

F. VIRAMGAM – MALIYA CORRIDOR

F.11 REVIEW OF FEASIBILITY STUDY

F.11.1 Status of Submittal

1. The report reviewed on pre-feasibility¹ of this corridor is the Draft Final Report submitted by the consultants in the month of December 2000.

F.11.2 Traffic Studies and Forecast

2. As per the report the following traffic studies were conducted:

- Classified traffic volume counts – 7 days;
- Origin – Destination Surveys;
- Turning Movement Counts at junctions;
- Speed and delay surveys;
- Willingness to pay; and
- Axle load surveys.

3. Outcome of above traffic studies and brief details which are referred for revalidation study are reproduced in this sub-section.

F.11.2.1 Base Year Traffic

4. For the study purpose the corridor from Viramgam to Maliya was divided in four links as follows:

- 1) Viramgam – Malvan
- 2) Malvan – Dhrangdhara
- 3) Dhrangdhara – Halvad
- 3) Halvad – Maliya

5. Details of 7 day traffic volume are tabulated as under for the base year (2000).

Sl. No.	Link Name	Location	ADT Vehicles	ADT PCU
1	Viramgam – Malvan	Hansalpur Chokdi	2566	5970
2	Malvan – Dhrangdhara	Malvan Chokdi	3013	6897
3	Dhrangdhara – Halvad	Dhrangdhara GIDC	3826	8461
4	Halvad – Maliya	Morbi Chokdi	2875	6414

¹. Consultancy Services for the Preparation of Pre-feasibility Study and Bidding Documents for Four Laning and Strengthening of Maliya – Halvad – Dhrangdhara – Bajana – Viramgam Road” – Final Report, December 2000.

F.11.2.2 Origin – Destination Surveys

6. The salient findings of O–D surveys conducted on the project corridor along with project influence area are :

- About 75% is through traffic on all the four sections of the corridor.
- Amongst through traffic component, trucks (HCV and Multi-Axle vehicle) observed are in the order of 80%.
- The report notes that ...“One interesting thing noted by us is that the existing users of the project road are more or less traffic from Ahmedabad and Kandla. The real long distance traffic through this corridor is very limited. This could work out to be a better advantage as the new corridor will offer much savings to the long distance traffic for example traffic destined to southern Gujarat, Maharashtra and Southern parts of India.”

F.11.2.3 Speed and Delay Surveys

7. Speed and delay surveys were conducted by floating car observe and method on project road sections. Findings of these surveys are reproduced as follows:

Particular		Distance Km	Speed kmph							
From	To		Morning Peak		Off Peak		Evening Peak		Nigh Time	
			Dn	Up	Dn	Up	Dn	Up	Dn	Up
Malvan Chokdi	Dhrangdhra Bypass start	33.1	48.2	45.7	52.2	51.2	45.7	50.3	43.2	42.5
Dhrangdhra Bypass start	Dhrangdhra Bypass end	28.4	48.4	56.5	58.4	56.5	44.0	49.1	38.2	45.2
Dhrangdhra Bypass end	Halvad Bypass start	6.7	30.2	40.1	34.0	40.1	23.0	30.5	25.2	29.8
Halvad Bypass start	Halvad Bypass end	25.3	44.2	52.2	54.2	52.2	40.6	45.2	35.2	43.2
Halvad Bypass end	Maliya Junction with NH8	4.5	50.3	51.5	55.5	51.5	40.1	41.3	40.2	44.6

F.11.3 Traffic Forecast

8. The report first describes advantages and disadvantages of four different theoretical methods for traffic forecast². They are:

- 1) Time series trends in traffic growth
- 2) Temporal trends in vehicle registrations
- 3) Socio-economic characteristics
- 4) Temporal trends in the growth of economy

². Referring this, report states on selection on methodology for traffic forecast as described, no one methodology can lay conclusive claim to the science of traffic forecasting. As such, we have adopted elements of all four techniques described above, in order to arrive at reasonable and defensible estimates of growth rates.

F.11.3.1 Time Series Approach

9. The consultants have mentioned that historical traffic data for 10 years was got collected from Gujarat R&BD. Based on this analysis the table for “Compounded Overall Annual Growth Rates” as given in report is presented as follows:

Mode	Compounded Overall Annual Growth Rates				
	Maliya – Halvad Section	Halvad – Dhrangdhra Section	Dhrangdhra – Malvan Section	Malvan – Viramgam Section	Maliya – Viramgam Section
Car	12%	20%	14%	25%	18%
Bus	13%	13%	12%	26%	16%
Trucks	29%	18%	12%	26%	21%
Two-Wheelers	4%	11%	7%	17%	10%
Total Traffic	18%	14%	8%	21%	15%

F.11.3.2 Vehicle Registration Approach

10. Based on vehicle registration data of the districts falling within project area, earlier study consultants have given following growth rates:

Vehicle Category	Growth Rate
Motorcycle, Scooter	20%
Motor Car	14%
Contract Carriageway (Buses)	3%
Goods Truck	4%
Light Goods Vehicle	24%

F.11.4 Socio Economic Approach

11. No growth rate/forecast were computed as clarified below:

“The socio-economic parameters that will influence traffic growth cannot be applied in this case as the data collected regarding the socio-economic growth of the immediate influence area did not yield acceptable regression co efficiency.”

F.11.4.1 Economic Growth Rate Approach

12. The consultants have studied NSDP of Gujarat for part 20 years and established that annual average economic growth rate of the state NSDP as 6%.

13. Further it is quoted to have growth rates based as economic growth as

“According to the World Bank, the accepted elasticity factor of truck traffic generation with respect to regional GDP is 1.5 – therefore, a conservative figure for growth rates for truck traffic will be approximate 9, according to this approach.”

14. Summarised mode wise growth rates by the consultant are as follows:

Vehicle Category	Growth Rate
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Vehicle Category	Growth Rate
Motorcycle, Scooter	20%
Motor Car	14%
Contract Carriageway/Buses	10%
Goods Vehicles/Truck	10%
Light Commercial Vehicle	10%

15. Finally for overall 30 year project horizon, average annual growth rates adopted are based on consultant's concept "in addition these values have been further tapered down in order to account for the saturation effect of the congestion along the corridor that will eventually occur over the long term". These growth rate figures are:

Type of Vehicle	Overall Growth Rate over Project Horizon
Cars	11.4%
Two Wheelers	12%
LCVs	7%
Trucks	7%
Buses	7%

16. Study report describes about actual traffic forecast after finalising mode wise growth rates for project horizon.

17. The consultant has worked out "Total Forecast Traffic" considering growth of "Existing Traffic" and "Diverted and New Traffic".

18. Existing traffic forecast – The table showing forecast of existing traffic is given as under:

Year	Viramgam – Malvan					Malvan – Dhrangdhra					Dhrangdhra – Halvad					Halvad – Maliya				
	Cars	2Wh	LCV	Truck	Bus	Cars	2Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus
2000	438	197	150	1597	205	467	233	206	1641	217	718	538	227	1789	280	400	477	83	1410	105
2005	843	317	242	2572	330	899	375	332	2643	349	1382	866	366	2881	451	770	768	134	2271	169
2010	1554	488	372	3957	508	1657	577	510	4066	538	2547	1333	562	4433	694	1419	1182	206	3494	260
2015	2738	717	546	5815	746	2920	848	750	5975	790	4489	1959	826	6514	1019	2501	1737	302	5134	382
2020	4614	1006	766	8155	1047	4920	1190	1052	8380	1108	7564	2747	1159	9136	1430	4214	2436	424	7200	536
2025	7431	1346	1025	10914	1401	7923	1592	1408	11214	1483	12182	3677	1551	12226	1913	6786	3260	567	9636	718
2030	11434	1718	1308	13929	1788	12191	2032	1797	14313	1893	18743	4692	1980	15603	2442	10442	4160	724	12298	916
2031	12463	1804	1374	14625	1877	13288	2134	1887	15028	1987	20430	4927	2079	16384	2564	11382	4368	760	12913	962

19. The same growth rates as per table (above) as established for the study were used for project horizon of 30 years since base year 2000.

F.11.4.2 Diverted traffic forecast

20. For the study analysis, consultant developed network model of the area. Based on this model diverted traffic got estimated.

