TABLE OF CONTENTS

EXECUTIVE SUMMARY

0.1 INTRODUCTION

Uttar Pradesh Expressways Industrial Development Authority (known by its acronym UPEIDA) was set up by the State Government under U.P. Industrial Areas Development Act 1976, in December 2007 for development of Expressways in Uttar Pradesh. This is a newly established Organization with lean and laborious employee base, on contract or on deputation basis from State Revenue Department/PWD, among them few are deployed on retainership basis or by service provider.

Govt. of Uttar Pradesh (GoUP) has successfully developed 165 km Noida to Agra 6 Lane Access Controlled Expressway (Yamuna Expressway). Rigid pavement has been constructed for the entire length of the expressway. The project was developed on Public Private Partnership (PPP) mode and is in operation since August 2012.

Fig. 0.1 - Yamuna Expressway

The work of linking this expressway with State Capital through another high speed six lane corridor namely "Agra to Lucknow Access Controlled Expressway (Green Field) Project" has also been successfully completed. It is India's largest 302 Km access controlled Greenfield expressway. The entire length of the project road is of flexible pavement type. This Expressway Project has been developed on EPC mode with Government funding.

Fig. 0.2 – Agra-Lucknow Expressway

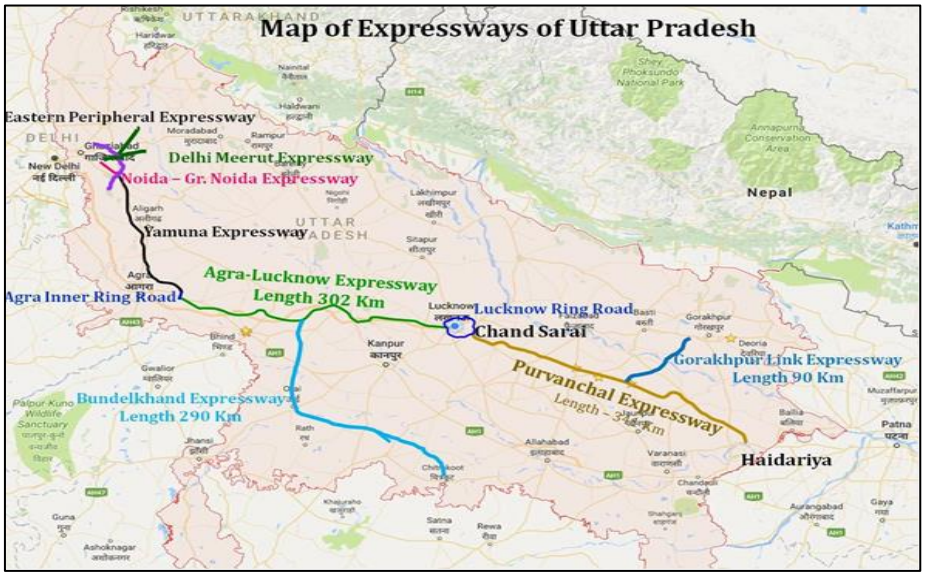
The Yamuna Expressway & Agra-Lucknow Expressway network starting from Noida area to Lucknow city provides seamless travel between State Capital and National Capital.

The Authority is developing another 6 Lane Access Controlled Green Field Expressway "The Purvanchal Expressway" in EPC Mode, which will connect to outer Ring Road in Lucknow which in turn will be connected to "Agra-Lucknow Access Controlled Expressway (Green Field) Project" at Lucknow. This Expressway project shall create immense opportunities to the people of eastern region of the State and over all development of the State by providing high speed connectivity between East & West borders of the State and with national capital.

The construction for 'Purvanchal Expressway', 'Bundelkand Expressway' & 'Gorakpur Link Expressway' projects are in progress & these Expressways are expected to be ready by 2020, 2022 & 2022 respectively.

Fig. 0.3 – Construction of Purvanchal Expressway

The Uttar Pradesh Government has decided to develop the "Ganga Expressway Project". UPEIDA is committed for the development of this expressway and has Entrusted M/s L N Malviya Infra Projects Pvt. Ltd., Highway Engineering Consultant and Intratech Civil Solutions (Consortium) to carry out the detailed project report to implement the project on EPC Mode and selection of developers through competitive bidding process.



The project will provide direct high speed connectivity from National Capital Region through proposed expressway to Meerut and then onwards to Prayagraj. It will facilitate construction of all-weather high speed access controlled expressway, which will decongest the increasing traffic on existing road network. The expressway will also decrease travel time substantially.

The Consultant has undertaken requisite surveys & studies for the project which includes costing to assess technical, environmental and social assessment studies, their analysis etc. As a part of the study to establish the viability, this Project Report has been prepared after carrying out engineering surveys and appropriate assessment of a preliminary design considering the engineering conditions, the present traffic and its growth, the environmental impact assessment as well as the social aspects along with cost assessment. This report among other aspects covers the details on finalization of alignment, grade separator interchanges and structures along the proposed Expressway, marking on the Khasra maps of ROW and marking of alignment on revenue maps, identification of Tourist spots, eco-friendly structures, water bodies etc. along the expressway.

The Project Report contains the following chapters:

- Executive Summary
- Chapter 1: Introduction
- Chapter 2: Project Description
- Chapter 3: Methodology and Design Standards
- Chapter 4: Traffic Studies
- Chapter 5: Highway Design & Proposed Typical Cross-Sections, Service Roads, Roadside Drains & Air Strip
- Chapter 6: Pavement Design & Proposals
- Chapter 7: Hydrological Studies & Drainage Design
- Chapter 8: Proposals for Structures & Interchanges
- Chapter 9: Project Facilities, Roadside Features & Road Safety
- Chapter 10: Social & Environmental Studies
- Chapter 11: Cost Estimate

0.2 APPROACH AND METHODOLOGY

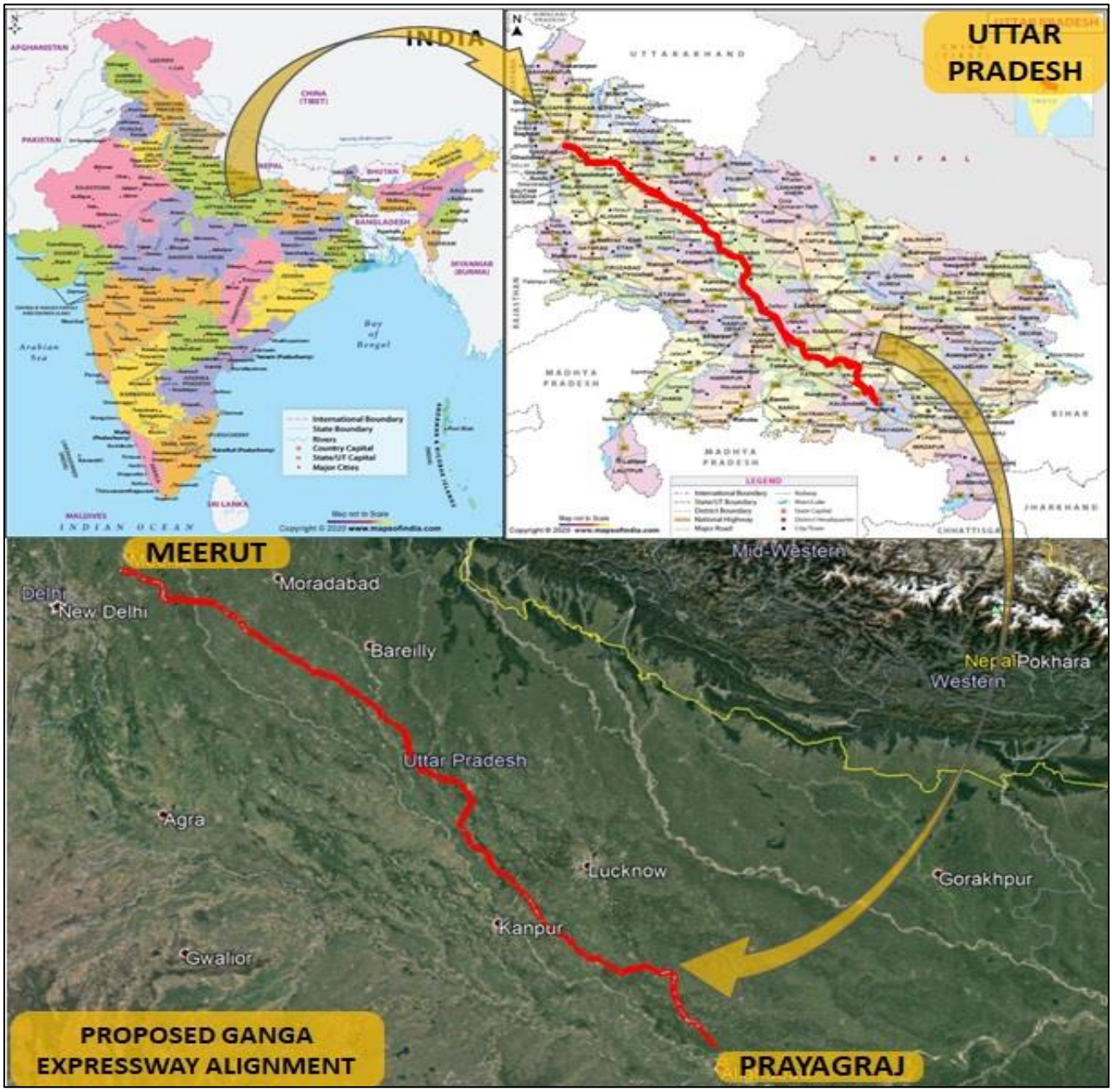
Methodology adopted for the study was initially presented in Inception Report. The methodology adopted for the project is based on initial studies, secondary data, traffic analysis, topographic survey, revenue calculations and Cost Estimates. The project area social screening/RAP and Environment Impact Assessment are also completed for the detailed Engineering stage (DPR). The government policies about Land acquisition is also covered in the detailed Engineering stage (DPR). The methodology adopted is in line with the requirements of the ToR. The methodology adopted to arrive at detailed Engineering stage is covered in chapter 3. Detailed Engineering and field studies such as soil investigations, Environment Impact Analysis and design works are completed for the most preferred alignment Option-1.

0.3 PROJECT ALIGNMENT DESCRIPTION

The proposed Ganga Expressway starts from **km 16+000** of Meerut-Bulandshahar (NH-334) near village Bijoli (Dist. Meerut) **(CH 7+900)** & terminates at Prayagraj Bypass on NH-19 near village Judapur Dando (Dist. Prayagraj) **(CH 601+847)**.

The length of the proposed expressway alignment is **593.947 km**.

The project Index Map is Shown below:



The proposed expressway has been divided into 12 packages. The chainage wise detail of the packages has been given in Table-0.1 below: The Project in consideration is Package-6

Table-0.1

Package No.	Section Details	Chainage (km)		Length
		From	To	
I	From Village Bijoli (Dist. Meerut) to Village-Chandner (Dist. Hapur)	7.900	56.900	49.000
II	From Village-Chandner (Dist. Hapur) to Village-Mirzapur Dugar (Dist. Amroha)	56.900	86.900	30.000
III	From Mirzapur Dugar (Dist. Amroha) to Village-Nagla Barah (Dist. Budaun)	86.900	137.600	50.700
IV	From Village-Nagla Barah (Dist. Budaun) to Village-Binawar (Dist. Budaun)	137.600	189.700	52.100
V	From Binawar (Dist.Budaun) to Girdharpur (Dist. Shahjahanpur)	189.700	236.400	46.700
VI	From Village- Girdharpur (Dist. Shahjahanpur) to Village-Ubariya Khurd (Dist. Hardoi)	236.400	289.300	52.900
VII	From Village-Ubariya Khurd (Dist. Hardoi) to Village- Pandra Lakhanpur (Dist. Hardoi)	289.300	341.700	52.400
VIII	From Village- Pandra Lakhanpur (Dist. Hardoi) to Village-Raiyamau(Dist. Unnao)	341.700	391.900	50.200
IX	From Village- Raiyamau (Dist. Unnao) to Village-Sarso (Dist. Unnao)	391.900	445.000	53.100
X	From Village- Sarso (Dist. Unnao) to Village-Terukha (Dist. Raebareli)	445.000	496.800	51.800
XI	From Village-Terukha (Dist. Raebareli) to Village-Arro (Dist. Pratapgarh)	496.800	548.800	52.000
XII	From Village- Arro (Dist. Pratapgarh) to Village-Judapur Dando (Dist. Prayagraj)	548.800	601.847	53.047
Total				**593.947**

The Expressway is access controlled with only entry/exit at Nodes (intersecting points of National Highway or State Highways or Major District Roads – crossing with the proposed Expressway Alignment), details of which has been described in Table-0.3.

0.3.1 Alignment & Structures

The expressway alignment is having 6 Lanes with Paved Shoulders Configuration with Service Roads, which is further expandable up to 8 Lanes. The alignment has been designed with the design speed of 120 km/h.

The key features of the project alignment are given in Table 0.2 below:

Table-0.2

S. No.	Particulars	Nos. / Length
1	Length (km)	52.900
2	Major Bridges	1
3	Minor Bridges	10
4	Culverts	80

S. No.	Particulars	Nos. / Length
5	ROB	0
6	VUP	4
7	LVUP	13
8	SVUP	11
9	Flyovers	2
10	Trumpet	0
11	Double Trumpet	1
12	Diamond Interchange	1
13	Way Side Amenities	1
14	Proposed Node Development	1

0.3.2 Node Development

The Expressway is access controlled with only entry/exit at Nodes (intersecting points of National Highway or State Highways or Major District Roads – crossing with the proposed Expressway Alignment). In view of the background and detailed discussions held with UPEIDA and other stake holders such as the Revenue Authorities, Eighteen locations were selected along the project corridor where Nodes would be developed and are lettered "A" to "R", out of which Node-J falls under Package-6 as listed in Table-0.3 below:

Table-0.3

Toll Nodes	Chainage	Details of the Intersecting Roads	Road No.	Type of Interchange
A	0+100	Delhi - Meerut Expressway	Expressway	Dummy Node
B	8+920	Meerut – Hapur	NH-334	Trumpet
C	35+270	Hapur - Garhmukteshwar	NH-24	Diamond
D	54+640	Bulandshahr - Garhmukteshwar	SH-65	Diamond
E	74+181	Hasanpur-Anupshahar	MDR-162W	Diamond
F	102+427	Anupshahr - Moradabad	ODR	Diamond
G	123+288	Babrala - Chandausi	NH-509	Double Trumpet
H	173+454	Chandausi - Budaun	SH-125	Diamond
I	189+394	Budaun - Bareilly	SH-33	Double Trumpet
J	255+167	Farukkhabad - Shahjahanpur	SH-29	Double Trumpet
K	282+845	Farukkhabad - Shahbad	SH-138	Diamond
L	329+945	Kannauj– Hardoi	SH-21	Double Trumpet
M	378+136	Agra - Lucknow Expressway	Agra Lucknow Exp	Double Trumpet
N	420+932	Kanpur - Lucknow	NH-27	Diamond
O	487+285	Lalganj - Raebareli	NH-31	Double Trumpet
P	517+708	Raebareli–Unchahar	NH-30	Double Trumpet
Q	554+951	Manikpur - Bela Pratapgarh	MDR-102E	Diamond
R	600+457	Prayagraj Bypass	NH-19	Trumpet

Node A is revised and treated as Dummy Node in this Report, as the Start Point of the Ganga Expressway has been changed from Node A to Node B due to Engineering Design Constraints, with prior approval of UPEIDA.

0.4 RIGHT OF WAY

ROW has been taken as total 120 m for the proposed expressway except at Interchange Locations, Way Side Amenities (including Toilet Block), Toll Plaza locations and at locations for training on the course of nallah/drain and at airstrip, where the ROW varies.

0.5 ABUTTING LAND USE PATTERN

The land use pattern on the both sides of the expressway in maximum section is agricultural.

0.6 TERRAIN

The terrain of this stretch can be termed as plain and flat throughout.

0.7 FOREST

No forest land observed along the road. However, the alignment passes some stretches of Social Forestry.

0.8 ARCHEOLOGICAL/ANCIENT STRUCTURE

No such type of structure found along the project corridor.

0.9 TRAFFIC SURVEYS, ANALYSIS AND PROJECTIONS

The traffic surveys were mainly:

(a) Origin and destination surveys (which included willingness-to-pay "stated-preference" questions and, in one instance where this type of survey was possible, a "revealed-preference" survey – see below); and

(b) Classified Volume Count Surveys;

(c) Axle Load Surveys

All survey types were conducted in accordance with the guidelines specified in IRC 9-1972, IRC 102-1988 and IRC SP19-2001.

The surveys were conducted at points close to where the proposed Expressway would intersect with the National, State and other highways/district roads and other locations from which, traffic that may eventually use the Expressway either partly or entirely.

Table-0.5 Locations for Road-Side Origin and Destination (O-D) Surveys

OD. No.	Survey Location	Stretch & Road Name	Day & Date of O-D Survey
1	Siwaya Toll Booth	Muzaffarnagar - Meerut	Wednesday, 12thFebruary 2020
2	Nizampur	Meerut - Garhmukteshwar	Friday, 6th December 2019
3	Kurkawali	Hasanpur - Chandausi	Monday, 4th November 2019
5	Nagariya	Aligarh - Etah	Wednesday, 27th November 2019
6	Khankah e Niyaziya	Aliganj - Farrukhabad	Monday, 9th December 2019

OD. No.	Survey Location	Stretch & Road Name	Day & Date of O-D Survey
7	Samdhan	Farrukhabad - Kannauj	Wednesday, 27th November 2019
8	Bilhaur	Kannauj - Kanpur	Monday, 2nd December 2019
9	Katohan Toll Booth	Fatehpur - Prayagraj	Monday, 16th February 2020
10	Agwanpur	Bijnor - Moradabad	Friday, 29th November 2019
11	Faridpur Toll Booth	Bareilly - Shahjahanpur	Monday, 2nd December 2019
12	Nawada	Chandausi - Budaun	Thursday, 28th November 2019
13	Usawan	Budaun - Farrukhabad	Thursday, 5th December 2019
14	Shahabad	Shahjahanpur - Hardoi	Friday, 29th November 2019
15	Safipur	Bangarmau - Unnao	Wednesday, 4th December 2019
16	Semari	Unnao - Lalganj	Friday, 6th December 2019
17	Andiyari	Unchahar - Prayagraj	Tuesday, 10th December 2019

Seven-day count using video coverage was undertaken on National Highways/State Highways/Major District Roads where Road Side Origin-Destination Surveys were carried out – results **(Average Daily Traffic - ADT**) are shown on Tables 4.6 and detailed counts at each location are provided in Appendix.

Table-0.6 Average Daily Traffic (ADT) on Existing Alternate Roads

Vehicle Classification			PCU Factor	Muzaffarnagar – Meerut	Aligarh - Etah	Aliganj - Farrukhabad	Farrukhabad – Kannauj	Kannauj - Kanpur	Budaun – Farrukhabad	Meerut – Garhmukteshwar	Hasanpur - Chandausi	Chandausi - Budaun	Bijnor - Moradabad	Bareilly – Shahjahanpur	Shahjahanpur - Hardoi	Bangarmau - Unnao	Unnao - Lalganj	Unchahar - Prayagraj	Fatehpur - Prayagraj
Passenger Vehicles	Two Wheeler		0.5	5380	1750	2813	3569	2723	1776	3683	2285	3453	7080	9565	3514	6026	2838	6245	3162
	Three Wheeler		1.5	877	605	124	658	415	87	695	254	212	934	1749	347	362	74	586	300
	Car/Van/ Jeep		1.0	12525	736	679	1921	2444	964	4879	855	2027	5179	5976	2476	2163	1282	4632	3094
	Mini Bus		1.5	21	4	18	9	35	7	11	8	7	39	21	19	31	3	52	32
	Bus		3.0	1253	541	37	75	249	244	430	202	278	581	578	197	191	210	490	469
Govt. & Other Vehicles	Tempo/ LCV		1.5	1048	346	226	344	795	315	842	510	707	745	1794	783	742	618	956	1274
	Commercial Vehicles	2 Axle	3.0	484	1061	73	85	853	430	599	164	456	263	1509	231	280	493	448	1033
		3 Axle	3.0	325	1066	50	90	877	438	561	176	447	283	1453	392	491	501	656	1062
		M-Axle	4.5	665	826	138	146	972	454	481	152	509	143	2375	467	606	778	1171	2464
Agricultural Vehicles	Tractor		1.5	20	26	17	17	20	31	48	26	50	43	26	28	38	20	34	13
	Tractor with Trailer		4.5	71	82	139	99	103	151	250	250	282	325	206	243	111	37	356	89
Passenger Vehicles	Cycle		0.5	42	152	950	357	239	286	385	82	500	125	527	835	500	570	501	151
	Cycle Rickshaw		2.0	11	2	0	0	0	9	23	3	7	26	0	0	0	0	0	11
Goods Vehicles	Animal Drawn	Bullock Cart	8.0	0	2	13	10	1	24	50	0	6	14	84	30	16	17	47	0
		Horse	8.0	0	3	0	0	0	35	0	0	24	11	0	0	0	0	0	0
	Hand Cart		3.0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0
	Other (Pl. Specify)		2.0	24	10	0	3	6	17	28	7	14	42	29	31	1	9	3	16
Total Vehicles (Nos.)				**22749**	**7212**	**5277**	**7383**	**9733**	**5269**	**12966**	**4974**	**8980**	**15833**	**25892**	**9594**	**11558**	**7449**	**16178**	**13170**
Total Vehicles (PCUs)				**27761**	**15313**	**4975**	**7364**	**16617**	**9240**	**17867**	**6692**	**12859**	**17245**	**39371**	**12376**	**13428**	**11487**	**22484**	**26414**

0.10 PAVEMENT DESIGN

Flexible pavement has been adopted for new carriageways throughout the project length except at toll plaza/booth & Air strip locations. In the toll plaza/booth area & Air strip, rigid pavement has been adopted.

(a) New Flexible Pavement Design

The pavement design basically aims at determining the total thickness of the pavement structure as well as thickness of individual structural components. The following assumptions are considered for the preliminary pavement design. The basic assumptions considered while designing are as follows:

- Design life of 20 (after construction period) years has been considered for flexible pavement design.
- Sub grade CBR (for design) has been taken as 8%.
- Design life for Cement Concrete pavement has been assumed as 30 years.

Proposed Crust Composition for New Construction

Proposed Crust For Main Carriageway										
Package No.	Section		Length (m)	Adopted MSA (20 Years)	Design CBR	Crust Composition (in mm)				
	From	To				Subgrade	GSB	WMM	DBM	BC
VI	236.40	289.30	52.90	108	8%	500	200	150	160	40

(b) Service roads have been designed for 5 MSA with design CBR of 8%. The crust composition of service roads is given in Table below:

Proposed Crust For Service Road							
Package No.	Design MSA	Design CBR	Crust Composition (in mm)				
			BC	DBM	WMM	GSB	Subgrade
VI	5	8%	30	50	150	150	500

0.11 ROAD SIDE DRAINS

Package wise lengths and types of Drains are given in table below:

Package No.	Length of Drain					Remarks
	Unlined Drain (LHS+RHS)	Lined Drain (LHS+RHS)	Median Drain	Covered Drain (LHS+RHS)	Chute Drain	
VI	37623	62293	45716	990	48345	
Total Length (km)	**37.623**	**62.293**	**45.716**	**0.990**	**48.345**	

0.12 SERVICE ROADS

Details of proposed Service Roads are as follows:

Package No.	3.75 m Service Road (Km)		7.0 m Service Road (Km)		10.0 m Service Road (Km)	
	LHS	RHS	LHS	RHS	LHS	RHS
VI	32.34	15.34	2.98	7.52	5.0	5.0

0.13 AIR STRIPS

The Air Strips may allow military aircraft to continue operating even if their regular air bases, some of the most vulnerable targets in any war, are degraded or destroyed.

