FEASIBILITY REPORT

1.1 PROJECT BACKGROUND

The The National Highways Authority of India (NHAI) as employer and executing agency has commissioned the services of Intercontinental Consultants and Technocrats Private Limited (ICT) with the assignment of carrying out Feasibility study for development of Greenfield 6/8 Lane Expressway from Sanchore to Ahmedabad via Deesa & Mehsana (approx. length 205 Km) under Bharatmala Pariyojana in the State of Gujarat with reference to Minutes of Meetings for Ministry of Road Transport and Highways meeting held on 07.09.2020 under the chairmanship of Hon'ble Minister (RT&H) where it was decided to finalize most optimal alignment from Sanchore – Ahmedabad to provide alternate and shorter route to Mumbai bound traffic considering the economic importance of the corridor.

It has been decided by NHAI to assign the Feasibility Study of the 6/8 Lane Greenfield Expressway from Sanchore to Ahmedabad as a variation to the main Contract namely "Project Management Phase-I including Preparation of Detailed Project Report for Upgradation of NH-168 from Sanchore via Dhanera to Deesa + Junction with NH-68 near Tharad connecting Dhanera, Panthawada Section of NH-168A to Two/Four Lane" which has been signed between IAHE and ICT dated 6th May, 2015.

The supplementary agreement for the services for the subject project was signed on 4th November 2020 and the NHAI has asked the Consultants to commence the consultancy services vide it's letter no. NHAI/Guj./Sanchore-Deesa/ICR/BM/ 2020/95 dated 6th November 2020.

Further, the Alignment Option Study report for Sanchore-Ahmedabad section has been submitted to NHAI vides our letter No: ICT/NHAI/SANC-AHD/853/459 dated 21st January 2021, subsequently NHAI vide letter No. NHAI/PIU/Palanpur/ ICT/2021/1868 dated 29th July 2021 approved the Alignment report for Greenfield alignment and requested consultant to proceed with future works as per signed contract for approved alignment option by LAC committee. LAC has approved the alignment starting from Amritsar-Santhalpur expressway at Vajegarh village in Banankantha district and terminating on Ahmedabad-Vadodara Expressway (NE1) in Bhuval village in Ahmedabad district.

Subsequent to the submission of alignment option report and approval of alignment from LAC committee; A go ahead was given by NHAI to prepare the Draft feasibility report. Based on the practical considerations observed at the site and the suggestions from public representatives and concerned PIUs, the proposed Greenfield alignment proposals was fine-tuned and finalized.

1.2 OBJECTIVE

The main objectives of the Consultancy services are as under:

- To establish the technical, economical, and financial viability of the project and prepare feasibility project report for Greenfield alignment between Tharad and Ahmedabad as per latest codal provisions.
- The Feasibility Report would inter-alia include detailed highway design, design of pavement for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, design of connecting roads, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analyses, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project on commercial basis for international / local competitive bidding.
- To ensure detailed project preparation incorporating aspects of value engineering and safety audit requirement in design and implementation

1.3 PROJECT DESCRIPTION

NHAI is constructing Six Lane Access Controlled Economic Corridor from Amritsar to Jamnagar under Bharatmala Pariyojana (Phase-I). This economic corridor is passing through India's most agricultural and industrial potential states like Punjab, Haryana, Rajasthan and Gujarat. This project is already in advance stage of implementation.

Further Ahmedabad and Vadodara are already connected with Expressway (NE1) and the Vadodara Mumbai Expressway including Spur to JNPT is also under construction. Hence, it is required to connect the Amritsar Jamnagar economic corridor through a Greenfield Expressway to Ahmedabad so that eventually there will be expressway connectivity between Amritsar and Mumbai. Considering the economic importance of the corridor, as mentioned above Hon'ble Minister (RT&H) directed NHAI to finalize most optimal Greenfield alignment connecting the Amritsar Jamnagar economic corridor near Sanchore in Rajasthan to Ahmedabad in Gujarat (approx. length 205 Km) considering that it would provide alternate and shorter route to traffic from/to Amritsar to/from Mumbai. Thus the proposed Sanchore Ahmedabad Expressway, a missing link between Amritsar and Mumbai provides expressway connectivity between major cities en-route which contributes and has huge potential for being part of economic development of the country.

1.3.1 Proposed Alternate Alignments

The selection of final alignment option proposal is key to ensure that planned expressway is easily accessible to the economic hubs at a shortest distance to reap benefits for economic activity and also to ensure the planned expressway serve maximum traffic in the region thus ensuring decongestion of existing highway network. Initially 6 alignment options have been studied, 2 alignment options starting from Sanchore in Rajasthan, and remaining 4 alignments starting from Tharad in Gujarat. It is observed that expressway between Amritsar and Jamnagar is already

under construction and it would provide smooth connection between Sanchore and Tharad which would reduce the project length about 45kms. Although there were 6 alignment options given during LAC, there are 3 most feasible alternatives of approved alignments.
Therefore following three options have been considered for further analysis in feasibility report.

Option-1: Tharad to NE-1 (Near Harniyav) via Patan, Unjha, Mehasana, Gandhinagar, Dahegam
Option-2: Tharad to NE-1 (Near Harniyav) via Patan, Sidhpur, Unjha, Visnagar, Gandhinagar, Dahegam.
Option-3: Tharad to NE-1 (Ramol Interchange) via Patan, Mehsana, Kadi, Sanand

Proposed Greenfield alignment options are presented in **Figure-1**. Comparative analysis for all the above three alternatives were done based upon the distance from Economic centers, Project length, Geometry complications, Social and Environment impact, Land acquisition, Forest / Protected areas involvement, structures, expected traffic, cost.

Consultant observed that **Option-1** is most suitable option with approx. length of 213.8 Km, passing through Banaskantha, Patan, Mahesana, Gandhinagar and Ahmedabad districts for consideration for connectivity between Amritsar Santhalpur Economic Corridor and Vadodara Mumbai Expressway for following reasons;

a) Length of option-1 **Alignment is around 13 and 30 Km shorter** as compared to Option-2 and Option-3 respectively.
b) Option-1 alignment has efficient connectivity with economic indicators compared to Option 3.
c) Expected diverted traffic on Option-1 is more compared to Option-2 & Option-3 and generated traffic would be more looking at the DMIC nodes along the corridors. More traffic would lead to more revenue so the financial viability.
d) **Diversion of forest land is minimum in option-1** as compared to Option-2 and Option-3 respectively
e) Shorter alignment length **also means lesser extent of land to be acquired** compared to other alignment Options.
f) The alignment also **would lead to minimize construction cost** substantially and **also associated implementation costs** which include monitoring cost during construction, implementation cost, minimized resettlement cost and etc.
g) The preferred option-1 alignment starting at proposed Tharad Bypass under Amritsar Santhalpur Economic Corridor (under construction) **would also mean economic prosperity in the region especially between Tharad and Patan** which is less developed, compared to later part from Patan towards Ahmedabad.