21. The estimated diverted traffic on project corridor as given in study report is reproduced here under:

Year	Viramgam – Malvan					Malvan – Dhrangdhra					Dhrangdhra – Halvad					Halvad – Maliya				
	Cars	2Wh	LCV	Truck	Bus	Cars	2Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus
2000	1218	1951	194	1908	114	1461	3952	233	2280	137	1218	3951	194	1908	114	1461	3952	233	2280	137
2005	1583	4781	235	2308	138	1899	4782	282	2770	166	1583	4781	235	2308	138	1899	4782	282	2770	166
2010	2916	7356	362	3552	213	3499	7358	434	4262	256	2916	7356	362	3552	213	3499	7358	434	4262	256
2015	5139	10809	532	5218	313	6167	10811	638	6262	376	5139	10809	532	5218	313	6167	10811	638	6262	376
2020	8659	15160	746	7319	439	10391	15163	895	8783	527	8659	15160	746	7319	439	10391	15163	895	8783	527
2025	13946	20287	998	9795	587	16735	20292	1198	11754	705	13946	20287	998	9795	587	16735	20292	1198	11754	705
2030	21457	25892	1274	12501	750	25749	25898	1529	15001	900	21457	25892	1274	12501	750	25749	25898	1529	15001	900

Year	Viramgam – Malvan					Malvan – Dhrangdhra					Dhrangdhra – Halvad					Halvad – Maliya				
	Cars	2Wh	LCV	Truck	Bus	Cars	2Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus
2031	23388	27187	1337	13126	787	28066	27193	1605	15751	944	23388	27187	1337	13126	787	28066	27193	1605	15751	944

F.11.4.3 New Traffic Forecast

22. New traffic is considered from ports, new industries and other developments in the area. The ports under consideration are:

- 1) Kandla
- 2) Mandvi
- 3) Mundra
- 3) Navlakhi

23. Based on certain specified assumptions new traffic forecast is given as under:

Year	Trucks
2002	640
2003	853
2004	1067
2005	1280
2006	1493
2007	1707
2008	1925
2009	2144
2010	2363
2011	2581
2012	2800
2013	3137
2014	3474
2015	3811
2016	4149
2017	4486

F.11.4.4 Total Traffic Forecast

24. Total traffic forecast for project corridor as furnished in report is reproduced:

Year	Viramgam – Malvan					Malvan – Dhrangdhra					Dhrangdhra – Halvad					Halvad – Maliya				
	Cars	2Wh	LCV	Truck	Bus	Cars	2Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus
2000	1260	3166	296	3030	291	1453	3202	381	3361	320	1540	3507	373	3222	366	1386	3446	258	3130	208
2005	2426	5098	477	6160	469	2798	5157	614	6693	516	2965	5647	601	6469	589	2669	5550	416	6321	335
2010	4470	7844	734	9872	721	5156	7935	945	10691	793	5463	8689	924	10347	907	4918	8540	640	10119	516
2015	7877	11526	1078	14845	1059	9086	11659	1388	16048	1166	9626	12768	1358	15544	1332	8667	12548	940	15207	758
2020	13273	16166	1512	20817	1486	15311	16353	1947	22505	1635	16223	17907	1905	21797	1869	14605	17599	1319	21326	1063
2025	21377	21633	2023	27858	1988	24658	21884	2605	30117	2188	26127	23964	2549	29170	2501	23521	23551	1765	28539	1422
2030	32891	27610	2582	35997	2538	37939	27930	3325	38881	2792	40200	30584	3254	37672	3192	36190	30058	2252	36866	1815
2031	35851	28991	2711	37893	2664	41354	29326	3491	40921	2932	43818	32114	3416	39651	3351	39448	31561	2365	38805	1906

25. Further, considering then future tolling of NH8A above total traffic forecast are re-worked. The resultant total traffic forecast for the project road given as:

Year	Viramgam – Malvan					Malvan – Dhrangdhra					Dhrangdhra – Halvad					Halvad – Maliya				
	Cars	2Wh	LCV	Truck	Bus	Cars	2Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus	Cars	3Wh	LCV	Truck	Bus
2000	1386	3483	326	3333	320	1598	3522	419	3697	352	1694	3858	410	3544	403	1525	3791	284	3443	229
2005	2669	5608	525	7386	516	3078	5673	675	8025	568	3262	6212	661	7756	648	2936	6105	458	7579	369

2010	4917	8628	807	12162	793	5672	8729	1040	13171	872	6009	9558	1016	12748	998	5410	9394	704	12467	568
2015	8665	12679	1186	19759	1165	9995	12825	1527	21360	1283	10591	14045	1494	20689	1465	9534	13803	1034	20241	834
2020	14600	17783	1663	25588	1635	16842	17988	2142	27664	1799	17845	19698	2096	26794	2056	16066	19359	1451	26215	1169
2025	23515	23796	2225	33402	2187	27124	24072	2866	36110	2407	28740	26360	2804	34975	2751	25873	25906	1942	34218	1564
2030	36180	30371	2840	42368	2792	41733	30723	3658	45763	3071	44220	33642	3579	44340	3511	39809	33064	2477	43391	1997
2031	39436	31890	2982	44600	2930	45489	32259	3840	48164	3225	48200	35325	3750	46669	3686	43393	34717	2602	45673	2097

F.11.4.5 Tollable Traffic

26. Study consultants and have mentioned that network analysis has been carried out towards estimation of tollable traffic. Basically the percentage share of traffic that would be reduced was assessed. Accordingly the share of traffic in percentage which will continue using the improved corridor was estimated and presented in tabular form:

Traffic	Percentage that will continue to use the Corridor				
	Cars	2 Wheelers	LCV	Trucks	Bus
Existing	80	0	60	80	80
Diverted	95	0	80	90	90
New Traffic	80	0	60	80	80

27. Hence the resultant traffic which is tollable is estimated as follows:

Year	Viramgam – Malvan					Malvan – Dhrangdhra					Dhrangdhra – Halvad					Halvad – Maliya				
	Cars	2Wh	LCV	Truck	Bus	Cars	2Wh	LCV	Truck	Bus	Cars	2Wh	LCV	Truck	Bus	Cars	2Wh	LCV	Truck	Bus
2000	1676	0	275	4271	321	1942	0	351	4661	355	2008	0	337	4475	401	1862	0	253	4415	235
2005	2178	0	333	5415	389	2524	0	425	5887	429	2609	0	408	5662	485	2420	0	306	5590	285
2010	4013	0	513	8725	598	4649	0	654	9452	660	4808	0	627	9106	747	4459	0	471	8994	438
2015	7072	0	753	13160	879	8194	0	960	14227	970	8473	0	921	13719	1097	7859	0	692	13554	644
2020	11918	0	1056	18454	1232	13807	0	1347	19951	1361	14277	0	1292	19238	1539	13243	0	970	19007	903
2025	19193	0	1413	24695	1649	22237	0	1803	26699	1821	22994	0	1729	25745	2059	21327	0	1298	25436	1208
2030	29531	0	1804	31961	2105	34241	0	2301	34518	2324	35379	0	2207	33301	2628	32815	0	1657	32907	1542
2031	32189	0	1894	33655	2210	37293	0	2416	36340	2440	38563	0	2317	35062	2760	35768	0	1740	34648	1619

28. Two wheelers were not considered by consultant for calculating revenues due to: (1) Service road will be provided, (2) To remain on conservative side.

F.11.5 Engineering Studies and Investigations

29. As detailed designs were not part of the scope of this particular study, project consultants did general inspections of corridor. Based on prevailing IRC standards, certain design standards are specified in the report. Report findings/summary is given in brief through this sub-section.

- (a) Widening options
 - Generally concentric widening along with service road on either sides
 - Rural median width as 1.5m
- (b) Access control
 - Partially access controlled highway
- (c) Design speed
 - 100 kmph
- (d) Lane width and paved shoulder width

- 3.5m standard single lane width (70m for each c/w) along with 1.5m paved shoulder, as per IRC standards.
- (e) Lane capacity
- Report mentions that as per IRC for two lane, undivided carriageway 32,000 PCU/day is the adopted capacity.
 - For four lane divided carriageway it is 96,000 PCU/day (LOS 'E')
- (f) Pavement design
- Major considerations
- Four lane divided facility
 - 20 year design life
 - Separate traffic growth rate adopted 7.5%
 - Sub-grade CBR assumed 5%
 - National VDF average takes 4.5
 - Worked out MSA 90 MSA

30. **Pavement composition** finally recommended as

Project Corridor

Pavement Layer	Thickness
Bituminous surfacing AC (Asphaltic Concrete)	40 mm
Bituminous surfacing DBM (Dense Bituminous Macadam)	180 mm
Base WMM (Wet Mix Macadam)	150 mm
Sub-base GSB (Granular Sub-base)	300 mm

Strengthening

Pavement Layer	Thickness
Bituminous surfacing AC (Asphaltic Concrete)	40 mm
Bituminous surfacing DBM (Dense Bituminous Macadam)	50 mm

Service Road

Pavement Layer	Thickness
Pre-mix Seal Coat (hot mix open graded carpet)	20 mm
Bituminous surfacing BM (Bituminous Macadam)	50 mm
Base WMM (Wet Mix Macadam)	150 mm
Sub-base GSB (Granular Sub-base)	300 mm

F.11.6 PROJECT COST

31. The total estimated cost for widening of Viramgam – Maliya corridor to 4 lane (with cost of Land Acquisition assumed to be borne by GoG) as presented in Report is summarised as follows:

1. Pavement	Rs. in crores Rs. 198.25
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2.	Drainage and protective works	Rs.	3.00
3.	Bridges	Rs.	51.47
4.	Junction improvement	Rs.	3.70
5.	Road furniture	Rs.	6.90
6.	Toll plaza	Rs.	8.00
7.	Shifting of services	Rs.	2.50
8.	Environmental management measures	Rs.	12.50
	Total Construction Cost	Rs.	286.32

