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भारतमाला
प्रगति के पथ पर अग्रसर
BHARATMALA
ROAD TO PROSPERITY

NHAI/PIU-SMG/12017/01/2018-19/ 06.11.2018

Project Name: Four laning of Tumkur - Shimoga Section of NH-206 from Km. 12+310 to Km. 217+000 in the State of Karnataka on HAM under Bharathmala Pariyojana-reg.

PROPOSAL: For diversion of 41.2081 Ha of forest land falling under Tumkur, Hassan, Chikkamagaluru and Bhadravati Forest Divisions which is being diverted for widening of existing National Highway to four lane - Section I (from Km. 12+310 to Km 217+000) of NH 206.

COST BENEFIT ECONOMIC ANALYSIS – Section I

1. Approach and Methodology of Economic Analysis

Proposed project road section of NH 206 for upgradation under NHDP in Karnataka State from Tumkur (Km 12+300) to Honnavera town (Km 370+000) with a total length of 358 km is in nine packages. Of the total 358 km length, 205 km in 4 packages (Section – I) is proposed for improving to four lane and the balance in 5 packages (Section – II) are proposed to improve to two lane standards, as shown in Table 1. The present section discusses about the economic analysis carried out for the four packages of the project road section proposed for four laning from Km 12+300 to Km 217+000 in Section I.

Table-1: Details of the Contract Packages in Section I

Package No	Chainage Km	Existing Length Km	Proposed Length Km
I	12+310 to 66+540	54.23	52.895
II	66+540 to 119+790	53.25	53.210
III	119+790 to 166+100	46.31	53.440
IV	166+100 to 217+000	50.90	53.850
Combined Section 1		**204.69**	**213.395**

The objective of the cost benefit economic analysis is to identify and quantify the benefits and costs associated with the project with respect to rehabilitation of the selected project road), in order to select the optimum solution along with the economic viability in terms of its likely investment return potential. This is carried out to assist the NHAI and Government of Karnataka (GoK) in taking the right decision.

This cost benefit economic feasibility study is carried out using the overall guidelines stipulated by the Indian Roads Congress (IRC) and the World Bank in their manuals like Economic Evaluation of Highway Projects in India (SP – 30, 2009) and, Manual for Road Investment Decision Model' (SP – 38, February 1992) and Manual for HDM - 4 Version 1.3 (World Bank, 2000), as these are accepted by the World Bank, Ministry of Road Transport & Highways (MORT&H), National Highways Authority of India (NHAI) and State Highway Departments for highway projects in India including Karnataka.

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 linked with the project. This is followed by a 'Sensitivity Analysis' carried out by

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increasing or decreasing the critical factors affecting the cost and benefit streams of the proposed project, in order to ascertain their effect on the economic feasibility indicators i.e. ENPV, EIRR.

2. Framework of Analysis

The following scenarios are considered for the economic analysis.

A. "Without up-gradation proposal for road sections" (Base Strategy):

This is the 'without up gradation proposal' situation in which there will be no improvement to the roads, except the normal maintenance. The traffic on the existing road will likely to continue in a congested level with higher vehicle operating cost (VOC) and increased travel time due to reduced service level. In the analysis, this is the 'base strategy' against which the up gradation is compared.

B. "With up gradation proposal for road sections in place"

This is the 'with up gradation proposal for the road sections' situation where the traffic on the existing road, which is likely to be impacted for the improvement of the project road. In this case the future traffic volume on the road is assumed to continue in the improved paved four/two lane with paved shoulder project road (with service roads wherever necessary) at a lower VOC. In the analysis, this alternative is compared against the 'base strategy'. The 'with project' situation helps to determine the levels of benefits.

3. Approach

The economic evaluation has been carried out within the broad framework of social cost-benefit analysis assuming the analysis period of 15 years plus the planning and 1.5 years construction periods. The economic feasibility of the project has been sought to maximize the economic returns on investment. There will be reduction in road user costs of motorized traffic (MT) and non-motorized traffic (NMT) upon the improvement of the existing road. The economic savings at significant level in the following areas are expected to occur due to improvement of the existing roads.

- Savings in VOC
- Savings in Journey time of passengers and goods
- Savings in accident cost

The economic analysis has been based on comparison of costs and benefits under two scenarios, 'without the up gradation project' and 'with up gradation road project'. All costs and benefits are valued in monetary terms and expressed in economic prices to have the analysis on resource based frame-work. The analysis is made package-wise and combined one for the full project of 4-laning and the results are expressed in terms of Economic Internal Rate of Return (EIRR) and Economic Net Present Value (ENPV).