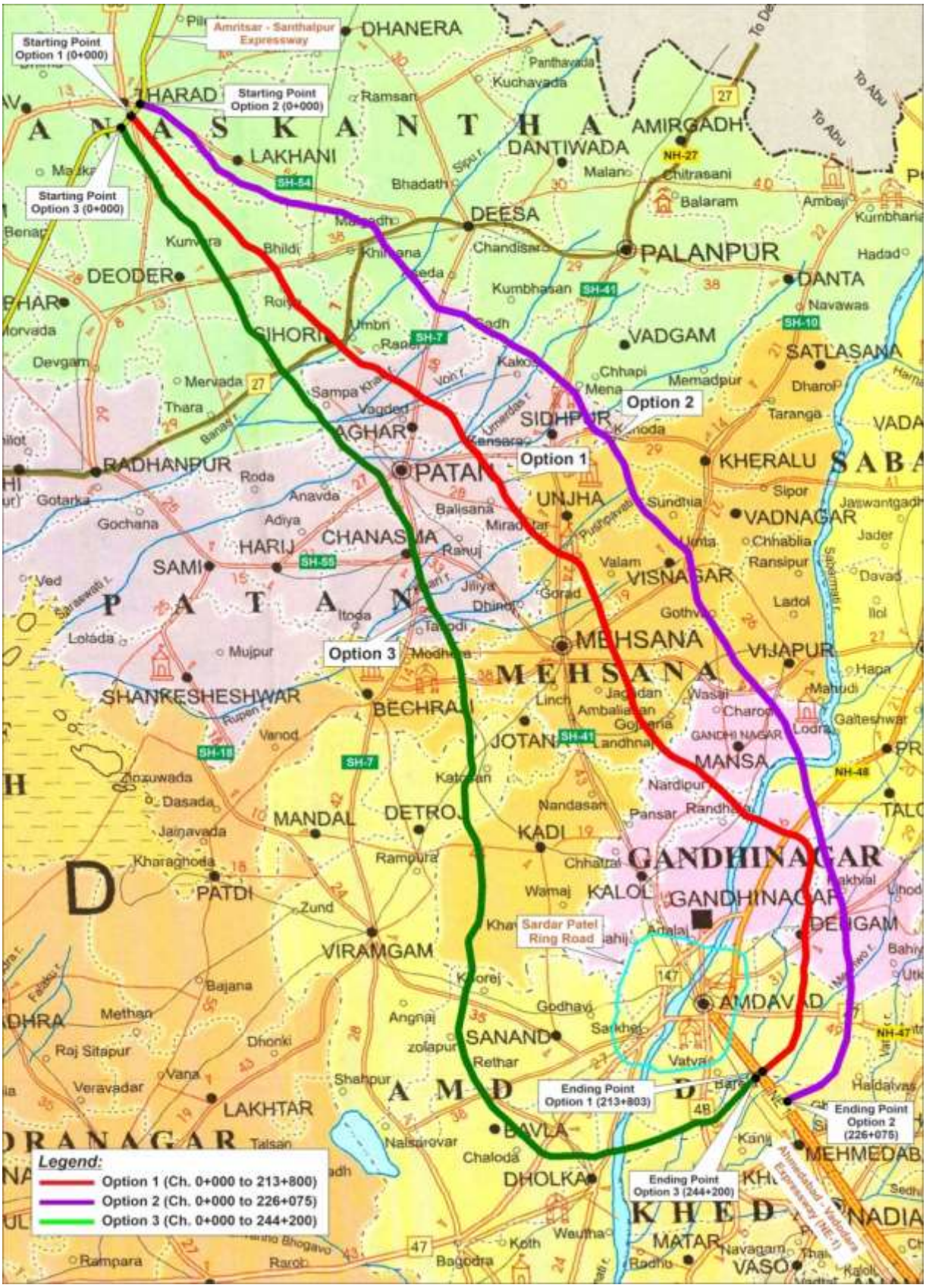

Figure-1 Index Map showing the Project Road and Alternative alignments

1.4 ENGINEERING SURVEYS AND INVESTIGATIONS

The consultants have carried out engineering surveys and investigations that include Topographic Surveys, Road Inventory of Existing Roads in Influence Area, Alignment Studies, Initial Environmental Screening and Assessment, Initial Social Screening Assessment, Pavement Composition, subgrade soil Investigations, Hydrological and Hydraulic investigation, preliminary Material Investigations for Construction Materials.

1.4.1 Road Inventory Surveys-Existing Roads in influence Area

Since the entire project road between Tharad and Ahmedabad is Greenfield alignment, the road inventory survey has been carried out for existing major roads in PIA which provides the connectivity between different economic centers along the project road alignment. Summary of road inventory/conditions is presented in tabular form in **Table-1.**

Table-Error! No text of specified style in document. **Road Inventory and Condition of Competing roads in PIA**

S. No.	Parameters	Competing Roads		
		SH-54	**SH-7**	**SH-41**
1.	Competing stretch	Tharad-Deesa	Deesa-Patan	Mehsana-Ahmedabad
2.	Roughness	IRI- 5m/km	IRI-5m/km	IRI-4m/km
3.	Pavement Cracks	10-15%	10-15%	10-15%
4.	Rutting	10mm	10mm	10mm
5.	Traffic Scenario	Medium Flow	Low to Medium	Heavy Flow
6.	Land Use	Mostly Agriculture	Mostly Agriculture	Commercial/ Agriculture
7.	**Geometry** i) Rise and Fall ii) Super elevation iii) Horizontal Curvature iv) Avg. Speed	 3 nos. per km 5% 50 degree 30kmph	 5 nos. per km 7% 75degree 30kmph	 3 nos. per km 5% 50degree 40kmph
8.	Drainage Condition	Poor	Poor	Poor

1.4.2 Hydrological Investigation

A reconnaissance survey of the site was carried in December 2021 in order to investigate the study area in terms of geological formation, rainfall and runoff potential and the hydraulic performance of the existing bridges / cross drainage structures to pass flood runoff of the past years

During the site visit the local enquiry about highest flood level, scour at bridge foundations, lowest water level, river bed material and river bed profile at all bridge locations have been observed. It is seen that the streams are weedy or Sandy in nature and surrounded by agricultural land and forest.

The project road is a Greenfield alignment; therefore, the existing bridges in upstream / downstream of the proposed alignment were visited and enquired about their hydraulic adequacy. Detailed discerption of various Hydrological Survey and Investigation carried out is discussed under Chapter 6: Engineering Surveys and Investigations

In addition to above the project road crosses existing canal network. The details of canal data were collected from respective departments.

1.4.3 Soil and Material Investigations

The survey and investigations includes field and laboratory testing of insitu soil samples collected along project alignment, identification of borrow soil locations for embankment and subgrade construction, aggregate sources, sand sources, fly ash and pond ash sources, sources of bitumen, steel, cement, admixture and laboratory testing of material as appropriate.

Sampling and Testing

For evaluating the characteristics and suitability of soils and various construction materials, representative samples of soil/construction materials as mentioned in TOR, are collected from in-situ alignment soil, identified borrow area, identified quarries of stone metal/sand , water sources and fly ash/pond ash.

As per requirements in TOR and visual inspection analysis, the sampling frequency was adopted. Dynamic Cone Penetration test (DCP), Field Dry Density (FDD), and Field Moisture Content (FMC) tests were carried out within large test pits (1m x 1m) at 5 km of the project road alignment. In-situ soil samples were also collected from each of the test pits dug for DCP tests. Additionally small test pits were dug at an interval of 2 km along the proposed alignment for determination of the soil classification of in-situ soil. The sampling and various laboratory tests conducted on soil and other construction materials.