F.11.7 Environmental and Social Impact Assessment

32. Major findings of initial environmental and social impact assessment as stated on report are:

- (i) Maliya – Viramgam section does not pass through any such ecologically sensitive area and hence does not require a clearance from the Ministry of Environment and Forests. However clearance will have to be obtained from the Forest Department, Government of Gujarat, before the project taken up for implementation.
- (ii) Potential negative impacts
 - (a) wild ass movement (which require further study)
 - (b) project corridor falls under command area of Sardar Sarovar canal.
- (iii) Positive impacts
 - (a) reduction in fuel consumption, reduced travel time
 - (b) general improvement in the economy

F.11.8 Economic Analysis

33. For conducting economic analysis following basic parameters were considered:

- (a) Do minimum scheme: Implementation of the proposed project
- (b) Do nothing: Continuation of existing status of roads
- (c) Base year for cost and benefit calculating: 2001, all price figures are in constant rupees (Rs.) 2001.
- (d) Base year for traffic forecast: 2000
- (e) First year of construction: 2001
- (f) Construction period: 2 years
- (g) Project life: 30 years
- (h) Discount rate for NPV: 12%
- (i) Conversion factor for economic costs: 0.8 of financial cost

34. Output of economic analysis is reported as under :

Particulars	VOC & VOT Savings	VOC Savings Only
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	VOC & VOT Savings		VOC Savings Only	
	EIRR (%)	NPV (Rs. Crores) 30 Years	EIRR (%)	NPV (Rs. Crores) 30 Years
Malia – Viramgam Project	44%	1,119.45	41%	995.57

F.11.9 Financial Analysis

35. The study findings are:

Project Cost (Rs. Lacs)	:	33,000
Concession Period	:	30 years
Part Tax IRR (%)	:	23.74
Pay back period	:	7.5 years
Loan repayment period	:	12 years

36. It is state in the report that “The project is viable for implementation on PPP basis. Even in the case of 20 year concession period the project IRR is 22.58%, which is a strong indication of the robustness of the project”.

F.12 OUR EFFORTS AND FINDINGS

F.12.1 Salient Corridor Characteristics

37. Viramgam to Maliya corridor is a part of the longer corridor between Ahmedabad and Maliya. It is the SH-17. It forms the shortest link between the Ahmedabad region with Kandla port and Kuttch (Figure F.12-1).

38. The alternative route to the present corridor is the NH-8A and NH-15, which most of the traffic is presently using to reach Kandla port/Kuttch region, even though this alternative route is longer to SH-17. This is because of the poor condition of SH-17. The section between Halvad and Viramgam has been widened to two lane, with World Bank funding, under the GSHP.

F.12.2 Traffic Studies and Forecast

F.12.2.1 Traffic Survey Locations

39. The classified traffic volume survey (at 3 locations), origin-destination survey (at one locations) and axle load survey (at one location) as per the details given below (Map given as Annexure F-1) were conducted to establish base year traffic volume and and desire levels, apart from axle load spectrum on the corridor.

Table F.12-1: Traffic Survey Locations

Location	Chainage	Survey Detail	Survey Duration
CORRIDOR: Km 59.0 to Km 195.065 , Viramgam-Dhrangadhra- Halvad-Maliya			
At Malvan Chowkdi	at 91/400km	Traffic Volume	7 Days
At Soladi Village	at 131/200km	Traffic Volume	3 Days
		Origin Destination	1 Day
Near Anniyari Bus Stop	at 182/200 km	Traffic Volume	7 Days

F.12.2.2 Traffic Volume Levels-2006

40. The average daily traffic volume levels recorded by sections on project corridor (Table F.12-2 (1)) were converted to annual average traffic volume levels by applying seasonal correction factor of 0.9 (Table F.12-2 (2)). The details of base year traffic are given in Tables F.12-2.

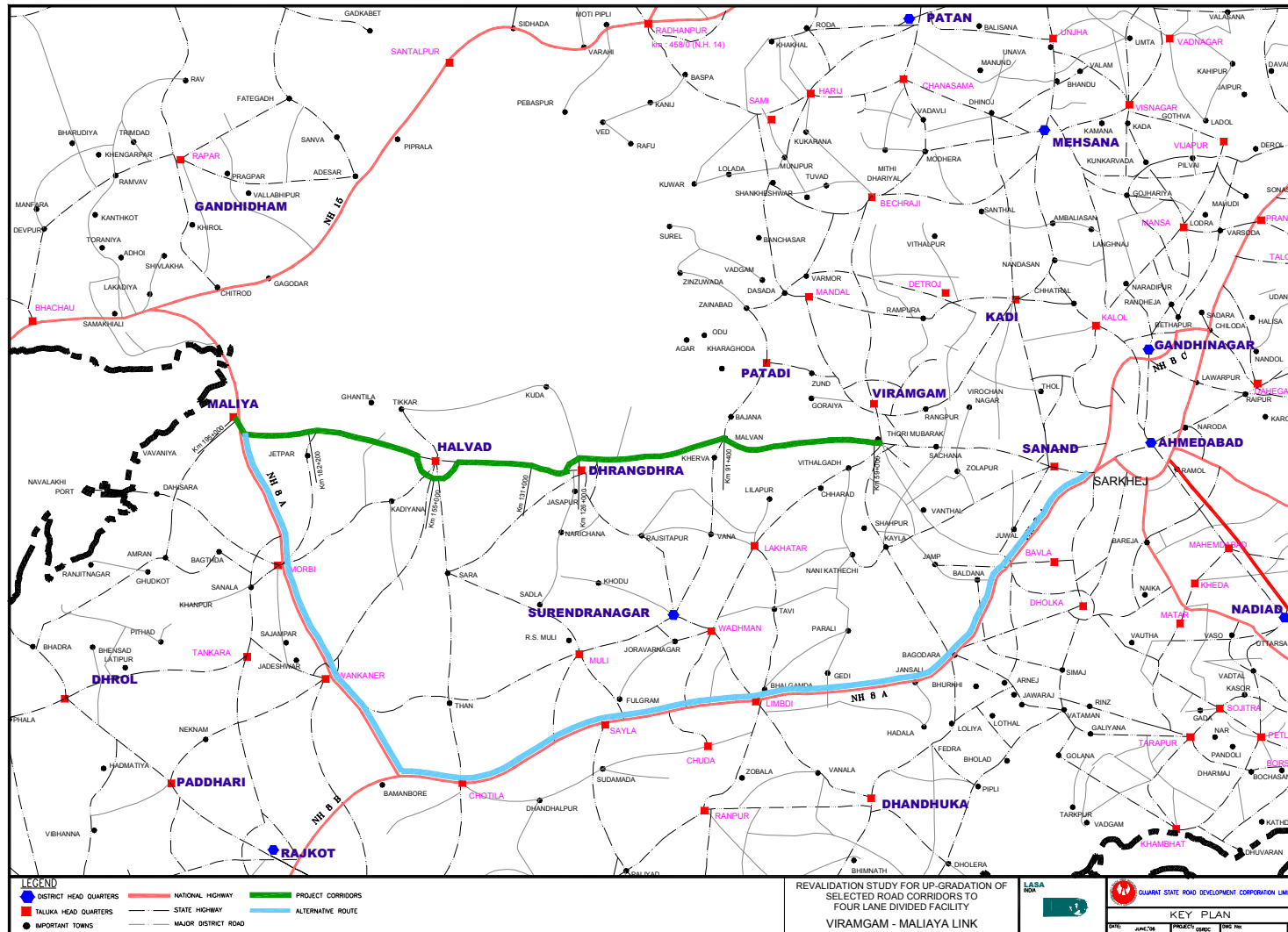


Figure F.12-1: Project Key Plan

Table F12.-2: Viramgam –Maliya: Traffic Volume Levels and Characteristics

Table F.12-2 (1): Average Daily Traffic Volume (ADT in VEHs)

Corridor Name	Link Name	Sc/Mc	Auto Rickshaw/ Chakda	Car/Jeep (Old Tech)	Car/Jeep (New Tech)	Mini Bus	Std. Bus	Tempo/ LCV	2-Axle Trucks	3-Axle Trucks	M-Axle Trucks	Tractor with Trailer	Tractor without Trailer	Cycle	Cycle-Rikshaw	Animal Drawn Vehicles	Others	ADT (VEH)
Viramgam-Maliya	Viramgam-Dhrangadra	1047	204	162	1110	96	325	346	1464	1656	138	139	126	134	1	2	4	6954
	Dhrangadra-Halvad	1139	348	149	1017	92	314	412	1465	1967	146	112	55	115	1	4	7	7344
	Halvad-Maliya	508	247	294	516	95	213	238	1147	1428	193	50	44	37	4	9	11	5034

Table F.12-2-(2): Annual Average Traffic Volume (AADT in VEHs and PCU)

