	9.0	2.4	2.4	2.4	2.4	2.4	2.4	4.4
- Income - Incremental				59.5	60.9	62.9	64.9	67.1	136.5	181.0	226.9
-New Connection Fees		0.0	8.0		0.6	0.8	0.8	0.9	0.6	0.4	0.4
Sewerage and Sanitation											
- Income - Existing										0.0	(0.0)
- Income - Incremental				3.8	4.3	4.9	5.5	6.1	17.0	27.1	34.2
-New Connection Fees				5.6	0.8	0.8	0.8	0.8	0.8	0.2	0.2
Total- Inflow	144.5	481.7	195.1	68.9	66.6	69.5	72.1	74.9	155.0	208.8	261.7
<u>Disposition of Funds</u>											
Equity Drawdown	48.2	160.6	62.4								
Project Capex	192.7	642.3	249.5								
Water Supply											
- Expenditure - Existing	12.4	12.4	12.4	12.4	12.4	16.0	16.7	17.4	22.2	27.8	30.9
- Expenditure - Incremental				22.7	30.7	32.1	33.5	34.9	44.2	54.9	61.0
Sewerage and Sanitation											
- Expenditure - Existing											
- Expenditure - Incremental				5.5	7.1	7.4	7.7	8.1	10.3	12.8	14.2
Total- Outflow	240.8	802.8	311.9	28.2	37.8	39.5	41.2	43.0	54.4	67.7	75.2
Net Cash Flow	(96.3)	(321.1)	(116.8)	40.7	28.8	30.0	30.9	32.0	100.5	141.0	186.5
Govt Subsidy for Tariff											
Net Cash Flow (after subsidy)	(96.3)	(321.1)	(116.8)	40.7	28.8	30.0	30.9	32.0	100.5	141.0	186.5
Closing Balance	(96.3)	(417.4)	(534.2)	(493.5)	(464.7)	(434.7)	(403.8)	(371.8)	64.2	795.6	1,308.5
Cumulative Closing Balance	(96.3)	(417.4)	(534.2)	(493.5)	(464.7)	(434.7)	(403.8)	(371.8)	64.2	795.6	1,308.5

SECTION 3

DEVELOPEMENT OF MULTIMODEL TRANSIT CENTRE AT ANAND VIHAR, NCTD

3.1 TRANSPORTATION SECTOR STATUS IN NCR – EXISTING SITUATION AND THE DEVELOPMENT PLANS

1. NCR India, or the most commonly known NCR of Delhi or the National Capital Region of Delhi is the name given to the metropolis areas in and around New Delhi - the capital of India. The NCR comprises of the entire NCT of Delhi, eight districts of Haryana, one district of Rajasthan and five districts of Uttar Pradesh with a population of over 371 lakhs in 2001.
2. The sub-region wise distribution of population in NCR as of 2001 is shown in Table 3.1. The NCR population is projected to reach 64 million by 2021 as per Regional Plan 2021.

Table 3-1 Population Distribution of NCR

Sub Region/ Year	Population (Persons)			Decadal growth rate (%)		Share of population (%)		
	1981	1991	2001	1981 1991	1991 2001	1981	1991	2001
NCT-Delhi	62,20,406	94,20,644	1,38,50,507	51.45	47.02	31.28	34.43	37.33
Haryana	49,38,541	66,43,604	86,87,050	34.53	30.76	24.84	24.28	23.42
Rajasthan	17,55,575	22,96,580	29,92,592	30.82	30.31	8.83	8.39	8.06
Uttar Pradesh	69,68,646	90,01,704	1,15,70,117	29.17	28.53	35.05	32.90	31.19
Total	1,98,83,168	2,73,62,532	3,71,00,266	37.62	35.59	100	100	100

Source: Regional Plan 2021

3. NCR transport system includes an extensive road network system of about 36,305 km, a large fleet of public transport bus system operated by state transport undertakings (3144 buses) and private operators, a rail network of about 1000 Km, Metro rail of about 190 Km (90 km is operational as of November 2009 and the rest under construction) and an International airport at Delhi¹.
4. **Road network:** Existing road network in the region shows convergence of five national highways i.e., NH-1, 2, 8,10 and 24 on Delhi and two National Highways namely NH58 and NH91 meet NH24 at Ghaziabad. In addition to this, NH71, NH71A and NH71B also pass through the region. Ten state highways also serve in strengthening the regional road network. Most of the state highways are of single lane or intermediate lane. Though accessibility is good with reasonably good level of road density, mobility is poor with congested roads (poor road condition, capacity constraints, absence of access controlled high speed facilities for inter city travel and poor traffic management).

¹ Source: Integrated Transportation Plan for National capital Region prepared by Consulting Engineering Services(India) private Limited for NCRPB and DMRC and Wikipedia websites

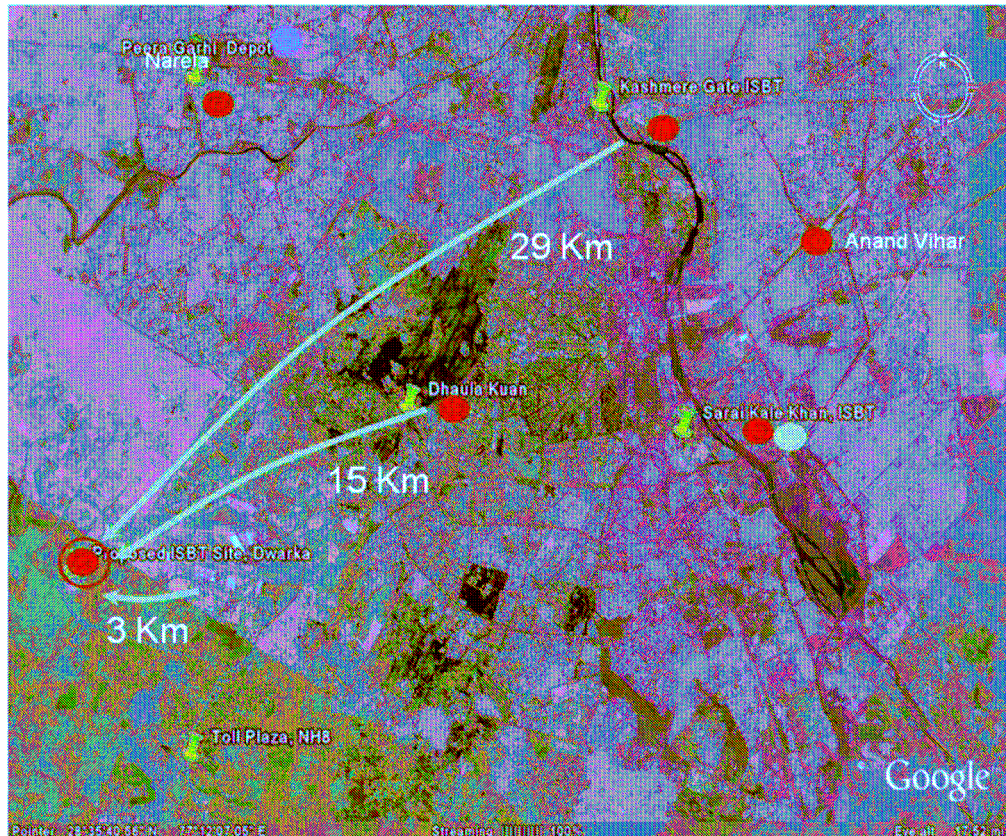
5. **Rail Network:** The NCR rail network covers three zonal railways (Northern, Western and Central) zones and five divisions. The rail network in the region consists of both broad and meter gauges. Five broad gauge railway lines converge at Delhi. The rail network has two specially identified lines known as the Goods Avoiding lines (GAL) and Delhi Avoiding Lines (DAL). The GAL provides a direct entry from Ghaziabad to New Delhi bypassing the congested Delhi Railway Station Complex. The DAL provides a direct passage from the major yards-Tughlakabad and Ghaziabad directly into the Delhi-Ambala-Kalka section and through Lajpat Nagar, Patel Nagar, Daya Basti and Azadpur link. Development of road network alone will not be able to meet the transport demand in NCR. Hence, a supportive rail network will have to be developed for meeting the gap in demand and supply.

6. The Regional Plan-2001 for NCR notified in January 1989 formulated a set of policies for the control of land uses and development of infrastructure in the region. The Functional Plan on Transport prepared and approved by the NCR Planning Board in 1995 envisaged an organized transport network to improve accessibility and the movement of goods and passengers within the region. The Functional Plan on Transport suggested construction of road and rail linkages along the high-density routes, in and around the Capital and also in the National Capital Region. The issues pertaining to the present transport system in NCR could be broadly summarized as follows:
 - The phenomenal increase in the growth of vehicles and traffic in NCR.
 - Development of major town ships, SEZs etc in bordering regions of NCR attracts large number of heavy trucks and passenger traffic to the NCR.
 - Despite measures by way of increasing the length of the road network and road surface space through widening, construction of a number of flyovers/grade separators and, launching of the Metro, the traffic congestion has continued to increase unabated.
 - High rate of accidents, pollution, commuting time, and wasteful energy / fuel consumption.
 - Delhi will host Common Wealth Games on 2010. Special requirements of better congestion free traffic facilities will arise from the mega events such as the Commonwealth Games.
 - Lack pedestrian and bicycle facilities.
 - Limited availability of the land constrains development program.

7. **Master Plan Provisions:** The Regional Plan 2021 for NCR, based on an assessment of the traffic and travel characteristics puts forth a transport system development plan for the NCR. The plan includes the following proposals.
 - To decongest NCT-Delhi roads, rail and rail terminals by diverting the through traffic from Delhi.
 - To provide linkages amongst Metro/Regional Urban Settlements in the outlying areas of NCR.
 - To connect Metro/Regional Centers with the Capital by an efficient and effective transport network for facilitating faster movement of traffic among such centres and NCT-Delhi.
 - To link the Sub-regional Centers with effective and efficient transport network for facilitating the faster movement of traffic among such centers and higher order settlements.
 - To directly link other urban nodes having maximum attracting and generating characteristics.
 - To create the Unified Metropolitan Transport Authority for NCR.

8. The Integrated Multi-Modal transportation Plan prepared for NCR in 2009 in accordance with the policy framework formulated in Regional Plan 2021 propose an investment plan costing US\$ 37 billion over a 25 year period (2007-2032) in the NCR region to meet the growing transport needs. The investments proposed include some of the projects under development since 2007 and new projects. The NCR RP-

- 2021 has proposed extensive development of the transportation system of the region and the Transportation plan developed thus include (1) Large scale road network expansion including Expressways, Regional Arterials, Regional Sub-arterials and Secondary and tertiary road network in sub-regions; (2) Regional rail links and Rail rapid transit systems; (3) Regional metro rail system; (4) Public bus transport system and bus terminals; (5) Logistic hubs; (6) Integrated freight complexes; (7) Highway facilities centers; and (8) Airports.
9. **Airports:** With the growing air traffic, it is suggested to develop an international airport at a suitable location within the region to act as an alternative to the existing international airport in Delhi. In addition, it is also suggested to develop domestic air terminals within the region.
10. **Public transport:** Towards improvement of the public transport systems in the city, the plan suggests the development of a public mass transport system, light rail transit system apart from the modernization and expansion of the existing bus systems. The public transport system exists in the NCR includes the following:
- Buses
 - Rail
 - Delhi Metro
11. **Inter State Bus Terminals (ISBT):** Delhi and NCR have 5 Inter State Bus Terminals at various stages of their lifecycle. Three are operational for many years at Kashmere Gate, Anand Vihar and Sarai Kale Khan. Another two are planned at Dwaraka (south-west) and Narela (North-west). According to the 1998 Supreme Court order for controlling environmental pollution, buses run on diesel are restricted beyond 12 km of distance inside the city. The ISBT's are planned to terminate long distance buses at the outskirts of the city and use city public transport system to travel within the city. The buses within the city are run with CNG which is environment friendly. To enable integration of the various modes of the system, the plan suggests development of modern multi model transit centers at these locations.



3.2 SUB-PROJECT SELECTION

3.2.1 Transport System in Delhi

12. Delhi is planned on a ring-radial pattern with a hierarchical road system comprising of national highways, arterial roads, sub-arterial roads and local streets. The road network is designed for regional, intra-city and local traffic. The capital is well connected to other parts of India by 5 National Highways: NH-1, NH-2, NH-8, NH-10 and NH-24. The Ring Road, Outer Ring Road and other radial roads constitute a distinct feature of the road network in Delhi. Ring Road has a length of about 48 km, of which 16km is common with Outer Ring Road and NH-1. The total road length in Delhi was 31,183 km in March 2006 and is of ring and radial pattern. The road network is being developed and is maintained by NHAI, PWD, MCD, NDMC, DCB, and DDA. The registered vehicles in Delhi have significantly increased over the years. The national capital presently has about 48 lakh vehicles and the share of two wheelers is highest (about 65 percent) and it is also significant to note that about 30 percent of vehicles now in Delhi are cars and jeeps.
13. Buses have an integral and pre-eminent position in Delhi's transport system. This is evident in the last major travel survey conducted in Delhi in 2007- 08, viz. the RITES Primary Survey in 2008. According to the RITES Primary Survey in 2008, the residents of Delhi in 2007-08 generated 21.99 million trips every day, i.e., each resident made an average of 1.37 trips per day. The passenger carriage by DMRC is about 0.65 to 0.75 million passengers per day and buses carry about 7.0 million passengers per day, of which 1.7 million are on DTC buses and 5.5 million on private stage carriage buses. Buses have this

large share of public transportation by virtue of their low usage cost and extensive network, which comprises more than 600 routes with 17 terminals and approximately 5,000 bus stops.

3.2.2 Transport Policy

14. Due to increased usage of personalized transport, the congestion levels are increasing, speeds reducing, and the transportation is becoming a source of environmental and economic problem. Increasing levels of urban congestion create the need for new transportation solutions, including innovative mass transit systems. Perhaps the public transport did not keep pace with growing population and needs of mobility; private vehicles have become predominant mode of transport, particularly in Delhi and generally in National Capital Region (NCR). As a result of this, in spite of vast improvements to road corridors, there are frequent traffic jams all over the Delhi road network. In order to cope up with this issue of urban transport, the Government of National Capital Territory of Delhi (GNCTD) is actively trying to take measures through their transport policy set as: With the objective of achieving a balanced modal mix and to discourage personalized transport, it is proposed to augment mass transport by massive investments accompanied by institutional improvements. The focus, therefore, will be on increasing mass transport options by providing adequate, accessible and affordable modes like buses, mini-buses, electric trolley bus complemented by a network of rail based mass rapid transit systems like metro and commuter rail. Para transit modes like autos and taxis are envisaged to provide feeder services in designated areas catering to work and leisure trips. Non-motorized transport like bicycles and cycle rickshaws will be accommodated. Based on the policy, to deter the use of personalized mode and to promote the usage of transit system for travel in Delhi, measures that have already been initiated include:

- Modernizing ISBT and other bus terminals
- Integrating all modes of public transport
- Development of a world class Metro in NCR
- Induction of high capacity low floor buses into the fleet of Delhi Transport Corporation
- Corporatization of Blue-line buses
- Development of Bus Rapid Transit Corridors
- Development of Light Rail Transit, Monorail, etc.
- Construction of better bus stops

3.2.3 Sub-Project Selection

15. The project selection is based on the transport policy of Delhi. The **proposed MMTC at Anand Vihar** is planned to meet the policy objective of integrated Transit Terminal development. The proposed Multi-Modal Transit Centre (MMTC) will play an important role in facilitating integration of bus, rail and private/IPT modes for travel within the region as well as in facilitating more modal shift to public transport within Delhi and thus contributing to reducing the road congestion.

16. To de-congest Delhi road network, and to provide an integrated transit solution, Government of NCT of Delhi has provided ISBT's on the outskirts of Delhi with a range of modes (local bus, auto rickshaws, etc.) connecting these with rest of the Delhi. At present, three Inter state bus terminals (ISBT) are functioning at Kashmere Gate, Sarai Kale Khan and Anand Vihar which are focusing on the requirement of interstate bus traffic and associated transport needs. The local buses also operate from these terminals providing access to the ISBT from various parts of the city.

17. There is a need for improving the transport infrastructure as stated in the transport policy to keep pace with the rapid development and to achieve this goal, Government of NCT of Delhi has proposed to

develop/redevelop/upgrade Inter State Bus Terminals (ISBTs) in Delhi and the same is also to act as Multi Modal Transit Center (MMTC). It is proposed to upgrade the ISBT at Anand Vihar to a MMTC as it provides an ideal location with Anand Vihar metro rail station and Anand Vihar railway station located next to each other (Figure 3.1). A proper integration of all four modes of public transport which is servicing from Anand Vihar viz. Interstate bus, Local bus, Rail and Delhi Metro is essential to achieve objective to have an integrated multi-modal network of mass transit systems.

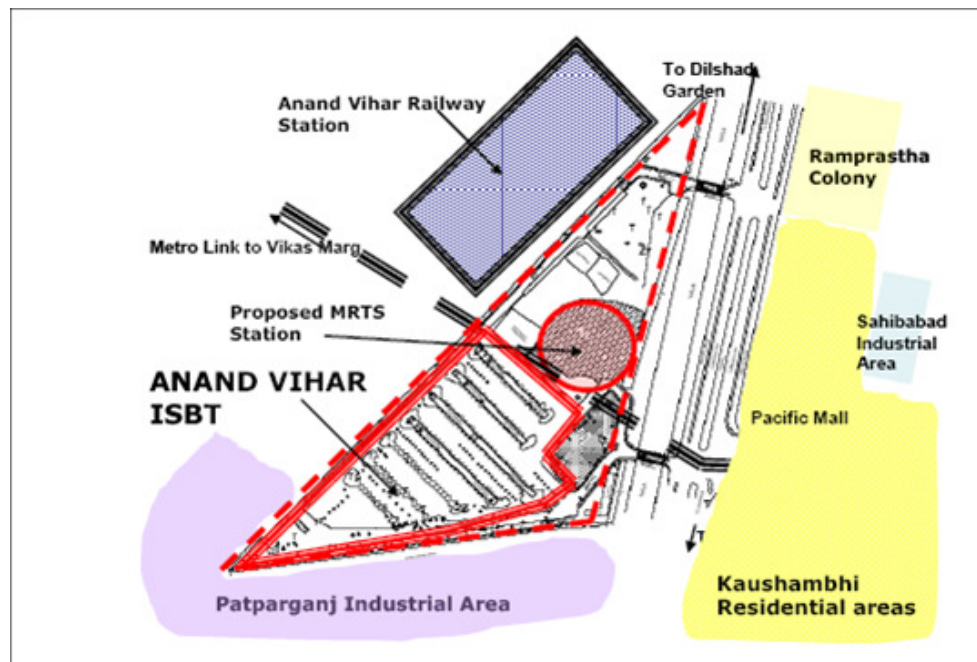


Figure 3.1 Schematic representation of the bus, metro and rail terminal locations

18. The MMTC planned at Anand Vihar will facilitate seamless integration of the inter-city and intra city transit options in the area and largely benefit inter modal transfer by transit passengers with reduced transfer times and improved comfort. This will also have significant impact on the utilization of transit services as transfer between local bus to metro rail and interstate bus/train services become very convenient. The metro station is under construction and will be operational in 2010. It is reported that the Anand Vihar metro rail line will cater to about 100,000 passengers a day with Anand Vihar station being one of the main station on the line. Also the Anand Vihar railway terminal will become a main boarding/ alighting station for trains from East. Most of the trains coming from Uttar Pradesh, Bihar, West Bengal and Orissa would terminate at this station. These two developments will have major impact on the transfers from/to local buses at Anand Vihar and a convenient transfer will have a positive impact on the utilization of the mode combination thus reducing personal modes for access to the metro and train services. Also this will have a positive effect on the metro rail ridership thus further reducing the traffic on the road. The single ticket scheme being developed for bus and metro rail use will further help in this aspect. The passengers will also benefit from the pedestrian friendly design for the MMTC, which will improve the safety of passengers and improved environmental comfort. The proposed MMTC will thus provide significant community benefits and will have a positive impact on the transport movement in the area.

19. The Department of Transport (DoT), Government of NCT of Delhi has retained the service of DIMTS to prepare DPR for development of MMTC at Anand Vihar. The project DPR is complete except for the detailed structural design with all layout and functional design complete. The detailed structural design is in progress and is expected to be completed in December 2009. The project is ready for implementation within few months and the various clearances required are also being processed. DIMTS, a public private partnership promoted by the Delhi Government and IDFC will be entrusted with the operation and maintenance of the facility. The project design incorporates commercial development and an assured revenue stream to ensure the funding of long term operation and maintenance of the facility and the management contract with DIMTS will ensure efficient operation of the terminal. Overall the project meets the requirements of developing modern transport infrastructure in the NCR including the mandate for the proposed ADB loan assistance to NCRPB of fostering public-private partnership in infrastructure development. Thus the sub-project has been selected for consideration under the proposed ADB loan assistance.
20. The technical and background material included in this report have been mainly taken from the DPR prepared for the project. The project layout has been reviewed as part of the PPTA effort and observations on project layout were given to DIMTS and have been incorporated in the design by DIMTS as agreed during the discussion on the project layout. The detailed designs of project elements have not been reviewed by the PPTA Consultant. The economic analysis and financial analysis have been carried out by the PPTA consultant based on the project design and project costing provided in the DPR.

3.3 SUB-PROJECT DESCRIPTION AND TECHNICAL ASSESSMENT

21. The objective of the development of MMTC at Anand Vihar is as listed below:
- To redevelop the existing ISBT as Multi Modal Transit Center (MMTC).
 - To decongest the internal city roads by restricting the flow of inter-state buses.
 - To facilitate an effective multi-modal changeover by integrating the existing ISBT with the Anand Vihar Gate Metro station and Railway Station.
 - To provide a state-of-the-art Multi Modal Transit Center that is user friendly, catering to varied passengers' comfort, pedestrian-friendly, ecologically sustainable, handicapped-friendly, and aided with facilities as per best international practices.
22. The technical assessment of the sub-project has been made based on the review and analysis of the Draft DPR prepared by DIMTS in September 2009. The broad project components are:
- ISBT – Bus bays with boarding and alighting platforms segregated, Idle bays, Washing/Workshop facilities for buses, Booking/Ticketing counters
 - Local Bus Terminal - Bus bays with boarding and alighting platforms segregated.
 - Admin/Terminal office – Includes ISBT administration, CCTV security room, maintenance room and office DTC and other roadways.
 - Offices for DTTDC and other tour operators.
 - Pedestrian Connectivity to Anand Vihar Gate Railway Station and under construction Metro Station.
 - Passenger facilities include dormitories, waiting hall, toilet, cloak room and restaurant/cafeteria.

- Parking facilities include for Auto, taxi, rickshaw and private vehicles
- Commercial retail and office space
- Hotel (space allocated for development by private sector)

23. ISBT Anand Vihar is presently functioning on Triangular shaped plot facing a 60 m arterial road, known as Ghazipur Road in East Delhi. It is one of the key interstate bus terminals of Delhi, catering to city wide population traveling towards the states of Uttar Pradesh, Uttarakhand and Madhya Pradesh. The site lies at the juncture of three key regions, Ghaziabad, East Delhi and Noida. The Anand Vihar Railway station is situated on the west side of ISBT and the Anand Vihar Metro Station under construction is on the north side. The project location is presented in **Figure 3-2**.



Existing ISBT at Anand Vihar



Condition of Existing Auto Stand

24. The Anand Vihar ISBT is adjacent to Patparganj Industrial Area and is approximately 1 km from the main city Ghaziabad (mainly approached through NH-24) and is located in proximity to residential colonies of East Delhi like Patparganj, Preet Vihar, Anand Vihar, Karkarduma and Krishna Nagar and residential areas of Ghaziabad like Vaishali, Indrapuram and Kaushambi. The site is approximately 4km each from the proposed Shahadra C.B.D. (Central Business District) and the Yamuna Games Village.

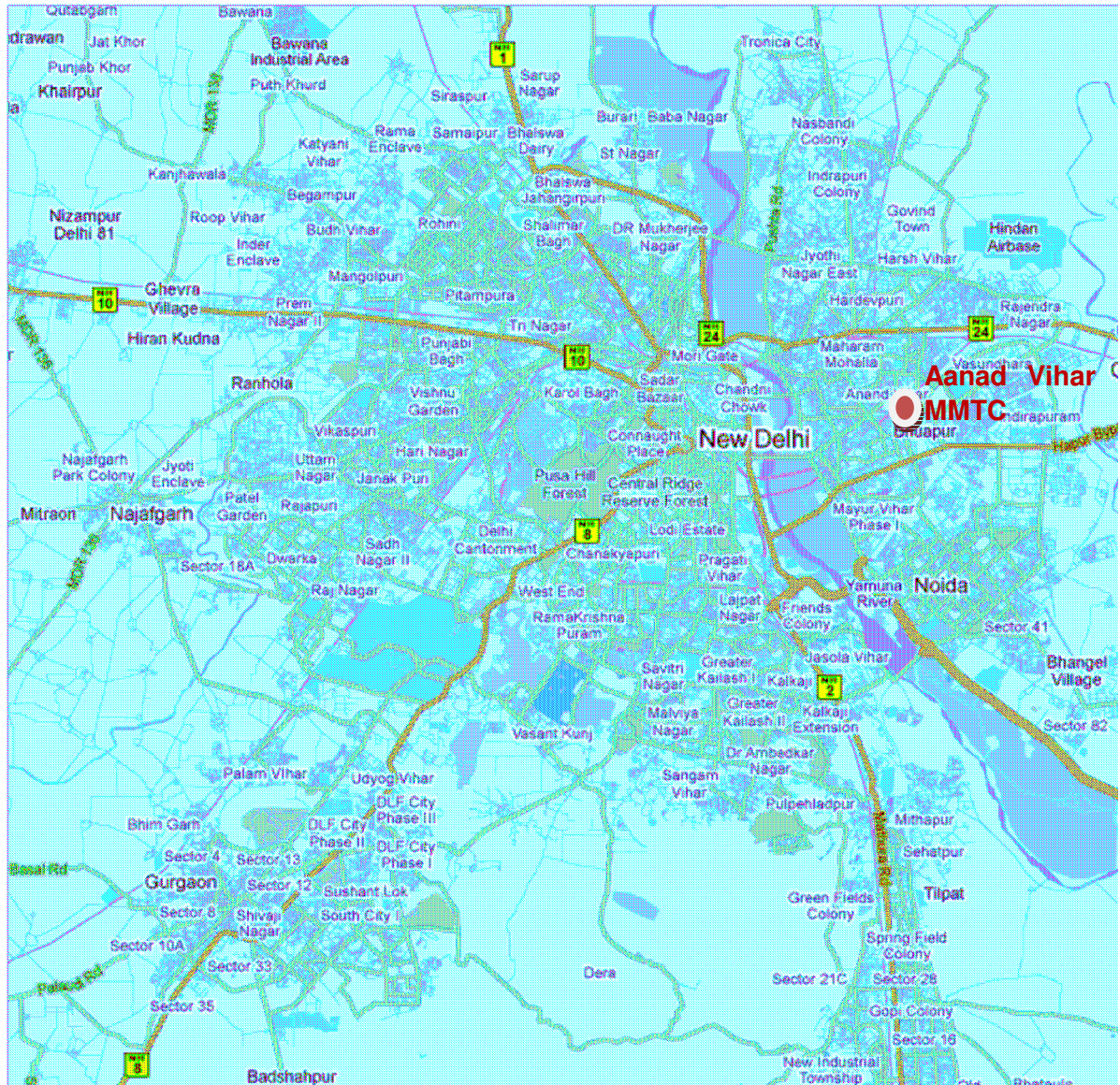


Figure 3.2 Project Location

3.3.1 DPR Surveys

25. Various surveys conducted as part of the DPR was finalized based on requirements of the TOR and the data collected during the site reconnaissance. The surveys conducted as part of the DPR study include the basic engineering, environmental, infrastructure and market assessment survey. Salient outcome of the various surveys are discussed below.

26. **Location and Topographic Survey:** Data mapped as part of the location survey include details of approach road, metro station and other features including utility lines, boundary wall etc. Spot levels at 50m interval were also collected to prepare the contour map of the area. In addition to that details of

drains including L section and cross sections of the drains were also collected. The information collected by the above survey was used for the preparation of layout plan and traffic circulation plan.

27. Soil Investigation and Hydro-geological Survey: Bore hole investigation and laboratory sampling was conducted for 8 locations in the project area as per IS specifications. The result of the bore log investigation was used for the determination safe bearing capacity of the area for various type of foundation. The bearing capacity assessed for isolated square and raft foundation varies from 18 to 24 t/m². No laboratory tests were conducted on soil sample from the project location to find the CBR value of the sub grade soil which is required for the design of road pavement. It is suggested to design the road pavement based on CBR tests of subgrade material to be used.

28. Traffic Survey: The following traffic surveys were conducted to understand the flow of bus traffic:

- Classified count of buses
- Bus Origin Destination surveys
- Bus registration number plate surveys
- Bus occupancy surveys

29. The **Figure 3.3** represents the survey locations.

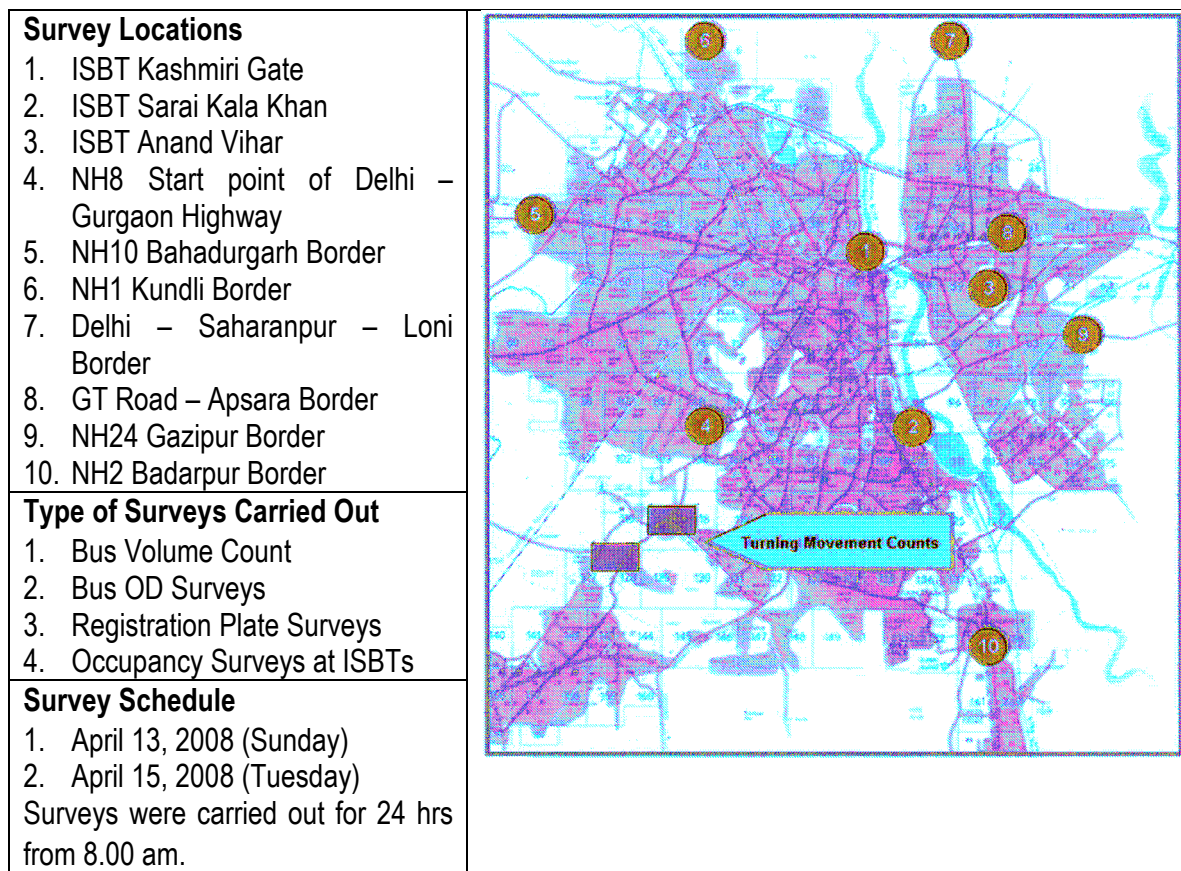


Figure 3.3 Traffic Survey Location

30. The survey covered all the cordon points into which buses generally enters into Delhi and also the three ISBTs where circulation pattern, occupancy etc were also collected. Summary of the traffic count details of Anand Vihar is tabulated in **Table 3-2**.

Table 3.2 Bus Volume Count at ISBT Anand Vihar

Bus Traffic count at Anand Vihar		Number of Trips	
	Based on schedules	Observed on 13-04-2008 (Sunday)	Observed on 15-04-2008 (Tuesday)
Inter State Buses	950	1032	1118
Local Buses	1535	1433	1597
Total Buses	2485	2465	2715

31. A slight increase in number of trips is observed from the given details of trips. The variation is due to recently declared new routes. A lower number of trips are observed on Sunday compared to weekday. This difference is more evident in the case of local buses.
32. From the vehicle occupancy survey carried out at Anand Vihar, it was estimated that the average occupancy of local buses is 35 and that of interstate buses is 17. The average foot fall from local bus is estimated at 79252 and that of interstate buses at 48476. From the difference in foot fall of local buses and interstate bus, it can be inferred that ISBT is also used by public for their local movement. This will definitely increase substantially if there is a proper multi model facility built.

3.3.2 Demand Assessment

33. The requirement for various components of the MMTC which includes bus bays for interstate and local buses, parking space for private vehicle and parking requirement of taxi and auto are analyzed based on the demand survey data and presented in the following sections with comparison of the requirement and design provisions made in the DPR.
34. The requirement of bus bays are assessed based on dwelling time of the buses and the total number of trips. The estimate of dwelling times of intercity buses at Anand Vihar Gate is given in the **Table 3-3**.

Table 3.3 Dwelling Times of Intercity Buses at Anand Vihar Gate

Time Period (Minutes)	Distribution	
	Number	Percentage
Less than 15	88	9.7
15 to 30	79	8.7
30 to 45	385	42.3
More than 60	358	39.3
Total	910	100

35. On week days, 2715 bus trips are observed in Anand Vihar ISBT with average occupancy of 17.4 with a foot-fall of 94279.

36. Estimation of number of bus bays required for the ISBT is done based on the following assumption
- 10 minutes occupancy time for local buses.
 - 20 minutes occupancy time for intercity buses at boarding bays.
 - 5 minutes occupancy time for intercity buses at alighting bays.
37. For the purpose of design, 10% peak hour arrival/departure of buses have been considered and the demands for boarding and alighting bus bays are estimated accordingly. From the above table it can be noticed that over 39% of the buses stays more than 60 minutes in the terminal. No further data was available to assess the weighted average time spend by the long stay buses which will use idle parking bays. Assessment of number of idle bus bays are made for three different average idle parking time of 1hrs, 2hrs and 3hrs. The requirement of idle bus bays assessed based on average idle time of 3hr. The estimation of number of bus bays required and the provision made in the DPR are shown in the **Table 3.4 Requirement of Number of Bays**.

Table 3.4 Requirement of Number of Bays and DPR Provisions

Type of Service	Requirement				Provision in the DPR for 2028
	2008	2018	2028	2048	
Local Buses	27	36	46	68	34
Interstate Buses (Boarding)	56	75	96	143	97
Interstate Buses (Alighting)	9	13	16	24	30
Interstate Buses (Idle) – 1hr	18	24	31	46	46
Interstate Buses (Idle) – 2hr	36	49	63	93	
Interstate Buses (Idle) – 3hr	55	73	94	139	

38. From the above table it can be seen that number of bays provided for local buses are less than the requirement and the provision made of alighting bus bays (interstate) are more than the requirement. However the combined number of bays provided for local and alighting bays of interstate buses satisfies the requirement. Idle bus bays are provided based an average idle time of between 1 and 2hr. This may warrant separate bus depot space for long stay buses. A dynamic assignment of bus bays during night and day time will ensure effective utilization of bays as requirement of local bus bays and interstate bays will vary during day and night. An effective computerized system is needed for bay allocation.
39. The provision made for the bays are for the requirement only upto 2028. For further expansion, idle parking bays may be shifted to a separate location and those idle bays can be converted as boarding/alighting bays. The requirement of further bays beyond may greatly depend on the transport policy at that time. Development of various modes of public transport facilities like mono rail, trams etc may further limit the requirement of addition bays. Hence the proposed plan for upto 2028 is reasonable.
40. Parking demand is assessed based on the detailed parking survey conducted. The distribution of passengers and the type and mode used are presented in **Figure 3-4**. From the distribution of the mode, it can be seen that more than half of the intercity passengers use local buses to reach the terminal.

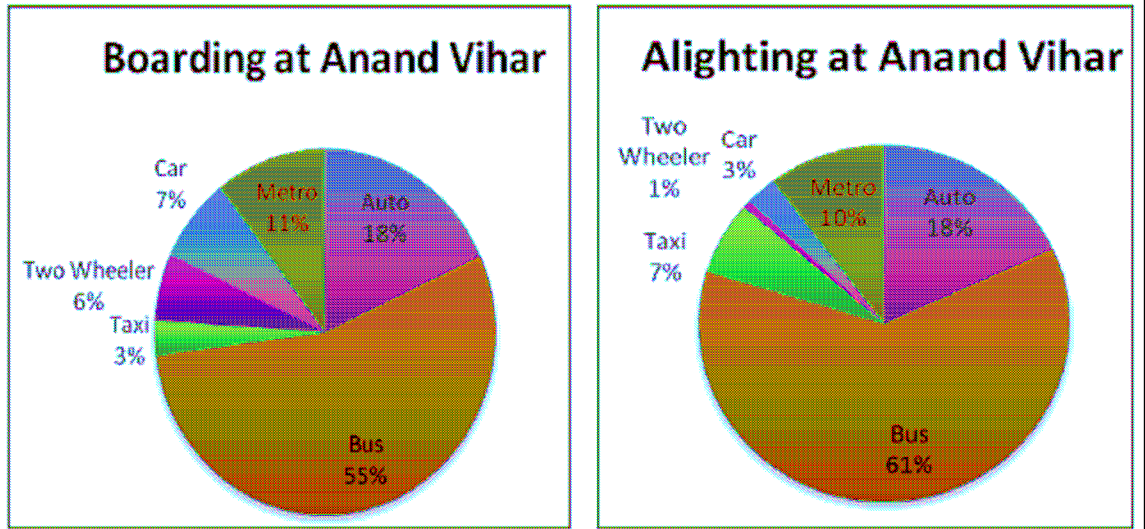


Figure 3.4 Distribution of Modes

41. The parking demand assessed based parking survey and provision made in the DPR is presented in the **Table 3-5**.

Table 3-5 Requirement of Parking spaces and Provisions in the DPR

Type of Vehicle	Parking Demand		DPR Provision		
	2028	2038	Total	Drop By	Pick UP
Auto Rickshaw	100	122	171	39	132
Taxi	16	18	44	17	27
Two Wheeler	70	85	100		
Car	45	55	80		

42. From the above table it can be seen that parking provision made in the DPR is more than sufficient for demand upto 2028. Multi storied parking complex may be needed in the future.
43. The demand assessed for cars and two wheelers for commercial spaces are 1288 and 85 respectively. Sufficient provision for the car and two wheeler parking is made in basement

3.3.3 Concept Plan

44. The concept plan for MMTC is developed considering the basic requirement of MMTC such as conflict free traffic circulation (Unidirectional flow of all modes of transport), easy pedestrian movement, minimum disturbance to the operation of the present ISBT, facilities for passengers and crews, park and drop facilities, energy efficient and environment friendly design etc. Various component of the concept plan is discussed briefly in following sub sections.
45. The proposal ensures conflict free movement of pedestrians from one collection zone to other both within and outside the complex. Key measures adopted to achieve smooth traffic circulation include pedestrian

- barriers, foot over bridges and forcing vehicular merging and de-merging along the direction of vehicular flow. Proper planning for the movement of the physically challenged is envisaged. It is proposed to use mechanical systems like lifts and escalators for making it easier for pedestrians and physically challenged to encounter changes in grades.
46. Lighting is proposed using high mast lighting, pole lights and pedestrian bollard lights so that a minimum of 100 lux is available everywhere around the complex and paths are properly lit for the pedestrians.
47. Design Standards and specification followed in the DPR report have been taken from the Time Saver Standards Space Requirement and Neufert Architect's Data handbook.
48. The various facilities provided in the MMTC include following
- Passenger amenities such as restaurant, coffee shop, medical shop, stationary & book shops, hair salon, toilet, waiting room, cloak room, dormitories etc.
 - Banks/ATMs, Doctor/dentist, communication facilities, insurance offices etc.
 - Infrastructure facilities such as power, water, sewer etc.
 - Operational facilities such bus bays, circulation roads, service station etc.
 - Storm water drainage system.
 - STP, Diesel Generator set and Sub Station and Garbage Collection Chamber.
49. Indian Standard specification is followed for the design of various structural elements. Design also considered special requirement of seismic zone.