Highway Development & Management (HDM-4) analysis model was used for the present economic analysis, which also calculates vehicle user costs based on the pavement deterioration models. HDM-4 model was tested in more than 20 countries before its release and because of its strong continuous research and development background in the world including India. Also it was developed with the support of World Bank, with continuous improvement, supported with adequate test applications in different situations, including the Indian highway projects. This justifies the relevance of HDM – 4 for Indian highway projects and use for the present study.

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4. Construction Program

The analysis period of the project has been taken as 15 years and 550 days construction time. Construction is assumed to start in 2018 itself and complete in 2020. The construction program for project road network is summarized below. For the analysis purpose, it is assumed that traffic is opened in 2020 on completion of all construction activities.

- 2018 - 40%
- 2019 – 40%
- 2020 – 20%

5. Model for Estimation of Benefits

The following inputs / approaches were used for HDM-4 model to estimate the aforesaid project benefits.

- Identification of homogeneous sections and further packages of project.
- Estimation of present traffic volume (Average Annual Daily Traffic - AADT) on the identified road sections/packages from field surveys. All AADT is updated to the base year of 2017 from the survey year.
- Estimation traffic growth rate (as estimated in the Traffic Section of this report for all vehicle categories)
- All the unit values like existing condition, traffic volume, growth rates, improvement proposals, maintenance strategy, costs, etc. are adopted from the data collected for the DPR preparation.
- 2017 is considered as 'Base year' to which all costs are updated.
- Usual maintenance provisions and costs in 'With' and 'Without' project conditions have been considered.
- This model help to estimate total road user costs for the project road
- Road user benefits considered include:
  - ✓ VOC savings
  - ✓ Time savings
  - ✓ Accident cost savings
- Decision parameters considered:
  - ✓ Economic Internal Rate of Return (EIRR)
  - ✓ Economic Net Present Value (ENPV)
- The Total Net Benefits worked above is considered against economic cost of project to determine on EIRR and ENPV.
- EIRRs of the packages have been estimated with the output from HDM and the practical O&M cost cycle planned during the analysis period.
- The EIRR of the full project can be obtained by combining the packages appropriately.

6. Conversion to Economic Prices and Distribution of Cost

The adopted Standard Conversion Factor (SCF) to convert the financial cost of project to economic cost is 0.90.

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A. Components of Cost

The financial cost for different packages of the project have been adopted from cost estimates section discussed earlier and per km economic cost has been worked out by multiplying 0.90 SCF to the financial cost per km and is presented in below ***Table-2.***

Table-2: Details of Project Cost

Details	Package 1 Km 12+300 to 66+540	Package 2 Km 66+540 to 119+790	Package 3 Km 119+790 to 166+100	Package 4 Km 166+100 to 217+000	Total Km 12+300 to 217+000
Project Cost Rs Crore	885.62	1614.27	1267.52	1515.87	5283.3
Project Cost Excl: Escalation & LA Rs Crore	841.33	929.77	747.86	1440.08	3959.0
Length Km	52.90	53.21	53.44	53.85	213.4
Project Cost Excl: Escalation / Km Rs Crore	15.91	17.48	14.00	26.74	18.55
Economic Cost / Km Rs Crore	14.32	15.73	12.60	24.07	16.70

Source: Consultant Estimate

B. Maintenance Cost

The maintenance works considered in the analysis include:

- Annual Routine maintenance
- Periodic Maintenance

The financial costs pertaining to maintenance operations have been converted into economic costs by applying the Conversion Factor of 0.90. The details of the maintenance program have been adopted for the analysis is presented in below ***Table-3.***

Table-3: Maintenance Program and Cost Adopted

Project Alternative	Terrain Type	Maintenance Type	Maintenance Cost (/ Km) – Financial Cost	Maintenance Year
Base-Case	Plain/ Rolling	Periodic	Rs. 2.07 Million	Every 7th year
		Routine	Rs. 0.20 million	Annual
		Overlay	Rs. 5.77 million	Every14th year
Upgraded Four Lane Flexible Pavement with Paved Shoulder	Plain/ Rolling	Periodic	Rs. 3.50 Million	Every 7th year
		Routine	Rs. 0.35million	Annual
		Overlay	Rs. 9.62 million	Every14th year

Note: Under 'With project' case, the maintenance cost of service roads with BT surface will be included along with the maintenance cost of the main carriage way.