A total 38 Borrow soil locations have been identified, visited, inspected and soil samples were collected for laboratory testing. The soaked CBR (97% compaction) of the borrow soil varies from 5.2% to 32%. Considering all the borrow areas, 80% of total borrow area soil have soaked CBR (97% Compaction) more than 10%., It is suggested that the borrow area soil which have soaked CBR (97% compaction) of 8% or more will be considered for subgrade construction and soaked CBR (97% compaction) of 6% or more will be considered for Embankment construction

A total of 7 course aggregate materials were collected and tested. It is observed from field visit and laboratory tests that sufficient quantities of Stone/Aggregate material are available in the quarries for construction purposes. The aggregate from all the identified sources can be used for pavement construction

It has been observed that sand from source Banas river (CH 52+500) and Sabarmati

river (CH 163+500) falls in Zone II and Zone I respectively and also the fineness modulus is within the MORTH prescribed limit of 2.0-3.5. Thus the sand from source at Km 52+500 and Km 163+500 can be used for road construction, whereas the sand from other two sources (km 79+500 and km 204+500) does not fall in any zone and its fineness modulus is also less than the minimum MORTH specified value 2.0, thus the sand from these sources can be used if required by mixing it with stone dust.

39 water samples out of total 44 samples are found suitable for concrete works. The water sources at Km 70+000, Km 74+000, Km 100+000, Km 105+000 and Km 110+000 have more chloride content than the specified limits of MORTH, hence cannot be used for construction. During construction time, the contractor will explore more sources for use of water during construction if required.

Four sources of pond ash have been identified in the proposed alignment vicinity. Representative samples of pond ash from two sources had been collected from these sources for testing. Manufactured Materials like cement, bitumen and steel is available in vicinity of project road.

Detailed field and laboratory tests were conducted on existing subgrade, granular layer, bituminous layers and borrow material, sand, aggregate, water and fly ash and test details with results is discussed under Chapter 6: Engineering Surveys and Investigations.

1.5 APPLICABLE DESIGN STANDARDS

Design standards for this project conform with “Manual for Safety in Road Design” by Government of India, Ministry of Surface Transport (Roads Wing) September 1998, Manual of Specification & Standards for Expressways (IRC:SP:99), Manual on Road Safety Audit (IRC:SP:88) and various relevant standards published by Indian Road Congress (IRC) and Bureau of Indian Standards (BIS). However, where IRC does not cover any particular feature or aspect appropriately, AASHTO or other International Standards be followed. All notations, abbreviations and symbols used in the reports, documents and drawings are as per IRC:71.

1.6 TRAFFIC SURVEYS ANALYSIS AND FORECASTING

1.6.1 Traffic Survey Analysis

A reconnaissance survey was taken up in view of delineating the road network and identifying the traffic survey locations to estimate expected traffic movement on the proposed expressway alignment. Traffic survey locations were identified considering that locations can are able to replicate the base year demand of the present network and can capture the traffic flow characteristics, travel pattern of users and also to identify the possible attraction of traffic to proposed expressway alignment. The finalized survey locations are schematically shown in **Figure-2.**

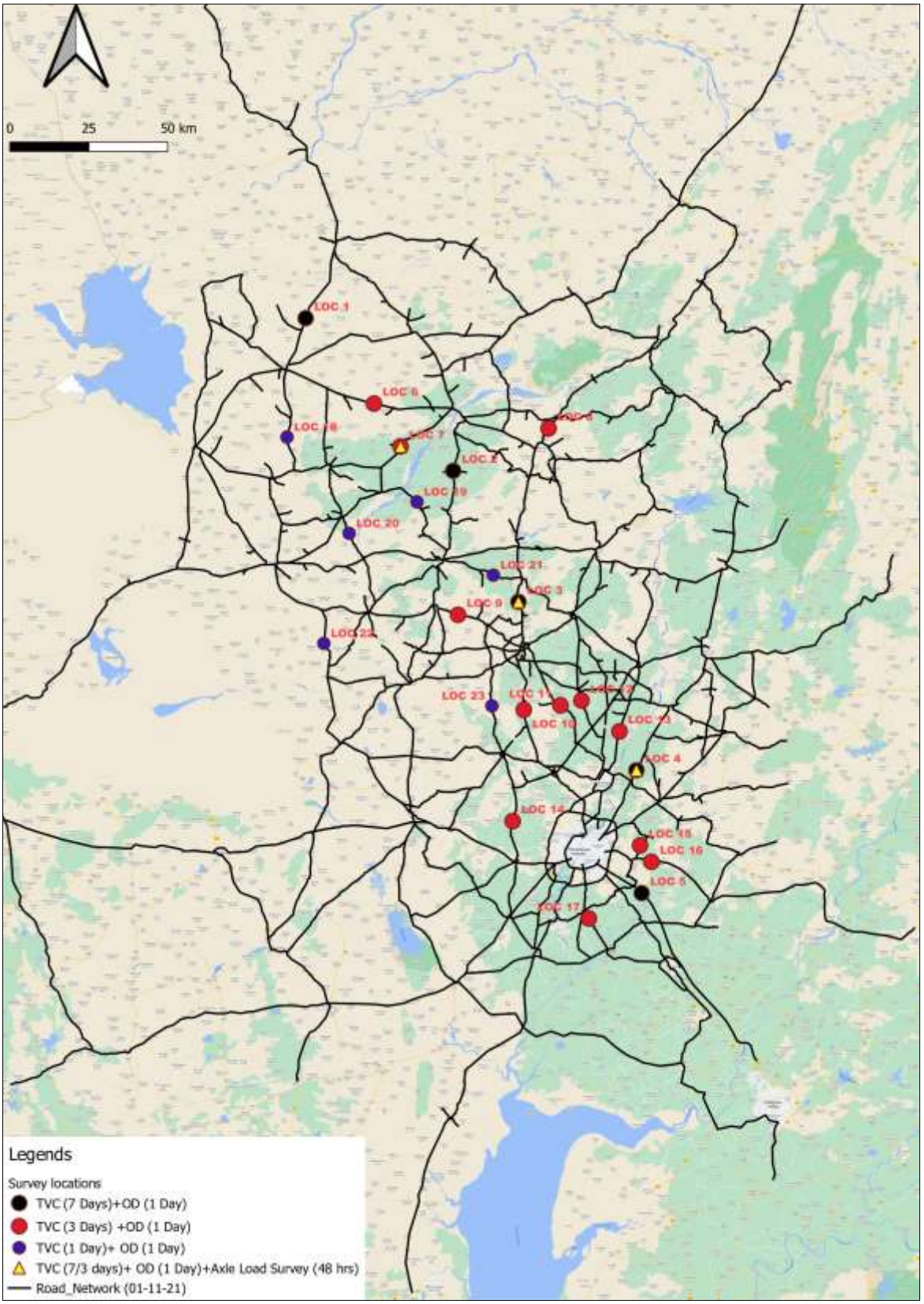

Figure-2 Traffic Survey Locations

Following primary traffic surveys were planned and conducted for the feasibility stage:

1. Automatic Traffic Classified Count (ATCC) for 7/3/1 Days;
2. Origin-Destination and Commodity Movement Survey (OD);
3. Speed and Delay; and
4. Axle Load Survey.