Corridor Name	Link Name	Sc/ Mc	Auto Rickshaw/ Chakda	Car/Jeep (Old Tech)	Car/Jeep (New Tech)	Mini Bus	Std. Bus	Tempo LCV	2-Axle Trucks	3-Axle Trucks	M-Axle Trucks	Tractor with Trailer	Tractor without Trailer	Cycle	Cycle-Rikshaw	Animal Drawn Vehicles	Others	ADT (VEH)	AADT (PCU)
Viramgam-Maliya	Viramgam-Dhrangadra	942	184	146	999	86	292	312	1318	1490	124	125	114	121	1	2	4	6259	13132
	Dhrangadra-Halvad	1025	313	134	915	83	283	371	1319	1770	132	101	50	103	1	4	7	6610	13957
	Halvad-Maliya	457	223	265	464	85	192	214	1033	1285	174	45	40	33	4	8	10	4531	10392

Table F.12-2-(3): Traffic Composition

Corridor Name	Link Name	Sc/Mc	Auto Rickshaw/ Chakda	Car/Jeep (Old Tech)	Car/Jeep (New Tech)	Mini Bus	Std. Bus	Tempo/ LCV	2-Axle Trucks	3-Axle Trucks	M-Axle Trucks	Tractor with Trailer	Tractor without Trailer	Cycle	Cycle-Rikshaw	Animal Drawn Vehicles	Others	AADT (VEH)
Viramgam-Maliya	Viramgam-Dhrangadra	15.1%	2.9%	2.3%	16.0%	1.4%	4.7%	5.0%	21.1%	23.8%	2.0%	2.0%	1.8%	1.9%	0.0%	0.0%	0.1%	100%
	Dhrangadra-Halvad	15.5%	4.7%	2.0%	13.8%	1.2%	4.3%	5.6%	19.9%	26.8%	2.0%	1.5%	0.8%	1.6%	0.0%	0.1%	0.1%	100%
	Halvad-Maliya	10.1%	4.9%	5.8%	10.2%	1.9%	4.2%	4.7%	22.8%	28.4%	3.8%	1.0%	0.9%	0.7%	0.1%	0.2%	0.2%	100%

Table F.12-2-(4): Peak Hour Share of Traffic by Mode Types

Corridor Name	Link Name	Peak hour	Sc/Mc	Auto Rickshaw/Chakda	Car/ Jeep (Old Tech)	Car/ Jeep (New Tech)	Mini Bus	Std. Bus	Tempo/ LCV	2-Axle Trucks	3-Axle Trucks	M-Axle Trucks	Tractor with Trailer	Tractor without Trailer	Cycle	Cycle-Rikshaw	Animal Drawn Vehicles	Others	AADT (VEHs)	AADT (PCUs)
Viramgam-Maliya	Viramgam-Dhrangadra	07:00-08:00	83	21	14	66	13	16	26	92	92	18	25	21	29	0	0	0	516	1047
	Dhrangadra-Halvad	19:00-20:00	82	17	10	67	3	9	22	76	100	5	6	3	5	0	0	0	405	786
	Halvad-Maliya	18:00-19:00	38	16	16	25	6	6	12	53	73	11	5	5	4	0	1	2	273	604

Table F.12-3: Traffic Volume on Corridor -Salient Aspects

S.No	Section	Traffic Volume			PCU Factor
		ADT(Veh)	AADT(Veh)	AADT(PCU)	
1	Viramgam-Dhrangadra	6954	6259	13132	2.10
2	Dhrangadra-Halvad	7344	6610	13957	2.11
3	Halvad-Maliya	5034	4531	10392	2.29

41. Traffic composition (Table F.12-2 (3)) reveals that goods traffic share vary from 55% to 60% or even more. This is evident from PCU factor derived which is over 2.0. The peak traffic share was observed to be about 5.5% to 8.0% across the study sections (Table F.12-2 (4)). The details on base year traffic volume data are given in Annexure F-2.

42. The pre feasibility study traffic levels were revisited. Comparisons could not be made as locations selected for conduct of surveys were different in studies. However it is important to note that traffic on the corridor has been experiencing growth and more so in the recent past. The traffic levels when compared Updated SOS³ traffic volume levels of 2005, reveal high traffic growth. It is not rate of growth that should to be considered as an indicator but the trend is what is important. It can inferred satisfactorily that project corridor has been experiencing increased traffic levels from moderate to high growths. Further project corridor has major component of commercial traffic.

F.12.2.3 Traffic Desire Pattern

43. The Origin-Destination data by mode was analyzed. The trip ends by mode type were seen with respect to immediate influence area zones, traffic originating and terminating within Gujarat state and traffic which has one of the trip ends (either origin or destination) outside Gujarat. The broad analysis of the same is given below.

44. The traffic zoning scheme and maps are placed at Annexure B-3.

Table F.12-3: Traffic Desire Pattern: Trips internal to and external (to and from) Gujarat

Section		Cars			Goods Traffic		
		Both Trip ends on Corridor	With one Trip end on corridor-Generated in Gujarat	With one of Trip ends out side Gujarat	Both Trip ends on Corridor	With one Trip end on corridor-Generated in Gujarat	With one of Trip ends out side Gujarat
Viramgam-Dhrangadhra	Veh	70	1185	16	41	3242	320
	%	5.5%	93.2%	1.3%	1.1%	90.0%	8.9%
Dhrangadhra-Halvad	Veh	306	845	15	149	3479	362
	%	26.2%	72.5%	1.3%	3.7%	87.2%	9.1%
Halvad-Maliya	Veh	385	425	0	62	2886	59
	%	47.5%	52.5%	-	2.1%	96.0%	2.0%

45. The mode wise break up of trips internal to Gujarat and external (to and from Gujarat) is given at Table F.12-3. The desire lines are given at Maps F.12-1 & F.12-2 suggest that very high proportion of tollable traffic amongst the modes which are tollable.

³ Updated SOS was done in 2005 under GSHP

F.12.2.4 Traffic Forecast

46. The traffic volume on the project corridor is forecasted under various considerations. The updated SOS method was based on the assumption that the state shall implement the development of roads and there shall be no imposition of road user charges. In these conditions the normal traffic shall grow at fairly high growth rates. Further, to this the latent demand for travel will be realised leading to induced and generated traffic levels. If projects are implemented under commercial format, their perceived to be disutility by the road users, as need to pay user fee. This phenomenon is observed across several road projects in India, if an alternate route is available. The project roads are state roads. It is important to implicitly consider alternative routes for road users' are available. Hence, in this revalidation study, the traffic volume levels forecasted explicitly consider likely diversions and suppression of demand, as road users shall maximise benefits by performing less trips. With these considerations as the base alternative traffic forecasts were made. The adopted traffic forecast for financial analysis is suppressed demand alternative (Table F.12-4).

Table F.12-4: Projected Traffic Volume by Alternate Considerations

Link Name	Study	Year	Sc/Mc	Auto Rickshaw/ Chakda	Car/Jeep (Old Tech)	Car/Jeep (New Tech)	Mini Bus	Std. Bus	Tempo/ LCV	2-Axle Trucks	3-Axle Trucks	M-Axle Trucks	Tractor with Trailor	Tractor without Trailor	Cycle	Cycle-Rikshaw	Animal Drawn Vehicles	Others	AADT (VEH)	AADT PCUs
Halvad-Maliya	SOS-II	2006	675	206	66	346	29	130	108	1906	1117	94	15	30	30	0	1	0	4753	11193
		2010	907	242	77	434	32	152	131	2432	1458	125	17	35	33	0	1	0	6076	14309
		2015	1272	297	95	580	36	181	169	3332	2059	182	21	43	37	0	1	0	8304	19652
		2020	1702	365	117	776	40	209	214	4459	2834	258	24	51	41	0	1	0	11092	26394
		2025	2172	434	139	991	45	243	271	5967	3901	365	29	61	46	0	1	0	14663	35375
	Revalidation Study - Trend based	2006	457	223	265	464	85	192	214	1033	1285	174	45	40	33	4	8	10	4531	10392
		2010	621	262	312	586	95	224	262	1328	1698	235	53	46	37	4	8	11	5783	13325
		2015	872	322	383	784	108	267	338	1820	2403	342	64	56	41	4	8	13	7825	18198
		2020	1166	396	471	1050	120	309	427	2435	3308	484	76	67	46	4	8	15	10383	24346
		2025	1489	470	559	1339	133	358	540	3259	4554	685	91	80	51	4	9	17	13638	32517
	Revalidation Study - Supressed Demand	2006	457	223	226	388	82	148	156	730	903	122	45	40	33	4	8	10	3573	7760
		2010	568	250	258	457	89	167	181	851	1069	146	50	44	36	4	8	11	4189	9064
		2015	722	289	304	562	98	192	216	1030	1321	184	58	51	39	4	8	12	5089	10991
		2020	886	334	359	690	107	216	255	1229	1604	227	65	58	43	4	8	13	6099	13147
		2025	1053	377	412	820	116	244	300	1467	1947	280	74	65	47	4	8	14	7230	15670