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C. Traffic Specific Parametric Values

The economic unit costs parametric values for motorized and non-motorized vehicles are adopted from Indian Roads Congress (IRC) guidelines (2009) [1] with suitable update to 2016 price level and used in HDM Model as inputs. Where ever necessary, additional inputs are collected from primary sources or similar other studies in the region and used in the present analysis. Existing road characteristic like condition, deflection, pavement history, equivalent standard axles per vehicle, average operating load weight, etc. were collected through primary and secondary sources for DPR preparation were adopted. Details of the road sections characteristics for the existing condition and proposed design are presented in ***Appendices I and II.***

D. Volume of Traffic and Growth Rates

AADT traffic different road packages during 2017 and the growth rates for future projection adopted from DPRs are given in ***Table-4*** and ***Table-5***.

Table-4: AADT (No. of Vehicles) – NH 206 Four Lane Packages (2017)

Vehicle Type	Package -1		Package -2		Package -3		Package -4	
	Km 12+310 to 66+540		Km 66+540 to 119+790		Km 119+790 to 166+100		Km 166+100 to 217+000	
	No.	%	No.	%	No.	%	No.	%
Bus	896	*5.5%*	700	*6.5%*	758	*7.1%*	993	*9.5%*
Mini Bus	225	*1.4%*	136	*1.3%*	135	*1.3%*	234	*2.2%*
MAV	227	*1.4%*	200	*1.9%*	217	*2.0%*	358	*3.4%*
3-Axle Trucks	453	*2.8%*	436	*4.1%*	460	*4.3%*	457	*4.4%*
2-Axle Trucks	606	*3.7%*	447	*4.2%*	775	*7.2%*	957	*9.1%*
LCV	1785	*11.0%*	1379	*12.9%*	1478	*13.8%*	1502	*14.3%*
Two Wheelers	5753	*35.3%*	2999	*28.0%*	3054	*28.5%*	1688	*16.1%*
Car /Van/Jeep	5464	*33.5%*	3897	*36.4%*	3470	*32.4%*	4017	*38.3%*
Auto rickshaw	879	*5.4%*	522	*4.9%*	351	*3.3%*	274	*2.6%*
Total Motorised	**16,287**	*100.0%*	**10,717**	*100.0%*	**10,697**	*100.0%*	**10,480**	*100.0%*
Cycles	49	*92.8%*	100	*99.5%*	45	*82.7%*	2	*14.3%*
Cycle rickshaw	1	*2.6%*	1	*0.5%*	0	*0.0%*	1	*7.1%*
Animal Drawn Vehicles	2	*4.6%*	0	*0.0%*	9	*17.3%*	11	*78.6%*
Total Non-Motorised	**53**	*100.0%*	**101**	*100.0%*	**54**	*100.0%*	**15**	*100.0%*

Source: Consultant Estimate

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Table-5: Adopted Growth Rates

Vehicle Type	Section 1			
	2015-2020	2020-2025	2025-2030	Beyond 2030
Motorised				
Bus	7.8%	7.1%	6.6%	6.1%
Mini Bus	7.8%	7.1%	6.6%	6.1%
MAV	9.6%	8.5%	7.7%	7.0%
3-Axle Trucks	9.6%	8.5%	7.7%	7.0%
2-Axle Trucks	9.6%	8.5%	7.7%	7.0%
LCV	9.6%	8.5%	7.7%	7.0%
Two Wheelers	8.3%	7.6%	7.0%	6.5%
Car /Van/Jeep	10.7%	9.7%	9.0%	8.4%
Auto rickshaw	8.7%	7.9%	7.3%	6.8%
Non- Motorised				
Cycles	2.0%	2.0%	2.0%	2.0%
Cycle rickshaw	2.0%	2.0%	2.0%	2.0%
Animal Drawn Vehicles	2.0%	2.0%	2.0%	2.0%

Source: Consultant Estimate

E. Project Benefits

A. Vehicle Operating Cost Savings

The model comprehensively predicts the performance and operating costs of motorized and non-motorized vehicles in the selected fleet. Vehicle performance predictions include speeds (free flow and congested conditions) and consumptions. Predictions for vehicle operating costs include fuel, oil, tire and parts costs, crew and maintenance labor costs, capital depreciation, borrowing costs, and overhead costs.