The average daily traffic was computed for various locations in the road network where the mid-block volume count survey was done. Daily traffic volumes were averaged to find the Average Daily Traffic (ADT).

Observations have been given section wise to have better understanding of the traffic in the network near to particular section. Location in the section is divided as follows:

Influence Region	Locations
Tharad – Patan influence region	1,2,6,7,8,18,19,20,22,25
Patan – Mehsana influence region	3,9,10,11,12,21,23
Mehsana – Ahmedabad influence region	4,5,13,14,15,16,17,24

A. Tharad-Patan Influence Region: There are 9 TVC locations in the section. It can be seen that maximum traffic volume is at Location 08 (near Khemana NH 27) which is of the order of 39774 PCUs (20027 veh). Lowest traffic volume has been found at Location 22 (Near Moti Chandur SH18) which is of the order 4031 PCUs (2663 veh). Traffic at Location 08 is high as it falls on NH 27 which is important highway. This road is North East Coridor which starts from Porbandar and terminates in Silichar. The highway passes through the states of Gujarat, Rajasthan, Madhya Pradesh, U.P, Bihar, West Bengal and Assam. Other than NH 27, SH 7 is also important highway which is parallel to NH 27.

B. Patan-Mehsana Influence Region : There are 7 TVC locations are situated near Patan–Mehsana region, maximum traffic volume is found at Location 10 (Near,Mandali SH41) which is of the order 48915 PCUs (38873 veh). Lowest traffic volume is recorded near Location 11 (Near Saldi SH 217) which is of the order of 4721 PCUs (4527 veh). Location 10 falls on SH 41 which is important state highway. SH 41 connect with NH 27 in Palanpur and NH 147 in Ahmedabad. Most of the traffic from NH 27 takes SH 41 to move towards Ahmedabad and further south.

C. Mehsana-Ahmedabad Influence Region: There are 5 TVC location falls in Mehsana-Ahmedabad, maximum traffic volume is found 56005 PCUs (33245 veh) at Location 05 (Near Near Jinjar NE1) followed by location 17 (Near Viraj plant NH64) which is of the order 52215 PCUs (42353 veh). Lowest volume is found at Location 15 (Near Lalpur SH144) which is of the order of 6570 PCUs (7594 veh). NE1 is the important highway in the region which connects Vadodara to Ahmedabad. Traffic from NH 47 takes NE1 to move towards Mumbai

A speed and delay survey using the moving car observer method was carried out along the green field alignment from Tharad- Ahmedabad section. All the existing National highway and State Highway along the green filed alignment has been considered for this survey. The average speed at Tharad-Ahmedabad section ranges from 40-80 kmph.

Based on the Consultant's experience in similar project observed data, it is considered that for LCV/2A/3A trucks VDF of 50% of SH 41, 25% of NH-48 & NH 27 and for MAVs VDF of 10.0 is reasonable for proposed expressway. Adopted VDFs are given in **Table-2**.

Table-2 Vehicle Damage Factor (VDF) for Proposed Alignment

Location	Direction	Vehicle Damage Factor (VDF)				
		LCV	2 Axle Truck	3Axle Truck	Multi Axle Truck (≥ 4 Axle)	Bus
Proposed Alignment	UP	1.24	2.37	7.09	10.00	1.74
	DN	0.43	1.80	6.07	10.00	1.55

1.6.2 Traffic Forecast

The comprehensive primary traffic surveys in association with the mapping of socio-economic profile of study area has provided a valuable input to undertake the exercise of traffic estimation for the proposed Expressway. The Consultant has developed a Regional Transport Demand Model (RTDM) for the study area for this purpose. The model is useful in considering a number of parameters during the process of transport demand generation, trip distribution in the study area, and traffic assignment on the road network of study area.

Base year travel demand model was prepared and it was further calibrated and validated. The calibrated model was used to distribute the trip ends and horizon year O-D matrices for different modes were obtained.

In the process of traffic forecast, it is necessary to distinguish between the various types of traffic. For this report, as defined in the document "**IRC: 108-2015, Guidelines for Traffic Forecast on Highways**" published by the Indian Roads Congress, New Delhi, following traffic components considered are as under:

- Normal Traffic
- Generated Traffic
- *Diverted Traffic*
- *Induced Traffic*
- Developmental Traffic

The growth rates for normal traffic estimated in account of the following factors, which normally affect the future traffic levels:

- The prospective growth in the economy
- The prospective demographic growth
- The estimated elasticity of demand for transport, and

Change in the structure of the vehicle fleet, for example in terms of vehicle productivity and changes in the inter-modal share of passenger and freight demand
To estimate the generated traffic, GIDC Industrial parks and SEZ falling close to project influence districts of Mehsana, Banaskantha, Patan, Gandhinagar and Ahmedabad have been considered for contributing significant trips to the Project road. A total of 43 industrial parks have been considered which have significant potential to contribute traffic on the project road. It is mostly going to be the freight traffic which is going to get contributed to the project road. Among the 43, 11 parks lie in Mehsana, 6 in Banaskantha and Patan each, 1 in Gandhinagar and Sabarkantha each and the rest in Ahmedabad district. There are 8 SEZs also which have potential to contribute traffic significantly to the project road.

Future Scenarios

The validated base year RTDM was further developed to examine various scenarios in order to predict and analyze future traffic in the region. A total of four scenarios as summarized in **Table-3** were developed for evaluation.

Table-1 Details of Future Scenarios

Scenario	Description
I	Do Nothing Scenario
II	Expressway with 4 Lane Facility and 9 Interchanges
III	Expressway with Six Lane Facility and 9 Interchanges
IV	Expressway with Six Lane Facility and 11 Interchanges

Homogenous sections for Project Road

Following homogenous sections are considered for trips assignment on proposed expressway and added in future road network along with Dholera and Amritsar-Jamnagar Expressway corridor. Details of all the homogenous sections of project road in different scenario is provided in **Table-4** and **Figure-3**.