3.3.4 Layout Plan and Construction Phasing

50. Layout plan effectively utilizes the available space and located the main ISBT building with bus parking bays located on southern side of the plot which gives the best connectivity from the ISBT to Metro station and Anand Vihar Railway Station. The commercial site earmarked for the Hotel development is segregated from the MMTC and provided separate entry. Auto and Taxi stands are provided on the main road with separate entry.
51. The redevelopment of Anand Vihar ISBT into MMTC is proposed in two phases. The Phase 1 includes construction of main ISBT building and boarding and alighting bays on the side of the main terminal building. The phase 2 include the rest of the development which include construction of the basement parking area beyond main terminal and bus bays and circulation area above the basement.
52. Preconstruction activities planned prior to the construction of phase are also very critical as this interfere with the normal operation of the ISBT also involve coordination with many other utility agencies. Preconstruction activities planned include the following:
- Trimming of existing ISBT shelters to create peripheral road. This peripheral road will provide an exit for the ISBT buses from the corner of the plot earmarked for Hotel.
 - Re-routing and rehabilitation of existing utility lines.
 - Construction of temporary arrangement for ISBT operation at the proposed Hotel area.

53. The proposed construction phasing is generally agreeable however necessary precaution to be taken during the construction to the safety of the passengers and other ISBT activities as there is mix up of construction vehicle and ISBT traffic.

3.3.5 Traffic Circulation

54. Traffic circulation of the ISBT designed with conflict free unidirectional movement. Separate entry is provided for Railway station, local buses and interstate buses from the left side of the layout. Exit for all is provided on the right side and hence avoiding the entry and exit conflict and ensure smooth flow of traffic inside the MMTC area.
55. Separate parking space for taxi and auto is provided with unidirectional circulation. The suggested circulation ensures searching all the parking lots in single circulation.
56. Grade separated U turn movement facilities are planned on the main road on both ends of the MMTC and this will ensure smooth exit and entry of vehicles. The construction of this grade separated U turn facilities are not included as part of MMTC development program but is planned to be constructed by Delhi PWD. Construction of this facility on time needs to be ensured for the smooth functioning of the MMTC.

3.3.6 Pedestrian Network

57. Integrated pedestrian network is designed to ensure safe and efficient movement of pedestrian. The proposed pedestrian network includes foot over bridges, escalators, lift etc.
58. Pedestrian network needs to be properly integrated with the terminal building floor plans to ensure smooth pedestrian movement across the terminal as bus bays are located on either side of the terminal building.

3.3.7 Land Distribution

59. Area statement of Anand Vihar MMTC development is given in **Table 3.6**.

Table 3.6 Area Statement

A	Land for ISBT owned by Transport Dept of GNCTD	10.2 Hector
B	Land area under Metro	1 Hector
C	Balance are for ISBT (A-B)	9.2 Hector
D	Ground Coverage 25% of (C)	2.273 Hector As / DDA NOC
E	Permissible (FAR = 100)	92000 SqM
F	FAR for ISBT including operational Structures 70% of D	64400 SqM
G	FAR for Hotel 30% of D	27600 SqM
Proposed Covered Area Statement for ISBT		
1	Basement	54241.258
2	Floors (Ground and I to 8)	34787 SqM
3	Achieved Ground Coverage (10515.321/64400*100) Excluding basement	16.328%
4	Achieved FAR (34787/64400*100)	54%

60. The space utilization is within the permissible limits.

3.3.8 Road Geometry and Cross section

61. The entry and exit to terminal is provided from Gazipur – Dilshad Garden Road which is a divided road. The turning radius provided varies from 15m to 42m and width of the of the circulation area between the bays ranges from 18 to 20m. The geometry provided satisfies the minimum turning radius for buses.

3.3.9 Detailed Design and Drawings

62. The DPR consultant has submitted floor plan, Elevations, landscape plan, and design load criteria and other design parameters. Further detailed drawings which are required for construction are under preparation and it is reported that the final set of drawings will be ready by end December 2009. As per the condition of agreement between DoT and DIMTS, proof checking of the design is to be carried by an agency acceptable to DoT.

3.3.10 Revenue Generation Components

63. The proposed development includes commercial development such as kiosks in the terminal area, commercial and office space above the terminal area which will be leased out for generating revenue for the operation and maintenance of the MMTC. The commercial area created will include 3500 sq. ft of kiosk area, 58000 sq. ft of retail area and 107600 sq. ft of office area. Other revenue earners will include bus usage fee, parking space fee and revenue from advertisement space.

64. The proposal also includes leasing out a part of the land area for a major hotel development which will generate major upfront revenue. The development of the hotel will be by a private developer and no cost is included in the project for site development for hotel.

3.4 COST ESTIMATES

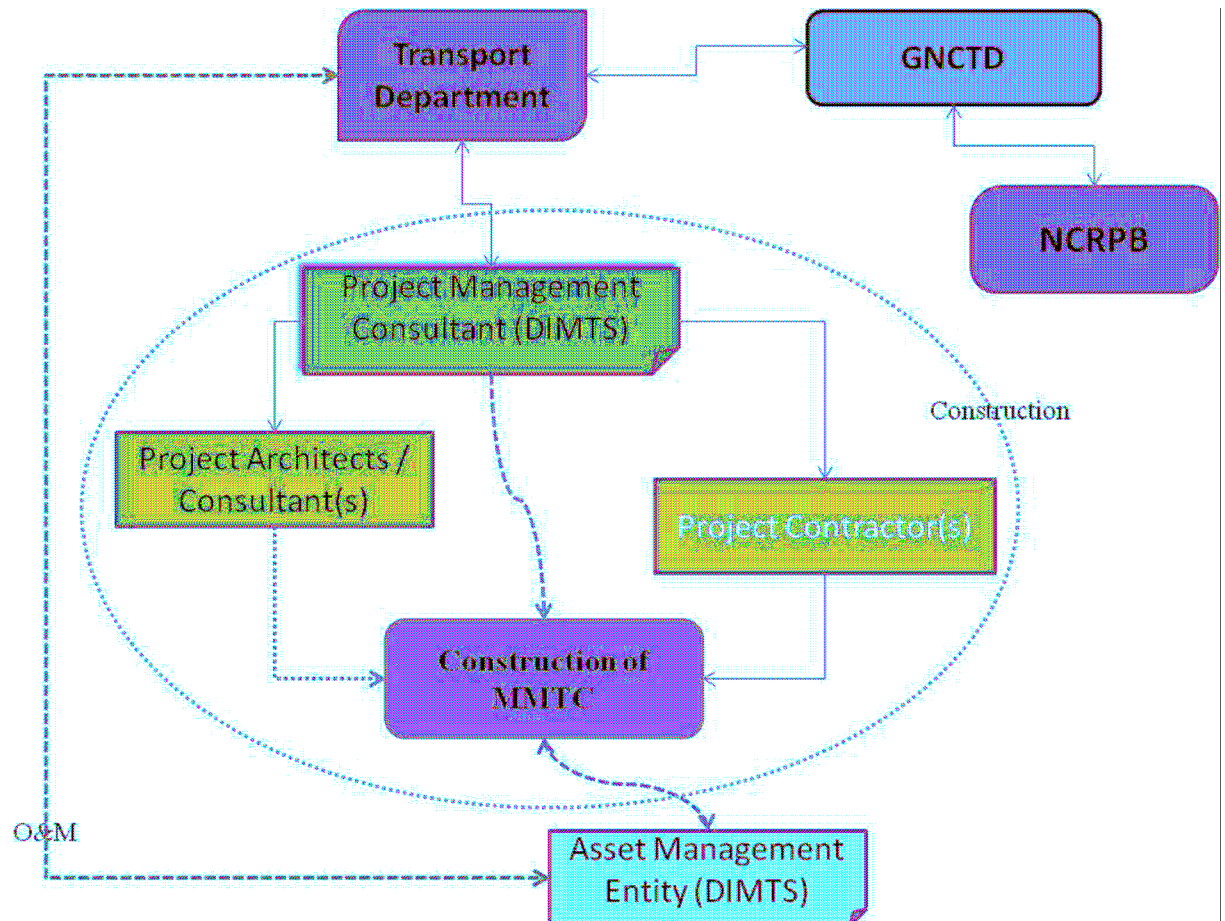
65. The quantification of building works, site development, utilities, pedestrian facilities, parking facilities and landscaping items were calculated by the DPR consultant from the floor plans and layout plans. Plinth area based item rate estimate based on PAR-CPWD-2007 was adopted for cost estimate and the escalated cost on June 2009 was worked out by adding CPWD approved cost index of 13%. The construction items covered in cost estimates are: buildings, site development; services; rehabilitation and reconstruction, cost implication of green certified building and cost of sale/demolishing. The cost estimates also consider market rate for the Basement Floors, and all items for which unit rates are not provided in the CPWD manual. The project cost summary is shown in **Table 3-7**.

Table 3-7 Project Cost Summary

Particulars	Amount (Rs in mn)
Civil works	1030.95
Plumbing works	38.93
Electrical works	250.03
Sub-station	96.11
Fire Fighting	27.41
HVAC works	99.74
Development site	21.23
Elevators & Escalators	69.35
Miscellaneous incl. S.Teel Works, strutting/shoring/dewatering etc.	24.56
Total construction cost	1658.30
Design & Construction management	126.03
Contingency @10%	178.43
Total Construction Cost	1962.76
Interest during Construction	87.40
Total Project Cost	2050.17

3.5 PROJECT IMPLEMENTATION AND SCHEDULE

66. The project implementation arrangement as presented in the DPR is described here. Transport Department, GNCTD shall be the nodal agency implementing the Project. It has appointed DIMTS as the Project Management Consultant for implementing the project. It is envisaged that the funds released by NCRPB/lenders to GNCTD shall be provided to Transport Department for implementation of the Project. The above funds shall be transferred to Project Account (which will be established and maintained by DIMTS) for meeting the capital expenditure. The Transport Department shall undertake bid process management for identification of developer/operator for development of Hotel and receive upfront amount and the same shall be utilized for implementation of the Project. DIMTS is also proposed to be appointed as the Asset Management Entity for Operation, Maintenance and Management of MMTC after competing the construction.



67. The PPTA consultant hasn't reviewed the contractual arrangement between the GNTCD and DIMTS. It is assumed that the agreement ensures performance by the Project Management Consultant and includes proper risk management. Under the assumption, project implementation arrangement is efficient. The operation and maintenance through an Asset Management Company such as DIMTS will ensure the functional efficiency to be maintained. Also the revenue generation components will ensure sufficient funding for operation and maintenance.

68. The implementation of the project (construction phase) shall be completed over a fifteen month period.

3.6 ECONOMIC ANALYSIS

69. The MMTC planned at Anand Vihar will facilitate seamless integration of the inter-city and intra city transit options in the area and largely benefit inter modal transfer by transit passengers with reduced transfer times and improved comfort. This will also have significant impact on the utilization of transit services as transfer between local bus to metro rail and interstate bus/train services become easy and comfortable which are important for encouraging more private vehicle users to shift to transit. The metro station is under construction and will be operational in 2010. Also the Anand Vihar railway terminal will become a main boarding/ alighting station for trains towards East. These two developments will have major impact

- on the transfers from/to local buses at Anand Vihar and a convenient transfer will have a positive impact on the utilization of the mode combination thus reducing personal modes for access to the metro and train services. The single ticket scheme being developed for bus and metro rail use will further help in this aspect. The ISBT is already operational and local buses are serving the transfer at present and therefore no significant transfer benefits are anticipated for those passengers transferring between interstate bus passengers transferring to local buses. However, those passengers will also benefit from the pedestrian friendly design for the MMTC which will improve the safety of passengers and improved environmental comfort. The proposed MMTC will thus provide significant community benefits and will have a positive impact on the transport movement in the area. An economic analysis of the proposed MMTC at Anand Vihar has been undertaken to determine its economic viability.
70. The Government of Delhi has included major public transport improvements including development of MMTC in its Transport Policy as explained earlier and is taking up the development of three MMTC's this year at Kashmere Gate, Anand Vihar and Sarai Kale Khan. The proposed development of MMTC at Anand Vihar is part of the larger effort by the Government of Delhi to provide improved public transport alternatives to encourage increased usage of public transport alternatives. This is especially important in the current scenario of increasing vehicle ownership and the heavy traffic congestion, which will deteriorate much faster without acceptable public transport alternatives.
71. The proposed development plan includes major commercial development also in order to recover the cost of implementation and to generate sufficient revenue for operation and maintenance. The project implementation plan also includes public-private participation for management of project implementation and operation and maintenance. The overall project design thus ensures efficiency in implementation, operation and maintenance and a dedicated funding source, which will ensure the long-term sustainability of the project objectives of providing attractive public transport option.
72. Economic Cost – The financial cost estimates prepared based on the project report has been converted into economic costs by excluding taxes and duties, as well as price contingencies, and using conversion factors where appropriate. For the analysis purpose the tax element of 12% included in the financial cost has been excluded. Considering the standard procedures recommended for economic feasibility analysis, the financial cost was converted into economic cost for the analysis. The O&M cost for the bus terminal is taken in the first full year of operation based on the detailed estimates made for financial analysis. The project is expected to be completed in 15 months with construction costs distributed 30% in 2010 and 70% in 2011. All costs are expressed in 2009 constant prices.
73. The major economic benefits comprise (i) vehicle operating cost saving for passengers shifting from private modes to public transport with upgrading of ISBT, (ii) time savings for passengers with easy transfer between different transit modes, (iii) improved circulation with well maintained roads compared to deteriorated roads at present, and (iv) additional employment. Other benefits are envisaged to accrue but have not been quantified. These include transit passenger satisfaction with significant environmental improvement; environment and health benefits due to reduced emissions and reduced conflict; improved ridership on metrorail with better connectivity etc.
74. The benefits included in the calculation are those which can be estimated reasonably with the survey information and some assumptions.

75. The benefit streams considered in the economic analysis are estimated based on the following:

- The construction of MMTC will increase the use of local bus to access the rail and metro at Anand Vihar. Currently, the access to the Anand Vihar terminal is by personal or para-transit modes by about 40% of trips and 60% access by local bus. It is assumed that the provision of an integrated terminal and integrated ticketing will result in increasing the share of local bus use to access to/from the terminal to 80% and reduce the share of private/para-transit modes to 20%. The resultant reduction in trips by car, taxi, auto-rickshaw and two-wheeler to access to/from MMTC will result in vehicle operating cost saving. The savings in vehicle operating cost of private/para-transit modes to access to/from the MMTC have been estimated and included in the benefits. However, no time saving is considered for the passengers for shifting the mode of access as total time taken by local bus or private/para-transit modes may be in similar magnitude with high local bus frequency.
- Well designed pedestrian circulation including elevators is assumed to reduce the passenger transfer time significantly. Also the integration will facilitate easy transfer for metro rail users and faster access by local buses from nearby areas rather than walking. Overall for the analysis, it is assumed that passengers using local bus and ISBT will save on an average 6 minutes and those using the rail and bus modes will save 10 minutes and is valued as per transit passenger travel time of Rs. 21 per hour (estimated based on per capita income of Delhi).
- Passenger and bus traffic increase is taken as per traffic forecast. It is also assumed that atleast 60% of the metro rail passengers will come by local buses and this will mostly be served by increased occupancy on the local buses but also will increase the number of local buses serving the MMTC. For the analysis, a 12% increase in local buses is assumed.
- The buses using the terminal will benefit from vehicle operating costs savings (VOC) due to improved road condition, conflict free movement and well laid out roads. The benefit is calculated for circulation length of 1.5 km for the estimated number of buses with a VOC of Rs. 19.34/km with the project and Rs. 30.44/km without the project. The roadway condition is represented by assuming a roughness index of 2.5 average with the project and 5.0 without the project. Also assumed is a speed increase of 10 kmph for conflict free movement with the project.
- The net value addition from provision of advertising spaces, parking and shopping area has been calculated and added.

76. Based on the above considerations, the economic cost and benefit streams over the analysis period have been worked out. A 25 year analysis period has been used. To be acceptable for implementation, the proposed investments have to result in an EIRR of at least equal to the opportunity cost of capital, which is set at 12 percent. NPV's are calculated using opportunity cost of capital as the discount rate. The results of economic analysis for the project Anand Vihar MMTC are given in Table 3.8 below.

Table 3.8 Results of Economic Analysis

Economic Analysis for Anand Vihar MMTC - Base Case									Values in Rs. Million
Year	Economic Cost			Economic Benefits					Net Benefits
	Capital Cost	O&M Cost	Total Cost	Vehicle operating cost saving with use of local buses for access to ISBT with the upgrading	Time savings for passengers for transfer at MMTC	Vehicle operating cost saving for buses with improved roads for circulation	Net value addition from advertizing space rentals, parking provision and shops	Total Benefits	
2010	458.53	-	458.53						(458.53)
2011	1,069.90	-	1,069.90						(1,069.90)
2012	-	63.37	63.37	133.81	112.58	22.79	31.63	300.81	237.44
2013	-	63.37	63.37	137.82	115.96	23.48	32.58	309.83	246.46
2014	-	63.37	63.37	141.96	119.44	24.18	33.56	319.13	255.76
2015	-	63.37	63.37	146.22	123.02	24.91	34.56	328.70	265.33
2016	-	63.37	63.37	150.60	126.71	25.65	35.60	338.56	275.19
2017	-	63.37	63.37	155.12	130.51	26.42	36.67	348.72	285.35
2018	-	63.37	63.37	159.77	134.43	27.22	37.77	359.18	295.81
2019	-	63.37	63.37	164.57	138.46	28.03	38.90	369.96	306.59
2020	-	63.37	63.37	168.68	141.92	28.73	39.87	379.21	315.84
2021	-	63.37	63.37	172.90	145.47	29.45	40.87	388.69	325.32
2022	-	63.37	63.37	177.22	149.11	30.19	41.89	398.41	335.03
2023	-	63.37	63.37	181.65	152.83	30.94	42.94	408.37	344.99
2024	-	63.37	63.37	186.19	156.65	31.72	44.01	418.57	355.20
2025	-	63.37	63.37	190.85	160.57	32.51	45.11	429.04	365.67
2026	-	63.37	63.37	195.62	164.58	33.32	46.24	439.77	376.39
2027	-	63.37	63.37	200.51	168.70	34.15	47.40	450.76	387.39
2028	-	63.37	63.37	205.52	172.92	35.01	48.58	462.03	398.66
2029	-	63.37	63.37	210.66	177.24	35.88	49.80	473.58	410.21
2030	-	63.37	63.37	214.87	180.78	36.60	50.79	483.05	419.68
2031	-	63.37	63.37	219.17	184.40	37.33	51.81	492.71	429.34
2032	-	63.37	63.37	223.56	188.09	38.08	52.84	502.57	439.20
2033	-	63.37	63.37	228.03	191.85	38.84	53.90	512.62	449.25
2034	-	63.37	63.37	232.59	195.69	39.62	54.98	522.87	459.50
2035	-	63.37	63.37	237.24	199.60	40.41	56.08	533.33	469.96
2036	(764.21)	63.37	(700.84)	241.98	203.59	41.22	57.20	543.99	1,244.83
							EIRR (%)		17.7
							NPV (Rs. Million)		674.6

77. The economic analysis indicates a robust economic rate of return, which is well above the acceptable rate of return of 12%.

78. The cost and benefit estimates involve uncertainties. Sensitivity analysis has been carried out by changing cost and benefit estimates. The results of the sensitivity analysis are given in Table below. The results indicate that even with significant adverse variation in benefits, the rate of return is above 12%. The analysis do not include the value of the overall environmental improvement and the wider impact of an integrated urban multi-modal terminal due to the difficulty in quantifying the benefits but is considered

to be large enough to compensate for any adverse variation in benefit estimates included and thus the proposed MMTC at Anand Vihar is justified in social cost benefit terms.

Project	Scenario				
	Base case	Cost increase by 15%	Benefit decrease by 15%	Cost increase by 15% & Benefit decrease by 15%	Construction delayed by one year
	EIRR (%)	EIRR (%)	EIRR (%)	EIRR (%)	EIRR (%)
Anand Vihar MMTC	17.7	15.7	14.9	13.1	17.3

79. The economic analysis indicates an economic rate of return above the acceptable rate of return of 12% even with adverse variation in costs and benefits. The proposed MMTC at Anand Vihar fulfils a social need, have a wider impact in alleviating the traffic congestion, improving the financial sustainability of public transport operation, reducing environmental pollution and will improve and maintain the level of service for the public transit users and is therefore recommended for implementation.

3.7 FINANCIAL ANALYSIS

80. Financial analysis has been carried out to assess the viability of the proposed project investment for MMTC at Anand Vihar based on the capacity of MMTC to generate sufficient incremental revenues with project implementation to cover the capital and operating costs of the project. The analysis was carried out on an incremental basis using the discounted cash flow methodology, and measuring the internal rate of return of the project. The analysis is based on the following assumptions:

- The estimated project cost of the proposed redevelopment of Anand Vihar MMTC is given earlier in Table 3.7.
- **Construction Schedule:** The construction activity has been envisaged over a period of fifteen months. Construction is tentatively assumed to commence in February 2010 and the redeveloped structure is scheduled to start operating from May, 2011. The table below gives the capex programme.

Particulars	Deadline
Project start date	January 2010
Construction Start	January 2010
Construction Period	15
Construction End	March 2011
Commencement of Operations	April 2011
Capex phasing - Year 1 (3 months)	20%
Capex phasing - Year 2 (12 months)	80%

- The assumptions relating to means of finance for the project are described below:

Equity: GNCTD is expected to contribute Rs 578.10 million (including internal accruals during project construction phase from bidding out of the hotel.

Lenders: The balance amount is expected to be borrowed from NCRPB and other lenders. The total debt expected to be raised is Rs 1472.07 million. The indicative details of the debt are given below:

Total project cost	:	2050.17
Debt	:	1472.07
Own funds	:	578.10
D:E ratio	:	2.55:1
Loan period	:	10 years
Moratorium	:	2 years
Repayment period	:	8 years
Rate of Interest	:	9.5% p.a.

Each drawdown has its own repayment schedule

- The construction period is 15 months, starting January 2010 and ending March 2011. Hence Interest During Construction has been worked for 3 months in 2009-10 and 12 months during 2010-2011.
- **Basic Assumptions relating to revenue and costs:**
 - 1 **Real estate income:** The rental income from lease of kiosks, retail and office space forms the bulk of the revenue contributing about 54% of the total revenues.
 - 2 **Hotel income:** The expected income from franchise of hotel is expected to contribute 25% of the total revenues.
 - 3 **Bus fees, car parking charges and advertisement charges:** The revenue from these activities contributes the balance of 21% of the total revenues.
 - 4 **Depreciation:** Depreciation at the appropriate rates has been taken for analysis.
 - 5 **Tax:** As the assets would be in the books of accounts of the Delhi Government, no income tax is applicable.
 - 6 **O&M expenditure** has been assumed at about 8.25% of project cost (excluding Interest During Construction)
 - 7 DIMTS is expected to be appointed as the Asset Manager of the project after commencement of operations. DIMTS is also expected to have a share of the operating surplus (details of which have been enumerated earlier) as an incentive for maximizing revenues from the MMTC facility.
 - 8 Financials for the period FY 2010 to FY 2025 has been analysed for evaluation.
 - 9 A summary of certain critical assumptions for the Base Case of the financial model is given below:

Particulars	Asset created	Tariff	Year on Year increase in tariff
Kiosk area created	3500 sq ft	Rs 250 per sq ft per month	7%
Retail area created	58000 sq ft	Rs 165 per sq ft per month	7%
Office area created	107600 sq ft	Rs 50 per sq ft per month	7%
Interstate bus avg. daily traffic	2,000 nos.	Rs 50 per entry	5%
Local bus avg daily traffic	1,500 nos.	Rs 35 per entry	5%
Total number of parking spaces (85% occupancy)	473 Nos	Rs 30 per day	5%
% of parking demand diverted to night parking	5%	Of Normal parking	5%
Advertising revenue per year		Rs 12 million	10%
<i>Hotel Annuity Inputs</i>			
Valuation of Hotel		Rs 950 million	
Upfront payment from Hotel developer		Rs 190 million	
Annuity payment from Hotel developer		Rs 79.4 million	10%
Hotel Concession Period		33 years	
No of days for which daily revenue is calculated in a year	300		
<i>O&M Expenses</i>			
O&M expenses (per annum) as % of Revenue (First year)		8.25%	7%

81. Following observations have been made while undertaking the financial analysis:

- 1 Substantial reliance has been placed on income from hotel and real estate (contributing 79% of revenue). Consequently, any impact of economic downturn leading to reduction in such income would greatly affect the viability of the project.
- 2 Also, a sum of Rs 285 million has been taken as inflow from the hotel developer (initial premium of Rs 190 million and first year's contribution of Rs 95 million) for funding the capital expenditure. Any delay or reduction in these amounts would impact the funds availability for the project. Government of Delhi would need to meet any shortfall in the funds availability if required.
- 3 DIMTS is expected to be appointed as the Asset Manager and is expected to be paid a fees linked to operating surplus, prior to debt service. Any shortfall in cash flows for meeting debt service due to such payment to DIMTS is to be made up by the Delhi Government

- 4 While the project financials show cash generation from day one, in the event any of the revenue profiles does not perform as per projection, there could a cash shortfall in meeting debt service. Consequently, any shortfall in meeting various commitments would need to be met by the Delhi Government.

82. **Financial Analysis:** A financial analysis has been carried out based on the above assumptions and Financial Internal Rate of Return (FIRR) is estimated at 11.64% for the Base Case. Further a sensitivity analysis of the Base case have been carried out to test the impact of adverse changes in cost and revenue assumptions on the financial rate of return and the results are given below:

Sensitivities	Project Cost	Project FIRR (%)
Base Case (1)	2050.17	11.64
Project Cost Increase 10% (2)	2255.18	9.30
Rental income from real estate – Less by 10% (3)	2050.17	10.68
Hotel income – Less by 50% (4)	2050.17	5.96
Hotel income gets postponed by 1 year (5)	2050.17	10.15
Combined impact (2) + (3) + (5)	2255.18	7.02

83. A review of the sensitivity analysis indicates that :

- 1 With the Project FIRR being only 11.64% p.a., the project economics is extremely sensitive to any variation in project cost and revenues.
- 2 While individual sensitivity analysis enumerated above shows the impact of each scenario separately, a combination of increase in project cost by 10%, decrease in rental income by 10% and a postponement of hotel income by one year has a major impact on the project financials leading to a reduction in FIRR from 11.64% p.a. (in Base Case) to 7.02% p.a.
- 3 In view of the above, it is essential that NCRPB ensures budgetary support of the Government of Delhi as additional security apart from the security of assets created. This would provide additional comfort to NCRPB that the project would be able to meet its debt service obligations, irrespective of the performance of the project

84. **The Implementation Schedule:** The DPR provides limited information on the implementation schedule, which should consist of:

Status of administrative and technical sanction and other statutory approvals	Anand Vihar requires approvals from Delhi Government and other agencies
Issue of advertising for bidding	To be included as part of the procurement plan
Finalization of tender	To be included as part of the procurement

	plan
Site clearance and site development	Schedule to be included in the implementation schedule
Procurement	Based on discussions, To be included as part of the procurement plan

85. Risk and Uncertainties

Risk	Risk Level	Mitigation Measure
Project Completion Risk	Moderate	<ul style="list-style-type: none"> ▪ Implementation Schedule and Procurement Plan to be finalized upfront ▪ Budgetary provision for counterpart contribution and any shortfall in meeting project expenditure ▪ Obtain necessary clearances for utility shifting priori to release ▪ Short Resettlement Plan based management of project affected persons ▪ Support in supervision and management of project from project development facility ▪ Contractor Selection based on ICB procedures
Financial Risk		
1 Hotel income not being achieved	High	Need budgetary support of Government of Delhi for debt servicing
2 Income from rentals – Retail space, offices	High	Need budgetary support of Government of Delhi for debt servicing
3 Inadequate cash flows during the initial years for debt servicing	High	Need budgetary support of Government of Delhi for debt servicing
Increase in O&M expenses	Low	Increase in tariff
Technology	Low	<ul style="list-style-type: none"> ▪ Traditional

86. Recommendation: Conditions of lending

By End December 2009, Borrower to provide

- i. Submit Final IEE
- ii. Submit Final Short Resettlement Plan to NCRPB
- iii. Completion of design and updated costs
- iv. A procurement plan and implementation schedule for the project
- v. Draft Bid Documents confirming to ADB document for Review by NCRPB/ADB

- vi. Executed O&M contract and performance benchmarks

By March 2010

- vii. Utility shifting plan and Certificate of clearance from agencies for shifting of utility
- viii. Budget Provision of counterpart contribution of at least 25 % of project cost

SECTION 4

DEVELOPEMENT OF MULTIMODEL TRANSIT CENTRE AT SARAI KHALE KHAN, NCTD

4.1 TRANSPORTATION SECTOR STATUS IN NCR – EXISTING SITUATION AND THE DEVELOPMENT PLANS

1. NCR India, or the most commonly known NCR of Delhi or the National Capital Region of Delhi is the name given to the metropolis areas in and around New Delhi - the capital of India. The NCR comprises of the entire NCT of Delhi, eight districts of Haryana, one district of Rajasthan and five districts of Uttar Pradesh with a population of over 371 lakhs in 2001.
2. The sub-region wise distribution of population in NCR as of 2001 is shown in Table 4.1. The NCR population is projected to reach 64 million by 2021 as per Regional Plan 2021.

Table 4-1 Population Distribution of NCR

Sub Region/ Year	Population (Persons)			Decadal growth rate (%)		Share of population (%)		
	1981	1991	2001	1981 1991	1991 2001	1981	1991	2001
NCT-Delhi	62,20,406	94,20,644	1,38,50,507	51.45	47.02	31.28	34.43	37.33
Haryana	49,38,541	66,43,604	86,87,050	34.53	30.76	24.84	24.28	23.42
Rajasthan	17,55,575	22,96,580	29,92,592	30.82	30.31	8.83	8.39	8.06
Uttar Pradesh	69,68,646	90,01,704	1,15,70,117	29.17	28.53	35.05	32.90	31.19
Total	1,98,83,168	2,73,62,532	3,71,00,266	37.62	35.59	100	100	100

Source: Regional Plan 2021

3. NCR transport system includes an extensive road network system of about 36,305 km, a large fleet of public transport bus system operated by state transport undertakings (3144 buses) and private operators, a rail network of about 1000 Km, Metro rail of about 190 Km (90 km is operational as of November 2009 and the rest under construction) and an International airport at Delhi¹.
4. **Road network:** Existing road network in the region shows convergence of five national highways i.e., NH-1, 2, 8,10 and 24 on Delhi and two National Highways namely NH58 and NH91 meet NH24 at Ghaziabad. In addition to this, NH71, NH71A and NH71B also pass through the region. Ten state highways also serve in strengthening the regional road network. Most of the state highways are of single lane or intermediate lane. Though accessibility is good with reasonably good level of road density, mobility is poor with congested roads (poor road condition, capacity constraints, absence of access controlled high speed facilities for inter city travel and poor traffic management).

¹ Source: Integrated Transportation Plan for National capital Region prepared by Consulting Engineering Services(India) private Limited for NCRPB and DMRC and Wikipedia websites

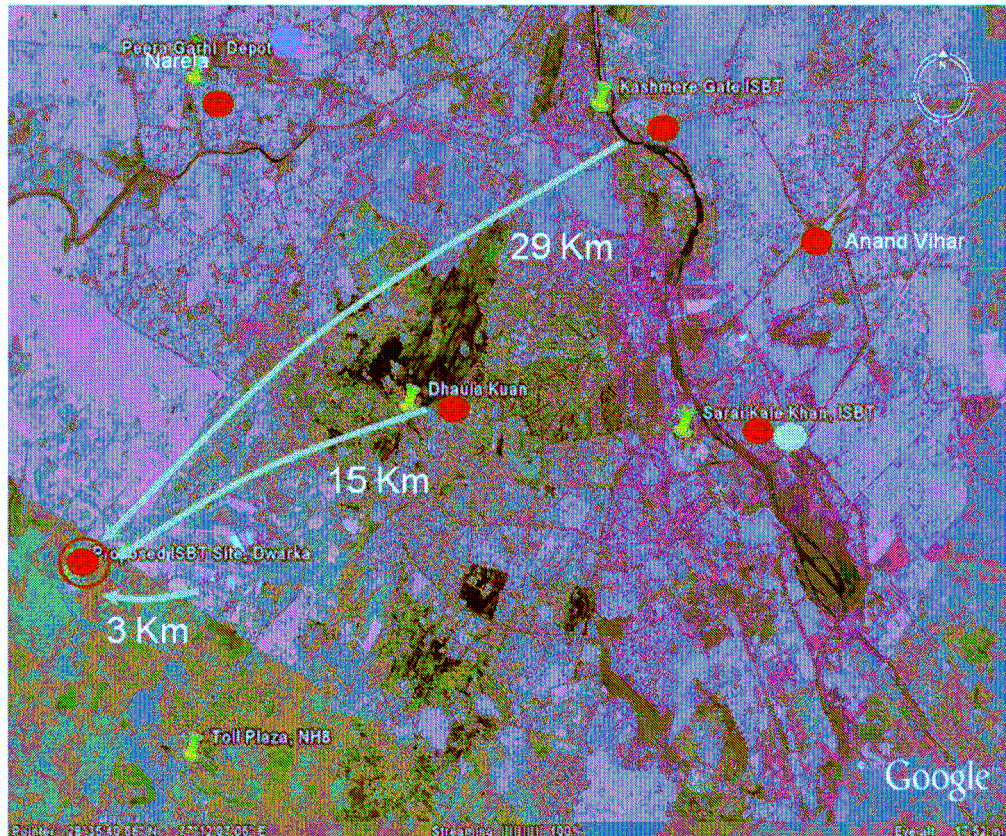
5. **Rail Network:** The NCR rail network covers three zonal railways (Northern, Western and Central) zones and five divisions. The rail network in the region consists of both broad and meter gauges. Five broad gauge railway lines converge at Delhi. The rail network has two specially identified lines known as the Goods Avoiding lines (GAL) and Delhi Avoiding Lines (DAL). The GAL provides a direct entry from Ghaziabad to New Delhi bypassing the congested Delhi Railway Station Complex. The DAL provides a direct passage from the major yards-Tughlakabad and Ghaziabad directly into the Delhi-Ambala-Kalka section and through Lajpat Nagar, Patel Nagar, Daya Basti and Azadpur link. Development of road network alone will not be able to meet the transport demand in NCR. Hence, a supportive rail network will have to be developed for meeting the gap in demand and supply.

6. The Regional Plan-2001 for NCR notified in January 1989 formulated a set of policies for the control of land uses and development of infrastructure in the region. The Functional Plan on Transport prepared and approved by the NCR Planning Board in 1995 envisaged an organized transport network to improve accessibility and the movement of goods and passengers within the region. The Functional Plan on Transport suggested construction of road and rail linkages along the high-density routes, in and around the Capital and also in the National Capital Region. The issues pertaining to the present transport system in NCR could be broadly summarized as follows:
 - The phenomenal increase in the growth of vehicles and traffic in NCR.
 - Development of major town ships, SEZs etc in bordering regions of NCR attracts large number of heavy trucks and passenger traffic to the NCR.
 - Despite measures by way of increasing the length of the road network and road surface space through widening, construction of a number of flyovers/grade separators and, launching of the Metro, the traffic congestion has continued to increase unabated.
 - High rate of accidents, pollution, commuting time, and wasteful energy / fuel consumption.
 - Delhi will host Common Wealth Games on 2010. Special requirements of better congestion free traffic facilities will arise from the mega events such as the Commonwealth Games.
 - Lack pedestrian and bicycle facilities.
 - Limited availability of the land constrains development program.

7. **Master Plan Provisions:** The Regional Plan 2021 for NCR, based on an assessment of the traffic and travel characteristics puts forth a transport system development plan for the NCR. The plan includes the following proposals.
 - To decongest NCT-Delhi roads, rail and rail terminals by diverting the through traffic from Delhi.
 - To provide linkages amongst Metro/Regional Urban Settlements in the outlying areas of NCR.
 - To connect Metro/Regional Centers with the Capital by an efficient and effective transport network for facilitating faster movement of traffic among such centres and NCT-Delhi.
 - To link the Sub-regional Centers with effective and efficient transport network for facilitating the faster movement of traffic among such centers and higher order settlements.
 - To directly link other urban nodes having maximum attracting and generating characteristics.
 - To create the Unified Metropolitan Transport Authority for NCR.

8. The Integrated Multi-Modal transportation Plan prepared for NCR in 2009 in accordance with the policy framework formulated in Regional Plan 2021 propose an investment plan costing US\$ 37 billion over a 25 year period (2007-2032) in the NCR region to meet the growing transport needs. The investments proposed include some of the projects under development since 2007 and new projects. The NCR RP-

- 2021 has proposed extensive development of the transportation system of the region and the Transportation plan developed thus include (1) Large scale road network expansion including Expressways, Regional Arterials, Regional Sub-arterials and Secondary and tertiary road network in sub-regions; (2) Regional rail links and Rail rapid transit systems; (3) Regional metro rail system; (4) Public bus transport system and bus terminals; (5) Logistic hubs; (6) Integrated freight complexes; (7) Highway facilities centers; and (8) Airports.
9. **Airports:** With the growing air traffic, it is suggested to develop an international airport at a suitable location within the region to act as an alternative to the existing international airport in Delhi. In addition, it is also suggested to develop domestic air terminals within the region.
10. **Public transport:** Towards improvement of the public transport systems in the city, the plan suggests the development of a public mass transport system, light rail transit system apart from the modernization and expansion of the existing bus systems. The public transport system exists in the NCR includes the following:
- Buses
 - Rail
 - Delhi Metro
11. **Inter State Bus Terminals (ISBT):** Delhi and NCR have 5 Inter State Bus Terminals at various stages of their lifecycle. Three are operational for many years at Kashmere Gate, Anand Vihar and Sarai Kale Khan. Another two are planned at Dwaraka (south-west) and Narela (North-west). According to the 1998 Supreme Court order for controlling environmental pollution, buses run on diesel are restricted beyond 12 km of distance inside the city. The ISBT's are planned to terminate long distance buses at the outskirts of the city and use city public transport system to travel within the city. The buses within the city are run with CNG which is environment friendly. To enable integration of the various modes of the system, the plan suggests development of modern multi model transit centers at these locations.



4.2 SUB-PROJECT SELECTION

4.2.1 Transport System in Delhi

12. Delhi is planned on a ring-radial pattern with a hierarchical road system comprising of national highways, arterial roads, sub-arterial roads and local streets. The road network is designed for regional, intra-city and local traffic. The capital is well connected to other parts of India by 5 National Highways: NH-1, NH-2, NH-8, NH-10 and NH-24. The Ring Road, Outer Ring Road and other radial roads constitute a distinct feature of the road network in Delhi. Ring Road has a length of about 48 km, of which 16km is common with Outer Ring Road and NH-1. The total road length in Delhi was 31,183 km in March 2006 and is of ring and radial pattern. The road network is being developed and is maintained by NHAI, PWD, MCD, NDMC, DCB, and DDA. The registered vehicles in Delhi have significantly increased over the years. The national capital presently has about 48 lakh vehicles and the share of two wheelers is highest (about 65 percent) and it is also significant to note that about 30 percent of vehicles now in Delhi are cars and jeeps.
13. Buses have an integral and pre-eminent position in Delhi's transport system. This is evident in the last major travel survey conducted in Delhi in 2007- 08, viz. the RITES Primary Survey in 2008. According to the RITES Primary Survey in 2008, the residents of Delhi in 2007-08 generated 21.99 million trips every day, i.e., each resident made an average of 1.37 trips per day. The passenger carriage by DMRC is about 0.65 to 0.75 million passengers per day and buses carry about 7.0 million passengers per day, of which 1.7 million are on DTC buses and 5.5 million on private stage carriage buses. Buses have this

large share of public transportation by virtue of their low usage cost and extensive network, which comprises more than 600 routes with 17 terminals and approximately 5,000 bus stops.