HDM -4 has been used to estimate the Vehicle Operating Costs (VOC) for traffic in each vehicle category on each selected road packages with and without improvement taking into account the speed and travel time including surface quality and road congestion. The resulting VOC values for each package can be found in the HDM results. Relevant input variables considered for VOC estimation is given in below ***Table-6.***

Table-6: Vehicle Economics at Economic Prices

Item	Car	Two Wheel	Three Wheel	Bus	2-Axle Truck	3-Axle Truck	Multi Axle Truck	LCV	Tractor
Vehicle price Rs.	3,28,259	51,817	1,32,483	12,03,299	12,82,484	18,69,384	23,28,967	7,37,506	5,85,707
No. of wheels	4	2	3	6	6	10	12	4	7
No. of axles	2	2	2	2	2	3	4	2	3
Passengers	4	1	3	25					
Tyre price Rs.	1,548	1,219	1,219	11,515	11,809	11,809	11,809	5,054	5,054

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Item	Car	Two Wheel	Three Wheel	Bus	2-Axle Truck	3-Axle Truck	Multi Axle Truck	LCV	Tractor
Fuel Per/Lt. Rs.	31	31	31	30	30	30	30	30	30
Lubricating oil (Rs)	78	78	78	78	78	78	78	78	78
Maint. labor (Rs. per hr.)	59	26	85	121	132	129	129	110	110
Crew wages (Rs. per hr.)	30	-	21	83	132	132	132	34	34
Annual overhead (Rs.)	22,088	1,165	3,417	1,48,756	31,063	57,688	57,688	12,656	12,656
Interest rate (%)	12	12	12	12	12	12	12	12	12
Passenger work time value (Rs. per/hr.)	92	47	47	58					-
Non work time value (Rs. per hr)	27	14	14	17					
Cargo time value (Rs. per/hr.)	-	-	-	-	33	33	61	10	10
PCSE	1	1	1	2	2	2	2	2	

Source: Updated from IRC: SP30 (2009) from 2009 to 2016 using the WPI and along with the market price in the region.

B. Travel Time Saving

The model estimates the Value of Travel Time (VOTT) for passengers and goods in transit in both the with- and without-project scenarios taking into account speed and travel time including surface quality, road congestion, and unit time value for different vehicle travelers etc. Input to the model in terms of unit time value for passengers of different vehicles during work and non-work periods along with cargo time value during transit are indicated in ***Table-6.***

C. Accident Cost Savings

There can be some anticipated reduction of accidents due to improved signage and engineering intervention, the benefits deriving from this rehabilitation project are deemed to be moderate. Model has predicted the future speed and vehicle composition and finally the resultant accident numbers and the accident-related benefits through 'accident prediction model'. Input for the accident benefits prediction is given in ***Table-7.***

Table-7: Unit cost adopted for Accident Cost Savings

Details	2009-10 (Rs.)	2016-17 (Rs.)
Fatal	864,350	12,64,717
Serious Injury	391,800	5,73,282
Major Injury	172,650	2,52,621
Minor Injury	30,450	44,554
Cost of Damage		
Car	26,150	38,263

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Details	2009-10 (Rs.)	2016-17 (Rs.)
TW	6,650	9,730
Three Wheeler	7,600	11,120
Bus	76,050	1,11,276
HCV	8,600	12,584
MAV	1,340,400	19,61,273

Source: IRC: SP-30-2009, Manual on Economic Evaluation of Highway Projects in India

Note: Values in IRC - SP 30 (2009) are suitably updated using the Wholesale Price Index (WPI)

F. Economic Viability

The results of section wise economic analysis conducted considering DPR cost of project road is summarized in ***Table-8***. Results of sensitivity analysis with the following scenarios for individual packages and full project are presented in ***Table-9.***

- 20% increase in project cost (Capital and O&M)
- 20% reduction in project benefits
- One-year delay in construction