Table-2 Details of Homogenous section for proposed Expressway

Homo-geneous Section	Scenario II/III			Scenario IV		
	Chainage (Km)		Details	Chainage (Km)		Details
	From	To		From	To	
Section 1	0+000	43+343	Tharad- NH27 Crossing (near Khimana)	0+000	43+343	Tharad- NH27 Crossing (near Khimana)
Section 2	43+343	71+140	NH27 Crossing (near Khimana) - SH7 Crossing (near Patan)	43+343	71+140	NH27 Crossing (near Khimana)- SH7 Crossing (near Patan)
Section 3	71+140	106+017	SH7 Crossing (near Patan) - SH41 Crossing	71+140	83+341	SH7 Crossing (near Patan)- SH10 Crossing (near

Homo-geneous Section	Scenario II/III			Scenario IV		
	Chainage (Km)		Details	Chainage (Km)		Details
	From	To		From	To	
			(near Mehsana)			Patan)
Section 4	106+017	162+063	SH41 Crossing (near Mehsana)- Gandhinagar Vijapur Road Crossing (near Gandhinagar)	83+350	106+017	SH10 Crossing (near Patan)- SH41 Crossing (near Mehsana)
Section 5	162+063	171+003	Gandhinagar Vijapur Road Crossing (near Gandhinagar)- NH48 Crossing (near Chiloda)	106+017	125+900	SH41 Crossing (near Mehsana)- SH55 Crossing (near Mehsana)
Section 6	171+850	188+543	NH48 Crossing (near Chiloda)- SH68 Crossing (near Dahegam)	125+900	162+063	SH55 Crossing (near Mehsana)- Gandhinagar Vijapur Road Crossing (near Gandhinagar)
Section 7	188+200	204+345	SH68 Crossing (near Dahegam)- NH47 Crossing (near Kujad)	162+063	171+003	Gandhinagar Vijapur Road Crossing (near Gandhinagar)- NH48 Crossing (near Chiloda)
Section 8	204+345	213+803	NH47 Crossing (near Kujad)- NE1 crossing (near Ahmedabad)	171+850	188+543	NH48 Crossing (near Chiloda)- SH68 Crossing (near Dahegam)
Section 9	--	--	--	188+543	204+345	SH68 Crossing (near Dahegam)- NH47 Crossing (near Kujad)
Section 10	--	--	--	204+345	213+803	NH47 Crossing (near Kujad)- NE1 crossing (near Ahmedabad)

Homogenous sections in Scenario II/III

Homogenous sections in Scenario IV

Figure-3: Homogenous Sections for Project Road in Different Scenario

Based upon the V/C ratio analysis and LOS criteria define in expressway manual that project road to be operational with "LOS B" (V/C ratio <0.5) or design volume 1, 20,000 PCUs for peak hour traffic of 6.5%, it is recommended that project road to be developed with 6 lane configuration with consideration of 20/30 years of design life of the road. Further, to capture more traffic and to provide wider accessibility of the project road for traffic bound to Patan. Deesa, and Mehsana, it is recommended to Scenario IV to be considered for the development of Project road with 11 interchanges. Traffic Forecast and capacity analysis for Scenario-IV is provided in **Table-5** and **Table-6** respectively.

Table-3 Section wise Estimated AADT (in PCUs) for Expressway as 6- Lane Facility (Scenario IV)

Section No.	Chainage (Km)		Estimated AADT (in PCU)				
	Start	End	2025	2030	2035	2045	2055
Section 1	0+000	43+343	27694	39942	56733	77712	117604
Section 2	43+343	71+140	25179	36250	51680	71152	109859
Section 3	71+140	83+341	23434	34128	49231	67729	106085
Section 4	83+341	106+017	30716	41734	56852	74811	112326
Section 5	106+017	125+914	37363	52141	73024	97134	131507
Section 6	125+914	162+063	41936	58191	81043	106640	142985
Section 7	162+063	171+003	45719	64686	91129	120055	159251

Section No.	Chainage (Km)		Estimated AADT (in PCU)				
	Start	End	2025	2030	2035	2045	2055
Section 8	171+003	188+543	38224	55510	79403	105554	139635
Section 9	188+543	204+354	40007	57511	81167	106486	136577
Section 10	204+354	213+803	34997	51834	74822	99548	128909

Table-4 V/C Ratio for Various Homogenous Section of Scenario IV of the Proposed Expressway (6 lane facility)

Proposed Expressway Section	Chainages (Start – End)		Year 2025	Year 2030	Year 2035	Year 2045	Year 2055
HS I	0+000	43+343	0.12	0.17	0.24	0.32	0.49
HS II	43+343	71+140	0.10	0.15	0.22	0.30	0.46
HS III	71+140	83+341	0.10	0.14	0.21	0.28	0.44
HS IV	83+341	106+017	0.13	0.17	0.24	0.31	0.47
HS V	106+017	125+914	0.16	0.22	0.30	0.40	0.55
HS VI	125+914	162+063	0.17	0.24	0.34	0.44	0.60
HS VII	162+063	171+003	0.19	0.27	0.38	0.50	0.66
HS VIII	171+003	188+543	0.16	0.23	0.33	0.44	0.58
HS IX	188+543	204+354	0.17	0.24	0.34	0.44	0.57
HS X	204+354	213+803	0.15	0.22	0.31	0.41	0.54

1.6.3 Toll Lanes

In Tharad-Ahmedabad Section, toll lane has been estimated for 10 years (Year 2035) of projected traffic as per toll policy for all the scenarios. Adequate land for Toll Plazas shall be acquired to permit the provision of toll lanes subjected to a minimum number of 6 toll lanes/8 toll lanes/12 lanes for 2-lane/ 4-Lane /6 Lane Project Highway respectively including buildings and structure to be accommodated at the toll plaza location. For toll plazas at interchange ramps, toll lane estimation is carried out for 10 year projected traffic as per M/M/s queuing theory based upon poisson distribution. In Scenario III, the toll lane requirement varies from 4 lane per direction to 5 lane per direction on main plaza and on sub toll plazas at interchange ramps, the toll lane requirement varies from 1-2 lane for all intermediate interchange for the year 2035.In scenario IV ,the toll lane requirement varies from 4 lane per direction to 5 lane per direction on main plaza and on sub toll plazas at interchange ramps, the toll lane requirement varies from 1-2 lane for all intermediate interchange for the year 2035. In addition to the number of toll lanes required on toll plaza, one extra-wide lane will have to be provided for oversized vehicles. The requirement of toll lanes for all toll plazas on the project road is summarized in the **Table-7**.

Table-5 Toll lanes requirements for toll plazas in Scenario III and IV in Year 2035

Interchange No.	Scenario III			Interchange No.	Scenario IV		
	2035				2035		
	Toll Plaza	Direction (Entry: to expressway, Exit: from expressway)	No. of Toll Lanes required (in each direction)		Toll Plaza	Direction (Entry: to expressway, Exit: from expressway)	No. of Toll Lanes required
Interchange 1	T1	Main	2x(5+1)	Interchange 1	T1	Main	2x(5+1)
Interchange 2	T21	Entry	1+1	Interchange 2	T2-1	Entry	1+1
		Exit	1+1			Exit	1+1
	T22	Entry	1+1		T2-2	Entry	1+1
		Exit	1+1			Exit	1+1
	T23	Entry	1+1		T2-3	Entry	1+1
		Exit	1+1			Exit	1+1
	T24	Entry	1+1		T2-4	Entry	1+1
		Exit	1+1			Exit	1+1
Interchange 3	T31	Entry	1+1	Interchange 3	T3-1	Entry	1+1
		Exit	1+1			Exit	1+1
	T32	Entry	1+1		T3-2	Entry	1+1
		Exit	1+1			Exit	1+1
	T33	Entry	1+1		T3-3	Entry	1+1
		Exit	1+1			Exit	1+1
	T34	Entry	1+1		T3-4	Entry	1+1
		Exit	1+1			Exit	1+1
Interchange 4	T41	Entry	2+1	Interchange 4	T4-1	Entry	1+1
		Exit	2+1			Exit	1+1
	T42	Entry	1+1		T4-2	Entry	2+1
		Exit	1+1			Exit	1+1
	T43	Entry	2+1		T4-3	Entry	1+1
		Exit	2+1			Exit	1+1
	T44	Entry	1+1		T4-4	Entry	1+1
		Exit	1+1			Exit	2+1
Interchange 5	T51	Entry	1+1	Interchange 5	T5-1	Entry	2+1
		Exit	2+1			Exit	2+1
	T52	Entry	1+1		T5-2	Entry	1+1
		Exit	1+1			Exit	1+1
	T53	Entry	2+1		T53	Entry	2+1
		Exit	1+1			Exit	2+1