Package wise details of Air Strips are given below:

Package No.	Component Start/ End		Chainage	Length	Remarks
6	**Start**	Clear Zone	242+500	0.750	
		Air Strip	243+250	3.500	Clear Zone End
	End	Air Strip	246+750		Clear Zone Start
		Clear Zone	247+500	0.750	

Proposals for the Air Strips have been made on selected locations. The Width of Carriageway at Airstrip locations has been kept 36.0 m with 15.0 m Earthen Shoulders on both sides. The type of Pavement proposed for Air Strip is Rigid Pavement.

0.14 GRADE SEPARATED STRUCTURES

Package wise count & details of Grade Separated structures are given in table below:

Package No.	ROB (Nos.)	VUP (Nos.)	LVUP (Nos.)	SVUP (Nos.)	Flyover (Nos.)	Trumpet (Nos.)	Double Trumpet (Nos.)	Diamond Interchange (Nos.)
Package-6	0	4	13	11	2	0	1	1

Table 0.12 (a) List of Road Over-bridge (ROB)

S. No.	Chainage	Type of Structure			Span Arrangement	Width of Structure (m)	Skew Angle, if any	Remarks
		Foundation	Sub Structure	Super Structure				
NIL								

Table 0.12 (b) List of Vehicular Underpass (VUP)

S. No.	Chainage	Type of Crossing	Structure Type	Span Arrangement		Width of Structure (m)	Skew Angle, if any	Remarks
				Lateral Clearance (m)	Vertical Clearance (m)			
1	248+627	MDR	Box	2X10	5.5	2x21.25	20	Package-6
2	254+200	WSA	Box	2X10	5.5	2x21.25	0	Package-6
3	256+316	Interchange	Box	2X10	5.5	2x21.25	0	Package-6
4	281+928	ODR	Box	2X10	5.5	2x21.25	41	Package-6

Table 0.12 (c) List of Light Vehicular Underpass (LVUP)

S. No.	Chainage	Type of Crossing	Structure Type	Span Arrangement		Width of Structure (m)	Remarks
				Lateral Clearance (m)	Vertical Clearance (m)		
1	237+680	VR	Box	12	4.5	2X21.25	Package-6
2	239+488	VR	Box	12	4.5	2X21.25	Package-6
3	242+188	VR	Box	12	4.5	2X21.25	Package-6
4	247+530	VR	Box	12	4.5	2X21.25	Package-6
5	250+304	VR	Box	12	4.5	2X21.25	Package-6
6	260+080	VR	Box	12	4.5	2X21.25	Package-6
7	262+202	VR	Box	12	4.5	2X21.25	Package-6
8	266+035	VR	Box	12	4.5	2X21.25	Package-6
9	269+200	VR	Box	12	4.5	2X21.25	Package-6
10	271+063	VR	Box	12	4.5	2X21.25	Package-6
11	283+719	VR	Box	12	4.5	2X21.25	Package-6
12	286+000	VR	Box	12	4.5	2X21.25	Package-6
13	289+045	VR	Box	12	4.5	2X21.25	Package-6

Table 0.12 (d) List of Smaller Vehicular Underpass (SVUP)

S. No.	Chainage	Type of Crossing	Type of Structure	Span Arrangement		Width of Structure	Remarks
				Lateral Clearance (m)	Vertical Clearance (m)		
1	236+662	VR	Box	7	4.0	2X21.25	Package-6
2	240+623	VR	Box	7	4.0	2X21.25	Package-6
3	251+455	VR	Box	7	4.0	2x21.25	Package-6
4	260+913	VR	Box	7	4.0	2X21.25	Package-6
5	263+565	VR	Box	7	4.0	2x21.25	Package-6
6	276+196	VR	Box	7	4.0	2X21.25	Package-6

S. No.	Chainage	Type of Crossing	Type of Structure	Span Arrangement		Width of Structure	Remarks
				Lateral Clearance (m)	Vertical Clearance (m)		
7	277+359	VR	Box	7	4.0	2X21.25	Package-6
8	279+167	VR	Box	7	4.0	2X21.25	Package-6
9	281+023	VR	Box	7	4.0	2X21.25	Package-6
10	284+940	VR	Box	7	4.0	2X21.25	Package-6
11	287+293	VR	Box	7	4.0	2X21.25	Package-6

Table 0.12 (e) List of Flyovers

S. No.	Chainage	Type of Crossing	Structure Type			Span Arrangement	Width of Structure	Remarks
			Foundation	Sub Structure	Super Structure			
1	255+167	SH-29	Pile	R.C.C.	PSC I Girder	2x30	2X21.25	Package-6
2	282+845	SH-138	Pile	R.C.C.	PSC I Girder	2x30	2x21.25	Package-6

Table 0.12 (f) List of Trumpets

S. No.	Chainage	Type of Crossing	Remarks
NIL			

Table 0.12 (g) List of Double Trumpets

S. No.	Chainage	Type of Crossing	Remarks
1	255+167	SH-29	Package-6

Table 0.12 (h) List of Diamond Interchanges

S. No.	Chainage	Type of Crossing	Remarks
1	282+845	SH-138	Package-6

0.15 CROSS DRAINAGE STRUCTURES

Package wise count of Major Bridges, Minor Bridges & culverts is given in table below:

Package No.	Major Bridges (Nos.)	Minor Bridges (Nos.)	Culverts (Nos.)
Package-6	1	10	80

Table-0.13 (a) List of Major Bridges

S. No.	Chainage	Type of Crossing	Type of Structure			Span Arrangement	Width of Structure	Skew Angle, if any	Remarks
			Found-ation	Sub Structure	Super Structure				
1	238+190	River	Well	R.C.C.	PSC I Girder	4 X 38	2x21.25	31	Package-6

Table-0.13 (b) List of Minor Bridges

S. No.	Chainage	Type of Crossing	Type of Structure			Span Arrangement	Width of Structure	Skew Angle, if any	Remarks
			Found-ation	Sub Structure	Super Structure				
1	242+125	Stream/ Nallah	Raft	Box MNB	Box MNB	2x8	2x21.25	0	Package-6
2	247+260	Canal	Raft	Box MNB	Box MNB	1x10	2x21.25	40	Package-6
3	249+320	Canal	Raft	Box MNB	Box MNB	2x8	2x21.25	0	Package-6
4	252+418	Canal+Road	Raft	Box MNB	Box MNB	2x10	2x21.25	30	Package-6
5	257+521	Canal+Road	Raft	Box MNB	Box MNB	2 x 8	2x21.25	45	Package-6
6	258+544	Canal+Road	Raft	Box MNB	Box MNB	2 x7	2x21.25	50	Package-6
7	261+324	Canal	Raft	Box MNB	Box MNB	1x8	2x21.25	42	Package-6
8	268+340	Canal	Raft	Box MNB	Box MNB	1x8	2x21.25	53	Package-6
9	274+000	Canal	Raft	Box MNB	Box MNB	1x10	2x21.25	0	Package-6
10	274+780	Canal+Road	Raft	Box MNB	Box MNB	2X7	2x21.25	0	Package-6

Table-0.13 (c) List of Culverts

S. No.	Chainage	Structure Type	Span Arrangement		Width of Structure (m)	Remarks
			Lateral Clearance (m)	Vertical Clearance (m)		
1	237+071	Culvert	3	3	2X21.25	Package -6
2	238+932	Culvert	3	3	2X21.25	Package -6
3	239+200	Culvert	2	2	2X21.25	Package -6
4	240+055	Culvert	2	2	2X21.25	Package -6
5	240+910	Culvert	3	3	2X21.25	Package -6
6	241+580	Culvert	3	3	2X21.25	Package -6
7	244+210	Culvert	3	2	2X21.25	Package -6
8	247+900	Culvert	3	3	2X21.25	Package -6
9	248+990	Culvert	3	3	2X21.25	Package -6

S. No.	Chainage	Structure Type	Span Arrangement		Width of Structure (m)	Remarks
			Lateral Clearance (m)	Vertical Clearance (m)		
10	249+710	Culvert	2	2	2X21.25	Package -6
11	250+000	Culvert	2	2	2X21.25	Package -6
12	250+950	Culvert	2	2	2X21.25	Package -6
13	251+742	Culvert	3	3	2X21.25	Package -6
14	252+110	Culvert	3	3	2X21.25	Package -6
15	253+232	Culvert	2	2	2X21.25	Package -6
16	254+657	Culvert	3	3	2X21.25	Package -6
17	255+370	Culvert	3	2	2X21.25	Package -6
18	255+910	Culvert	3	3	2X21.25	Package -6
19	257+220	Culvert	3	3	2X21.25	Package -6
20	258+050	Culvert	2	2	2X21.25	Package -6
21	258+960	Culvert	4	2	2X21.25	Package -6
22	259+456	Culvert	3	3	2X21.25	Package -6
23	260+657	Culvert	3	3	2X21.25	Package -6
24	261+646	Culvert	3	3	2X21.25	Package -6
25	262+530	Culvert	2	2	2X21.25	Package -6
26	263+185	Culvert	2	2	2X21.25	Package -6
27	263+900	Culvert	3	3	2X21.25	Package -6
28	264+280	Culvert	2	2	2X21.25	Package -6
29	264+950	Culvert	3	3	2X21.25	Package -6
30	265+700	Culvert	3	3	2X21.25	Package -6
31	266+618	Culvert	3	3	2X21.25	Package -6
32	267+170	Culvert	2	2	2X21.25	Package -6
33	267+510	Culvert	2	2	2X21.25	Package -6
34	268+900	Culvert	3	3	2X21.25	Package -6
35	269+915	Culvert	2	2	2X21.25	Package -6
36	270+295	Culvert	2	2	2X21.25	Package -6
37	270+831	Culvert	2	2	2X21.25	Package -6
38	271+657	Culvert	3	3	2X21.25	Package -6
39	272+100	Culvert	3	3	2X21.25	Package -6
40	272+950	Culvert	2	2	2X21.25	Package -6
41	273+500	Culvert	2	2	2X21.25	Package -6
42	274+365	Culvert	3	3	2X21.25	Package -6
43	275+576	Culvert	3	3	2X21.25	Package -6
44	276+600	Culvert	2	2	2X21.25	Package -6

S. No.	Chainage	Structure Type	Span Arrangement		Width of Structure (m)	Remarks
			Lateral Clearance (m)	Vertical Clearance (m)		
45	277+700	Culvert	2	2	2X21.25	Package -6
46	278+059	Culvert	2	2	2X21.25	Package -6
47	278+575	Culvert	3	3	2X21.25	Package -6
48	279+950	Culvert	2	2	2X21.25	Package -6
49	280+450	Culvert	2	2	2X21.25	Package -6
50	281+535	Culvert	3	3	2X21.25	Package -6
51	281+982	Culvert	4	2	2X21.25	Package -6
52	282+300	Culvert	2	2	2X21.25	Package -6
53	283+405	Culvert	2	2	2X21.25	Package -6
54	284+280	Culvert	2	2	2X21.25	Package -6
55	285+438	Culvert	2	2	2X21.25	Package -6
56	286+171	Culvert	2	2	2X21.25	Package -6
57	286+971	Culvert	2	2	2X21.25	Package -6
58	287+935	Culvert	2	2	2X21.25	Package -6
59	288+700	Culvert	3	3	2X21.25	Package -6
60	242+710	HPC	2x1200			Package -6
61	243+610	HPC	2x1200			Package -6
62	245+550	HPC	2x1200			Package -6
63	246+520	HPC	2x1200			Package -6
64-66	255+167	Culverts @ Double Trumpet	3	3	3 culverts	Package-6
67-74	255+167	Culverts @ Double Trumpet	1x1200		8 culverts	Package-6
75-78	282+845	Culverts @ Diamond Interchange	3	3	4 culvert	Package-6
79	254+200	HPC @ Way Side Amenities	1x1200		1 culvert	Package-6
80	254+200	HPC @ Way Side Amenities	1x1200		1 culvert	Package-6

0.16 RAILWAY TRACKS/CROSSINGS

There is no Railway crossing in this Package.

0.17 TOLL PLAZAS & RAMP PLAZAS

1 Toll Plazas (8 Lanes each) on Double Trumpet Interchange & 4 Ramp Plazas (2 lanes on each leg) on Diamond Interchange have been proposed along the project corridor. List of the Toll Plazas & Toll Booths is attached below:

S. No.	Location		Remarks
1	255+167	Farukkhabad - Shahjahanpur	Double Trumpet (8 lanes)
2	282+845	Farukkhabad - Shahbad	Ramp Plaza

0.18 WAY SIDE AMENITIES

Way Side Amenities has been proposed on 1 location along the project corridor. WSA will be approachable from both side of MCW.

S. No.	Chainage	LHS/RHS	Distance between WSA (km)
1	254+200	RHS	79.2

0.19 SOCIAL IMPACT ASSESSMENT (SIA) AND R&R POLICY

Social Impact Assessment will involve:

(i) Agricultural/Homestead/Commercial Land Impacts;

(ii) Loss of Structures (Residential/Commercial/Other);

(iii) Loss of livelihood due to loss of primary source of income;

(iv) Loss of community infrastructure/common property resources;

(v) Temporary Impacts on agricultural land due to plant site for contractor etc.;

(vi) Any unanticipated impacts due to the project will be documented and mitigated based on the spirit of the principle agreed upon in this policy framework.

R&R Policies:

The project being greenfield alignment will require acquisition of large area of agriculture/ private/ government land. However, it is kept in mind while finalizing the alignment that the impact to the structures is minimum.

The R&R policies for the impacts to the Land (agricultural/Private/Government), Structures, Persons, Livelihood & others will involve various kind of compensations involving financial assistance, compensation for land, land for land (if feasible), compensation for crops, rental accommodation etc., whichever applicable based on the policy norms.

0.20 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The major objective of EIA study is to establish present environmental condition along the project corridor through available data / information supported by field studies to evaluate the impacts on relevant environmental attributes due to the construction & operation of the proposed project; to recommend adequate mitigation measures to minimize / reduce adverse impacts and to prepare an Environmental Management Plan (EMP) for timely implementation of the mitigation measures to make the project environmentally sound and sustainable. An Environmental Impact Assessment (EIA) study basically includes:

- Establishment of the present environmental scenario
- Study of the specific activities related to the project
- Evaluation of the probable environmental impacts

- Recommendations of necessary environmental control measures.
- Preparation of Environmental Management Plan

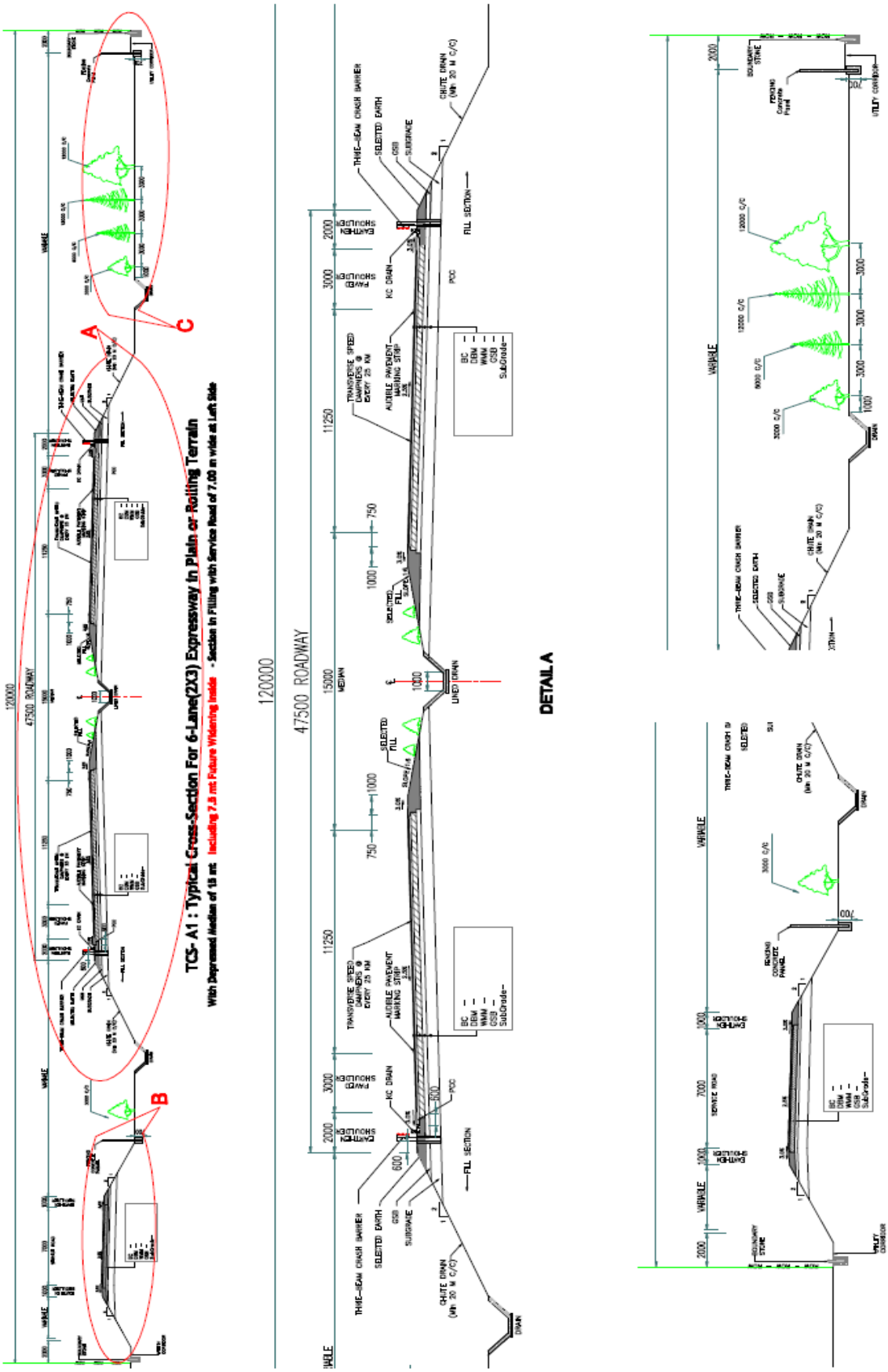
0.21 TCS SCHEDULE FOR THE PROJECT

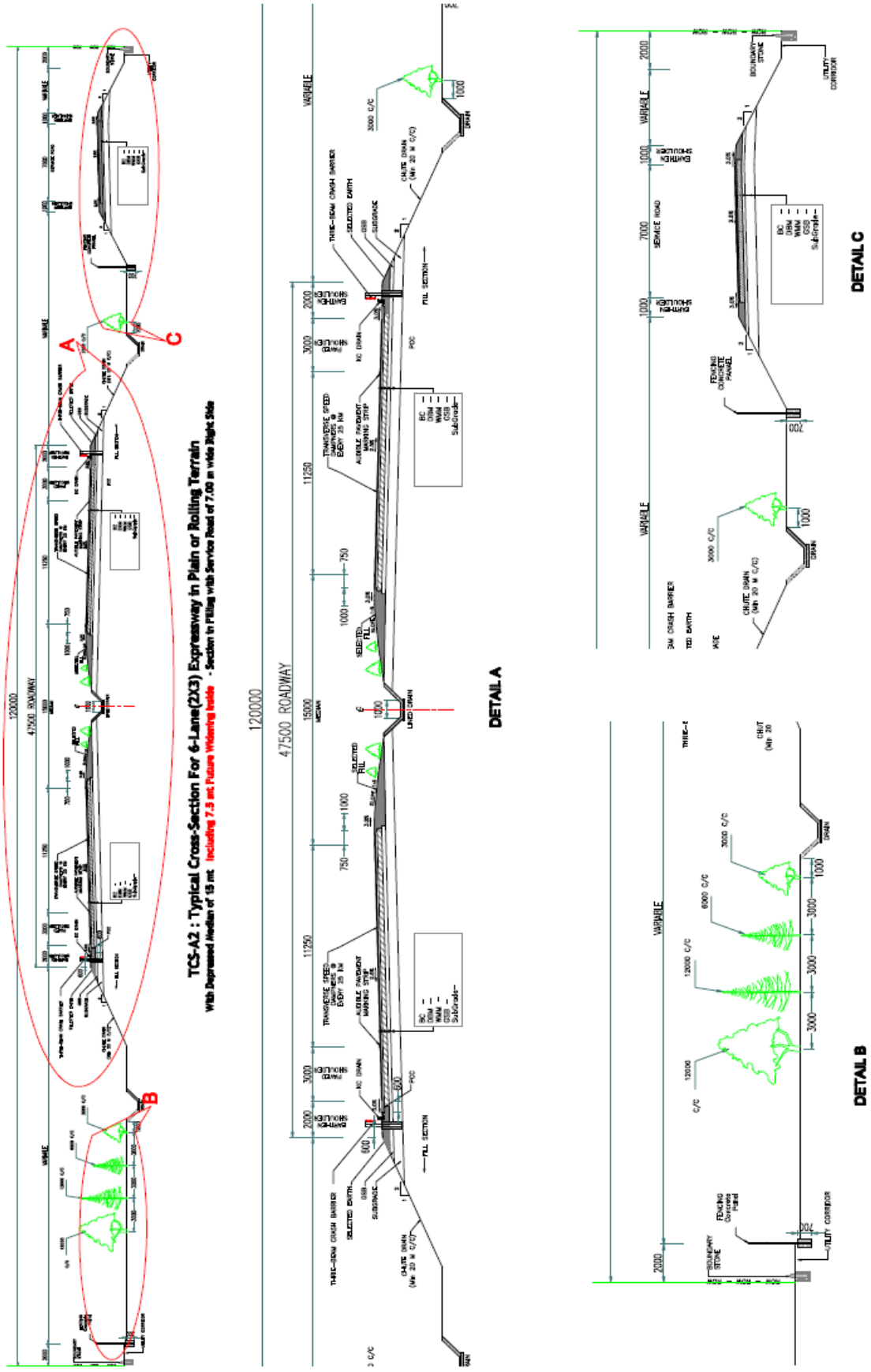
The chainage wise list of Typical Cross-sections applicable along the project is attached below:

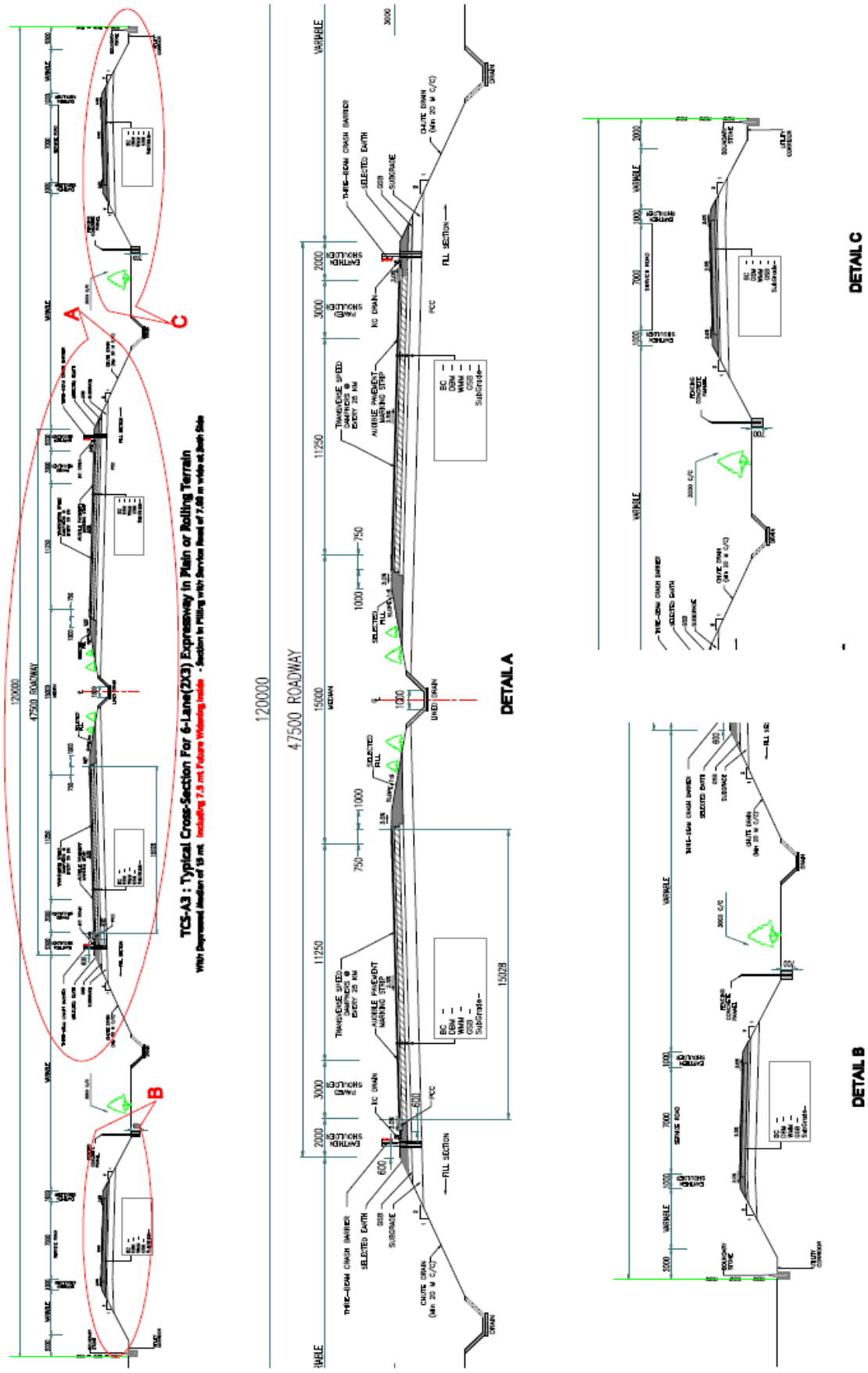
Chainage		Length (Km)	Service Road Width (Km)		Type of C/S	Package No.
From	To		LHS	RHS		
236.400	236.555	0.155	3.75	Nil	B1	Package-6
236.555	237.100	0.545	3.75	3.75	B3	Package-6
237.100	237.714	0.614	3.75	Nil	B1	Package-6
237.714	238.380	0.666	Nil	Nil	C	Package-6
238.380	240.910	2.530	3.75	3.75	B3	Package-6
240.910	241.925	1.015	3.75	Nil	B1	Package-6
241.925	242.500	0.575	7.00	Nil	A1	Package-6
242.500	247.500	5.000	10.00	10.00	F	Package-6
247.500	247.759	0.259	3.75	3.75	B3	Package-6
247.759	248.643	0.884	3.75	Nil	B1	Package-6
248.643	249.220	0.577	3.75	7.00	D	Package-6
249.220	250.304	1.084	Nil	7.00	A2	Package-6
250.304	250.747	0.443	3.75	7.00	D	Package-6
250.747	252.085	1.338	Nil	7.00	A2	Package-6
252.085	252.390	0.305	3.75	7.00	D	Package-6
252.390	253.642	1.252	Nil	7.00	A2	Package-6
253.642	254.245	0.603	3.75	7.00	D	Package-6
254.245	255.167	0.922	Nil	7.00	A2	Package-6
255.167	255.915	0.748	3.75	Nil	B1	Package-6
255.915	256.180	0.265	3.75	3.75	B3	Package-6
256.180	257.321	1.141	3.75	Nil	B1	Package-6
257.321	257.721	0.400	7.00	Nil	A1	Package-6
257.721	258.344	0.623	3.75	Nil	B1	Package-6
258.344	258.744	0.400	7.00	Nil	A1	Package-6
258.744	260.080	1.336	3.75	Nil	B1	Package-6
260.080	260.170	0.090	3.75	3.75	B3	Package-6
260.170	261.124	0.954	3.75	Nil	B1	Package-6
261.124	261.524	0.400	7.00	Nil	A1	Package-6
261.524	261.648	0.124	3.75	Nil	B1	Package-6

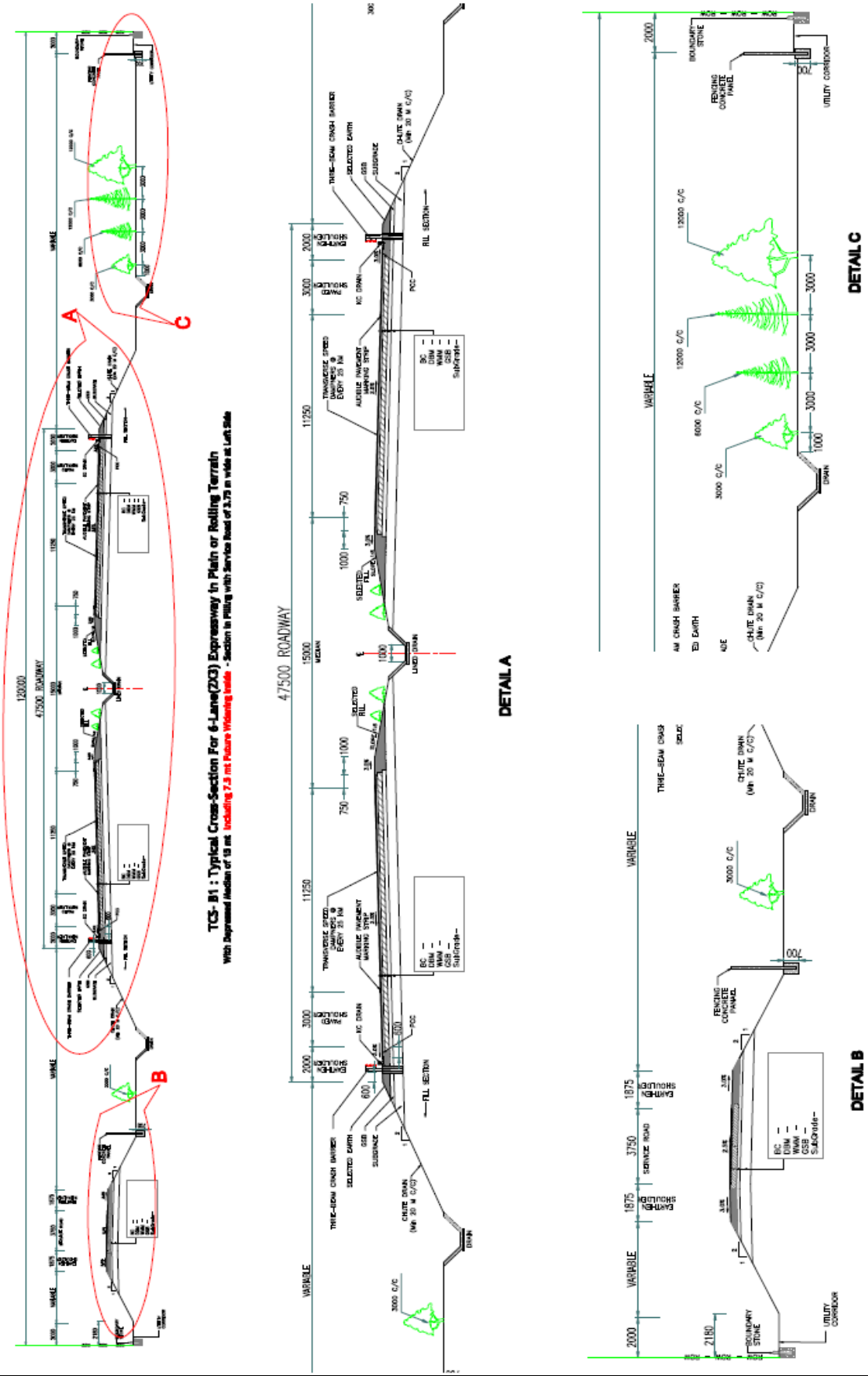
Chainage		Length (Km)	Service Road Width (Km)		Type of C/S	Package No.
From	To		LHS	RHS		
261.648	262.202	0.554	3.75	3.75	B3	Package-6
262.202	263.565	1.363	3.75	Nil	B1	Package-6
263.565	264.195	0.630	3.75	3.75	B3	Package-6
264.195	264.957	0.762	3.75	Nil	B1	Package-6
264.957	265.420	0.463	3.75	3.75	B3	Package-6
265.420	268.060	2.640	3.75	Nil	B1	Package-6
268.060	268.140	0.080	3.75	3.75	B3	Package-6
268.140	268.540	0.400	7.00	3.75	D	Package-6
268.540	269.200	0.660	3.75	3.75	B3	Package-6
269.200	271.063	1.863	3.75	Nil	B1	Package-6
271.063	271.660	0.597	3.75	3.75	B3	Package-6
271.660	273.800	2.140	3.75	Nil	B1	Package-6
273.800	274.200	0.400	7.00	Nil	A1	Package-6
274.200	274.580	0.380	3.75	Nil	B1	Package-6
274.580	274.980	0.400	7.00	Nil	A1	Package-6
274.980	277.355	2.375	3.75	Nil	B1	Package-6
277.355	279.167	1.812	3.75	3.75	B3	Package-6
279.167	281.850	2.683	3.75	Nil	B1	Package-6
281.850	281.980	0.130	3.75	7.00	D	Package-6
281.980	282.845	0.865	Nil	7.00	A2	Package-6
282.845	289.300	6.455	Nil	3.75	B2	Package-6

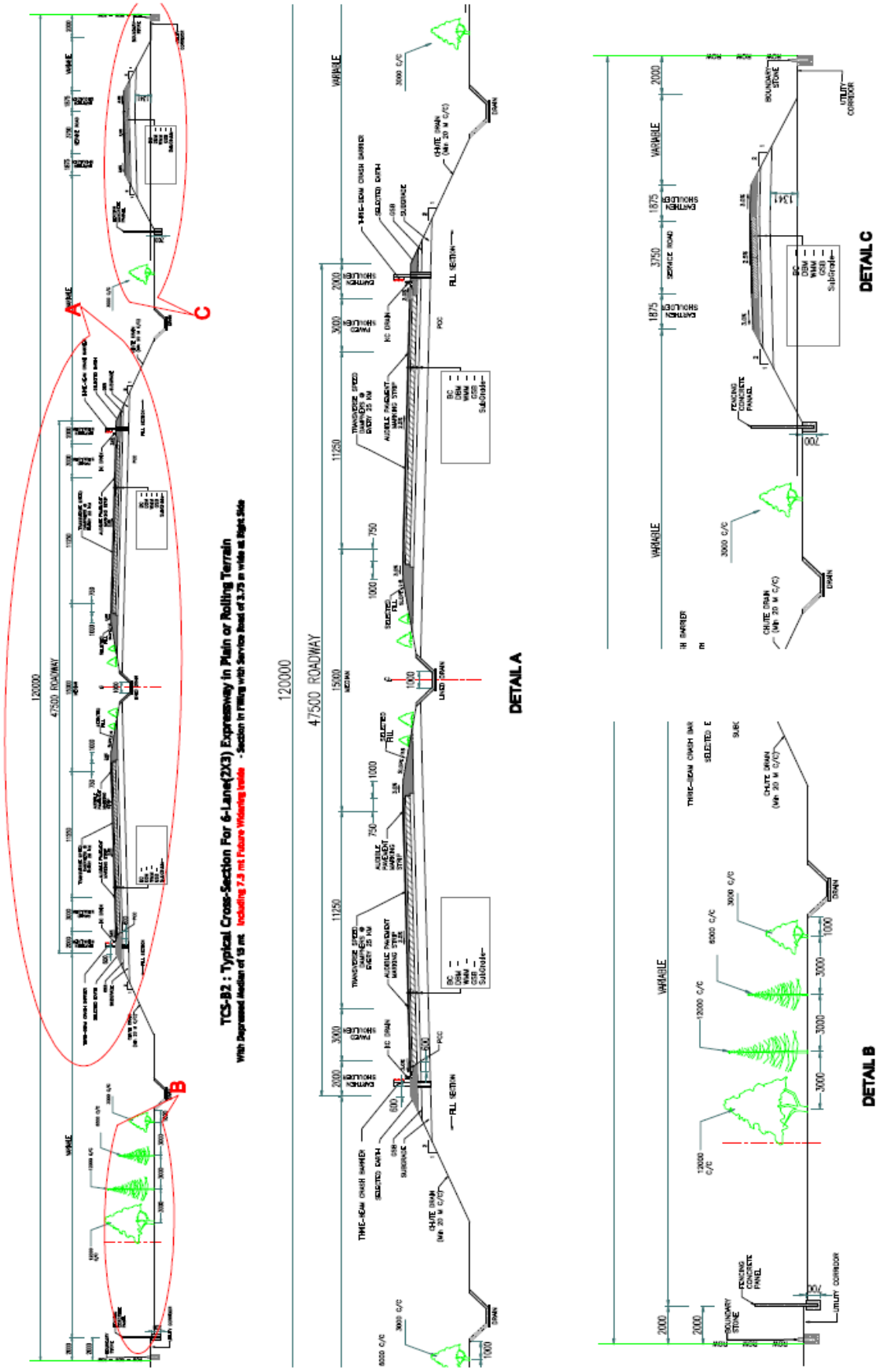
Typical cross-sections mentioned in the above table have been attached below:

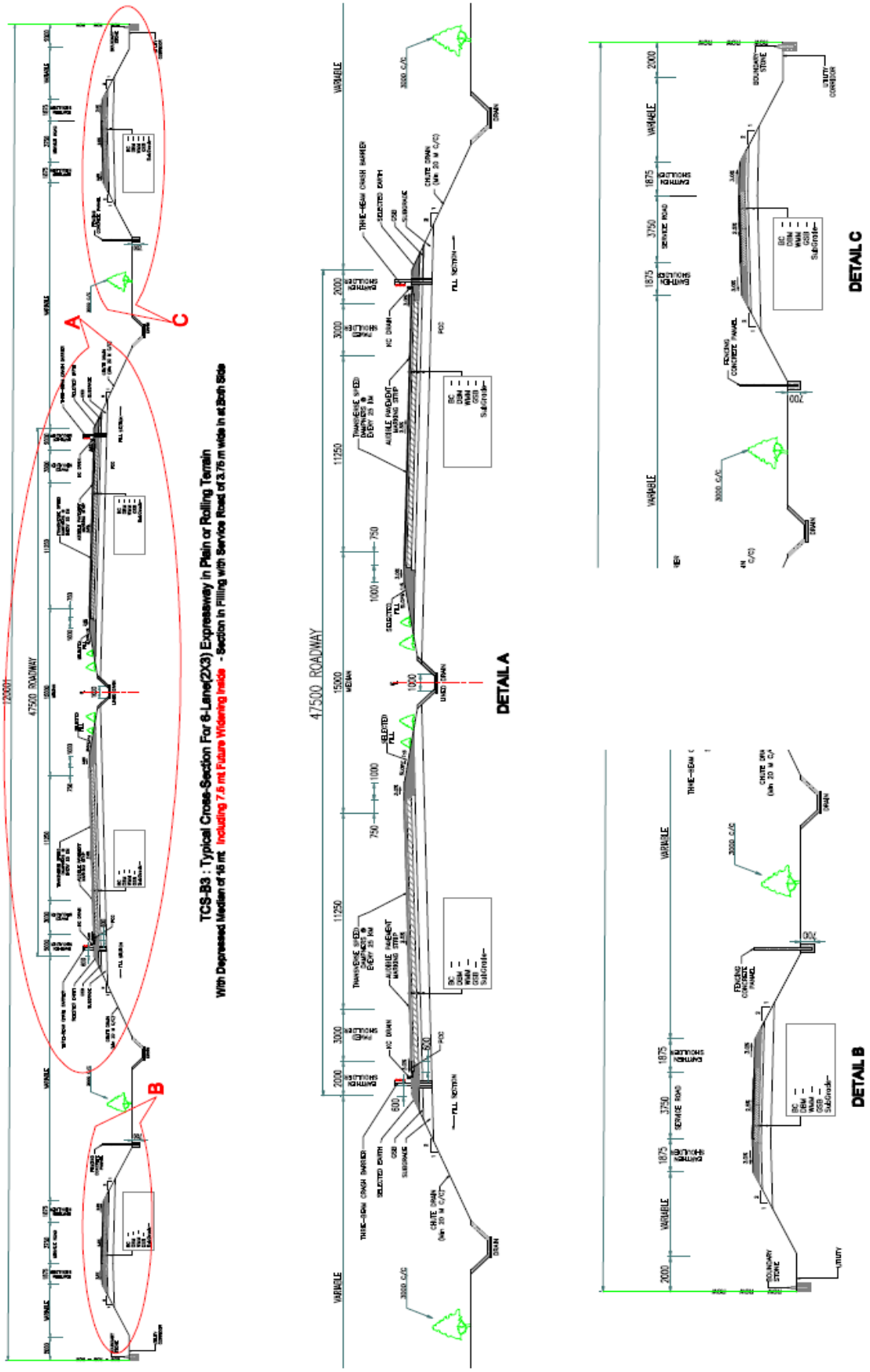

TCS- A1 : Typical Cross-Section For 6-Lane(2X3) Expressway in Plain or Rolling Terrain
With Depressed Median of 15 mt Including 7.5 mt. Future Widening Inside - Section in Filling with Service Road of 7.00 m wide at Left Side
47500 ROADWAY
120000
DETAIL A
A
B
C

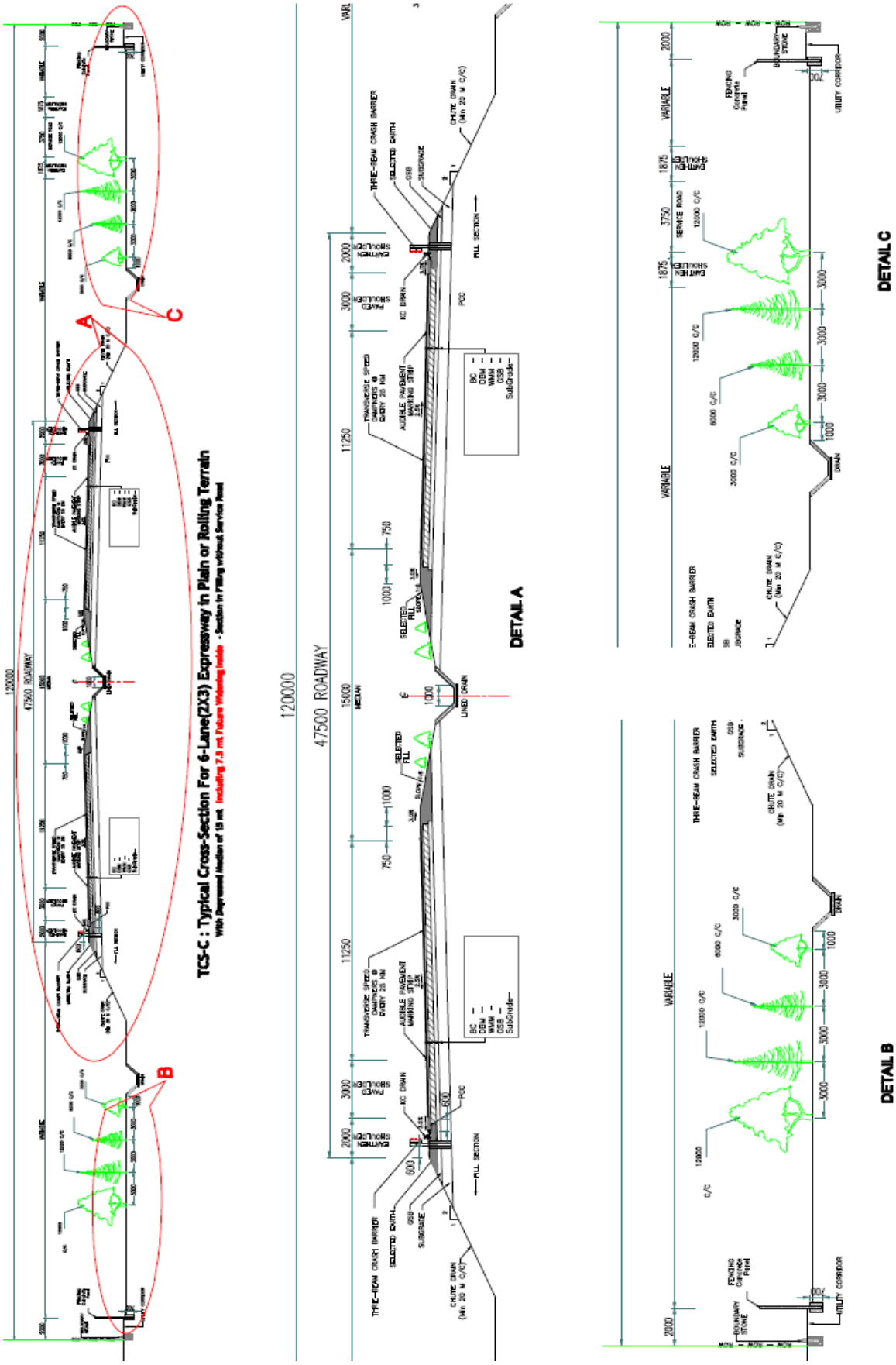

TCS-A2 : Typical Cross-Section For 6-Lane(2X3) Expressway in Plain or Rolling Terrain
With Depressed Median of 15 mt Including 7.5 mt. Future Widening Inside - Section in Filling with Service Road of 7.00 m wide Right Side
120000
47500 ROADWAY
DETAIL A
DETAIL B
DETAIL C
A
B
C

