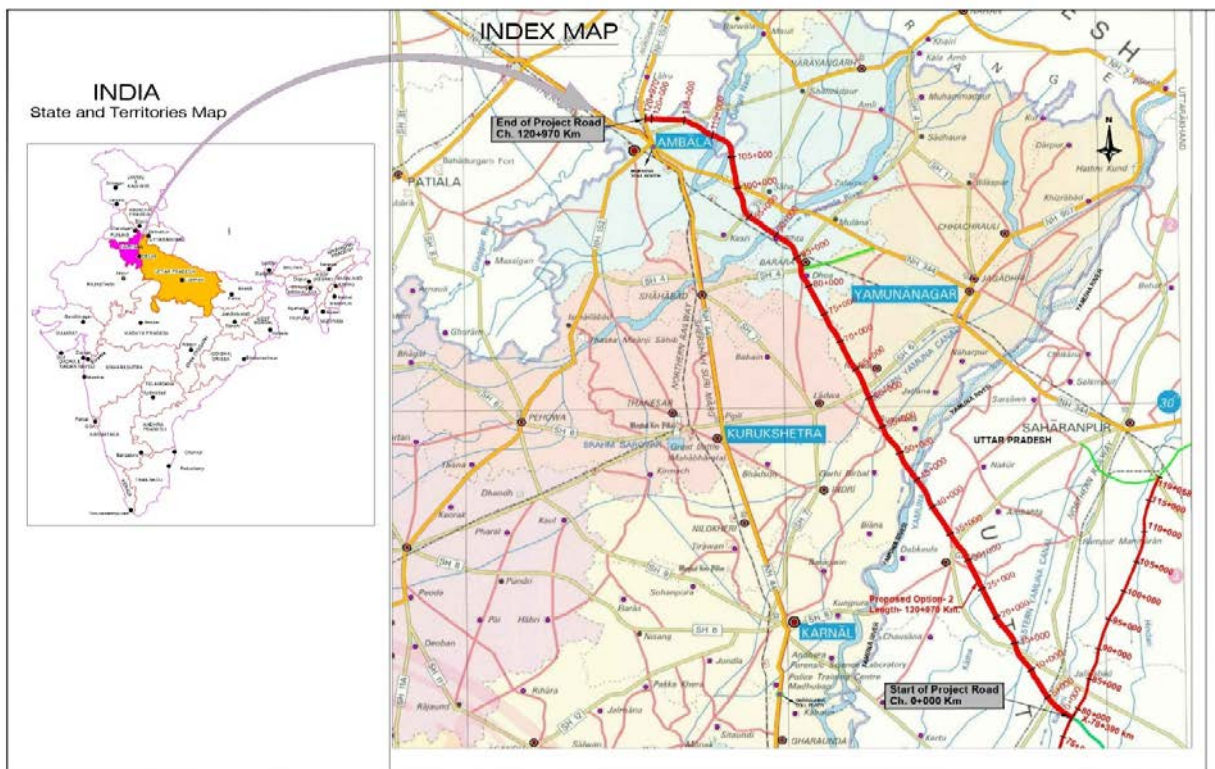


NATIONAL HIGHWAY AUTHORITY OF INDIA

Consultancy services for preparation of DPR for development of Economic corridor, Inter corridor, Feeder routes & Coastal roads to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-9/Package-1)



SHAMLI- AMBALA 6-LANE ACCESS CONTROLLED HIGHWAY

PACKAGE- 2 (Ch. 45+500 To Ch. 84.400)

TECHNICAL SCHEDULE – A, B & C

JANUARY 2022

Submitted by

M/s Egis India Consulting Engineers Pvt Ltd

in Joint Venture with

M/s K & J Projects Private Limited



NATIONAL HIGHWAYS AUTHORITY OF INDIA

(Ministry of Road Transport and Highways)
Government of India

TECHNICAL SCHEDULES

Development of Six-Lane Access Controlled Highway from Ranipur Barsi (Saharanpur district) to Adhoya Musalmana (Ambala district) (from Ch. 45+500 to 84+400) of Shamli – Ambala section of Bareilly – Ludhiana Economic Corridor on EPC Mode under Bharatmala Pariyojana Phase-I in the State of Haryana (Package-2).

G-5 & G-6, Sector – 10, Dwarka, New Delhi – 110 075

January 2022

SCHEDULE – A

(See Clause 2.1 and 8.1)

SITE OF THE PROJECT**1. THE SITE**

1.1. Site of the 6-Lane Access Controlled Highway shall include the land, buildings, structures and road works as described in Annex-I of this Schedule-A.

1.2. An inventory of the Site including the land, buildings, structures, road works, trees and any other immovable property on, or attached to, the Site shall be prepared jointly by the Authority Representative and the Contractor, and such inventory shall form part of the memorandum referred to in Clause 8.2.1 of this Agreement.

1.3. The alignment plans of the Project Highway are specified in Annex-III. The proposed levels as indicated in the alignment plan shall be treated as an approximate assessment. The contractor shall design the Road Profile of the project highway based on site/design requirement specified in Schedule-D.

1.4. The status of the environment clearances obtained or awaited is given in Annex IV.

Annex – I**(Schedule-A)****Site for Six Laning****2. The Site**

The Site of the 6-Lane Access Controlled Highway is a section of Shamli – Ambala 6- Lane Access Controlled Highway commencing at Design Ch. 45+500 near Ranipur Barsi village of Saharanpur district and ends at Design Ch. 84.400 near village Adhoya Musalmana of Ambala District passing through greenfield area in the State of Haryana. The land, carriageway and structures comprising the site are described below.

3. Description of the Project Highway

The important places through which the proposed alignment traverses are Chandraon, Hanso Majra, Khokhani, Khurdban, Dholra, Bubka, Dhanupura, Ghillour, Gajlana, Alawalpur and Adhoya Musalmana. An index map showing the existing features of the Project Highway is given at Appendix A-I.

Latitude and longitude of the project corridor

Location	Latitude	Longitude	Altitude (m)
Start point near Ranipur Barsi	29.888162°	77.208662°	259.000
End point near Adhoya Musalmana	30.207635°	77.023959°	274.000

4. Terrain

The terrain along the project stretch is predominantly plain terrain.

5. Land

The site of the project highway comprises the land (sum total of land already in possession and land to be possessed) is detailed in Annex-II of this Schedule A.

6. Carriageway

There is no existing alignment as the proposed project is a new Greenfield alignment.

7. Major Bridges

The Site includes the following existing Major Bridges:

S. No.	Existing Chainage (Km)	Type of Structure			No. of Spans with span length (m)	Width (m)
		Foundation	Sub-structure	Superstructure		
Nil						

8. Road over-bridges (ROB)/ Road under-bridges (RUB)

The Site includes the following ROB (road over railway line)/RUB (road under railway line):

S. No.	Existing Chainage (Km)	Type of Structure		No. of Spans with span length (m)	Width (m)	ROB/ RUB
		Foundation	Superstructure			
Nil						

9. Grade separators

The Site includes the following grade separators

S. No.	Chainage (km)	Type of Structure		No. of Spans with span length (m)	Width (m)
		Foundation	Superstructure		
Nil					

10. Minor bridges

The Site includes the following existing minor bridges:

S.No.	Existing Chainage (Km)	Type of structure			No. of Spans x length (m)	Overall Width (m)
		Type of Foundation	Sub Structure	Super Structure		
Nil						

11. Railway level crossings

The Site includes the following railway level crossings:

S. No.	Existing Chainage (Km)	Railway Chainage	Level Crossing No.	Remarks
Nil				

12. Underpasses (vehicular, non-vehicular)

The Site includes the following underpasses:

S. No.	Existing Chainage (Km)	Type of Structure	No. of Spans with span length (m)	Width
Nil				

13. Culverts

The Site has the following existing culverts:

S. No.	Existing Chainage (Km)	Type of Culvert	Spans/Opening x span length/Pipe dia. (m)	Overall Width (m)
Nil				

14. Bus bays

The Stretch has the following Bus Bays /Bus Shelters:

S. No.	Chainage (km)	Bus Stop Name	Side	Remarks
Nil				

15. Truck Lay byes

The details of truck lay byes are as follows:

S. No.	Chainage (km)	Length (m)	Left Hand Side	Right Hand Side
Nil				

16. Road side drains

The Road Side Drains along the Project Highway is as follows:

S. No.	Location		Type	
	From km	to km	Masonry/cc (Pucca)	Earthen (Kutcha)
Nil				

17. Major junctions

The details of major junctions are as follows:

S. No.	Existing Chainage (Km)	At grade	Separated	Category of Cross Road			
				NH	SH	MDR	Others
Nil							

(NH: National Highway, SH: State Highway, MDR: Major District Road)

18. Minor junctions

The details of the minor junctions are as follows:

S.No.	Existing km	Type of Junction	Direction	Width of Road	Name of Place
Nil					

19. Bypasses

The details of the bypasses are as follows:

S. No.	Name of bypass (town)	Chainage (km)		Length (in Km)
		From km	to km	
Nil				

20. Details of any other Structures

S. No	Existing Chainage (Km)	Type of Structure	Height (m)	Remarks
Nil				

21. Submergence Locations

No existing road has been utilized as part of the project alignment hence submergence location is not applicable.