Interchange No.	Scenario III			Interchange No.	Scenario IV		
	2035				2035		
	Toll Plaza	Direction (Entry: to expressway, Exit: from expressway)	No. of Toll Lanes required (in each direction)		Toll Plaza	Direction (Entry: to expressway, Exit: from expressway)	No. of Toll Lanes required
	T54	Entry	1+1		T54	Entry	1+1
		Exit	1+1			Exit	1+1
Interchange 6	T61	Entry	2+1	Interchange 6	T6-1	Entry	1+1
		Exit	1+1			Exit	1+1
	T62	Entry	1+1		T6-2	Entry	2+1
		Exit	1+1			Exit	1+1
	T63	Entry	1+1		T6-3	Entry	1+1
		Exit	2+1			Exit	1+1
	T64	Entry	1+1		T6-4	Entry	1+1
		Exit	1+1			Exit	1+1
Interchange 7	T71	Entry	1+1	Interchange 7	T7-1	Entry	1+1
		Exit	1+1			Exit	2+1
	T72	Entry	1+1		T7-2	Entry	1+1
		Exit	1+1			Exit	1+1
	T73	Entry	1+1		T7-3	Entry	2+1
		Exit	1+1			Exit	1+1
	T74	Entry	1+1		T7-4	Entry	1+1
		Exit	1+1			Exit	1+1
Interchange 8	T81	Entry	1+1	Interchange 8	T8-1	Entry	2+1
		Exit	1+1			Exit	1+1
	T82	Entry	1+1		T8-2	Entry	1+1
		Exit	1+1			Exit	1+1
	T83	Entry	1+1		T8-3	Entry	1+1
		Exit	1+1			Exit	2+1
	T84	Entry	1+1		T8-4	Entry	1+1
		Exit	1+1			Exit	1+1
Interchange 9	T9	Main	2x(5+1)	Interchange 9	T9-1	Entry	1+1
						Exit	1+1
					T9-2	Entry	1+1
						Exit	2+1
					T9-3	Entry	1+1
						Exit	1+1
					T9-4	Entry	1+1
						Exit	1+1
				Interchange 10	T10-1	Entry	1+1
						Exit	1+1
					T10-2	Entry	1+1

Interchange No.	Scenario III			Interchange No.	Scenario IV		
	2035				2035		
	Toll Plaza	Direction (Entry: to expressway, Exit: from expressway)	No. of Toll Lanes required (in each direction)		Toll Plaza	Direction (Entry: to expressway, Exit: from expressway)	No. of Toll Lanes required
						Exit	1+1
					T10-3	Entry	1+1
						Exit	1+1
					T10-4	Entry	1+1
						Exit	1+1
				Interchange 11	T11	Main	2x(5+1)

1.7 PROPOSED IMPROVEMENTS

The project road consists of a Greenfield alignment of length 213.803 Km from Tharad to Ahmedabad. The project road takes off on 6-Lane Amritsar-Santhalpur Expressway at Ch. 39+825 and ends at Km 14+450, Bhuval village by connecting Ahmedabad-Vadodara Expressway.

Following are the key points of the project road proposed for 6-Laning of Greenfield alignment as per the design standards in order to achieve safe, smooth and efficient movement of traffic flow in the new facility.

- Tharad-Ahmedabad Expressway forms an important intra-state link and also provides the connectivity between two major regional expressways which connects 5 Indian states (Punjab, Haryana, Rajasthan, Gujarat and Maharashtra).
- Greenfield alignment proposed from Tharad to Ahmedabad to reduce the travel length and travel time compared to existing road.
- 11 Interchanges are proposed to provide access controlled mobility to various economic centers along the project road.
- Provision of grade separated structures at multiple locations to serve crossing of motorised, non-motorised traffic and animals.
- Provision of adequate numbers and size of cross drainage structures across major river crossings as per hydraulic and hydrological requirements
- The approved ROW in general is 70 m.
- Provision of **project facilities** like bus bays, truck lay-byes, wayside amenities, street lighting, boundary walls etc., at appropriate locations as per the requirements of the manual. **Provision of road safety devices** which includes crash barriers, anti-glare devices, delineators, road studs, pedestrian guard rails,

road signs, road markings etc., as per the requirements of the manual to enhance the safety of road users

- **Start and Termination** of Project road by Interchange facility with Amritsar-Santhalpur Expressway and Ahmedabad-Vadodara Expressway respectively.

1.7.1 Proposed Interchanges

The number/spacing of the interchanges will have a bearing on the cost of the expressway, operation of traffic and utilization of the expressway. Closely spaced interchanges will affect the flow of the through traffic due to shorter available weaving length as well as it will be costlier. The interchanges at a long interval will lead to long detour and the expressway may not be able to capture enough traffic for its justification and the users will not be able to avail the facility of fast movement corridor. The locations of other intermediate interchanges have been decided through the use of transport demand model developed for Tharad-Ahmedabad Expressway study. The transport demand model has been run for different combinations of interchanges and the most optimum locations which will lead to maximum traffic on the expressway has been found. Based on this study, a total of 11 interchanges have been recommended for the expressway. Selection of interchange locations has been discussed in detailed in chapter 8 of this report. Interchange locations finalised for proposed alignment option are provided in **Table-8.**

Table-6 Location of Interchanges

Inter-change No.	Intersecting Road	Chainage (km)	Developments on either side	
			From	To
1	Amritsar- Santhalpur Expressway (NH754K)	0+000	Sanchore	Santalpur
2	Santalpur- Palanpur National Highway (NH-27)	43+343	Chekhala	Samanva
3	Deesa-Patan Highway (SH-7)	71+140	Aghar	Vadu
4	Patan-Siddhpur Highway (SH-10)	83+341	Kamliwada	Nedra
5	Palanpur- Mehsana Highway (SH-41)	106+017	Bhandu	Jetalvasana
6	Mehsana- Himmatnagar Highway (SH-55)	125+900	Devrasan	Udalpur
7	Gandhinagar- Vijapur Road	162+063	Pimplaj	Aluva
8	Ahmedabad-Udaipur National Highway (GIDC) (NH-48)	171+003	Dhanap	Chhala
9	Naroda- Dehgam Road (SH-68)	188+543	Sonarda	Dahegam
10	Indore- Ahmedabad National Highway (NH-47)	204+345	Kujad	Kuha
11	Ahmedabad- Vadodara Expressway (NE-1)	213+803	Ahmedabad	Vadodara

1.7.2 Structures

The expressway is access controlled facilities and therefore access will only be provided at the interchanges. All other road crossings therefore will be provided either with a flyover or with a vehicular underpass with no access to the expressway. Summary of grade separated structured provided in **Table-9**.