4.2.2 Transport Policy

14. Due to increased usage of personalized transport, the congestion levels are increasing, speeds reducing, and the transportation is becoming a source of environmental and economic problem. Increasing levels of urban congestion create the need for new transportation solutions, including innovative mass transit systems. Perhaps the public transport did not keep pace with growing population and needs of mobility; private vehicles have become predominant mode of transport, particularly in Delhi and generally in National Capital Region (NCR). As a result of this, in spite of vast improvements to road corridors, there are frequent traffic jams all over the Delhi road network. In order to cope up with this issue of urban transport, the Government of National Capital Territory of Delhi (GNCTD) is actively trying to take measures through their transport policy set as: With the objective of achieving a balanced modal mix and to discourage personalized transport, it is proposed to augment mass transport by massive investments accompanied by institutional improvements. The focus, therefore, will be on increasing mass transport options by providing adequate, accessible and affordable modes like buses, mini-buses, electric trolley bus complemented by a network of rail based mass rapid transit systems like metro and commuter rail. Para transit modes like autos and taxis are envisaged to provide feeder services in designated areas catering to work and leisure trips. Non-motorized transport like bicycles and cycle rickshaws will be accommodated. Based on the policy, to deter the use of personalized mode and to promote the usage of transit system for travel in Delhi, measures that have already been initiated include:

- Modernizing ISBT and other bus terminals
- Integrating all modes of public transport
- Development of a world class Metro in NCR
- Induction of high capacity low floor buses into the fleet of Delhi Transport Corporation
- Corporatization of Blue-line buses
- Development of Bus Rapid Transit Corridors
- Development of Light Rail Transit, Monorail, etc.
- Construction of better bus stops

4.2.3 Sub-Project Selection

15. The project selection is based on the transport policy of Delhi. The **proposed MMTC at Sarai Kale Khan** is planned to meet the policy objective of integrated Transit Terminal development. The proposed Multi-Modal Transit Centre (MMTC) will play an important role in facilitating integration of bus, rail and private/IPT modes for travel within the region as well as in facilitating more modal shift to public transport within Delhi and thus contributing to reducing the road congestion.

16. At present an Interstate bus terminal (ISBT) is functioning at Sarai Kale Khan(SKK), which is focusing on the requirement of interstate bus traffic and associated transport needs. The local buses also operate from the terminal providing access to the ISBT from various parts of the city. The ISBT at SKK provides an ideal location with Hazrat Nizamudin railway station located adjacent to SKK. A proper integration of all three modes of public transport which are servicing from the area viz. Interstate bus, Local bus and Rail is essential to achieve objective to have an integrated multi-modal network of public transport systems. The phased development plan for Delhi Metro includes extension of metro rail to connect SKK and hence MMTC should have proper integration with Metro also.

17. The MMTC planned at SKK will facilitate seamless integration of the inter-city and intra city transit options in the area and largely benefit inter modal transfer by transit passengers with reduced transfer times and improved comfort. This will also have significant impact on the utilization of transit services as transfer between local bus to interstate bus/train services become very convenient. The passengers will also benefit from the pedestrian friendly design for the MMTC, which will improve the safety of passengers and improved environmental comfort. The proposed MMTC will thus provide significant community benefits and will have a positive impact on the transport movement in the area.
18. The Department of Transport (DoT), Government of NCT of Delhi has retained the service of DIMTS as Project Management Consultant to prepare DPR and for implementation of MMTC at SKK. The project DPR is complete except for the detailed structural design with all layout and functional design complete. The detailed structural design is in progress and is expected to be completed in December 2009. The project is ready for implementation within few months and the various clearances required are also being processed. DIMTS, a public private partnership promoted by the Delhi Government and IDFC will be entrusted with the operation and maintenance of the facility. The project design incorporates commercial development and an assured revenue stream to ensure the funding of long term operation and maintenance of the facility and the management contract with DIMTS will ensure efficient operation of the terminal. Overall the project meets the requirements of developing modern transport infrastructure in the NCR including the mandate for the proposed ADB loan assistance to NCRPB of fostering public-private partnership in infrastructure development. Thus the sub-project has been selected for consideration under the proposed ADB loan assistance.
19. The technical and background material included in this report have been mainly taken from the DPR prepared for the project. The project layout has been reviewed as part of the PPTA effort and observations on project layout were given to DIMTS and have been incorporated in the design by DIMTS as agreed during the discussion on the project layout. The detailed designs of project elements have not been reviewed by the PPTA Consultant. The economic analysis and financial analysis have been carried out by the PPTA consultant based on the project design and project costing provided in the DPR.

4.3 SUB-PROJECT DESCRIPTION AND TECHNICAL ASSESSMENT

20. The objective of the development of MMTC at Sarai Kale Khan is as listed below:
 - To redevelop the existing ISBT as Multi Modal Transit Center (MMTC).
 - To decongest the internal city roads by restricting the flow of inter-state buses.
 - To facilitate an effective multi-modal changeover by integrating the existing ISBT with the Nizamudeen Railway Station and the planned Metro rail station.
 - To provide a state-of-the-art Multi Modal Transit Center that is user friendly, catering to varied passengers' comfort, pedestrian-friendly, ecologically sustainable, handicapped-friendly, and aided with facilities as per best international practices.
21. The technical assessment of the sub-project has been made based on the review and analysis of the Draft DPR prepared by DIMTS in September 2009. The broad project components are:
 - ISBT – Bus bays with boarding and alighting platforms segregated, Idle bays, Washing/Workshop facilities for buses, Booking/Ticketing counters
 - Local Bus Terminal - Bus bays with boarding and alighting platforms segregated.

- Admin/Terminal office – Includes ISBT administration, CCTV security room, maintenance room and office DTC and other roadways.
 - Offices for DTTDC and other tour operators.
 - Pedestrian Connectivity to Railway Station.
 - Passenger facilities include dormitories, waiting hall, toilet, cloak room and restaurant/cafeteria.
 - Parking facilities include for Auto, taxi, rickshaw and private vehicles
 - Commercial retail and office space
 - Hotel (space allocated for development by private sector)
22. ISBT at Sarai Kale Khan is located on the inner ring road near South Delhi localities. Sarai Kale Khan is a major bus terminus in Delhi. It is adjacent to the Hazrat Nizamuddin Railway Station situated in South of Delhi. Sarai Kale Khan is the terminus for most buses heading for towns south of Delhi. It is also a DTC bus depot for many Moffusil bus routes. The project location is presented in **Figure 4-1**. Some photos are shown below indicate the poor condition of the current facility. The existing bus terminal at the site is a temporary structure with 85 bus bays. There are no separate areas for alighting and boarding of passengers. The terminal is in shortage of passenger facilities and parking for private vehicles. There is also no segregation of pedestrian and vehicular circulation which is a major conflict.
23. The 10.5 hectares of site is a linear patch along 45 m wide inner ring road, which connects ITO on north and Ashram Chowk on south. The project site has an irregular shape and is part of the Public / Semi-Public Use designated by the existing land use plan of the city, in the Master Plan of Delhi, 2021. The entire site is sloping north to South along the length of the site. It has close proximity with river Yamuna on its eastern side and a deep drain/ Nallah very close on its Southern side. Parts of the site are covered with Debris/ filled-up dumps/ bushes/ grass etc. The variation in level of site and ring road is approximately 2 meter.



Existing Entry of SKK ISBT



Poor drainage condition



Platform and Passenger Shelter



SKK Boundary wall.

by the above survey was used for the preparation of layout plan and traffic circulation plan. Contour plan, which is essential for reviewing the drainage plan of the area, is not provided in the DPR.

26. **Traffic Survey:** The following traffic surveys were conducted to understand the flow of bus traffic:

- Classified count of buses
- Bus Origin Destination surveys
- Bus registration number plate surveys
- Bus occupancy surveys

27. The **Figure 4.2** represents the survey locations.

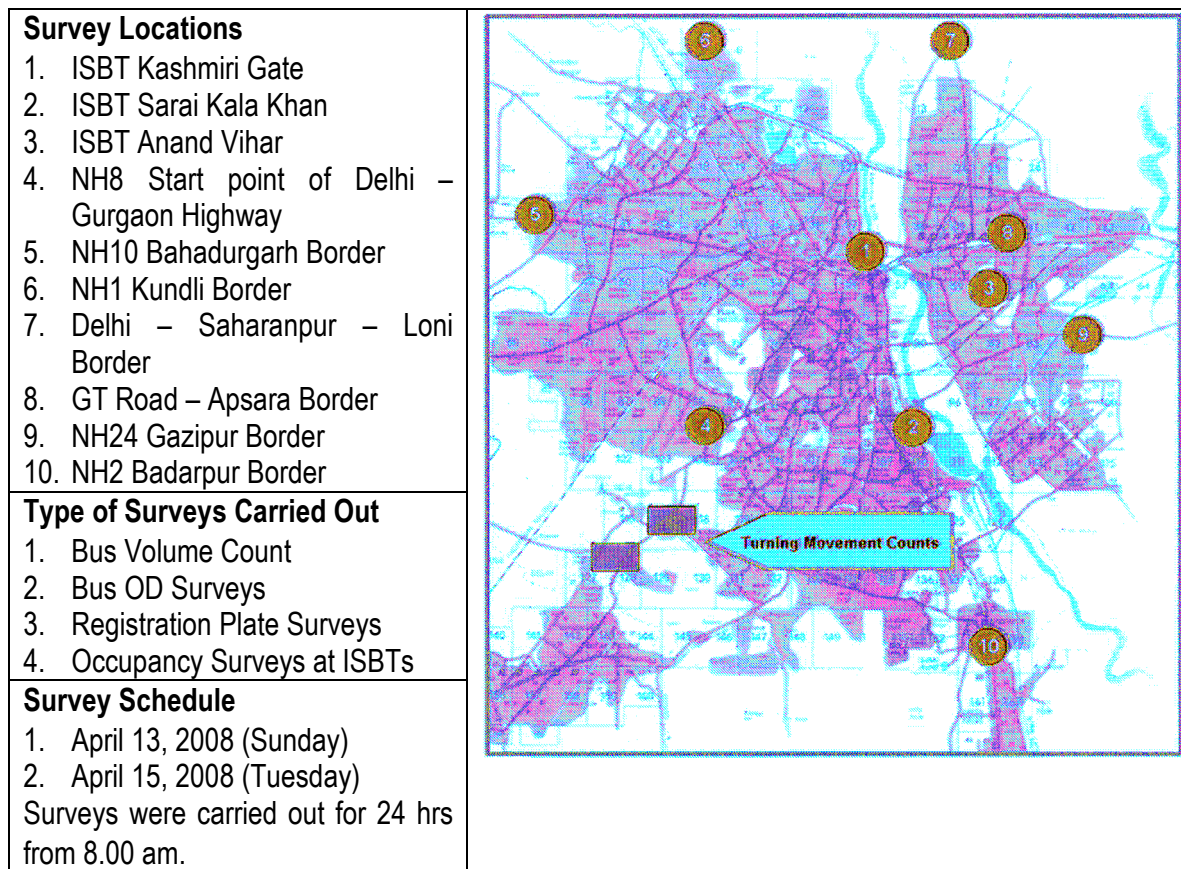


Figure 4.2 Traffic Survey Locations

28. The survey covered all the cordon points into which buses generally enters into Delhi and also the three ISBTs where circulation pattern, occupancy etc were also collected. Summary of the traffic count details of Sarai Kale Khan is tabulated in **Table 4-2**.

Table 4.2 Bus Volume Count at ISBT Sarai Kale Khan

Bus Traffic count at Sarai Kale Khan		Number of Trips	
	Based on schedules	Observed on 13-04-2008 (Sunday)	Observed on 15-04-2008 (Tuesday)
Inter State Buses	909	444	460
Local Buses	58	140	145
Total Buses	967	584	605

29. The present utilization ratios at SKK are only about 60%. This could be due to the fact that most of the boarding and alighting takes place near Ashram and very less passenger's board/alight at SKK. The local bus volume is very low at present. The integrated terminal with connections to rail terminals is expected to substantially increase the local bus volume.
30. From the vehicle occupancy survey carried out at SKK, it was analyzed that the average occupancy of buses is 18.8. The average footfall from buses is analyzed as 22731. From the difference in foot fall of local buses and interstate bus, it can be inferred that ISBT is also used by public for their local movement. This will definitely increase substantially if there is a proper multi model facility built.
31. **Soil Investigation and Hydro-geological Survey:** Bore hole investigation and laboratory sampling was conducted for 10 locations in the project area as per IS specifications. The result of the bore log investigation was used for the determination safe bearing capacity of the area for various type of foundation. As the project area comes under seismic zone IV, the design of the foundation shall be based on the requirement seismic zone IV. As there is potential for liquefaction during earthquake at a depth of 11m, open foundation / raft foundations at shallow depths are not feasible. Accordingly pile foundation is recommended by geo-technical consultant. No laboratory tests were conducted on soil sample from the project location to find the CBR value of the sub grade soil which is required for the design of road pavement. It is suggested to design the road pavement based on CBR tests of subgrade material to be used.

4.3.2 Demand Assessment

32. The requirement for various components of the MMTC which includes bus bays for interstate and local buses, parking space for private vehicle and parking requirement of taxi and auto are analyzed based on the demand survey data and presented in the following sections with comparison of the requirement and design provisions made in the DPR.
33. Assumptions were made in order to estimate the demand for intercity buses at Sarai Kale Khan terminal. Also considered is the decision to shift ISBTs to the periphery of Delhi and terminate intercity buses at the periphery of Delhi itself. The assumptions made are listed below:
- Growth rate of Delhi population would be 35% per decade, i.e., approximately 3% per annum.
 - The growth rate of buses in Delhi would be 3% annually till 2018, 2.5% till 2028 and 2% from thereon.

- All the intercity buses currently using NH8 and NH10 will terminate or originate at proposed Dwarka terminal.
- Local bus routes will continue to originate from the Sarai Kale Khan terminal

34. The requirements of bus bays are assessed based on dwelling time of the buses and the total as well as peak hour number of trips. The total number of bus schedules and peak demand are given in Table 4.3 based on the above considerations (estimate shown for 2008 is based on above assumptions which are yet to materialize).

Table 4.3 Estimated Bus Volumes based on the assumptions

Type of Service	Total Buses	Peak Hour (at 10%)			
		2008	2018	2028	2048
Local Buses	396	40	53	68	101
Interstate Buses	766	77	103	132	196

Note: Interstate buses at Sarai Kale Khan are after accounting for diversion of 201 buses from Kashmiri Gate to Dwarka. Local Buses at this ISBT generally pass through

35. The estimate of dwelling times of intercity buses at SKK is given in the **Table 4-4**.

Table 4.4 Dwelling Times of Intercity Buses at Sarai Kale Khan Gate

Time Period (Minutes)	Distribution	
	Number	Percentage
Less than 15	61	10.1
15 to 30	79	13.1
30 to 45	349	58.1
More than 60	112	18.6
Total	601	100

36. From the above table it can be noticed that 18.6% of the buses stays more than 60 minutes in the terminal. No further data was available to assess the weighted average time spend on the long stay buses which will use idle parking bays. O On week days, 605 bus trips observed in ISBT SKK with average occupancy of 18.8 with a foot-fall of 22731.

37. Estimation of number of bus bays required for the ISBT is done based on the following assumption:

- 10 minutes occupancy time for local buses.
- 20 minutes occupancy time for intercity buses at boarding bays.
- 5 minutes occupancy time for intercity buses at alighting bays.

38. Time required for the circulation inside the terminal is not accounted for the above assumption and which assumed as 10 minutes. For the purpose of design, 10% peak hour arrival/departure of buses have been considered and the demands for boarding and alighting bus bays are estimated accordingly. Assessment of number of idle bus bays are made for three different average idle parking time of 1hrs, 2hrs and 3hrs. The requirement of idle bus bays assessed based on average idle time of 3hr. The

estimation of number of bus bays required and the provision made in the DPR are shown in the **Table 4.5 Requirement of Number of Bays**.

Table 4.5 Requirement of Number of Bays and DPR Provisions

Type of Bus bays	Required on 2028	Provided
Alighting Bays	14	16
DTC Bays	11	17
Boarding Bays	52	85
Idle Bays	22	33
Total	99	151

39. The local bus demand may change after the commissioning of Metro rail in future. The requirement of local bus bays due to Metro needs to be estimated based on the passenger predictions of Metro rail.
40. The provision made for the bays are for the requirement only upto 2028. For further expansion, idle parking bays may be shifted to a separate location and those idle bays can be converted as boarding/alighting bays. The requirement of further bays beyond may greatly depend on the transport policy at that time. Development of various modes of public transport facilities like mono rail, trams etc may further limit the requirement of addition bays. Hence the proposed plan for upto 2028 is reasonable.
41. Parking demand is assessed based on the detailed parking survey conducted. The distribution of passengers and the type and mode used are presented in **Figure 4-3**. From the distribution of the mode, it can be seen that more than half of the intercity passengers use local buses to reach the terminal.

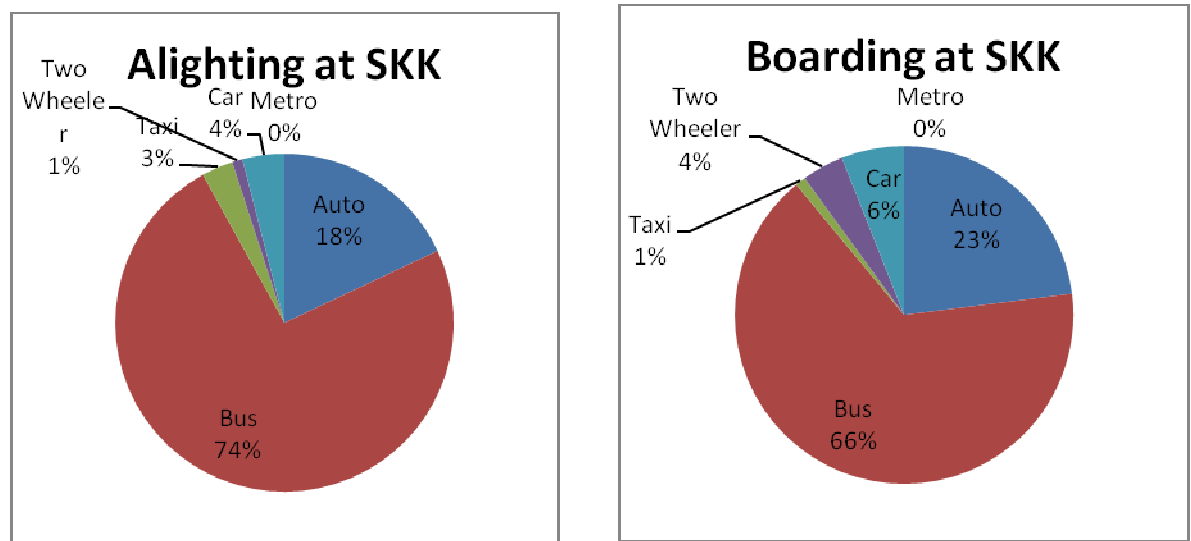


Figure 4.3 Distribution of Modes

42. The parking demand assessed based parking survey and provision made in the DPR is presented in the **Table 4-6**.

Table 4-6 Requirement of Parking spaces and Provisions in the DPR

Type of Vehicle	Parking Demand				
	2008	2018	2028	2038	2048
Auto	38	50	65	79	96
Taxi	6	8	11	13	16
Two Wheeler	10	14	18	22	27
Car	12	16	20	24	30

4.3.3 Concept Plan

43. The concept plan for MMTC is developed considering the basic requirement of MMTC such as conflict free traffic circulation (Unidirectional flow of all modes of transport), easy pedestrian movement, minimum disturbance to the operation of the present ISBT, facilities for passengers and crews, park and drop facilities, energy efficient and environment friendly design etc. Various component of the concept plan is discussed briefly in following sub sections.
44. The proposal ensures conflict free movement of pedestrians from one collection zone to other both within and outside the complex. Key measures adopted to achieve smooth traffic circulation include pedestrian barriers, foot over bridges and forcing vehicular merging and de-merging along the direction of vehicular flow. Proper planning for the movement of the physically challenged is envisaged. It is proposed to use mechanical systems like lifts and escalators for making it easier for pedestrians and physically challenged to encounter changes in grades.
45. Lighting is proposed using high mast lighting, pole lights and pedestrian bollard lights so that a minimum of 100 lux is available everywhere around the complex and paths are properly lit for the pedestrians.
46. Design Standards and specification followed in the DPR report have been taken from the Time Saver Standards Space Requirement and Neufert Architect's Data handbook.
47. The various facilities provided in the MMTC include following
- Passenger amenities such as restaurant, coffee shop, medical shop, stationary & book shops, hair salon, toilet, waiting room, cloak room, dormitories etc.
 - Banks/ATMs, Doctor/dentist, communication facilities, insurance offices etc.
 - Infrastructure facilities such as power, water, sewer etc.
 - Operational facilities such bus bays, circulation roads, service station etc.
 - Storm water drainage system.
 - STP, Diesel Generator set and Sub Station and Garbage Collection Chamber.
48. Indian Standard specification is followed for the design of various structural elements. Design also considered special requirement of seismic zone.

4.3.4 Layout Plan and Construction Phasing

49. Layout plan effectively utilizes the available space and located the main ISBT building with bus parking bays located on southern side of the plot as the southern side of the plot is wider. However the Nizamudin Railway station is on the northern side and the walking distance from the ISBT is slightly high. A shuttle bus service is planned in the initial years.
50. The present ISBT is also functioning on the southern side and hence temporary relocation of the ISBT operation is required during the construction.
51. The proposed ISBT terminal is designed in such a way that arrival and departure is segregated. All the bus bays are accommodated on the sides on the terminal by designing multi face terminal building.
52. Auto and Taxi stands are provided on the main road with separate entry.
53. The construction phasing drawings were not provided in the Draft DPR. It was informed that it will be included in the final submission. As metro connection at SKK is yet to finalize, proper coordination with metro rail authorities are required to ensure appropriate integration of metro rail.

4.3.5 Traffic Circulation

54. Traffic circulation is designed with conflict free unidirectional movement. Grade separated entry from south side is provided for buses. The common exit for both local and interstate buses is provided on the right side and hence avoiding the entry and exit conflict and ensure smooth flow of traffic inside. The entry of right turning buses from the inner ring road to the ISBT is not marked in the circulation plan. This aspect need further review and provision for right turn entry from the inner ring road to the ISBT is to be made.
55. Separate parking space for taxi and auto is provided with unidirectional circulation. The suggested circulation ensures searching the all the parking lots in single circulation. However exit point to main road is very close to junction and this needs revision.
56. Drop area is proposed on the terminal side of the Taxi/Auto parking area, which ensures easy pedestrian access from drop off area to terminal building.

4.3.6 Pedestrian Network

57. Integrated pedestrian network is designed to ensure safe and efficient movement of pedestrians. The proposed pedestrian network consists of foot over bridges, escalators, lift, travelators etc.
58. Travelators are proposed for the pedestrians to connect the ISBT to Nizamudin railway station in the future. But no pedestrian connection is proposed to metro station as the plan of metro is not finalized yet. The travelators proposed as part of the project is not included in the project cost as this facility falling outside the ISBT land. Installation of the travelators will improve the integration and significantly increase the utilization of the integrated system.

59. All the bus bays are provided on the sides of a single multi faced terminal building and movement of passengers from one bay to another is possible without climbing foot over bridges.

4.3.7 Land Distribution

60. Area statement for the proposed SKK MMTTC development is given in Table 4.7. The space utilization is within the permissible limits.

Table 4.7 Area Statement

A	Land for ISBT owned by Transport Dept of GNCTD	10.2 Hector
B	Land area under Metro	1 Hector
C	Balance are for ISBT (A-B)	9.2 Hector
D	Ground Coverage 25% of (C)	2.273 Hector As / DDA NOC
E	Permissible (FAR = 100)	92000 SqM
F	FAR for ISBT including operational Structures 70% of D	64400 SqM
G	FAR for Hotel 30% of D	27600 SqM
Proposed Covered Area Statement for ISBT		
1	Basement	54241.258
2	Floors (Ground and I to 8)	34787 SqM
3	Achieved Ground Coverage (10515.321/64400*100) Excluding basement	16.328%
4	Achieved FAR (34787/64400*100)	54%

4.3.8 Detailed Design and Drawings

61. The DPR consultant has submitted floor plan, elevations, landscape plan, and design load criteria and other design parameters. Detailed drawings, which are required for construction, are under preparation and it is reported that the final set of drawings will be ready by 6 weeks time. As per the condition of agreement between DoT and DIMTS, proof checking of the design is to be carried by an agency acceptable to DoT.

4.3.9 Revenue Generation Components

62. The proposed development includes commercial development such as kiosks in the terminal area, commercial and office space above the terminal area, which will be leased out for generating revenue for the operation and maintenance of the MMTTC. The commercial area created will include 4760 sq. ft of kiosk area, 30,816 sq. ft of retail area and 157,371 sq. ft of office area. Other revenue earners will include bus usage fee, parking space fee and revenue from advertisement space.

63. The proposal includes leasing out a part of the land area for a major hotel development, which will generate major upfront revenue. The development of the hotel will be by a private developer and no cost is included in the project for site development for hotel.

4.4 COST ESTIMATES

64. The quantification of building works, site development, utilities, pedestrian facilities, parking facilities and landscaping items were calculated by the DPR consultant from the floor plans and layout plans. Plinth area based item rate estimate based on PAR-CPWD-2007 was adopted for cost estimate and the current cost was worked out by adding CPWD approved cost index of 19%. The construction items covered in cost estimates are: buildings, site development; services; rehabilitation and reconstruction, cost implication of green certified building and cost of sale/demolishing. The cost estimates consider market rate for escalators, electric substation, air conditioning and for superior finishes. The project cost summary is shown in **Table 4-8**.

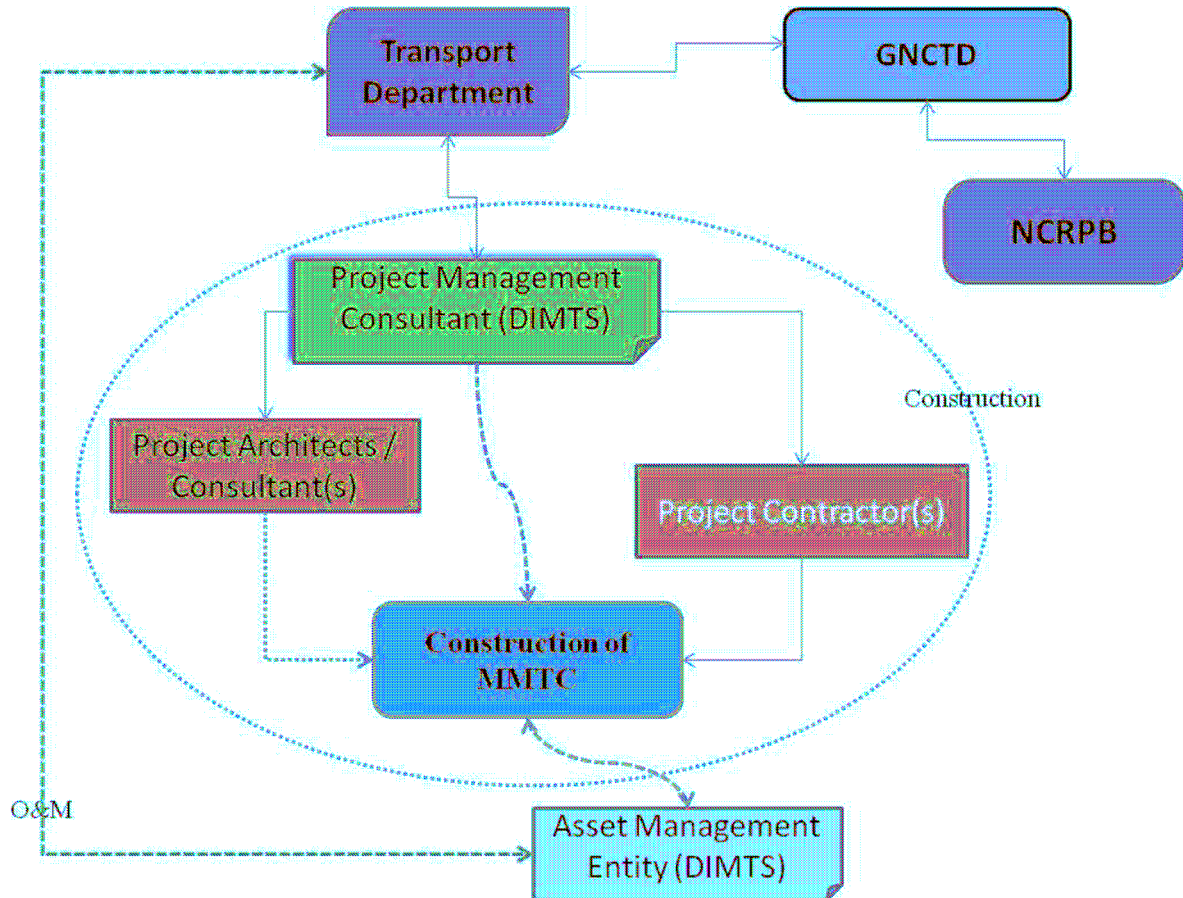
Table 4-8 Project Cost Summary

Particulars	Amount (Rs in mn)
Civil works	1113.26
Plumbing works	42.05
Electrical works	162.95
Sub-station	65.40
Fire Fighting	44.51
HVAC works	110.00
Development site	34.78
Elevators & Escalators	56.96
Miscellaneous incl. S.Teel Works, strutting/shoring/dewatering etc.	58.59
Total construction cost	1688.50
Design & Construction management	149.43
Contingency @10%(3% physical contingency and 7% price contingency)	183.79
Total Construction Cost	2021.72
Interest during Construction	84.63
Total Project Cost	2106.35

4.5 PROJECT IMPLEMENTATION AND SCHEDULE

65. The project implementation arrangement as presented in the DPR is described here. Transport Department, GNCTD shall be the nodal agency implementing the Project. It has appointed DIMTS as the Project Management Consultant for implementing the project. It is envisaged that the funds released by NCRPB/lenders to GNCTD shall be provided to Transport Department for implementation of the Project. The above funds shall be transferred to Project Account (which will be established and maintained by DIMTS) for meeting the capital expenditure. The Transport Department shall undertake bid process management for identification of developer/operator for development of Hotel and receive upfront amount and the same shall be utilized for implementation of the Project. DIMTS is also proposed to be appointed as the Asset Management Entity for Operation, Maintenance and Management of MMTC after competing the construction.

66. Implementation structure: The proposed structure for implementation of the project is as follows:



67. The PPTA consultant hasn't reviewed the contractual arrangement between the GNCTD and DIMTS. It is assumed that the agreement ensures performance by the Project Management Consultant and includes proper risk management. Under the assumption, project implementation arrangement is efficient. The operation and maintenance through an Asset Management Company such as DIMTS will ensure the functional efficiency to be maintained. Also the revenue generation components will ensure sufficient funding for operation and maintenance.

68. The implementation of the project (construction phase) shall be completed over a fifteen-month period once the contract is awarded.

4.6 ECONOMIC ANALYSIS

69. The MMTC planned at Sarai Kale Khan will facilitate integration of the inter-city and intra city transit options in the area and largely benefit inter modal transfer by transit passengers with reduced transfer times and improved comfort. This will also have significant impact on the utilization of transit services as transfer between local bus and interstate bus/train services as well as the planned metro rail in future become easy and comfortable which are important for encouraging more private vehicle users to shift to transit. An ISBT is in operation at SKK as well as the Nizamudeen railway station is nearby and some transfer is taking at present but the poor condition and lack of properly designed facilities makes it less

- attractive for commuters who have a choice between various modes including private modes. With sub-urban train operation from rail station, planned metro rail connection, local and intercity bus operation from this area make it an ideal location to develop an integrated MMTC thus creating an environment for increased public transport utilization. This is especially important in the current scenario of increasing vehicle ownership and the heavy traffic congestion, which will deteriorate much faster without acceptable public transport alternatives.
70. The Government of Delhi has included major public transport improvements including development of MMTC in its Transport Policy as explained earlier and is taking up the development of three MMTC's this year at Kashmere Gate, Anand Vihar and Sarai Kale Khan. The proposed development of MMTC at Sarai Kale Khan is part of the larger effort by the Government of Delhi to provide improved public transport alternatives to encourage increased usage of public transport alternatives.
71. The proposed development plan includes major commercial development also in order to recover the cost of implementation and to generate sufficient revenue for operation and maintenance. The project implementation plan also includes public-private participation for management of project implementation and operation and maintenance. The overall project design thus ensures efficiency in implementation, operation and maintenance and a dedicated funding source, which will ensure the long-term sustainability of the project objectives of providing attractive public transport option.
72. An economic analysis of the proposed MMTC at Sarai Kale Khan has been undertaken to determine its economic viability.
73. Economic Cost – The financial cost estimates prepared based on the project report has been converted into economic costs by excluding taxes and duties, as well as price contingencies, and using conversion factors where appropriate. For the analysis purpose the tax element of 12% included in the financial cost has been excluded. Considering the standard procedures recommended for economic feasibility analysis, the financial cost was converted into economic cost for the analysis. The O&M cost for the bus terminal is taken in the first full year of operation based on the detailed estimates made for financial analysis. The project is expected to be completed in 15 months with construction costs distributed 30% in 2010 and 70% in 2011. All costs are expressed in 2009 constant prices.
74. The major economic benefits comprise (i) vehicle operating cost saving for passengers shifting from private modes to public transport with upgrading of ISBT, (ii) time savings for passengers with easy transfer between different transit modes, (iii) improved circulation with well maintained roads compared to deteriorated roads at present, and (iv) additional employment. Other benefits are envisaged to accrue but have not been quantified. These include transit passenger satisfaction with significant environmental improvement; environment and health benefits due to reduced emissions and reduced conflict; improved ridership on metrorail with better connectivity etc.
75. The benefits included in the calculation are those which can be estimated reasonably with the survey information and some assumptions.
76. The benefit streams considered in the economic analysis are estimated based on the following:

- The construction of MMTC will increase the use of local bus to access the rail and metro at Sarai Kale Khan. Currently, the access to the Anand Vihar terminal is by personal or para-transit modes by about 30% of trips and 70% access by local bus. It is assumed that the provision of an integrated terminal and integrated ticketing will result in increasing the share of local bus use to access to/from the terminal to 85% and reduce the share of private/para-transit modes to 15%. The resultant reduction in trips by car, taxi, auto-rickshaw and two-wheeler to access to/from MMTC will result in vehicle operating cost saving. The savings in vehicle operating cost of private/para-transit modes to access to/from the MMTC have been estimated and included in the benefits. However, no time saving is considered for the passengers for shifting the mode of access as total time taken by local bus or private/para-transit modes may be in similar magnitude with high local bus frequency.
- Well designed pedestrian circulation including elevators is assumed to reduce the passenger transfer time significantly. Also the integration will facilitate easy transfer for metro rail users and faster access by local buses from nearby areas rather than walking. Overall for the analysis, it is assumed that passengers using local bus and ISBT will save on an average 8 minutes and those using the rail and bus modes will save 15 minutes (shuttle bus is planned for transfer to Nizamudeen station) and is valued as per transit passenger travel time of Rs. 21 per hour (estimated based on per capita income of Delhi).
- Passenger and bus traffic increase is taken as per traffic forecast.
- The buses using the terminal will benefit from vehicle operating costs savings (VOC) due to improved road condition, conflict free movement and well laid out roads. The benefit is calculated for circulation length of 1.5 km for the estimated number of buses with a VOC of Rs. 19.34/km with the project and Rs. 30.44/km without the project. The roadway condition is represented by assuming a roughness index of 2.5 average with the project and 5.0 without the project. Also assumed is a speed increase of 10 kmph for conflict free movement with the project.
- The net value addition from provision of advertising spaces, parking and shopping area has been calculated and added.

77. Based on the above considerations, the economic cost and benefit streams over the analysis period have been worked out as given in Table 4.9. A 25 year analysis period has been used. To be acceptable for implementation, the proposed investments have to result in an EIRR of at least equal to the opportunity cost of capital, which is set at 12 percent for transport projects in India. NPV's are calculated using opportunity cost of capital as the discount rate. The results of economic analysis for the project Sarai Kale Khan MMTC are summarized in Table 4.9. The economic analysis indicates an economic rate of return above the acceptable rate of return of 12%.

Table 4.9 Results of Economic Analysis

Economic Analysis for Sarai Kalai Khan MMTC - Base Case									Values in Rs. Million
Base Case									
Year	Economic Cost			Economic Benefits					Net Benefits
	Capital Cost	O&M Cost	Total Cost	Vehicle operating cost saving with use of local buses for access to ISBT with the upgrading	Time savings for passengers for transfer at MMTC	Vehicle operating cost saving for buses with improved roads for circulation	Net value addition from advertizing space rentals, parking provision and shops	Total Benefits	
2010	466.88	-	466.88						(466.88)
2011	1,089.38	-	1,089.38						(1,089.38)
2012	-	64.52	64.52	100.00	82.65	15.75	27.85	226.26	161.74
2013	-	64.52	64.52	103.00	85.13	16.23	28.68	233.05	168.52
2014	-	64.52	64.52	106.09	87.69	16.71	29.54	240.04	175.51
2015	-	64.52	64.52	109.28	90.32	17.22	30.43	247.24	182.72
2016	-	64.52	64.52	112.55	93.03	17.73	31.34	254.66	190.13
2017	-	64.52	64.52	115.93	95.82	18.26	32.28	262.30	197.77
2018	-	64.52	64.52	119.41	98.69	18.81	33.25	270.17	205.64
2019	-	64.52	64.52	122.99	101.65	19.38	34.25	278.27	213.75
2020	-	64.52	64.52	126.07	104.20	19.86	35.11	285.23	220.70
2021	-	64.52	64.52	129.22	106.80	20.36	35.98	292.36	227.83
2022	-	64.52	64.52	132.45	109.47	20.87	36.88	299.67	235.14
2023	-	64.52	64.52	135.76	112.21	21.39	37.80	307.16	242.63
2024	-	64.52	64.52	139.15	115.01	21.92	38.75	314.84	250.31
2025	-	64.52	64.52	142.63	117.89	22.47	39.72	322.71	258.18
2026	-	64.52	64.52	146.20	120.84	23.03	40.71	330.78	266.25
2027	-	64.52	64.52	149.85	123.86	23.61	41.73	339.05	274.52
2028	-	64.52	64.52	153.60	126.95	24.20	42.77	347.52	283.00
2029	-	64.52	64.52	157.44	130.13	24.80	43.84	356.21	291.69
2030	-	64.52	64.52	160.59	132.73	25.30	44.72	363.34	298.81
2031	-	64.52	64.52	163.80	135.38	25.81	45.61	370.60	306.08
2032	-	64.52	64.52	167.08	138.09	26.32	46.53	378.01	313.49
2033	-	64.52	64.52	170.42	140.85	26.85	47.46	385.57	321.05
2034	-	64.52	64.52	173.83	143.67	27.39	48.40	393.29	328.76
2035	-	64.52	64.52	177.30	146.54	27.93	49.37	401.15	336.63
2036	(778.13)	64.52	(713.60)	180.85	149.47	28.49	50.36	409.17	1,122.78
							EIRR		12.7%
							NPV (Rs. Millions)		75.7

78. The cost and benefit estimates involve uncertainties. Sensitivity analysis has been carried out by changing cost and benefit estimates. The results of the sensitivity analysis are given in Table 4.10. The results indicate that with adverse variation in benefits or costs, the rate of return falls below 12%. The analysis do not include the value of the overall environmental improvement and the wider impact of an integrated urban multi-modal terminal but is considered to be large enough to compensate for any adverse variation in benefit estimates included.

Table 4.10 Summary of Sensitivity Analysis

Project	Scenario				
	Base case	Cost increase by 15%	Benefit decrease by 15%	Cost increase by 15% & Benefit decrease by 15%	Construction delayed by one year
	EIRR (%)	EIRR (%)	EIRR (%)	EIRR (%)	EIRR (%)
Sarai Kale Khan MMTC	12.7	12.1	10.3	9.1	12.3

79. The economic analysis indicates an economic rate of return above the acceptable rate of return of 12% in the base case but with adverse variation in costs and benefits, the rate of return falls well below 12%. The proposed MMTC at Sarai Kale Khan fulfils a social need, have a wider impact in alleviating the traffic congestion, improving the financial sustainability of public transport operation, reducing environmental pollution and will improve and maintain the level of service for the public transit users and is therefore recommended for implementation.

4.7 FINANCIAL ANALYSIS

80. Financial analysis has been carried out to assess the viability of the proposed project investment for MMTC at Sarai Kale Khan based on the capacity of MMTC to generate sufficient incremental revenues with project implementation to cover the capital and operating costs of the project. The analysis was carried out on an incremental basis using the discounted cash flow methodology, and measuring the internal rate of return of the project. The analysis is based on the following assumptions:

- The estimated project cost of the proposed redevelopment of Sarai Kale Khan MMTC is given earlier in Table 4.8.
- **Construction Schedule:** The construction activity has been envisaged over a period of fifteen months. Construction is tentatively assumed to commence in January 2010 and the redeveloped structure is scheduled to start operating from April, 2011. The table below gives the capex programme.