S. No.	Existing Chainage (Km)		Overtopping above the existing road (m)
	From	To	
Nil			

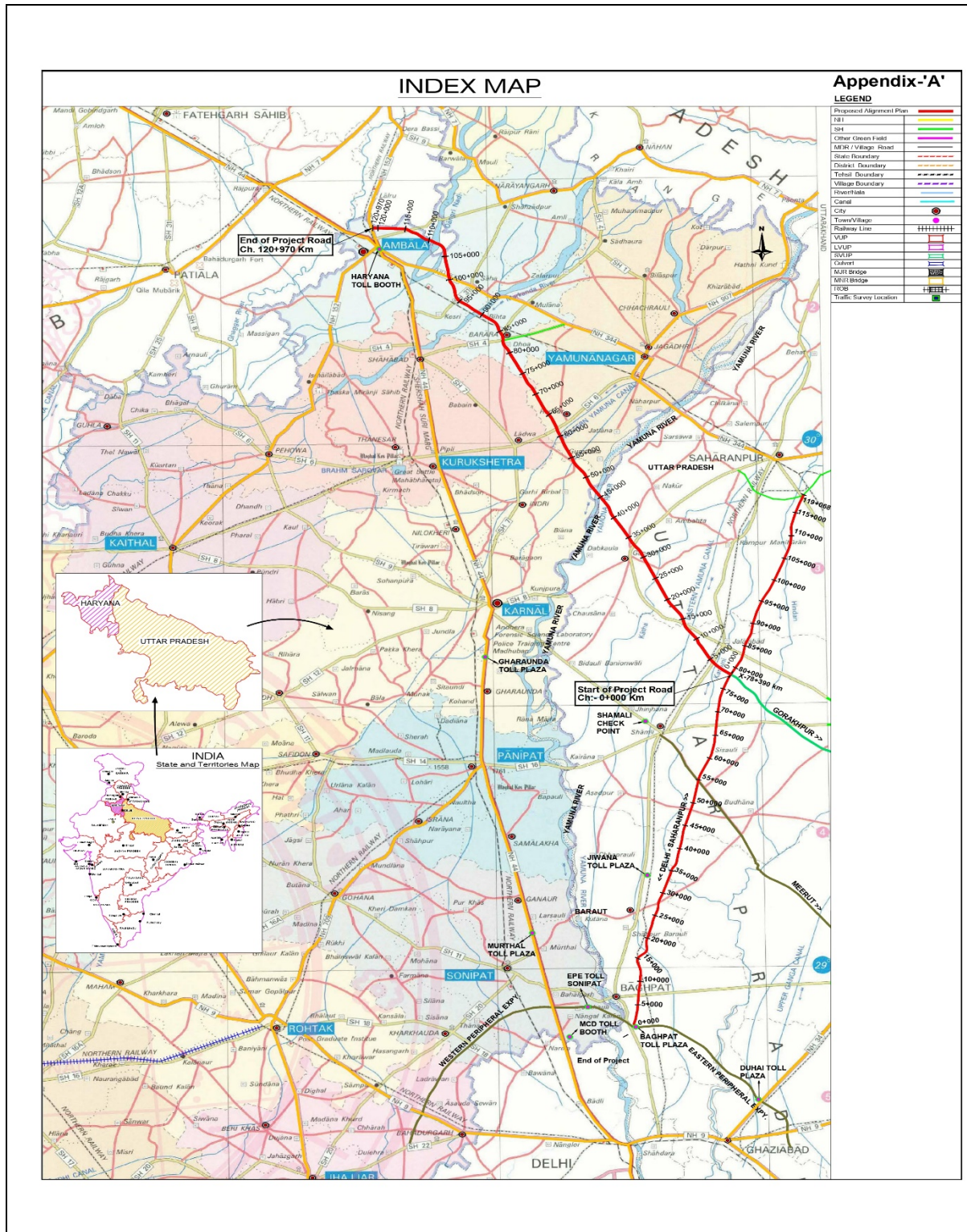
22. Details of Existing Utilities**i. Electrical Utilities**

The site includes the following electrical utilities:

Sr.No.	Chainage Start	Chainage End	Under Ground crossing Proposed(Nos.)		Over Head Line proposed(Mtr)		No.of transformer shifted
			Crossing-11 KV	Crossing-LT	11KV-OH	LT-OH	
1	45+500	46+000					
2	46+000	47+000					
3	47+000	48+000	1				1
4	48+000	49+000	2		400		2
5	49+000	50+000	2		50		1
6	50+000	51+000	2		650		3
7	51+000	52+000	2		400		1
8	52+000	53+000	1		600		2
9	53+000	54+000	3		300		2
10	54+000	55+000	1		800		3
11	55+000	56+000	1	2		300	
12	56+000	57+000		2		400	1
13	57+000	58+000	2	1	200		
14	58+000	59+000	2	2	350	50	
15	59+000	60+000	1	2	200		1
16	60+000	61+000	4	1	100	150	1
17	61+000	62+000	7	1			1
18	62+000	63+000	1	1		100	
19	63+000	64+000	1	3	700	200	3
20	64+000	65+000		1	200	150	1
21	65+000	66+000	2				

Development of Six-Lane Access Controlled Highway from Ranipur Barsi (Saharanpur district) to Adhoya Musalmana (Ambala district) (from Ch. 45+500 to 84+400) of Shamli – Ambala section of Bareilly – Ludhiana Economic Corridor on EPC Mode under Bharatmala Pariyojana Phase-I in the State of Haryana (Package-2).

Sr.No.	Chainage Start	Chainage End	Under Ground crossing Proposed(Nos.)		Over Head Line proposed(Mtr)		No.of transformer shifted
			Crossing-11 KV	Crossing-LT	11KV-OH	LT-OH	
22	66+000	67+000	1				
23	67+000	68+000	2	1	200	100	
24	68+000	69+000	1	1	450		1
25	69+000	70+000	2	2	100	300	2
26	70+000	71+000	2	3	100		
27	71+000	72+000	2		300		2
28	72+000	73+000	5		400		3
29	73+000	74+000	1		300		1
30	74+000	75+000	1		250		2
31	75+000	76+000	1				
32	76+000	77+000	3	2	550		2
33	77+000	78+000	1	2	50		
34	78+000	79+000	2	1			
35	79+000	80+000	1	2	200	100	
36	80+000	81+000	3	1	150		2
37	81+000	82+000	5	1	300	200	1
38	82+000	83+000	7	1	150		1
39	83+000	84+000	1	1		50	
40	84+000	84+400	1	1			
	Total		77	35	8450	2100	40

Appendix A-I**Index map of Project Highway**

Development of Six-Lane Access Controlled Highway from Ranipur Barsi (Saharanpur district) to Adhoya Musalmana (Ambala district) (from Ch. 45+500 to 84+400) of Shamli – Ambala section of Bareilly – Ludhiana Economic Corridor on EPC Mode under Bharatmala Pariyojana Phase-I in the State of Haryana (Package-2).

Annex II**(Schedule-A)****Dates for providing Right of Way**

The dates on which the Authority shall provide Right of Way of Construction Zone to the Contractor on different stretches of the Site are stated below:

Sl. No	From	To	Length (km)	Width (m)	Date of providing RoW
1	45+500	84+400	38.900	60.000 (approx.)	85% ROW to be handed over on Appointed Date
2	45+500	84+400	38.900		Remaining 15% of RoW of the total length and RoW for Proposed Toll Plaza, Interchange and Wayside Amenities within 150 days from Appointed date

The co-ordinates of Centreline and RoW are given below: -

Note- Contractor shall check and satisfy the coordinates with respect to the PROW marked on ground before quoting the tender.

Coordinates of Centre Line & Right of Way

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
45500	712637	3309332	712613	3309314	712661	3309349
45550	712608	3309372	712584	3309354	712632	3309390
45600	712578	3309412	712554	3309394	712602	3309430
45650	712549	3309453	712524	3309435	712573	3309470
45700	712519	3309493	712495	3309475	712543	3309511
45750	712489	3309533	712465	3309515	712514	3309551
45800	712460	3309573	712436	3309556	712484	3309591
45850	712430	3309614	712406	3309596	712454	3309632
45900	712401	3309654	712376	3309636	712425	3309672
45950	712371	3309694	712347	3309677	712395	3309712
46000	712341	3309735	712317	3309717	712366	3309752
46050	712312	3309775	712288	3309757	712336	3309793
46100	712282	3309815	712258	3309798	712307	3309833
46150	712253	3309856	712229	3309838	712277	3309873
46200	712223	3309896	712199	3309878	712247	3309914
46250	712194	3309936	712169	3309919	712218	3309954
46300	712164	3309977	712140	3309959	712188	3309994
46350	712134	3310017	712110	3309999	712159	3310035
46400	712105	3310057	712081	3310039	712129	3310075
46450	712075	3310098	712051	3310080	712099	3310115
46500	712046	3310138	712022	3310120	712070	3310156
46550	712016	3310178	711992	3310160	712040	3310196
46600	711987	3310218	711962	3310201	712011	3310236
46650	711957	3310259	711933	3310241	711981	3310277
46700	711927	3310299	711903	3310281	711952	3310317
46750	711898	3310339	711874	3310322	711922	3310357
46800	711868	3310380	711844	3310362	711892	3310397
46850	711839	3310420	711814	3310402	711863	3310438
46900	711809	3310460	711785	3310443	711833	3310478
46950	711779	3310501	711755	3310483	711804	3310518
47000	711750	3310541	711726	3310523	711774	3310559
47050	711720	3310581	711696	3310564	711745	3310599
47100	711691	3310622	711667	3310604	711715	3310639
47150	711661	3310662	711637	3310644	711685	3310680
47200	711632	3310702	711607	3310684	711656	3310720
47250	711602	3310743	711578	3310725	711626	3310760
47300	711572	3310783	711548	3310765	711597	3310801
47350	711543	3310823	711519	3310805	711567	3310841
47400	711513	3310863	711489	3310846	711537	3310881
47450	711484	3310904	711459	3310886	711508	3310922