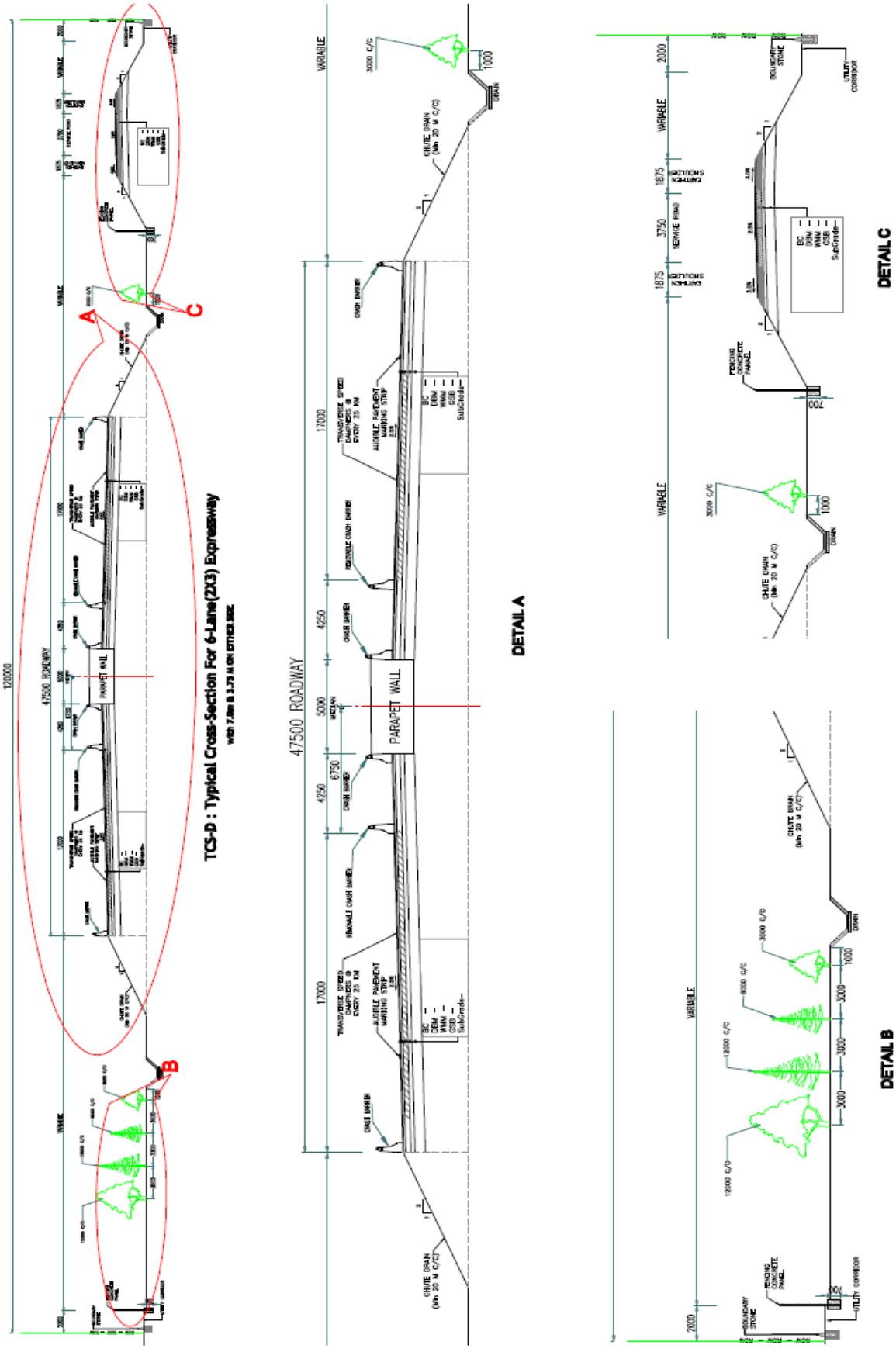

TCS-A3 : Typical Cross-Section For 6-Lane(2X3) Expressway In Plain or Rolling Terrain
47500 ROADWAY
120000
DETAIL A
DETAIL B
DETAIL C
A
B
C

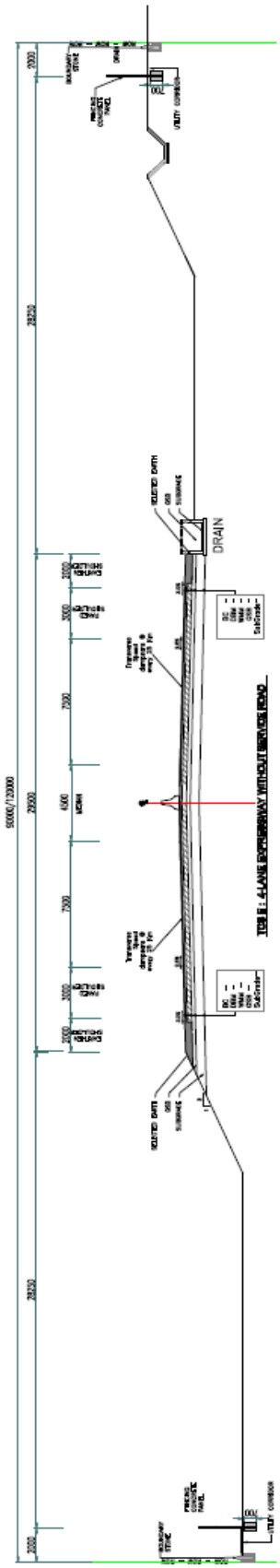

TCS- B1 : Typical Cross-Section For 6-Lane(203) Expressway in Plain or Rolling Terrain
With Depressed Median of 15 mt. including 7.5 mt Future Widening Inside - Section in Filling with Service Road of 3.75 m wide on Left Side
47500 ROADWAY
DETAIL A
DETAIL B
DETAIL C
A
B
C
VARIABLE
SERVICE ROAD
EARTHEN SHOULDER
PAVED SHOULDER
RCC DRAIN
CHUTE DRAIN
FENCING CONCRETE PANEL
UTILITY CORRIDOR
BOUNDARY STONE
THREE-BEAM CRASH BARRIER
SELECTED EARTH
GSB
SUBGRADE
FILL SECTION
CUT SECTION
BC
DBM
WMM
GSB
Subgrade

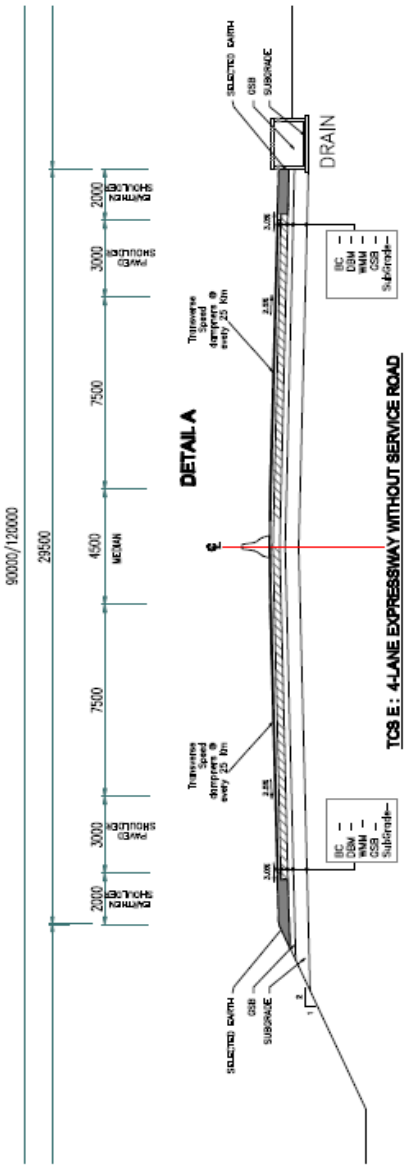

TCS-B2 : Typical Cross-Section For 6-Lane(2X3) Expressway in Plain or Rolling Terrain
With Depressed Median of 15 mt. Including 7.3 mt Future Widening inside - Section in Filling with Service Road of 3.75 m wide at Right Side
120000
47500 ROADWAY
VARIABLE
DETAIL A
DETAIL B
DETAIL C
A
B
C

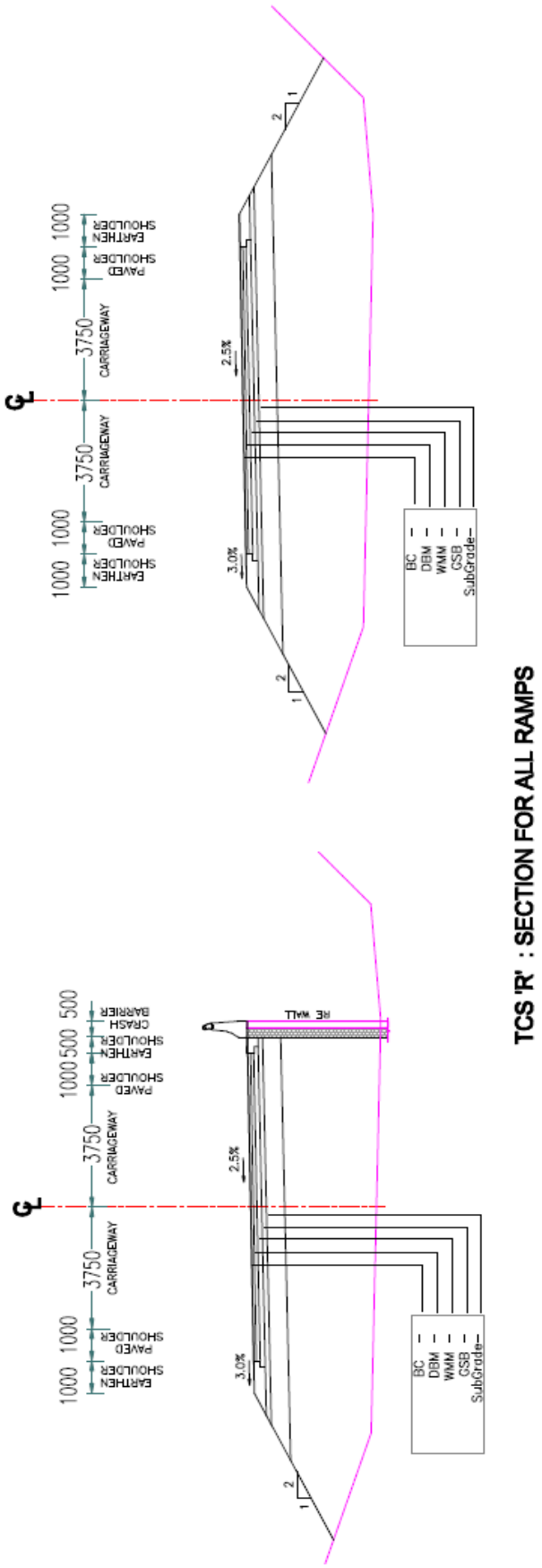

TCS-B3 : Typical Cross-Section For 6-Lane(2X3) Expressway in Plain or Rolling Terrain
With Depressed Median of 15 mt Including 7.5 mt Future Widening Inside - Section in Filling with Service Road of 3.75 m wide in at Both Side
47500 ROADWAY
DETAIL A
DETAIL B
DETAIL C
A
B
C


TCS-C : Typical Cross-Section For 6-Lane(2X3) Expressway in Plain or Rolling Terrain
With Depressed Median of 19 mt Including 7.3 mt Future Widening Inside - Section in Filling without Service Road
120000
47500 ROADWAY
DETAIL A
DETAIL B
DETAIL C
A
B
C

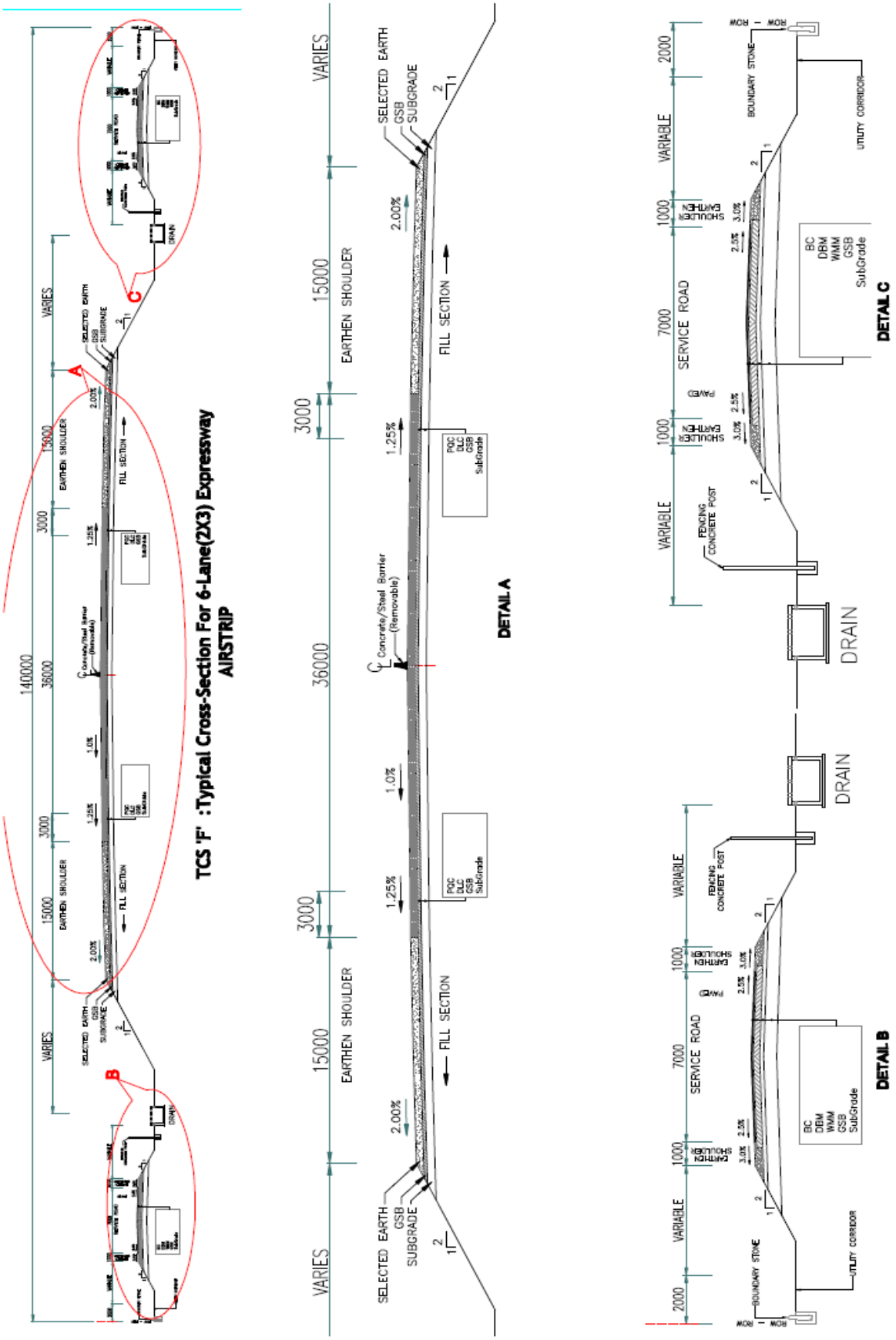

TCS-D : Typical Cross-Section For 6-Lane(2X3) Expressway
47500 ROADWAY
PARAPET WALL
DETAIL A
DETAIL B
DETAIL C
A
B
C


DRAIN
TCS E : 4-LANE EXPRESSWAY WITHOUT SERVICE ROAD


DETAIL A
DRAIN
TCS E : 4-LANE EXPRESSWAY WITHOUT SERVICE ROAD



TCS 'R' : SECTION FOR ALL RAMPS


TCS 'F' :Typical Cross-Section For 6-Lane(2X3) Expressway
AIRSTRIP
DETAIL A
DETAIL B
DETAIL C
VARIES
EARTHEN SHOULDER
FILL SECTION
SELECTED EARTH
GSB
SUBGRADE
Concrete/Steel Barrier (Removable)
PQC
DLC
GSB
Subgrade
SERVICE ROAD
VARIABLE
DRAIN
FENCING CONCRETE POST
BOUNDARY STONE
UTILITY CORRIDOR
BC
DBM
WMM
GSB
SubGrade

0.22 TOLLING STRATEGY

- The closed tolling system needs to be adopted and implemented for the primary reason of amassing the maximum toll fee from the maximum number of commuters in order to adequately recover the project costs.
- Further, closed tolling system is also a transparent and authentic way of tolling as the commuter pays toll fee based on the distance travelled.
- Moreover, in a closed tolling system, the commuter has an advantage of commuting with minimum halts at only two locations namely, ingress and egress; whereas in the open tolling system, the commuter might have to stop at multiple locations.
- Additionally, a closed tolling system will reduce the fuel consumption of the vehicles by eliminating conventional deceleration and acceleration and cost of travel.

0.23 COST ESTIMATES & RATE ANALYSIS

This being a Project Report, cost estimate is carried out based on preliminary design. The project cost estimates have been prepared considering various items of works associated with the identified proposals. Package-6 cost summary is given below:

Package No.	Chainage (km)		Length	Cost		
	From	To		Civil Cost	Civil Cost (Including 12% GST)	Capital Cost
VI	236.4	289.3	52.9	₹ 17,564,234,099	₹ 19,671,942,190	₹ 30,811,919,833.74

0.24 ECONOMIC & FINANCIAL ANALYSIS

Financial Viability Report & Economic Viability Report is attached separately as Volume-VII.

1. INTRODUCTION

1.1 GENERAL

During the last two decades India has witnessed significant improvements in road infrastructure. Highways can now facilitate higher speed and volume of transportation due to their increased capacity. Today road transport in India carries 65 per cent of freight and it has more than doubled over the last 20 years. This is despite about 45% lower freight cost of rail on per ton per km basis. In addition to freight, it also caters to 80% of passenger traffic.

Thus considering the trend of massive dependence of trade and commerce on roads, and the catalytic growth expected from the recent policies to boost manufacturing in India, the creation of increased high quality and efficient transport infrastructure system is extremely mandatory. Good roads bring about overall development in the region as it helps in the success of all developmental activities, be it in the sphere of movement of people or goods, development of agriculture, commerce, education, health and social welfare, or even maintenance of law and order and security.

The State of Uttar Pradesh (UP) is the most populous state in the country accounting for 16 per cent of the country's population. It is also the fourth largest state in geographical area covering 9.0 per cent of the country's geographical area, encompassing about 243 lakhs hectare land. Garlanded by the river Ganga and Yamuna, Uttar Pradesh is surrounded by Bihar in the East, Madhya Pradesh in the South, Rajasthan, Delhi, Himachal Pradesh and Haryana in the West and Uttarakhand in the North and Nepal touches the northern borders of Uttar Pradesh.

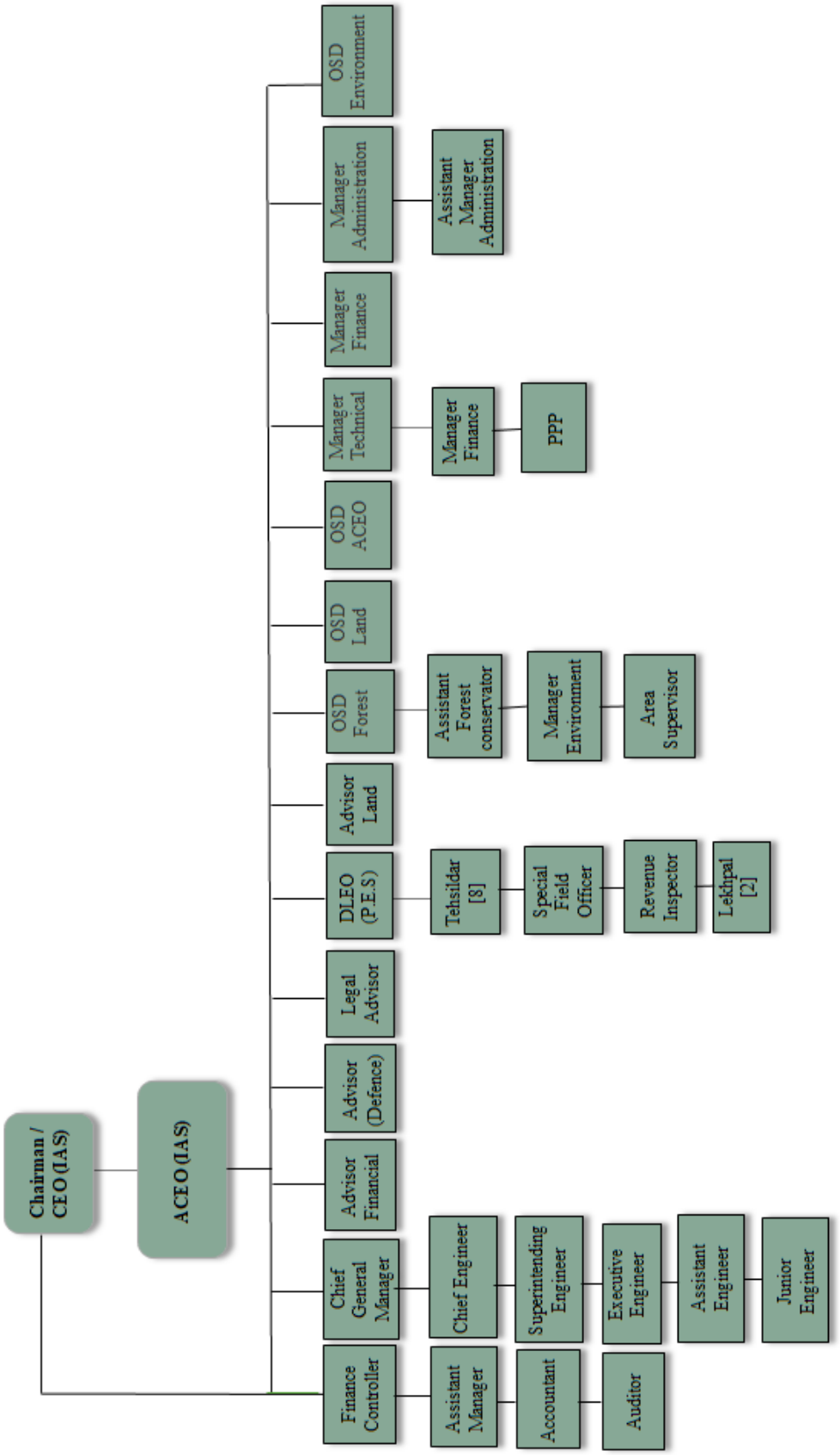
The Government of Uttar Pradesh has set up an Authority named "Uttar Pradesh Expressways Industrial Development Authority" (UPEIDA), under UP Industrial Area Development Act 1976, vide Notification Number 4246/77-4-07-94 Bha/07TC, dated December 27, 2007 issued by Industrial Area Development Department-4, Government of Uttar Pradesh.

1.2 ABOUT UPEIDA

Uttar Pradesh Expressways Industrial Development Authority (known by its acronym UPEIDA) was set up by the State Government under U.P. Industrial Areas Development Act 1976, in December 2007 for development of Expressways in Uttar Pradesh. This is a newly established Organisation with lean and laborious employee base, on contract or on deputation basis from State Revenue Department/PWD, among them few are deployed on retainership basis or by service provider.

1.2.1 UPEIDA Organisational Structure

An organizational structure is a system that outlines how certain activities are directed in order to achieve the goals of an organization. These activities can include rules, roles, and responsibilities. The organisational structure of UPEIDA is given below:


UPIEDA ORGANISATIONAL STRUCTURE
Chairman / CEO (IAS)
ACEO (IAS)
OSD Environment
Manager Administration
Assistant Manager Administration
Manager Finance
Manager Technical
Manager Finance
PPP
OSD ACEO
OSD Land
OSD Forest
Assistant Forest conservator
Manager Environment
Area Supervisor
Advisor Land
DLEO (P.E.S)
Tehsildar [8]
Special Field Officer
Revenue Inspector
Lekhpal [2]
Legal Advisor
Advisor (Defence)
Advisor Financial
Chief General Manager
Chief Engineer
Superintending Engineer
Executive Engineer
Assistant Engineer
Junior Engineer
Finance Controller
Assistant Manager
Accountant
Auditor

1.2.2 Expressway Projects by UPEIDA

Expressway Projects executed/ under execution by UPEIDA so far are as under:

(a) Agra-Lucknow Expressway

This Greenfield Expressway project is 302.22 km long, starts from Agra passes through Firozabad, Mainpuri, Etawah, Auraiya, Kannauj, Kanpur Nagar, Unnao, Hardoi and ends at Lucknow districts. The expected travel time from Agra to Lucknow shall be reduced to 4 hours. The width of the Expressway is 6 lanes (expandable up to 8 lanes with all structured as 8 lanes) with a design speed of 120 km per hour. Inauguration of this expressway has been done on 21.11.2016 and at present this Expressways is operational.


(b) Purvanchal Expressway

This Greenfield Expressway project is 340.824 KM long, starts from Lucknow passes through districts Barabanki, Ayodhya. Amethi, Sultanpur, Ambedkarnagar, Azamgarh, Mau and ends at Ghazipur. Purvanchal Expressway 6 lane (expandable to 8 lane with all structures as 8 lane) Access Controlled expressway project with design speed of 120 km/h. This Expressway is under construction and expected to be operational at the end of year 2020.