Table-8: Results of the Economic Analysis

Package	Chainage Km	Existing Length Km	Proposed Length Km	EIRR %	ENPV (Rs Million)
Package 1	12+310 to 66+540	54.23	52.90	30.90	14,849
Package 2	66+540 to 119+790	53.25	53.21	17.81	6,748
Package 3	119+790 to 166+100	46.31	53.44	26.51	14,534
Package 4	166+100 to 217+000	50.90	53.85	24.52	11,867
Combined Section 1		**204.69**	**213.4**	**24.56**	**47,998**

Source: Analysis

EIRR for the project road Packages varied between 17.8 % and 30.9%, and 24.7% for the combined project road, which were more than the minimum required 12% EIRR. Hence the project road section was found to be economically viable. For the sensitivity analysis of individual packages, the EIRRs obtained were above the minimum required 12%. NPV discounted at 12% were also positive confirming the economic justification of the project even though the cost of civil works increased, or the projected traffic is not achieved or one-year construction delay.

G. Conclusions

The results discussed above show the robustness of the economic feasibility indicators under normal and the adverse sensitivity scenario including the benefits are decreased significantly. The EIRRs for the project road package was more than 12%. This justifies the project investment with more risk absorption capacity. However, this sensitivity is unlikely to happen (a) as traffic is expected to grow to accompany the current economic growth, (b) there is little uncertainty on the cost of the works and (c) VOCs are unlikely to be reduced in view of the past trend for the price of inputs such as fuel, lubricants, tyres and salaries.

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Table-9: Sensitivity Analysis Results

Details	Package 1			Package 2			Package 3			Package 4			All Four Packages Combined		
	EIRR %	ENPV INR Million	SV c/	EIRR %	ENPV INR Million	SV c/	EIRR %	ENPV INR Million	SV c/	EIRR %	ENPV INR Million	SV c/	EIRR %	ENPV INR Million	SV c/
Main Evaluation (Base Case) a/	30.90%	14849		17.81%	6748		26.15%	14534		24.52%	11867		24.56%	47998	
Cost Overrun (Capital and O&M) b/	27.55%	13610	239.57%	16.17%	5378	98.51%	23.78%	13432	263.79%	21.40%	9745	111.87%	21.91%	42165	164.57%
Decrease in Project Benefits d/	26.84%	10640	70.55%	15.82%	4028	49.62%	23.27%	10525	72.51%	20.72%	7372	52.80%	21.34%	32565	62.20%
One Year Delay in Implementation	30.92%	13781		17.84%	6126		26.17%	13171		24.59%	11304		24.61%	44382	
All Four Tests Combined	23.85%	8811		14.32%	2455		21.12%	8569		17.92%	5255		18.98%	25090	

a/ Base Case

b/ 20% increase in cost estimates.

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

d/ 20% decrease in project benefits

Source: Analysis

Note: EIRR=Economic Internal Rate of Return; ENPV =Economic Net Present Value in Rs. Million @12%; SV=Switching Value

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Table-10: Economic Feasibility Analysis Results – Section I