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
47500	711454	3310944	711430	3310926	711478	3310962
47550	711425	3310984	711400	3310967	711449	3311002
47600	711395	3311025	711371	3311007	711419	3311042
47650	711365	3311065	711341	3311047	711390	3311083
47700	711336	3311105	711312	3311088	711360	3311123
47750	711307	3311146	711282	3311129	711331	3311163
47800	711278	3311187	711253	3311170	711302	3311204
47850	711249	3311228	711225	3311211	711274	3311245
47900	711221	3311269	711197	3311253	711246	3311286
47950	711194	3311311	711169	3311295	711219	3311328
48000	711167	3311353	711141	3311337	711192	3311369
48050	711140	3311395	711115	3311379	711165	3311411
48100	711114	3311438	711088	3311422	711139	3311454
48150	711088	3311481	711062	3311465	711114	3311496
48200	711062	3311524	711037	3311509	711088	3311539
48250	711037	3311567	711011	3311552	711064	3311582
48300	711013	3311611	710987	3311596	711039	3311625
48350	710989	3311654	710962	3311640	711015	3311669
48400	710965	3311698	710939	3311684	710992	3311713
48450	710942	3311743	710915	3311729	710968	3311756
48500	710919	3311787	710892	3311774	710946	3311801
48550	710897	3311832	710870	3311819	710924	3311845
48600	710875	3311877	710848	3311864	710902	3311890
48650	710853	3311922	710826	3311909	710880	3311935
48700	710832	3311967	710805	3311955	710860	3311980
48750	710812	3312013	710784	3312001	710839	3312025
48800	710792	3312059	710764	3312047	710819	3312071
48850	710772	3312105	710744	3312093	710800	3312116
48900	710753	3312151	710725	3312139	710780	3312162
48950	710734	3312197	710706	3312186	710761	3312209
49000	710715	3312243	710687	3312232	710742	3312255
49050	710696	3312290	710668	3312278	710723	3312301
49100	710676	3312336	710649	3312324	710704	3312347
49150	710657	3312382	710630	3312371	710685	3312393
49200	710638	3312428	710611	3312417	710666	3312440
49250	710619	3312474	710592	3312463	710647	3312486
49300	710600	3312521	710572	3312509	710628	3312532
49350	710581	3312567	710553	3312555	710609	3312578
49400	710562	3312613	710534	3312602	710590	3312625
49450	710543	3312659	710515	3312648	710571	3312671
49500	710524	3312706	710496	3312694	710552	3312717
49550	710505	3312752	710477	3312740	710533	3312763

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
49600	710486	3312798	710458	3312787	710513	3312809
49650	710467	3312844	710439	3312833	710494	3312856
49700	710448	3312890	710420	3312879	710475	3312902
49750	710429	3312937	710401	3312925	710456	3312948
49800	710409	3312983	710382	3312971	710437	3312994
49850	710390	3313029	710363	3313018	710418	3313040
49900	710371	3313075	710344	3313064	710399	3313087
49950	710352	3313121	710325	3313110	710380	3313133
50000	710333	3313168	710305	3313156	710361	3313179
50050	710314	3313214	710286	3313202	710342	3313225
50100	710295	3313260	710267	3313249	710323	3313272
50150	710276	3313306	710248	3313295	710304	3313318
50200	710257	3313353	710229	3313341	710285	3313364
50250	710238	3313399	710210	3313387	710266	3313410
50300	710219	3313445	710191	3313433	710246	3313457
50350	710199	3313491	710172	3313479	710227	3313503
50400	710179	3313537	710152	3313524	710206	3313549
50450	710158	3313582	710131	3313569	710185	3313595
50500	710136	3313627	710109	3313614	710163	3313640
50550	710113	3313672	710087	3313658	710140	3313685
50600	710090	3313716	710064	3313702	710117	3313730
50650	710066	3313760	710040	3313745	710092	3313774
50700	710041	3313803	710015	3313788	710067	3313818
50750	710016	3313846	709990	3313831	710042	3313862
50800	709990	3313889	709964	3313873	710015	3313905
50850	709963	3313931	709938	3313915	709988	3313947
50900	709935	3313973	709910	3313956	709960	3313989
50950	709907	3314014	709882	3313997	709932	3314031
51000	709878	3314055	709854	3314037	709902	3314072
51050	709848	3314095	709824	3314077	709872	3314113
51100	709818	3314135	709794	3314116	709842	3314153
51150	709787	3314174	709764	3314155	709811	3314193
51200	709756	3314213	709732	3314194	709779	3314232
51250	709723	3314251	709701	3314231	709746	3314271
51300	709690	3314289	709668	3314269	709713	3314309
51350	709657	3314326	709635	3314306	709680	3314346
51400	709624	3314364	709602	3314344	709647	3314384
51450	709591	3314401	709569	3314381	709614	3314421
51500	709558	3314439	709536	3314419	709581	3314458
51550	709525	3314476	709502	3314456	709547	3314496
51600	709492	3314514	709469	3314494	709514	3314533
51650	709459	3314551	709436	3314531	709481	3314571

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
51700	709426	3314588	709403	3314569	709448	3314608
51750	709393	3314626	709370	3314606	709415	3314646
51800	709359	3314663	709337	3314644	709382	3314683
51850	709326	3314701	709304	3314681	709349	3314721
51900	709293	3314738	709271	3314718	709316	3314758
51950	709260	3314776	709238	3314756	709283	3314796
52000	709227	3314813	709204	3314793	709249	3314833
52050	709194	3314851	709171	3314831	709216	3314871
52100	709161	3314888	709138	3314868	709183	3314908
52150	709128	3314926	709105	3314906	709150	3314945
52200	709094	3314963	709072	3314943	709117	3314983
52250	709061	3315001	709039	3314981	709084	3315020
52300	709028	3315038	709006	3315018	709051	3315058
52350	708995	3315075	708973	3315056	709018	3315095
52400	708962	3315113	708940	3315093	708984	3315133
52450	708929	3315150	708906	3315131	708951	3315170
52500	708896	3315188	708873	3315168	708918	3315208
52550	708863	3315225	708840	3315205	708885	3315245
52600	708830	3315263	708807	3315243	708852	3315283
52650	708796	3315300	708774	3315280	708819	3315320
52700	708763	3315338	708741	3315318	708786	3315358
52750	708730	3315375	708708	3315355	708753	3315395
52800	708697	3315413	708675	3315393	708720	3315432
52850	708664	3315450	708642	3315430	708686	3315470
52900	708631	3315488	708608	3315468	708653	3315507
52950	708598	3315525	708575	3315505	708620	3315545
53000	708565	3315562	708542	3315543	708587	3315582
53050	708532	3315600	708509	3315580	708554	3315620
53100	708499	3315638	708476	3315619	708522	3315657
53150	708467	3315676	708444	3315657	708490	3315695
53200	708436	3315715	708412	3315697	708459	3315734
53250	708405	3315755	708381	3315736	708429	3315773
53300	708375	3315795	708351	3315777	708399	3315812
53350	708345	3315835	708321	3315818	708370	3315853
53400	708317	3315876	708292	3315859	708341	3315893
53450	708289	3315917	708264	3315901	708314	3315934
53500	708261	3315959	708236	3315943	708287	3315975
53550	708235	3316002	708209	3315986	708260	3316017
53600	708209	3316044	708183	3316029	708235	3316060
53650	708184	3316088	708158	3316073	708210	3316102
53700	708159	3316131	708133	3316117	708185	3316146
53750	708135	3316175	708109	3316161	708162	3316189

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
53800	708112	3316219	708086	3316206	708139	3316233
53850	708090	3316264	708063	3316251	708117	3316277
53900	708068	3316309	708041	3316297	708096	3316322
53950	708048	3316355	708020	3316343	708075	3316367
54000	708028	3316401	708000	3316389	708055	3316412
54050	708008	3316447	707981	3316435	708036	3316458
54100	707990	3316493	707962	3316482	708018	3316504
54150	707971	3316540	707943	3316528	707999	3316551
54200	707952	3316586	707925	3316575	707980	3316597
54250	707934	3316632	707906	3316621	707962	3316644
54300	707915	3316679	707887	3316668	707943	3316690
54350	707897	3316725	707869	3316714	707924	3316736
54400	707878	3316772	707850	3316760	707906	3316783
54450	707859	3316818	707831	3316807	707887	3316829
54500	707841	3316864	707813	3316853	707869	3316876
54550	707822	3316911	707794	3316900	707850	3316922
54600	707803	3316957	707776	3316946	707831	3316968
54650	707785	3317004	707757	3316992	707813	3317015
54700	707766	3317050	707738	3317039	707794	3317061
54750	707748	3317096	707720	3317085	707775	3317108
54800	707729	3317143	707701	3317132	707757	3317154
54850	707710	3317189	707683	3317178	707738	3317200
54900	707692	3317236	707664	3317224	707720	3317247
54950	707673	3317282	707645	3317271	707701	3317293
55000	707655	3317328	707627	3317317	707682	3317340
55050	707636	3317375	707608	3317363	707664	3317386
55100	707617	3317421	707589	3317409	707644	3317433
55150	707597	3317467	707569	3317455	707624	3317479
55200	707577	3317513	707549	3317501	707604	3317525
55250	707556	3317558	707529	3317546	707584	3317571
55300	707535	3317604	707508	3317591	707562	3317616
55350	707514	3317649	707487	3317636	707541	3317662
55400	707492	3317694	707465	3317680	707519	3317707
55450	707469	3317738	707443	3317725	707496	3317752
55500	707447	3317783	707420	3317769	707473	3317797
55550	707423	3317827	707397	3317813	707450	3317841
55600	707400	3317871	707374	3317857	707427	3317885
55650	707377	3317916	707350	3317902	707403	3317930
55700	707354	3317960	707327	3317946	707380	3317974
55750	707330	3318004	707304	3317990	707357	3318018
55800	707307	3318048	707280	3318034	707333	3318062
55850	707284	3318093	707257	3318079	707310	3318107