Particulars	Deadline
Project start date	February 01, 2010
Construction Start	February 01, 2010
Construction Period	15

Construction End	April 30, 2011
Commencement of Operations	May 1, 2011
Capex phasing – 2009-2010 (2 months)	10%
Capex phasing – 2010-2011 (12 months)	80%
Capex phasing – 2011-2012 (1 month)	10%

- The assumptions relating to means of finance for the project are described below:

Equity: GNCTD is expected to contribute Rs 590.06 million (including internal accruals during project construction phase from bidding out of the hotel).

Lenders: The balance amount is expected to be borrowed from NCRPB and other lenders. The total debt expected to be raised is Rs 1516.29 million. The indicative details of the debt are given below:

Total project cost	:	2106.35
Debt	:	1516.29
Own funds	:	590.06
D:E ratio	:	2.57:1
Loan period	:	10 years
Moratorium	:	2 years
Repayment period	:	8 years
Rate of Interest	:	9.5% p.a.

Each drawdown has its own repayment schedule

- The construction period is 15 months, starting February 2010 and ending April 2011. Hence Interest During Construction has been worked for 2 months for 2009-10, 12 months during 2010-2011 and 1 month during 2011-12.

- Basic Assumptions relating to revenue and costs:**

- Real estate income:** The rental income from lease of kiosks, retail and office space forms the bulk of the revenue contributing about 53% of the total revenues. These incomes have been assumed for a full year in Apr 2011-March 2012 as it has been indicated that many facilities would already starting operating even though some minor construction work might be continuing during 2011-2012.
- Hotel income:** The expected income from franchise of hotel is expected to contribute 37% of the total revenues.
- Bus fees, car parking charges and advertisement charges:** The revenue from these activities contributes the balance of 10% of the total revenues.
- Depreciation:** Depreciation at the appropriate rates have been taken for analysis.
- Tax:** As the assets would be in the books of accounts of the Delhi Government, no income tax is applicable.
- O&M expenditure** has been assumed at about 7.8% of project cost (excluding IDC). As the facilities would start operating even before construction completion, full year's expenditure for 2012 has been assumed.

- 7 DIMTS is expected to be appointed as the Asset Manager of the project after commencement of operations, and is also expected to be paid 40% of operating surplus (based on an agreed formula for calculating the same), with the Delhi government retaining the balance to meet other expenses
- 8 Financials for the period FY 2010 to FY 2025 has been analysed for evaluation.
- 9 A summary of certain critical assumptions for the Base Case of the financial model is given below:

Particulars	Asset created	Tariff	Year on Year increase in tariff
Kiosk area created	4760 sq ft	Rs 250 per sq ft per month	7%
Retail area created	30816 sq ft	Rs 175 per sq ft per month	7%
Office area created	157,371 sq ft	Rs 50 per sq ft per month	7%
Interstate bus avg. daily traffic	800 nos.	Rs 50 per entry	5%
Local bus avg daily traffic	150 nos.	Rs 35 per entry	5%
Total number of parking spaces (85% occupancy)	300 Nos	Rs 30 per day	5%
% of parking demand diverted to night parking	5%	Of Normal parking	5%
Advertising revenue per year		Rs 12 million	10%
Hotel Annuity Inputs			
Valuation of Hotel		Rs 1240 million	
Upfront payment from Hotel developer		Rs 100 million	
Annuity payment from Hotel developer		Rs 119 million	10%
Hotel Concession Period		33 years	
No of days for which daily revenue is calculated in a year	300		
O&M Expenses			
O&M expenses (per annum) as % of Project Cost (First year)		7.8%	7%

81. Following observations have been made while undertaking the financial analysis:

- 1 Substantial reliance has been placed on income from hotel and real estate (contributing 90% of revenue). Consequently, any impact of economic downturn leading to reduction in such income would greatly affect the viability of the project.
- 2 Also, a sum of Rs 100 million and Rs 119 million have been taken as inflow from the hotel developer towards initial premium for funding the capital expenditure. Any delay or reduction in

this amount would impact the funds availability for the project. Government of Delhi would need to meet any shortfall in the funds availability if required.

- 3 DIMTS is expected to be appointed as the Asset Manager and is expected to be paid a fees linked to operating surplus, prior to debt service. Any shortfall in cash flows for meeting debt service due to such payment to DIMTS is to be made up by the Delhi Government
- 4 While the project generates operating income, it is however not sufficient to meet the debt service obligations once the repayment of debt commences.
- 5 The base case of the project financials shows a cumulative cash surplus only in the year 2021 and consequently, any shortfall in meeting various commitments would need to be met by the Delhi Government.

82. Financial Analysis: A financial analysis has been carried out based on the above assumptions and Financial Internal Rate of Return (FIRR) is estimated at 10.07% for the Base Case. Further a sensitivity analysis of the Base case have been carried out to test the impact of adverse changes in cost and revenue assumptions on the financial rate of return and the results are given below:

Sensitivities		Project Cost	Project FIRR (%)
Base Case	(1)	2106.35	10.07
Project Cost Increase 10%	(2)	2316.99	7.83
Rental income from rentals – Less by 10%	(3)	2106.35	9.15
Hotel income – Less by 50%	(4)	2106.35	2.89
Hotel income gets postponed by 1 year	(5)	2106.35	8.15
Combined impact (2) + (3) + (5)		2316.99	4.59

83. A review of the sensitivity analysis indicates that

- 1 With the Project FIRR being only 10.07% p.a., the project economics is extremely sensitive to any variation in project cost and revenues.
- 2 While individual sensitivity analysis enumerated above shows the impact of each scenario separately, a combination of increase in project cost by 10%, decrease in rental income by 10% and a postponement of hotel income by one year has a major impact on the project financials leading to a reduction in FIRR from 10.07% p.a. (in Base Case) to 4.59% p.a.
- 3 In view of the above, it is essential that NCRPB ensures budgetary support of the Government of Delhi as additional security apart from the security of assets created. This would provide additional comfort to NCRPB that the project would be able to meet its debt service obligations, irrespective of the performance of the project.

84. The Implementation Schedule: The DPR provides limited information on the implementation schedule, which should consist of:

Status of administrative and technical	Sarai Kale Khan has required approvals from
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sanction and other statutory approvals	Delhi Government
Issue of advertising for bidding	To be included as part of the procurement plan
Finalization of tender	To be included as part of the procurement plan
Site clearance and site development	Schedule to be included in the implementation schedule
Procurement	Based on discussions, To be included as part of the procurement plan

85. Risk and Uncertainties

Risk	Risk Level	Mitigation Measure
Project Completion Risk	Moderate	Implementation Schedule and Procurement Plan to be finalized upfront Budgetary provision for counterpart contribution and any shortfall in meeting project expenditure Obtain necessary clearances for utility shifting prior to release Short Resettlement Plan based management of project affected persons Support in supervision and management of project from project development facility Contractor Selection based on ICB procedures
Financial Risk		
1 Hotel income not being achieved	High	Need budgetary support of Government of Delhi for debt servicing
2 Income from rentals – Retail space, offices	High	Need budgetary support of Government of Delhi for debt servicing
3 Inadequate cash flows during the initial years for debt servicing	High	Need budgetary support of Government of Delhi for debt servicing
Increase in O&M expenses	Low	Increase in tariff
Technology	Low	Traditional

86. Recommendation: Conditions of lending

By End December 2009, Borrower to provide

- i. Submit Final IEE
- ii. Submit Final Short Resettlement Plan to NCRPB
- iii. Completion of design and updated costs
- iv. A procurement plan and implementation schedule for the project
- v. Draft Bid Documents confirming to ADB document for Review by NCRPB/ADB
- vi. Executed O&M contract and performance benchmarks

By March 2010,

- vii. Utility shifting plan and Certificate of clearance from agencies for shifting of utility
- viii. Budget Provision of counterpart contribution of 25%
- ix. Delhi Government Guarantee for Debt Servicing

SECTION 5

CONSTRUCTION OF BADLI BYPASS, HARYANA

5.1 ROAD NETWORK STATUS IN NCR – EXISTING SITUATION AND THE DEVELOPMENT PLANS¹

1. NCR India, or the most commonly known NCR of Delhi or the National Capital Region of Delhi is the name given to the metropolis areas in and around New Delhi - the capital of India. The NCR comprises of the entire NCT of Delhi, eight districts of Haryana, one district of Rajasthan and five districts of Uttar Pradesh with a population of over 371 lakhs in 2001.
2. The sub-region wise distribution of population in NCR as of 2001 is shown in Table 5.1. The NCR population is projected to reach 64 million by 2021 as per Regional Plan 2021.

Table 5-1 Population Distribution of NCR

Sub Region/ Year	Population (Persons)			Decadal growth rate (%)		Share of population (%)		
	1981	1991	2001	1981 1991	1991 2001	1981	1991	2001
NCT-Delhi	62,20,406	94,20,644	1,38,50,507	51.45	47.02	31.28	34.43	37.33
Haryana	49,38,541	66,43,604	86,87,050	34.53	30.76	24.84	24.28	23.42
Rajasthan	17,55,575	22,96,580	29,92,592	30.82	30.31	8.83	8.39	8.06
Uttar Pradesh	69,68,646	90,01,704	1,15,70,117	29.17	28.53	35.05	32.90	31.19
Total	1,98,83,168	2,73,62,532	3,71,00,266	37.62	35.59	100	100	100

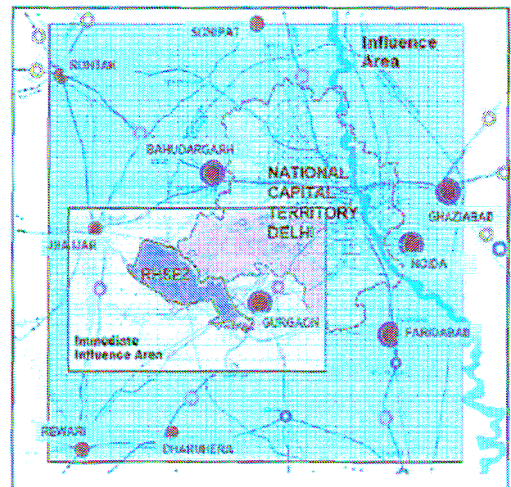
Source: Regional Plan 2021

3. NCR transport system includes an extensive road network system of about 36,305 km, a large fleet of public transport bus system operated by state transport undertakings (3144 buses) and private operators, a rail network of about 1000 Km, Metro rail of about 190 Km (90 km is operational as of November 2009 and the rest under construction) and an International airport at Delhi².
4. **Road network:** Existing road network in the region shows convergence of five national highways i.e., NH-1, 2, 8,10 and 24 on Delhi and two National Highways namely NH58 and NH91 meet NH24 at Ghaziabad. In addition to this, NH71, NH71A and NH71B also pass through the region. Ten state highways also serve in strengthening the regional road network. Most of the state highways are of single lane or intermediate lane. Though accessibility is good with reasonably good level of road density, mobility is poor with congested roads (poor road condition, capacity constraints, absence of access controlled high speed facilities for inter city travel and poor traffic management).

¹ Information used mainly from Integrated Transportation Plan for National capital Region prepared by Consulting Engineering Services (India) private Limited for NCRPB

² Source: DMRC and Wikipedia websites

5. **Master Plan Provisions:** The Regional Plan 2021 for NCR, based on an assessment of the traffic and travel characteristics puts forth a transport system development plan for the NCR. The plan includes the following proposals.
- To decongest NCT-Delhi roads, rail and rail terminals by diverting the through traffic from Delhi.
 - To provide linkages amongst Metro/Regional Urban Settlements in the outlying areas of NCR.
 - To connect Metro/Regional Centers with the Capital by an efficient and effective transport network for facilitating faster movement of traffic among such centres and NCT-Delhi.
 - To link the Sub-regional Centers with effective and efficient transport network for facilitating the faster movement of traffic among such centers and higher order settlements.
 - To directly link other urban nodes having maximum attracting and generating characteristics.
 - To create the Unified Metropolitan Transport Authority for NCR.
6. The Integrated Multi-Modal transportation Plan prepared for NCR in 2009 in accordance with the policy framework formulated in Regional Plan 2021 propose an investment plan costing US\$ 37 billion over a 25 year period (2007-2032) in the NCR region to meet the growing transport needs. The investments proposed include some of the projects under development since 2007 and new projects. The NCR RP-2021 has proposed extensive development of the transportation system of the region and the Transportation plan developed thus include (1) Large scale road network expansion including Expressways, Regional Arterials, Regional Sub-arterials and Secondary and tertiary road network in sub-regions; (2) Regional rail links and Rail rapid transit systems; (3) Regional metro rail system; (4) Public bus transport system and bus terminals; (5) Logistic hubs; (6) Integrated freight complexes; (7) Highway facilities centers; and (8) Airports.
7. In the last several years, there have been many major development projects planned and some of them under implementation which affect the NCR road network significantly as they triggers further accelerated development in the adjoining areas requiring major investment in the secondary and tertiary road network. Some of the project that have a large influence on the adjoining areas in Haryana include:
- Haryana SEZ – An SEZ extending over 10,000 Ha is proposed for development in Gurgaon and Jhajjar district. There have been delay in the project due to delay in land acquisition. It is reported that about 8000 acres have been acquired by the developer in Jhajjar but only 1400 acres in Gurgaon. It is now planned for two separate SEZ's with 12500 acres each in Gurgaon and Jhajjar. It is expected that with two-thirds of land acquired in Jhajjar district, the SEZ planned in Jhajjar is likely to materialize. The development will have major impact on the transport scenario in the surrounding areas. The road connecting from Jhajjar to Delhi, a Major Distric Road (MDR 136) and passing through Badli borders the proposed SEZ on the North. The Kundli-Maneswar-Palwai Expressway under construction is also in the vicinity.



- Kundli-Maneswar-Palwai Expressway (KMP)

Expressway) which is under construction on the western side of Delhi in combination with Faridabad-Ghaziabad-Kundi eastern peripheral expressway is envisaged to form cordon around the NCTD to enable bypassing of non-Delhi based traffic. The Government of Haryana is proposing to develop 14 new townships along the KMP Expressway to take advantage of the development potential. One of the township planned is the Jahangirpur-Badli new township which will have large impact on the town of Badli and the whole district of Jhajjar.

8. The road network development plan calls for capacity augmentation of the MDR's and ODR's in the NCR region to support the development anticipated in the NCR region. Also suggested is development of bypasses for each major urban center considering the growth potential and complementing the planned regional road network development.

5.2 SUB-PROJECT SELECTION

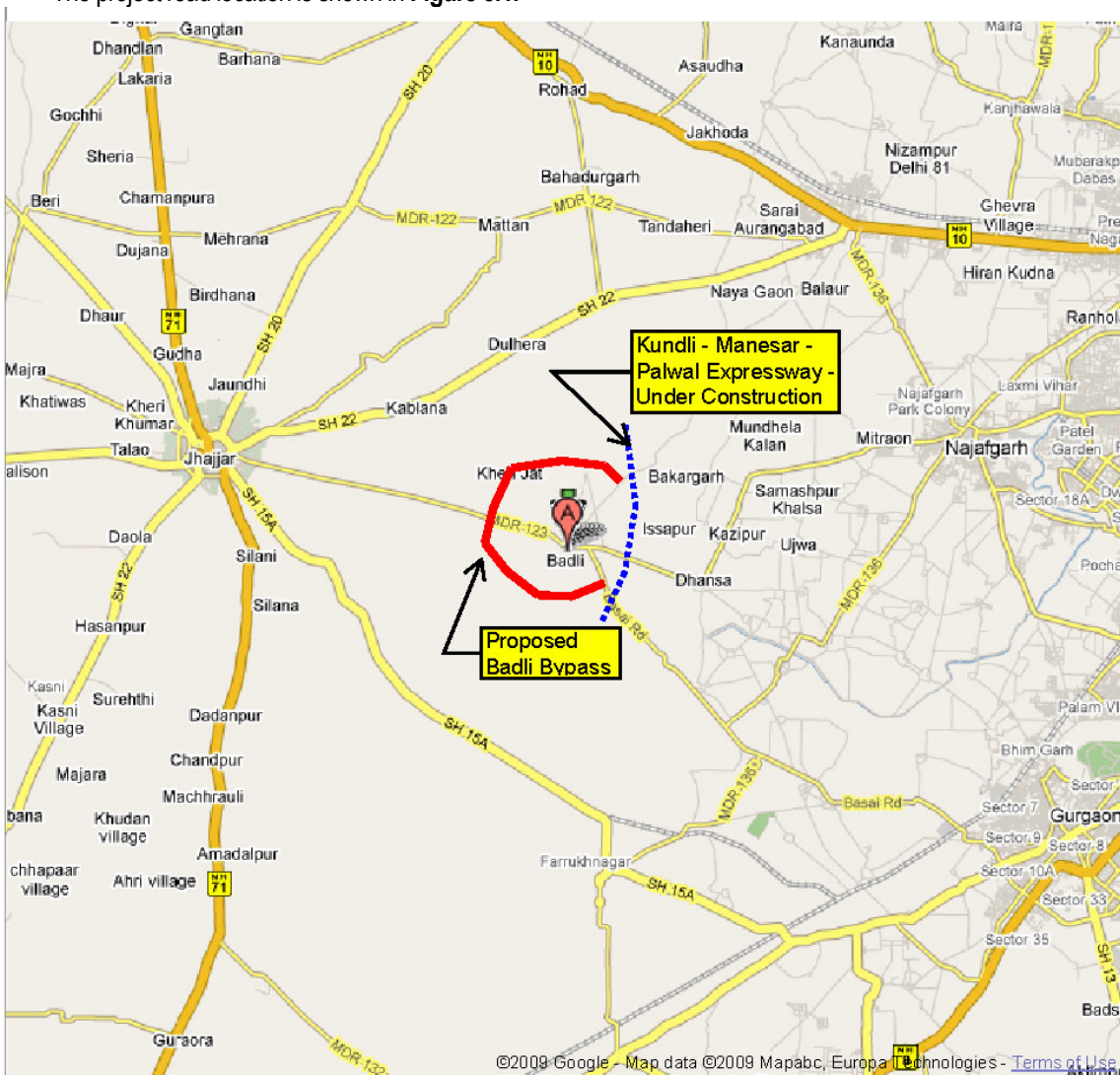
9. The state of Haryana surrounds the National Capital on three sides. The road network of Haryana act as a conduit to enter the National Capital for large number of commercial traffic from Jammu & Kashmir, Punjab, Himachal Pradesh, Rajasthan and Parts of Utter Pradesh. Eight districts of Haryana viz. Faridabad, Mewat, Gurgaon, Rohtak, Sonapat, Rewari, Jhajjar and Panipat are part of the NCR. Many major development projects are taking place in NCR of Haryana, which includes 20 SEZs with an investment of Rs 870 Billion. All this developments also attracts heavy good and industrial traffic to the NCR region of Haryana from surrounding states.
10. The rapid growth in the region is putting pressure on the main road network and especially the towns along these routes with the narrow width and heavy urban traffic. One such town is Badli in Jhajjar district of Haryana where about 8 roads cross the town which includes roads from the major villages around and connecting roads to Delhi, Gurgaon, Jhajjar and Bahadurgarh. Large number of trucks transporting material for the bitumen plants located on the north-east of Badli town. The material is transported from all around Badli town and the output from the bituminous plants mostly transported to various parts of NCTD. In addition, large regional traffic also travels through Badli town resulting in congestion in the town and there is little scope for widening the road through the town. In order to mitigate the transport situation in and around Badli, it is proposed to develop a Bypass to cater to all through traffic which has no business in the town.
11. The traffic studies indicate that more than 50% of the traffic currently going through Badli town is bypassable. This will have a major positive impact on the traffic situation in the town and improve the traffic safety. The savings to the society in terms of vehicle operating with reduced congestion is large enough as can be seen from the economic rate of return of the project and is therefore highly justified in social cost benefit terms.
12. The proposed project is provides relief from severe congestion in Badli town. Also the truck and through traffic is provided with an almost free flow condition thus significantly benefiting all traffic with vehicle operating cost savings and improved road safety. The project has been selected based on the benefit to the traffic and the improvement in road network connectivity it provides.
13. The Haryana State Road Development Corporation (HSRDC), the implementing agency has engaged a Consultant and completed preparation of a Detailed Project Report for the project. The new bypass alignment has been finalized and land acquisition for the right of way has been initiated. The project preparation is thus well advanced and can be taken up immediately. The data and analysis from the

DPR has been used for the preparation of this report. The PPTA consultant carried out the economic analysis based on the project design and project costing provided in the DPR.

5.3 SUB-PROJECT DESCRIPTION AND TECHNICAL ASSESSMENT

5.3.1 Scope and Components

14. The proposed Badli Bypass starts from Km 16/550 of Gurgaon – Bahadurgarh road and its joins the same road at Km 18/580 and will be 5.68 km long connecting 8 roads converging in Badli town. The road is designed as a 4 lane divided carriageway and in the first phase two lane carriageway with paved shoulders will be constructed. The proposal also involves rehabilitation of existing road section of Gurgaon – Bahadurgarh road from Km 16/550 to Km 18/580 and about 1.3 km length of cross roads. The project road location is shown in **Figure 5.1**.



Note: Section of KMP Expressway near Badli only is shown

Figure 5.1: Project Road Location

5.3.2 DPR Review Approach

15. The DPR and other available reports were collected and studied in detail to prepare this feasibility study report. The approach involved site reconnaissance, preliminary desk review of the available reports, additional data gathering if needed and final review of the DPR analysis and drawings to obtain the required information for feasibility study as illustrated in the flowchart below. Broad observations and suggestions on the design are included in the relevant sections of the report.

5.3.3 DPR Surveys

16. For the preparation of Detailed Project Report, the HSRDC Consultant carried out the following surveys and investigations along the bypass road alignment:

- Field Reconnaissance Survey
- Traffic and transportation surveys, including classified traffic volume counts and origin-destination surveys
- Topographic surveys of the proposed alignment
- Sub soil investigations
- Census survey of the potential APs and preparation of Resettlement Plans
- Environmental reconnaissance surveys and preparation of IEE



5.3.4 Corridor Description

17. The Badli Bypass, starts from Km 16/550 of Gurgaon – Bahadurgarh road and joins back the same road at Km 18/580. The entire project alignment is traversing through plain terrain and the project corridor is predominantly passing through agricultural land. The subgrade soil is generally silty clay and the entire alignment is proposed on embankment. As the project road alignment is passing through agricultural fields and on embankment, adequate provision of balancing culverts are required to avoid any chance of flooding on one side on the road. The project road alignment in true sense will act as a ring road to Badli town along with Gurgaon – Bahadurgarh road and it crosses six other roads and hence effectively preventing the through traffic from those roads entering to the town center. The lists of cross roads, which will cross the bypass alignment, are given in Table 5.2.

Table 5.2 List of Cross Roads

S No	Crossing Road
1	Rohad Road
2	Goelakalan Road
3	Kheri Road
4	Jhajjar Road
5	Munimpur Road
6	Yakubpur Road

18. The proposed alignment is not crossing any railway line or river. The construction of Palwal-Manesar-Kundli Express way is in progress, which is crossing the Gurgaon – Bahadurgarh road about 100m before the start of the bypass alignment in the north, and again it is crossing the Gurgaon – Bahadurgarh road about 100m after the end of bypass. Presently grade separated crossing is planned for the Expressway without any connection to Gurgaon – Bahadurgarh road.
19. The basic industries located in the Jhajjar district are ceramics, glass, chemicals, engineering, electrical & electronics. The area is under rapid industrial growth owing to its proximity to Delhi. Jhajjar city has many pages of history engulfed in it. There are several historical buildings, mausoleums etc which reflect the historical importance of this city. population. The literate males percentage in the district is 83.95 where as females are 61.65 percent.
20. The cross roads on the proposed Badli bypass are frequently used for transportation of stone metals/ crushed material to Gurgaon and capital city of Delhi for development works, as most of the quarries are located across this area. Moreover high growth of heavy traffic is expected as two Thermal Power Plants are proposed to be installed at Chhuchkawas and Badli.
21. The district comes under the low lying eastern margin of Punjab plains which is part of great Indo Gangetic plain, formed by the deposition of alluvial sediments and sands brought from Himalayas. Yamuna is the only River following from North to South at the eastern margin. The general elevation of the district lies between 150 to 300 m. The Jhajjar district is mainly covered with older alluvial soil in the western portion and younger alluvial soil in the eastern portion bordering Yamuna River.
22. There are no protected areas, wildlife sanctuaries or forests in the area. However, some wild animals like the neilguys are found in the area and could be expected to cross the proposed bypass alignment.
23. The bypass alignment passes through agricultural fields and is also linked to a number of local roads and MDR 123. The area is largely rural with Badli village being surrounded by agriculture fields and brick kilns. Along the alignment only a few trees may require removal for the construction of the road. The area has many brick kilns and the topsoil in part of identified area has been removed and sold to the brick kilns. It is reported that t no brick kilns will be affected by the bypass construction.
24. The area does not have any natural drainage network, though due to the removal of soil for building bricks the area is prone to water accumulation where the soil has been removed after a heavy rain.

5.3.5 Traffic Surveys and Analysis

25. The traffic volume data forms an important input to project design and economic analysis As part of the DPR, traffic surveys were carried out on all roads entering Badli and the total traffic and bypassable traffic observed are given in Table 5.3. Overall diversion is estimated at 38%.

Table 5.3 Bypass traffic estimates from DPR survey

Sr. no.	TYPE OF VEHICLE	TOTAL Vehicles	Percentage of by passable traffic (As per studies of OD Survey	By-passable Traffic	City Bound Traffic	
1	TRUCKS	Two axle	937	75%	703	234
2		Multi Axle	1198	75%	899	300
3	BUS	MINI BUS	96	20%	19	77
4		BUS	391	20%	78	313
5	Tractor Trailer		835	30%	251	585
6	Scoter /Motor Cycle		14903	35%	5216	9687
7	CAR JEEP		5916	40%	2366	3550
8	Three Wheeler		1089	10%	109	980
9	L.C.V.		389	30%	117	272
10	CYCLE		2647	0%	0	2647
11	Camel CART		172	0%	0	172
	TOTAL		25754		9757	15997

26. As part of the PPTA, an OD survey was carried out on Jhajjar-Badli road at the town boundary where majority of the potential bypass traffic pass through and have obtained the following traffic estimates for diversion as given in Table 5.4. The survey didn't cover tractors, two wheelers and buses.

Table 5.4 Bypass traffic estimates from OD survey on Jhajjar Road

Mode	Total Traffic	Estimated Bypass Traffic
Car	2155	1490
Van	133	86
LCV	1664	746
2 Axle	1420	1015
3 Axle	1563	770
MAV	133	56
Overall Total	7068	4163

27. The DPR survey estimated the bypass traffic from all roads and the total traffic estimated may not travel the entire length. The PPTA survey was done on the main linkage to Jhajjar and may cover most of the bypassable traffic. Also with improvement of Gurgaon – Bahadurgarh road, it is unlikely that traffic between Gurgaon and Bahadurgarh to use the bypass as the bypass is much longer for the Gurgaon – Bahadurgarh traffic. The truck traffic observed in the DPR survey seems on the lower side compared to the traffic observed recently as well as observed during multiple visits to the site by the PPTA team. Considering the overall traffic pattern in the area, the bypassable traffic estimated from the recent OD survey has been taken as representative traffic on the bypass.

5.3.6 Traffic Forecast

28. Both economic growth and population growth contribute to the traffic growth. There are no time series traffic data on the roads in the area and hence no assessment could be made of past traffic growth using time series data. The best approach to assess traffic growth is to examine population and economic growth as well as the growth of vehicle registrations and to establish the 'transport demand elasticity' that can be used to estimate future traffic growths based on forecasts of economic growth. Traffic growth rates for the region have been worked out using this approach.
29. The net state domestic product of the state in the past few years has been obtained from the published documentation available in the Reserve Bank of India website and is given in Table 5.5. The overall trend indicates growth rates of close to 8.8% in the 1999-2008 period. A comparison with all India GDP growth indicate that Haryana enjoyed a much higher growth than the national average growth in GDP in this decade.

Table 5.5 Net State Domestic Product of Haryana at Constant Prices

Year	NSDP (Rs. Lakhs)
1999-00	5127783
2000-01	5547672
2001-02	5985030
2002-03	6365901
2003-04	6938802
2004-05	7567606
2005-06	8260388
2006-07	9205311
2007-08	10131942

30. The vehicle registration growth also gives indication of the traffic growth. The vehicle registration data for the past few years have been obtained and is given in Table 5.6. The growth rates observed in the case of Trucks and Cars are in line with the national trends whereas LCV and bus growth shows some abnormal growth. LCV growth in later years seems reasonable except for the jump in 2002-03 and in case of buses it again shows such drastic jumps which may be due to the low base initially and the large scale developments in the NCR area resulting in huge increase in buses. However, this may not continue in the same way once the number of buses increases.

Table 5.6: Vehicle Registration data of different vehicles in Haryana

Year	Truck	LCV	Bus	TW	Car/Jeep
2000-01	110238	27707	5120	1136917	306972
2001-02	110238	27707	5120	1136917	306972
2002-03	126109	49160	8091	1356957	354518
2003-04	147667	58325	9369	1526404	412929
2004-05	166437	67991	11297	1729236	463118
2005-06	176046	74494	19986	1881174	531311
Overall Growth Rate (%)	9.8	21.9	31.3	10.6	11.6

31. The NSDP growth for the same time period as the vehicle registration data is about 8.3 % and the analysis indicate a transport demand elasticity of 1.18 for trucks, 1.28 for two wheelers and 1.43 for cars which are very realistic and is adopted for the traffic growth rate assessment. The elasticity values for LCV's were taken similar to Trucks and for buses based on values observed in other similar states. The GDP growth rates for the future has been taken based on the current forecast for the immediate future and long term outlook as reported in the various recent articles. The elasticity values have also been adjusted lower over the long term as is expected. Based on the economic growth out look for the region (7.5% upto 2011-12 and increasing to 8% for the next 5 years and then reducing 1 to 2% every 5 years), the resultant traffic growth rates were estimated and is given in Table 5.7.

Table 5.7: Forecast Growth Rates (%) for Traffic in the Region

Period	Forecast Traffic Growth Rates				
	Truck	LCV	Bus	Tw	Car/Jeep
2008-12	9.0	9.0	7.5	9.4	10.5
2012-17	8.8	8.8	6.4	8.0	11.2
2017-22	6.0	6.0	3.6	4.2	7.8
2022-27	5.0	5.0	2.5	3.0	6.0
2027-32	4.0	4.0	2.0	2.4	4.4

5.3.7 Engineering Surveys and Analysis

32. Topographic Survey: As part of the DPR study, detailed topographic survey was carried out using Total Stations and collected essential ground features along the existing alignment. Cross sectional and longitudinal details of the project roads at every 30m interval has been collected during the topographic survey. The details of the topographic survey were presented in the plan and profile drawings of the DPR. The topographic survey data collected has become the base information for the detailed design and for the computation of earthwork and other quantities.
33. Subsoil Investigations: Sub soil investigation along the project corridor is conducted to obtain the CBR of the subgrade soil, which will guide the flexible pavement design.

5.3.8 Design Standards

34. The project road has been proposed to be constructed to a four lane divided carriageway in two phases and two lane with paved shoulder will be constructed in the first phase. Based on the traffic estimate, the second phase may need to be taken up in about 2020. The DPR is prepared for the first phase with adequate provisions for future widening.
35. The various design elements and factors, which govern the functioning of the project road can be broadly grouped under the following requirements.
- Road Classification
 - Road Right of Way
 - Terrain

- Design Speed
- Design Cross-sections
- Geometric Design, Alignment and Profile
- Side Slope
- Pavement
- Cross Drainage Works and Structures
- Junctions and intersections
- Traffic control and safety measures
- Roadside facilities
- Realignment & Bypasses
- Pedestrian facilities
- Road safety

36. Road right of way is the land acquired for road purpose and also to accommodate future road connections or changes in alignment, road width or junction layout in existing roads and to enhance the safety, safety operation and appearance of the roads. The road right of way shall be varying between 30m to 60m for national highways and state highways. Considering the requirement of future four laning, 60m wide RoW is proposed in the DPR. The proposed 60m wide RoW will adequately accommodate the utilities, road side plantation, service road etc.

37. The project road is proposed to be designed as per the standards of State Highways. Accordingly IRC 73 "Geometric Design Standards for Rural Highways-1980" published by the Indian Road Congress is referred for finalizing project design standards. The design parameters considered for the project road improvements are summarized in the **Table 5-8**.

Table 5-8 Design Parameters

S. No	Description	IRC Standards	
1	Design speed Plain and Rolling	Max – Min	100 - 80 km/hr
2	Lane width		3.5 m
3	Paved shoulder width		1.5 m
4	Earthen Shoulder		1.0
5	Road Way Width	Two Lane	12.0 m
6	Right of Way		15 m
7	Cross-slopes	Carriageway Paved shoulder Unpaved shoulder	2.5 % 2.5 % 3.5 %
8	Maximum super elevation		7.0 %
9	Minimum horizontal curve radius	For 100 Km/hr For 80 Km/hr	360 m 230 m
10	Radii beyond which super elevation not required	For 100 Km/hr For 80 Km/hr	1800 m 1100 m
11	Super elevation runoff rate	For Plain and rolling For mountainous &	<1 in 150 <1 in 60

S. No	Description	IRC Standards		
		steep		
12	Transition curves to be used with length of spiral more than or equal to length of super elevation runoff			
13	Extra widening of carriageway on curves	For curve radius >300m 101 to 300m	Nil 0.6m	
14	Gradient	Ruling Gradient Limiting Gradient Exceptional Gradient	3.3 % 5 % 6.7%	
15	Minimum Length of Vertical Curves / Grade change not requiring vertical curve	Design Speed	min. curve length	max. grade change
		100 km/hr 80 km/hr	60m 50m	0.5% 0.6%
16	Vertical curve 'K' values Crest vertical curve/Sag vertical curve	For design Speed	Crest	Sag
		100 km/hr 80 km/hr	74 33	42 26
17	Vertical clearance	Road over road Road over railway Electrical lines H.T.Electrical lines Telecommunication Lines	5.5 m 6.525 m 6.0m (Up to 650 V) 6.5m (More than 650 V) 5.5m (Up to 110 V)	

5.3.9 Geometric Design, Alignment & Profile

38. The horizontal curves for this project were designed in accordance with the requirements stipulated in the IRC 73 Geometric Design Standard for Rural Highways. Horizontal alignment essentially comprises three major elements: tangent section, circular curve and transition curve. The proposed alignment consist of six curves with minimum radius of the horizontal curve proposed is of 475m. The proposed horizontal geometry fully satisfies the IRC requirement for state highways and the entire alignment is designed for ruling design speed of 100km/h.

39. The design elements of the vertical alignment are straight grades and vertical curves. The entire project road alignment is passing through plain agricultural fields and is proposed on embankment. As the alignment pass through plain terrain, flat geometry is proposed much below the maximum permissible gradient and hence the road profile satisfies the IRC specifications for vertical geometry.

5.3.10 Typical Cross Section

40. The entire length of the project road is proposed on virgin alignment and the eccentric two lane cross section is proposed for the first phase in such way that the centre line of the proposed four lane centre line will coincide with the centre line of the right of way. DPR typical sections for straight sections are similar to the standard sections proposed by the IRC/ Morth except the formation width of 13m with 1.5m earthen shoulder against 1m wide earthen shoulders. It is recommended to adopt standard IRC cross section with 1m wide earthen shoulder. For super elevated section, DPR propose raised kerb on the edge of the inner carriageway. The raised kerb will cause drainage problem as the project alignment is

on plain terrain with flat gradient. Hence standard typical section without raised kerb, which is generally adopted by the MoRTH, is recommended. The recommended typical cross sections for straight and super elevated sections are shown in Figure 5-2 and Figure 5-3.

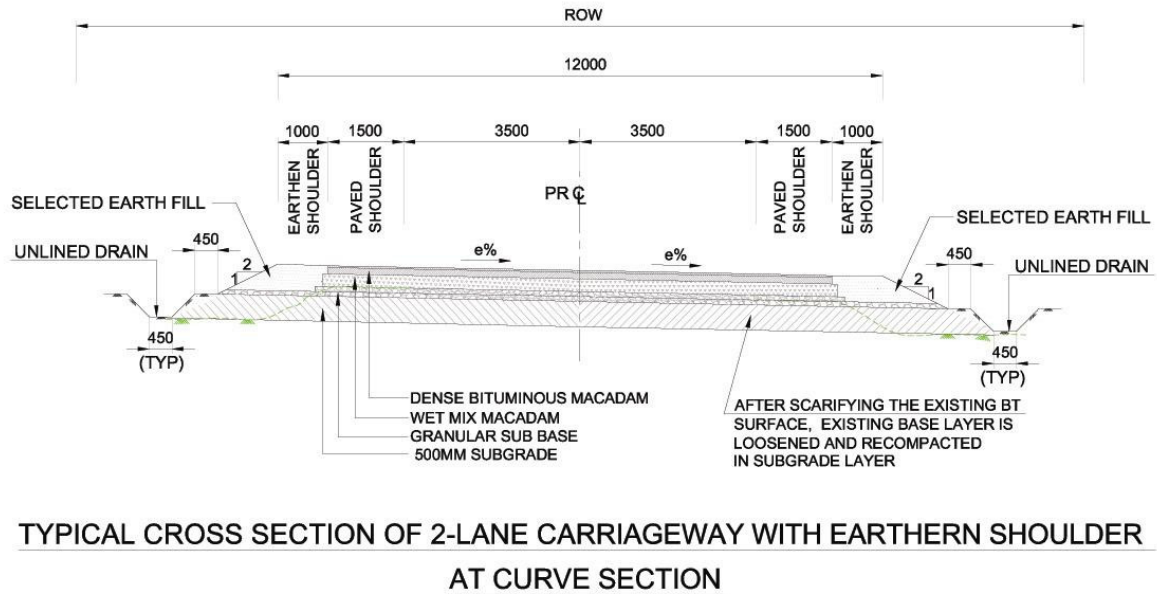


Figure 5.2 Suggested Typical Cross Section at Curved Section

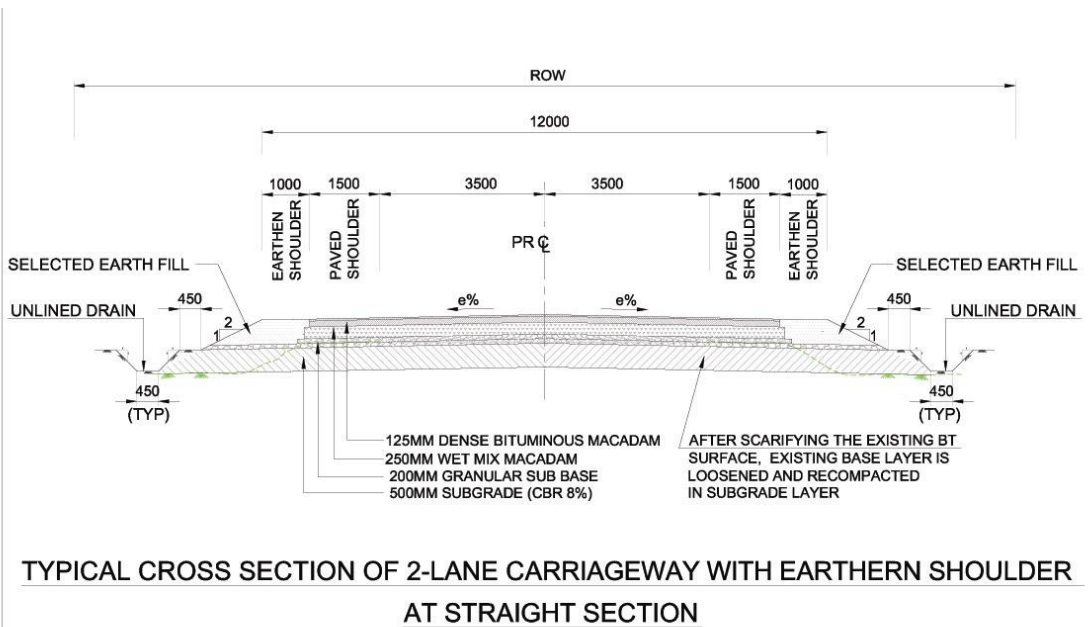


Figure 5.3 Suggested Typical Cross Section at Straight Section

5.3.11 Pavement Design

41. Flexible pavement is recommended due to low initial investment and also due to the availability of many bitumen mixing plants near the project area. The design of flexible pavement is carried out as per IRC 37 and the recommended pavement composition for the project road as given below:
- BC - 40mm
 - DBM - 90mm
 - WMM - 250mm
 - GSB - 230mm
 - Selected Subgrade of CBR > 7% - 500mm
42. All embankment slopes shall be constructed as per the guidelines given in the IRC 36 “Recommended practice for the construction of earth embankment road works” and the MoRTH specifications. An embankment side slope of 1:2 proposed in the DPR is as per the IRC guidelines.