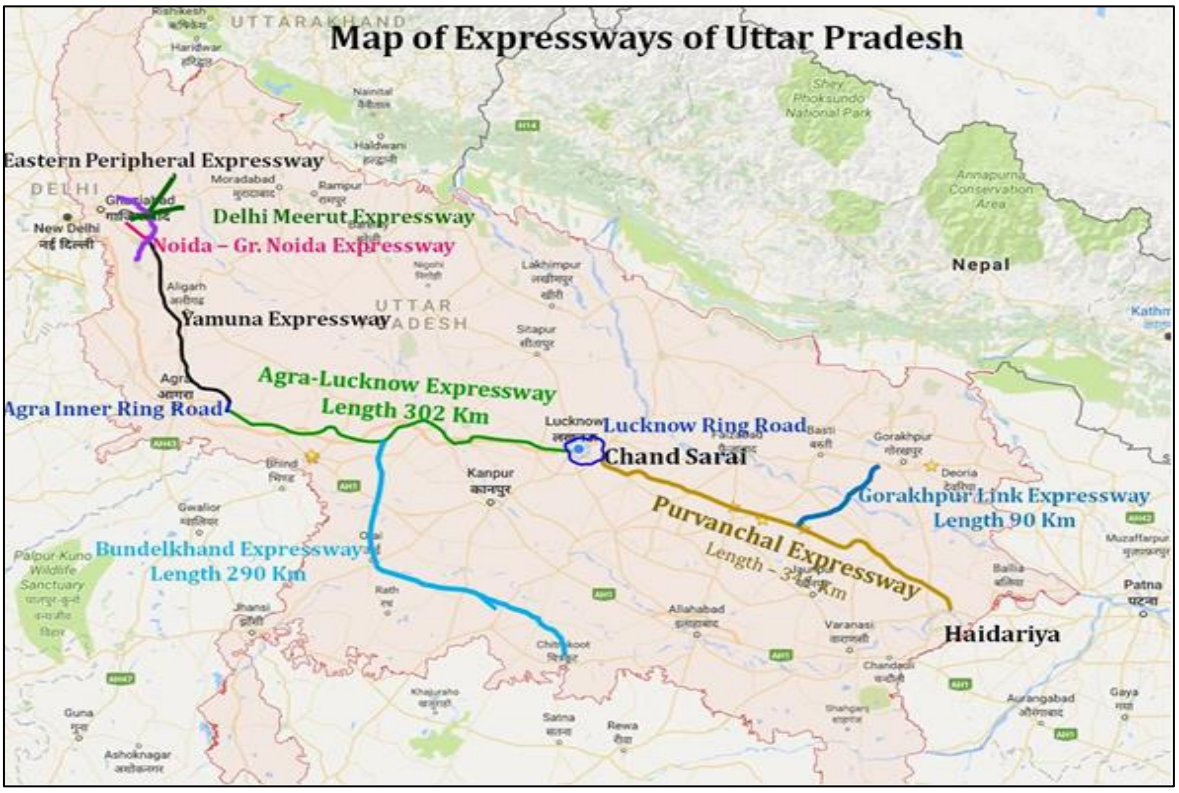
(c) Bundelkhand Expressway

This Greenfield Expressway project is 296.07 KM long, starts from Chitrakoot passes through districts Banda, Mahoba, Hamirpur, Jalaun, Auraiya and ends at Agra-Lucknow Expressway in

district Etawah. Bundelkhand Expressway is 4 lane (expandable to 6 lane with all structures as 6 lane) Access Controlled expressway project with design speed of 120 km/h. This Expressway is under construction and expected to be operational by the year 2022.

(d) Gorakhpur Link Expressway

This Greenfield Expressway project is 91.352 KM long, starts from Gorakhpur passes through districts Ambedkar nagar, Sant Kabir nagar and ends at Purvanchal Expressway in district Azamgarh. Gorakhpur Link Expressway is 4 lane (expandable to 6 lane with all structures as 6 lane) Access Controlled expressway project with design speed of 120 km/h. This Expressway is under construction and expected to be operational in the year 2022.

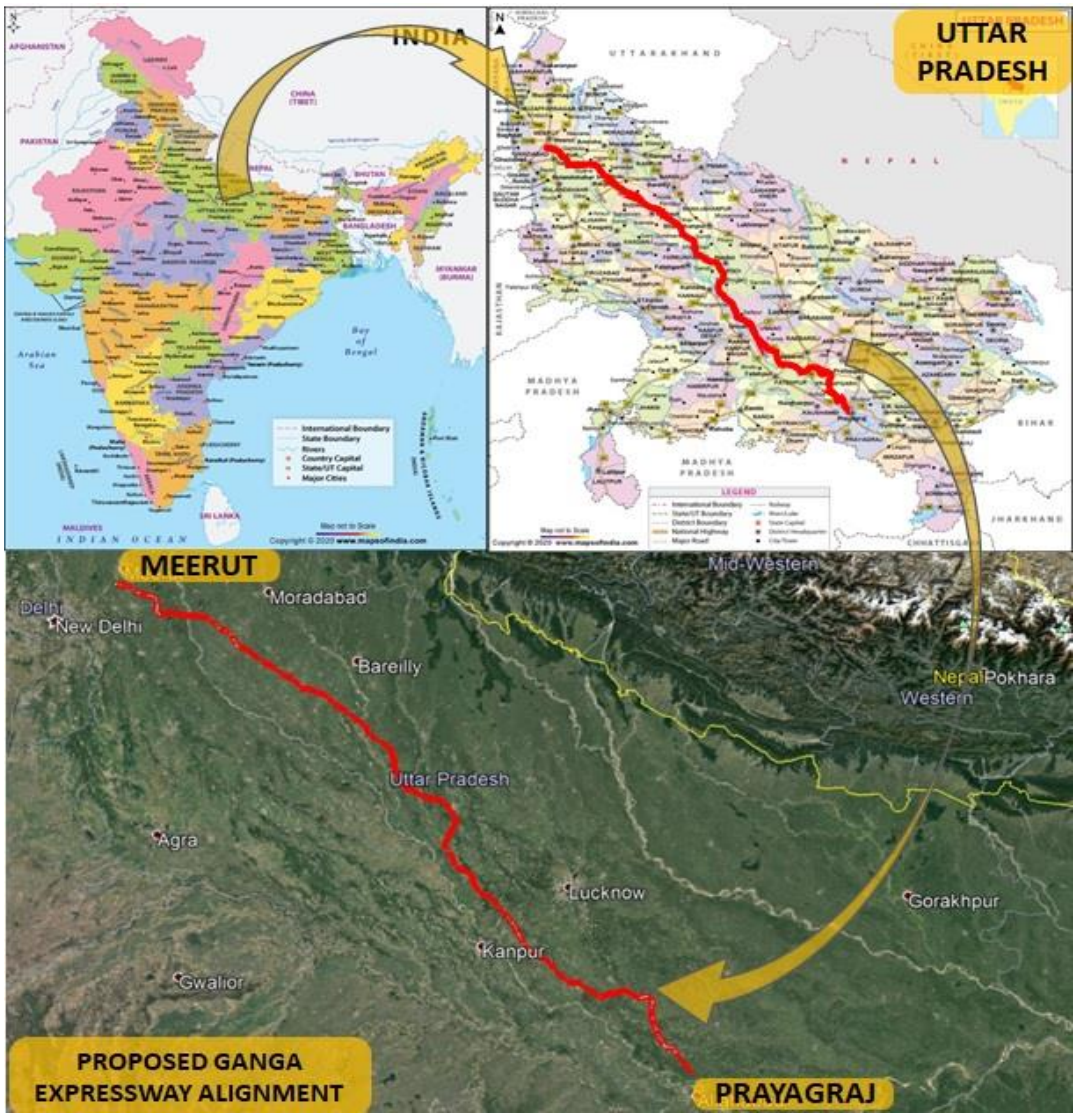


1.3 NEWLY PROPOSED GANGA EXPRESSWAY (THE PROJECT)

The proposed "Ganga Expressway" is Access Controlled Expressway (Green Field) Project which will connect Meerut to Prayagraj. This proposed Expressway project shall create immense opportunities to the people of Western & Central region of the State and over all development of the State by providing safer & faster connectivity from East to West borders of the State and with National Capital and NCR Region.

The project will provide direct high speed connectivity from National Capital Region through proposed expressway to Meerut and then onwards to Prayagraj. It will facilitate construction of all-weather high speed access controlled expressway, which will decongest the increasing traffic on existing road network. The expressway will also decrease travel time substantially.

Index Map showing proposed Ganga Expressway alignment is presented below:



Index map of Ganga Expressway

The Uttar Pradesh Government has decided to develop the "Ganga Expressway Project". UPEIDA is committed for the development of this expressway and has Entrusted M/s L N Malviya Infra Projects Pvt. Ltd., Highway Engineering Consultant and Intratech Civil Solutions (Consortium) to carry out the detailed project report to implement the project on EPC Mode and selection of developers through competitive bidding process.

The Consultant has undertaken requisite surveys & studies for the project which includes costing to assess technical, environmental and social assessment studies, their analysis etc. As a part of the study to establish the viability, this Project Report has been prepared after carrying out engineering surveys and appropriate assessment of a preliminary design considering the engineering conditions, the present traffic and its growth, the environmental impact assessment as well as the social aspects along with cost assessment. This report among other aspects covers the details on finalization of alignment, grade separator interchanges and structures along the proposed Expressway, marking on the Khasra maps of ROW and marking of alignment on

revenue maps, identification of Tourist spots, eco-friendly structures, water bodies etc. along the expressway.

1.4 OBJECTIVE

The objective of this consultancy (the "Objective") is to undertake feasibility study and prepare a 'Detailed Project Report' of the Project Expressway.

1.5 SCOPE OF CONSULTANCY SERVICES

(a) Preparation of feasibility report having different alignment options conforming to expressway Geometric Standards and also showing their merits & demerits so that most appropriate Alignment can be selected.

(b) Traffic surveys and demand assessment.

(c) Engineering surveys and investigations.

(d) Location and layout of toll plazas, truck lay byes, bus bays and bus shelters, public utilities, restaurant, workshops, PCO etc.

(e) Social and Environmental impact assessment including providing all assistance in obtaining necessary clearances including Forest, Wild-Life & Environment Clearance from GoUP/GoI.

(f) Designs of Road/Bridges/Structures/interchanges etc.

(g) Preparation of detailed cost estimates on the basis of designs & Bill of Quantities.

(h) Detailed cost of shifting and relocation of utilities (duly authenticated by the competent authority in the department owning the Utilities), land acquisition, removal of encroachments and rehabilitation etc.

(i) Evaluating the financial viability/economic analysis of the project.

(j) For SELECTED mode the consultant shall have to suggest the possible modes of financing of the project and help the Authority/ Government to arrange funds from external resources, if required. For PPP mode, the consultant shall have to assist the Authority in getting the VGF. For other modes, necessary assistance for the funding of the project shall have to be provided by the consultant.

(k) Preparation of bid documents for selection of prospective "Developer(s)/Contractor(s)" including all schedules of the Agreement.

(l) Finalization of Expressway Packages and evaluating their detailed costs separately and including measurements of different items, analysis of rates based on prevalent PWD rates, BOQ including Costing of Structures, Toll Plaza, utility areas etc. and for evaluation of the Financial viability of Project separately for each distinct package as well as the complete Project as a whole.

(m) The Project is to be bidded out in a way so that the Bidders may have an option of bidding for individual packages/ combination of packages/ Complete Project.

(n) Preparation of supporting information to assist bidders in preparation of their bids, and where relevant, creation of a data base and management access to the data base.

(o) Support to communication with the prospective bidders and interaction with them, including managing and responding to requests for clarification.

(p) Preparation of a bid evaluation plan, assistance in evaluation and preparation of evaluation reports.

(q) Assistance in negotiation with one or more parties prior to contract award, if required.

(r) Monitoring and advice on bidder performance against any conditions precedent to financial close; and

(s) Providing assistance in obtaining necessary clearances from the Forest Department which includes preparation of proposal for clearance under Forest Conservation Act., counting & marking of trees, joint inspection with Forest Department officials etc.

(t) Preparation of TOR, Bid Documents, Contract Agreement for selection of Authority's Engineer, Project Management Consultant (PMC) and Safety Engineer etc. as per requirement and facilitation of Authority in their selection and appointment.

1.6 CONSULTANT'S APPROACH

The Consultant's approach to the project is in accordance with the "Description of Services" given in the Contract Document, understanding of the project objectives and further discussions with the Client during progress of the project study. The main approach of this consultancy service comprise of the following:

(a) The Greenfield alignment is within the proposed Right of Way (ROW);

(b) The most economical but sound proposal is arrived at for the required roadwork and related bridge works;

(c) Engineering, economic, environmental and social feasibility studies of the proposed road improvements are carried out keeping in view of several important aspects of project execution.

(d) International "best practices" including use of "State of the art" and computer based survey and design techniques (e.g. GPS, Total Station Survey, LiDAR, Computer Aided Designs (MX/MOSS/Equivalent etc.) is incorporated for preparation of the technical proposal, development of designs, cost estimates, bid documents etc.;

(e) Preliminary designs of the agreed road and related bridge works is prepared, as a basis for completing Environmental Impact Assessment (EIA) shall be prepared;

(f) Reports and analysis shall be provided, suitable for meeting the standards and specifications laid down according to Ministry of Road Transport and Highways (MORTH), Government of India requirements on environmental and social assessment.

1.7 STRUCTURE OF DETAILED PROJECT REPORT

The Detailed Project Report has been divided in following volumes:

Volume-I: Main Report

Volume-II: Cost Estimates

Volume-III: Rate Analysis

Volume-IV: Design Report

Volume-V: Technical Specifications

Volume-VI: Investigation Reports

(a) Report on traffic survey and demand assessment

(b) Soil, geotechnical and drainage report

(c) Social Impact Assessment Report

(d) EIA Report and Environmental Management Plan

Volume-VII: Financial Analysis & Economic Analysis

Volume-VIII: Drawings (Highways, Structures & Miscellaneous)

Volume-IX: Land Acquisition Reports & LA Plans

Volume-X: Report on Project Clearances

2. PROJECT DESCRIPTION

2.1 GENERAL

Uttar Pradesh is a state in northern part of India. It was formed on 1 April 1937 as It was created on 1 April 1937 as the United Provinces of Agra and Oudh during British rule, and was renamed Uttar Pradesh (UP) in 1950. The state is divided into 18 divisions and 75 districts with the capital being Lucknow. On 9 November 2000, a new state, Uttarakhand, was carved out from the state's Himalayan hill region.

The two major rivers of the state, the Ganges and Yamuna, join at Allahabad and flow further east as Ganges. Other prominent rivers are Gomti and Varuna. Hindi is the most widely spoken language and is also the official language of the state, along with Urdu.

From population, political awareness, historical and cultural heritage and freedom movement points of view, Uttar Pradesh is a very important state of the country. As much as 16.17% of India's population lives in the state. Geographically, it acquires 5th position after Rajasthan, Madhya Pradesh, Maharashtra and Andhra Pradesh and covers 7.3% land area of India. Area wise it covers 240.928 square Kilo meters. For administrative convenience, it has 18 divisions, 75 districts, 915 urban bodies, 8135 Nyaya Panchayats. 13 Municipal corporations, 226 municipal boards, 59163 gram sabhas, 822 development blocks, 97941 populated villages 180000 post offices and 2885 telephone exchanges.

Uttar Pradesh sends 80 members to Lok Sabha, 31 members to Rajya Sabha and 404 members to its Legislative Assembly and 100 members to its Legislative council.

It is pertinent to mention that the strength of work force in the state is 23.7%, out of which 65.9% are farmers and 5.6% are industrial workers. Its per capita income is Rs. 13,262 as per existing rate.

Area	240928 square K.M.
No. of districts	75
Total population (year 2011)	199812341
Male	104480510
Female	95331831
Population growth during 2001-2011	33614420
Decline in population rate during 2001-2011	20.29%
Density of population (per sq. km)	829
Sex ratio	912:1000
percentage of children population in the age group of 0-6 years	
Total children	18.35%
Boys	18.18%
Girls	18.54%
Literacy among in the age group of 7 years and above (2011)	
Total	69.72%
Male	79.24%
Female	59.26%

2.2 PROJECT BACKGROUND

After Successful Preparation/ Execution of various Expressway Projects viz. Yamuna Expressway, Agra-Lucknow Expressway, Purvanchal Expressway & Bundelkhand Expressway, the Uttar Pradesh Government has decided to develop the "Ganga Expressway Project".

The project will provide direct high speed connectivity from National Capital Region through proposed expressway to Meerut and then onwards to Prayagraj. It will facilitate construction of all-weather high speed access controlled expressway, which will decongest the increasing traffic on existing road network. The expressway will also decrease travel time substantially.

UPEIDA is committed for the development of this expressway and has entrusted M/s L N Malviya Infra Projects Pvt. Ltd., Highway Engineering Consultant and Intratech Civil Solutions (Consortium) to carry out the detailed project report to implement the project on EPC Mode and selection of developers through competitive bidding process.

The Consultant has undertaken requisite surveys & studies for the project which includes costing to assess technical, environmental and social assessment studies, their analysis etc. As a part of the study to establish the viability, this Project Report has been prepared after carrying out engineering surveys and appropriate assessment of a preliminary design considering the engineering conditions, the present traffic and its growth, the environmental impact assessment as well as the social aspects along with cost assessment. This report among other aspects covers the details on finalization of alignment, grade separator interchanges and structures along the proposed Expressway, marking on the Khasra maps of ROW and marking of alignment on revenue maps, identification of Tourist spots, eco-friendly structures, water bodies etc. along the expressway.

2.3 PROJECT DESCRIPTION

The The proposed Ganga Expressway **(CH 7+900)** starts from km 16+000 of Meerut-Bulandshahar (NH-334) near village Bijoli in District Meerut & terminates at Prayagraj Bypass on NH-19 near village Judapur Dando (Dist. Prayagraj) **(CH 601+847)**.

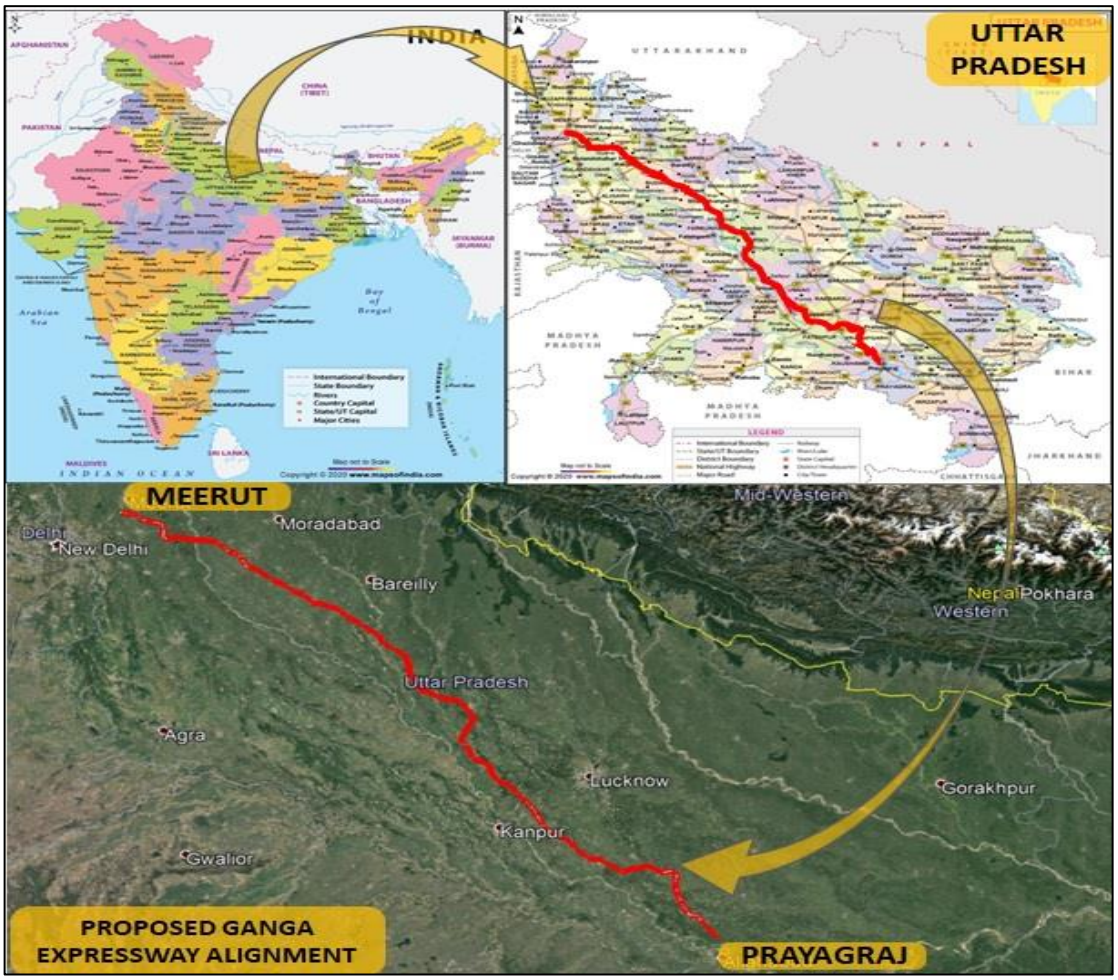
The length of the proposed expressway alignment is **593.947 km**.

The proposed expressway has been divided into 12 packages. The chainage wise details of the packages have been given below: The Project under consideration is Package-6

Package No.	Section Details	Chainage (km)		Length
		From	To	
I	From Village Bijoli (Dist. Meerut) to Village-Chandner (Dist. Hapur)	7.900	56.900	49.000
II	From Village-Chandner (Dist. Hapur) to Village-Mirzapur Dugar (Dist. Amroha)	56.900	86.900	30.000
III	From Mirzapur Dugar (Dist. Amroha) to Village-Nagla Barah (Dist. Budaun)	86.900	137.600	50.700
IV	From Village-Nagla Barah (Dist. Budaun) to Village-Binawar (Dist. Budaun)	137.600	189.700	52.100
V	From Binawar (Dist.Budaun) to Girdharpur (Dist. Shahjahanpur)	189.700	236.400	46.700

Package No.	Section Details	Chainage (km)		Length
		From	To	
VI	From Village- Girdharpur (Dist. Shahjahanpur) to Village-Ubariya Khurd (Dist. Hardoi)	236.400	289.300	52.900
VII	From Village-Ubariya Khurd (Dist. Hardoi) to Village- Pandra Lakhanpur (Dist. Hardoi)	289.300	341.700	52.400
VIII	From Village- Pandra Lakhanpur (Dist. Hardoi) to Village-Raiyamau(Dist. Unnao)	341.700	391.900	50.200
IX	From Village- Raiyamau (Dist. Unnao) to Village-Sarso (Dist. Unnao)	391.900	445.000	53.100
X	From Village- Sarso (Dist. Unnao) to Village-Terukha (Dist. Raebareli)	445.000	496.800	51.800
XI	From Village-Terukha (Dist. Raebareli) to Village-Arro (Dist. Pratapgarh)	496.800	548.800	52.000
XII	From Village- Arro (Dist. Pratapgarh) to Village-Judapur Dando (Dist. Prayagraj)	548.800	601.847	53.047
Total				**593.947**

The project Index Map is Shown below:



3. METHODOLOGY & DESIGN STANDARDS

3 General

All the services are carried out strictly as per ToR. The Guidelines for Expressway published by Ministry of Road Trans-port and Highways (MoRT&H) have been followed for preparing this Project Report. Specific Codes and Guidelines of the IRC and publications of the MoRT&H including circulars & general/special publications, technical Specifications & Standards have also been considered. All the field activities have been completed as discussed in detail with Authority.