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
55900	707260	3318137	707234	3318123	707287	3318151
55950	707237	3318181	707210	3318167	707264	3318195
56000	707214	3318225	707187	3318211	707240	3318239
56050	707190	3318270	707164	3318256	707217	3318284
56100	707167	3318314	707141	3318300	707194	3318328
56150	707144	3318358	707117	3318344	707170	3318372
56200	707121	3318402	707094	3318388	707147	3318416
56250	707097	3318447	707071	3318433	707124	3318461
56300	707074	3318491	707047	3318477	707100	3318505
56350	707051	3318535	707024	3318521	707077	3318549
56400	707027	3318579	707001	3318565	707054	3318593
56450	707004	3318624	706977	3318610	707031	3318638
56500	706981	3318668	706954	3318654	707007	3318682
56550	706957	3318712	706931	3318698	706984	3318726
56600	706934	3318756	706908	3318742	706961	3318770
56650	706911	3318800	706884	3318787	706937	3318814
56700	706888	3318845	706861	3318831	706914	3318859
56750	706864	3318889	706838	3318875	706891	3318903
56800	706841	3318933	706814	3318919	706867	3318947
56850	706818	3318977	706791	3318963	706844	3318991
56900	706794	3319022	706768	3319008	706821	3319036
56950	706771	3319066	706744	3319052	706798	3319080
57000	706748	3319110	706721	3319096	706774	3319124
57050	706724	3319154	706698	3319140	706751	3319168
57100	706701	3319199	706675	3319185	706728	3319213
57150	706678	3319243	706651	3319229	706704	3319257
57200	706655	3319287	706628	3319273	706681	3319301
57250	706631	3319331	706605	3319317	706658	3319345
57300	706608	3319376	706581	3319362	706634	3319390
57350	706585	3319420	706558	3319406	706611	3319434
57400	706561	3319464	706535	3319450	706588	3319478
57450	706538	3319508	706511	3319494	706565	3319522
57500	706515	3319553	706488	3319539	706542	3319566
57550	706492	3319597	706465	3319584	706519	3319611
57600	706470	3319642	706443	3319629	706497	3319655
57650	706448	3319687	706421	3319674	706475	3319700
57700	706427	3319732	706400	3319720	706454	3319745
57750	706406	3319778	706379	3319765	706433	3319790
57800	706386	3319823	706358	3319811	706413	3319835
57850	706366	3319869	706338	3319857	706393	3319881
57900	706346	3319915	706319	3319904	706374	3319927
57950	706327	3319961	706299	3319950	706355	3319973

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
58000	706309	3320008	706281	3319997	706337	3320019
58050	706291	3320055	706263	3320044	706319	3320065
58100	706273	3320101	706245	3320091	706301	3320112
58150	706255	3320148	706227	3320137	706283	3320159
58200	706237	3320195	706209	3320184	706265	3320205
58250	706219	3320241	706191	3320231	706247	3320252
58300	706201	3320288	706173	3320277	706229	3320299
58350	706184	3320335	706156	3320324	706212	3320345
58400	706166	3320381	706138	3320371	706194	3320392
58450	706148	3320428	706120	3320418	706176	3320439
58500	706130	3320475	706102	3320464	706158	3320486
58550	706112	3320522	706084	3320511	706140	3320532
58600	706094	3320568	706066	3320558	706122	3320579
58650	706077	3320615	706049	3320604	706105	3320626
58700	706059	3320662	706031	3320651	706087	3320672
58750	706041	3320708	706013	3320698	706069	3320719
58800	706023	3320755	705995	3320745	706051	3320766
58850	706005	3320802	705977	3320791	706033	3320813
58900	705987	3320849	705959	3320838	706015	3320859
58950	705970	3320895	705942	3320885	705998	3320906
59000	705952	3320942	705924	3320931	705980	3320953
59050	705934	3320989	705906	3320978	705962	3320999
59100	705916	3321035	705888	3321025	705944	3321046
59150	705898	3321082	705870	3321071	705926	3321093
59200	705880	3321129	705852	3321118	705908	3321140
59250	705863	3321176	705835	3321165	705891	3321186
59300	705845	3321222	705817	3321212	705873	3321233
59350	705827	3321269	705799	3321258	705855	3321280
59400	705809	3321316	705781	3321305	705837	3321326
59450	705791	3321362	705763	3321352	705819	3321373
59500	705773	3321409	705745	3321398	705801	3321420
59550	705755	3321455	705727	3321444	705782	3321467
59600	705736	3321502	705708	3321491	705764	3321513
59650	705717	3321548	705689	3321537	705745	3321560
59700	705698	3321594	705670	3321583	705726	3321606
59750	705678	3321640	705651	3321629	705706	3321652
59800	705659	3321686	705631	3321675	705686	3321698
59850	705639	3321732	705612	3321720	705667	3321744
59900	705619	3321778	705592	3321766	705646	3321790
59950	705599	3321824	705571	3321812	705626	3321836
60000	705578	3321869	705551	3321857	705605	3321882
60050	705557	3321915	705530	3321902	705585	3321927

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
60100	705537	3321960	705509	3321948	705564	3321973
60150	705516	3322006	705488	3321993	705543	3322018
60200	705495	3322051	705467	3322039	705522	3322064
60250	705474	3322097	705447	3322084	705501	3322109
60300	705453	3322142	705426	3322130	705480	3322155
60350	705432	3322187	705405	3322175	705459	3322200
60400	705411	3322233	705384	3322220	705439	3322246
60450	705390	3322278	705360	3322264	705421	3322292
60500	705369	3322324	705337	3322309	705402	3322339
60550	705348	3322369	705316	3322354	705381	3322384
60600	705328	3322415	705295	3322400	705360	3322429
60650	705307	3322460	705274	3322445	705340	3322475
60700	705286	3322505	705250	3322489	705322	3322522
60750	705265	3322551	705226	3322533	705304	3322569
60800	705244	3322596	705204	3322578	705285	3322615
60850	705224	3322642	705185	3322625	705262	3322659
60900	705204	3322688	705169	3322673	705238	3322703
60950	705185	3322734	705141	3322716	705228	3322752
61000	705166	3322780	705115	3322760	705216	3322801
61050	705147	3322827	705113	3322813	705181	3322840
61100	705129	3322873	705091	3322859	705168	3322888
61150	705112	3322920	705070	3322905	705153	3322936
61200	705094	3322967	705054	3322953	705135	3322982
61250	705078	3323014	705040	3323001	705116	3323028
61300	705062	3323062	705026	3323050	705097	3323074
61350	705046	3323109	705012	3323098	705080	3323120
61400	705031	3323157	704997	3323146	705065	3323167
61450	705016	3323205	704982	3323194	705050	3323215
61500	705002	3323252	704969	3323242	705034	3323262
61550	704987	3323300	704958	3323291	705016	3323309
61600	704972	3323348	704944	3323339	705001	3323357
61650	704958	3323396	704929	3323387	704987	3323405
61700	704943	3323444	704915	3323435	704972	3323452
61750	704929	3323492	704900	3323483	704957	3323500
61800	704914	3323539	704885	3323530	704943	3323548
61850	704899	3323587	704870	3323578	704927	3323596
61900	704883	3323634	704855	3323625	704912	3323644
61950	704867	3323682	704839	3323672	704896	3323692
62000	704851	3323729	704822	3323719	704879	3323739
62050	704834	3323776	704806	3323766	704862	3323786
62100	704816	3323823	704788	3323812	704844	3323834
62150	704798	3323870	704770	3323859	704826	3323880

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
62200	704780	3323916	704752	3323905	704808	3323927
62250	704761	3323962	704733	3323951	704789	3323974
62300	704742	3324008	704714	3323997	704769	3324020
62350	704722	3324054	704694	3324042	704749	3324066
62400	704701	3324100	704674	3324088	704729	3324112
62450	704681	3324146	704654	3324133	704708	3324158
62500	704660	3324191	704633	3324179	704688	3324204
62550	704640	3324237	704613	3324225	704667	3324249
62600	704619	3324282	704592	3324270	704647	3324295
62650	704599	3324328	704572	3324316	704626	3324340
62700	704578	3324374	704551	3324361	704606	3324386
62750	704558	3324419	704530	3324407	704585	3324432
62800	704537	3324465	704510	3324452	704565	3324477
62850	704517	3324510	704489	3324498	704544	3324523
62900	704496	3324556	704469	3324544	704524	3324568
62950	704476	3324602	704448	3324589	704503	3324614
63000	704455	3324647	704428	3324635	704483	3324660
63050	704435	3324693	704407	3324680	704462	3324705
63100	704414	3324738	704387	3324726	704442	3324751
63150	704394	3324784	704366	3324772	704421	3324796
63200	704373	3324830	704346	3324817	704401	3324842
63250	704353	3324875	704325	3324863	704380	3324887
63300	704332	3324921	704305	3324908	704360	3324933
63350	704312	3324966	704284	3324954	704339	3324979
63400	704291	3325012	704264	3325000	704318	3325024
63450	704271	3325058	704243	3325045	704298	3325070
63500	704250	3325103	704223	3325091	704277	3325115
63550	704230	3325149	704202	3325136	704257	3325161
63600	704209	3325194	704182	3325182	704236	3325207
63650	704189	3325240	704161	3325228	704216	3325252
63700	704168	3325286	704141	3325273	704195	3325298
63750	704147	3325331	704120	3325319	704175	3325343
63800	704127	3325377	704100	3325364	704154	3325389
63850	704106	3325422	704079	3325409	704133	3325435
63900	704085	3325467	704058	3325454	704112	3325480
63950	704063	3325512	704036	3325499	704090	3325526
64000	704040	3325557	704014	3325544	704067	3325571
64050	704018	3325602	703991	3325588	704044	3325615
64100	703994	3325646	703968	3325632	704021	3325660
64150	703971	3325690	703944	3325676	703997	3325704
64200	703947	3325734	703921	3325719	703973	3325748
64250	703922	3325777	703896	3325762	703948	3325792

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
64300	703897	3325821	703871	3325806	703923	3325836
64350	703872	3325864	703846	3325848	703898	3325879
64400	703846	3325907	703821	3325891	703872	3325922
64450	703820	3325949	703794	3325933	703845	3325965
64500	703793	3325991	703768	3325975	703819	3326008
64550	703766	3326033	703741	3326017	703791	3326050
64600	703739	3326075	703714	3326059	703764	3326092
64650	703711	3326117	703686	3326100	703736	3326134
64700	703682	3326158	703658	3326141	703707	3326175
64750	703654	3326199	703629	3326181	703678	3326216
64800	703625	3326239	703600	3326222	703649	3326257
64850	703595	3326280	703571	3326262	703619	3326298
64900	703565	3326320	703541	3326302	703589	3326338
64950	703535	3326360	703511	3326341	703558	3326378
65000	703504	3326399	703480	3326380	703528	3326418
65050	703473	3326438	703449	3326419	703496	3326457
65100	703442	3326477	703418	3326458	703465	3326496
65150	703410	3326516	703387	3326497	703434	3326535
65200	703379	3326555	703356	3326536	703402	3326574
65250	703348	3326594	703324	3326575	703371	3326613
65300	703316	3326633	703293	3326614	703340	3326652
65350	703285	3326672	703262	3326653	703309	3326691
65400	703254	3326711	703230	3326693	703278	3326730
65450	703223	3326751	703199	3326732	703247	3326769
65500	703193	3326790	703169	3326772	703216	3326808
65550	703162	3326830	703138	3326812	703186	3326848
65600	703132	3326870	703108	3326852	703156	3326888
65650	703103	3326910	703078	3326892	703127	3326928
65700	703073	3326951	703049	3326933	703097	3326968
65750	703044	3326991	703020	3326974	703068	3327009
65800	703015	3327032	702991	3327015	703040	3327049
65850	702987	3327073	702962	3327056	703011	3327090
65900	702958	3327114	702934	3327097	702983	3327131
65950	702930	3327156	702905	3327139	702955	3327172
66000	702903	3327197	702878	3327181	702928	3327214
66050	702875	3327239	702850	3327223	702901	3327256
66100	702848	3327281	702823	3327265	702874	3327297
66150	702822	3327324	702796	3327308	702847	3327340
66200	702795	3327366	702770	3327350	702821	3327382
66250	702769	3327409	702743	3327393	702794	3327424
66300	702743	3327451	702717	3327436	702769	3327467
66350	702717	3327494	702692	3327479	702743	3327510