5.3.12 Intersection Design

43. Intersection design ensures adequate capacity at the intersections to avoid bottlenecks that would results in extended delays and also safe operation to traffic by reducing the number of conflict points and conflict area. Drivers should be able to make merging, diverging or crossing maneuvers at junction with minimal risk when the junction is properly designed.
44. For the design of intersections, items considered include design speeds and the principles adopted in the design included the following:
- Traffic movements channelized to eliminate dangerous maneuvers;
 - Layout assists the driver to quickly discern his path in merging and diverging;
 - Minimize the number of conflict points and conflict area;
 - Provide adequate storage for right turners and other vehicles crossing the stream.
 - Provide proper line marking and traffic signs including advanced direction markers.
45. Site-specific junction drawings provided in the DPR is satisfying the IRC requirement and also due care has been taken for widening requirement of future four laning. **Table 5.9** lists the proposed junctions along the project road.

Table 5.9 List of Junctions

Junction No	Chainage	Description
1	0/0	T Junction. Bahadurgarh – Badli Road. (4 Lane Junction)
2	0/650	X Junction. Badli – Rohad Road
3	1/190	X Junction. Badli – Goelakalan Road
4	1/820	X Junction. Badli – Kheri Road
5	2/560	X Junction. Badli – Jhajjar Road
6	3/315	X Junction. Badli – Munimpur Road
7	4/460	X Junction. Badli – Yakubpur Road

Junction No	Chainage	Description
8	5/680	T Junction Badli – Gurgaon Road (4 Lane Junction)

5.3.13 Cross Drainage structures

46. Project road alignment is not crossing any river or stream and hence no bridge is required on the project alignment. However cross drainage structures in the form of balancing culverts are required as the alignment generally passing through agricultural fields. A total of 22 culverts are provided in DPR and meets this requirement.

5.3.14 Way side Amenities and Road furniture

47. The project road alignment is passing through agricultural field and hence no truck parking and bus bays are proposed in the DPR.

48. Road furniture represents a collection of roadside elements intended to improve the driver's perception and comprehension of the continually changing appearance of the road. Road markings and road signs standards shall be provided as per IRC: 35 -1997 and IRC: 67 -2001 respectively. Road and traffic signs will be provided at appropriate places to give caution and to inform the traffic (vehicular and pedestrians) for safe and smooth movement and the provision will be made based on the IRC guidelines. All signs shall be of Retro-reflective grade, for undisturbed traffic movement in the night times. Adequate provisions with drawings showing the locations of signs are given in the DPR.

49. Wherever applicable, roadside landscaping provision is included. But care would be taken not to reduce the sight distance at any of the intersections.

5.4 COST ESTIMATES

50. Detailed cost estimate was carried out as part of the DPR study and the same was approved by the PWD Haryana. The project cost estimate based on the DPR study is placed at 496.28 million. A review of the DPR estimate was done the TA consultant and is in agreement with DPR estimate The cost estimates have been prepared for the new two lane road with provision of paved shoulder and earthen shoulder. Project cost also include provision of strengthening of the existing pavement of Bahadurgarh - Gurgaon road section for Km 16/550 to 18/580 as well as providing covered drain in this section (the provision for covered drain in BOQ is not clear but is assumed to be for this section). The strengthening of the existing Gurgaon – Bahadurgarh road section complete a full circle around Badli town. Also at crossing roads, reconstruction is proposed for an additional 60 to 535 m along the cross roads. These additional items added to the bypass are adding substantial cost to the project. Project cost estimate provide provision for cross drainage structures, longitudinal drains, junction improvements, road furniture, street lighting, environmental mitigation measures etc. The summary cost estimate prepared by the DPR consultants are given in **Table 5.10**.

Table 5.10 Summary of Project Cost

Construction of Badli By-pass (KM. 0.00 to KM. 5.681) including upgrading of Bhadurgarh - Gurgaon road section for Km 16/550 to 18/580 and		
ABSTRACT OF PROJECT COST		
S. No.	Description	Amount (in Rupees)
1	Land Acquisition	151,883,949
2	Site clearance and dismantling	591,316
3	Earth work	43,527,460
4	Granular base course and Sub-base	69,527,469
5	Bitumenous Work	133,244,330
6	Cement Concrete Pavement	-
7	Bridges, Culverts& Causeway	18,115,325
8	Miscellaneous items/Traffic signs etc	14,019,580
9	Shifting utilities	2,840,500
10	Masonry Drain in built-up area	41,628,584
11	Retaining Wall, Brest Wall	-
12	Removal of trees and compulsory aforestation	3,976,700
13	Improvement of Railway crossing	-
A	Total	479,355,212
	Contingency 1.5%	7,190,328
	Supervision Charges 2%	9,730,911
B	Grand Total	496,276,451
	Add 6% escalation from start till completion of project	29,776,587
C	Grand Total (incl. escalation)	526,053,038

51. The cost revision for the changes recommended in the feasibility study is given below.
 - Cost reduction for EW on account of 1m earthen shoulder - 28.76 Lakhs
 - Cost reduction for removal of Kerb on superelevated section – 20.84 lakhs

52. The BOQ as well as the drawings and project description need to be updated to include clearly all the provisions made in the project and to give clarity during bid.

5.5 PROJECT IMPLEMENTATION

53. The project will be implemented by the Project Implementation Unit (PIU) of the HSRDC. The HSRDC is implementing a number of similar projects and have the institutional capacity to undertake the project. The project is proposed to be implemented as a single contract package. The procurement shall be carried out in compliance with ADB procedures. A supervision consultant shall be engaged for the contract management. The implementation of the project shall be completed over a period of 18 months (2010-11). A procurement and implementation schedule is included in the Annexures.

54. The project involves land acquisition for the entire length and may involve considerable utility shifting for the rehabilitation of Gurgaon – Bahadurgarh road section and sections of cross roads included. These are to be carried out prior to commencement of contractors mobilization to avoid delay in project implementation. A detailed utility shifting plan is to be prepared and steps to be initiated to implement them. The DPR is lacking on the utility shifting details.

5.6 ECONOMIC ANALYSIS

55. An economic analysis of the proposed Badli Bypass has been undertaken to determine its economic viability.

56. The major economic benefits comprise (i) Vehicle operating cost savings to diverted traffic with improved surface and free flow traffic situation, (ii) Vehicle operating cost savings to traffic on road through the town with improved surface and reduced congestion with traffic diversion and, (iii) travel time savings to all traffic with improved speeds. Other benefits are envisaged to accrue but have not been quantified. These include reduced emissions due to reduced congestion and improved road safety in the town sections with diversion of all truck traffic.

57. Based on the above considerations, the economic cost and benefit streams over the analysis period have been worked out using the HDM-4 model. All costs and benefits are valued in monetary terms and expressed in economic prices to avoid distortions in the input prices of labor, materials, equipment and foreign exchange due to market imperfections. In calculating the road agency economic costs (construction and maintenance), a Conversion Factor (CF) 0.9 was used, as generally used for road projects in India, to derive economic costs from the estimated financial cost.

58. The economic cost of vehicle operating cost components and time costs (VOCs) have been calculated separately for each individual component and input to the HDM model. The input values used for recent road sector studies in India have been used.
59. A 20 year analysis period has been used. A residual value of 40% is assumed, as the land acquisition cost comprise of 30% of the cost. To be acceptable for implementation, the proposed investments have to result in an EIRR of at least equal to the opportunity cost of capital, which is set at 12 percent. NPV's are calculated using opportunity cost of capital as the discount rate. The results of economic analysis for the Badli Bypass are summarized in below. The increase in cost and decrease in benefits stream over the analysis period "with the project " is given in Table 5.11.

Project	Net Present Value (NPV) (Million INR)	Net Present Value by Cost Ratio	Internal Rate of Return (EIRR) (%)
Badli Bypass, Haryana	617.5	1.4	25.2

Table 5.11 Cost – Benefit Streams

Year	Increase in Road agency Costs	Decrease in Road User Costs		Net Benefits
		VOC	Time	
2010	221.07	0.00	0.00	-221.07
2011	218.61	0.00	0.00	-218.61
2012	-0.04	75.22	15.42	90.68
2013	-0.04	81.46	17.02	98.51
2014	-0.04	90.95	18.92	109.91
2015	-0.04	100.11	21.49	121.64
2016	6.55	107.48	22.93	123.86
2017	-5.32	117.59	24.34	147.25
2018	-0.04	122.43	25.81	148.27
2019	-0.04	130.91	27.32	158.27
2020	-0.04	139.09	28.90	168.03
2021	3.50	146.47	30.61	173.58
2022	3.06	156.91	32.24	186.08
2023	-5.32	167.39	33.91	206.62
2024	-0.04	172.68	35.71	208.42
2025	-0.04	181.49	37.52	219.05
2026	3.56	188.30	39.33	224.07
2027	-0.04	201.81	40.97	242.82
2028	3.17	192.64	39.97	229.44
2029	-5.32	162.92	35.53	203.77
2030	-0.04	125.14	31.00	156.18
2031	-176.89	85.41	26.01	288.31

Year	Increase in Road agency Costs	Decrease in Road User Costs		Net Benefits
		VOC	Time	
		EIRR (%)		25.2
		NPV (Rs. Million)		617.5

60. The economic analysis indicates a robust economic rate of return well above the acceptable rate of return of 12%. The proposed Badli Bypass will relieve serious traffic congestion at Badli town and has an acceptable economic rate of return and is therefore recommended for implementation.

61. The cost and benefit estimates involve uncertainties. Sensitivity analysis has been carried out by changing cost and benefit estimates. The results of the sensitivity analysis are given in Table below. The results indicate that with adverse variation in benefits or costs, the rate of return is still above the acceptable rate of return.

Project	Scenario				
	Base case	Cost increase by 15%	Benefit decrease by 15%	Cost increase by 15% & Benefit decrease by 15%	Construction delayed by one year
	EIRR (%)	EIRR (%)	EIRR (%)	EIRR (%)	EIRR (%)
Badli Bypass, Haryana	25.2	22.6	22.2	19.8	24.3

SECTION 6

UPGRADING OF SECONDARY ROADS IN SONIPAT DISTRICT, HARYANA

6.1 ROAD NETWORK STATUS IN NCR – EXISTING SITUATION AND THE DEVELOPMENT PLANS¹

1. NCR India, or the most commonly known NCR of Delhi or the National Capital Region of Delhi is the name given to the metropolis areas in and around New Delhi - the capital of India. The NCR comprises of the entire NCT of Delhi, eight districts of Haryana including Sonipat District, one district of Rajasthan and five districts of Uttar Pradesh with a population of over 371 lakhs in 2001.
2. The sub-region wise distribution of population in NCR as of 2001 is shown in Table 6.1. The NCR population is projected to reach 64 million by 2021 as per Regional Plan 2021.

Table 6-1 Population Distribution of NCR

Sub Region/ Year	Population (Persons)			Decadal growth rate (%)		Share of population (%)		
	1981	1991	2001	1981 1991	1991 2001	1981	1991	2001
NCT-Delhi	62,20,406	94,20,644	1,38,50,507	51.45	47.02	31.28	34.43	37.33
Haryana	49,38,541	66,43,604	86,87,050	34.53	30.76	24.84	24.28	23.42
Rajasthan	17,55,575	22,96,580	29,92,592	30.82	30.31	8.83	8.39	8.06
Uttar Pradesh	69,68,646	90,01,704	1,15,70,117	29.17	28.53	35.05	32.90	31.19
Total	1,98,83,168	2,73,62,532	3,71,00,266	37.62	35.59	100	100	100

Source: Regional Plan 2021

3. NCR transport system includes an extensive road network system of about 36,305 km, a large fleet of public transport bus system operated by state transport undertakings (3144 buses) and private operators, a rail network of about 1000 Km, Metro rail of about 190 Km (90 km is operational as of November 2009 and the rest under construction) and an International airport at Delhi².
4. **Road network:** Existing road network in the region shows convergence of five national highways i.e., NH-1, 2, 8,10 and 24 on Delhi and two National Highways namely NH58 and NH91 meet NH24 at Ghaziabad. In addition to this, NH71, NH71A and NH71B also pass through the region. Ten state highways also serve in strengthening the regional road network. Most of the state highways are of single lane or intermediate lane. Though accessibility is good with reasonably good level of road density,

¹ Information used mainly from Integrated Transportation Plan for National capital Region prepared by Consulting Engineering Services (India) private Limited for NCRPB

² Source: DMRC and Wikipedia websites

mobility is poor with congested roads (poor road condition, capacity constraints, absence of access controlled high speed facilities for inter city travel and poor traffic management). Figure 6.1 shows the Sonipat town in relation to the NCR road network.

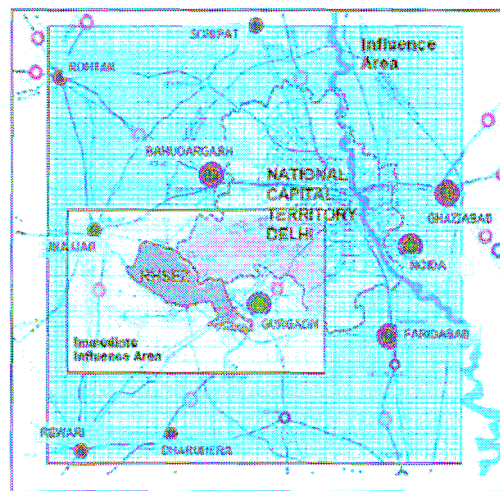


Figure 6.1 NCR Road Network

5. **Master Plan Provisions:** The Regional Plan 2021 for NCR, based on an assessment of the traffic and travel characteristics puts forth a transport system development plan for the NCR. The plan includes the following proposals.

- To decongest NCT-Delhi roads, rail and rail terminals by diverting the through traffic from Delhi.
- To provide linkages amongst Metro/Regional Urban Settlements in the outlying areas of NCR.
- To connect Metro/Regional Centers with the Capital by an efficient and effective transport network for facilitating faster movement of traffic among such centres and NCT-Delhi.
- To link the Sub-regional Centers with effective and efficient transport network for facilitating the faster movement of traffic among such centers and higher order settlements.
- To directly link other urban nodes having maximum attracting and generating characteristics.
- To create the Unified Metropolitan Transport Authority for NCR.

6. The Integrated Multi-Modal transportation Plan prepared for NCR in 2009 in accordance with the policy framework formulated in Regional Plan 2021 propose an investment plan costing US\$ 37 billion over a 25 year period (2007-2032) in the NCR region to meet the growing transport needs. The investments proposed include some of the projects under development since 2007 and new projects. The NCR RP-2021 has proposed extensive development of the transportation system of the region and the Transportation plan developed thus include (1) Large scale road network expansion including Expressways, Regional Arterials, Regional Sub-arterials and Secondary and tertiary road network in sub-regions; (2) Regional rail links and Rail rapid transit systems; (3) Regional metro rail system; (4) Public bus transport system and bus terminals; (5) Logistic hubs; (6) Integrated freight complexes; (7) Highway facilities centers; and (8) Airports.



7. In the last several years, there have been many major development projects planned and some of them under implementation which affect the NCR road network significantly as they triggers further accelerated development in the adjoining areas requiring major investment in the secondary and tertiary road network. Some of the project that have a large influence on the adjoining areas in Haryana such as the districts of Gurgaon, Jhajjar and Sonipat include:

- Haryana SEZ – An SEZ extending over 10,000 Ha is proposed for development in Gurgaon and Jhajjar district. There have been delay in the project due to delay in land acquisition. It is reported that about 8000 acres have been acquired by the developer in Jhajjar but only 1400 acres in Gurgaon. It is now planned for two separate SEZ's with 12500 acres each in Gurgaon and Jhajjar. It is expected that with two-thirds of land acquired in Jhajjar district, the SEZ planned in Jhajjar is likely to materialize. The development will have major impact on the transport scenario in the surrounding areas. The road connecting from Jhajjar to Delhi, a Major District Road (MDR 136) and passing

through Badli borders the proposed SEZ on the North. The Kundli-Maneswar-Palwai Expressway under construction is also in the vicinity.

- Kundli-Maneswar-Palwai Expressway (KMP Expressway) which is under construction on the western side of Delhi in combination with Faridabad-Ghaziabad-Kundi eastern peripheral expressway is envisaged to form cordon around the NCTD to enable bypassing of non-Delhi based traffic. The Government of Haryana is proposing to develop 14 new townships along the KMP Expressway to take advantage of the development potential. One of the township planned is the Jahangirpur-Badli new township which will have large impact on the town of Badli and the whole district of Jhajjar.
 - Global corridor along KMP Expressway: The Government of Haryana has proposed development of 14 townships covering an area of 62,000 hectares along this Expressway, which has been designated as the Global Corridor. Even a fraction of planned development will have large impact on the road network of Sonipat and Jhajjar districts.
 - Sonipat-Kundli Multifunctional Urban Complex: Sonipat town is located at a distance of about 50 km from NCTD. The NCR Plan 2001 proposed Kundli area in Sonipat to be developed as a Delhi Metropolitan Area town. In view of this and available development potential, the Government of Haryana has proposed to develop an integrated complex comprising of controlled areas declared around Sonipat town and Kundli township as a Sonipat-Kundli Multifunctional Urban complex for a population of 1 million by 2021. The transport network including NH1 expansion, KMP expressway and rapid transit corridors from Sonipat to Delhi are planned/under implementation to cater to this planned development. This will induce considerable development in the surrounding areas of Sonipat district and there is need to develop the secondary road network to support the development.
8. The road network development plan calls for capacity augmentation of the MDR's and ODR's in the NCR region to support the development anticipated in the NCR region. Also suggested is development of bypasses for each major urban center considering the growth potential and complementing the planned regional road network development. The proposed upgrading of selected roads in Sonipat district is essential to support the development plans and also for the population at large in Sonipat district to benefit from the development.

6.2 SUB-PROJECT SELECTION

9. The state of Haryana surrounds the National Capital on three sides. The road network of Haryana act as a conduit to enter the National Capital for large number of commercial traffic from Jammu & Kashmir, Punjab, Himachal Pradesh, Rajasthan and Parts of Utter Pradesh. Eight districts of Haryana viz. Faridabad, Mewat, Gurgaon, Rohtak, Sonipat , Rewari, Jhajjar and Panipat are part of the NCR. Many major development projects are taking place in NCR of Haryana, which includes 20 SEZs with an investment of Rs 870 Billion. All this developments also attracts heavy good and industrial traffic to the NCR region of Haryana from surrounding states.

10. The proposed upgrading of selected roads in Sonapat district will provide access for the population of the district the developments planned in the district and thus promote the regional development goals of NCR and therefore an important component for the success of the NCR development plan and thus the sub-project meets the objective of regional development in NCR.
11. The traffic studies described later indicate that the present AADT is in the range of 1900 to 4000 vehicles and is expected to grow at a faster pace with the proposed developments. The poor pavement condition, bad geometry and the high traffic growth combined together warrant for an immediate rehabilitation and improvement of the project roads.
12. The Haryana State Road Development Corporation (HSRDC), the implementing agency has engaged a Consultant and completed preparation of a Detailed Project Report for the sub-project. The upgrading proposal will mostly be along the existing alignment and land acquisition is not anticipated. The sub-project will involve utility shifting for which advance action needs to be taken. The project preparation is thus well advanced and the project implementation can be taken up immediately. The data and analysis from the DPR has been used for the preparation of this report. The PPTA consultant carried out the economic analysis based on the project design and project costing provided in the DPR.

6.3 SUB-PROJECT DESCRIPTION AND TECHNICAL ASSESSMENT

6.3.1 Scope and Components

13. The five roads proposed for rehabilitation and widening is given in Table 6.2 and also shown on Figure 6.2.

Table 6-2 List of Project Roads

S.No.	Name of the Road	District	Length(km)
1	Gohana-Sisana Road	Sonepat	28.563
2	Sonepat-Mehlana-Farmana Road	Sonepat	21.883
3	Sonepat-Kakroi-Bidhlan Road VT	Sonepat	19.635
4	Jagsi-Gangana Road VT	Sonepat	6.177
5	Kharkhauda-Assaudha Road	Sonepat and Jhajjar	18.045

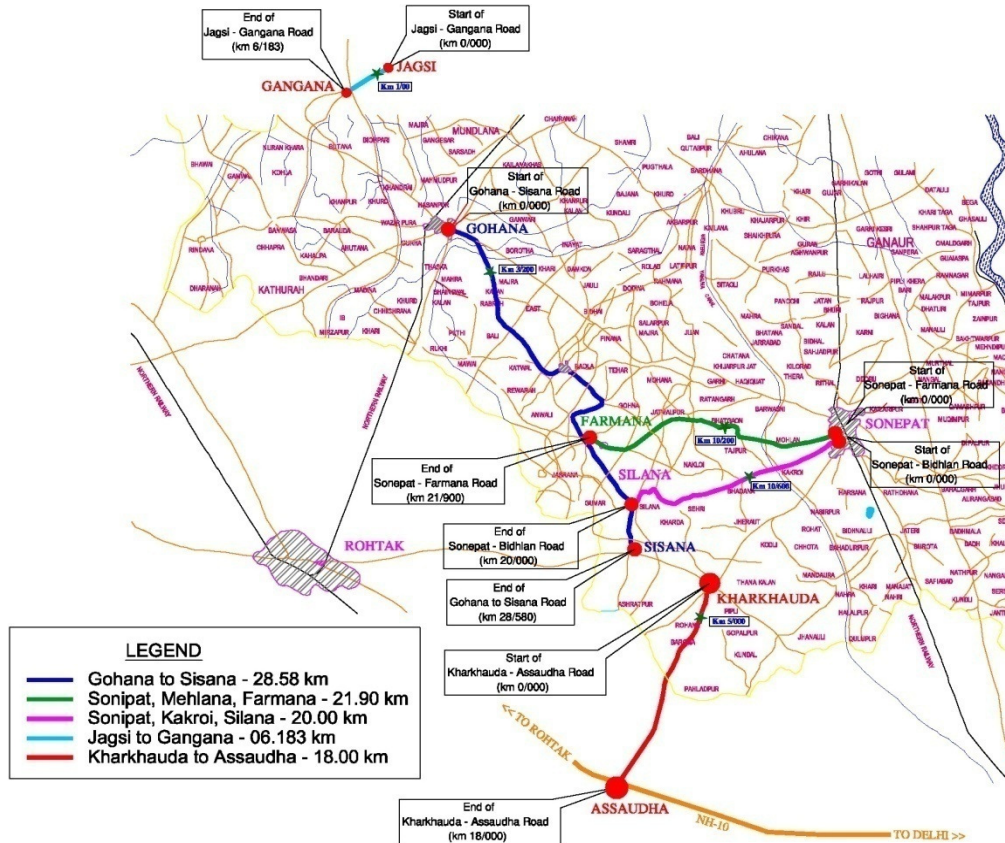


Figure 6.2 Project Roads in Sonepat District

6.3.2 Project Description

14. The main road network of Sonepat district consist two national highway (NH1 and NH71), five state highways and two major District Roads. The five roads selected for improvements are linking various villages to the main transport network consisting of National Highways and State Highways. In addition to the requirement for widening, the conditions of the existing road are very poor and needs rehabilitation.
15. The HSRDC has taken up project preparation for upgrading roads in many districts. The sub-project under consideration forms part of Package 7 and links many villages to major arterial roads of Sonepat district. The upgrading proposal is for strengthening and capacity augmentation. The HSRDC has retained the service of M/s SAI Consulting Engineers Private Ltd for carrying out detailed engineering design report for proposed improvement of five roads in Sonepat districts. The data collected as part of the DPR study is generally used for the preparation of this feasibility report.
16. The project road location is shown in Figure 6.2. Most of the roads in this package are having single to intermediate lane width with bituminous pavement. The drainage conditions of the project roads especially in the village area are very poor. Concrete pavements are generally provided in the village areas. The horizontal geometry of the project roads is reasonable except at village sections where many

- sharp curves are observed. As the project area is in flat terrain, smooth vertical profile which meets the required design standards are generally observed on all the roads.
17. The district comes under the low lying eastern margin of Punjab plains which is part of great Indo Gangetic plain, formed by the deposition of alluvial sediments and sands brought from Himalayas. Yamuna is the only River following from North to South at the eastern margin. The general elevation of the district lies between 150 to 300 m. The district is mainly covered with older alluvial soil in the western portion and younger alluvial soil in the eastern portion bordering Yamuna River.
 18. The project roads run on low to medium embankments except in built-up areas where the road is in level with the adjoining land. Earthen shoulders are also in bad shape and the berm dressing has not been carried out resulting accumulation of rainwater at the edge of the carriageway. The carriageway has thus settled considerably at the edges. There is no submergence zone. Drainage condition barring village section is considered to be in fair condition. In village section, lack of drainage caused failure of concrete pavement. Thus, in village section, there is an immediate requirement to construct roadside drain.
 19. There are no protected areas, wildlife sanctuaries or forests in the area.
 20. The available ROW varies between 8 m-25 m and HSRDC expressed their intention that land acquisition should be used as last resort. In other words, improvement to road geometrics is to be within the available land width. As such, there is no need to design the road links for high speed as most of the road users have their prime concern to reduce wear and tear to their vehicle by plying over good surface instead of present poor road. Therefore, the scope of geometric improvement can be considered fairly limited for this project.
 21. Features of all roads which includes cross sectional element, bridges, culverts, junctions, number of curves etc are given in Table 6.3.

Table 6.3 Project Road Features

Rd.No.	Name of the Road	Length (km)	Start Point	End Point	District	Chainage (m)		ROW As per DPR (m)	Existing features along Project Road											
						From	To		Land Use	Existing Pavement width (m)	Shoulder on either side	Lowlying area	Embankment height	Terrain	Drainage	Pavement Condition	Water Logged	Level Crossing	Minor Bridge	Culvert
1	Gohana-Sisana Road	28.563	At nagar junction with Sonapat-Gohana road in Gohana	At Sisana on Kharkhoda – Rohtak road	Sonapat	0+000	18+000	9	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	4	17
						18+000	18+800	11	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	-	1
						18+800	19+200	10	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	-	1
						19+200	25+200	11	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	-	9
						25+200	25+600	10	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	1	-
						25+600	28+500	9	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	-	4
2	Sonapat - Mehana - Farmana Road	21.883	at Gohana chowk in Sonapat on Sonapat-Gohana road	Farmana on Gohana-Sisana Road	Sonapat	0+000	0+500	11	Builtup	5.5	2m	No	No	Plain	No	Poor	No	No	-	-
						0+500	1+600	10	Builtup	5.5	2m	No	No	Plain	No	Poor	No	No	-	-
						1+600	5+300	9	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	-	-
						5+300	5+800	11	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	-	-
						5+800	11+600	9	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	2	5
						11+600	12+600	11	Agri	5.5	1m	Yes	1m	Plain	No	Poor	Yes	No	-	5
						12+600	15+900	9	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	1	2
						15+900	16+500	10	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	-	1
						16+500	21+450	9	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	1	10
	21+450	22+000	11	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	-	-					

3	Sonapat-Kakroi-Bidhlan Road VT	19.6 35	Sonapat-Kakroi road in Sonapat	Silana	Sonapat	0+000	1+900	11	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	-	-
						1+900	2+500	10	Builtup	5.5	1m	No	1m	Plain	No	Poor	No	No	-	-
						2+500	6+000	9	Agri	3.5	1m	Yes	1m	Plain	No	Poor	Yes	No	2	10
						6+000	6+100	10	Agri	3.5	1m	No	1m	Plain	No	Poor	No	No	3	-
						6+100	6+700	11	Builtup	3.5	1m	No	No	Plain	No	Poor	No	No	-	-
						6+700	7+000	10	Agri	3.5	1m	Yes	1m	Plain	No	Poor	Yes	No	-	1
						7+000	10+500	9	Agri	3.5	1m	No	1m	Plain	No	Poor	No	No	1	3
						10+500	11+300	10	Builtup	3.5	1m	No	1m	Plain	No	Poor	No	No	-	-
						11+300	16+670	9	Agri	3.5	1m	No	1m	Plain	No	Poor	No	No	-	3
						16+670	16+800	11	Agri	3.5	1m	Yes	1m	Plain	No	Poor	Yes	No	-	-
4	Jagsi-Gangana Road VT	6.17 7	Jagsi	Gangana	Sonapat	0+000	1+000	9	Agri	3.5	1m	Yes	1m	Plain	No	Fair	Yes	No	-	1
						1+000	6+000	11	Agri	3.5	1m	No	1m	Plain	No	Poor	No	No	1	2
5	Kharkhau da-Assaudha Road	18.0 45	Kharkhau da village	Delhi-Rohtak NH-10	Sonapat/Jhajjar	0+000	0+600	11	Builtup	5.5	1m	No	No	Plain	No	Good	No	No	-	-
						0+600	2+700	9	Agri	5.5	1m	No	2m	Plain	No	Poor	No	No	-	1
						2+700	3+450	10	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	-	-
						3+450	7+500	9	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	-	8
						7+500	8+600	11	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	-	2
						8+600	11+200	9	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	-	1
						11+200	11+700	11	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	-	-
						11+700	12+400	10	Builtup	5.5	1m	No	1m	Plain	No	Poor	No	No	-	-
						12+400	14+200	9	Agri	5.5	1m	No	1m	Plain	No	Poor	No	No	1	3
						14+200	15+600	11	Builtup	5.5	1m	No	No	Plain	No	Poor	No	No	1	1
	15+600	9	Agri	5.5	1m	Yes	1m	Plain	No	Poor	Yes	1	-	2						

6.3.3 DPR Review Approach

22. The DPR and other available reports were collected and studied in detail to prepare this feasibility study report. The approach involved site reconnaissance, preliminary desk review of the available reports, additional data gathering if needed and final review of the DPR analysis and drawings to obtain the required information for feasibility study. Broad observations and suggestions on the design are included in the relevant sections of the report.

6.3.4 DPR Surveys

23. For the preparation of Detailed Project Report, the HSRDC Consultant carried out the following surveys and investigations along the bypass road alignment:
- Field Reconnaissance Survey
 - Traffic and transportation surveys, including classified traffic volume counts and origin-destination surveys
 - Topographic surveys of the proposed alignment
 - Sub soil investigations
 - Census survey of the potential APs and preparation of Resettlement Plans
 - Environmental reconnaissance surveys and preparation of IEE

6.3.5 Traffic Surveys and Analysis

24. The traffic volume data forms an important input to project design and economic analysis. As part of the DPR, classified traffic count surveys were carried out on all the five roads and road. As the project roads are minor links connecting to villages, no major diverted traffic is envisaged and hence no Origin – Destination Surveys were carried out for the DPR study.
25. Based on field reconnaissance and further review of the DPR traffic study report, TA consultant concluded that no further traffic study is needed as the traffic count of the DPR study is generally found matching with field conditions.
26. For the present project, as mentioned in the DPR TOR, a period of 10 years has been adopted as pavement design life.
27. Capacity analysis of the project roads are carried out based on IRC 64 and the projected traffic. Design service volume (DSV) varies depending on the type of terrain, lane width, shoulder width etc. The DSV considered for the lane requirement analysis is presented in Table 6.4.

Table 6.4 Design Service Volume

Road Type	Design Service Volume in PCU
Single Lane	2000
Intermediate Lane	6000
Two Lane	15000
Two Lane with paved shoulder	18000

28. The Average Annual Daily Traffic (AADT) estimated based on the classified volume count are given in Table 6.5. The traffic counts were carried out in November 2008 and a seasonal correction factor of 1.0 has been assumed for arriving at the AADT from the counts.

Table 6.5: Average Annual Daily Traffic on the Project Road Sections

Name of Road	2 - wheelers	3 - wheelers	Cars	Bus	LCV	Trucks	Agricultural Tractor	Slow moving vehicles	Total	
					Freight				Vehicles	PCU
Gohana-Sisana	1425	240	472	92	149	477	334	417	3606	5420
Sonepat-Farmana	1352	205	317	78	72	72	261	323	2680	3062
Sonepat-Bidhlan	734	126	265	75	64	70	371	198	1903	2746
Jagsi-Gangana	657	47	168	25	32	37	476	497	1939	4023
Kharkhauda-Assaudha	1424	200	623	71	338	598	251	488	3993	5984

6.3.6 Traffic Forecast

29. Both economic growth and population growth contribute to the traffic growth. There are no time series traffic data on the roads in the area and hence no assessment could be made of past traffic growth using time series data. The best approach to assess traffic growth is to examine population and economic growth as well as the growth of vehicle registrations and to establish the 'transport demand elasticity' that can be used to estimate future traffic growths based on forecasts of economic growth. Traffic growth rates for the region have been worked out using this approach.

30. The net state domestic product of the state in the past few years has been obtained from the published documentation available in the Reserve Bank of India website and is given in Table 6.6. The overall trend indicates growth rates of close to 8.8% in the 1999-2008 period. A comparison with all India GDP growth indicate that Haryana enjoyed a much higher growth than the national average growth in GDP in this decade.

Table 6.6 Net State Domestic Product of Haryana at Constant Prices

Year	NSDP (Rs. Lakhs)
1999-00	5127783
2000-01	5547672
2001-02	5985030
2002-03	6365901
2003-04	6938802
2004-05	7567606
2005-06	8260388
2006-07	9205311
2007-08	10131942

31. The vehicle registration growth also gives indication of the traffic growth. The vehicle registration data for the past few years have been obtained and is given in Table 6.7. The growth rates observed in the case of Trucks and Cars are in line with the national trends whereas LCV and bus growth shows some abnormal growth. LCV growth in later years seems reasonable except for the jump in 2002-03 and in case of buses it again shows such drastic jumps which may be due to the low base initially and the large scale developments in the NCR area resulting in huge increase in buses. However, this may not continue in the same way once the number of buses increases.

Table 6.7: Vehicle Registration data of different vehicles in Haryana

Year	Truck	LCV	Bus	TW	Car/Jeep
2000-01	110238	27707	5120	1136917	306972
2001-02	110238	27707	5120	1136917	306972
2002-03	126109	49160	8091	1356957	354518
2003-04	147667	58325	9369	1526404	412929
2004-05	166437	67991	11297	1729236	463118
2005-06	176046	74494	19986	1881174	531311
Growth rate over the period	9.8	21.9	31.3	10.6	11.6

32. The NSDP growth for the same time period as the vehicle registration data is about 8.3 % and the analysis indicate a transport demand elasticity of 1.18 for trucks, 1.28 for two wheelers and 1.43 for cars which are very realistic and is adopted for the traffic growth rate assessment. The elasticity values for LCV's were taken similar to Trucks and for buses based on values observed in other similar states. The GDP growth rates for the future has been taken based on the current forecast for the immediate future and long term outlook as reported in the various recent articles. The elasticity values have also been adjusted lower over the long term as is expected. Based on the economic growth outlook for the region (7.5% upto 2011-12 and increasing to 8% for the next 5 years and then reducing 1 to 2% every 5 years), the resultant traffic growth rates were estimated and is given in Table 6.8.

Table 6.8: Forecast Growth Rates (%) for Traffic in the Region

Period	Forecast Traffic Growth Rates				
	Truck	LCV	Bus	Tw	Car/Jeep
2008-12	9.0	9.0	7.5	9.4	10.5
2012-17	8.8	8.8	6.4	8.0	11.2
2017-22	6.0	6.0	3.6	4.2	7.8
2022-27	5.0	5.0	2.5	3.0	6.0
2027-32	4.0	4.0	2.0	2.4	4.4

6.3.7 Engineering Surveys and Analysis

33. **Topographic Survey:** As part of the DPR study, detailed topographic survey was carried out using Total Stations and collected essential ground features along the existing alignment. Cross sectional and longitudinal details of the project roads at every 30m interval has been collected during the topographic survey. The details of the topographic survey were presented in the plan and profile drawings of the DPR. The topographic survey data collected has become the base information for the detailed design and for the computation of earthwork and other quantities.
34. **Pavement and Subsoil Investigations:** Pavement investigations are accomplished by undertaking trial pits from edge of the existing roads and taking note of layer thickness of pavement crust and collecting the soil samples from the subgrade for laboratory tests. The pavement crust in general appears of two later system of Premix Carpet underlain with base of stone aggregate as suggested in the report. Thickness of aggregate base layer and that of premix bituminous carpet is varying significantly for all the roads of Package 7. As such existing condition of the road is bad to very bad at places full of undulations, cracks, potholes, raveling, broken edges etc.
35. The existing subgrade has been tested for FDD and FMC and also DCP tests have been undertaken at regular interval in order to ascertain the quality of subgrade soil in-situ. DCP-CBR values evaluated for different roads are in the range of 2.6% to 4.3%. FDD of existing subgrade is matching closely to dry density achieved at lowest energy level of 35 numbers of blows. From test result of Sub Grade soil, the DPR study concluded and recommended for 4.8%, 5.0%, 5.5%, 4.8% and 4.8% of soaked CBR compaction at 97% of MDD for pavement design purpose for Sonapat-Fermata, Khakhoda-Assudha, Gohana Sisana, Jagsi – Gagnana and Sonapat-Bidhalan respectively.
36. **Inventory and condition surveys for bridges and other structures:** There are 18 no's of minor bridges on the project roads. The condition of 6 nos of bridges is poor and proposed for new construction. Eleven bridges are in good condition and require only some minor repairs. Superstructure of one minor bridge is poor and proposed for the replacement of the same. There are 99 culverts consisting of 39 slab type, 44 RCC pipe culverts, and 16 Box culverts exist in the project roads. The proposals include 20 new culverts.
37. **Geotechnical and Material Investigation:** Geotechnical investigation were carried at sites for bridge construction and the details are given in Table 6.9.

Table 6.9 Bore Hole details

Sr. No.	Road	Chainage	No. of Boreholes	Depth of Exploration (m)	No. of Spans
1	Gohana - Sisana	0.33 / 0.248	2	15	2
2	Gohana - Sisana	7.779	2	15	3
3	Gohana - Sisana	27.743	3	15	Drawings / GAD not available
4	Jagsi - Gangana	0.764	2	15	1
5	Jagsi - Gangana	3.536	2	15	1
6	Sonipat-Mehlana-Fermana	5.859	3	15	3
7	Sonipat-Kakroi-Bidhalan	6.05	2	15	1

38. Geotechnical investigation reports do not specify reduced level (RL) of the ground at the above borehole locations explored and the same need to be verified in order to ascertain characteristic of the foundation soil below the proposed pier and abutment structures as shown in the respective GAD. It would be prudent to place the borehole information according to their location and level on to the GAD of respective bridges.
39. Accordingly there is a need to verify suitable foundation level for each of the minor bridges listed above keeping in view the loads, scour depth (if applicable) and competency of the foundation soil strata in terms of settlement and bearing capacity criteria for specific structural arrangements recommended before finalizing the bid documents.
40. Safe bearing capacity of the proposed open foundation of respective structures need be reviewed and foundation size be confirmed accordingly.
41. Proposed shallow foundations for the Bridge at Km 27.743 on Gohana – Sisana road is likely to be supported on Silty Clay (CL) strata and foundation details are to be confirmed according to requirements of the proposed superstructure. Likewise also the founding strata at rest of the bridge’s piers and abutment location is to be reviewed and foundation details to be shown on the construction drawings accordingly.
42. Chemical test results of samples from subsoil and water from the site show absence of any harmful substances and therefore safe for normal concrete and RCC works.
43. **Pavement and Construction Material Investigation:** A comprehensive report on existing pavement condition and source material investigation has been prepared by the DPR consultant. The report entails investigation on the following roads:

- Gohana to Sisana; km 0.00 to km 31.5
 - Sonapat to Bidhlan; km 0.00 to km 20.00
 - Jagsi to Gangana; km 0.00 to km 6.183
 - Sonapat to Farmana; km 0.00 to 23.00
 - Kharkhaudha to Assaudha; km 0.00 to km 18.00
44. Earthworks: From the DPR it appears sufficient quantity of soil would be available from nearby borrow areas for the earthworks within about 20m to 100m lead distance at different chainages of the above mentioned roads. Engineering properties of the soil samples collected from the borrow areas appear within the specification limits of Ministry of Road Transport and Highways.
45. Quarry Materials: Stone and aggregate quarries are located at Tosham and Kalyana at approximate 160km and 105km respectively. Figure III/1.0 mentioned shall be referred as Fig. 6 in the report in relation to the location plan of quarries. Also the photographs mentioned as Figures III/1.1 to 1.5 appears taken from the existing road surface and not from the soil borrow and aggregate sources. Several brick kilns are located close to the proposed routes.
46. It is recommended that wash sand from Kalyana quarry is suitable for RCC works involved with the bridges and the cross drainage works. Sand from river Yamuna could only be used if its fineness modulus satisfies the specification requirements.
47. DPR consultant has recommended use of Flyash as fill material available from Panipat thermal power station. It is suggested to undertake enough number of samples in order to ascertain its engineering characteristics as per specifications. The flyash fill works is to be capped by a suitable thickness of good clayey soil as per IRC recommendations.