Year	Base Case			20% increase in Cost (Construction and O&M)			20% Reduction In Benefits			One Year Delay In Construction			Worst Scenario of All Combined together		
	Incremental Cost	Benefits, (VOC saving + VOT savings+ Accident cost	Net Benefits	Incremental Cost	Benefits, (VOC saving + VOT savings+ Accident cost	Net Benefits	Incremental Cost	Benefits, (VOC saving + VOT savings+ Accident cost	Net Benefits	Incremental Cost	Benefits, (VOC saving + VOT savings+ Accident cost	Net Benefits	Incremental Cost	Benefits, (VOC saving + VOT savings+ Accident cost	Net Benefits
2017	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	14252.54	0.00	-14252.54	17103.05	0.00	-17103.05	14252.54	0.00	-14252.54	0.00	0.00	0.00	0.00	0.00	0.00
2019	14252.54	389.30	-13863.24	17103.05	389.30	-16713.75	14252.54	311.44	-13941.10	14252.54	0.00	-14252.54	17103.05	0.00	-17103.05
2020	7126.27	1208.54	-5917.73	8551.52	1208.54	-7342.98	7126.27	966.83	-6159.44	14252.54	389.30	-13863.24	17103.05	311.44	-16791.61
2021	-18.24	3718.95	3737.19	-21.89	3718.95	3740.84	-18.24	2975.16	2993.40	7,126.27	1208.54	-5917.73	8,551.52	966.83	-7584.69
2022	-4.80	5481.23	5486.03	-5.76	5481.23	5486.99	-4.80	4384.99	4389.79	-18.24	3718.95	3737.19	-21.89	2975.16	2997.05
2023	-349.67	7479.38	7829.05	-419.60	7479.38	7898.98	-349.67	5983.51	6333.17	-4.80	5481.23	5486.03	-5.76	4384.99	4390.75
2024	22.09	9577.66	9555.57	26.50	9577.66	9551.16	22.09	7662.13	7640.04	-349.67	7479.38	7829.05	-419.60	5983.51	6403.11
2025	28.81	11900.31	11871.51	34.57	11900.31	11865.75	28.81	9520.25	9491.44	22.09	9577.66	9555.57	26.50	7662.13	7635.62
2026	28.81	13523.61	13494.80	34.57	13523.61	13489.04	28.81	10818.88	10790.08	28.81	11900.31	11871.51	34.57	9520.25	9485.68
2027	28.81	15188.02	15159.21	34.57	15188.02	15153.45	28.81	12150.42	12121.61	28.81	13523.61	13494.80	34.57	10818.88	10784.32
2028	633.75	18384.63	17750.88	760.50	18384.63	17624.13	633.75	14707.71	14073.95	28.81	15188.02	15159.21	34.57	12150.42	12115.85
2029	28.81	21334.36	21305.56	34.57	21334.36	21299.80	28.81	17067.49	17038.68	633.75	18384.63	17750.88	760.50	14707.71	13947.20
2030	-1040.81	25138.57	26179.37	-1248.97	25138.57	26387.53	-1040.81	20110.85	21151.66	28.81	21334.36	21305.56	34.57	17067.49	17032.92
2031	28.81	28411.93	28383.12	34.57	28411.93	28377.36	28.81	22729.54	22700.74	-1,040.81	25138.57	26179.37	-1,248.97	20110.85	21359.82
2032	28.81	29808.17	29779.37	34.57	29808.17	29773.60	28.81	23846.54	23817.73	28.81	28411.93	28383.12	34.57	22729.54	22694.98
2033	28.81	29630.53	29601.72	34.57	29630.53	29595.96	28.81	23704.42	23675.62	28.81	29808.17	29779.37	34.57	23846.54	23811.97
2034	28.81	28653.01	28624.20	34.57	28653.01	28618.44	28.81	22922.40	22893.60	28.81	29630.53	29601.72	34.57	23704.42	23669.86
2035	28.81	32089.87	32061.06	34.57	32089.87	32055.30	28.81	25671.89	25643.09	28.81	28653.01	28624.20	34.57	22922.40	22887.84
2036	1808.30	31960.81	30152.51	2169.96	31960.81	29790.85	1808.30	25568.65	23760.35	28.81	32089.87	32061.06	34.57	25671.89	25637.32
2037	-325.50	30210.09	30535.60	-390.60	30210.09	30600.70	-325.50	24168.08	24493.58	1,808.30	31960.81	30152.51	2,169.96	25568.65	23398.69
2038	36.81	25629.17	25592.37	44.17	25629.17	25585.00	36.81	20503.34	20466.53	-325.50	30210.09	30535.60	-390.60	24168.08	24558.68
2039	40.81	19237.80	19197.00	48.97	19237.80	19188.83	40.81	15390.24	15349.43	36.81	25629.17	25592.37	44.17	20503.34	20459.17
2040	44.81	13771.84	13727.03	53.77	13771.84	13718.07	44.81	11017.47	10972.67	40.81	19237.80	19197.00	48.97	15390.24	15341.27
2041	48.81	6978.44	6929.63	58.57	6978.44	6919.87	48.81	5582.75	5533.94	44.81	13771.84	13727.03	53.77	11017.47	10963.70
2042	52.81	-833.46	-886.26	63.37	-833.46	-896.82	52.81	-666.76	-719.57	48.81	6978.44	6929.63	58.57	5582.75	5524.18
2043	56.81	-14510.73	-14567.53	68.17	-14510.73	-14578.90	56.81	-11608.58	-11665.39	52.81	-833.46	-886.26	63.37	-666.76	-730.13
2044	-403.86	-27869.98	-27466.12	-484.63	-27869.98	-27385.35	-403.86	-22295.99	-21892.13	56.81	-14510.73	-14567.53	68.17	-11608.58	-11676.75
2045	64.81	-38009.44	-38074.24	77.77	-38009.44	-38087.21	64.81	-30407.55	-30472.36	-403.86	-27869.98	-27466.12	-484.63	-22295.99	-21811.35
2046	68.81	-45659.72	-45728.53	82.57	-45659.72	-45742.29	68.81	-36527.78	-36596.59	64.81	-38009.44	-38074.24	77.77	-30407.55	-30485.32
Total	**36,626**	**2,82,823**	**2,46,197**	**43,952**	**2,82,823**	**2,38,871**	**36,626**	**2,26,258**	**1,89,632**	**36,558**	**3,28,483**	**2,91,925**	**43,869**	**2,62,786**	**2,18,917**
ENPV	**29,166**	**77,165**	**47,998**	**35,000**	**77,165**	**42,165**	**29,166**	**61,732**	**32,565**	**26,039**	**70,421**	**44,382**	**31,247**	**56,337**	**25,090**
EIRR			**24.56%**			**21.91%**			**21.34%**			**24.61%**			**18.58%**