For Topographic survey latest electronic instruments like Differential Global Positioning System (DGPS), RTK GPS and Total Station were used. Data was collected as per formats and procedures approved by the MoRT&H and analyzed using in-house developed software. MX Roads software for the highway designs and STADD-proV8i for the structure designs are used. For the pavement designs standard software/programs developed in-house have been used.

In depth consultation process with UPEIDA was held on a regular basis to enhance the progress of the work. As time and quality are the essence of the project, before any analysis and designs, all the parameters to be used were got approved by the Client during preparation of draft reports so there is minimum changes later on, i.e. minimum time requirement in the finalization of final reports without compromising quality.

The idea is to seek prior approval from client through meeting/discussion on Inception, alignment finalization, bid evaluation, pre-bid conference etc. Similarly, various traffic scenarios will be developed and presented to client for discussion and approval.

3.1 Design Basis

The broad methodology has been developed keeping standard practices / IRC guidelines, with certain additions and modifications as felt necessary.

3.2 Review of Earlier Reports

The Consultants have collected and reviewed the relative study reports to have a better understanding of the project & also for getting some inputs as a part of the services. The study reports thus considered for review are:

1. Concept Report for Development of Purvanchal Express-way (Green Field) Project.
2. Road development plan in the region by UPEIDA.
3. Any useful details relevant for the project available with the Client/ Other agencies have been collected. Other details are also collected and collated to form recommendations by considering the following inputs:
    - Material details
    - Soil Test results
    - Geo-technical investigation reports
    - Topographic survey details / Bench mark details and other survey information
    - Utility Services/Utility Relocation Plans
    - Traffic Studies

- Tree plantation records
- Hydrological and Hydraulic details
- Development Plans for major towns and areas along the project road
- Availability of construction materials and unit rates for work items
- Recent acquisition rates for different types of land/immovable properties
- Right of Way Details from Revenue maps

3.3 Socio-Economic Profile

Socio-economic profile of the influence area is prepared, after study of data on growth of population and density, human settlement pattern, land use, sub-profiles of agriculture and industries, economic base, trends in socio-economic indicators, development scenarios for various sectors, transport infrastructure and its uses such as use of waterways & rail transport etc.

The relevant data is collected from the following sources:

- State Statistical Abstracts
- State Year Books

Census Publications – Districts and State

- Hand Books of Statistics of Districts in the area of influence
- Economic Surveys of the State constituting the zone of influence
- The Bureau of Economics & Statistics of Uttar Pradesh

3.4 Traffic Survey, Analysis and Projections

Traffic surveys include (only those surveys would be carried out which are required for correctly forecasting the traffic along the proposed road):

- Classified Traffic Volume Counts
- Origin – Destination and commodity Movement Surveys

Standard procedures given in IRC Codes have been followed for carrying out Traffic Surveys. The data arrived from the Surveys has been analyzed to determine ADT of surrounding roads of the proposed project road and travel characteristics.

Growth of traffic in project road influence area and also on the project road is regarded as the most important aspect since the whole project design is based on this. To establish the realistic growth rates, road transport data, population growth rates and socio-economic parameters have been studied and analyzed. The growth rates for passenger vehicles have been worked out on the basis of annual growth rate of population and per capita income while the growth rates of freight vehicles have been based on the rate of growth in agricultural, industrial and tourism sectors and historical traffic data. These growth rates have been used to arrive at the traffic projections for the design period. After the development of project corridor to six lane standard configuration, greater amount of traffic is expected to be diverted from the peripheral road network. Appropriate traffic diversion models have been used for assessment of diverted traffic to this road. Details on traffic data & projections have been discussed in Chapter 5 of this Report.

3.5 Engineering Surveys and Investigations

3.5.1 Reconnaissance Survey of the Project Road

Reconnaissance survey has been carried out immediately before the kick off meeting to examine the general characteristics of the Project Corridor. Consultants have undertaken a site visit along with the experts in the field of Highway, Pavement and Bridge Engineering. This has helped in the detailed appreciation of the project corridor in terms of traffic and other engineering measures and judicious assessment of the following salient factors have generally been made:

- Topography of the area
- Terrain and soil conditions
- Climate and Rainfall
- Drainage Characteristics
- Traffic patterns and preliminary identification of traffic homogeneous sections of road.
- Railway lines and other critical utilities/services having impact on road alignment
- Land use (agricultural, build-up, forest land, etc.,)
- Environmental factors
- Availability of materials
- Any other useful information

The findings are described in the following paragraphs;

3.5.2 Topographic Surveys

Topographic survey has been carried out along the proposed alignment to know the topography, natural and manmade features present within the proposed ROW and to assess the existing geometric deficiencies along with land use plan. The survey has been carried out only after establishing horizontal and vertical control grids. Horizontal grid has been established through DGPS points and been erected at every 5 km interval. For vertical grid, bench mark has been erected at every 250m interval and connecting these to the nearest BM of Survey of India.

Selection of primary Control Points and Observations is as detailed below:

- These are located on the edge of the proposed right of way (ROW) at inter-visible locations at every 5 km.
- These are, as far as possible, on either side of 5 km stone so that it can be identified easily in the field and an arrow has been painted on the existing road indicating their location. They are recorded in separate field with their three dimensional locations.
- The stations selected are free from obstruction towards sky at an angle of 15° with horizontal plane.
- The horizontal control station is established on nail fixed in centre of RCC (M15) pillar of size 15 cm x 15 cm x 45 cm embedded in concrete M10 (5 cm all around) up to a depth of 30 cm and the balance 15 cm above the ground painted yellow.

- The Primary Control Stations are fixed using DGPS Trimble make instrument. The time of observations at Base Stations is observed for a minimum of 30 minutes and at Reference Stations for 20 minutes or longer if instrument signal is not indicating sufficient data received, to eliminate the possible projection and time errors in the signals received from various satellites being observed at respective locations in order to ensure high accuracy in the positioning of control stations within + 20 mm.
- Minimum of 6 satellites are available during observation to ensure high accuracy Secondary control stations are established at 2 km intervals using Total Station and through closed traverse distributed linearly running between two nearest Primary Control Stations ensuring accuracy in the order of $12\sqrt{K}$ in mm, where 'K' is the distance in kilometers between two primary control stations. Any errors within permissible limits are distributed in rational manner to establish the accurate and effective horizontal control grid. These are established on reference pillars having configuration similar to primary control station with an arrow painted on the surface of existing road indicating their location.

3.5.2.1 Pillar Construction

Benchmark pillars at every 1000m along the route within the ROW have been constructed. All these pillars will have to be furnished with X, Y, Z co-ordinates. The pillars are of size 150 x 150 x 600mm long. The pillar is concreted and embedded in a manner that 150mm is remain above ground. A steel rod has been fixed in the centre for punching the point and finally these are to be painted yellow.

3.5.2.2 Total Station Traverse

A closed traverse is run for a loop length of 5 km. While traversing, station is established 200 to 250mts apart. The pillars constructed along the route are connected. These points are further used for detailed survey. The minimum accuracy of this survey is 1:10,000.

3.5.2.3 Bench mark

These are located, as far as possible, along the proposed right of way (ROW) boundaries at an interval of 250 m with BM No. marked on it with red paint.

- Bench Mark pillar is of size 15 cm x 15 cm x 45 cm cast in RCC M15 with a nail fixed in the centre of the top surface and embedded in concrete M10 (5cm all around) up to a depth of 30 cm. The balance 15 cm above the ground is painted yellow.
- An arrow indicating the location of the BM is painted on the road with the permanent yellow paint and recorded in separate field books with its three dimensional location.

The Bench Mark is established using high accuracy Digital Level and Bar coded staff by way of double run leveling in small circuits of 3 km length ensuring an accuracy in the order of $12\sqrt{k}$ mm, where 'K' is the distance in Kilometers between two Bench Marks avail-able in the project area, and error, if any, within permissible limits is distributed in rational manner to establish the accurate and effective vertical control grid.

The topographic survey has been extending up to the proposed Right of Way (ROW). Wherever necessary, the survey corridor width is further increased to accommodate situations arising out of encroachments and any other contingencies. The survey areas at the locations of intersections cover up to a minimum of 500m on the either side of the centre-line and have sufficient width to accommodate improvement measures. Necessary surveys are

also carried out for determining the requirements of service roads for local traffic, where appropriate.

3.5.2.4 Detailed Survey

Using the horizontal and vertical control points established accurate data in the digital format in terms of Northing (Y). Easting (X) and Elevation (Z) co-ordinates for all breaks in terrain such as ridges and ditches are collected perpendicular to the centre line at 50m intervals in tangent sections and 20-25m in curve sections using Total Stations. Cross sections are taken for the specified corridor width of 110m; however this corridor width is increased to 150m on the inside of sharp curves to account for minor adjustments.

All natural and man-made features such as buildings, irrigation channels, drainage structures, temples, mosques, trees and utility installations etc. are captured during the survey. Spot level on the existing carriageway are captured at five points namely at centerline, mid points of both lanes of traffic movement and pavement edges at both ends to calculate the profile corrective courses more realistically. Trees with girth wise are captured with areas of plantation. Wherever there are groups of trees/plantations, they are picked with the areas of plantation. Boundaries of Agricultural Land area have been surveyed to demarcate the cultivation land limit.

Where existing major roads cross the alignment, the survey has been extended to a maximum of 500m on either side of the road centerline to allow improvements including grade separated intersections to be designed. Apart from this, the survey has covered a maxi-mum of 1000m and 500m on either side of centerline in cases of major and minor bridges respectively.

3.5.2.5 Data Processing

The field survey data are processed in the office to provide a digital output file for the de-sign engineers. The data is structured so that the existing vertical profile along the pro-posed alignment can be produced automatically. The format of the resulting data readily promotes the calculations of earthworks and other quantities required for the evaluation of cost estimates.

Roadway plans have been produced from the survey data, which identify the available Right of Way (ROW) along the existing road corridors. In addition, the plans identify all existing utilities /installations within the corridor/ROW that require re-location by the new road design. Action Plans for covering the relocation of these obstructing installations and public utilities are to be prepared on a km to km basis.

3.5.2.6 Material Investigations

The Material Investigation for road construction has been carried out to identify the potential sources of construction materials and to assess their general availability, mechanical properties and quantities. This is one of the most important factors for stable, economic and successful implementation of the road program within the stipulated time for improvement work as well as for new carriageway, the list of materials includes the following:

a) Granular material for lower sub-base works.

b) Crushed stone aggregates for upper sub-base, base, surfacing and cement concrete works.

c) Sand for filter material and cement, concrete works, sub-base and filling material.

d) Borrow material for embankment, sub-grade and filling.

e) Manufactured material like cement, steel, bitumen, geo-textiles etc. for other related works. The Information on material sources has been carried out with the following basic objectives:

Source location, indicating places, kilometer age, availability and the status whether in operation or new source.

- Access to source, indicating the direction and nature of the access road i.e. left / right of project road, approximate lead distance from the gravity centre and type of access road.
- Ownership of land / quarries, either government or private.
- Probable uses indicating the likely use of materials at various stages of construction work i.e. fill materials, sub-grade, sub-base, base and wearing course and cross drainage structures.

During the process of investigation, due consideration has been given to the locally available materials for reducing the cost of construction.

The samples have been collected as described below:

- From quarry sites for aggregate characteristics like, aggregate impact value, gradation, soundness, flakiness index and elongation, stripping value and water absorption etc.
- From random pits (farmland) along the proposed alignment for availability of suitable embankment and sub grade material, and identification of the borrow areas and tested in line with relevant IRC code.

3.5.2.7 Geotechnical Investigations

Sufficient information about the arrangement & behavior of the underlying materials and their physical properties for adopting and designing the structural foundation is essential. Soil exploration through field investigation and laboratory testing of the substrata are helpful in arriving at required parameters for designing of safe and economical foundations. The data obtained from these investigations has been analyzed for safe design of the foundation. In the geotechnical report's recommendations has been made for type of foundations and its safe bearing capacity/load carrying capacity required for the structure design.

3.5.2.8 Hydrological Investigations

Hydrological investigations have been carried out for the entire project. It has been ensured that majority of the cross drainage structures are hierologically adequate to carry the discharge of the river / streams.

3.6 Traffic Design

3.6.1 General

The capacity standards for expressway have been adopted as per the "Guidelines for Expressways". Capacity analysis is fundamental to the planning, design and operation of roads and provides, among other things, the basis for determining the carriageway width to be provided at any point in a road network with respect to the volume and composition of traffic. Moreover, it is a valuable tool for evaluation of the investments needed for future road constructions and improvements.

3.6.1.1 Equivalency Factors

The need of expressing capacity in passenger car units has triggered off many studies for establishing appropriate passenger car equivalency (PCE) values for different types of vehicles. Notable among the studies carried out in India are the road user cost studies (RUCS) by CRRI and the MoRT&H. It has been recognized that the PCE values vary under different traffic, roadway conditions and composition for any given type of vehicle.

Equivalency Factor is a factor to convert the mixed flow of traffic in to single unit to express the capacity of road. The unit generally employed is the passenger car unit (PCU). The equivalency factors for conversion of different types of vehicles in to equivalent passenger car units based on their relative interference value are given in Table 2.1 (as per IRC: 64 – 1990).

Table 2.1: PCU Factor for Various types of Vehicles on Rural Roads

S. No.	Vehicle Type	Equivalency Factors
Fast moving vehicles		
1	Motor cycle or scooter	0.50
2	Passenger car, pick up van or auto-rickshaw	1.00
3	Agricultural tractor, light commercial vehicle	1.50
4	Truck or bus	3.00
5	Truck – trailer, agricultural tractor – trailer	4.50
Slow moving vehicles		
1	Cycle	0.50
2	Cycle rickshaw	2.00
3	Hand cart	3.00
4	Horse drawn vehicle	4.00
5	Bullock cart	8.00

3.6.2 Capacity Analysis for 6-Lane Expressway

As per the Guidelines for Expressways Volume-I: Planning, the capacity of an expressway is sensitive to the traffic flow characteristics on divided highways.

3.6.2.1 Free Flow Speed

An important element of the speed – flow curves of the project roads is the free flow speed. It is the speed at which driver feel comfortable travelling under the physical, environmental and traffic control conditions on a non-congested section of a multi lane highway, - HCM (2000). All recent studies suggest that speed on project road is insensitive to flow over a broad range of flows. Thus free-flow speed can be established on an existing facility by measuring in the field, the average speed of vehicles when flow rates do not exceed 1300 passenger car per hour per lane (PCPHPL) (HCM 1994). In the absence of traffic flow speed data on highway in India, the free flow speed is required to be assumed.

3.6.2.2 Factors affecting the Free Flow Speed (FFS):

The FFS of an expressway depends on the traffic and roadway conditions described below:

- Lane width
- Lateral Clearance
- Number of Lanes
- Interchange Density
- Geometric design

The basic equation used to calculate the FFS is as given below:

$$FFS = BFFS - f_{LW} - f_{LC} - f_N - f_{ID} \quad \text{----Eq(1)}$$

Where,

BFFS=base free flow speed, kmph

f_{LW} = adjustment factor for lane width

f_{LC} = adjustment factor for right shoulder lateral clearance

f_N = adjustment factor for number of lanes

f_{ID} = adjustment factor for interchange density

Base Free Flow Speed BFFS is set at 120 kmph for rural facilities.

Adjustment factor for Lane width (f_{LW}) is given in Table 2.2.

Table 2.2: Adjustment Factor for Lane Width

Lane Width (m)	Reduction in FFS (kmph)
3.6	0.0
3.5	1.0
3.4	2.1
3.3	3.1
3.2	5.6
3.1	8.1
3.0	10.6

For the project road, the lane width considered is 3.75, hence, the reduction in FFS =0.0

Adjustment factor for left shoulder clearance (f_{LC}) is given in Table 2.3.

Table 2.3: Adjustment Factors for Left Shoulder Clearance.

Left Shoulder width(m)	Reduction in FFS (Kmph; fLC)			
	Number of Lanes in One Direction			
	2	3	4	>=5
>=1.8	0.0	0.0	0.0	0.0
1.5	1.0	0.6	0.3	0.2

1.2	2.0	1.3	0.6	0.3

For the project road, the left shoulder width is greater than 1.8, hence adjustment factor is 0.0.

Adjustment factor for Number of Lanes (fN):

For rural facilities f***N*** is set as 0.

Adjustment factor for Interchange density (fID)

Since the minimum interchange spacing more than 4 kms, the adjustment factor for interchange density is set as 0.

The using Equation (1) we get

FFS=120-0-0-0-0

FFS = 120kmph

Calculation of Base Capacity (Base Cap)

The base capacity (pcphpl) of an expressway facility is given by

Base Capacity = 1700+10FFS; for FFS<=112 ----------Eq(2)

Base Capacity = 2400; for FFS>112 ----------Eq(3)

Since, the FFS is (120kmph)>112kmph, base capacity =2400pcphpl

Determination of Peak Capacity (Peak Cap)

The peak capacity is given by,

Peak Cap = Base Cap*PHF*N*f_{HV}*f_P

Where,

Peak Capacity = Peak capacity, vehicles per hour (all lanes, one direction)

PHF = Peak Hour Factor; *0 .88 so as to maintain LOS B always on Expressway*

N = Number of lanes in one direction (3 for 6-lane); *3 for one direction flow on Expressway*

f_{HV} = Adjustment factor for heavy vehicles; *0.8253 for expressway as calculated below*

f_P = Adjustment factor for driver population; *0.975 for rural expressways*

Assign a final PHF is given in **Table 2.4.:**

Table 2.4: Peak Hour Factor

Area Type	V/C Ratio	PHF
Rural	<0.7744 0.7744<=v/c<=0.9025 >0.9025	0.88 Equation (4.04) 0.95
Urban	<0.8100 0.8100<=v/c<=0.9025 >0.9025	0.90 Equation (4.04) 0.95

For the project road the PHF of 0.88 has been considered.

Adjustment factor for Heavy Vehicles (fHV)

The adjustment factor for heavy vehicles is based on calculating passenger car equivalents for trucks and buses.

$f_{HV} = 1/(1+PT(ET-1))$

Where,

PT= Proportion of trucks and buses in the traffic stream; 42% as per traffic projections

ET=Passenger car Equivalents; 1.5 for rural expressways in level terrain.

The f_{HV} factor for the expressway using the above equation is 0.8253

Adjustment factor for Driver Population (f_P)

On rural expressways, the factor is set to 0.975 but has been considered as 1.0 for the project road.

Thus, the peak capacity for the 6-lane expressway

Peak Capacity = 2400*0.88*3*0.8253*.975

= 5089 pcphpl *(for 3-lane in one direction)*

= 5089*2/0.08 = 127225 PCUs per day *(for 6-lane carriageway with depressed median)*

The peak capacity of the Ganga Expressway shall be 127225 PCUs per day

3.6.2.3 Recommended Design Service Volume for Six Lane Expressway

Assuming a V/C ratio of 0.77 lesser than 0.7744 corresponding to PHF of 0.88 to maintain a Level of Service B, the Design Service Volume for 6-Lane Expressway with depressed median shall be 98000 PCU per day for peak hour flow of 8%

= 127225 * 0.77 = 97963, say 98000 PCUs per day

3.7 Engineering Design

3.7.1 Geometric Design of the Alignment

The Preliminary Design has been carried out on the selected alignment so as to have optimum Construction, Operation & maintenance cost and Vehicle Operation Cost; minimum Social Impacts and Social Costs and Environmental Impacts and Environmental Mitigation Costs.

The preferred alignment would definitely have minimum Rehabilitation and Resettlement i.e. it would utilize to the maximum possible barren / agriculture / government land to minimize Land Acquisition in villages / habited areas. A thorough consultation with stakeholders including industries, relevant government agencies, NGOs, project affected persons (including farmers & people having property) and other consultants working in the region will be made.

Geometric Design Control

The detailed design for geometric elements covers, but is not limited to the following major aspects:

- Horizontal alignment
- Longitudinal profile

- Cross-sectional elements
- Junctions, intersections and Interchanges
- Service road along the alignment

Different options for providing grade separated interchanges were examined and the geometric design of interchanges has taken into account the site conditions, turning movement characteristics, level of service, overall economy and operational safety.

Indicative Design Standards

The indicative design standards for geometric design of road are illustrated in Table 2.5 for main carriageway, geometric standards for Interchange elements and Length of speed change lanes. Ruling design speed is adopted for designing the Project Highway in conformity with the provisions of the Guidelines for Expressway Manual.

Table 2.5: Indicative Design Standards

S.No.	Descriptipn		Details of Project Road
1	Design speed		120 Kmph
2	Lane width		3.75 m
3	Depressed Median (including shyness)		15.0 m
4	Median side paved strip (Shy distance)		0.75 m
5	3-Lane carriageway		11.25m
6	Paved Shoulder		3.00m
7	Earthen Shoulder		2.00m
8	Camber/Cross-fall	C/W & PS	2.50%
		Earthen shoulder	3.00%
9	Width of Service Road		3.75 m/7.00m/10.00m
10	Utility Corridor		2.00m
11	Maximum	For below 1000m radius	7.00%
	Super-elevation	For above 1000m radius	5.00%
12	Safe Stopping Sight Distance (SSD)		250 m
13	Desirable Minimum Sight Distance (ISD)		500 m
14	K-Value for Sag-curve (minimum)		132
	K-Value for Hog-curve (minimum)		261
15	Desirable Minimum radius of horizontal curve		1000 m
16	Minimum radius of Horizontal curve without transition		4000 m
17	Minimum vertical Gradient		0.30%

S.No.	Descriptipn		Details of Project Road
18	Min. Longitudinal slope for Drain	Unlined	1%
		Lined	0.50%
19	Ruling/Limiting gradients		2.5% / 3%
20	Minimum grade change requiring vertical curve		0.50%
21	Minimum length of vertical curve		100m
21	Minimum Height of Embankment		Bottom of Sub-grade is at least 1.5 m above the High Flood Level/Water Table/Pond Level.
22	Vertical clearance for SVUP		4.0 m
	Vertical clearance for LVUP		4.5 m
	Vertical clearance for VUP		5.5 m
	Vertical clearance for Interchanges/Flyovers		6.5 m
	Vertical clearance for ROB		7.3 m
23	K-Value for Sag-curve (minimum)		132
24	K-Value for Hog-curve (minimum)		261

Design Speed

Design speed 120 Km/h is the basic parameter, which determines the geometric features of the road. The proposed design speeds for different terrain categories are as per "Guidelines for Expressway".

In general, the ruling design speed is adopted for geometric design of the highway. Only in exceptional circumstances, minimum design speed may be adopted where site conditions are extremely restrictive and adequate land width is not available.

3.7.2 Cross Sectional Elements

Right of Way (ROW)

As per Guidelines for Expressway the minimum right of way (ROW) for up to 6 lanes expressways is 90m for plain and rolling terrain in case of without service road. The minimum ROW of 120 m has been adopted for the proposed expressway in rural section (open areas i.e. green field section). The ROW at toll plaza locations, ROBs and flyovers/interchange sections may vary depending on their respective layout and requirement. A 2m wide utility corridor outside the boundary fencing has been taken into account within the proposed ROW width.

Table 2.6: Right of Way in Plain/Rolling Terrain

Section	Right Of Way Width* (ROW)
Rural Section	90 m – 120 m

Rural Section passing through semi-urban areas	120 m#

* The ROW width includes 2 m wide strip on either side reserved for placement of utilities outside fencing.