6.3.8 Design Standards

48. The various design elements and factors, which govern the functioning of the project road can be broadly grouped under the following requirements.
- Road Classification
 - Road Right of Way
 - Terrain
 - Design Speed
 - Design Cross-sections
 - Side Slope
 - Pavement
 - Cross Drainage Works and Structures
 - Junctions
 - Traffic control and safety measures
 - Roadside facilities
 - Realignment & Bypasses
 - Pedestrian facilities

49. The project roads are proposed to be designed as per the standards of Other Districts Roads. Accordingly IRC 73 “Geometric Design Standards for Rural Highways-1980” published by the Indian Road Congress is referred for finalizing project design standards. The design parameters considered for the project road improvements are summarized in the **Table 6.10**.

Table 6.10 Design Parameters

S. No	Description	IRC Standards		
1	Design speed Plain and Rolling	Max – Min	65 - 50 km/hr	
2	Lane width		3.5 m	
3	Paved shoulder width		1.5 m	
4	Earthen Shoulder		1.0	
5	Road Way Width	Intermediate Two Lane	7.5 m (5.5 m carriageway width) 9.0 m	
6	Right of Way		15 m	
7	Cross-slopes	Carriageway Paved shoulder Unpaved shoulder	2.5 % 2.5 % 3.5 %	
8	Maximum super elevation		7.0 %	
9	Minimum horizontal curve radius	For 65 Km/hr For 50 Km/hr	150 m 90 m	
10	Radii beyond which super elevation not required	For 65 Km/hr For 50 Km/hr	750 m 450 m	
11	Super elevation runoff rate	For Plain and rolling For mountainous & steep	<1 in 150 <1 in 60	
12	Transition curves to be used with length of spiral more than or equal to length of super elevation runoff			
13	Extra widening of carriageway on curves	For curve radius >300m 101 to 300m	Nil 0.6m	
14	Gradient	Ruling Gradient Limiting Gradient Exceptional Gradient	3.3 % 5 % 6.7%	
15	Minimum Length of Vertical Curves / Grade change not requiring vertical curve	Design Speed	min. curve length	max. grade change
		65 km/hr 50 km/hr	40m 30m	0.8% 1.0%
16	Vertical curve 'K' values Crest vertical curve/Sag vertical curve	For design Speed 65 km/hr 50 km/hr	Crest 18.4 8.1	Sag 10 17.4
17	Vertical clearance	Road over road Road over railway Electrical lines H.T.Electrical lines Telecommunication Lines	5.5 m 6.525 m 6.0m (Up to 650 V) 6.5m (More than 650 V) 5.5m (Up to 110 V)	

50. The traffic projection for the design period of 10 years indicate that the projected traffic is within the design service volume of two lane road and therefore two lane road cross section is proposed for the project roads.

6.3.9 Geometric Design, Alignment & Profile

51. No geometric improvement is considered in the DPR as the project improvement was limited within the available width of land. During the site reconnaissance, TA consultant observed many substandard curves which need geometric correction and in some case realignment of such sections. Details of sub standard curves identified by desk review of the alignment and the site reconnaissance are given in **Table 6.11**. The HSRDC should atleast include the improvement of these curves in their future program.

Table 6.11 Details Horizontal Curves

Radius of Curve (m)	Safe Design Speed (km/h)	No. of Curves					Remarks
		Road - 1	Road - 2	Road - 3	Road - 4	Road - 5	
0 - 45	<35	1	5	5	-	-	Curves Below Design Speed
45 - 60	35	-	2	-	-	-	
60 - 90	40	1	4	2	-	-	
	Total	2	11	7	0	0	
90 - 150	50	3	6	5	4	3	Curves meets Design Speed
150 - 230	65	1	9	3	5	4	
230 - 360	80	8	9	6	5	4	
>360	100	51	32	59	14	31	
	Total	63	56	73	28	42	
Total No of Curves		65	67	80	28	42	

52. From the above table it can be seen that 20 curves in the existing project road alignment is below the stipulated design standard. The stretches identified for geometric improvement are shown in Table 6.12. As land acquisition for the geometric improvement is time consuming, the improvement works within the available alignment to be taken up immediately.

53. All the project roads are on plain terrain and as such no vertical geometric corrections required the entire length except at low lying where road profile needs to lifted. The details of the low lying areas with improvement suggestions are presented in Table 6.12.

Table 6.12 Details of Low-lying areas and Sections identified for geometric improvement

Name of the Road	Length(km)	Realignment Chainage (m)		Low-lying area Chainage (m)	
		From	To	From	To
Gohana-Sisana Road	28.56	-	-	18+500	18+800
Sonepat-Mehlana-Farmana Road	21.88	8+200	8+600	11+600	12+000
Sonepat-Kakroi-Bidhlan Road VT	19.64	10+800	11+000	4+500	5+000
		11=200	11=350	5+600	5+700
		17+700	18+000	11+000	11+400
		18+550	18+700	16+800	17+100
Jagsi-Gangana Road VT	6.177	-	-	0+000	1+000
		-	-	5+200	5+400
		-	-	5+800	5+900
Kharkhauda-Assaudha Road	18.05	-	-	17+200	18+000

6.3.10 Typical Cross Section

54. Various typical cross sections are adopted for the project improvement proposal depending upon the lane width and drain type. Typical section generally adopted are listed below:

- Two Lane rural section
- Two Lane urban section

55. The proposed sections consist of 7m wide carriageways and 1m wide gravel shoulder on either side of the carriageway. The proposed sections meet the IRC requirements of ODR.

6.3.11 Pavement Design

56. A ten-year design period is considered for the pavement design. Flexible pavement is recommended for the project road improvement due to low initial investment. The design of new flexible pavement is carried out as per IRC 37 and the overlay design is done as per IRC 81. Based on the structural analysis of the existing pavement layers, it is recommended to scarify the bituminous layer and remaining layers is considered as part of the granular sub base required for the pavement structure. Accordingly top layers consist of WMM, BM/DBM and PC/BC is proposed as part of the overlay design. Overlay for strengthening the pavement is recommended for the entire length of the project road except from km 0 to 1 of Jagsi –Gangana road as condition of the existing road is beyond repairs. Hence it is proposed to reconstruct this portion of the road. Design of overlay and widening/reconstruction is presented in Table 6.13 and 6.14 respectively.

Table 6.13 Proposed Overlay for strengthening of existing section

Name of Road	PC (mm)	BC (mm)	BM (mm)	DBM (mm)	WMM (mm)
Sonepat-Bidhalan	20		50		150
Jagsi-Gangana	20		50		150
Gohana -Sisana		40		70	150
Kharkhauda - Assaudha		40		85	75
Sonepat -Mehlalna Farmana	20		50		100

Table 6.14 Proposed pavement composition for widening/reconstruction

Name of Road	PC (mm)	BC (mm)	BM (mm)	DBM (mm)	WMM (mm)	GSB (mm)
Sonepat-Bidhalan	20		50		225	215
Jagsi-Gangana	20		50		225	205
Gohana Sisana		40		70	250	300
Kharkhauda Assaudha		40		85	250	300
Sonepat Mehlalna Farmana	20		50		250	230

6.3.12 Junction Design

57. Junction design ensures adequate capacity to avoid bottlenecks that would result in extended delays and also safe operation to traffic by reducing the number of conflict points and conflict area. Drivers should be able to make merging, diverging or crossing maneuvers at junction with minimal risk when the junction is properly designed. Details of Junctions along the project road alignments are presented in the Table 6.15. All the junctions listed below are proposed to be improved as per IRC standards.

Table 6.15 Details of Junctions along the project roads

Sr. No.	Name of project road	Type of Junction	Total Number of Junctions
1	Gohana- Sisana	T	31
		X	8
2	Sonepat - Farmana	T	31
		X	7
3	Sonepat - Silana	T	30
		X	6
4	Jagsi-Gangana	T	12
		X	-
5	Kharkhauda-Assaudha	T	28
		X	4

6.3.13 Way side Amenities and Road furniture

58. The project roads are MDR's or other roads and are not main truck routes. Therefore no truck parking area is provided. The numbers of buses in the projects roads are not substantial and hence no bus bays are proposed in the DPR.
59. Road furniture represents a collection of roadside elements intended to improve the driver's perception and comprehension of the continually changing appearance of the road. Road markings and road signs standards shall be provided as per IRC: 35 -1997 and IRC: 67 -2001 respectively. Road markings and traffic signs will be provided at appropriate places to give caution and to inform the traffic (vehicular and pedestrians) for safe and smooth movement and the provision will be made based on the IRC guidelines. All signs shall be of Retro-reflective grade, for undisturbed traffic movement in the night times. Adequate provisions road furniture and signs are provided in estimate.

6.4 COST ESTIMATES

60. The cost estimates have been prepared for widening of the existing single/intermediate road to two lane roads including strengthening of the existing pavement, strengthening / widening of existing bridge structures, construction of new bridges, rehabilitation and reconstruction / widening of cross drainage structures, longitudinal drains, junction improvements, road furniture, street lighting, environmental mitigation etc. The summary cost estimate prepared by the DPR consultants is presented in Table 6.16.

6.5 PROJECT IMPLEMENTATION

61. The project will be implemented by the Project Implementation Unit (PIU) of the HSRDC. A single construction package is recommended to have a good size project to attract larger contractors and also to have better contract management. The HSRDC is implementing a number of similar projects and have the institutional capacity to undertake the project but may need to augment its strength when taking up more projects. The procurement shall be carried out in compliance with ADB procedures. A supervision consultant shall be engaged for the contract management. The implementation of the project shall be completed over a period of 18 months (2010-11). A procurement and implementation schedule is included in the Annexure.
62. The project involves utility shifting to some extent. These are to be carried out prior to commencement of Contractor's mobilization to avoid delay in project implementation. A detailed utility shifting plan is to be prepared and steps to be initiated to implement them.

Table 6.16 Project Cost Summary (in Rupees)

Items	Sonipat- Bidhalan	Jagsi - Gangana	Gohna - Sisana	Kharkhauda - Asaudha	Sonipat - Farmana
Bill No 1: Site Clearance	775140.45	332528.99	1692240.07	651867.79	986089.60
Bill No 2: EarthWork	18096297.25	6692980.95	21087585.17	12209864.94	20515326.42
Bill No 3: Sub Base and base Courses	70268678.29	24535047.63	103598533.87	40045852.79	61783416.47
Bill No 4: Bituminous Courses	55772762.13	18489064.19	143280043.70	94647663.58	64620387.90
Bill No 5: Concrete pavement	11865918.27	0.00	8625540.90	15307641.68	0.00
Bill No 6 & 7: Cross Drainage works and Bridges	15930156.15	8310967.30	23692862.04	2480750.05	13890974.96
Bill No 8: Drainage and Protection Works	15367120.00	0.00	6883800.00	19701500.00	15002678.40
Bill No 9: Traffic Safety and Road Appurtenances	25176360.75	8143514.94	35741640.28	22929797.83	27093056.35
Bill No 10: Miscellaneous Items	4907752.97	1688978.99	8761927.79	4368484.23	61783416.47
Deforestation	15708000.00	4941600.00	22850400.00	14436000.00	17506400.00
Utility shifting	3927000.00	1235400.00	5712600.00	3609000.00	4376600.00
Land Acquisition	600000.00	0.00	0.00	0.00	0.00
Sub total	238,395,186	74,370,082	381,927,173	230,388,422	287,558,346
Add 3.5% towards Physical Contingencies, Supervision, etc	8343831	2602953	13367451	8063595	10064542
Total Project cost (Rs)	246,739,017	76,973,035	395,294,624	238,452,017	297,622,888
Total Project cost (Rs. Million)	246.7	77.0	395.3	238.5	297.2
Stretch Length (km)	19.635	6.177	28.563	18.045	21.883
Cost per km (Rs. Million/km)	12.57	12.46	13.84	13.21	13.60

6.6 ECONOMIC ANALYSIS

63. An economic analysis of the proposed project has been undertaken to determine its economic viability. The major economic benefits comprise (i) Vehicle operating cost savings to traffic on the project roads with improved surface and capacity and (ii) travel time savings to all traffic with improved speeds. Other benefits are envisaged to accrue with better access but have not been quantified. These include reduced emissions due to better level of service, social benefits and improved road safety in the town sections.

64. Based on the above considerations, the economic cost and benefit streams over the analysis period have been worked out using the HDM-4 model. All costs and benefits are valued in monetary terms and expressed in economic prices to avoid distortions in the input prices of labor, materials, equipment and foreign exchange due to market imperfections. In calculating the road agency economic costs (construction and maintenance), a Conversion Factor (CF) 0.9 was used, as generally used for road projects in India, to derive economic costs from the estimated financial cost.

65. The economic cost of vehicle operating cost components and time costs (VOCs) have been calculated separately for each individual component and input to the HDM model. The input values used for recent road sector studies in India have been used.
66. A 20 year analysis period has been used. A residual value of 10% is assumed, as the project involves widening. To be acceptable for implementation, the proposed investments have to result in an EIRR of at least equal to the opportunity cost of capital, which is set at 12 percent. NPV's are calculated using opportunity cost of capital as the discount rate. The results of economic analysis for the project is summarized below in Table 6.17. Cost-benefit streams are given in Annex 1.

Table 6.17 Economic Analysis Results

Road	NPV	NPV/Cost Ratio	EIRR
	(Rs. Million)		(%)
Gohana - Sisana	1804.9	5.7	57.5
Jagsi - Gangana Road	100.0	1.3	28.1
Kharkhauda-Assaudha Road	1320.3	6.8	64.8
Sonepat-Farmana	952.6	4.0	49.2
Sonepat - Kakroi Road	393.0	1.8	31.4

67. The economic analysis indicates a robust economic rate of return well above the acceptable rate of return of 12% for all project road sections. The proposed project will improve the level of service and augment capacity to sustain the level of service over the design period and has an acceptable economic rate of return and is therefore recommended for implementation.
68. The cost and benefit estimates involve uncertainties. Sensitivity analysis has been carried out by changing cost and benefit estimates. The results of the sensitivity analysis are given in Table 6.18. The results indicate that with adverse variation in benefits or costs, the rate of return is still above the acceptable rate of return.

Table 6.18 Sensitivity Analysis Results

Road Section	Economic Internal Rate Of Return Under Different Scenarios				
	Base Case	Increase in Cost by 15%	Decrease in Benefits by 15%	Increase in Cost and Decrease in Benefits By 15%	Delay in Construction by One Year
Gohana - Sisana	57.5%	52.1%	51.3%	46.5%	48.0%
Jagsi - Gangana	28.1%	24.9%	24.4%	21.6%	27.0%
Kharkhauda - Assaudha Road	64.8%	58.8%	57.9%	52.5%	53.5%
Sonepat - Farmana	49.2%	44.2%	43.5%	39.0%	39.0%
Sonepat-Kakroi-Bidhlan Road	31.4%	28.1%	27.5%	24.5%	26.1%

Annex 1

Gohana Sisana				Decrease in Road User Costs						Gohana Sisana		
Year	Increase in Road Agency Costs			MT VOC	MT Time	NMT	Accidents	Exogenous Benefits	Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special									
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	158.98	-2.59	0.00	0.00	0.00	0.00	0.00	0.00	-156.39	156.39	0.00	-156.39
2011	177.87	0.00	0.00	-10.32	-0.32	0.00	0.00	0.00	-188.51	177.87	-10.64	-188.51
2012	0.00	0.00	0.00	160.64	40.98	0.00	0.00	0.00	201.61	0.00	201.61	201.61
2013	0.00	0.00	0.00	179.75	45.38	0.00	0.00	0.00	225.13	0.00	225.13	225.13
2014	0.00	0.00	0.00	201.06	50.33	0.00	0.00	0.00	251.39	0.00	251.39	251.39
2015	0.00	0.00	0.00	225.96	56.01	0.00	0.00	0.00	281.96	0.00	281.96	281.96
2016	0.00	0.00	0.00	255.55	62.62	0.00	0.00	0.00	318.17	0.00	318.17	318.17
2017	37.78	0.01	0.00	291.61	70.54	0.00	0.00	0.00	324.35	37.80	362.15	324.35
2018	-18.89	-0.16	0.00	338.11	80.02	0.00	0.00	0.00	437.18	-19.05	418.13	437.18
2019	0.00	0.00	0.00	316.67	82.22	0.00	0.00	0.00	398.88	0.00	398.88	398.88
2020	0.00	0.00	0.00	347.21	89.21	0.00	0.00	0.00	436.42	0.00	436.42	436.42
2021	0.00	0.00	0.00	382.76	97.28	0.00	0.00	0.00	480.04	0.00	480.04	480.04
2022	0.00	0.00	0.00	423.74	106.69	0.00	0.00	0.00	530.43	0.00	530.43	530.43
2023	37.78	0.02	0.00	458.45	116.23	0.00	0.00	0.00	536.88	37.81	574.68	536.88
2024	0.00	0.00	0.00	486.57	123.21	0.00	0.00	0.00	609.78	0.00	609.78	609.78
2025	0.00	0.00	0.00	510.02	130.66	0.00	0.00	0.00	640.68	0.00	640.68	640.68
2026	-18.89	-0.16	0.00	534.75	138.67	0.00	0.00	0.00	692.48	-19.06	673.43	692.48
2027	0.00	0.00	0.00	488.14	139.97	0.00	0.00	0.00	628.11	0.00	628.11	628.11
2028	-35.57	0.00	0.00	530.74	150.29	0.00	0.00	0.00	716.60	-35.57	681.02	716.60
TOTAL	339.06	-2.88	0.00	6,121.41	1,579.98	0.00	0.00	0.00	7,365.20			
										EIRR		57.5%
										NPV (Rs. Millions)at 12%		1,611.53
Jagsi Gangana Road VT				Decrease in Road User Costs						Jagsi Gangana Road VT		
Year	Increase in Road Agency Costs			MT VOC	MT Time	NMT	Accidents	Benefits	Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special									
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	77.00	-0.53	0.00	0.00	0.00	0.00	0.00	0.00	-76.47	76.47	0.00	-76.47
2011	0.00	-0.02	0.00	12.49	2.26	0.00	0.00	0.00	14.77	-0.02	14.75	14.77
2012	0.00	-0.05	0.00	15.62	2.62	0.00	0.00	0.00	18.29	-0.05	18.24	18.29
2013	0.00	-0.09	0.00	18.61	3.04	0.00	0.00	0.00	21.74	-0.09	21.65	21.74
2014	-4.09	-0.24	0.00	20.10	3.33	0.00	0.00	0.00	27.75	-4.32	23.43	27.75
2015	0.00	0.00	0.00	16.32	3.24	0.00	0.00	0.00	19.57	0.00	19.57	19.57
2016	8.18	0.01	0.00	18.19	3.59	0.00	0.00	0.00	13.60	8.18	21.78	13.60
2017	0.00	0.00	0.00	20.43	3.98	0.00	0.00	0.00	24.41	0.00	24.41	24.41
2018	0.00	0.00	0.00	22.95	4.43	0.00	0.00	0.00	27.38	0.00	27.38	27.38
2019	0.00	0.00	0.00	25.17	4.80	0.00	0.00	0.00	29.97	0.00	29.97	29.97
2020	0.00	0.00	0.00	27.75	5.23	0.00	0.00	0.00	32.97	0.00	32.97	32.97
2021	0.00	0.00	0.00	30.81	5.73	0.00	0.00	0.00	36.55	0.00	36.55	36.55
2022	4.09	-0.14	0.00	33.69	6.25	0.00	0.00	0.00	36.00	3.95	39.95	36.00
2023	0.00	0.00	0.00	30.47	6.21	0.00	0.00	0.00	36.68	0.00	36.68	36.68
2024	0.00	0.00	0.00	33.02	6.63	0.00	0.00	0.00	39.65	0.00	39.65	39.65
2025	0.00	0.00	0.00	35.94	7.11	0.00	0.00	0.00	43.05	0.00	43.05	43.05
2026	0.00	0.00	0.00	39.33	7.67	0.00	0.00	0.00	47.01	0.00	47.01	47.01
2027	0.00	0.00	0.00	42.47	8.25	0.00	0.00	0.00	50.72	0.00	50.72	50.72
2028	0.48	0.01	0.00	44.69	8.74	0.00	0.00	0.00	52.94	0.49	53.43	52.94
TOTAL	85.65	-1.05	0.00	488.06	93.12	0.00	0.00	0.00	496.57			
										EIRR		28.1%
										NPV (Rs. Millions)at 12%		89.28

Kharkhauda Assaudha Road										Kharkhauda Assaudha Road		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Exogenous Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	95.36	-1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-93.66	93.66	-93.66
2011	107.30	0.00	0.00	-6.99	-0.23	0.00	0.00	0.00	0.00	-114.52	107.30	-114.52
2012	0.00	0.00	0.00	114.49	29.00	0.00	0.00	0.00	0.00	143.49	0.00	143.49
2013	0.00	0.00	0.00	128.36	32.17	0.00	0.00	0.00	0.00	160.53	0.00	160.53
2014	0.00	0.00	0.00	143.90	35.73	0.00	0.00	0.00	0.00	179.63	0.00	179.63
2015	0.00	0.00	0.00	162.17	39.85	0.00	0.00	0.00	0.00	202.03	0.00	202.03
2016	0.00	0.00	0.00	184.09	44.70	0.00	0.00	0.00	0.00	228.80	0.00	228.80
2017	23.88	0.01	0.00	211.14	50.59	0.00	0.00	0.00	0.00	237.84	23.90	237.84
2018	-11.94	-0.16	0.00	242.26	57.26	0.00	0.00	0.00	0.00	311.63	-12.10	311.63
2019	0.00	0.00	0.00	224.07	58.50	0.00	0.00	0.00	0.00	282.57	0.00	282.57
2020	0.00	0.00	0.00	246.09	63.55	0.00	0.00	0.00	0.00	309.65	0.00	309.65
2021	0.00	0.00	0.00	271.85	69.42	0.00	0.00	0.00	0.00	341.28	0.00	341.28
2022	0.00	0.00	0.00	300.59	76.21	0.00	0.00	0.00	0.00	376.79	0.00	376.79
2023	23.88	0.03	0.00	324.47	83.03	0.00	0.00	0.00	0.00	383.60	23.91	383.60
2024	0.00	0.00	0.00	345.07	88.11	0.00	0.00	0.00	0.00	433.18	0.00	433.18
2025	0.00	0.00	0.00	362.00	93.55	0.00	0.00	0.00	0.00	455.55	0.00	455.55
2026	-11.94	-0.16	0.00	379.87	99.41	0.00	0.00	0.00	0.00	491.39	-12.10	491.39
2027	0.00	0.00	0.00	348.06	100.50	0.00	0.00	0.00	0.00	448.56	0.00	448.56
2028	-21.46	0.00	0.00	379.01	108.09	0.00	0.00	0.00	0.00	508.55	-21.46	508.55
TOTAL	205.08	-1.98	0.00	4,360.49	1,129.47	0.00	0.00	0.00	0.00	5,286.86		
										EIRR		64.8%
										NPV (Rs. Millions)at 12%		1,178.81

Sonepat Farmana										Sonepat Farmana		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	133.91	-1.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-131.99	131.99	-131.99
2011	133.91	-0.14	0.00	10.69	0.58	0.00	0.00	0.00	0.00	-122.50	133.77	-122.50
2012	0.00	-0.31	0.00	113.82	24.25	0.00	0.00	0.00	0.00	138.38	-0.31	138.38
2013	-14.47	-0.25	0.00	126.56	26.94	0.00	0.00	0.00	0.00	168.22	-14.72	168.22
2014	0.00	0.00	0.00	105.78	27.35	0.00	0.00	0.00	0.00	133.13	0.00	133.13
2015	0.00	0.00	0.00	117.98	30.25	0.00	0.00	0.00	0.00	148.23	0.00	148.23
2016	0.00	0.00	0.00	132.03	33.55	0.00	0.00	0.00	0.00	165.58	0.00	165.58
2017	28.95	0.01	0.00	148.37	37.34	0.00	0.00	0.00	0.00	156.75	28.96	156.75
2018	0.00	0.00	0.00	168.68	41.75	0.00	0.00	0.00	0.00	210.43	0.00	210.43
2019	0.00	0.00	0.00	186.91	45.43	0.00	0.00	0.00	0.00	232.35	0.00	232.35
2020	0.00	0.00	0.00	207.25	49.65	0.00	0.00	0.00	0.00	256.90	0.00	256.90
2021	-14.47	-0.16	0.00	223.84	53.76	0.00	0.00	0.00	0.00	292.23	-14.64	292.23
2022	0.00	0.00	0.00	204.00	54.65	0.00	0.00	0.00	0.00	258.65	0.00	258.65
2023	28.95	0.01	0.00	223.62	59.29	0.00	0.00	0.00	0.00	253.96	28.96	253.96
2024	0.00	0.00	0.00	246.72	63.59	0.00	0.00	0.00	0.00	310.32	0.00	310.32
2025	0.00	0.00	0.00	269.73	68.46	0.00	0.00	0.00	0.00	338.20	0.00	338.20
2026	0.00	0.00	0.00	288.28	73.13	0.00	0.00	0.00	0.00	361.42	0.00	361.42
2027	0.00	0.00	0.00	301.65	77.41	0.00	0.00	0.00	0.00	379.06	0.00	379.06
2028	-26.78	0.00	0.00	315.60	81.99	0.00	0.00	0.00	0.00	424.38	-26.78	424.38
TOTAL	269.98	-2.74	0.00	3,391.54	849.38	0.00	0.00	0.00	0.00	3,973.69		
										EIRR		49.2%
										NPV (Rs. Millions)at 12%		850.54

Sonepat Kakroi Bidhlan Road VT										Sonepat Kakroi Bidhlan Road VT		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	123.44	-1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-121.73	121.73	-121.73
2011	123.44	-0.09	0.00	4.58	0.20	0.00	0.00	0.00	0.00	-118.58	123.35	-118.58
2012	0.00	-0.19	0.00	59.93	10.04	0.00	0.00	0.00	0.00	70.16	-0.19	70.16
2013	0.00	-0.34	0.00	70.37	11.53	0.00	0.00	0.00	0.00	82.24	-0.34	82.24
2014	-12.99	-0.25	0.00	76.04	12.64	0.00	0.00	0.00	0.00	101.92	-13.24	101.92
2015	0.00	0.00	0.00	60.28	12.29	0.00	0.00	0.00	0.00	72.58	0.00	72.58
2016	0.00	0.00	0.00	67.30	13.60	0.00	0.00	0.00	0.00	80.90	0.00	80.90
2017	25.98	0.01	0.00	75.34	15.09	0.00	0.00	0.00	0.00	64.44	25.99	64.44
2018	0.00	0.00	0.00	85.11	16.80	0.00	0.00	0.00	0.00	101.91	0.00	101.91
2019	0.00	0.00	0.00	93.46	18.18	0.00	0.00	0.00	0.00	111.65	0.00	111.65
2020	0.00	0.00	0.00	103.22	19.79	0.00	0.00	0.00	0.00	123.01	0.00	123.01
2021	0.00	0.00	0.00	114.88	21.70	0.00	0.00	0.00	0.00	136.58	0.00	136.58
2022	-12.99	-0.14	0.00	127.00	23.82	0.00	0.00	0.00	0.00	163.96	-13.14	163.96
2023	25.98	0.01	0.00	115.01	23.81	0.00	0.00	0.00	0.00	112.83	25.99	112.83
2024	0.00	0.00	0.00	126.26	25.48	0.00	0.00	0.00	0.00	151.74	0.00	151.74
2025	0.00	0.00	0.00	137.88	27.40	0.00	0.00	0.00	0.00	165.28	0.00	165.28
2026	0.00	0.00	0.00	151.51	29.68	0.00	0.00	0.00	0.00	181.19	0.00	181.19
2027	0.00	0.00	0.00	163.03	31.87	0.00	0.00	0.00	0.00	194.89	0.00	194.89
2028	-24.69	0.00	0.00	170.63	33.71	0.00	0.00	0.00	0.00	229.02	-24.69	229.02
TOTAL	248.17	-2.69	0.00	1,801.83	347.64	0.00	0.00	0.00	0.00	1,903.99		
										EIRR		31.4%
										NPV (Rs. Millions)at 12%		350.89

SECTION 7

UPGRADING OF SECONDARY ROADS IN JHAJJAR DISTRICT, HARYANA

7.1 ROAD NETWORK STATUS IN NCR – EXISTING SITUATION AND THE DEVELOPMENT PLANS¹

1. NCR India, or the most commonly known NCR of Delhi or the National Capital Region of Delhi is the name given to the metropolis areas in and around New Delhi - the capital of India. The NCR comprises of the entire NCT of Delhi, eight districts of Haryana including Jhajjar District, one district of Rajasthan and five districts of Uttar Pradesh with a population of over 371 lakhs in 2001.
2. The sub-region wise distribution of population in NCR as of 2001 is shown in Table 7.1. The NCR population is projected to reach 64 million by 2021 as per Regional Plan 2021.

Table 7-1 Population Distribution of NCR

Sub Region/ Year	Population (Persons)			Decadal growth rate (%)		Share of population (%)		
	1981	1991	2001	1981 1991	1991 2001	1981	1991	2001
NCT-Delhi	62,20,406	94,20,644	1,38,50,507	51.45	47.02	31.28	34.43	37.33
Haryana	49,38,541	66,43,604	86,87,050	34.53	30.76	24.84	24.28	23.42
Rajasthan	17,55,575	22,96,580	29,92,592	30.82	30.31	8.83	8.39	8.06
Uttar Pradesh	69,68,646	90,01,704	1,15,70,117	29.17	28.53	35.05	32.90	31.19
Total	1,98,83,168	2,73,62,532	3,71,00,266	37.62	35.59	100	100	100

Source: Regional Plan 2021

3. NCR transport system includes an extensive road network system of about 36,305 km, a large fleet of public transport bus system operated by state transport undertakings (3144 buses) and private operators, a rail network of about 1000 Km, Metro rail of about 190 Km (90 km is operational as of November 2009 and the rest under construction) and an International airport at Delhi².
4. **Road network:** Existing road network in the region shows convergence of five national highways i.e., NH-1, 2, 8,10 and 24 on Delhi and two National Highways namely NH58 and NH91 meet NH24 at Ghaziabad. In addition to this, NH71, NH71A and NH71B also pass through the region. Ten state highways also serve in strengthening the regional road network. Most of the state highways are of single lane or intermediate lane. Though accessibility is good with reasonably good level of road density,

¹ Information used mainly from Integrated Transportation Plan for National capital Region prepared by Consulting Engineering Services (India) private Limited for NCRPB

² Source: DMRC and Wikipedia websites

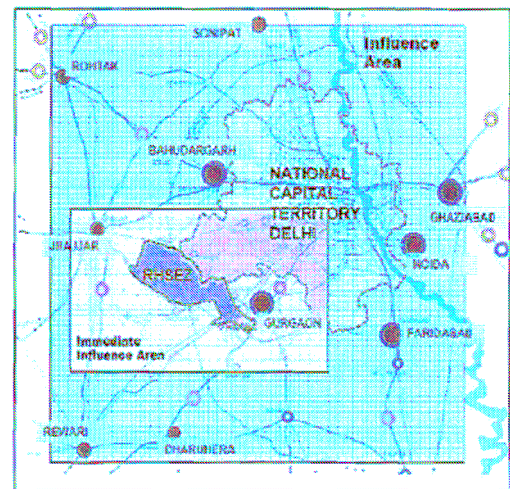
mobility is poor with congested roads (poor road condition, capacity constraints, absence of access controlled high speed facilities for inter city travel and poor traffic management). Figure 7.1 shows the Jhajjar town in relation to the NCR road network.



Figure 7.1 NCR Road Network

5. **Master Plan Provisions:** The Regional Plan 2021 for NCR, based on an assessment of the traffic and travel characteristics puts forth a transport system development plan for the NCR. The plan includes the following proposals.
- To decongest NCT-Delhi roads, rail and rail terminals by diverting the through traffic from Delhi.
 - To provide linkages amongst Metro/Regional Urban Settlements in the outlying areas of NCR.
 - To connect Metro/Regional Centers with the Capital by an efficient and effective transport network for facilitating faster movement of traffic among such centres and NCT-Delhi.
 - To link the Sub-regional Centers with effective and efficient transport network for facilitating the faster movement of traffic among such centers and higher order settlements.
 - To directly link other urban nodes having maximum attracting and generating characteristics.
 - To create the Unified Metropolitan Transport Authority for NCR.
6. The Integrated Multi-Modal transportation Plan prepared for NCR in 2009 in accordance with the policy framework formulated in Regional Plan 2021 propose an investment plan costing US\$ 37 billion over a 25 year period (2007-2032) in the NCR region to meet the growing transport needs. The investments proposed include some of the projects under development since 2007 and new projects. The NCR RP-2021 has proposed extensive development of the transportation system of the region and the Transportation plan developed thus include (1) Large scale road network expansion including Expressways, Regional Arterials, Regional Sub-arterials and Secondary and tertiary road network in sub-regions; (2) Regional rail links and Rail rapid transit systems; (3) Regional metro rail system; (4) Public bus transport system and bus terminals; (5) Logistic hubs; (6) Integrated freight complexes; (7) Highway facilities centers; and (8) Airports.
7. In the last several years, there have been many major development projects planned and some of them under implementation which affect the NCR road network significantly as they triggers further accelerated development in the adjoining areas requiring major investment in the secondary and tertiary road network. Some of the project that have a large influence on the adjoining areas in Haryana such as the districts of Gurgaon, Jhajjar and Sonipat include:

- Haryana SEZ – An SEZ extending over 10,000 Ha is proposed for development in Gurgaon and Jhajjar district. There have been delay in the project due to delay in land acquisition. It is reported that about 8000 acres have been aquired by the developer in Jhajjar but only 1400 acres in Gurgaon. It is now planned for two separate SEZ's with 12500 acres each in Gurgaon and Jhajjar. It is expected that with two-thirds of land acquired in Jhajjar district, the SEZ planned in Jhajjar is likely to materialize. The development will have major impact on the transport scenario in the surrounding areas. The road connecting from Jhajjar to Delhi, a Major Distric Road (MDR 136) and passing



through Badli borders the proposed SEZ on the North. The Kundli-Maneswar-Palwai Expressway under construction is also in the vicinity.

- Kundli-Maneswar-Palwai Expressway (KMP Expressway) which is under construction on the western side of Delhi in combination with Faridabad-Ghaziabad-Kundi eastern peripheral expressway is envisaged to form cordon around the NCTD to enable bypassing of non-Delhi based traffic. The Government of Haryana is proposing to develop 14 new townships covering an area of 62,000 hectares along this Expressway, which has been designated as the Global Corridor. Even a fraction of planned development will have large impact on the road network of Sonipat and Jhajjar districts.
 - Sonipat-Kundli Multifunctional Urban Complex: Sonipat town is located at a distance of about 50 km from NCTD. The NCR Plan 2001 proposed Kundli area in Sonipat to be developed as a Delhi Metropolitan Area town. In view of this and available development potential, the Government of Haryana has proposed to develop an integrated complex comprising of controlled areas declared around Sonipat town and Kundli township as a Sonipat-Kundli Multifunctional Urban complex for a population of 1 million by 2021. The transport network including NH1 expansion, KMP expressway and rapid transit corridors from Sonipat to Delhi are planned/under implementation to cater to this planned development. This will induce considerable development in the surrounding areas of Sonipat district including Jhajjar district and there is need to develop the secondary road network to support the development.
8. The road network development plan calls for capacity augmentation of the MDR's and ODR's in the NCR region to support the development anticipated in the NCR region. Also suggested is development of bypasses for each major urban center considering the growth potential and complementing the planned regional road network development. The proposed upgrading of selected roads in Jhajjar district is essential to support the development plans and also for the population at large in Jhajjar district to benefit from the development.

7.2 SUB-PROJECT SELECTION

9. The state of Haryana surrounds the National Capital on three sides. The road network of Haryana act as a conduit to enter the National Capital for large number of commercial traffic from Jammu & Kashmir, Punjab, Himachal Pradesh, Rajasthan and Parts of Utter Pradesh. Eight districts of Haryana viz. Faridabad, Mewat, Gurgaon, Rohtak, Sonipat , Rewari, Jhajjar and Panipat are part of the NCR. Many major development projects are taking place in NCR of Haryana, which includes 20 SEZs with an investment of Rs 870 Billion. All this developments also attracts heavy good and industrial traffic to the NCR region of Haryana from surrounding states.
10. The rapid growth in the region is putting pressure on the main road network of these districts. The Government of Haryana is taking up upgrading of the road network in these districts and has prepared a project for taking up thirteen roads for upgrading in Jhajjar district which is located on the north-west side of NCTD. HSRDC has approached NCRPB for funding of this project of upgrading 13 roads in Jhajjar district.

11. In addition to the major developments mentioned earlier which will have large impact on the road network in Jhajjar district, Bahadurgarh is emerging as an industrial hub of the district and is famous for glazed Tiles, steel pipes, biscuits and sanitaryware products. Moreover two Thermal Power Plants are proposed to be installed at Chhuchkawas and Badli. In addition to these industrial developments this district is also an agri based district adjacent to NCTD. The proposed upgrading of selected roads in Jhajjar district will provide access for the population of the district and the developments planned in the district and thus promote the regional development goals of NCR and therefore is an important component for the success of the NCR development plan. The sub-project meets the objective of regional development in NCR.
12. The traffic studies described later indicate that the present AADT on these roads is in the range of 700 to 3200 which will increase by more than 2.5 times in the next 10 years . The poor pavement condition, bad geometry and the heavy traffic growth combined together warrant for an immediate rehabilitation and capacity augmentation of the project road sections to support the regional development plan.
13. The Haryana State Road Development Corporation (HSRDC), the implementing agency has engaged a Consultant and completed preparation of a Detailed Project Report for the sub-project. The upgrading proposal will mostly be along the existing alignment and land acquisition is not anticipated. The sub-project will involve utility shifting for which advance action needs to be taken. The project preparation is thus well advanced and the project implementation can be taken up immediately. The data and analysis from the DPR has been used for the preparation of this report. The PPTA consultant carried out the economic analysis based on the project design and project costing provided in the DPR.