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
66400	702692	3327538	702666	3327522	702718	3327553
66450	702667	3327581	702641	3327566	702693	3327596
66500	702643	3327624	702617	3327610	702669	3327639
66550	702618	3327668	702592	3327654	702645	3327683
66600	702594	3327712	702568	3327698	702621	3327726
66650	702571	3327756	702544	3327742	702597	3327770
66700	702547	3327800	702521	3327786	702574	3327814
66750	702524	3327845	702498	3327831	702551	3327858
66800	702502	3327889	702475	3327875	702528	3327903
66850	702479	3327934	702452	3327920	702506	3327947
66900	702457	3327979	702430	3327965	702484	3327992
66950	702435	3328024	702408	3328010	702462	3328037
67000	702413	3328068	702386	3328055	702440	3328082
67050	702391	3328113	702364	3328100	702418	3328127
67100	702369	3328158	702342	3328145	702396	3328172
67150	702348	3328203	702321	3328190	702375	3328216
67200	702326	3328248	702299	3328235	702353	3328261
67250	702304	3328293	702277	3328280	702331	3328306
67300	702282	3328338	702255	3328325	702309	3328351
67350	702260	3328383	702233	3328370	702287	3328396
67400	702238	3328428	702211	3328415	702265	3328441
67450	702216	3328473	702189	3328460	702243	3328486
67500	702194	3328518	702167	3328505	702221	3328531
67550	702172	3328563	702145	3328550	702199	3328576
67600	702151	3328608	702124	3328595	702177	3328621
67650	702129	3328653	702102	3328640	702156	3328666
67700	702107	3328698	702080	3328685	702134	3328711
67750	702085	3328743	702058	3328730	702112	3328756
67800	702063	3328788	702036	3328775	702090	3328801
67850	702041	3328833	702014	3328820	702068	3328846
67900	702019	3328878	701992	3328865	702046	3328891
67950	701997	3328923	701970	3328909	702024	3328936
68000	701975	3328968	701948	3328954	702002	3328981
68050	701954	3329013	701927	3328999	701980	3329026
68100	701932	3329057	701905	3329044	701959	3329071
68150	701910	3329102	701883	3329089	701937	3329116
68200	701888	3329147	701861	3329134	701915	3329161
68250	701866	3329192	701839	3329179	701893	3329205
68300	701844	3329237	701817	3329224	701871	3329250
68350	701822	3329282	701795	3329269	701849	3329295
68400	701800	3329327	701773	3329314	701827	3329340
68450	701778	3329372	701751	3329359	701805	3329385

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
68500	701757	3329417	701730	3329404	701783	3329430
68550	701735	3329462	701708	3329449	701762	3329475
68600	701713	3329507	701686	3329494	701740	3329520
68650	701691	3329552	701664	3329539	701718	3329565
68700	701669	3329597	701642	3329584	701696	3329610
68750	701647	3329642	701620	3329629	701674	3329655
68800	701625	3329687	701598	3329674	701652	3329700
68850	701603	3329732	701576	3329719	701630	3329745
68900	701581	3329777	701554	3329764	701608	3329790
68950	701559	3329822	701533	3329809	701586	3329835
69000	701538	3329867	701511	3329854	701565	3329880
69050	701516	3329912	701489	3329898	701543	3329925
69100	701494	3329957	701467	3329943	701521	3329970
69150	701472	3330002	701445	3329988	701499	3330015
69200	701450	3330046	701423	3330033	701477	3330060
69250	701428	3330091	701401	3330078	701455	3330105
69300	701406	3330136	701379	3330123	701433	3330150
69350	701384	3330181	701357	3330168	701411	3330194
69400	701362	3330226	701336	3330213	701389	3330239
69450	701341	3330271	701314	3330258	701368	3330284
69500	701319	3330316	701292	3330303	701346	3330329
69550	701297	3330361	701270	3330348	701324	3330374
69600	701275	3330406	701248	3330393	701302	3330419
69650	701253	3330451	701226	3330438	701280	3330464
69700	701231	3330496	701204	3330483	701258	3330509
69750	701209	3330541	701182	3330528	701236	3330554
69800	701187	3330586	701160	3330573	701214	3330599
69850	701165	3330631	701139	3330618	701192	3330644
69900	701144	3330676	701117	3330663	701171	3330689
69950	701122	3330721	701095	3330708	701149	3330734
70000	701100	3330766	701073	3330753	701127	3330779
70050	701078	3330811	701051	3330798	701105	3330824
70100	701056	3330856	701029	3330842	701083	3330869
70150	701034	3330901	701007	3330887	701061	3330914
70200	701012	3330946	700985	3330932	701039	3330959
70250	700990	3330990	700963	3330977	701017	3331004
70300	700968	3331035	700942	3331022	700995	3331049
70350	700947	3331080	700920	3331067	700974	3331094
70400	700925	3331125	700898	3331112	700952	3331138
70450	700903	3331170	700876	3331157	700930	3331183
70500	700881	3331215	700854	3331202	700908	3331228
70550	700859	3331260	700832	3331247	700886	3331273

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
70600	700837	3331305	700810	3331292	700864	3331318
70650	700815	3331350	700788	3331337	700842	3331363
70700	700793	3331395	700766	3331382	700820	3331408
70750	700771	3331440	700744	3331427	700798	3331453
70800	700750	3331485	700723	3331472	700777	3331498
70850	700728	3331530	700701	3331517	700755	3331543
70900	700706	3331575	700679	3331562	700733	3331588
70950	700684	3331620	700657	3331607	700711	3331633
71000	700662	3331665	700635	3331652	700689	3331678
71050	700640	3331710	700613	3331697	700667	3331723
71100	700618	3331755	700591	3331741	700645	3331768
71150	700596	3331799	700569	3331786	700622	3331813
71200	700572	3331844	700546	3331830	700599	3331858
71250	700549	3331888	700522	3331873	700575	3331902
71300	700524	3331931	700498	3331916	700550	3331946
71350	700499	3331974	700473	3331959	700524	3331990
71400	700473	3332017	700447	3332001	700498	3332033
71450	700446	3332059	700421	3332043	700471	3332075
71500	700418	3332101	700393	3332084	700443	3332118
71550	700390	3332142	700365	3332125	700415	3332159
71600	700361	3332183	700337	3332165	700386	3332200
71650	700332	3332223	700308	3332205	700356	3332241
71700	700302	3332263	700278	3332245	700325	3332281
71750	700271	3332302	700247	3332284	700294	3332321
71800	700239	3332341	700216	3332322	700262	3332360
71850	700207	3332380	700184	3332360	700230	3332399
71900	700174	3332417	700152	3332398	700197	3332437
71950	700141	3332455	700119	3332435	700164	3332475
72000	700108	3332492	700086	3332473	700131	3332512
72050	700075	3332530	700053	3332510	700097	3332550
72100	700042	3332567	700019	3332547	700064	3332587
72150	700009	3332605	699986	3332585	700031	3332625
72200	699976	3332642	699953	3332622	699998	3332662
72250	699943	3332680	699920	3332660	699965	3332700
72300	699910	3332717	699887	3332698	699933	3332737
72350	699877	3332756	699854	3332736	699901	3332775
72400	699846	3332794	699822	3332776	699869	3332813
72450	699815	3332834	699791	3332815	699839	3332852
72500	699784	3332873	699760	3332855	699808	3332891
72550	699755	3332914	699731	3332896	699779	3332931
72600	699726	3332954	699701	3332937	699750	3332971
72650	699697	3332995	699673	3332979	699722	3333012

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
72700	699670	3333037	699645	3333021	699695	3333054
72750	699643	3333079	699618	3333063	699668	3333095
72800	699617	3333122	699591	3333106	699642	3333137
72850	699591	3333165	699565	3333150	699617	3333180
72900	699566	3333208	699540	3333194	699593	3333223
72950	699542	3333252	699516	3333238	699569	3333266
73000	699519	3333296	699492	3333283	699546	3333310
73050	699496	3333341	699470	3333328	699523	3333354
73100	699475	3333386	699447	3333373	699502	3333399
73150	699453	3333431	699426	3333419	699481	3333444
73200	699433	3333477	699406	3333465	699460	3333489
73250	699413	3333523	699385	3333511	699440	3333535
73300	699393	3333568	699365	3333556	699420	3333580
73350	699373	3333614	699345	3333602	699400	3333626
73400	699352	3333660	699325	3333648	699380	3333672
73450	699332	3333706	699305	3333694	699360	3333718
73500	699312	3333751	699285	3333739	699340	3333764
73550	699292	3333797	699265	3333785	699319	3333809
73600	699272	3333843	699244	3333831	699299	3333855
73650	699252	3333889	699224	3333877	699279	3333901
73700	699232	3333934	699204	3333922	699259	3333947
73750	699211	3333980	699184	3333968	699239	3333992
73800	699191	3334026	699164	3334014	699219	3334038
73850	699171	3334072	699144	3334060	699199	3334084
73900	699151	3334118	699124	3334105	699179	3334130
73950	699131	3334163	699103	3334151	699158	3334175
74000	699111	3334209	699083	3334197	699138	3334221
74050	699091	3334255	699063	3334243	699118	3334267
74100	699071	3334301	699043	3334289	699098	3334313
74150	699050	3334346	699023	3334334	699078	3334358
74200	699030	3334392	699003	3334380	699058	3334404
74250	699010	3334438	698983	3334426	699038	3334450
74300	698990	3334484	698962	3334472	699017	3334496
74350	698970	3334529	698942	3334517	698997	3334542
74400	698950	3334575	698922	3334563	698977	3334587
74450	698930	3334621	698902	3334609	698957	3334633
74500	698909	3334667	698882	3334655	698937	3334679
74550	698889	3334712	698862	3334700	698917	3334725
74600	698869	3334758	698842	3334746	698897	3334770
74650	698849	3334804	698822	3334792	698876	3334816
74700	698829	3334850	698801	3334838	698856	3334862
74750	698809	3334896	698781	3334883	698836	3334908