Table-7 Summary of Grade Separated Structures

S. No.	Description	Numbers
1	Flyover	36
2	VUP	16
3	LVUP	87
4	SVUP	83
5	Railway Over Bridge	8
6	Major Bridge	23
7	Minor Bridge	57
	Total Structures	**310**

1.7.3 Pavement Design

Life Cycle Cost Analysis

In accordance to MORT&H's Circular number "RW/NH-33044/53/2013-S&R(R) dated 20th November 2013", Life Cycle Cost Analysis (LCCA) needs to be carried out for various pavement options considered for the project road. Thus, LCCA is carried out for **all the pavement options designed for 20 years design life for expressway**.

The main purpose of LCCA is to evaluate and finalize best pavement option primarily according to the criteria of minimum total life cycle cost. The Net Present Value (NPV) method has been used for this project to calculate the current value of costs occurring over the expected service lives of the treatments. In this method all costs are converted into capital sums of money which, invested at present for the analysis period, would provide the sums necessary for construction of a project and subsequent maintenance during the period.

In estimating the Net Present Value of the costs, the principal parameters are:

- Initial cost
- Subsequent costs associated with the regime of maintenance and rehabilitation activities including routine, periodic maintenance, structural rehabilitation, appropriate to intervention required for each pavement type.
- Salvage value of the pavement at the end of analysis period
- Evaluation year, the year to which future costs are discounted
- Discount and Inflation rate
- Analysis period

The project road is divided into total 10 homogenous sections and the LCCA is carried out for all the HS. Year 2022 has been selected as the evaluation year and an analysis

period of 30 years has been adopted. Cost of all the options has been calculated using a discount rate of 10% and escalation of 6%.

As per clause 4.3.1 of IRC 37-2018, pavements for very high density corridors (more than 300 msa) and expressways shall preferably be designed as long-life pavements. Otherwise, for such corridors, the pavement shall be designed for a minimum period of 30 years. As the project road is expressway and thus with due consideration of this clause along with very low maintenance for long life pavements with only functional overlay, **for the project expressway long life pavement (perpetual) is recommended**

Summary of Pavement Design Recommendations

As per the pavement design and analysis as presented in above sections and taking site condition into consideration, **Table-10** presents the recommended pavement structure of main carriageway for new construction and **Table-11** presents the rigid pavement structure at toll plaza. For connecting roads/slip roads, the recommended flexible pavement structure is shown in **Table-12**.

Table-8 Recommended Pavement Structure for Main Carriageway

Traffic Homogeneous Section	Pavement Composition (mm)			
	BC*	DBM**	WMM	GSB
HS-1	50	230	200	200
HS-2	50	240	200	200
HS-3	50	240	200	200
HS-4	50	260	200	200
HS-5	50	240	200	200
HS-6	50	250	200	200
HS-7	50	240	200	200
HS-8	50	230	200	200
HS-9	50	240	200	200
HS-10	50	250	200	200

***Note**- * BC layer is with polymer modified bitumen.*
***DBM – The lower 70 mm thickness shall have DBM grading 2 and the remaining thickness shall be Grading 1 laid in two layers.*

Table-9 Recommended Rigid Pavement for Toll Plaza Pavements

Pavement details	Toll Plaza Locations	
	HS 1 to HS 4	HS 5 to HS 10
Pavement quality concrete (PQC)	270	280
Dry lean concrete (DLC)	150	150
GSB layer	200	200
Prepared sub-grade	500	500
Dowel Bar		
Diameter (mm)	36	36

Pavement details	Toll Plaza Locations	
	HS 1 to HS 4	HS 5 to HS 10
Spacing (mm)	300	300
Length (mm)	500	500
Tie Bar (Deformed)		
Diameter (mm)	12	12
Spacing (mm)	660	640
Length (mm)	640	640

Table-10 Recommended Flexible Pavement Structure for connecting roads/ Slip Roads

HS-1 to HS-10	
Layer Type	**Thickness in mm**
Bituminous concrete, VG-40	40
Wet mix aggregate base	150
CTSB	200
Sub-grade	500

1.7.4 Project Facilities & Toll Plaza Locations

Consultant has field verified project road both along existing and proposed alignment and has carefully identified locations for Toll Plaza based on traffic circulation and project facilities as per guidelines under section 10 & Section 12 of IRC:SP: 99. Road Boundary wall along the entire project length has been provided and shown in Typical Cross-sections as provided under Volume III - Drawings. Toll Plaza Locations and other project facilities is been given under **Table-13** and **Table-14** below:

Table-11 Toll Plaza Locations

Toll Plaza Location	Toll Plaza Code	Remarks
Interchange 1, Km 2+475 on Main Expressway	T1	Trumpet Interchange (single toll plaza on main carriageway)
Interchange 2, Km 43+343	T2	Offset Interchange (Single Toll Plaza between two Trumpets)
Interchange 3, Km 71+140	T3	Offset Interchange (Single Toll Plaza between two Trumpets)
Interchange 4, Km 83+341	T4-A	Toll Plaza at Every Loops of Cloverleaf Interchange (One Toll plaza would cater 2 movement)
	T4-B	
	T6-B	Offset Interchange (Single Toll Plaza between two Trumpets)
	T4-D	Additional Toll Plaza For Ahmedabad-Patan Left manoeuvring
Interchange 5, Km 106+017	T5	Offset Interchange (Single Toll Plaza between two Trumpets)

Toll Plaza Location	Toll Plaza Code	Remarks
Interchange 6, Km 125+914	T6-A	Offset Interchange (Single Toll Plaza between two Trumpets)
	T6-C	Additional Toll Plaza For Ahmedabad-Patan Left manoeuvring
Interchange 7, Km 162+063	T7	Offset Interchange (Single Toll Plaza between two Trumpets)
Interchange 8, Km 171+003	T8	Offset Interchange (Single Toll Plaza between two Trumpets)
Interchange 9, Km 188+543	T9	Offset Interchange (Single Toll Plaza between two Trumpets)
Interchange 10, Km 204+345	T10-A	On Partial Cloverleaf arm in South-west Quadrant
	T10-B	On Diamond Arm to cater Ahmedabad-Tharad Left manoeuvring (Entry)
	T10-C	On Diamond Arm to cater Tharad-Godhra Left manoeuvring (Exit)
	T10-D	On Diamond Arm to cater Godhra-Vadodara Left manoeuvring (Entry)
Interchange 11, (Km 211+350 on Main Expressway)	T11	Trumpet Interchange (Single Toll on main carriageway)

Table-12 Locations for Proposed Wayside Amenities (WSA)

Sr. No.	Locations	
	LHS	RHS
1	15+100	15+100
2	76+500	76+500
3	131+700	121+200
4	163+800	176+450

1.8 ENVIRONMENTAL SCREENING OF THE PROJECT

The proposed project is the construction of 6/8 lane Greenfield Expressway from Tharad to Ahmedabad and the alignment of the proposed expressway is passing through 5 Districts and 14 Talukas in the State of Gujarat.