7.3 SUB-PROJECT DESCRIPTION AND TECHNICAL ASSESSMENT

7.3.1 Scope and Components

14. The thirteen roads proposed for rehabilitation and widening is given in Table 7.2 and also shown on Figure 7.2.

Table 7-2 List of Project Roads

Road No.	Name of Work	Length in (km)	Existing width (m)
1.	Jharli Mohanbari Approach road	3.235	3.66
2.	Jhajjar, Talao, Chhuchakawas road	13.460	5.50
3.	Beri, Rohtak road	8.560	5.50
4.	Badli to Durina via Ladpur Munimpur	11.430	5.50
5.	Badli Pela Sondhi Yakubpur road	9.800	5.50
6.	Sahlawas Amboli Bithla Dhakla SH-22 including Jatwara approach road	16.220	3.66
7.	Subana (SH-22) Sarola Ahri road.	6.640	3.66

Road No.	Name of Work	Length in (km)	Existing width (m)
8.	Patauda (MDR-132 Dhani Saniyan Kahari Machroli(NH-71).	10.080	3.66
9.	Jhajjar Farrukhnagar road (SH15A) Mubarakpur Ismailpur Mundakhera (MDR-136)	11.755	3.66
10.	Badli Iqbalpur road Lohtat Delhi Border.	3.765	3.66
11.	Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road.	12.475	3.66
12.	Godhri Safipur Impota.	6.290	3.66
13.	Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijrodh (NH-71)	15.020	3.66
	Total	128.73	

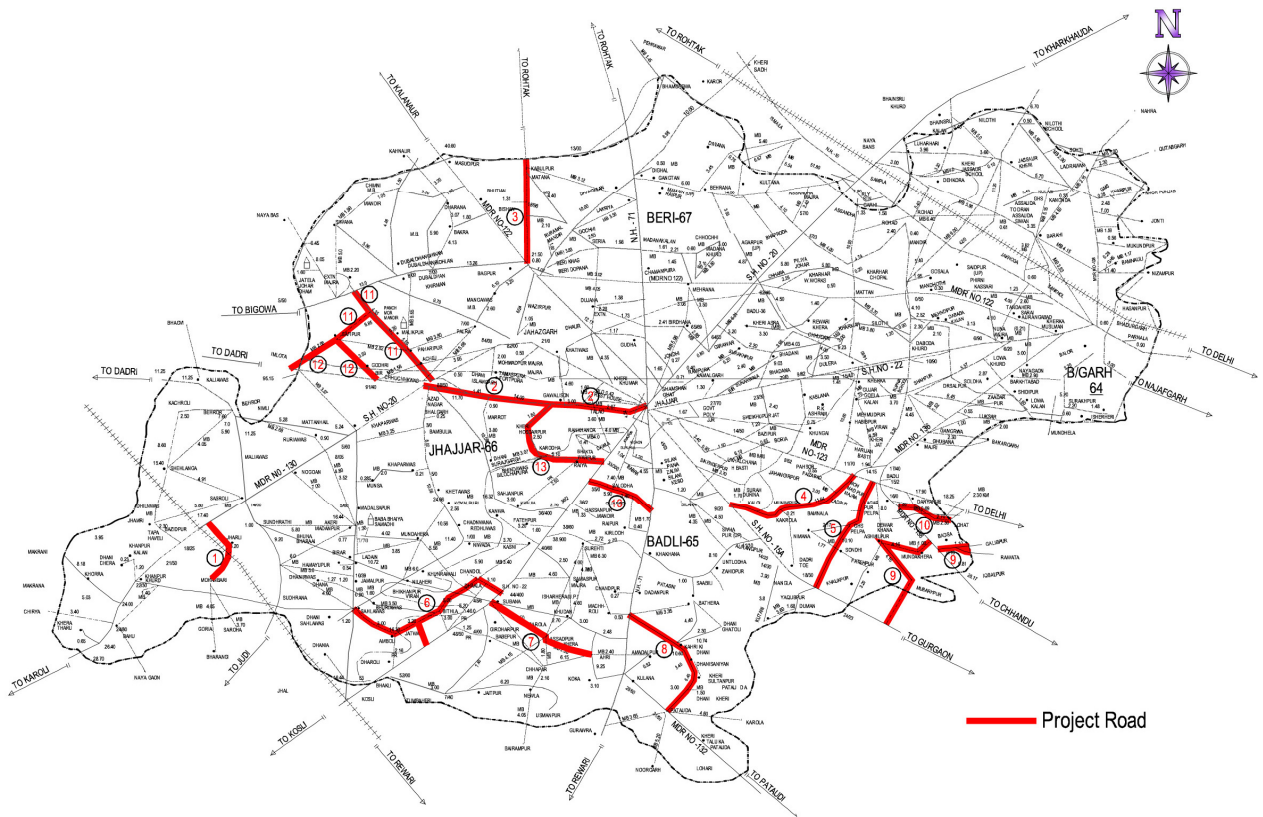


Figure 7.2 Project Roads in Jhajjar District

7.3.2 Project Description

15. Thirteen roads which forms part of this package (Package 2) links many villages to major arterial roads of Jhajjar district. The improvement proposal for strengthening and capacity augmentation. Haryana State

- Road Development Corporation (HSRDC) the executing agency for this project has retained the service of M/s Consulting Engineers Associates for carrying out detailed engineering design report for proposed improvement of 13 roads in Jhajjar district. The data collected as part of the DPR study is generally used for the preparation of this feasibility report.
16. Most of the roads in this package are having single lane width and some have to intermediate lane width with bituminous pavement. The drainage conditions of the project roads especially in the village area are very poor. Concrete pavements are generally provided in the village areas. The horizontal geometry of the project roads are reasonable except at village sections where many sharp curves are observed. As the project area is in flat terrain, smooth vertical profile which meets the required design standards are generally observed on all the roads.
 17. The proposed roads of Package 2 are frequently used for transportation of stone metals/ crushed material to Gurgaon and capital city of Delhi for development works, as most of the quarries are located across this area.
 18. The district comes under the low lying eastern margin of Punjab plains which is part of great Indo Gangetic plain, formed by the deposition of alluvial sediments and sands brought from Himalayas. Yamuna is the only River following from North to South at the eastern margin. The general elevation of the district lies between 150 to 300 m. The Jhajjar district is mainly covered with older alluvial soil in the western portion and younger alluvial soil in the eastern portion bordering Yamuna River.
 19. The project roads run on low to medium embankments except in built-up areas where the road is in level with the adjoining land. Earthen shoulders are also in bad shape and the berm dressing has not been carried out resulting accumulation of rainwater at the edge of the carriageway. The carriageway has thus settled considerably at the edges. In village section, lack of drainage caused the failure of concrete pavement. Thus, in village section, there is an immediate requirement to construct the roadside drain.
 20. There are no protected areas, wildlife sanctuaries or forests in the area.
 21. The HSRDC expressed their intention that land acquisition should be used as last resort and hence improvements are limited within the available land width. As such, there is no need to design the road links for high speed as most of the road users have their prime concern to reduce wear and tear to their vehicle by plying over good surface instead of present earthen/ gravel road. Therefore, the scope of geometric improvement can be considered fairly limited for this project except improvement to enhance blind curves which pose a major safety issue.
 22. Features of all roads which includes cross sectional element, bridges, culverts, junctions, number of curves etc are given in Table 7.3. Following paragraphs briefly explain features of each road.
 23. Jharti - Mohanbari Approach road: This Road Starts at km 17/40 of MDR130 and terminates at Mohanbari village. The single lane bituminous carriageway is badly damaged. Extensive cracks, pot holes and raveling is noticed for the entire length. The proposed Fuel storage yard for Thermal Power Plant is located along the project road alignment and on commissioning of the yard, Tanker Lorries can use this road to carry fuel to the yard. No properly developed shoulder or defined ROW is noticed in this road. The project road is traversing through plain terrain and in general it is passing through agricultural

- land. The existing profile is generally at same level with general ground level and hence proper road drainage is absent. The pavement failure can be generally attributed to the poor drainage condition and lack of maintenance. The project road crosses Rewari – Jhajjar broad gauge railway line at Km 1+290. About 1.2km of the initial stretch of the project road has trees on the right side of the project road. Eccentric widening on the left side will save these trees. Project alignment is also passing through built-up locations with narrow RoW.
24. Jhajjar-Talao-Chhuchakawas road: This Road start from Jhajjar town and about 400m of alignment is passing through town area of Jhajjar having commercial and residential buildings on the either side of road. On the way it crosses Jhajjar bypass at Km0+400 and it ends at centre of Chuchhakwas village. One section of Project Road No.13 to Kheri village starts from Km 7+580. At chainage 0+840, construction of a new formation of railway line from Jhajjar to Rohatak is in progress and ROB/level crossing is required on commencement of train service. Big Eucalyptus trees on both the sides of the alignment is observed and about 1300 trees needs to be cut for the proposed widening. Intermediate lane bituminous carriageway with 1 to 1.5m wide earthen shoulder partially covered by vegetation exists all along the project road length. The existing alignment traverse through flat terrain and general land use is agricultural with exception of few builtup stretches. The height of embankment of the project road varies from 1.5 to 2m with earthen drain for about 2km. Existing condition of pavement is very poor with pot holes, alligator cracks and raveling present throughout the project road. Village portion of the alignment is provided with concrete road and it is in fair condition. Project road crosses two irrigation canals. The 5.5 m wide minor bridge on these canal crossings is found in good condition and can be widened.
25. Beri - Rohtak Road: The project road stretch starts at km 35+050 of MDR 122 and ends at Jhajjar district boundary in Ritoli village at Km 8+560. The alignment runs through plain agriculture fields and low lying areas prone to flooding. Flooding is observed at three stretches of about aggregate length of 900m where rising of embankment is required. Earthen shoulder is totally covered by vegetations and bushes. Pot holes, cracks and raveling are observed for the entire length of the alignment and pavement condition is rated as poor. Present avenue plantations are very close to the pavements in some stretches and that needs to be cut for proposed widening. Existing culverts are to be improved and new culverts to be introduced on low lying area where embankment rising is required.
26. Badli to Durina via Ladpur Munimpur: This road starts on the main market place in Badli town at km 17+200 of MDR 123 and ends at km 10+200 of SH15A. Predominantly flexible pavement with 5.5m wide carriageway exist except at builtup stretches where concrete pavement with width varying from 3.5 to 5.5m. In most of the village areas no offset distance is available to the buildings from pavement/drain edge and hence further widening would be near impossible. Shoulder is missing in general and average embankment height of the project road which is generally runs through plain agricultural field is 1.5m. Pavement condition is generally poor which requires immediate strengthening to protect the residual life of existing crust.

Table 7.3 Project Road Features

Rd No	Name of the Project Road	Road Length in km	Junctions		Bridges		Culverts	Carriageway (m)	Shoulder (m)	Pavement Condition	Horizontal Curves	
			Major	Minor	Major	Minor					Meets Design Speed	Sub Standards
1	Jharli Mohanbari Approach road	3.235	2	5	-	-	-	3.5	-	Fair	3	11
2	Jhajjar, Talao, Chhuchakawas road	13.46	3	6	-	3	12	5.5	1	Poor	14	6
3	Beri, Rohtak road	8.56	1	26	-	2	15	5.5	1	Poor	17	4
4	Badli to Durina via Ladpur Munimpur	11.43	-	-	-	1	7	5.5	1	Fair	8	9
5	Badli Pela Sondhi Yakubpur road	9.8	-	-	-	3	5	5.5	1	Fair	8	9
6	Sahlawas Amboli Bithla Dhakla SH-22 including Jatwara approach road	16.22	2	16	-	2	24	3.5	1	Poor	6	26
7	Subana (SH-22) Sarola Ahri road.	6.64	1	13	-	2	9	3.5	-	Poor	12	9
8	Patauda (MDR-132 Dhani Saniyan Kahari Machroli(NH-71).	10.08	-	-	-	1	30	3.5	1	Poor	9	8
9	Jhajjar Farrukhnagar road (SH15A) Mubarakpur Ismailpur Mundakhera (MDR-136) Badli, Iqbalpur Galibpur upto Distt Border.	11.755	-	-	-	-	7	3.5	1	Fair	7	42
10	Badli Iqbalpur road Lohat Delhi Border.	3.765	-	-	-	-	1	3.5	-	Fair	4	7
11	Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road.	12.475	2	23	-	1	20	3.5	1	Poor	33	23
12	Godhri Safipur Impota.	6.29	2	19	-	-	14	3.5	1	Poor	16	14
13	Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijrodh (NH-71)	15.02	4	28	-	1	30	3.5	-	Poor	41	30
	Total	128.73	17	136	-	16	174			Poor	178	198

27. Badli Pela Sondhi Yakubpur Road: This road also starts on the main market place in Badli town at km 18/9 of MDR123 and ends at km 20/1 of SH15A. Starting stretch of about 350m is passing through builtup section with buildings abutting on the edge of the pavement. Most of the project road is passing through flat terrain and agricultural land. About 700m of the project road is in low lying area where the road to be raised and proper cross drainage structures also to be provided. Towards the end, from Km 7+800 to Km 9+800 has avenue plantation on either side of the road. Pavements condition varies from good to fair except at few bad stretches of about 1500m.
28. Sahlawas Amboli Bithla Dhakla (SH-22) Road: Begins at Sahlawas village and ends at km 14/3 of SH22. Mostly the road runs through agricultural land with the exception of few builtup stretches in village areas. Strengthening and widening work is ongoing in this road and existing pavement has already scarified for the reconstruction of the pavement. It is noticed that domestic waste water is directly discharged into the road and causing stagnation of waste water in the pavement leading to pavement failure. Adequate drainage provision is needed at this stretches to protect the pavement life and hygiene in the area. Throughout the road, the profile is at same level with that of the surrounding agricultural land which used to get water logged and cause major reason for the pavement failure. The road profile in this area to be raised to have sufficient free board of 0.6 to 1m from the perched water table with balancing culverts are essential for protecting the design life of the pavement.
29. Subana (SH-22) Sarola Ahri road: Project road starts at km 18/4 on SH.22 and ends in Km. 7+280 in Ahari village. Initial 400m is running through built up area, where domestic waste water is directly discharged into the road side drain and it often overflows and causing stagnation of waste water into the pavement leading to pavement failure. Most of the stretches are covered by agricultural land except village Sarola where buildings are constructed adjacent to the road edge preventing further widening. Some of the places are affected by water logging and the pavement is in very bad condition. Road stretch from Km 2+600 to end of the road could not be accessed due to ongoing road construction activities.
30. Patauda (MDR-132 Dhani Saniyan Kahari Machroli(NH-71): This road begins at km 31/5 of MDR123 and ends at km 17/2 of NH 71. The alignment traverse largely through plain agricultural land and the average embankment height of the project road is about 1m. Continuous avenue tree plantations on either side of the road are observed on stretches from Km 1+ 800 to 4+800 and Km 7+600 to 10+000. Poor pavements condition is found on the entire length project road. Water stagnation is noticed at Km 7/6 due to poor drainage condition and at present vehicular movement is obstructed.
31. Jhajjar Farrukhnagar road (SH15A), Mubarakpur Ismailpur Mundakhera (MDR-136) Badli, Iqbalpur Galibpur upto Distt Border: This road has two distinct parts in which one part starts at km 26/7 of SH.15A from Jhajjar and ends at MDR 136 and the second part starts from MDR 136 about 1850m away from end of the previous stretch. It has an abandoned railway crossing at Km 0+297. Alignment runs mostly through plain agricultural land. Pavements are in bad condition throughout except at newly laid stretches of about 600m.

32. Badli Iqbalpur road - Lohat - Delhi Border: This road starts at km 34/2 of MDR 136 and ends at Delhi border. Most of the stretches are passing through agricultural field and avenue tree plantation is seen on intermittent stretches. Existing bituminous pavements are generally in good to fair condition.
33. Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road: Project Road starts at ChuChhkwas village and ends at km 13/05 of Beri Dadri Road. Here also most part of the project road is passing through agricultural fields except at few villages in between. Many water logged stretched exist in this road which require embankment rising. At village sections, outlet of domestic waste water is discharges directly into the road side drain and often overflows to road and this eventually leads to pavement failure. One metre wide earthen shoulder available on either side of the road and avenue tree plantation is seen on the extreme edge of the shoulder on many stretches. The condition of the existing pavement is very bad with presence of extensive pot holes, raveling and cracks throughout the road. The existing culverts need to be rebuilt for proper drainage in case of rising of road level.
34. Godhri - Safipur: This road starts at km 91/950 of SH.20 – Chuchhakwas – Dadri road and ends at km 97/1 of SH.20 – Chuchhakwas – Dadri road. It runs mainly on agricultural land but at village stretches buildings are very close to the edge of the pavement. Water logged areas in this stretch need embankment rising with adequate provision of cross drainage structures. The pavement condition varies from good to poor.
35. Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijroth (NH-71): This project road has two different parts in which the first part starts at Km 7+580 of Jhajjar-Talao-Chhuchakawas road and ends at Kosli Jhajjar Road and the second part starts at same road where the previous road ends but it is 500m away from the end of previous road and then it ends at km 149/0 of NH 71A Jhajjar - Rewari Road. Most of the road alignment is traversing through agricultural land. At village areas concrete pavements are generally seen. Project alignment is passing through rolling terrain for about 400m from Km 6+200 to 6+600 with valley of about 10m deep on right side and flat terrain on the left side. Construction needs to be limited to available width as many buildings are situated on left side. Construction of new railway line is in progress at Km12+350. About 800m of the road has only earthen road. Culverts along the road needs to be rebuilt wherever embankment rising needed.
36. In general, it is observed that there is no possibility for widening at built-up areas of villages along the road alignment where buildings are adjacent to pavement which in most case is cement concrete pavement. The width varies from 3.5 to 5 m. The drainage situation is poor. In order to improve the living in these settlements, it is essential that bypasses are built to these built-up areas as widening along the existing alignment will required major resettlement effort. The HSRDC should commit to take initiatives to implement this in the near future.

7.3.3 DPR Review Approach

37. The DPR and other available reports were collected and studied in detail to prepare this feasibility study report. The approach involved site reconnaissance, preliminary desk review of the available reports, additional data gathering if needed and final review of the DPR analysis and drawings to obtain the required information for feasibility study. Broad observations and suggestions on the design are included in the relevant sections of the report.

7.3.4 DPR Surveys

38. For the preparation of Detailed Project Report, the HSRDC Consultant carried out the following surveys and investigations along the bypass road alignment:

- Field Reconnaissance Survey
- Traffic and transportation surveys, including classified traffic volume counts and origin-destination surveys
- Topographic surveys of the proposed alignment
- Sub soil investigations
- Census survey of the potential APs and preparation of Resettlement Plans
- Environmental reconnaissance surveys and preparation of IEE

7.3.5 Traffic Surveys and Analysis

39. The traffic volume data forms an important input to project design and economic analysis. As part of the DPR, classified traffic count surveys were carried out on all the thirteen roads. As the project roads are minor links connecting to villages, no major diverted traffic is envisaged and hence no Origin – Destination Surveys were carried out for the DPR study.

40. Based on field reconnaissance and further review of the DPR traffic study report, TA consultant concluded that no further traffic study is needed as the traffic count of the DPR study is generally found matching with field conditions.

41. For the present project, as mentioned in the DPR TOR, a period of 10 years has been adopted as pavement design life.

42. Capacity analysis of the project roads are carried out based on IRC 64 and the projected traffic. Design service volume (DSV) varies depending on the type of terrain, lane width, shoulder width etc. The DSV considered for the lane requirement analysis is presented in Table 7.4.

Table 7.4 Design Service Volume

Road Type	Design Service Volume in PCU
Single Lane	2000
Intermediate Lane	6000
Two Lane	15000
Two Lane with paved shoulder	18000

43. The Average Annual Daily Traffic (AADT) estimated based on the classified volume count are given in Table 7.5. The traffic counts were carried out in November 2008 and a seasonal correction factor of 1.0 has been assumed for arriving at the AADT from the counts.

Table 7.5: Average Annual Daily Traffic on the Project Road Sections

Name of Road	2 - wheelers	3 - wheelers	Cars	Bus	LCV	Trucks	Agricultural Tractor	Slow moving vehicles	Total	
									Vehicles	PCU
Jharli Mohanbari Approach road	603	43	241	173	0	99	211	43	1413	2408
Jhajjar, Talao, Chhuchakawas road	1365	118	846	205	50	305	255	742	3886	4700
Beri, Rohtak road	822	117	356	121	60	219	155	434	2284	2887
Badli to Durina via Ladpur Munimpur	1087	108	431	272	0	584	230	86	2798	4995
Badli Pela Sondhi Yakubpur road	600	48	351	271	0	584	230	38	2123	4600
Sahlawas Bithla Dhakla SH-22 including Jatwara approach road	795	83	260	126	0	59	161	75	1560	2066
Subana (SH-22) Sarola Ahri road	803	68	318	145	0	44	148	53	1579	2053
Patauda (MDR-132) Dhani Saniyan Kahari Machroli(NH-71)	638	120	396	203	0	82	173	45	1657	2517
Jhajjar Farrukhnagar road (SH15A) - Mubarakpur Ismailpur Mundakhera (MDR-136) upto District Border	383	54	161	96	0	38	96	50	877	1266
Badli Iqbalpur road at Lohat - Delhi Border	555	68	209	148	0	68	129	45	1221	1823
Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road	141	56	174	131	0	89	92	45	728	1430
Godhri Safipur Impota	267	86	200	140	0	133	126	82	1034	1890
Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijroth (NH-71)	795	83	260	126	0	59	161	75	1559	2067

7.3.6 Traffic Forecast

44. Both economic growth and population growth contribute to the traffic growth. There are no time series traffic data on the roads in the area and hence no assessment could be made of past traffic growth using time series data. The best approach to assess traffic growth is to examine population and economic growth as well as the growth of vehicle registrations and to establish the 'transport demand elasticity' that

can be used to estimate future traffic growths based on forecasts of economic growth. Traffic growth rates for the region have been worked out using this approach.

45. The net state domestic product of the state in the past few years has been obtained from the published documentation available in the Reserve Bank of India website and is given in Table 7.6. The overall trend indicates growth rates of close to 8.8% in the 1999-2008 period. A comparison with all India GDP growth indicate that Haryana enjoyed a much higher growth than the national average growth in GDP in this decade.

Table 7.6 Net State Domestic Product of Haryana at Constant Prices

Year	NSDP (Rs. Lakhs)
1999-00	5127783
2000-01	5547672
2001-02	5985030
2002-03	6365901
2003-04	6938802
2004-05	7567606
2005-06	8260388
2006-07	9205311
2007-08	10131942

46. The vehicle registration growth also gives indication of the traffic growth. The vehicle registration data for the past few years have been obtained and is given in Table 7.7. The growth rates observed in the case of Trucks and Cars are in line with the national trends whereas LCV and bus growth shows some abnormal growth. LCV growth in later years seems reasonable except for the jump in 2002-03 and in case of buses it again shows such drastic jumps which may be due to the low base initially and the large scale developments in the NCR area resulting in huge increase in buses. However, this may not continue in the same way once the number of buses increases.

Table 7.7: Vehicle Registration data of different vehicles in Haryana

Year	Truck	LCV	Bus	TW	Car/Jeep
2000-01	110238	27707	5120	1136917	306972
2001-02	110238	27707	5120	1136917	306972
2002-03	126109	49160	8091	1356957	354518
2003-04	147667	58325	9369	1526404	412929
2004-05	166437	67991	11297	1729236	463118
2005-06	176046	74494	19986	1881174	531311
Growth rate over the period	9.8	21.9	31.3	10.6	11.6

47. The NSDP growth for the same time period as the vehicle registration data is about 8.3 % and the analysis indicate a transport demand elasticity of 1.18 for trucks, 1.28 for two wheelers and 1.43 for cars which are very realistic and is adopted for the traffic growth rate assessment. The elasticity values for LCV's were taken similar to Trucks and for buses based on values observed in other similar states. The

GDP growth rates for the future has been taken based on the current forecast for the immediate future and long term outlook as reported in the various recent articles. The elasticity values have also been adjusted lower over the long term as is expected. Based on the economic growth outlook for the region (7.5% upto 2011-12 and increasing to 8% for the next 5 years and then reducing 1 to 2% every 5 years), the resultant traffic growth rates were estimated and is given in Table 7.8.

Table 7.8: Forecast Growth Rates (%) for Traffic in the Region

Period	Forecast Traffic Growth Rates				
	Truck	LCV	Bus	Tw	Car/Jeep
2008-12	9.0	9.0	7.5	9.4	10.5
2012-17	8.8	8.8	6.4	8.0	11.2
2017-22	6.0	6.0	3.6	4.2	7.8
2022-27	5.0	5.0	2.5	3.0	6.0
2027-32	4.0	4.0	2.0	2.4	4.4

7.3.7 Engineering Surveys and Analysis

48. **Topographic Survey:** As part of the DPR study, detailed topographic survey was carried out using Total Stations and collected essential ground features along the existing alignment. Cross sectional and longitudinal details of the project roads at every 30m interval has been collected during the topographic survey. The details of the topographic survey were presented in the plan and profile drawings of the DPR. The topographic survey data collected has become the base information for the detailed design and for the computation of earthwork and other quantities.
49. **Pavement and Subsoil Investigations:** Details of the existing pavement investigations by DPR consultant and its analysis by TA consultant are presented in **Table 7.9**.

Table 7.9 Existing Pavement Condition and Analysis

Road No	Roads Name	Pavement Thickness in mm	Pavement Condition Assessment
1.	Jharli Mohanbari Approach road	200	Bad to worse, Reconstruction is required in some reaches. Strengthening required in remaining reaches
2.	Jhajjar, Talao, Chhuchakawas road	170	Worse and low lying, Reconstruction required in full reach.
3.	Beri, Rohtak road	350	Good to Bad. Reconstruction required in some reaches. Strengthening needed in remaining reaches.
4.	Badli to Durina via Ladpur Munimpur	200	Bad to worse, Reconstruction required in some reaches. Strengthening required in remaining reaches
5.	Badli Pela Sondhi Yakubpur road	200	Bad to worse, Reconstruction required in some reaches. Strengthening required in remaining reaches.

6.	Sahlawas Amboli Bithla Dhakla SH-22 including Jatwara approach road	170	Bad to worse, Reconstruction required in some reaches. Strengthening required in remaining reaches.
7.	Subana (SH-22) Sarola Ahri road.	170	Bad to worse, Reconstruction required in some reaches. Strengthening required in remaining reaches.
8.	Patauda (MDR-132 Dhani Saniyan Kahari Machroli(NH-71).	170	Bad to worse, Reconstruction required in some reaches. Strengthening is required in remaining reaches.
9.	Jhajjar Farrukhnagar road (SH15A) Mubarakpur Ismailpur Mundakhera (MDR-136) Badli, Iqbalpur Galibpur upto Distt Border.	170	Bad to worse, Reconstruction required in some reaches. Strengthening required in remaining reaches.
10.	Badli Iqbalpur road Lohat Delhi Border.	150	Bad to worse, Reconstruction required in some reaches. Strengthening required in remaining reaches.
11.	Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road.	170	Bad to worse, Reconstruction required in some reaches. Strengthening required in remaining reaches.
12.	Godhri Safipur Impota.	170	Bad to worse, Reconstruction required in some reaches. Strengthening required in remaining reaches.
13.	Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijroth (NH-71)	175	Bad to worse, Reconstruction required in some reaches. Strengthening required in remaining reaches.

50. Laboratory tests as per IS 2710 conducted on the soil samples collected from the project roads during the DPR study found that the sub-grade soils on all the project road areas are of fine sand and are generally of good quality. The CBR values of the sub-grade soil ranges from 5% to 6%.

51. **Inventory and condition surveys for bridges and other structures:** There are 174 culverts and 16 minor bridges exist in the project road.

52. Details of the four level crossings are presented in **Table 7.10**. All the existing level crossings are proposed to be retained with minor improvement at the approaches which includes proper signage.

Table 7.10 Railway Level Crossings

Rd No	Road Name	Railway line	Chainage	Existing
1	Jharli Mohanbari Approach road	Rewari- Bhiwani	1290	Level Crossing
2	Jhajjar, Talao, Chhuchakawas road	Rewari – Jhajjar	840	Level Crossing (under construction)
9	Jhajjar Farrukhnagar Road	Delhi- line	300	Level Crossing
13	Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijroth (NH-71)	Rewari – Jhajjar	12340	Level Crossing (under construction)

7.3.8 Design Standards

53. The various design elements and factors, which govern the functioning of the project road can be broadly grouped under the following requirements.

- Road Classification
- Road Right of Way
- Terrain
- Design Speed
- Design Cross-sections
- Side Slope
- Pavement
- Cross Drainage Works and Structures
- Junctions
- Traffic control and safety measures
- Roadside facilities
- Realignment & Bypasses
- Pedestrian facilities

54. The project roads are proposed to be designed as per the standards of Other Districts Roads. Accordingly IRC 73 "Geometric Design Standards for Rural Highways-1980" published by the Indian Road Congress is referred for finalizing project design standards. The design parameters considered for the project road improvements are summarized in the **Table 7.11**.

Table 7.11 Design Parameters

S. No	Description	IRC Standards	
1	Design speed - Plain and Rolling	Max – Min	65 - 50 km/hr
2	Lane width		3.5 m
3	Paved shoulder width		1.5 m
4	Earthen Shoulder		1.0
5	Road Way Width	Intermediate Lane Two Lane	7.5 m (5.5 m carriageway) 9.0 m
6	Right of Way		15 m
7	Cross-slopes	Carriageway Paved shoulder Unpaved shoulder	2.5 % 2.5 % 3.5 %
8	Maximum super elevation		7.0 %
9	Minimum horizontal curve radius	For 65 Km/hr For 50 Km/hr	150 m 90 m
10	Radii beyond which super elevation not required	For 65 Km/hr For 50 Km/hr	750 m 450 m
11	Super elevation runoff rate	For Plain and rolling For mountainous & steep	<1 in 150 <1 in 60
12	Transition curves to be used with length of spiral more than or equal to length of super elevation runoff		
13	Extra widening of carriageway on curves	For curve radius >300m 101 to 300m	Nil 0.6m

14	Gradient	Ruling Gradient Limiting Gradient Exceptional Gradient	3.3 % 5 % 6.7%
15	Minimum Length of Vertical Curves / Grade change not requiring vertical curve	Design Speed	min. curve length
		65 km/hr 50 km/hr	40m 30m
16	Vertical curve 'K' values Crest vertical curve/Sag vertical curve	For design Speed	Crest
		65 km/hr 50 km/hr	18.4 8.1
17	Vertical clearance	Road over road	5.5 m
		Road over railway	6.525 m
		Electrical lines	6.0m (Up to 650 V)
		H.T.Electrical lines	6.5m (More than 650 V)
		Telecommunication Lines	5.5m (Up to 110 V)

55. The traffic projection for the design period of 10 years indicate that the projected traffic is within the design service volume of two lane road and therefore two lane road cross section is proposed for the project roads.

7.3.9 Geometric Design, Alignment & Profile

56. No geometric improvement is considered in the DPR as the project improvement was limited within the available width of land. During the site reconnaissance, TA consultant observed many substandard curves which need geometric correction and in some case realignment of such sections. Details of sub standard curves identified by desk review of the alignment and the site reconnaissance are given in **Table 7.12**. The HSRDC should atleast include the improvement of these curves in their future program.

Table 7.12 Details Horizontal Curves

Radius of Curve	Safe Design Speed(kmph)	No. of Corves														Remarks
		RD 1	RD 2	RD 3	RD 4	RD 5	RD 6	RD 7	RD 8	RD 9	RD 10	RD 11	RD 12	RD 13	Total	
0 - 45	<35	9	6	2	8	8	23	8	5	33	6	17	12	18	155	Curves Below Design Speed
45 - 60	35	2	0	1	1	1	1	0	0	3	0	1	0	5	15	
60 - 90	40	0	0	1	0	0	2	1	3	6	1	5	2	7	28	
90 - 150	50	1	3	3	1	1	4	3	3	4	0	4	1	12	40	Curves meets Design Speed
150 - 230	65	1	3	4	2	2	2	2	3	0	1	3	1	5	29	
230 - 360	80	1	0	3	1	1	0	2	1	2	0	5	5	6	27	
>360	100	0	8	7	4	4	0	5	2	1	3	21	9	18	82	
Total No of Curves		14	20	21	17	17	32	21	17	49	11	56	30	71	376	

57. From the above table it can be seen that 198 curves in the existing project road alignment is below the stipulated design standard. Most of these curves are identified in the village sections and hence increasing the curve radius is difficult due to the presence of buildings on the road edges. Minor realignment to bypass these village areas are required to improve the geometry of these stretches as well for the reason explained earlier with regard to widening. However, the realignment is suggested in the near future and no improvement is suggested at these sections under the present project other than rehabilitation. The stretches identified for realignment are shown in Table 7.13.

58. All the project roads are on plain terrain and as such no vertical geometric corrections required the entire length except at low lying where road profile needs to be lifted. The details of the low lying areas with improvement suggestions are presented in Table 7.13.

Table 7.13 Details of Low-lying areas and Sections identified for geometric improvement

Road No.	Road Name	Realignment Chainage (m)		Low-lying area Chainage (m)	
		From	To	From	To
1	Jharli Mohanbari Approach road	-	-	1600	1740
2	Jhajjar, Talao, Chhuchakawas road	2160	2440	-	-
		2720	2940	-	-
3	Beri, Rohtak road	-	-	620	920
		-	-	6340	6440
		-	-	7040	7160
4	Badli to Durina via Ladpur Munimpur	2940	3200	-	-
		7860	8040	-	-
5	Badli Pela Sondhi Yakubpur road	3520	3660	4980	5250
		4440	4580	-	-
6	Sahlawas Amboli Bithla Dhakla SH-22 including Jatwara approach road	600	940	3680	3860
		3020	3320	7620	8020
		7600	7720	9820	9920
		11860	11980	10400	10900
7	Subana (SH-22) Sarola Ahri road.	2340	2640	2360	2900
		6160	6340	5800	6040
8	Patauda (MDR-132 Dhani Saniyan Kahari Machroli(NH-71).	7400	7560	3100	3360
		-	-	6400	6780
9	Jhajjar Farrukhnagar road (SH15A) Mubarakpur Ismailpur Mundakhera (MDR-136) Poorli, Iqbalpur Galibpur upto Distt Border.	1540	1700	8600	8760
		5400	5560	-	-
		8140	8280	-	-
10	Poorli Iqbalpur road Lohat Delhi Border.	2160	2320	3600	3740
		2560	2760	-	-

11	Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road.	10020	10080	3420	3620
		11600	11780	5580	5720
12	Godhri Safipur Impota.	80	200	60	200
		5180	5280	480	720
13	Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijroth (NH-71)	460	640	3320	3440
		4000	4240	11200	11480

7.3.10 Typical Cross Section

59. Various typical cross sections are adopted for the project improvement proposal depending upon the lane width and drain type. Typical section generally adopted are listed below:

- Intermediate Lane rural section
- Intermediate Lane builtup section
- Two Lane rural section
- Two Lane urban section
- Two Lane rural section
- Two Lane urban section

60. The proposed roadway configuration is given in Table 7.14. These meet the projected design service volume.

Table 7.13 Summary of Classified Traffic Volume Count Survey

Road No.	Name of Work	Existing CW (m)	Carriageway width proposed
1.	Jharli Mohanbari Approach road	3.66	Intermediate
2.	Jhajjar, Talao, Chhuchakawas road	5.50	Two Lane with Paved Shoulder
3.	Beri, Rohtak road	5.50	Two Lane
4.	Badli to Durina via Ladpur Munimpur	5.50	Two Lane
5.	Badli Pela Sondhi Yakubpur road	5.50	Two Lane
6.	Sahlawas Amboli Bithla Dhakla SH-22 including Jatwara approach road	3.66	Intermediate
7.	Subana (SH-22) Sarola Ahri road.	3.66	Intermediate
8.	Patauda (MDR-132 Dhani Saniyan Kahari Machroli(NH-71).	3.66	Intermediate
9.	Jhajjar Farrukhnagar road (SH15A) Mubarakpur Ismailpur Mundakhera (MDR-136) Badli, Iqbalpur Galibpur upto Dist Border.	3.66	Intermediate
10.	Badli Iqbalpur road Lohat Delhi Border.	3.66	Intermediate
11.	Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road.	3.66	Intermediate

12.	Godhri Safipur Impota.	3.66	Intermediate
13.	Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijrodh (NH-71)	3.66	Intermediate

7.3.11 Pavement Design

61. A ten-year design period is considered for the pavement design. Flexible pavement is recommended for the project road improvement due to low initial investment. The design of new flexible pavement is carried out as per IRC 37 and the overlay design is done as per IRC 81. Proposed pavement composition is presented in Table 7.14.

Table 7.14 Proposed pavement composition for widening/reconstruction

Road No.	Name of Road	CBR	Projected		Proposal	
			MSA	PCUs	Crust (mm)	CW (m)
1.	Jhari Mohanbari Approach road	5	8	5906	BC 40 DBM 60 WMM 250 GSB 300	5.5
2.	Jhajjar, Talao, Chhuchakawas road	5	11	15367	BC 40 DBM 75 WMM 250 GSB 300	10
3.	Beri, Rohtak road	5	8	7880	BC 40 DBM 60 WMM 250 GSB 300	7
4.	Badli to Durina via Ladpur Munimpur	5	17	12685	BC 40 DBM 90 WMM 250 GSB 300	7
5.	Badli Pela Sondhi Yakubpur road	5	17	11087	BC 40 DBM 90 WMM 250 GSB 300	7
6.	Sahlawas Amboli Bithla Dhakla SH-22 including Jatwara approach road	5	5	5617	SDBC 25 DBM 55 WMM 250 GSB 250	5.5
7.	Subana (SH-22) Sarola Ahri road.	5	5	5619	SDBC 25 DBM 55 WMM 250 GSB 250	5.5
8.	Patauda (MDR-132 Dhani Saniyan	5	5	5153	BC 25	5.5

Road No.	Name of Road	CBR	Projected		Proposal	
			MSA	PCUs	Crust (mm)	CW (m)
	Kahari Machroli(NH-71).				DBM 55 WMM 250 GSB 250	
9.	Jhajjar Farrukhnagar road (SH15A) Mubarakpur Ismailpur Mundakhera (MDR-136) Badli, Iqbalpur Galibpur upto Distt Border.	5	7	5986	BC 40 DBM 60 WMM 250 GSB 250	5.5
10.	Badli Iqbalpur road Lohat Delhi Border.	6	4	3381	SDBC 25 DBM 50 WMM 250 GSB 210	5.5
11.	Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road.	5	5	4878	SDBC 25 DBM 55 WMM 250 GSB 250	5.5
12.	Godhri Safipur Impota.	5	5	3422	BC 25 DBM 55 WMM 250 GSB 250	5.5
13.	Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijrodh (NH-71)	6	10	5569	BC 40 DBM 65 WMM 250 GSB 260	5.5

7.3.12 Junction Design

62. Junction design ensures adequate capacity to avoid bottlenecks that would results in extended delays and also safe operation to traffic by reducing the number of conflict points and conflict area. Drivers should be able to make merging, diverging or crossing maneuvers at junction with minimal risk when the junction is properly designed. Details of Junctions along the project road alignments are presented in the Table 7.15. All the junctions listed below are proposed to be improved as per IRC standards.

Table 7.15 Details of Junctions along the project roads

Sl. No.	Name of the Project Road	Type of Junction	Major	Minor	Total	Road Length in km
1	Jharli Mohanbari Approach road	T	1	5	6	3.235
		X	1		1	
2	Jhajjar, Talao, Chhuchakawas road	T			0	13.46
		X	3	6	9	

Sl. No.	Name of the Project Road	Type of Junction	Major	Minor	Total	Road Length in km
3	Beri, Rohtak road	T		22	22	8.56
		X	1	4	5	
4	Badli to Durina via Ladpur Munimpur	T			0	11.43
		X			0	
5	Badli Pela Sondhi Yakubpur road	T			0	9.8
		X			0	
6	Sahlawas Amboli Bithla Dhakla SH-22 including Jatwara approach road	T	2	13	15	16.22
		X		3	3	
7	Subana (SH-22) Sarola Ahri road.	T		13	13	6.64
		X	1		1	
8	Patauda (MDR-132 Dhani Saniyan Kahari Machroli(NH-71).	T			0	10.08
		X			0	
9	Jhajjar Farrukhnagar road (SH15A) Mubarakpur Ismailpur Mundakhera (MDR-136) Badli, Iqbalpur Galibpur upto Distt Border.	T			0	11.755
		X			0	
10	Badli Iqbalpur road Lohat Delhi Border.	T			0	3.765
		X			0	
11	Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road.	T	1	22	23	12.475
		X	1	1	2	
12	Godhri Safipur Impota.	T	2	18	20	6.29
		X		1	1	
13	Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijrodh (NH-71)	T	4	24	28	15.02
		X		4	4	
Total			17	136	153	128.73

7.3.13 Way side Amenities and Road furniture

63. The project roads are MDR's or other roads and are not main truck routes. Therefore no truck parking area is provided. The numbers of buses in the projects roads are not substantial and hence no bus bays are proposed in the DPR.

64. Road furniture represents a collection of roadside elements intended to improve the driver's perception and comprehension of the continually changing appearance of the road. Road markings and road signs standards shall be provided as per IRC: 35 -1997 and IRC: 67 -2001 respectively. Road markings and traffic signs will be provided at appropriate places to give caution and to inform the traffic (vehicular and pedestrians) for safe and smooth movement and the provision will be made based on the IRC guidelines. All signs shall be of Retro-reflective grade, for undisturbed traffic movement in the night times. Adequate provisions road furniture and signs are provided in estimate.

7.4 COST ESTIMATES

65. The cost estimates have been prepared for widening of the existing single/intermediate road to two lane roads including strengthening of the existing pavement, strengthening / widening of existing bridge structures, construction of new bridges, rehabilitation and reconstruction / widening of cross drainage structures, longitudinal drains, junction improvements, road furniture, street lighting, environmental mitigation etc. The summary cost estimate prepared by the DPR consultants is presented in Table 7.16.

Table 7.16 Project Cost Summary

DPR of Various Roads in scheme in Jhajjar Distt:		
S. No.	Description	Amount (in Rupees)
1	Site clearance and dismentling	5223195
2	Earth work	104360605
3	Granular base course and Subbase	433965442
4	Bitumenous Work	563901415
5	Cement Concrete Pavement	261176656
6	Bridges & Culverts	88247450
7	Miscleneous items/Traffic signs etc	132234689
8	Shifting utilities	64365000
9	Drain	143194272
10	Retaining Wall	50595400
11	Removal of trees and compulsory afforestation	90111000
12	Improvement of Railway crossing	40000000
A	Total	1,977,375,124
	Contingency 1.5%	29660627
	Supervision Charges 2%	40140715
B	Grand Total	2,047,176,466
	Add 6% escalation from start till completion of project	122830588
C	Grand Total (incl. escalation)	2,170,007,054
	SAY (Rs. Million)	2170.0

66. The cost of construction for each road is given in Table 7.17. Also the project design or the BOQ and project description is not clear about the treatment at the built-up areas. Bid documents and final BOQ are to be prepared in a comprehensive way clearly defining the improvements with no works in the built up area where there is little offset between pavement edge and buildings. Only minor repairs as per Engineer's instruction may be done in those sections. Also to be confirmed is the rehabilitation work observed in some of the sections by removing sections taken up prior to this contract award.