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
74800	698788	3334941	698761	3334929	698816	3334954
74850	698768	3334987	698740	3334974	698795	3334999
74900	698746	3335032	698719	3335019	698774	3335045
74950	698725	3335077	698698	3335064	698752	3335090
75000	698703	3335122	698676	3335109	698729	3335135
75050	698680	3335167	698653	3335153	698707	3335180
75100	698657	3335211	698631	3335197	698684	3335225
75150	698634	3335255	698607	3335241	698660	3335269
75200	698610	3335299	698583	3335285	698636	3335313
75250	698585	3335343	698559	3335328	698612	3335357
75300	698561	3335386	698535	3335371	698587	3335401
75350	698535	3335429	698510	3335414	698561	3335445
75400	698510	3335472	698484	3335457	698535	3335488
75450	698484	3335515	698458	3335499	698509	3335531
75500	698458	3335558	698432	3335542	698483	3335573
75550	698432	3335600	698406	3335585	698457	3335616
75600	698406	3335643	698380	3335627	698431	3335659
75650	698380	3335686	698354	3335670	698405	3335701
75700	698353	3335728	698328	3335713	698379	3335744
75750	698327	3335771	698302	3335755	698353	3335787
75800	698301	3335814	698276	3335798	698327	3335829
75850	698275	3335856	698250	3335841	698301	3335872
75900	698249	3335899	698224	3335883	698275	3335915
75950	698223	3335942	698198	3335926	698249	3335957
76000	698197	3335984	698171	3335969	698223	3336000
76050	698171	3336027	698145	3336011	698197	3336043
76100	698145	3336070	698119	3336054	698171	3336085
76150	698120	3336113	698094	3336098	698146	3336128
76200	698095	3336156	698069	3336141	698121	3336171
76250	698070	3336200	698044	3336185	698096	3336214
76300	698046	3336243	698020	3336229	698072	3336258
76350	698022	3336287	697996	3336273	698049	3336301
76400	697999	3336332	697972	3336318	698025	3336345
76450	697976	3336376	697949	3336363	698003	3336390
76500	697954	3336421	697927	3336408	697981	3336434
76550	697932	3336466	697905	3336452	697959	3336479
76600	697910	3336511	697883	3336497	697937	3336524
76650	697888	3336555	697861	3336542	697914	3336569
76700	697866	3336600	697839	3336587	697892	3336614
76750	697844	3336645	697817	3336632	697870	3336658
76800	697821	3336690	697795	3336677	697848	3336703
76850	697799	3336735	697773	3336722	697826	3336748

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
76900	697777	3336780	697750	3336767	697804	3336793
76950	697755	3336825	697728	3336812	697782	3336838
77000	697733	3336870	697706	3336856	697760	3336883
77050	697711	3336914	697684	3336901	697738	3336928
77100	697688	3336959	697662	3336945	697715	3336973
77150	697666	3337003	697639	3336990	697692	3337017
77200	697643	3337048	697616	3337034	697669	3337062
77250	697619	3337092	697593	3337078	697646	3337106
77300	697596	3337136	697569	3337122	697622	3337150
77350	697572	3337180	697546	3337166	697599	3337195
77400	697548	3337224	697522	3337210	697575	3337239
77450	697524	3337268	697498	3337254	697551	3337283
77500	697500	3337312	697474	3337297	697526	3337326
77550	697476	3337356	697450	3337341	697502	3337370
77600	697452	3337399	697426	3337385	697478	3337414
77650	697428	3337443	697401	3337429	697454	3337458
77700	697404	3337487	697377	3337473	697430	3337502
77750	697379	3337531	697353	3337516	697406	3337545
77800	697355	3337575	697329	3337560	697382	3337589
77850	697331	3337618	697305	3337604	697357	3337633
77900	697307	3337662	697281	3337648	697333	3337677
77950	697283	3337706	697257	3337691	697309	3337720
78000	697259	3337750	697232	3337735	697285	3337764
78050	697235	3337794	697208	3337779	697261	3337808
78100	697210	3337837	697184	3337823	697237	3337852
78150	697186	3337881	697160	3337867	697213	3337896
78200	697162	3337925	697136	3337910	697188	3337939
78250	697138	3337969	697112	3337954	697164	3337983
78300	697114	3338012	697088	3337998	697140	3338027
78350	697090	3338056	697064	3338042	697116	3338071
78400	697066	3338100	697039	3338086	697092	3338115
78450	697042	3338144	697015	3338129	697068	3338158
78500	697017	3338188	696991	3338173	697044	3338202
78550	696993	3338231	696967	3338217	697020	3338246
78600	696969	3338275	696943	3338261	696995	3338290
78650	696945	3338319	696919	3338305	696971	3338333
78700	696921	3338363	696895	3338348	696947	3338377
78750	696897	3338407	696870	3338392	696923	3338421
78800	696873	3338450	696846	3338436	696899	3338465
78850	696848	3338494	696822	3338480	696875	3338509
78900	696824	3338538	696798	3338523	696851	3338552
78950	696800	3338582	696774	3338567	696826	3338596

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
79000	696776	3338626	696750	3338611	696802	3338640
79050	696752	3338669	696726	3338655	696778	3338684
79100	696728	3338713	696701	3338699	696754	3338728
79150	696704	3338757	696677	3338742	696730	3338771
79200	696679	3338801	696653	3338786	696706	3338815
79250	696655	3338844	696629	3338830	696682	3338859
79300	696631	3338888	696605	3338874	696657	3338903
79350	696607	3338932	696581	3338918	696633	3338947
79400	696583	3338976	696557	3338961	696609	3338990
79450	696559	3339020	696532	3339005	696585	3339034
79500	696535	3339063	696508	3339049	696561	3339078
79550	696511	3339107	696484	3339093	696537	3339122
79600	696487	3339151	696461	3339137	696514	3339165
79650	696464	3339196	696437	3339182	696491	3339209
79700	696441	3339240	696415	3339227	696468	3339254
79750	696419	3339285	696392	3339272	696446	3339298
79800	696397	3339330	696370	3339317	696424	3339343
79850	696376	3339375	696349	3339363	696403	3339388
79900	696355	3339421	696328	3339408	696383	3339433
79950	696335	3339466	696307	3339454	696362	3339479
80000	696315	3339512	696287	3339500	696342	3339524
80050	696295	3339558	696268	3339547	696323	3339570
80100	696276	3339605	696249	3339593	696304	3339616
80150	696258	3339651	696230	3339640	696286	3339662
80200	696240	3339698	696212	3339687	696268	3339708
80250	696222	3339744	696194	3339733	696250	3339755
80300	696203	3339791	696176	3339780	696231	3339802
80350	696185	3339837	696157	3339826	696213	3339848
80400	696167	3339884	696139	3339873	696195	3339895
80450	696148	3339930	696120	3339918	696175	3339942
80500	696127	3339976	696100	3339963	696154	3339988
80550	696105	3340021	696079	3340007	696132	3340034
80600	696083	3340065	696056	3340051	696109	3340079
80650	696059	3340109	696033	3340094	696085	3340124
80700	696034	3340152	696008	3340137	696060	3340168
80750	696008	3340195	695982	3340179	696033	3340211
80800	695981	3340237	695956	3340221	696006	3340254
80850	695953	3340279	695928	3340261	695977	3340296
80900	695924	3340319	695899	3340301	695948	3340337
80950	695893	3340359	695870	3340341	695917	3340377
81000	695862	3340398	695839	3340379	695885	3340417
81050	695830	3340437	695807	3340417	695853	3340456

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
81100	695797	3340474	695775	3340454	695820	3340494
81150	695764	3340512	695742	3340492	695787	3340532
81200	695731	3340549	695709	3340530	695754	3340569
81250	695698	3340587	695676	3340567	695721	3340607
81300	695665	3340624	695643	3340605	695688	3340644
81350	695632	3340662	695610	3340642	695655	3340682
81400	695600	3340700	695577	3340681	695623	3340719
81450	695568	3340739	695545	3340720	695591	3340757
81500	695537	3340778	695513	3340760	695561	3340796
81550	695507	3340818	695483	3340800	695532	3340836
81600	695478	3340859	695454	3340842	695503	3340876
81650	695451	3340900	695425	3340884	695476	3340917
81700	695424	3340943	695398	3340927	695449	3340958
81750	695398	3340986	695372	3340971	695424	3341001
81800	695374	3341029	695347	3341015	695400	3341044
81850	695350	3341073	695323	3341059	695377	3341087
81900	695328	3341118	695301	3341105	695355	3341131
81950	695306	3341163	695279	3341151	695334	3341176
82000	695286	3341209	695259	3341197	695314	3341221
82050	695267	3341255	695239	3341244	695295	3341266
82100	695250	3341302	695221	3341292	695278	3341312
82150	695233	3341349	695204	3341339	695261	3341359
82200	695217	3341397	695189	3341388	695246	3341406
82250	695203	3341445	695174	3341436	695232	3341453
82300	695190	3341493	695161	3341485	695219	3341500
82350	695178	3341541	695149	3341535	695207	3341548
82400	695168	3341590	695138	3341584	695197	3341596
82450	695158	3341639	695129	3341634	695188	3341645
82500	695150	3341689	695120	3341684	695180	3341693
82550	695143	3341738	695113	3341734	695173	3341742
82600	695137	3341788	695108	3341785	695167	3341791
82650	695133	3341838	695103	3341835	695163	3341840
82700	695130	3341888	695100	3341886	695160	3341889
82750	695128	3341938	695098	3341937	695158	3341938
82800	695127	3341988	695097	3341987	695157	3341988
82850	695127	3342038	695098	3342038	695157	3342037
82900	695129	3342087	695099	3342088	695159	3342087
82950	695131	3342137	695101	3342138	695161	3342136
83000	695132	3342187	695102	3342188	695162	3342186
83050	695134	3342237	695104	3342238	695164	3342236
83100	695136	3342287	695106	3342288	695166	3342286
83150	695137	3342337	695107	3342338	695167	3342336