In case an elevated expressway on viaduct is proposed, the width of ROW may be reduced as per site conditions and availability of land

Lane Width

As per Guidelines for Expressway the width of a lane in Plain and Rolling terrains has been taken as 3.75 m. The kerb shyness of 0.75 m shyness on median side has been provided.

Median width of Carriageway

The median shall be depressed or flush. As a rule, depressed median shall be provided except in situations where the availability of ROW is a constraint. The width of median is the distance between inside edges of carriageways. The recommended width of median is given in Table 2.7 below:

Table 2.7: Median Width

Type of Median	Recommended Median Width (m)	
	Minimum	Desirable
Depressed	12	15
Flushed	4.5	4.5
Flush (to accommodate structure/pier on median)	8	8

The depressed median shall have suitably designed drainage system so that water does not stagnate in the median.

An edge strip of 0.75 m width of depressed median adjacent to carriageway in either direction shall be paved with same specifications as of the adjoining carriageway.

As far as possible, the median shall be of uniform width in a particular section of the Project Expressway. However, where changes are unavoidable, a transition of 1 in 50 shall be provided.

Paved Shoulder

Paved shoulders shall be designed as an integral part of the pavement for the main carriageway. Width of these shoulders has been taken as 3 m. This will provide for better traffic operation conditions, lower maintenance and facility of directly using these as part of carriageway when the road is subsequently widened on these sides.

The Composition and specification of the paved shoulder shall be as that of the main carriageway.

Earthen Shoulder

The earthen shoulder has been proposed with good borrowed earth having a width of 2m on the outer side.

Sight Distance

The Safe stopping sight distance and desirable minimum sight distance for divided carriageway for various design speed given in Table 2.8. The desirable values of the sight distance shall be adopted unless there are sight constraints. A minimum of Safe stopping sight distance shall be available throughout.

Table 2.8: Safe Sight Distance

Design Speed (km/h)	Safe Stopping Sight Distance (m)	Desirable minimum Sight Distance (m) (Intermediate Sight Distance)
120	250	500
100	180	360

At critical locations decision or decision points where changes in cross sections occurs such as Toll Plazas and Interchanges, the sight distance shall not be less than decision sight distance given in Table 2.9. The criteria for measuring sight distance are same as for the stopping sight distance.

Table 2.9: Decision of Sight Distance

Design Speed (km/h)	Decision Sight Distance (m)
120	360
100	315

Horizontal Alignment

The horizontal curves on the project road are designed for maximum radii (where feasible) as per Guidelines of Expressway manual and IRC:SP:99-2013, absolute minimum radius has been used at couple of locations.

The Alignment shall be fluent and blend with the topography. The horizontal curve shall be designed to have largest practical radius and shall consist of circular portion flanked by spiral transitions at both the ends.

Super – Elevation

Super-Elevation shall be limited to 7%, if radius of curve is less than desirable minimum radius. It shall be limited to 5% if radius is more than or equal to desirable minimum. Super elevation shall not be less than the minimum specified Cross fall.

The super elevation at curves is arrived at as per the following equation:

$(e + f) = v2/127R$

Where,

v = Vehicle speed in Km/h.

e = Super elevation ratio in meter per meter

f = Coefficient of side friction between vehicle tyre and pavement (0.1)

R = Radius in meters.

The super elevation is calculated keeping in view the horizontal radii and gradient at curves at different locations.

3.7.3 Method for attaining super-elevation

Dual – inner edge pivot of both carriageways at different chainage is used for attaining super-elevation. This method pivots the dual carriageway about the inner edge strings of both carriageways using different chainage, so that the central reservation levels are not changed. The application of super-elevation to the left and the right carriageways will start (or end) at different chainage, to ensure that the rate of change remains the same for both. The method is explained in Figure 2.1:

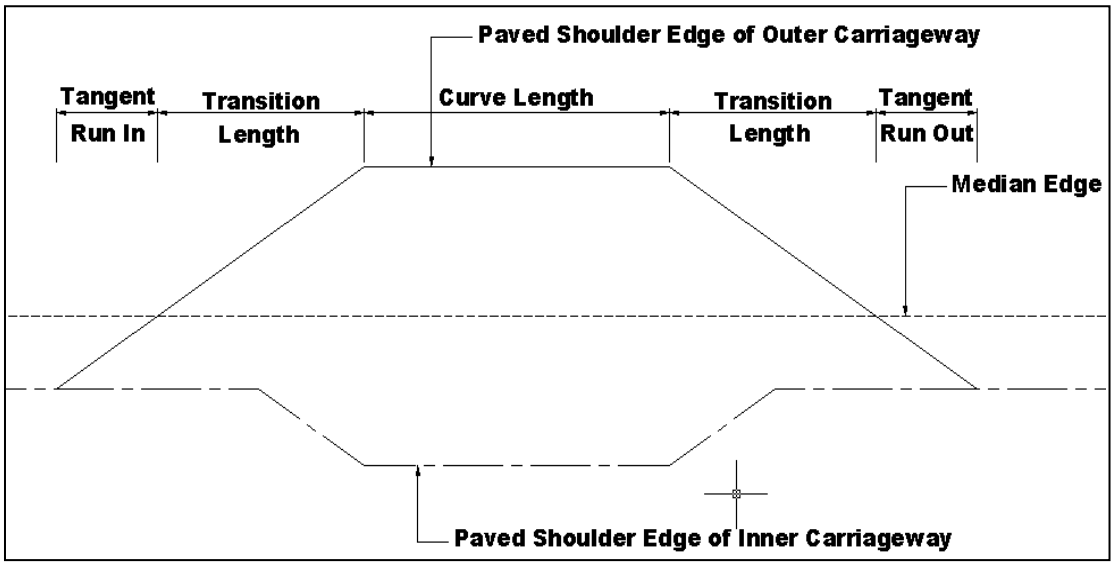


Figure 2.1: Method for attaining Super-Elevation

3.7.4 Transition Curves

The following three formulae are used for calculating the transition lengths and the maximum value is being adopted for design:

a) Rate of change of centrifugal acceleration

Ls = 0.0215 V3/ CR

Where,
R – Radius of curve in meters
V – Vehicle speed in Km / hour
Ls – Length of transition in meters
C – Rate of change of acceleration.
C = 80/(75+V)

Subject to maximum of 0.6 & minimum of 0.4

b) Rate of change of super elevation or runoff.

The rate of change of super elevation is being considered not steeper than 1 in 200 for roads in plain and rolling terrain and 1 in 150 for roads in Mountainous terrain.

c) Three seconds time for manipulating the steering. The minimum length of transition curves for this criterion is as in Table 2.10.

Table 2.10: Minimum Length of Transition Curve

Design Speed (km/h)	Minimum length of transition curve (m)
120	100
100	85

3.7.5 Vertical Alignment

General

The vertical alignment of the carriageway is generally compatible with the guidelines given in the Guidelines of Expressway manual as well as IRC: SP: 99-2013.

At locations of grade break of 0.5%, vertical curves are being provided.

- There shall be no change in grade within a distance of 150m
- The length of vertical curve will not be less than 0.6V (kmph)
- Number of vertical intersection point shall not be more than 4 per km.
- At locations of sight deficiency, at least stopping sight distance (SSD) is being provided.

The aspect of efficient drainage shall be kept into consideration while designing the vertical profile and cross sections of the Project Expressway as stipulated in IRC:SP:42 and IRC:SP:50.

The vertical alignment shall be coordinated with the horizontal alignment

Gradients

The ruling and limiting gradients are given in Table 2.11.

Table 2.11: Gradients

Terrain	Ruling Gradient	Limiting Gradient
Plain	2.5%	3.0%
Rolling	3.0%	4.0%

The ruling gradient shall be adopted as far as possible. Limiting gradient shall be adopted only in very difficult situation and for short lengths.

In cut sections, minimum gradient for drainage considerations is 0.5% (1 in 200) if the side drains are lined; and 1.0% (1 in 100) if these are unlined.

Vertical Curves

Long sweeping vertical curves shall be provided at all grade changes. Summit curves and valley curves shall be designed as square parabolas. The length of the vertical curves is controlled by sight distance requirements, but desirably curves with the longer length shall be provided from aesthetic considerations. The minimum grade changes requiring vertical curve and the minimum length of vertical curve shall be as given in Table 2.12. More liberal

values are adopted wherever this is economically feasible. Valley curves are designed for headlight sight distance.

Table 2.12: Minimum Length of Transition Curve

Design Speed (km/h)	Minimum Grade Change requiring Vertical curve	Minimum length of Vertical Curve(m)
120	0.5%	100
100	0.5%	85

Lateral and Vertical Clearance at Underpasses

Lateral Clearance

Minimum clearance at under passes shall be as follows:

i) For Vehicular Underpass, the lateral clearance shall not be less than 20 m

ii) For Light Vehicular Underpass, the lateral clearance shall not be less than 12 m including 1.5 m wide raised footpaths on either side.

iii) For Smaller Vehicular Underpass, the lateral clearance shall not be less than 7m.

iv) Crash barrier shall be provided for protection of vehicles from colliding with abutments and piers and the deck of the super structures.

Vertical Clearance

The vertical clearances at underpasses shall not be less than the values given in Table 2.13.

Table 2.13: Vertical Clearance

Rail Over Bridges	7.3 m
Interchange/Flyover	6.5 m
Vehicular Underpass	5.5 m
Light Vehicular Underpass	4.5 m
Smaller Vehicular Underpass	4.0 m

Lateral and Vertical Clearance at Overpasses

Lateral Clearance

Shall be provided as a full roadway width as specified in Schedule of Contract Agreement.

Vertical Clearance

A minimum of 5.5m Vertical Clearance shall be provided from all points of the Carriageway of the Project Expressway.

3.7.6 Cross-Fall

The cross-fall on each sections of the expressway carriageway shall be as given in Table 2.14. Each carriageway shall have unidirectional cross fall.

Table 2.14: Cross-fall on different surfaces

Cross-Sectional Element	Annual Rainfall	
Carriageway, Paved shoulders, Edge Strip, Flush Median.	**1000mm or more**	**Less than 1000mm**
	2.5 %	2.0 %

The cross-fall for earthen/granular shoulders on straight portions shall be at least 0.5% steeper than the values given in Table above. On Super Elevated sections, the earthen portion of the shoulder on the outer side of the curve would be provided with reverse crossfall so that the earth does not drain on the carriageway and the storm water drains out with minimum travel path.

3.8 Design OF Horizontal and Vertical Alignment

The general principles and design criteria laid down in MoRTH Guidelines for Expressways shall be followed except as otherwise indicated in this Manual.

Culverts

The culverts are proposed to be built to the full formation width of the road and have been designed accordingly.

Highway Signs and Marking

The road signs conforming to latest IRC: 67 have been proposed. Location of route marker signs are as per the latest IRC: 2; the provision for hectometer stones, 5th kilometer stone, Kilometer and 200 m stones are as per latest IRC: 8 and latest IRC: 26 respectively. The boundary stones are as per latest IRC: 25. Road Delineators are as per latest IRC: 79.

All road signs are considered as retro-reflective sheet of high intensity grade with encapsulated lens fixed over aluminium substratum and conforming to MoRT&H Specifications for road and bridge works. Provisions for Road markings have been considered as latest IRC: 35.

3.9 Access Control

Project Expressway shall be designed for fast motorized traffic with full control of access. Access to the Expressway shall be provided with grade separators at location of intersections. Parking/standing, loading/unloading of goods and passengers and pedestrians/animals shall not be permitted on the Expressway.

Location of interchange – The locations of individual interchanges are determined primarily to reduce detour considering regional network and nearness to places of importance. Location of interchange is guided by the following situations:

i) At crossing or nearest points of other Expressways, National Highways, State Highways and important arterial roads.
ii) At crossing or nearest points of major roads to important ports, airports, material transport facilities, commercial and industrial areas, and places of tourist interest.

The interchanges shall be provided at the locations specified in Schedule-B of the Concession Agreement.

3.10 Connecting roads

Connecting roads where required to maintain proper circulation of local traffic, continuity of travel and to facilitate crossing over to the other side of the Project Expressway through an under/overpass shall be constructed on the land acquired within the ROW of the Project Expressway. These shall be provided outside the fencing. The location, length, other details and specifications of connecting roads to be constructed shall be specified in Schedule-B of the Concession Agreement. The width of the connecting road shall be 7.0 m. The construction and maintenance of connecting roads shall be part of the Project Expressway

3.11 Pavement Design

Type of Pavement – The Authority may require provision of specific type (flexible/rigid) of pavement depending upon specific site conditions. Such requirements shall be as specified in Schedule-B of the Contract Agreement. Unless otherwise specified in Schedule-B, the may adopt any type (flexible/rigid) of pavement structure for new construction.

Flexible pavement is designed by using IRC: 37-2012 and rigid pavement is designed as per the provisions contained in latest IRC: 58. Besides the above, designs for service roads, toll plaza, parking bays have been carried out.

Design of flexible pavement – The pavement shall be designed to ensure the specified performance for the projected traffic needs, climate and type of soils in the given area. The Contractor is expected to use a design procedure that is appropriate to produce a cost-effective structure meeting the performance requirements and long term durability. The Contractor may use IRC:37 "Tentative Guidelines for the Design of Flexible Pavements" or it may use any internationally accepted design procedure that is based on past performance and research. It will be the Contractor's responsibility to provide a pavement structure that fully meets the prescribed performance requirements throughout the operation period.

Design of rigid pavement – Jointed rigid pavement shall be designed in accordance with the method prescribed in IRC:58 "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways". Continuously Reinforced Concrete Pavements (CRCP) shall be designed as per any recognized international guidelines which shall be subject to approval by the Independent Engineer.

Design Life

The bituminous pavement with design life of 20 years has been considered for the flexible pavement design. For rigid pavement a design life of 30 years has been considered.

Design Traffic

The Design traffic has been estimated in terms of cumulative number of standard axles (8160kgs) to be carried by the Pavement during the design period.

Any likely change in traffic due to proposed improvement of the facility and/or future development plans, land use, shall be duly considered in estimating the Design Traffic. The Growth rates mentioned in the Traffic Studies chapter has been considered while calculating the Million Standard Axle loads. The project road is a green field highway and there is no existing carriageway, therefore, the VDF has been calculated based on the Axle Load Surveys

conducted on alternate roads and the values of VDF has been presented in Section 3.3.3 of this report.

Rigid Pavement Design

Design of Concrete Slab

Once the parameters are decided, actual stresses developed in the concrete slab due to design wheel load is computed by the Westergaard's Equation modified by Teller and Sutherland. The maximum stress occurs in the corner and the minimum in the interior. The edge load condition gives an intermediate value.

Temperature stresses at the edge are calculated by using Bradbury's formula. The temperature stresses in the corner region is negligible as the corners are relatively free to wrap and may be ignored.

The design wheel load stress and the temperature stress at the edge are then added up together and this summation shall be less than 28 days flexural strength of concrete for the assumed thickness to be adequate from design point of view.

Once the assumed slab thickness is found adequate for the combined stresses developed due to temperature and design wheel load, its adequacy needs to be checked from the view point of its consumption of fatigue resistance. In this case also, edge stresses are computed as discussed earlier for various axle load classes. Then stress ratio (SR) is calculated as ratio of stress due to wheel load and the 28 days flexural strength of concrete for all axle load class. Consumption of fatigue resistance is computed for this stress ratio for each axle load class. Summation of this consumption of fatigue resistance should not exceed the allowable limit for the assumed thickness to be adequate from the view point of fatigue consideration.

Design of Joints

Once the concrete slab thickness is designed based on particular spacing and location of joints, the remaining job is the design of dowel bars and tie bars with the provision of adequate sealants.

Dowel Bars

The design of dowel bar at joints is carried out on the basis of its load transfer capacity. It is recommended that 40% of wheel load can be transferred through dowel bar system. It is observed that failure of dowel bar occurs due to the crushing of concrete below the dowel bar and hence bearing stress shall be considered for its design.

Generally, 500 mm long 32 mm diameter M.S. bar at a spacing of 250 – 300 mm is used as dowel bar for concrete slab of 200 -350 mm thick. No dowel bar is required for slab thickness less than 150 mm. However separate calculation has been made for present situation for dowel bar design.

Tie Bar

Tie bars are provided to prevent the adjoining slabs from separating. Longitudinal joints are provided with tie bars. It does not increase the structural capacity of the slab and are not designed as load transferred devices.

3.12 Hydrological Design

Design Standards

The hydrological & hydraulic design for cross drainage structure shall conform to the following codes and reports:

IRC: SP-13 – Guidelines for the design of small bridges and culverts

IRC: 5 – Code of practice for Road Bridges, Section I (General features of Design)

IRC: 78 – Code of Practice for Road Bridges, Section VII (Design of Foundation and Substructure)

IRC: SP-87 – Manual of Specifications and Standards for Six-Laning of Highways through Public Private Partnership

Design Approach

The hydrological & hydraulic design of bridges is an important aspect to determine the minimum required waterway; design highest flood level (HFL) and minimum scour levels of piers & abutments of the bridges proposed on the new alignments. The various design standards (latest) which have been adopted for the hydrological & hydraulic design of bridges are given below. Approach slabs shall be provided for all bridges and grade separated structures as per Clause 217 of IRC:6 and Section 2700 of MORTH Specifications.

Design Parameters –

Area of catchment & length of longest stream have been obtained from topographical sheets of Survey of India (SOI).

The Cross Section of stream at 500 m U/S and 500 m D/S depending upon catchment area along with longitudinal gradient has been obtained to evaluate design discharge .The various method such as area velocity , unit hydrograph Rankins method has been considered for obtaining of design discharge .

Scour Depth

Scour depth can be calculated as per Clause 703.2 of latest IRC: 78 and as explained in latest IRC: SP 13. The mean depth of scour, dsm below the highest flood level is given by the following equation:

dsm = 1.34 (Db2/Ksf)1/3

Where, Db = the design discharge for foundation in cumec per meter width. The value of Db shall be the total design discharge divided by the effective linear waterway width be-tween abutments.

"Silt Factor" (Ksf) have been assumed based on the silt factor values of the Agra to Etawah project. As per latest IRC: 78, for the design of piers and abutments located in a straight reach and having individual foundations without any floor protection works, the maximum depth of scour from the highest flood level is given by:

For piers: dmax = 2 x dsm

For abutments: dmax = 1.27 x dsm (having retained approach)

Minimum Founding Level: The foundation has been taken to a level to safeguard against scour. In case of bridges, where the mean scour depth dsm is calculated by using the equation given in Clause 703.2 of latest IRC-78, the depth of foundation has not been taken less than that of existing structures in the vicinity.

3.12.1

3.12.2 Drainage and Protection Works

The drainage requirements for the project road and adjoining areas are assessed through the DTM prepared from topographical survey data. Pavement internal and external drain-age is ensured by providing drainage layer and camber respectively. Longitudinal slopes in roadside ditches and central drain are generally equal to generate self-cleaning velocity at the time of storm.

Small catchment analysis with project specific unit hydrograph is undertaken for the hydraulic design of the drain channel. The shape of the channels is fixed to facilitate easy and economical construction and easy maintenance. Suitable drainage system is planned for the high embankment, super-elevated carriageway and other key areas, with a view to en sure easy collection and disposal of storm water. A network has been conceptualized from runoff till final disposal and its continuity is ensured at each critical point.

3.13 Structural Design

3.13.1 General

This section deals with the standards to be adopted in design of vis-à-vis ROBs, flyovers, bridges, underpasses and culverts. It also provides for the type of materials and their specifications that had been adopted for the above structures, the loads and forces to be considered. The project road is 6 lane and the structures are also designed for 6 lanes.

3.13.2 Cross-sectional Elements

a) Structural width for bridges / flyovers / road over rail bridges

The overall deck width for all bridges, underpasses has been kept as 21.25 m (including 0.5m crash barrier on either side) & 2X12.5 m for ROBs in each direction of traffic. Please refer for structure drawing and GADs of each major/minor structures.

b) Median width

A median width of 12.5 m is maintained between two outer faces of RCC crash barriers.

c) Reinforced Earth Retaining Structures –

The design and construction of reinforced earth structures shall conform to section 3100 of MORTH Specifications. Reinforced earth retaining structures shall not be provided near water bodies. Such structures should be given special attention in design, construction, ground improvement where necessary, maintenance and selection of System/System design. Local and global stability of the structure shall be ensured.

d) Road over bridge (road over railway line)

i) If the alignment of road at the existing railway crossing has skew angle more than 45°, the alignment of road or of pier/abutment shall be suitably designed to reduce skew angle up to 45°.

ii) Railways normally do not allow construction of solid embankment in their right of way. The horizontal and vertical clearances to be provided on the railway land shall be as per requirement of the Railway authorities.

iii) In case the Authority has obtained approval of General Arrangement Drawings, the same shall be appended with the Request for Proposal. The Contractor shall have option of adopting the same span arrangement or have his revised proposal for GAD approved from the Railways. In case the total length of stilt portion is not reduced, it will not be considered as change of scope. However, before submitting the revised proposal to the Railways, prior consent of the Authority shall be required.

iv) The Contractor shall be required to obtain approvals of all designs and drawings from the concerned Railway authorities.

v) The construction of ROB within the railway boundary shall be under the supervision of the Railway authorities.

vi) The approach gradient shall not be steeper than 1 in 40.

vii) Outside the railway boundary, one span of 12 m conforming to the requirements of Vehicular Underpass shall be provided on either side of ROB to cater for the local traffic, inspection, and pedestrian movement.

3.13.3 Specification for Material

a) **Concrete:** The grades of concrete are either equal to or higher than those pre-scribed in latest IRC: 112. Grade of concrete in various structural elements is for moderate conditions of exposure.

Superstructure

PSC Members : M 45

RCC T-Girder and Deck Slab : M 35

RCC Solid Slab : M 35

RCC Box cell : M 35

RCC Crash Barriers: M 40

Substructure

RCC substructures and foundations: M 35

All PCC structural members: M 20

All PCC non structural members: M 15

Pedestals for bearings

Pot/PTFE : M 40

Elastomeric: M 40

b) **Steel:** This conforms to the provisions given in IS: 1786, IS: 432 (Part I).

Reinforcement steel:

- High yield strength deformed bars conforming to Fe 500 / TMT.
- Mild steel not to be used.
- Pre-stressing steel

These conform to IS: 14268-1995

System : 19 K13 or 12 T13 low relaxation multiple strands system

Cables :19 K13 or 12 T13 systems with strands of 12.7 mm nominal diameters.

Sheathing : 90 mm / 75mm Corrugated HDPE sheathing duct.

c) Bearings

All bearings shall be easily accessible for inspection, maintenance and replacement. Suitable permanent arrangements shall be made for inspection of bearings from bridge deck. Design and specifications of bearings shall be as per IRC: 83 (Part I, II and III). Spherical bearings shall conform to the requirements of BS:5400 and materials of such bearings may conform to the relevant BIS codes nearest to the specifications given in BS:5400. The drawing of bearings shall include the layout plan showing exact location on top of pier and abutment cap and the type of bearings i.e. fixed/free/rotational at each location along with notes for proper installation. The bearing should cater for rotation and movement in both longitudinal and lateral direction. Elastomeric bearing has been provided under RCC T-beams and RCC solid slabs type superstructures as per latest IRC: 83 (Part II) and shall conform to clause 2005 of MoRT&H specification for Road and Bridge Works.