47. The traffic volume by sections is forecasted by suppressed growth rate approach⁴. The growth rates considered are conservative⁵. The categorized growth rates by components of traffic are as given under :

Table F.12-5: Adopted Traffic Growth Rates by mode Types

Mode \ Region	Central Gujarat				India			
	2006-10	2010-15	2015-20	2020-25	2006-10	2010-15	2015-20	2020-25
Scooter/Motor Cycle	5.6	4.9	4.2	3.5	4.2	4.2	4.2	4.2
Auto Rickshaw/ Chakda	2.9	2.9	2.9	2.5	2.9	2.9	2.9	2.9
Car/ Jeep (OT)	3.4	3.4	3.4	2.8	3.4	3.4	3.4	3.4
Car/ Jeep (NT)	4.2	4.2	4.2	3.5	4.2	4.2	4.2	4.2
Mini Bus	2.2	2.0	1.7	1.7	2.2	2.2	2.2	2.2
Standard Bus	3.2	2.8	2.4	2.4	3.2	3.2	3.2	3.2
Tempo/ LCV	3.6	3.6	3.4	3.4	3.6	3.6	3.4	3.4
2-Axle Truck	3.9	3.9	3.6	3.6	3.9	3.9	3.6	3.6
3-Axle Truck	4.3	4.3	4.0	4.0	4.3	4.3	4.0	4.0
MAV	4.7	4.7	4.3	4.3	4.7	4.7	4.3	4.3
Tractor with Trailer	2.7	2.7	2.5	2.5	2.7	2.7	2.5	2.5
Tractor without Trailer	2.7	2.7	2.5	2.5	2.7	2.7	2.5	2.5
Cycle	1.9	1.9	1.9	1.6	1.9	1.9	1.9	1.9
Cycle Rickshaw	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.5
Animal Drawn	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Others	2.1	2.1	2.1	1.8	2.1	2.1	2.1	2.1

48. The traffic volume levels thus derived are adopting above growth rates are given in Table F.12-6.

Table F.12-6: Predicted Overall Traffic Volume Levels

Section		2006	2010	2020	2030
Viramgam - Dhrangadhra	Veh	4859	5721	8374	11768
	PCU	9687	11319	16403	23248
	GR		4.2%	3.9%	3.5%
Dhrangadhra-Halvad	Veh	5113	6027	8837	12440
	PCU	10227	11965	17388	24714
	GR		4.2%	3.9%	3.5%
Halvad-Maliya	Veh	3573	4189	6099	8576
	PCU	7760	9064	13147	18694
	GR		4.1%	3.8%	3.5%

49. The detailed statements on forecasted traffic levels by mode and sections are given at Annexure F-3.

⁴ .It is considered appropriate to have conservative approach to the growth pattern of traffic as facility is proposed to be developed on commercial format. There is a strong possibility of some diversions on to other corridors. As network based approach is not followed it is difficult to assess accurately at this level.

⁵ . The diversion on imposition of tolls is likely. Prediction of the same is not done as part of this study. More elaborate effort is needed to undertake such task. The growth rates adopted are conservative.

F.12.3 Engineering Studies and Investigations

F.12.3.1 Alignment Verification

50. The alignment verification for Viramgam – Maliya road corridor was undertaken. For this purpose all the available alignment details from earlier studies along with Gujarat State Highway Project (GSHP) were studied and used.

51. The GSHP design drawings formed as the base for this purpose. Considering GSHP improvements and looking at the ground condition proposed improvement scheme was finalised.

F.12.3.2 Strip Mapping

52. Linear diagrams in term of strip maps are to be developed as part of this study. The following details were followed for updating latest ground information :

- (a) Viramgam – Halvad : GSHP design drawings; and
- (b) Halvad – Maliya : New strip mapping conducted

53. Based on the above effort on strip mapping the Strip Maps were finalised showing the existing and proposed scenario.

54. As desired by GSRDC, strip maps were got prepared early and submitted for needful action.

F.12.3.3 Highway Geometrics

55. After reviewing the earlier study details the geometrics as adopted in GSHP, where applicable are adopted for proposed new four-lane facility.

F.12.3.4 Pavement Design

56. On reviewing the feasibility study and GSHP pavement design details, the work on pavement design was carried out considering observed traffic volumes and the VDF values computed.

F.12.4 Design and Project Cost

F.12.4.1 Geometric Design

57. Geometric design standards are adopted following the GSHP and IRC standards.

58. The adopted typical cross sections are placed at Annexure B-5.

F.12.4.2 Pavement Design

59. **VDF:** The adopted VDF values for computation of MSA are:

LCV	–	0.54
Bus	–	1.13

2-Axle Truck	–	9.78
3-Axle Truck	–	9.6
Multi Axle Truck	–	5.6

60. **CBR:** Design CBR values are adopted from GSHP pavement design:

Section Name	Design CBR
Viramgam – Maliya	8%

61. **New Pavement Design:** For design of new pavement IRC-37:2001 was followed. The design life is taken as 20 years. Average growth of commercial vehicles is considered as 5.2%⁶. For two different sections respective maximum, directional, traffic is considered for calculation of design lane MSA. Lane distribution factor as stipulated was considered.

62. New pavement design crust for Viramgam – Maliya road corridor is tabulated as under:

Viramgam – Maliya		
	CBR – 5%	
	MSA – 376	
	Adopted Design for CBR 5%, MSA – 150 ⁷	
	Required	Recommended
BC	50	50
DBM	170	100
WMM	250	400 ⁸
GSB	300	300
Total	770 mm	850 mm

F.12.4.3 Overlay and Profile Correction

63. Wherever GSHP improved facility is in place it was thought appropriate to have only profile corrective course, to get unidirectional camber. To address issues related to some of the specific minor/major distresses in the Secretary, R&BD advised for conducting BBD surveys for ensuring adequacy of structural strength and accordingly design of overlays as per the needs of corridor.

64. The analysis and findings of BBD survey shall be incorporated in the Final Report.

65. At this stage of DFR following scheme has been adopted:

⁶ .It is considered on higher side as recorded volumes suggest high proportion of commercial traffic. In case project attracts more traffic than predicted then the pavement design considered may fall short the needs of high commercial traffic. Therefore moderately high growth rate is adopted.

⁷ . As stipulated by IRC:37 – 2001, “For traffic exceeding 150 msa, the pavement design appropriate to 150 msa may be chosen and further strengthening carried out to extend the life at the appropriate time based on pavement deflection measurements as per IRC:81.

⁸ . Substitution of pavement layers as per IRC:37-2001 and IRC:81-1997.

- (i) Profile correction with BM – Average 80mm thick
- (ii) Overlay – DBM – 160mm, BC – 50mm

F.12.4.4 Structures' Design

66. Generally the new structures are proposed similar to that of GSHP. Details pertaining to existing structures and proposed scheme for four laning is placed at Annexure F-4. Based on these rates adopted for various structural items are given under :

Sl. No.	Description	Unit	Rate (Rs.)
1	Major Bridges	Sqm	26,000/-
2	ROB	Sqm	26,000/-
3	Minor Bridges	Sqm	24,000/-
4	Slab Culverts	Sqm	18,000/-
5	Box Culverts	Sqm	18,000/-
6	Pipe Culverts (Single Row)		
a	Diameter >= 0.90m	Rm	7,500/-
b	Diameter > 0.75m & < 0.60m	Rm	6,500/-
c	Diameter <= 0.60m	Rm	5,500/-

F.12.4.5 Project Cost

67. **Rates Adopted:** The National Highway – Ahmedabad Division (NH- Ahmedabad) schedule of rates were used for assessing the project cost. Escalation was applied as appropriate and for some items realistic rates were adopted.

68. Base year construction cost of Project is estimated to be :

Sl. No.	Description of Item	Total Amount (in million Rs.)
1	Highway Cost	329.87
2	Intersections, Toll Plaza, Bus Bay/Bus Shelters	332.47
3	Structure Cost	1163.74
4	Existing Road Maintenance	33.95
Total Construction Cost		4828.83

69. Details pertaining to quantity and cost calculation are placed at Annexure F-5.

F.12.5 Environmental and Social Impact Assessment

70. The Project Corridor⁹ Viramgam-Halvad-Maliya is spread out in six talukas of three districts. Dhrangadhra, Dasada and Halvad are the talukas which are likely to be affected the most and Lakhtar (4 km of the Project corridor passes through this taluka) - the least (Table F-12.7)

Table F-12-7: Propensity of Impacts (By Taluka)

⁹ . **Viramgam-Halvad-Maliya** is spread out in six talukas of three districts with a total population of 0.83 million and area of 6615 km² as per 2001 Census. Project Corridor traverses through one taluka in Ahmedabad district with a total length of 12.2 km, four talukas over a length of 94.4 km in Surendranagar district and one taluka over a length of 25.7 km in Rajkot district.