Source: Analysis

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Appendix I: HDM Input for Road Condition Data - Existing Network

Sl. No.	Corridor No.	Package 1	Package 2	Package 3	Package 4
1	Packages (Existing km)	**Km 12+310 to 66+540**	**Km 66+540 to 119+790**	**Km 119+790 to 166+100**	**Km 166+100 to 217+000**
2	FROM (km)(Design Chainage)	12.31	66.540	119.790	166.100
3	TO (km)(Design Chainage)	66.540	119.790	166.100	217.000
4	Length km(Design)	56.82	53.21	53.44	53.85
5	Length km(Existing)	54.23	53.25	46.31	50.90
6	Terrain (Plain/ Rolling / Hilly)	Plain/Rolling	Plain/Rolling	Plain/Rolling	Plain/Rolling
7	Carriageway Width (Mt)	7	7	7	7
8	No. of Lanes	2	2	2	
9	Shoulder Width (Mt)	1.7	1.5	1.5	1.5
10	Type of Shoulder (BT/CC/ GR/ ER)	ER	ER	ER	ER
11	Drain Type	SSM,ER,RCC	RCC,CD,ER,SSM	SSM,ER	RCC,SSM,ER
12	Drain Condition	Fair	Fair	Fair	Fair
13	Average Right of way (M)	31.5	32.37	29.6	29.7
14	Geometrics				
	i) Horizontal Curvature	68	95	31	35
	ii) Vertical	14	15	12	8
	ii) MSL (Mt)	822	845	935	1090
	Traffic				
15	**TVC Locations**				
	AADT (In Vehicles)				
	i) Fast(motorised)	16287	10717	10697	10480
	ii) Slow(non-motorised)	53	101	54	15
18	Design Traffic (10 years)(MSA)	20	20	20	20
19	Design Traffic (15 years)(MSA)	35	30	30	30
	Strength				
19	CBR Value (%)	8	8	8	8
20	Avg. BBD Value	0.888	0.777	1.087	1.27
	Condition				
21	Avg. IRI Value	2.82	2.87	2.82	2.99
22	Pavement Distress				
	i) Cracking %	23.22%	33%	17.93%	29.01%
	ii) Ravelling %	14%	18%	13%	19%
	iii) Pothole No's	1	NIL	7	
	iv) Rutting (N/M/S)	Moderate	Moderate	Moderate	Moderate
	v) Avg. PCI Value				
	vi) Texture				
	vii) Skid Resistance				
	PAVEMENT COMPOSITION				
23	Existing				
	i) Bituminous	100	120	100	100
	ii) WMM	85	145	0	110
	iii) GSB	150	130	140	140

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Appendix - II Proposed Design

Sl. No.	Corridor No.	NH 206			
		Package 1	Package 2	Package 3	Package 4
1	Proposed(main carriage way) 10MSA				
	i) Bituminous	125	125	125	125
	ii) WMM	250	250	250	250
	iii) GSB	200	200	200	200
	iv) Subgrade	500	500	500	500
2	Proposed(main carriage way) 15MSA				
	i) Bituminous	150	150	150	150
	ii) WMM	250	250	250	250
	iii) GSB	200	200	200	200
	iv) Subgrade	500	500	500	500
3	Proposed service road(Flexible pavement)				
	i) Bituminous	100	100	100	100
	ii) WMM	250	250	250	250
	iii) GSB	200	200	200	200

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