POT cum PTFE bearing has been provided for span more than 25m where we have to cater for large loads and conforming to latest IRC: 83 (Part III) and clause 2006 of MoRT&H specifications for Road & Bridge works.

d) Expansion Joints

All Structures shall have minimum number of expansion joints. This may be achieved by adopting longer spans, making the superstructure continuous or by adopting integrated structures. Expansion joints shall conform to IRC:SP:69. In any case, the number of expansion joints shall not be more than 1 for each 100 m length of the bridge or part thereof. For avoidance of doubt, the structures upto 100 m length shall have only one joint at one side abutment, the structures over 100 m and upto 200 m length may have two joints and structures over 200 m and upto 300 m length may have maximum 3 expansion joints. Elastomeric strip seal type expansion joints are provided on all the bridges and ROBs as per Clause No. 2607 of MoRT&H specification for road and bridge works and interim specifications for expansion joints issued subsequently vide MoRT&H letter no. RW/NH-34059/1/96-S&R dated 25.01.2001 and addendum there to circulated vide letter of even no; dated 30.11.2001. In case of bridges with smaller spans slab seal type expansion joints are provided.

3.13.4 Loads and Forces to be considered in Design

Vertical Loads

a) Dead Loads

Following unit weights are assumed in the design as per latest IRC Codes.

Pre-stressed Concrete: 2.5 t / m3

Reinforced Concrete: 2.5 t / m3

Plain Cement Concrete: 2.2 t / m3

Structural steel: 7.85 t / m3

Dry Density of Backfill Soil: 2.0 t / m3

Saturated Density of Backfill Soil: 2.0 t / m3

b) Superimposed Dead Loads

Wearing Coat: 65mm thick with 40mm bituminous concrete overlaid + 25mm thick bituminous mastic layer

Crash barriers: 1.0 t / m / side

c) Live Loads

Carriageway live loads: The following load combinations are considered in the analysis and whichever produces the worst effect is considered.

Five Lanes of IRC Class A

One Lane of 70R (wheeled) with Three lanes of IRC Class A.

Resultant live load stresses are reduced by 20% in case all the five lanes are loaded. Impact factor is as per latest IRC: 6 for the relevant load combinations. For simplicity in design, Impact factor for continuous structures is calculated for the smallest span of each module and used for all the spans of that module.

d) Horizontal Forces

(i) Longitudinal Forces due to live load

Following effects are considered in the design

- Braking forces as per the provision of latest IRC: 6
- Distribution of longitudinal forces due to horizontal deformation of bearings/frictional resistance offered to the movement of free bearings as per latest IRC: 6

(ii) Horizontal forces due to water currents

The portion of bridge, which may be submerged in running water, is designed to sustain safely the horizontal pressure due to force of water current as per the stipulations of latest IRC:6

(iii) Earth load

Earth forces are calculated as per the provisions of latest IRC:6 assuming the following soil properties:

a. Type of soil assumed for backfilling: As per latest IRC: 112

Angle of Internal Friction: Φ= 30O

Angle of Wall Friction: δ = 20O

Coefficient of Friction 'μ'at base : tan (2/3 Φ), while Φ is the angle of internal friction of substrata immediately under the foundations.

b. Live load surcharge is considered as per the provisions of latest IRC: 6.

e) Centrifugal forces

Centrifugal forces are calculated as per the provisions of latest IRC: 6 for a design speed applicable at horizontal curves.

f) Wind effect

Structures are designed for wind effects as stipulated in latest IRC: 6. The wind forces are considered in the following two ways and the one producing the worst effect shall govern design.

g) Seismic Effect

The road stretch is located in Seismic Zone-III as per the revised seismic map of India (IS: 1893-2002). The seismic forces will be coefficient method as suggested by the modified clause for the interim measures for seismic provisions in latest IRC: 6.

h) Other Forces / Effects

Temperature effects: The bridge structure / components i.e. bearings and expansion joints, are designed for a temperature variation of + 250 C considering extreme cli-mate. The superstructures are also designed for effects of distribution of temperature across the deck depth as given in latest IRC: 6, suitably modified for the surfacing thickness.

Temperature effects considered are as follows:

- Effects of non-linear profile of temperature combined with 50% live load and full value of 'E' is considered.
- Effects of global rise and fall of temperature combined with 100% live load and full value of 'E' is considered.

Differential shrinkage effects: A minimum reinforcement of 0.2% of cross sectional area in the longitudinal direction of the cast-in-situ slab is provided to cater for differential shrinkage stresses in superstructures with cast-in-situ slab over precast Girders as per Clause 605.2 of latest IRC: 22.

However, effects due to differential shrinkage and / or differential creep are duly accounted for in the design.

Construction stage loadings / effects: A uniformly distributed load of 3.6 KN /m2 of the form area is considered to account for construction stage loadings in the design of superstructure elements, wherever applicable, as per Cl. 4.2.2.2.2 of IRC: 87 – 1984.

Buoyancy: 100% buoyancy is considered while checking stability of foundations 78um-spective of their resting on soil/weathered rock / or hard rock.

i) Load Combinations to be considered in Design

All members are designed to sustain safely the most critical combination of various loads and forces that can coexist. Various load combinations as relevant with increase in permissible stresses considered in the design are as per latest IRC: 6.

In addition, the stability of bridge supporting two superstructures (with an expansion joint) is checked under one span dislodged condition also.

j) Exposure Condition

Moderate exposure conditions are considered while designing various components of the bridge.

k) Design Codes

The main design criteria adopted is to evolve design of a safe structure having good durability conforming to the various technical specifications and sound engineering practices.

l) Load combinations

The various load combinations considered are as per provisions of latest IRC: 6

ROB

The design of ROB will be based on the guidelines of Ministry of Railways. As per the latest Railways Guidelines, a vertical clearance of 7.3 m is being imposed for electrified track.

CD structures & HO/Grade separators

The GAD of CD structures is based on hydraulic and hydrological studies.

The GAD of flyovers/Grade separator is based on the traffic surveys and guidelines as contained in relevant IRC codes.

Codes and Publications

The following codes and publications (latest editions) shall be used for the design of approach road and bridge components:

- Specifications For Road and Bridge Works (4th Revision, 2000)
- IRC: 5-1998 For General Features of Design
- IRC: 6-2000 For Loads and Stresses
- IRC: 18-2000 For Pre-stressed Concrete Road Bridges
- IRC: 21-2000 For Reinforced Concrete Design
- IRC: 78-2000 For Substructure and Foundations
- IRC: 83-1999 (Part I) For Metallic Bearings
- IRC: 83-1987 (Part II) For Elastomeric Bearings
- IRC: 83-1987 (Part III) For Pot cum PTFE Bearings

3.14 Environmental and Social Screening

3.14.1 Environmental Screening

An Environmental screening study has been undertaken. The preliminary environmental study focused on identifying the key areas, the need for assessment of key impacts, issues, including information necessary for proposed development. The following issues were identified:

- The important environmental issues and concerns;
- The significant effects and factors; and
- The appropriate content and boundaries of an EIA study.

The programme included:

- Field surveys;
- Consultation exercises; identifying existing relevant baseline data;
- Identifying the scope of baseline surveys required;
- Identifying key issues to be addressed within the EIA; and
- Providing a technical brief for the EIA.

To identify any potential environmental conflicts arising out from the construction of the road, information was collected to arrive at the environmental constraints for the proposed scheme. The main issues included as appropriate, local settlements and communities, traffic, agriculture, ecology, land-use and soils, water, archaeological heritage, cultural and religious sites and planning issues.

This part of the study was undertaken in parallel with the economic and engineering analyses in order to determine any significant social or environmental issues, which require further detailed study. The approach and methodology to be adopted for environmental assessment conforms to the requirement of the Environmental Impact Assessment Notification, MoEF, 2006 & its amendment.

3.14.1.1 Secondary data collection

Secondary data collection including relevant maps for all the corridors was made available from various government agencies regarding:

(i) Flora and fauna

(ii) Critical natural habitats

(iii) Built-up areas

(iv) Water bodies

(v) Other critical environmental indicators

(vi) Policy, legal and administrative framework etc.

The available data has been used for environmental screening. The results of the preliminary screening lead to identification of the nature and extent of environmental issues needing more detailed examination, which may be dealt as a full EIA.

3.14.2 Social Screening

The overall objective of the study is to assess the likely impact on persons/families in the process of land acquisition needed in the process of construction of project road.

Social assessment would be conducted to broadly assess the extent of impacts due to the project on persons and properties within the corridor of impact. Both desk research and identification of major settlements within project area through field survey are conducted.

Social assessment study also aims at identifying the project affected people (PAP) and project affected families (PAF) analysing their socio-economic status, assessing losses due to project implementation. Remedial measures are proposed in the RAP to ensure that the income levels of PAPs, after the project implementation, are improved or at least restored to the pre-project level.

3.14.2.1 Secondary data collection

Available information is collected from various agencies that have worked in the state. The information includes constitutional provisions, status of social related legislation and policies of the central government and the state of Uttar Pradesh, guidelines for entitlement framework and community, social, ethnic and economic indicators of the population.

3.14.3 Social Impact Screening

During this preliminary screening stage, the consultants made an initial visit to the site in order to develop a clear understanding of the proposed road changes that may be undertaken and to identify the impact on housing, business and agricultural activities expected to arise out of the changes to be adopted. The social impact screening concentrated on the areas where there is likely to be the greatest impact on the population.

The data is analysed and screening is done initially, through a reconnaissance survey.

The various indicators considered are:

- Community life and economic activities
- Severance of community
- Encroachment on local community facilities
- Encroachment on local economic activities
- Encroachment on the access to and rights of resources
- Cultural heritage / property
- Social structure, institution and customs
- Cultural shock
- Road safety
- Public health
- Waste

Land acquisition and resettlement

- Expropriation of resources
- Involuntary resettlement
- Conflict between target population and host population
- Indigenous or traditional population

The results of the screening are plotted on maps and tabulated to identify any major conflicts and extent of conflicts.

3.15 Schemes for Development and Assessment

From the existing field data a few alternatives are evolved. This task made use of available data, site reconnaissance desk studies and preliminary findings. The standards, codes of practice and other relevant controlling documents are listed thereby establishing the procedures, design controls and general engineering practice required.

In the review of project alignment due considerations are given to the environmental implications, land acquisition and impact on project affected people, using information, provided in the discipline desk study reports undertaken earlier.

3.16 Preliminary Cost Estimates

The rates of materials adopted in the preliminary cost estimate are based on the SoR from respective districts of the Uttar Pradesh. The basis of rate analysis is the MoRT&H Stan-dard Data Book. For the working out of preliminary cost estimate, work items are split into the following sub-heads:

- Site clearance and Dismantling
- Earth Work
- Granular Sub Base Courses and Base Courses (Non- Bituminous)
- Bituminous Courses
- Box Culverts
- Minor Bridges
- Major Bridges
- VUP/LVUP/PUP
- ROB
- Flyover and NH & SH Crossing
- Interchange and Junctions
- Retaining Wall
- Drainage & Protective Works
- Traffic signs, Road markings and other road appurtenances
- Toll Plaza
- Approach to Wayside Amenities, Toilet block & Median Opening
- Environmental Cost (Civil Works)
- Miscellaneous Works
- ATMS for Access Controlled Expressway,

4. TRAFFIC STUDIES

4.1 Introduction

This Chapter examines the Traffic Studies for the present day traffic and traffic forecast besides "Toll Studies" which section contains the analyses of system options, makes recommendations regarding the level of toll to be applied to different vehicle categories.

The presently available routes for traffic between Meerut (Start Point of Expressway) & Prayagraj Bypass on NH-19 (old NH-2) (End Point of Expressway) are indicated on Figure 4.1.

The Expressway is access controlled with only entry/exit at Nodes (*intersecting points of National Highway or State Highways or Major District Roads – crossing with the proposed Expressway Alignment*) are lettered "A" to "R" as listed on Table 4.1:

Table 4.1: Details of Toll Nodes for entry / exit proposed on the Expressway

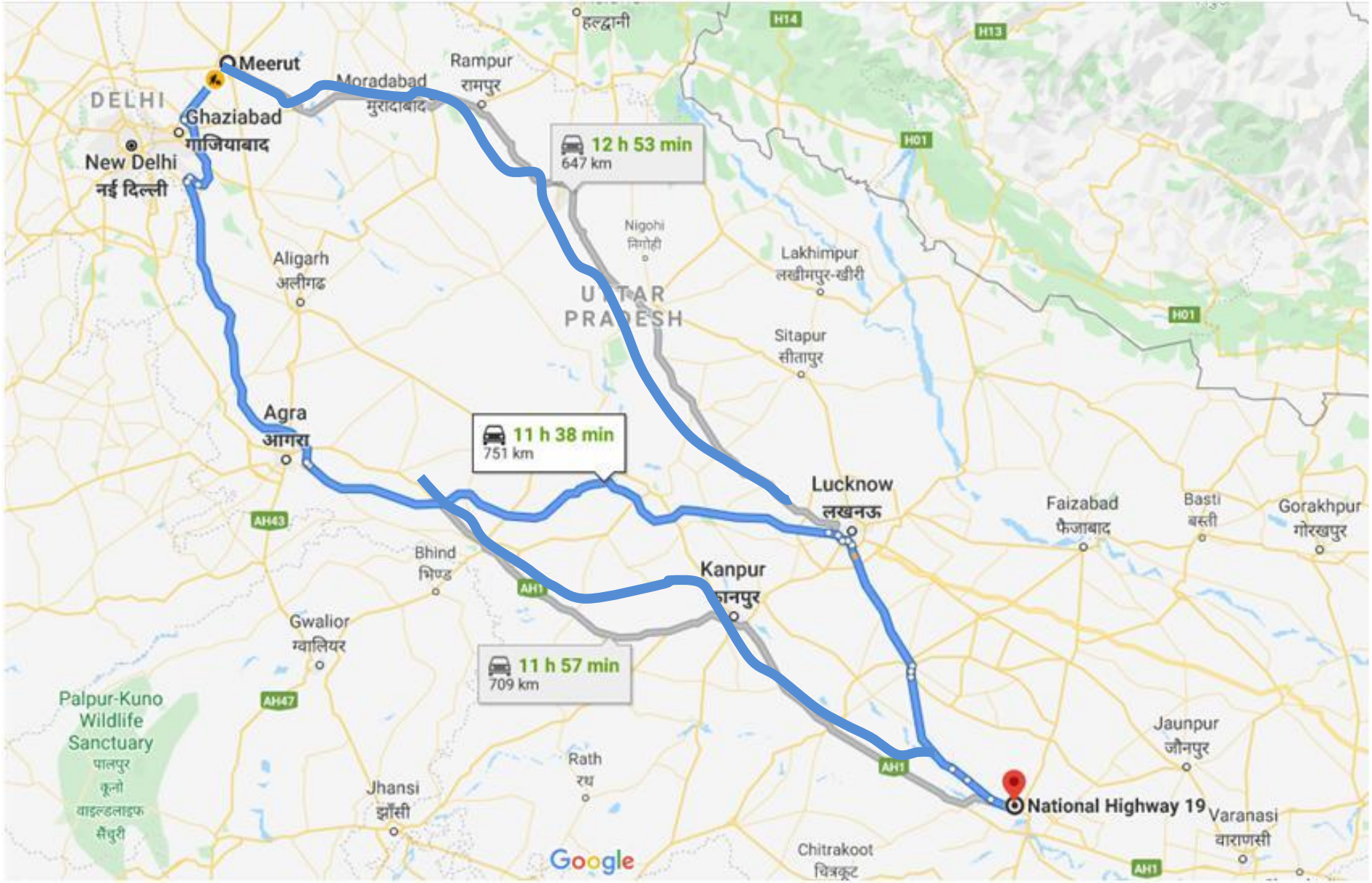
Toll Nodes	Chainage	Details of the Intersecting Roads	Road No.	Type of Intersection
A	0+100	Delhi - Meerut Expressway	Expressway	Dummy Node
B	8+920	Meerut – Hapur	NH-334	Trumpet
C	35+270	Hapur - Garhmukteshwar	NH-24	Diamond
D	54+640	Bulandshahr - Garhmukteshwar	SH-65	Diamond
E	74+181	Hasanpur-Anupshahar	MDR-162W	Diamond
F	102+427	Anupshahr - Moradabad	ODR	Diamond
G	123+288	Babrala - Chandausi	NH-509	Double Trumpet
H	173+454	Chandausi - Budaun	SH-125	Diamond
I	189+394	Budaun - Bareilly	SH-33	Double Trumpet
J	255+167	Farukkhabad - Shahjahanpur	SH-29	Double Trumpet
K	282+845	Farukkhabad - Shahbad	SH-138	Diamond
L	329+945	Kannauj– Hardoi	SH-21	Double Trumpet
M	378+136	Agra - Lucknow Expressway	Agra Lucknow Exp	Double Trumpet
N	420+932	Kanpur - Lucknow	NH-27	Diamond
O	487+285	Lalganj - Raebareli	NH-31	Double Trumpet
P	517+708	Raebareli–Unchahar	NH-30	Double Trumpet
Q	554+951	Manikpur - Bela Pratapgarh	MDR-102E	Diamond
R	600+457	Prayagraj Bypass	NH-19	Trumpet

Node A is revised and treated as Dummy Node in this Report, as the Start Point of the Ganga Expressway has been changed from Node A to Node B due to Engineering Design Constraints, with prior approval of UPEIDA. Table showing distances between various destinations from Ganga Expressway, that traffic which are likely to use the sections of Expressway between these lettered nodes "A"to "R" are provided as follows:

(a) on the presently available network of alternative routes – Table 4.2; and
(b) as estimated on the Proposed Expressway– Table 4.3.

Table 4.2 shows Traffic Zones from Expressway, the distances travelled by *"passenger cars"*. Distances travelled by truck are occasionally longer – these vehicles must use especially-designated truck routes.

Figure 4.1 Presently Available Routes for Through Traffic between Meerut and Prayagraj



National Highway NH 19 (old NH 2), Agra-Lucknow Expressway and NH 30 (Old NH24) are the alternate routes:

The present status of these alternate routes between Prayagraj and Meerut are as follows:

Alternate Route	Description of Route	Distance (Kms)	Travel Times (Hours : Minutes)	Journey Speed (Average) (Km/hr)
NH19 Route Prayagraj – Kanpur – Agra – Greater Noida – Dasna – Meerut	• Prayagraj - Kanpur (NH19, old NH2); • Kanpur – Bachhela/Bachheli – Agra (Agra Lucknow Expressway); • Agra – Greater Noida (Yamuna Expressway); • Greater Noida – Dasna (Easter Pheripheral Expressway); and • Dasna - Meerut (NH34, old NH58)	709	11h:57m *(includes lesser sections of other Expressways)*	59.33 (approx. 60 Km/hr)
Agra Lucknow Expressway Prayagraj – Lucknow – Agra – Greater Noida – Dasna – Meerut	• Prayagraj - Lucknow (NH 30); • Lucknow – Agra (Agra Lucknow Expressway); • Agra – Greater Noida (Yamuna Expressway); • Greater Noida – Dasna (Easter Pheripheral Expressway); and • Dasna - Meerut (NH34, old NH58)	751	11h:38m *(includes maximum sections of other Expressways)*	64.55 (approx. 65 Km/hr)
NH 30 Route (no sections of expressways) Prayagraj – Lucknow – Bareilly – Rampur – Moradabad – Garhmukteshwar – Meerut	• Prayagraj - Lucknow – Bareilly (NH 30); • Bareilly – Rampur (NH 530); • Rampur - Moradabad – Garhmukteshwar (NH9); and • Garhmukteshwar - Meerut (SH14)	647	12h:53m *(does not include any sections of other Expressways)*	50.21 (approx. 50 Km/hr)

Table 4.2: Distance (in Kms) to Destination Zones from Expressway

Name of District Centres	Origin Zones	Expressway Nodes (A to R)	Distance *(in Kms)*	Journey Speed *(Km/hr)*
Saharanpur	11	A	122.0	52
Muzaffarnagar	12	A	57.7	52
Bulandshahr	13	G	86.6	42
Ghaziabad	14	C	147.0	45
Meerut	15	B	11.0	-
Noida	16	C	74.3	49
Baghpat	17	B	60.9	44
Greater Noida	18	G	131.0	41
Shamli	19	A	75.2	51
Bijnor	20	E	86.4	39
Moradabad	21	G	61.6	43
Rampur	22	I	111.0	47
Jyotiba Phule Nagar	23	E	36.1	19
Kasganj	24	I	83.4	45
Bareilly	25	I	38.9	40
Pilibhit	26	J	129.0	43
Shahjahanpur	27	J	38.6	38
Ayodhya	28	M	217.0	55
Yusuf	29	-	-	-
Hardoi	30	L	26.7	38
Kheri	31	J	138.0	42
Lucknow	32	M	71.9	58
Raebareli	33	O	26.5	44
Sitapur	34	L	98.3	42
Unnao	35	N	9.0	54
Amethi	36	N	86.0	43
Hapur	37	C	17.1	45
Sambhal	38	F	7.0	53
Amroha	39	E	36.1	19
Bahraich	40	L	200.0	44
Barabanki	41	M	109.0	52
Faizabad	42	M	217.0	55
Gonda	43	M	199.0	51
Sultanpur	44	M	218.0	57
Ambedkar Nagar	45	M	283.0	63
Shrawasti	46	L	246.0	44
Balrampur	47	L	277.0	48
Budaun	48	I	13.2	36
Chitrakoot	49	R	129.0	43
Azamgarh	50	M	350.0	51
Basti	51	M	275.0	55
Deoria	52	M	399.0	54
Gorakhpur	53	M	351.0	55
Mau	54	M	395.0	60
Siddharth Nagar	55	M	351.0	53

Name of District Centres	Origin Zones	Expressway Nodes (A to R)	Distance *(in Kms)*	Journey Speed *(Km/hr)*
Mahrajganj	56	M	380.0	51
Padrauna	57	M	426.0	55
Sant Kabir Nagar	58	M	319.0	56
Hathras	59	M	304.0	68
Ballia	60	M	473.0	58
Ghazipur	61	M	422.0	58
Jaunpur	62	R	108.0	47
Mirzapur	63	R	120.0	41
Sonbhadra	64	R	213.0	43
Varanasi	65	R	134.0	44
Sant Ravidas Nagar	66	R	81.0	47
Chandauli	67	R	163.0	43
Kushinagar	68	M	426.0	55
Lakhimpur - Kheri	69	J	138.0	42
Prayagraj	70	R	10.0	60
Fatehpur	71	O	42.4	41
Pratapgarh	72	Q	41.9	44
Kaushambi	73	R	73.0	43
Kannauj	74	L	34.6	40
Etawah	75	M	149.0	68
Farrukhabad	76	J	50.5	39
Kanpur Dehat	77	N	89.6	42
Kanpur Nagar	78	N	21.6	26
Auraiya	79	M	125.0	50
Agra	80	M	260.0	76
Aligarh	81	M	362.0	69
Etah	82	I	101.0	44
Firozabad	83	M	219.0	67
Mainpuri	84	M	179.0	74
Mathura	85	M	320.0	76
Mahamaya Nagar	86	M	295.0	69
Kanshiram Nagar	87	I	70.1	45
Lalitpur	88	-	-	-
Mahoba	89	-	-	-
Banda	90	-	-	-
Hamirpur	91	-	-	-
Jalaun	92	-	-	-
Jhansi	93	-	-	-
Other Influence States Assam, Bihar, Chhattisgarh, Chandigarh, Gujarat, Himachal Pradesh, Haryana, Jharkhand, Karnataka, Maharashtra, Madhyapradesh, New Delhi, Nepal, Odisha, Punjab, Rajasthan, TamilNadu, Telangana, Uttarakhand, WestBengal	AS, BR, CG, CH, GJ, HP, HR, JH, KA, MH, MP, NDLS, Nepal, OR, PB, RJ, TN, TS, UK, WB	-	500+	-