Chainage	Centre Line		Left PROW		Right PROW	
	Easting	Northing	Easting	Northing	Easting	Northing
83200	695139	3342387	695109	3342388	695169	3342387
83250	695139	3342437	695109	3342437	695169	3342437
83300	695139	3342487	695109	3342487	695169	3342488
83350	695137	3342537	695107	3342536	695167	3342539
83400	695134	3342587	695104	3342585	695163	3342589
83450	695129	3342637	695099	3342634	695159	3342640
83500	695124	3342687	695094	3342683	695153	3342690
83550	695117	3342736	695087	3342732	695146	3342741
83600	695109	3342786	695079	3342780	695138	3342791
83650	695099	3342835	695070	3342829	695129	3342841
83700	695089	3342884	695059	3342877	695118	3342890
83750	695077	3342932	695048	3342925	695106	3342940
83800	695064	3342980	695035	3342972	695093	3342989
83850	695050	3343028	695021	3343019	695078	3343037
83900	695034	3343076	695006	3343066	695063	3343086
83950	695018	3343123	694990	3343113	695046	3343133
84000	695000	3343170	694972	3343159	695028	3343181
84050	694981	3343216	694953	3343204	695009	3343228
84100	694961	3343262	694934	3343250	694988	3343274
84150	694940	3343307	694913	3343294	694967	3343320
84200	694917	3343352	694891	3343338	694944	3343366
84250	694894	3343396	694868	3343382	694920	3343410
84300	694870	3343440	694844	3343425	694895	3343455
84350	694844	3343483	694818	3343467	694870	3343498
84400	694818	3343526	694793	3343510	694844	3343541

Note: For WSA line joining successive Co-ordinate is considered straight.

Annex – III

(Schedule-A)

Alignment Plans:

The alignment of the Project Highway is enclosed in alignment plan. Finished road level indicated in the alignment plan shall be treated as an approximate assessment. The contractor shall design the road profile of the project highway based on site/design requirement specified in Schedule-D.

Annex – IV**(Schedule-A)****Environment and Forest Clearances**

Sr	Clearances	Present Status
1	Environmental Clearance	The environmental clearance proposal for the project has been submitted to MoEFCC vide proposal no. IA/HR/NCP/221492/2021. The TOR of the project has been approved and received vide file no. 10/33/2021-IA.III dated 22/09/2021 from MoEFCC. Environmental Clearance is under progress.
2	Forest Clearance	Alignment of the project is passing through protected forest (Strip plantation along cross roads & canal) Proposal for diversion of 3.644 hectare of forest land submitted for approval. Joint site visit along with forest officials completed. Approval process is in progress.

SCHEDULE – B**DEVELOPMENT OF THE PROJECT HIGHWAY****1. Development of the Project**

Development of the Project Highway shall include construction of the project as described in this **Schedule B** and in **Schedule C**.

2. Project Highway (6 lane)

2.1. Construction of six lane access-controlled highway starting near Saharanpur (Vill - Ranipur Barsi) Design Chainage 45+500 to Ambala district (Vill – Adhoya Musalmana) at Design Chainage 84+400 in the state of Uttar Pradesh and Haryana on Engineering Procurement Construction Mode under Bharatmala Pariyojana as described in Annex-I of **Schedule-B** and in **Schedule-C**.

2.2. The Project Highway shall be designed and constructed in conformity with the Specifications and Standards specified in **Schedule-D**.

Annex – I**(Schedule-B)****DESCRIPTION OF DEVELOPMENT****1. Width of Carriageway**

1.1. Main Highway: The Paved Carriageway for main carriageway shall be as indicated in **Appendix B-I(A)** of this **Schedule B**.

1.2. Loops/Ramps: The Paved Carriageway for loops and ramps at interchanges shall be as indicated in **Appendix B-I(B)** of this **Schedule B**.

1.3. Cross road /Vehicular Overpass: The Paved Carriageway shall be as indicated in **Appendix B- I(C)** of this **Schedule B**.

1.4. The entire cross-sectional elements shall be accommodated in the available/ proposed ROW. If required, suitable retaining structures shall be provided to accommodate the highway cross section within the available/proposed ROW and the same shall not constitute a Change of Scope.

1.5. Except as otherwise provided in this Agreement, the width of the paved carriageway and cross- sectional features shall confirm to above clauses.

Note: -

a) In addition to width of paved carriageway mentioned in clauses above, additional lane/lanes shall be given as acceleration/deceleration lane and taper for Loops/Ramps to the required length shall be provided at interchange locations as per Specifications.

b) In addition to width of paved carriageway mentioned in clause above, at RE wall and Retaining wall locations the width of paved carriageway and edge strip shall be as given in the corresponding TCS.

2. Project Facilities

Project facilities shall be constructed in conformity with **Annex-I of Schedule- C**.

3. Specifications and Standards

The Project shall be constructed in conformity with the Specifications and Standards specified in **Schedule-D**.

4. Other Features of Project Highway

4.1. Geometric Design and General Features

Geometric design and general features of the Project Highway shall be in accordance with Section 2 of the Manual.

4.2. Design Speed

The design speed of the Highway shall be 100 km per hour. Design speed of Service Road, Ramps/Roundabout and cross roads at interchanges shall be as per Schedule D.

4.3. Improvement of the Existing Road Geometrics

In the following sections, where improvement of the existing road geometrics to the prescribed standards is not possible, the existing road geometrics shall be improved to the extent possible within the given right of way and proper road signs and safety measures shall be provided:

S. no.	Stretch		Length (km)	Type of deficiency	Remarks
	From	To			
NIL					

The existing geometry of the crossroads at Vehicular overpass location and cross roads at Interchange location shall be improved as specified in this schedule and **Schedule D**.

4.4. Right of Way

Details of the Right of Way are given in Appendix B-IV of this schedule.

4.5. Type of Shoulders

For main carriageway earthen shoulders of 3.0 m width shall be provided on either side of the carriageway. The earthen shoulder shall be stabilized with cement/suitable admixtures to prevent erosion as well as to provide a stable platform for occasional parking of errant vehicles. Hard earthen shoulders shall meet the following strength parameters.

- a) Unconfined compressive strength (UCS) equivalent to the strength defined for the bound sub-base layer as per IRC: 37.
- b) CBR of laboratory mix at 97% MDD and 7 days cure+7 days soak: Minimum CBR 60.

For other sections, earthen shoulders shall be covered with 200mm thick compacted granular material. Design and specifications shall conform to the requirements specified in the manual.

4.6. Lateral and Vertical Clearances at Flyovers/Underpasses/Interchanges

The lateral and vertical clearances of all flyover/ Underpasses shall be as given in this schedule.

4.7. Lateral and Vertical Clearances at Overpasses

The lateral and vertical clearances of all Overpasses shall be as given in this schedule.

4.8. Connecting Roads

Connecting Roads shall be constructed as indicated in **Appendix B- III (A)**.

4.9. Grade Separated Structures

a) Grade separated structures shall be provided as given in Appendix B- V, Appendix B- VI, Appendix B- VII (A), Appendix B- VII (B) and Appendix B- VII (C).

b) In the case of grade separated structures, the type of structure and the level of the Project Highway and the cross roads shall be as specified in Appendices given above and Appendix B-II of this schedule.

4.10. Vehicular Underpass (VUP)/Light Vehicular Underpass (LVUP)/Overpass

a) Vehicular underpasses shall be constructed as given in **Appendix B-VII (A)**

b) Overpass shall be constructed as given in **Appendix B- VII (B)**

c) Light vehicular underpasses shall be constructed as given in **Appendix B-VII (C)**

4.11. Typical Cross Sections

a) The Project Highway shall be constructed to 6 lanes fully access controlled Highway configuration without paved shoulders and with or without connecting Roads. Typical cross sections for different segments of the project Highway shall be as **Appendix B-I (A)**.

b) The Loops/Ramps of Interchanges shall be constructed with the lane configuration except toll plaza as given in **Appendix B-I (B)**. At toll plaza location, the lane width shall be as per lane requirement and taper.

c) The cross road at vehicular overpass locations shall be constructed with lane configuration as given in **Appendix B-I (C)**.

4.12. Alignment Plan and Longitudinal Section

An alignment plan and vertical profile of complete project highway including interchanges along with their ramps & loops is given at **Appendix B-II** in soft copy.

4.13. Intersections and Grade Separators

All intersections and grade separators shall be as per Section 3 of the manual and as given in **Appendix B-V** of this Schedule.

The Project Highway shall be constructed as fully access controlled highway configuration and no at grade intersection will be permissible with highway. Interchanges shall be constructed at locations and as per layouts given in **Appendix B-V** and structures for interchange shall be constructed as given in **Appendix B- VI** of this Schedule.

The cross roads underneath the Flyovers, Underpasses shall be treated as at grade intersection. These junctions of the crossroads shall be developed as at-grade intersection as per requirement stipulated in the manual, layouts given in **Appendix B-II** and typical layout drawings as per MoRT&H type Design.

4.14. Road Embankment and Cut Section

The height of the embankment shall be measured with respect to the Finished Road Levels. No section of the highway in general shall be overtopped. The finished pavement profile of main carriageway for the total project length shall be designed so that the bottom of the sub grade is minimum 1.0m above the Highest Flood Level (HFL)/ High water table /NGL/Pond level subject to bottom of subgrade is 1mtr below the general ground level and for service road, top of subgrade is not less than 1.0m high above HFL/ High water table /NGL/Pond level. The Construction of new road embankment/cuttings shall conform to the Specifications and Standards given in Manual and the specified cross-sectional details.