District	Taluka	Area (km ²)	Length of Corridor (km)	Population
Ahmedabad	Viramgam	885.2	12.2	172400
		885.2	12.2	172400
Surendranagar	Lakhtar	741.8	4	69549
	Dasada	1630.1	28	169123
	Dhrangadhra	1369.8	36	195085
	Halvad	1218.2	26.4	144305
		4959.8	94.4	578062
Rajkot	Maliya	770	25.7	83471
		770	25.7	83471
Total		6615	132.3	833933

71. Dasada is the largest with an area of 1630 km² (24.64 % of total area of Talukas being traversed) and Lakhtar is the smallest, with only 741 km² (11.21 % of total area of Talukas being traversed). Population distribution Ranges between 69 thousand in Lakhtar to 195 thousand in Dhrangadhra which shows a wide variation. Dhrangadhra has the highest share of population (23.4 % of all Talukas being traversed) covering six Talukas.

72. **Impacts on Flora**¹⁰: There is no rare or endangered species among these plantations. Some Eucalyptus plantations are found within industrial parks. Other than that, the main concentration of trees, which are generally not of good timber value, are found in the strip plantations. (Figure F-12-2)



Figure F-12-2: Typical Roadside Plantation

73. Many of these roadside plantations¹¹ will be impacted by the widening of the road from two lane to four lane (Table F-12.8)

Table F-12-8: Tree Plantation along The corridor

Name	No. of Trees	No. of Trees to be impacted
Viramgam-Dhrangadhra	125	70
Dhrangadhra-Halvad	35	20
Halvad-Maliya	3500	1925
Total	3660	2016

74. **Reserve Forest within the Study Area:** Except for the roadside plantation, no reserve forest flora will be impacted by this project.

¹⁰. Negative impacts on flora will involve the removal of trees, shrubs and ground cover during pre-construction from within the Corridor of Impact. There may also be possible damage to remaining vegetation during the construction phase of the project. Strip plantations of trees within the RoW of State Highways have been declared as Protected Forests on all the project roads.

¹¹. To prevent vehicle collisions with the roadside trees, they cannot be close to the pavement, particularly trees with strong and rigid stems. Some trees are safety hazards because they preclude adequate sight distance.

75. **Bio-diversity and endangered species:** There are no rare and endangered species that occur in any of or are close to the corridor. Therefore, it is unlikely that the widening of the road to four lane is going to have any negative impact whatsoever on any endangered species of flora.

76. **Impacts on Fauna:** Some of the fauna of Gujarat has received world wide attention and concern. Two species in particular are famous and endangered as they exist in the only known habitat in the world. Asiatic Lion (*Panthera leo persica*) and; second, the Indian Wild Ass (*Eqous onager khur*) which are unique and confined to the narrow forest patches in Gir and the arid-zones of Kachchh respectively. Wild ass sanctuary is near vicinity of the project corridor. This is parallel to the Viramgam-Maliya section of the project corridor.



Figure F-12-3: Wild Ass Crossing

77. The sanctuary area is too far to be impacted by the project because the nearest being at a distance of 7.5 km from the corridor. However, the cause of concern is the Wild Ass inhabiting areas outside the sanctuary. In search of food and water the Wild Ass wander far, often crossing the highway and risk collision. However, for the past few years there have been no recorded collisions of the Wild Asses with the vehicles plying. This is primarily due to the installation of reflector system that reflects the headlight of an approaching vehicle and also due to construction of slab culverts at various places for safe movement of the animal to the other side of the highway. Refer Figure F-12-3.

78. **Impacts on Cultural Environment:** Strip mapping carried out on the project corridor was the main source of identification of the affected cultural properties falling within and just outside the RoW of the project corridors. All the Archaeological Monuments are beyond 2 km from the corridor. Therefore, it is unlikely that the widening of the road to four lane is going to have any negative impact on any Monuments. Table F-12-9.

Table F-12-9: Archaeological Monuments/Sites within 10 km of Project Corridor

Name	Location	Distance from corridor (in kms.)	Description
Munar Lake	Viramgam	Within 2.0 Km.	Built in about AD 1100. In shape it is irregular, and is supposed to resemble a conch (shanka). It is enclosed by a ghats or flight of steps, which lead down to the water.
Jagasar and Mansar	Dhrangadhra	Within 2.0 Km.	There are two lakes called Jagsar and Mansar and two towers about 100 years old.
Parvati Kunda	Drumath	4	It is well known ancient tank known as Parvati Kunda. On the banks of the tank, there are remains of several old temples.
Ancient temples	Methan	Within 2.0 Km.	It is known for the group of three ancient temples viz. Shiv, Vishnu and Sun temple. These temples were constructed in about 800 AD.
Satina Paliyas	Halvad	Within 2.0 Km.	The "Satina Paliyas" where the nuptial knots of the newly wed are untied.

Name	Location	Distance from corridor (in kms.)	Description
Step well	Halvad	Within 2.0 Km.	There are a number of old step wells, four of which are larger and consist of seven floors.
Mahadev temples	Halvad	Within 2.0 Km.	There are six Mahadev temples encircling the town, which are about 500 years old.
EK Dandiya Mahal	Halvad	Within 2.0 Km.	Beautiful palace called Ek Dandiya Mahal built on the bank of a fine lake called Samatsar is well known for its beautiful woodwork.
Pilgrim place	Halvad	Within 2.0 Km.	Pilgrim place of the Dawoodi Vohras in Saurashtra. Tourism corporation of the state has considered this place for eligible growth centre for tourist.

79. Cultural properties lying along the highways are most susceptible to impacts due to construction activities depending upon the access to the property, distance between the road pavement and the cultural property, the condition and scale of the built structure.

80. Road construction machinery operating during the construction phase is likely to require a belt of about 4-5m from the edge of the carriageway. In such instances cultural properties located within a distance of 5m from the edge of the carriageway, risk being damaged by the heavy machinery Table F-12-10.



Figure F-12-4: Temple Likely to be

Table F-12-10: Cultural Properties along Project Corridor

Place	Name	Condition	Location (Ch.)	Distance from Edge of Pavement (m)	Direction and Siting w.r.t. RoW	Environment, Annual Gathering and Other Details	Impacts during Construction
-	Meladi Mata Temple	Good	74.32	3.04	R	Rural Area	A,B,C
-	Shrine	Average	79.62	1.1	R	Scrub Land	A,B,C
Akhyana	Nagbaba Shrine	Good	96.25	15.7	L	Scrub Land	B,C
Akhyana	Samadhi	Good	131.10	11.3	R	Scrub Land	B,C
Soladi	Rama Pir Temple	Good	131.25	11.3	L	Rural Area	B,C
Soladi	Samadhi	Average	131.30	1.8	R	Rural Area	A,B,C,D
Soladi	Samadhi	Average	131.90	14.2	L	Scrub Land	B,C
Chuli	Melody Mata Shrine	Good	135.67	1.5	R	Agricultural	A,B,C,D
Chuli	Step Well	Good	142.70	12.9	R	Scrub Land	A,B,C
Chuli	Hanuman Shrine	Average	145.18	1.5	R	Agricultural	A,B,C
Halvad	Temple	Average	149.98	11.3	R	Agricultural	B
	Shrine	Good	160.24	3	R	Agricultural	A,B,C
Dhanala	Temple	Good	162.84	5	R	Rural Area	A,B,C
Dhanala	Shrine	Good	163.04	2.5	R	Rural Area	A,B,C
	Shrine	Average	163.76	4.5	L	Rural Area	A,B,C
Sheywan	Temple	Good	164.34	12	L	Rural Area	B,C
Devaliya	Shrine	Good	169.40	4	L	Agricultural	A,B

Impacts during Construction include (A) Damage to structure due to operation vehicles, (B) Contamination of site, (C) Pollution and (D) Interrupted Access to Site.

81. **Land Acquisition:** Widening from two lane to four lane of the roads requires land acquisition and clearing of various types of properties¹². However, due to the design considerations and limiting the proposed road widening not beyond the existing RoW, substantial land acquisition requirements are reduced. However, the proposed capacity augmentation needs land acquisition. It is assessed to be by land use type as under (Table F-12-11)

Table F-12-11: Properties Likely to be impacted in Project

Type of Land Acquisition	Viramgam-Dhrangadhra	Dhrangadhra-Halvad	Halvad-Maliya	Total Area in Ha
Agricultural in Ha	30.1	13.07	40.14	83.31
Residential in Ha	0.02	0	0.07	0.09
Commercial in Ha	0.03	0.05	0.54	0.62
Open in Ha	1.84	1.28	0.15	3.27
Scrub in Ha	36.42	4.24	2.62	43.28
Industry in Ha	0.03	0.03	0.12	0.18
Plantation in Ha	0.49	0.21	0	0.7
Community in Ha	0	0	0	0
Total area in Ha	68.92	18.88	43.63	131.45

82. **Impacts on Water Resources:** A road project can significantly alter the hydrological setting of an area and add to the siltation and pollution level in water sources. The identification and mitigation of such adverse impacts assume greater significance in water scarce regions such as Gujarat.