Table 7.17 Project Cost Estimate for Road Sections

Road Name	Length (Km)	Total Cost (Civil Works+Physical contingency+Sueprvision Cost) (Rs. Millions)	Cost per Km (Rs. Millions)
Jharli Mohanbari Approach road	3.24	50.21	15.52
Jhajjar, Talao, Chhuchakawas road	13.46	267.58	19.88
Beri, Rohtak road	8.56	125.57	14.67
Badli to Durina via Ladpur Munimpur	11.43	178.49	15.62
Badli Pela Sondhi Yakubpur road	9.80	156.49	15.97
Sahlawas Amboli Bithla Dhakla SH-22 including Jatwara approach road	16.22	242.40	14.94
Subana (SH-22) Sarola Ahri road.	6.64	94.43	14.22
Patauda (MDR-132 Dhani Saniyan Kahari Machroli(NH-71).	10.08	122.63	12.17
Jhajjar Farrukhnagar road (SH15A) Mubarakpur Ismailpur Mundakhera (MDR-136) upto Distt Border.	11.76	216.22	18.39
Badli Iqbalpur road Lohat Delhi Border.	3.77	59.87	15.90
Chhuchakwas (MDR-130) Achej Paharipur, Malikpur Safipur road.	12.48	186.56	14.95
Godhri Safipur Impota.	6.29	87.60	13.93
Gawalision (VT)Kheri Hosdarpur Karodha Raiya (SH-22) Salodha Gijrodh (NH-71)	15.02	260.08	17.32
Total	128.73	2047.18	15.90

7.5 PROJECT IMPLEMENTATION

67. The project will be implemented by the Project Implementation Unit (PIU) of the HSRDC. Since the number of road sections are many, it is recommended that two contract packages to have a good size project to attract larger contractors and also to have better contract management. The HSRDC is

implementing a number of similar projects and have the institutional capacity to undertake the project but may need to augment its strength when taking up more projects. The procurement shall be carried out in compliance with ADB procedures. A supervision consultant shall be engaged for the contract management. The implementation of the project shall be completed over a period of 18 months (2010-11). A procurement and implementation schedule is included in the Annexure.

68. The project involves utility shifting to some extent. These are to be carried out prior to commencement of Contractor's mobilization to avoid delay in project implementation. A detailed utility shifting plan is to be prepared and steps to be initiated to implement them.

7.6 ECONOMIC ANALYSIS

69. An economic analysis of the proposed project has been undertaken to determine its economic viability.
70. The major economic benefits comprise (i) Vehicle operating cost savings to traffic on the project roads with improved surface and capacity and (ii) travel time savings to all traffic with improved speeds. Other benefits are envisaged to accrue with better access but have not been quantified. These include reduced emissions due to better level of service, social benefits and improved road safety in the town sections.
71. Based on the above considerations, the economic cost and benefit streams over the analysis period have been worked out using the HDM-4 model. All costs and benefits are valued in monetary terms and expressed in economic prices to avoid distortions in the input prices of labor, materials, equipment and foreign exchange due to market imperfections. In calculating the road agency economic costs (construction and maintenance), a Conversion Factor (CF) 0.9 was used, as generally used for road projects in India, to derive economic costs from the estimated financial cost.
72. The economic cost of vehicle operating cost components and time costs (VOCs) have been calculated separately for each individual component and input to the HDM model. The input values used for recent road sector studies in India have been used.
73. A 20 year analysis period has been used. A residual value of 10% is assumed, as the project involves widening. To be acceptable for implementation, the proposed investments have to result in an EIRR of at least equal to the opportunity cost of capital, which is set at 12 percent. NPV's are calculated using opportunity cost of capital as the discount rate. The results of economic analysis for the project is summarized below in Table 7.18. The cost-benefit streams for each road is given in Annex 1.

Table 7.18 Economic Analysis Results for Jhjar District Roads

Road	NPV	NPV/Cost Ratio	EIRR
	(Rs. Million)		(%)
Badli Iqbalpur road	17.41	0.3	14.4
Badli Pela Sondhi Yakubpur road	199.1	1.5	25.5
Badli to Durina	360.2	2.2	33.1
Beri - Rohtak road	173.6	1.5	27.9

Road	NPV	NPV/Cost Ratio	EIRR
	(Rs. Million)		(%)
Chhuchakwas - Malikpur Safipur(MDR-130)	155.8	1.0	21.9
Gawalision(SH-22)	91.3	0.4	15.4
Godhri - Safipur	18.1	0.3	13.3
Jhajjar - Farrukhnagar road	202.0	1.1	22.2
Jhajjar-Talao-Chhuchakawas	702.3	3.0	39.9
Jharli - Mohanbari	52.2	1.2	23.4
Patauda (MDR-132)	221.1	2.1	32.8
Sahlawas-Amboli-Bithla	184.1	0.8	20.8
Subana-Sarola Ahri road.	135.3	1.7	28.3

74. The economic analysis indicates a robust economic rate of return well above the acceptable rate of return of 12% for all project road sections. The proposed project will improve the level of service and augment capacity to sustain the level of service over the design period and has an acceptable economic rate of return and is therefore recommended for implementation.

75. The cost and benefit estimates involve uncertainties. Sensitivity analysis has been carried out by changing cost and benefit estimates. The results of the sensitivity analysis are given in Table 7.18. The results indicate that with adverse variation in benefits or costs, the rate of return is still above the acceptable rate of return in most cases except in the case of Godhri-Safipur and Gwalision Roads. The sensitivity analysis indicates that the economic justification for the project investment is robust.

Table 7.18 Sensitivity Analysis Results

Road Section	Economic Internal Rate Of Return Under Different Scenarios				
	Base Case	Increase In Cost by 15%	Decrease In Benefits by 15%	Increase in Cost and Decrease in Benefits By 15%	Delay in Construction by One Year
Badli Iqbalpur road	14.4%	12.4%	12.1%	10.3%	14.2%
Badli Pela Sondhi Yakubpur road	25.5%	22.9%	22.4%	20.0%	25.4%
Badli to Durina	33.1%	29.6%	29.1%	26.0%	32.5%
Beri - Rohtak	27.9%	24.8%	24.3%	21.5%	26.7%
Chucchakwas	21.8%	19.2%	18.8%	16.4%	21.2%
Gwalision	15.4%	13.3%	13.0%	11.0%	15.0%
Godhri Safipur	13.3%	11.3%	11.0%	9.1%	13.1%

Road Section	Economic Internal Rate Of Return Under Different Scenarios				
	Base Case	Increase In Cost by 15%	Decrease In Benefits by 15%	Increase in Cost and Decrease in Benefits By 15%	Delay in Construction by One Year
Jhajjar Farrukhnagar road	22.1%	19.6%	19.3%	17.0%	21.8%
Jhajjar - Talao	39.9%	35.7%	35.1%	31.4%	37.8%
Jharli - Mohanbari	23.4%	20.8%	20.4%	18.0%	23.0%
Patauda	32.7%	29.1%	28.5%	25.3%	31.2%
Sahalwas - Bithala	20.8%	18.2%	17.8%	15.5%	20.4%
Subana Sarola Ahri road.	28.3%	25.2%	24.7%	21.9%	27.3%

Annex 1

Badli Iqbalpur road

Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits	
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	53.96	-0.32	0.00	0.00	0.00	0.00	0.00	0.00	-53.64
2011	0.00	-0.33	0.00	3.59	0.76	0.00	0.00	0.00	4.68
2012	0.00	-0.02	0.00	4.23	0.84	0.00	0.00	0.00	5.09
2013	0.00	-0.03	0.00	5.34	0.95	0.00	0.00	0.00	6.32
2014	0.00	-0.04	0.00	6.71	1.11	0.00	0.00	0.00	7.86
2015	-2.49	-0.22	0.00	7.69	1.26	0.00	0.00	0.00	11.67
2016	4.99	0.00	0.00	6.50	1.24	0.00	0.00	0.00	2.75
2017	0.00	0.00	0.00	7.26	1.37	0.00	0.00	0.00	8.63
2018	0.00	0.00	0.00	8.09	1.52	0.00	0.00	0.00	9.61
2019	0.00	0.00	0.00	8.79	1.64	0.00	0.00	0.00	10.42
2020	0.00	0.00	0.00	9.58	1.77	0.00	0.00	0.00	11.35
2021	0.00	0.00	0.00	10.49	1.92	0.00	0.00	0.00	12.40
2022	4.99	0.00	0.00	11.54	2.09	0.00	0.00	0.00	8.64
2023	-2.49	-0.14	0.00	12.62	2.27	0.00	0.00	0.00	17.53
2024	0.00	0.00	0.00	11.16	2.21	0.00	0.00	0.00	13.37
2025	0.00	0.00	0.00	12.01	2.35	0.00	0.00	0.00	14.36
2026	0.00	0.00	0.00	12.95	2.51	0.00	0.00	0.00	15.46
2027	0.00	0.00	0.00	14.02	2.69	0.00	0.00	0.00	16.71
2028	-3.11	0.00	0.00	15.24	2.89	0.00	0.00	0.00	21.23
TOTAL	55.84	-1.09	0.00	167.78	31.41	0.00	0.00	0.00	144.44

BASE CASE

Badli Iqbalpur road

COSTS	BENEFITS	NET BENEFITS
0.00	0.00	0.00
53.64	0.00	-53.64
-0.33	4.35	4.68
-0.02	5.07	5.09
-0.03	6.29	6.32
-0.04	7.82	7.86
-2.71	8.96	11.67
4.99	7.74	2.75
0.00	8.63	8.63
0.00	9.61	9.61
0.00	10.42	10.42
0.00	11.35	11.35
0.00	12.40	12.40
4.99	13.63	8.64
-2.64	14.89	17.53
0.00	13.37	13.37
0.00	14.36	14.36
0.00	15.46	15.46
0.00	16.71	16.71
-3.10	18.13	21.23
EIRR		14.4%
NPV (Rs. Millions)at 12%		8.11

Badli Pela Sondhi Yakubpur road

Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits	
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	140.85	-0.84	0.00	0.00	0.00	0.00	0.00	0.00	-140.00
2011	0.00	-0.88	0.00	14.49	3.17	0.00	0.00	0.00	18.54
2012	-10.19	-0.19	0.00	22.00	3.63	0.00	0.00	0.00	36.01
2013	0.00	0.00	0.00	23.31	3.96	0.00	0.00	0.00	27.27
2014	0.00	0.00	0.00	26.51	4.41	0.00	0.00	0.00	30.92
2015	0.00	0.00	0.00	30.34	4.96	0.00	0.00	0.00	35.30
2016	0.00	0.00	0.00	35.00	5.63	0.00	0.00	0.00	40.62
2017	0.00	0.00	0.00	40.70	6.47	0.00	0.00	0.00	47.16
2018	20.37	0.00	0.00	47.25	7.49	0.00	0.00	0.00	34.37
2019	0.00	0.00	0.00	52.80	8.21	0.00	0.00	0.00	61.01
2020	-10.19	-0.22	0.00	55.65	8.77	0.00	0.00	0.00	74.83
2021	0.00	0.00	0.00	45.67	8.05	0.00	0.00	0.00	53.72
2022	0.00	0.00	0.00	51.47	8.90	0.00	0.00	0.00	60.37
2023	0.00	0.00	0.00	58.40	9.97	0.00	0.00	0.00	68.37
2024	0.00	0.00	0.00	65.32	11.05	0.00	0.00	0.00	76.37
2025	0.00	0.00	0.00	70.09	11.96	0.00	0.00	0.00	82.05
2026	20.37	0.01	0.00	72.55	12.62	0.00	0.00	0.00	64.79
2027	0.00	0.00	0.00	78.45	13.34	0.00	0.00	0.00	91.79
2028	-31.31	-0.22	0.00	81.97	14.11	0.00	0.00	0.00	127.61
TOTAL	129.91	-2.35	0.00	871.96	146.70	0.00	0.00	0.00	891.11

Badli Pela Sondhi Yakubpur road

COSTS	BENEFITS	NET BENEFITS
0.00	0.00	0.00
140.00	0.00	-140.00
-0.88	17.66	18.54
-10.38	25.63	36.01
0.00	27.27	27.27
0.00	30.92	30.92
0.00	35.30	35.30
0.00	40.62	40.62
0.00	47.16	47.16
20.37	54.75	34.37
0.00	61.01	61.01
-10.41	64.42	74.83
0.00	53.72	53.72
0.00	60.37	60.37
0.00	68.37	68.37
0.00	76.37	76.37
0.00	82.05	82.05
20.38	85.17	64.79
0.00	91.79	91.79
-31.54	96.07	127.61
EIRR		25.5%
NPV (Rs. Millions)at 12%		146.68

Badli to Durina										Badli to Durina		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	160.64	-0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-159.66	159.66	-159.66
2011	0.00	-1.01	0.00	25.17	4.89	0.00	0.00	0.00	0.00	31.07	-1.01	30.06
2012	0.00	-0.08	0.00	35.10	5.66	0.00	0.00	0.00	0.00	40.85	-0.08	40.77
2013	-11.88	-0.33	0.00	48.10	7.07	0.00	0.00	0.00	0.00	67.37	-12.21	55.17
2014	0.00	0.00	0.00	40.85	6.81	0.00	0.00	0.00	0.00	47.67	0.00	47.67
2015	0.00	0.00	0.00	47.26	7.72	0.00	0.00	0.00	0.00	54.98	0.00	54.98
2016	23.76	0.00	0.00	55.16	8.87	0.00	0.00	0.00	0.00	40.26	23.76	64.02
2017	0.00	0.00	0.00	66.34	10.37	0.00	0.00	0.00	0.00	76.71	0.00	76.71
2018	0.00	0.00	0.00	76.22	11.95	0.00	0.00	0.00	0.00	88.17	0.00	88.17
2019	0.00	0.00	0.00	81.19	12.89	0.00	0.00	0.00	0.00	94.07	0.00	94.07
2020	0.00	0.00	0.00	85.53	13.80	0.00	0.00	0.00	0.00	99.33	0.00	99.33
2021	-11.88	-0.22	0.00	90.02	14.79	0.00	0.00	0.00	0.00	116.91	-12.10	104.80
2022	23.76	0.00	0.00	73.49	13.45	0.00	0.00	0.00	0.00	63.18	23.76	86.94
2023	0.00	0.00	0.00	86.38	15.13	0.00	0.00	0.00	0.00	101.50	0.00	101.50
2024	0.00	0.00	0.00	98.88	17.02	0.00	0.00	0.00	0.00	115.90	0.00	115.90
2025	0.00	0.00	0.00	109.69	18.86	0.00	0.00	0.00	0.00	128.55	0.00	128.55
2026	0.00	0.00	0.00	115.88	20.15	0.00	0.00	0.00	0.00	136.02	0.00	136.02
2027	0.00	0.00	0.00	120.76	21.34	0.00	0.00	0.00	0.00	142.10	0.00	142.10
2028	7.70	0.00	0.00	125.46	22.62	0.00	0.00	0.00	0.00	140.38	7.70	148.08
TOTAL	192.10	-2.62	0.00	1,381.48	233.36	0.00	0.00	0.00	0.00	1,425.36		
										EIRR		33.1%
										NPV (Rs. Millions)at 12%		277.52
Beri - Rohtak road										Beri - Rohtak road		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	113.01	-0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-112.28	112.28	-112.28
2011	0.00	-0.74	0.00	17.46	4.70	0.00	0.00	0.00	0.00	22.91	-0.74	22.17
2012	-8.90	-0.14	0.00	20.39	5.20	0.00	0.00	0.00	0.00	34.63	-9.04	25.59
2013	0.00	0.00	0.00	19.84	5.65	0.00	0.00	0.00	0.00	25.49	0.00	25.49
2014	0.00	0.00	0.00	21.92	6.21	0.00	0.00	0.00	0.00	28.13	0.00	28.13
2015	0.00	0.00	0.00	24.26	6.83	0.00	0.00	0.00	0.00	31.09	0.00	31.09
2016	17.80	0.00	0.00	26.90	7.52	0.00	0.00	0.00	0.00	16.63	17.80	34.42
2017	0.00	0.00	0.00	30.29	8.31	0.00	0.00	0.00	0.00	38.60	0.00	38.60
2018	0.00	0.00	0.00	33.87	9.19	0.00	0.00	0.00	0.00	43.05	0.00	43.05
2019	0.00	0.00	0.00	36.96	9.87	0.00	0.00	0.00	0.00	46.84	0.00	46.84
2020	-8.90	-0.22	0.00	40.59	10.65	0.00	0.00	0.00	0.00	60.35	-9.12	51.23
2021	0.00	0.00	0.00	37.32	11.11	0.00	0.00	0.00	0.00	48.43	0.00	48.43
2022	17.80	0.00	0.00	40.33	11.91	0.00	0.00	0.00	0.00	34.45	17.80	52.24
2023	0.00	0.00	0.00	44.42	12.80	0.00	0.00	0.00	0.00	57.22	0.00	57.22
2024	0.00	0.00	0.00	47.78	13.56	0.00	0.00	0.00	0.00	61.34	0.00	61.34
2025	0.00	0.00	0.00	51.54	14.40	0.00	0.00	0.00	0.00	65.93	0.00	65.93
2026	0.00	0.00	0.00	55.80	15.33	0.00	0.00	0.00	0.00	71.13	0.00	71.13
2027	0.00	0.00	0.00	60.69	16.39	0.00	0.00	0.00	0.00	77.08	0.00	77.08
2028	-2.40	-0.22	0.00	66.34	17.61	0.00	0.00	0.00	0.00	86.58	-2.63	83.96
TOTAL	128.40	-2.07	0.00	676.69	187.25	0.00	0.00	0.00	0.00	737.60		
										EIRR		27.9%
										NPV (Rs. Millions)at 12%		130.42

Chhuchakwas										Chhuchakwas		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	167.97	-1.08	0.00	0.00	0.00	0.00	0.00	0.00	-166.89	166.89	0.00	-166.89
2011	0.00	-1.10	0.00	20.08	3.67	0.00	0.00	0.00	24.85	-1.10	23.75	24.85
2012	0.00	-0.08	0.00	25.24	4.25	0.00	0.00	0.00	29.57	-0.08	29.49	29.57
2013	0.00	-0.14	0.00	30.48	4.95	0.00	0.00	0.00	35.58	-0.14	35.43	35.58
2014	0.00	-0.21	0.00	32.90	5.42	0.00	0.00	0.00	38.53	-0.21	38.32	38.53
2015	-8.26	-0.24	0.00	35.53	5.94	0.00	0.00	0.00	49.96	-8.49	41.47	49.96
2016	16.51	0.00	0.00	28.63	5.79	0.00	0.00	0.00	17.91	16.52	34.42	17.91
2017	0.00	0.00	0.00	32.01	6.40	0.00	0.00	0.00	38.41	0.00	38.41	38.41
2018	0.00	0.00	0.00	35.75	7.09	0.00	0.00	0.00	42.84	0.00	42.84	42.84
2019	0.00	0.00	0.00	38.93	7.64	0.00	0.00	0.00	46.57	0.00	46.57	46.57
2020	0.00	0.00	0.00	42.54	8.25	0.00	0.00	0.00	50.79	0.00	50.79	50.79
2021	0.00	0.00	0.00	46.69	8.95	0.00	0.00	0.00	55.64	0.00	55.64	55.64
2022	16.51	0.00	0.00	51.52	9.76	0.00	0.00	0.00	44.76	16.52	61.28	44.76
2023	-8.26	-0.14	0.00	57.48	10.70	0.00	0.00	0.00	76.58	-8.40	68.18	76.58
2024	0.00	0.00	0.00	51.63	10.54	0.00	0.00	0.00	62.17	0.00	62.17	62.17
2025	0.00	0.00	0.00	55.81	11.24	0.00	0.00	0.00	67.05	0.00	67.05	67.05
2026	0.00	0.00	0.00	60.56	12.03	0.00	0.00	0.00	72.58	0.00	72.58	72.58
2027	0.00	0.00	0.00	66.00	12.94	0.00	0.00	0.00	78.94	0.00	78.94	78.94
2028	-0.29	0.01	0.00	71.53	13.92	0.00	0.00	0.00	85.73	-0.28	85.45	85.73
TOTAL	184.19	-2.98	0.00	783.32	149.47	0.00	0.00	0.00	751.58			
										EIRR		21.8%
										NPV (Rs. Millions)at 12%		110.35

Gawalision										Gawalision		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	234.07	-1.29	0.00	0.00	0.00	0.00	0.00	0.00	-232.78	232.78	0.00	-232.78
2011	0.00	-1.32	0.00	19.26	3.54	0.00	0.00	0.00	24.12	-1.32	22.80	24.12
2012	0.00	-0.08	0.00	23.60	4.04	0.00	0.00	0.00	27.72	-0.08	27.64	27.72
2013	0.00	-0.14	0.00	28.58	4.69	0.00	0.00	0.00	33.41	-0.14	33.27	33.41
2014	0.00	-0.20	0.00	31.84	5.24	0.00	0.00	0.00	37.27	-0.20	37.07	37.27
2015	-9.94	-0.23	0.00	34.36	5.73	0.00	0.00	0.00	50.25	-10.16	40.09	50.25
2016	19.87	0.00	0.00	28.35	5.61	0.00	0.00	0.00	14.09	19.87	33.96	14.09
2017	0.00	0.00	0.00	31.75	6.20	0.00	0.00	0.00	37.95	0.00	37.95	37.95
2018	0.00	0.00	0.00	35.42	6.87	0.00	0.00	0.00	42.29	0.00	42.29	42.29
2019	0.00	0.00	0.00	38.54	7.40	0.00	0.00	0.00	45.94	0.00	45.94	45.94
2020	0.00	0.00	0.00	42.07	7.99	0.00	0.00	0.00	50.06	0.00	50.06	50.06
2021	0.00	0.00	0.00	46.13	8.67	0.00	0.00	0.00	54.80	0.00	54.80	54.80
2022	19.87	0.00	0.00	50.83	9.46	0.00	0.00	0.00	40.42	19.87	60.29	40.42
2023	-9.94	-0.14	0.00	56.06	10.31	0.00	0.00	0.00	76.45	-10.08	66.37	76.45
2024	0.00	0.00	0.00	49.71	10.08	0.00	0.00	0.00	59.79	0.00	59.79	59.79
2025	0.00	0.00	0.00	53.60	10.73	0.00	0.00	0.00	64.33	0.00	64.33	64.33
2026	0.00	0.00	0.00	57.99	11.46	0.00	0.00	0.00	69.45	0.00	69.45	69.45
2027	0.00	0.00	0.00	62.97	12.29	0.00	0.00	0.00	75.27	0.00	75.27	75.27
2028	-3.54	0.01	0.00	68.50	13.23	0.00	0.00	0.00	85.26	-3.53	81.73	85.26
TOTAL	250.41	-3.39	0.00	759.57	143.53	0.00	0.00	0.00	656.09			
										EIRR		15.4%
										NPV (Rs. Millions)at 12%		49.36

Jhajjar Farrukhnagar road										Jhajjar Farrukhnagar road		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	194.69	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-193.69	193.69	0.00
2011	0.00	-0.02	0.00	20.59	4.69	0.00	0.00	0.00	0.00	25.30	-0.02	25.28
2012	0.00	-0.04	0.00	23.59	5.16	0.00	0.00	0.00	0.00	28.79	-0.04	28.75
2013	0.00	-0.07	0.00	28.23	5.72	0.00	0.00	0.00	0.00	34.02	-0.07	33.95
2014	0.00	-0.10	0.00	35.74	6.51	0.00	0.00	0.00	0.00	42.35	-0.10	42.25
2015	-7.78	-0.22	0.00	44.26	7.62	0.00	0.00	0.00	0.00	59.88	-7.99	51.88
2016	15.56	0.00	0.00	39.30	7.73	0.00	0.00	0.00	0.00	31.46	15.56	47.03
2017	0.00	0.00	0.00	43.83	8.56	0.00	0.00	0.00	0.00	52.39	0.00	52.39
2018	0.00	0.00	0.00	48.60	9.50	0.00	0.00	0.00	0.00	58.10	0.00	58.10
2019	0.00	0.00	0.00	52.49	10.22	0.00	0.00	0.00	0.00	62.71	0.00	62.71
2020	0.00	0.00	0.00	56.79	11.03	0.00	0.00	0.00	0.00	67.82	0.00	67.82
2021	0.00	0.00	0.00	61.61	11.93	0.00	0.00	0.00	0.00	73.54	0.00	73.54
2022	15.56	0.01	0.00	67.01	12.95	0.00	0.00	0.00	0.00	64.39	15.57	79.96
2023	-7.78	-0.14	0.00	73.97	14.11	0.00	0.00	0.00	0.00	96.01	-7.92	88.08
2024	0.00	0.00	0.00	66.52	14.00	0.00	0.00	0.00	0.00	80.52	0.00	80.52
2025	0.00	0.00	0.00	71.10	14.88	0.00	0.00	0.00	0.00	85.97	0.00	85.97
2026	0.00	0.00	0.00	76.13	15.83	0.00	0.00	0.00	0.00	91.96	0.00	91.96
2027	0.00	0.00	0.00	81.67	16.89	0.00	0.00	0.00	0.00	98.56	0.00	98.56
2028	-3.91	0.02	0.00	87.82	18.07	0.00	0.00	0.00	0.00	109.78	-3.89	105.89
TOTAL	206.34	-1.56	0.00	979.24	195.39	0.00	0.00	0.00	0.00	969.86		
										EIRR		22.1%
										NPV (Rs. Millions)at 12%		143.49

Jhajjar Talao Chhuchakawas										Jhajjar Talao Chhuchakawas		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	226.83	-1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-225.58	225.58	0.00
2011	0.00	-1.14	0.00	51.90	11.88	0.00	0.00	0.00	0.00	64.93	-1.14	63.78
2012	0.00	0.00	0.00	59.15	13.20	0.00	0.00	0.00	0.00	72.35	0.00	72.35
2013	0.00	0.00	0.00	67.97	14.75	0.00	0.00	0.00	0.00	82.72	0.00	82.72
2014	0.00	0.00	0.00	78.48	16.61	0.00	0.00	0.00	0.00	95.08	0.00	95.08
2015	0.00	0.00	0.00	91.71	18.93	0.00	0.00	0.00	0.00	110.64	0.00	110.64
2016	27.98	0.00	0.00	105.65	21.60	0.00	0.00	0.00	0.00	99.27	27.98	127.25
2017	0.00	0.00	0.00	118.23	24.19	0.00	0.00	0.00	0.00	142.43	0.00	142.43
2018	-13.99	-0.22	0.00	128.54	26.82	0.00	0.00	0.00	0.00	169.58	-14.21	155.36
2019	0.00	0.00	0.00	112.90	26.36	0.00	0.00	0.00	0.00	139.27	0.00	139.27
2020	0.00	0.00	0.00	127.67	29.08	0.00	0.00	0.00	0.00	156.74	0.00	156.74
2021	0.00	0.00	0.00	145.41	32.44	0.00	0.00	0.00	0.00	177.85	0.00	177.85
2022	27.98	0.00	0.00	159.40	35.68	0.00	0.00	0.00	0.00	167.10	27.98	195.09
2023	0.00	0.00	0.00	171.59	38.45	0.00	0.00	0.00	0.00	210.05	0.00	210.05
2024	0.00	0.00	0.00	179.56	40.72	0.00	0.00	0.00	0.00	220.28	0.00	220.28
2025	0.00	0.00	0.00	187.90	43.15	0.00	0.00	0.00	0.00	231.04	0.00	231.04
2026	-13.99	-0.23	0.00	196.60	45.75	0.00	0.00	0.00	0.00	256.57	-14.22	242.35
2027	0.00	0.00	0.00	171.48	44.30	0.00	0.00	0.00	0.00	215.77	0.00	215.77
2028	-8.14	0.00	0.00	192.43	48.51	0.00	0.00	0.00	0.00	249.08	-8.14	240.94
TOTAL	246.68	-2.85	0.00	2,346.57	532.42	0.00	0.00	0.00	0.00	2,635.16		
										EIRR		39.9%
										NPV (Rs. Millions)at 12%		550.99

Jharli Mohanbari										Jharli Mohanbari		
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits	COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits				
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	45.12	-0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-44.85	44.85	0.00
2011	0.00	0.00	0.00	5.08	1.09	0.00	0.00	0.00	0.00	6.17	0.00	6.17
2012	0.00	-0.01	0.00	5.97	1.20	0.00	0.00	0.00	0.00	7.18	-0.01	7.17
2013	0.00	-0.02	0.00	7.31	1.35	0.00	0.00	0.00	0.00	8.68	-0.02	8.66
2014	0.00	-0.03	0.00	9.15	1.57	0.00	0.00	0.00	0.00	10.74	-0.03	10.72
2015	0.00	-0.03	0.00	10.73	1.81	0.00	0.00	0.00	0.00	12.57	-0.03	12.54
2016	2.14	-0.21	0.00	11.59	1.98	0.00	0.00	0.00	0.00	11.65	1.92	13.57
2017	0.00	0.00	0.00	10.00	1.96	0.00	0.00	0.00	0.00	11.97	0.00	11.97
2018	0.00	0.00	0.00	11.33	2.19	0.00	0.00	0.00	0.00	13.53	0.00	13.53
2019	0.00	0.00	0.00	12.56	2.38	0.00	0.00	0.00	0.00	14.94	0.00	14.94
2020	0.00	0.00	0.00	14.01	2.61	0.00	0.00	0.00	0.00	16.62	0.00	16.62
2021	0.00	0.00	0.00	15.59	2.87	0.00	0.00	0.00	0.00	18.46	0.00	18.46
2022	4.27	0.01	0.00	16.81	3.10	0.00	0.00	0.00	0.00	15.64	4.28	19.92
2023	0.00	0.00	0.00	17.89	3.32	0.00	0.00	0.00	0.00	21.21	0.00	21.21
2024	-2.14	-0.14	0.00	18.66	3.49	0.00	0.00	0.00	0.00	24.44	-2.28	22.16
2025	0.00	0.00	0.00	16.51	3.41	0.00	0.00	0.00	0.00	19.92	0.00	19.92
2026	0.00	0.00	0.00	18.11	3.66	0.00	0.00	0.00	0.00	21.77	0.00	21.77
2027	0.00	0.00	0.00	20.01	3.96	0.00	0.00	0.00	0.00	23.97	0.00	23.97
2028	-0.24	0.01	0.00	21.80	4.28	0.00	0.00	0.00	0.00	26.31	-0.23	26.08
TOTAL	49.16	-0.71	0.00	243.13	46.24	0.00	0.00	0.00	0.00	240.92		
										EIRR		23.4%
										NPV (Rs. Millions)at 12%		37.73

Godhri Safipur										Godhri Safipur		
Year	Increase in Road Agency Costs			Decrease in Road User Costs						COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits	Net Benefits			
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	78.84	-0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-78.30	78.30	-78.30
2011	0.00	-0.01	0.00	5.65	1.05	0.00	0.00	0.00	0.00	6.71	-0.01	6.70
2012	0.00	-0.02	0.00	6.67	1.18	0.00	0.00	0.00	0.00	7.87	-0.02	7.85
2013	0.00	-0.04	0.00	8.18	1.36	0.00	0.00	0.00	0.00	9.58	-0.04	9.54
2014	0.00	-0.06	0.00	9.51	1.56	0.00	0.00	0.00	0.00	11.13	-0.06	11.07
2015	0.00	-0.08	0.00	10.26	1.70	0.00	0.00	0.00	0.00	12.04	-0.08	11.96
2016	4.16	-0.22	0.00	11.07	1.86	0.00	0.00	0.00	0.00	8.99	3.94	12.93
2017	0.00	0.00	0.00	9.30	1.83	0.00	0.00	0.00	0.00	11.13	0.00	11.13
2018	0.00	0.00	0.00	10.33	2.02	0.00	0.00	0.00	0.00	12.35	0.00	12.35
2019	0.00	0.00	0.00	11.20	2.17	0.00	0.00	0.00	0.00	13.37	0.00	13.37
2020	0.00	0.00	0.00	12.17	2.34	0.00	0.00	0.00	0.00	14.50	0.00	14.50
2021	0.00	0.00	0.00	13.26	2.52	0.00	0.00	0.00	0.00	15.79	0.00	15.79
2022	8.32	0.00	0.00	14.51	2.73	0.00	0.00	0.00	0.00	8.92	8.32	17.25
2023	0.00	0.00	0.00	16.09	2.98	0.00	0.00	0.00	0.00	19.07	0.00	19.07
2024	-4.16	-0.14	0.00	17.38	3.19	0.00	0.00	0.00	0.00	24.88	-4.30	20.57
2025	0.00	0.00	0.00	15.35	3.12	0.00	0.00	0.00	0.00	18.47	0.00	18.47
2026	0.00	0.00	0.00	16.52	3.31	0.00	0.00	0.00	0.00	19.83	0.00	19.83
2027	0.00	0.00	0.00	17.82	3.53	0.00	0.00	0.00	0.00	21.35	0.00	21.35
2028	0.44	0.00	0.00	19.27	3.78	0.00	0.00	0.00	0.00	22.61	0.44	23.05
TOTAL	87.60	-1.11	0.00	224.54	42.22	0.00	0.00	0.00	0.00	180.27		
										EIRR		13.3%
										NPV (Rs. Millions)at 12%		6.14

Patauda										Patauda		
Year	Increase in Road Agency Costs			Decrease in Road User Costs						COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits	Net Benefits			
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	110.37	-0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-109.50	109.50	-109.50
2011	0.00	-0.04	0.00	21.55	3.91	0.00	0.00	0.00	0.00	25.50	-0.04	25.46
2012	0.00	-0.09	0.00	26.96	4.54	0.00	0.00	0.00	0.00	31.60	-0.09	31.50
2013	0.00	-0.17	0.00	32.13	5.26	0.00	0.00	0.00	0.00	37.56	-0.17	37.39
2014	-6.67	-0.25	0.00	34.68	5.76	0.00	0.00	0.00	0.00	47.36	-6.91	40.45
2015	0.00	0.00	0.00	27.56	5.60	0.00	0.00	0.00	0.00	33.16	0.00	33.16
2016	13.34	0.00	0.00	30.69	6.19	0.00	0.00	0.00	0.00	23.55	13.34	36.89
2017	0.00	0.00	0.00	34.60	6.87	0.00	0.00	0.00	0.00	41.46	0.00	41.46
2018	0.00	0.00	0.00	38.84	7.64	0.00	0.00	0.00	0.00	46.48	0.00	46.48
2019	0.00	0.00	0.00	42.56	8.26	0.00	0.00	0.00	0.00	50.82	0.00	50.82
2020	0.00	0.00	0.00	46.88	8.97	0.00	0.00	0.00	0.00	55.86	0.00	55.86
2021	0.00	0.00	0.00	52.01	9.82	0.00	0.00	0.00	0.00	61.83	0.00	61.83
2022	6.67	-0.14	0.00	57.57	10.78	0.00	0.00	0.00	0.00	61.82	6.53	68.35
2023	0.00	0.00	0.00	52.82	10.78	0.00	0.00	0.00	0.00	63.61	0.00	63.61
2024	0.00	0.00	0.00	57.28	11.52	0.00	0.00	0.00	0.00	68.80	0.00	68.80
2025	0.00	0.00	0.00	62.39	12.37	0.00	0.00	0.00	0.00	74.76	0.00	74.76
2026	0.00	0.00	0.00	68.35	13.36	0.00	0.00	0.00	0.00	81.71	0.00	81.71
2027	0.00	0.00	0.00	73.73	14.36	0.00	0.00	0.00	0.00	88.09	0.00	88.09
2028	2.30	0.01	0.00	77.46	15.22	0.00	0.00	0.00	0.00	90.36	2.31	92.67
TOTAL	126.00	-1.54	0.00	838.08	161.21	0.00	0.00	0.00	0.00	874.83		
										EIRR		32.7%
										NPV (Rs. Millions)at 12%		170.39

Sahlawas Amboli Bithla										Sahlawas Amboli Bithla		
Year	Increase in Road Agency Costs			Decrease in Road User Costs						COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits	Net Benefits			
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	218.16	-1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-216.76	216.76	-216.76
2011	0.00	-0.06	0.00	24.41	3.92	0.00	0.00	0.00	0.00	28.40	-0.06	28.40
2012	0.00	-0.13	0.00	32.16	4.69	0.00	0.00	0.00	0.00	36.99	-0.13	36.85
2013	0.00	-0.24	0.00	39.40	5.56	0.00	0.00	0.00	0.00	45.19	-0.24	44.96
2014	0.00	-0.36	0.00	42.47	6.09	0.00	0.00	0.00	0.00	48.92	-0.36	48.56
2015	-16.86	-0.29	0.00	45.80	6.68	0.00	0.00	0.00	0.00	69.63	-17.15	52.47
2016	33.72	0.00	0.00	33.63	6.14	0.00	0.00	0.00	0.00	6.05	33.72	39.77
2017	0.00	0.00	0.00	38.97	6.84	0.00	0.00	0.00	0.00	45.81	0.00	45.81
2018	0.00	0.00	0.00	44.78	7.68	0.00	0.00	0.00	0.00	52.46	0.00	52.46
2019	0.00	0.00	0.00	50.45	8.41	0.00	0.00	0.00	0.00	58.87	0.00	58.87
2020	0.00	0.00	0.00	57.36	9.33	0.00	0.00	0.00	0.00	66.70	0.00	66.70
2021	0.00	0.00	0.00	65.41	10.46	0.00	0.00	0.00	0.00	75.87	0.00	75.87
2022	33.72	0.00	0.00	71.50	11.47	0.00	0.00	0.00	0.00	49.24	33.72	82.96
2023	-16.86	-0.22	0.00	76.43	12.26	0.00	0.00	0.00	0.00	105.77	-17.08	88.69
2024	0.00	0.00	0.00	63.21	11.36	0.00	0.00	0.00	0.00	74.57	0.00	74.57
2025	0.00	0.00	0.00	70.44	12.32	0.00	0.00	0.00	0.00	82.77	0.00	82.77
2026	0.00	0.00	0.00	79.09	13.51	0.00	0.00	0.00	0.00	92.61	0.00	92.61
2027	0.00	0.00	0.00	87.95	14.84	0.00	0.00	0.00	0.00	102.79	0.00	102.79
2028	11.91	0.00	0.00	93.91	15.93	0.00	0.00	0.00	0.00	97.94	11.91	109.84
TOTAL	263.79	-2.71	0.00	1,017.37	167.50	0.00	0.00	0.00	0.00	923.79		
										EIRR		20.8%
										NPV (Rs. Millions)at 12%		127.87

Subana Sarola Ahri road.										Subana Sarola Ahri road.			
Year	Increase in Road Agency Costs			Decrease in Road User Costs					Net Benefits		COSTS	BENEFITS	NET BENEFITS
	Capital	Recurrent	Special	MT VOC	MT Time	NMT	Accidents	Benefits					
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2010	84.99	-0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-84.42	84.42	0.00	
2011	0.00	-0.02	0.00	13.62	2.50	0.00	0.00	0.00	0.00	16.14	-0.02	16.12	
2012	0.00	-0.05	0.00	17.13	2.89	0.00	0.00	0.00	0.00	20.07	-0.05	20.02	
2013	-4.39	-0.22	0.00	20.61	3.37	0.00	0.00	0.00	0.00	28.59	-4.61	23.98	
2014	0.00	0.00	0.00	17.41	3.30	0.00	0.00	0.00	0.00	20.71	0.00	20.71	
2015	0.00	0.00	0.00	19.46	3.66	0.00	0.00	0.00	0.00	23.12	0.00	23.12	
2016	8.78	0.01	0.00	21.83	4.07	0.00	0.00	0.00	0.00	17.11	8.79	25.91	
2017	0.00	0.00	0.00	24.73	4.55	0.00	0.00	0.00	0.00	29.28	0.00	29.28	
2018	0.00	0.00	0.00	28.06	5.12	0.00	0.00	0.00	0.00	33.18	0.00	33.18	
2019	0.00	0.00	0.00	31.16	5.62	0.00	0.00	0.00	0.00	36.78	0.00	36.78	
2020	0.00	0.00	0.00	33.85	6.10	0.00	0.00	0.00	0.00	39.96	0.00	39.96	
2021	-4.39	-0.14	0.00	35.74	6.53	0.00	0.00	0.00	0.00	46.80	-4.53	42.27	
2022	8.78	0.01	0.00	31.69	6.44	0.00	0.00	0.00	0.00	29.34	8.79	38.13	
2023	0.00	0.00	0.00	35.19	6.99	0.00	0.00	0.00	0.00	42.18	0.00	42.18	
2024	0.00	0.00	0.00	38.40	7.51	0.00	0.00	0.00	0.00	45.91	0.00	45.91	
2025	0.00	0.00	0.00	42.16	8.12	0.00	0.00	0.00	0.00	50.28	0.00	50.28	
2026	0.00	0.00	0.00	45.36	8.71	0.00	0.00	0.00	0.00	54.07	0.00	54.07	
2027	0.00	0.00	0.00	47.47	9.21	0.00	0.00	0.00	0.00	56.68	0.00	56.68	
2028	0.29	0.01	0.00	49.49	9.72	0.00	0.00	0.00	0.00	58.91	0.30	59.21	
TOTAL	94.06	-0.98	0.00	553.36	104.41	0.00	0.00	0.00	0.00	564.69			
										EIRR		28.3%	
										NPV (Rs. Millions)at 12%		102.07	