As per the EIA Notification, 2006 and its subsequent amendments, it is a category **"A"** project and **Environmental Clearance will be required** from the EAC of MoEF&CC. Obtaining ToR from MoEFCC for EIA Study is under progress. The Final EIA Report is to be prepared as per the approved ToR of MoEFCC.

There is no reserved forest along the alignment and close vicinity of the proposed expressway alignment. However, the proposed alignment is crossing existing National Highways (NH), State Highways (SH) & Major District Roads (MDR) and

plantation along these roads are declared as Protected Forest. The proposed project involves diversion of approx. **8.568 ha** of protected forest land out of which 1.12 ha in Banaskantha district, 1.995 ha in Patan district, 1.925 ha in Mahesana district, 2.31 ha in Ghandinagar district and 1.218 ha in Ahmedabad district. Hence, **Forest Clearance will be required**. Tree Felling Permission will be required from Forest Department of Government of Gujarat for the proposed project.

There are no protected areas (National Park, Wildlife Sanctuary, Biosphere Reserved etc.) and it's Eco-Sensitive Zone within 10 km radius of the proposed expressway. Hence, **Wildlife & ESZ Clearance are not required**.

Further, no ASI protected monument located within 300m of the proposed alignment of the expressway. Hence, NOC from ASI is also not required.

1,02,456 no. of trees and 2,74,289 no. of hedges have been proposed to be planted under greenbelt development plan. A capital cost provision of about **Rs. 63.38 Crores** has been kept towards implementation of the Environment Management Plan (EMP). This budgetary provision has been divided into two categories i.e. EMP works to be implemented by the Contractor under civil works contracts and cost of Compensatory Afforestation (CA) and Net Present Value (NPV) to be paid by the NHAI.

1.9 SOCIAL IMPACT ASSESSMENT

The initial social impact assessment and resettlement study is meant to determine the magnitude of potential impact on the population and properties due to improvement of proposed road with the objective to ensure the social considerations be given adequate weightage in the selection and design of proposed highway improvements. Basic idea is to minimize adverse social impacts with best possible engineering solutions at the optimal cost. Based on the LAC approval 70m width of ROW has been considered in general. However, additional land for interchanges, wayside amenities, connecting roads has been considered. As per assessment 1744.42 hectare of land is to be acquired for the project.
The total number of affected properties in project road is 805, out of which 778 are private, 15 are Government and 12 are CPRs. The descriptions of affected properties of different categories are briefed in the **Table-15.**

Table-13 Ownership of Properties to be Affected

Type of Properties	No. of affected Structure		Total
	Left	Right	
Private	372	406	778
Government	3	12	15
CPRs	2	10	12
Total	**377**	**428**	**805**

The R&R budget for the widening of existing road worked out approximately for project is **Rs. 2577.28 Crores**.

1.10 PRELIMINARY COST ESTIMATES

The Civil Cost and Total Capital Cost works out to be as under **Table-16.**

Table-14 Civil Cost and Total Capital Cost

S. No.	Descriptions	Cost (Rs. Crs.)
1	Civil Cost (In Crores)	9419.47
	Civil Cost/ km (In Crores)	44.06
2	Total Project Cost (In Crores)	13567.25
	Total Project Cost /km (In Crores)	63.46

1.11 ECONOMIC ANALYSIS

The economic analysis is carried out to evaluate the economic viability of the proposed 6 lane access controlled expressway in terms of savings in Vehicle Operating Costs (VoCs) and the time savings. In the present condition SH54 and SH41 are the nearest major roads running parallel to the proposed expressway. These roads currently having 2 lane and 4 lane divided configuration respectively. Also, widening of section of SH41 that is to the north of Mehsana to 6 lanes is in progress. Therefore Existing 2-Lane, 4-Lane and 6-Lane section of these roads are considered as the base case road network system which is nothing but “Without Project Case’ scenario. Alternatively in the “With Project Case” scenario there will be 6- lane expressway running parallel to SH54 and SH41. The economic analysis is carried out within the broad framework of social cost-benefit analysis. The appraisal compares the total transport costs in situations of “with” the project and “without” the Project highway.

The annual cost and benefit streams are used to derive the net cash flow for the project. The EIRR (Economic Internal Rate of Return) and discounted NPV (Net Present Value for both scenarios at 12% discount rate are determined using the discounted cash flow technique for all the Sections are given in **Table-17**.

Table-17 Result of Economic Evaluation in Base Scenario

Project Stretch	EIRR (%)	NPV (Rs. Cr)
Tharad Ahmedabad Expressway (213.8km)	9.8	-2,697.7

Sensitivity analysis has been carried out for the below mentioned three variations in costs and benefits for both scenarios. Sensitivity analysis has been performed for both with time and without time alternatives. The sensitivity scenarios take into account possible construction costs overrun decreased in traffic volume forecasted, revenue shortfalls, interest rate volatility, non-compliance or default by contractors, and political risks.

Case I Base Cost plus 15 % and Base Benefits
Case II Base Cost and Base Benefits minus 15%

Case III Base cost plus 15% and Base Benefits minus 15%

Summary for the Sensitivity analysis in terms of EIRR (%) and discounted NPV are given in **Table-18.**

Table-158 Sensitivity Analysis (30 Years life)

Project Stretch		Case I	Case II	Case III
Tharad Ahmedabad Expressway (213.6km)	EIRR (%)	8.8	-1.9	-2.4
	NPV (Rs. Cr)	-4,277.9	-10,783.22	-12,363.44

The above result indicates that the expressway with base traffic numbers and capital cost is not **economic viable**. However when the intangible benefits are considered, it is expected that the project shall be substantially viable base case as well as in sensitivity cases. The Implementation of the project road is highly desirable for the economic development of the region considering the stretch as main connectivity between two major ongoing expressway projects. Hence, development of the project roads should be taken up for implementation without any delay in view of full realization of benefits to the road users and the community along the Project influence area.

1.12 PROJECT IMPROVEMENT PROPOSAL CONCLUSIONS

Based on detailed study of the project road and latest circulars and codal provisions as issued by various implementing agencies, following are the recommendations to be adopted for the proposed improvement proposal for the Greenfield alignment between Tharad and Ahmedabad

- Improvement proposal as 6-lane divided carriageway based on initial traffic assessment.
- Publication of Gazette Notification / In-principal approval of Authority for the Greenfield Alignment as Expressway after finalization of the alignment by the MoEFCC
- Provision of Interchanges, Grade Separated Structures, Railway over Bridges as recommended in the improvement proposal to provide safe, smooth and efficient traffic movement, and improve safety of road users.
- Provision of project facilities wayside amenities, street lighting, boundary walls etc., at appropriate locations as per the requirements of the manual. Provision of road safety devices which includes crash barriers, anti-glare devices, delineators, road studs, pedestrian guard rails, road signs, road markings and ATMS etc., as per the requirements of the manual to enhance the safety of road users.
- Provision of adequate numbers and size of cross drainage structures across major river crossings as per hydraulic and hydrological requirements.
- Improvement Proposal within 70 m PRoW in general.

- Access Controlled facilities of entire project with 11 Interchanges including the start and end.
- The improvement proposal for Project Road between Tharad and Ahmedabad is recommended to be implemented under 6 Different Packages with package length raging between 23.5 to 43.5 m.

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