83. **Surface water:** The river basins in the Gujarat plains experience semiarid conditions. The long rivers in this region bisect the entire region into various basins. Owing to the higher elevation and steep slopes, over 18 metres per km in the catchment area, their upper and because their upper tributaries receive heavier rainfall, these have a potential to flood in the lower reaches. Table F-12-12.

Table F-12-12: River Basin and Tributaries in the Project Area

Corridors	River Basin	Region	Catchment Area (km2)	Rainfall (mm)
Viramgam - Maliya	Chandraragha, Phulka, Kanakawati, Machchhu, Bambhan	Saurashtra	275	335.3
			904	675.6

Source: Planning Atlas of Gujarat, 1987

¹² Land acquisition involves land take of legal lands for the larger interests of the society, like the creation of road infrastructure, as is the case in the four laning project.

84. **Water resources along the project corridors:** Widening of a road entails the removal of open wells, tube or bore wells within the RoW resulting in a permanent loss of water supply. Wells, which are non-perennial, or not in use, may be easily removed or filled in. A pond, in village Soladi, located at km 131.4 may lose some storage volume to filling during construction. (Figure F-12-6). The other concern is contamination of water in the pond by sediment-laden water during this phase. Since the locals use the pond for washing clothes and utensils, the pond may lose its value to the villagers.



Figure 12.6: Pond at Soladi

85. This pond also charges a well, located at chainage 130.5, which in turn recharges a bore well on the north side of the existing pavement. A loss of storage volume will therefore have a significant impact on the water supply in this area, especially in light of the fact that water is a scarce resource in area. This corridor has wells interspersed within the RoW along the corridor. The nearest well is at 7 m from existing edge of carriageway at km 71.23. Two wells are located on either side of the pavement at km 76.9. The common concern for all wells is contamination due to road run-off and collision during construction. During the operation, lubricants and exhaust emissions, which may be mixed with road run-off, may pollute the water. Table F-12-13.

Table F-12-13: Water bodies likely to be impacted by Project

Link Name	Sensitive Environment	Chainage	Direction	Distance from CL (m)	Phase	Impact
Virangam-Dhrangadhra	Well(s)	66.92	South	6.5	Construction	<input type="checkbox"/> Sedimentation from construction run-off
		71.21	South	8.11		<input type="checkbox"/> Collision potential from vehicles
		71.23	North	7.3	Operational	<input type="checkbox"/> Contamination due to run-off of lubricants and exhaust emission.
		76.79	North & South	9		
		77.75	North	13.92		
		79.34	North	10.72		
Dhrangadhra-Halvad	Well(s)	130.5	North	11.07	Construction	<input type="checkbox"/> Sedimentation from construction run-off
		131.05	South	7.66		<input type="checkbox"/> Collision potential from vehicles
	Pond	130.49	South	11.07	Operational	<input type="checkbox"/> Contamination due to run-off of lubricants and exhaust emission.
	Stepped Well	142.7	North	15.7	Construction	<input type="checkbox"/> Damage to the ancient structure
Halvad-Maliya	Well	163.34	South	11	Construction	<input type="checkbox"/> Sedimentation from construction run-off
	Pond	160.12	North	17		<input type="checkbox"/> Collision potential from vehicles
	Pond	162.8	North	10	Operational	<input type="checkbox"/> Contamination due to run-off of lubricants and exhaust emission.
	Pond	176.8	North	9		

F.12.6 Tollable Traffic

86. The vehicles which are tollable¹³ as per the Concession agreements are considered for assessment of tollable traffic in the base year. From the road side interview conducted the revealed desire of traffic is taken as the base to assess the tollable traffic. In assessing this all the intra zonal and inter-zonal trips of the zones lying on the corridor are excluded. This exclusion may lead to slightly under estimation of tollable traffic. The assessed tollable traffic is suppressed demand traffic figures and very conservative.

87. The assessed tollable traffic by sections and by mode is given under:

Table F12.14: Assessed Tollable Traffic

Corridor Name	Link Name	Toll Plaza Location	Traffic Category	Car/Jeep (Old Tech)	Car/Jeep (New Tech)	Mini Bus	Std. Bus	Tempo/ LCV	2-Axle Trucks	3-Axle Trucks	M-Axle Trucks	Total (AADT in Veh Nos)
Viramgam-Maliya	Varamgam-Dhrangadhra	km 88/00	Total Traffic	107	713	60	205	221	927	1047	87	3367
			Non Tollable Traffic	17	46	0	0	11	14	12	0	100
			Tollable Traffic	90	667	60	205	211	912	1035	87	3267
	Dhrangadhra-Halvad	km 133/00	Total Traffic	94	641	59	202	260	923	1239	92	3509
			Non Tollable Traffic	0	0	4	13	0	0	0	0	16
			Tollable Traffic	94	641	55	189	260	923	1239	92	3493
	Halvad-Maliya	km 180/00	Total Traffic	226	388	82	148	156	730	903	122	2754
			Non Tollable Traffic	136	210	73	44	22	24	9	0	519
			Tollable Traffic	90	178	9	104	134	706	893	122	2235

88. The forecasted tollable traffic, by mode and sections at 10 year interval is given at Table F.12-15. This forecast is based on growth rate approach. Annexure F-6 provides link wise tollable traffic projections.

Table F.12-15: Section wise and Mode wise Forecasted Tollable Traffic

Link Name	Toll Plaza Location Chainage	Year	Cars (OT)	Cars (NT)	Mini Bus	Std. Bus	Lcv/ Tempo	2-Axle Trucks	3-Axle Trucks	M-Axle Trucks	TOTAL AADT (VEH)	TOTAL AADT (PCU)
Viramgam-Dhrangadhra	88/000	2006	90	667	60	205	211	912	1035	87	3267	8040
Viramgam-Dhrangadhra	88/000	2010	103	786	66	232	243	1063	1226	104	3823	9417
Viramgam-Dhrangadhra	88/000	2020	144	1186	79	300	343	1537	1839	162	5589	13755
Viramgam-Dhrangadhra	88/000	2030	189	1675	93	380	478	2188	2711	247	7962	19717
Viramgam-Dhrangadhra	88/000	2040	249	2365	110	482	665	3117	3998	377	11363	28317
Dhrangadhra-Halvad	133/00	2006	94	641	55	189	260	923	1239	92	3493	8703
Dhrangadhra-Halvad	133/00	2010	107	755	60	215	300	1076	1467	111	4091	10204
Dhrangadhra-Halvad	133/00	2020	149	1139	72	277	423	1554	2201	172	5989	14941
Dhrangadhra-Halvad	133/00	2030	197	1609	86	352	588	2214	3246	262	8554	21475
Dhrangadhra-Halvad	133/00	2040	260	2272	101	446	819	3153	4787	401	12237	30920
Halvad-Maliya	180/000	2006	90	178	9	104	134	706	893	122	2235	6141
Halvad-Maliya	180/000	2010	103	209	9	117	155	822	1058	146	2620	7214
Halvad-Maliya	180/000	2020	143	316	11	152	219	1188	1587	227	3843	10613
Halvad-Maliya	180/000	2030	188	446	13	192	304	1692	2341	346	5524	15352
Halvad-Maliya	180/000	2040	248	629	16	244	424	2411	3451	528	7951	22240

¹³ Only Cars and commercial vehicles which include buses are tollable

89. In addition to above, estimated tollable traffic is forecasted at 2% p.a. up to “COD” and 5% thereafter¹⁴ the forecasted traffic by mode is given as Annexure F-7

F.12.7 Financial Analysis

90. The financial analysis of the project has been undertaken to assess the viability of the projects under a commercial format. A number of options/scenarios of project have been worked out to aid in decision-making process.

Scenario 1: Viramgam Maliya corridor (132.4 km);

Scenario 2: Ahmedabad Viramgam Maliya Corridor as one (179.9km);

F.12.7.1 Inputs and Assumption

Revenue Model

- (a) **Tollable Traffic:** The tollable traffic, by each toll plaza, has been estimated and presented in Sub-Section 12-6. This traffic forms an input to the financial analysis.
- (b) **Toll Rates:** The toll rates are those which have been recommended by the Ministry, vide a notification in the year 1997. These have been escalated to prices as on 31st March 2006. The per km toll rates as well as the toll rate for the project corridor, at 2006 prices, have been given in Table F.12-16.

Table F.12-16: Toll Structure (at 2006 prices)

Mode	Toll Rate (Rs./km at 2006 price)	Toll Rates (Rs./Trip at 2006 price)	
		Viramgam Maliya	Ahmedabad Viramgam Maliya
Car/Jeep	0.61	80	110
Mini Bus	1.07	140	190
Bus	2.13	285	385
LCV	1.07	140	190
2-Axle Truck	2.13	285	385
MAV	3.43	455	615

For future, the toll rates have been assumed to increase at an inflation rate of 5% p.a. For estimation of corridor level toll rate, this has been rounded to nearest five rupee.

91. Annual Toll Collection: The annual toll revenue realisation, over the project period, at current prices, has been given in Table F.12-17.

Table F.12-17: Annual Toll Revenue

Year	Annual Toll Collection (Mill Rs at current Prices)	
	Viramgam Maliya	Ahmedabad Viramgam Maliya
2010	461.4	804.6
2015	719.2	1248.3

¹⁴ This is based on new model concession agreement of Gol.

Year	Annual Toll Collection (Mill Rs at current Prices)	
	Viramgam Maliya	Ahmedabad Viramgam Maliya
2020	1102.6	1911.2
2025	1693.8	2930.4
2030	2598.4	4488.1
2035	4007.4	6894.9

Cost of Project

92. The initial civil cost of project has been estimated for the two scenarios of part and full development of the corridor. The construction activities have been assumed to be undertaken in the years 2008 and 2009. The total cost of project is as follows:

Type of Cost	Viramgam Maliya	Ahmedabad Viramgam Maliya
Civil Construction Cost	4828.83	6028.98
Contingency (10%)	482.88	602.90
Construction Supervision (3%)	159.35	198.96
Inflation During Construction	726.66	907.26
Total Cost of Project	6197.72	7738.10

93. Routine and periodic maintenance have been taken as follows:

Routine Maintenance – Rs. 40,000/km

Periodic Maintenance – Rs. 3 mill/km

Assumptions for Analysis

94. A number of assumptions have been considered for the analysis. They have been listed below:

- (a) The base debt-equity ratio has been taken as 7:3.
- (b) The analysis period has been taken as 30 years.
- (c) The rate of interest considered for the analysis has been assumed as 12% p.a. This is looking at the present increase in interest rates.
- (d) With respect to the increased interest rates, the expected post-tax return on investment has also been taken at a value of 15 – 17%.
- (e) The subsidy/grant component has been limited to 40% of the total project cost. Under the VGF scheme, a maximum of 20% of the total project cost is expected to come from the central government and the balance, if any, needs to be given by the state government.
- (f) The disbursement of VGF has been taken during the construction period. It is to be disbursed after the equity draw-down by the concessionaire in over. The phasing of VGF/capital grant has been linked to the debt draw-down.

- (g) The Corporate Tax is taken at 33.66%¹⁵. In the event of the tax rebate, a Minimum Alternative Tax of 11.22 %¹⁶ has been included in the analysis.
- (h) The depreciation schedule has been taken as per the IT and Companies Act.
- (i) Insurance premium has been assumed at 0.7% of the assets/investment.
- (j) The tax concession on road projects has been taken for the analysis. There is a 10 year, full tax rebate on road infrastructure projects, starting from the first year of operation of the same.
- (k) The loan repayment period has been assumed as seven years after two years of moratorium.

F.12.7.2 Results of Financial Analysis- Base Case: Realistic Traffic

95. The financial analysis for the base case has been presented in the Table F.12-18. As summary. The details of financial analysis are presented through Annexure F-8.

Table F.12-18: Results of the Analysis in Base Case

Indicators	Viramgam Maliya		Ahmedabad Viramgam Maliya	
	20 Yrs	30 Yrs	20 Yrs	30 Yrs
Viability Gap Funding mill Rs	3780.6	3284.8	3095.2	2321.4
% of Project Cost	61%	53%	40%	30%
Pre-Tax IRR (%)	17.82	17.94	17.93	18.24
Post-Tax IRR (%)	16.96	16.94	16.96	17.03
Return on Equity (%)	21.79	19.43	21.33	19.63
Minimum DSCR	0.05	0.04	0.41	0.35
Average DSCR	1.46	1.21	1.44	1.23
Payback Period	12yrs 5 mths	13yrs 8 mths	11 yrs 5 mths	12yrs 5 mths

96. The road section between Viramgam and Maliya is not a viable proposition from the commercial perspective. The requirement of VGF is high, even beyond the permissible limit of 40% of project cost. The full corridor, however, is viable with 30% of project cost as maximum VGF, if the concession period is kept at 30 years.

97. It is important to note that if only a section of the full corridor between Ahmedabad and Maliya is developed and widened to 4-lane, then the project attractiveness will not be as much as estimated, even for the section between Ahmedabad and Viramgam.

¹⁵ The breakup is 30% Corporate Tax, with 10% surcharge and 2% education cess.

¹⁶ The MAT is 10% with 10% surcharge and 2% education cess.

F.12.7.3 Sensitivity Analysis : Variation in Revenue and Cost Levels

98. In order to understand the sensitivity of variation in revenue and project cost on the project viability, a case of increased and reduced toll revenue realisation and project cost has been worked out and the results are presented in Table F.12-19.

Table F.12-19: Sensitivity Analysis : Results in Case of Revenue Variation (30 Year Period)

Indicators	Viramgam Maliya			Ahmedabad Viramgam Maliya		
	15% cost Increase	15% Reduced Revenue	15% Increase and Reduced Revenue and Cost	15% cost Increase	15% Reduced Revenue	15% Increase and Reduced Revenue and Cost
Viability Gap Funding						
mill Rs	4276.4	3904.6	4917.9	3559.5	3327.4	4627.4
% of Project Cost	60%	63%	69%	40%	43%	52%
Pre-Tax IRR (%)	17.89	17.96	17.99	18.20	18.16	18.26
Post-Tax IRR (%)	16.96	17.00	17.09	17.02	17.05	17.19
Return on Equity (%)	19.54	19.61	19.93	19.70	19.66	20.07
Minimum DSCR	0.03	-ve	-ve	0.35	0.17	0.16
Average DSCR	1.21	1.21	1.24	1.23	1.23	1.25
Payback Period	14 yrs 1 mths	14 yrs 4 mths	14 yrs 10 mths	12 yrs 9 mths	13 yrs	13 yrs 3 mths

99. The project section between Viramgam to Maliya is highly sensitive to cost and revenue variations.

F.12.7.4 New Model Concession Agreement as Base

100. The Committee on Infrastructure has recently prepared a New Model Concession Agreement, for the upcoming BOT projects. Anticipating the implementation of the same, a set of analysis has been undertaken with the new MCA as the base as well. The major assumptions, beyond the ones already stated, which have been incorporated in this analysis as per the new MCA are:

- The traffic growth has been considered at 5% per annum over the concession period, starting from the COD. However, from the base year to the year when the construction is completed, the traffic growth has been taken as 2% per annum.
- In case the project corridor qualifies for a six-lane, within the project period, the concession period has been limited to a maximum of that many years.

101. The analysis does not include the scenario of full corridor as one package. This is because as per the new MCA, the year of requirement of six laning varied for the two individual sections, which meant two different concession periods.

102. The results of the analysis have been presented in Table F-12.20.

Table F.12-20: Results under New MCA Assumptions

Indicators	Viramgam Maliya
Requirement of Six Lane	2033
Maximum Concession Period	26 yrs
Viability Gap Funding	
mill Rs	2479
% of Total Project Cost	40%
Pre-Tax IRR (%)	14.22
Post-Tax IRR (%)	13.25
Return on Equity (%)	14.41
Minimum DSCR	0.02
Average DSCR	0.93
Payback Period	14 yrs 10 mths

F.12.7.5 Conclusions

103. The project under study is not an attractive project if the section between Viramgam and Maliya is considered in isolation. However, the full corridor is viable with 30% of project cost as VGF, over a period of 30 years. The corridor is a strategic one hence needs to be taken up for implementation. Since the section between Ahmedabad and Viramgam is a very attractive project, it is suggested that both the sections be merged for implementation, so as to enable cross-subsidisation. Due to the narrow lane configuration and poor road condition, most of the port and Kutchh bound traffic takes the route via NH-8A, which is about 65 kms longer. If this corridor is widened, there will be a substantial saving to the vehicle owners as well as the society in the form of travel time as well as the vehicle operating costs.

F.	VIRAMGAM – MALIYA CORRIDOR.....	F-1
F.11	REVIEW OF FEASIBILITY STUDY.....	F-1
F.11.1	Status of Submittal	F-1
F.11.2	Traffic Studies and Forecast.....	F-1
F.11.3	Traffic Forecast	F-3
F.11.4	Socio Economic Approach	F-3
F.11.5	Engineering Studies and Investigations.....	F-7
F.11.6	PROJECT COST.....	F-8
F.11.7	Environmental and Social Impact Assessment.....	F-8
F.11.8	Economic Analysis	F-9
F.11.9	Financial Analysis.....	F-9
F.12	OUR EFFORTS AND FINDINGS.....	F-10
F.12.1	Salient Corridor Characteristics	F-10
F.12.2	Traffic Studies and Forecast.....	F-10
F.12.3	Engineering Studies and Investigations.....	F-19
F.12.4	Design and Project Cost.....	F-19
F.12.5	Environmental and Social Impact Assessment.....	F-24
F.12.6	Tollable Traffic.....	F-31
F.12.7	Financial Analysis.....	F-33