4.15. Pavement Design

Pavement design shall be carried out in accordance with Section-5 of the IRC: SP: 87-2019, IRC 37 & IRC 58.

4.15.1. Type of Pavement

- a) Flexible pavement shall be provided for main carriageway including loops/ramps at interchange locations for the entire length of project highway.
- b) Rigid Pavement shall be provided at Toll Plaza locations.

4.15.2. Design Period and Strategy

- a) Flexible pavement shall be constructed for the entire length of Project Corridor including slip/service roads to wayside amenities and excluding Toll Plaza. Flexible pavement shall be designed for a minimum design period of 20 years minimum MSA and pavement crust shall be specified in section 4.15.3 of this schedule.
- b) Rigid pavement shall be designed for a design period of 30 years.
- c) Stage construction shall not be permitted.

4.15.3. Design Requirements

Notwithstanding anything to the contrary contained in this Agreement or the IRC: SP: 87-2019, the Concessionaire shall design the pavement of main carriageway, loop/ramp/connecting road at interchange locations for a minimum subgrade CBR of 8% and

for service road/slip road minimum subgrade CBR of 8%. The pavement at Toll Plaza locations shall be designed as Rigid Pavement.

In order to meet the intended functional requirement of respective pavement layers the minimum thickness of respective pavement layers in no case be less than as given below:

Main carriageway including Loops, Ramps of Interchanges								
Section	Chainage		MSA	Minimum Crust Thickness (mm)*				
	From	To		BC	DBM	AIL	CTSB	CTB
Main Carriageway	45+500	84+400	110	50	70	100	100	200

Connecting/Service/ Slip road/ Crossroads at Interchange/ Grade Separator			
Section	Chainage		MSA
	From	To	
Service Road	50+040	50+310	20
	51+630	51+770	20
	53+460	53+800	20
	68+730	69+330	20
	72+233	72+695	20
	74+870	75+080	20
	75+510	75+770	20
Ramps			110
Loops			110
Cross Road/Connecting roads at Interchanges			100
Connecting roads at other locations			20

*BC – Bituminous concrete; DBM - Dense Bituminous Macadam; AIL- Aggregate Inter Layer; CTSB – Cement Treated Sub base; CTB – Cement Treated Base

Pavement Composition	Pavement Type	Min. Crust Thickness (mm)
Pavement Quality Concrete (PQC)	Rigid	300
Dry Lean Concrete (DLC)		150
Granular Sub-base (GSB)		200

Toll plaza and its approaches		
Pavement Composition	Pavement Type	Min. Crust Thickness (mm)
Pavement Quality Concrete (PQC)	Rigid	300
Dry Lean Concrete (DLC)		150
Granular Sub-base (GSB)		200

Note: De-bonding interlayer of polythene sheet having a minimum thickness of 125 micron is recommended separation layer between DLC and PQC.

4.15.4. Reconstruction of Stretches

The following stretches of the existing road shall be reconstructed. These shall be designed as new pavement.

Sl.no	Design Chainage		Length (m)	Remarks
	From	To		
1	49+991	50+141	150	Reconstruction due to VUP at 50+066
2	57+073	57+223	150	Reconstruction due to VUP at 57+148
3	60+904	61+054	150	Reconstruction due to IC at 60+979
4	66+432	66+582	150	Reconstruction due to VUP at 66+507
5	76+232	76+382	150	Reconstruction due to VUP at 76+307
6	80+879	81+029	150	Reconstruction due to VUP at 80+954
7	82+396	82+546	150	Reconstruction due to VUP at 82+471

For other sections, concessionaire shall assess the condition of existing pavement during execution and the overlay/reconstruction requirements shall be decided accordingly as per manual for the MSA specified in 4.15.3. All intersecting roads where underpasses and interchange are provided shall be made good within ROW as per existing condition of pavement and traffic.

4.16. Roadside Drainage

In addition to the provisions given in TCS, adequate Drainage system including surface and subsurface drains and median drainage system shall be provided as per Schedule D. At Cross roads/Connecting roads/other locations necessary drainage arrangements shall be provided as per site condition and the same shall not constitute a Change of Scope.

4.17. Design of Structures

4.17.1. General

a) All bridges, culverts and structures shall be designed and constructed in accordance with Section 7 of the Manual and shall conform to the cross-sectional features and details specified in **Appendices of this Schedule B**.

b) Width of the carriageway of bridges and structures shall be as specified in appendices given above.

4.17.2. Culverts

a) The minimum overall width of all culverts shall be equal to the roadway width of the approaches.

b) All culverts shall be designed and constructed in accordance with Section 7 of the Manual and shall conform to the cross-sectional features and details

specified in **Appendix B-IX (A), Appendix B-IX (B), Appendix B-IX (C) and Appendix B-IX (D)** in this schedule.

c) Floor protection works shall be as specified in the relevant IRC Codes and Specifications.

4.17.3. Bridges

A. Existing Bridges to be Re- constructed/Widened

a) The existing bridges at the following locations shall be re-constructed as new Structures.

Sl. No	Bridge location (Ch)	Salient details of existing bridge	Adequacy or otherwise of the existing waterway, vertical clearance, etc.
Nil			

b) The following narrow bridges shall be widened:

Sl. No.	Location (Ch)	Existing width(m)	Extent of widening(m)	Cross-section at deck level for widening
Nil				

B. New Bridges/Structures

New bridges/ structures shall be constructed as mentioned in **Appendix B-VIII (A), Appendix B-VIII (B), Appendix B-IX (A) and Appendix B-IX (B)** in this schedule

C. The railings of existing bridges shall be replaced by crash barriers at the following locations:

S. no.	Location in Km	Remarks
nil		

D. Repairs/replacements of railing/parapets of the existing bridges shall be undertaken as follows:

S. no.	Location in Km	Remarks
nil		

E. Drainage System for Bridge Decks

An effective drainage system for bridge decks shall be provided as specified in paragraph 6.8 of the Manual.

4.17.4. ROB/RUB

Design, construction and detailing of ROB/RUB shall be as specified in section 7 of the Manual. Details of ROB/RUBs to be constructed are given at **Appendix B-X**. Following points shall be taken care of:

- a) The proposed span arrangements of the ROB/RUBs are as per availability of railway boundaries/ requirement of the railways.
- b) ROB/RUBs shall be designed, constructed and maintained as per the requirements of Railway authorities. The construction plans shall be prepared in consultation with the concerned railway authority.
- c) The ROB/RUBs shall be constructed and maintained by the Concessionaire under supervision of the Railways.
- d) All expenditure related to construction, maintenance and supervision of ROB/RUBs (except P&E charges) shall be borne by the Concessionaire.

4.18. Grade Separated Structures

The grade separated structures shall be provided at the locations and of the type and length specified in this Schedule.

4.19. Repairs and Strengthening of Bridges and Structures

The existing bridges and structures to be repaired/ strengthened, and the nature and extent of repairs /strengthening required are given below:

Bridges		
Sl. No.	Location	Nature and extent of repairs to be carried out
NIL		

ROB / RUB		
Sl. No.	Location of ROB/RUB(Ch)	Nature and extent of repairs /strengthening to be carried out
NIL		

Overpasses/Underpasses and other structures		
Sl. No.	Location of Structure (Ch)	Nature and extent of repairs/strengthening to be carried out
NIL		

4.20. List of Bridges and Structures

The list of Bridges, structures, Flyovers, Underpasses and Overpasses are as given above and in Appendices in this Schedule.

4.21. Traffic Management Systems

In addition to the list given in **Appendix-B-XIV**, Advance Traffic Management System shall be provided per **Schedule D**.

4.22. Roadside Furniture

Roadside furniture shall be provided as mentioned in Schedule C.

4.23. Compulsory Afforestation

Median plantation, compulsory afforestation shall be as given Schedule 'C'

4.24. Hazardous Locations

The safety measures shall be provided as given in Schedule C. In addition to Schedule C, additional location as directed by IE/NHAI shall be identified and provided in accordance to Manual and the same shall not constitute a Change of Scope.

4.25. Retaining Structures

RCC Retaining Wall/Reinforced Earth Retaining structures/Toe wall shall be constructed to accommodate the cross section within Right of Way as mentioned in **Appendix-B-XII** and in accordance with Schedule D.

4.26. Slope Protection

The side slopes shall be protected by using suitable slope protection measures wherever required in accordance with Schedule D.

4.27. Reconstruction/ Realignment of Minor Nalla/ Drain and Canal

The minor nalla/drain and canals shall be realigned and constructed as given in **Appendix B-XIII**.

4.28. Ground Improvement

Ground Improvement, wherever required, shall be done as per Schedule D and the same shall not constitute a Change of Scope.

4.29. Fencing/ Boundary Wall

RCC boundary wall shall be provided along the entire length on either side (including transverse requirements at structure locations) as per typical layout drawing as mentioned in **Schedule C**.

4.30. Utilities

A minimum 2m wide strip of land at the extreme edge of ROW shall be kept for accommodating utilities. Utility duct shall be provided as shown in TCS and mentioned in **Schedule B & Schedule D**.

4.31. Emergency Crossover

Emergency crossovers shall be provided in accordance to Manual.

4.32. Overhead Signs

In addition to the list given in **Appendix B-XV**, signs shall be provided per **Schedule D**.

4.33. Utilities Shifting

Shifting of obstructing existing utilities indicated in Schedule A to an appropriate location in accordance with the standards and specifications of concerned Utility Owning Department is part of the scope of work of the Contractor. The bidders may visit the site and assess the quantum of shifting of utilities for the project before submission of their bid. Copy of utility relocation plan is enclosed in **Appendix B-II**. The specifications of concerned Utility Owning Department shall be applicable and followed. Brief details of shifting of utilities are given in **Appendix B-XVI**.

4.34. Change of Scope

The length of structures and bridges specified hereinabove shall be treated as an approximate assessment. The proposed span arrangement of structures may be changed based on innovative design of structure, latest construction techniques and aesthetics of structures. Actual lengths of structures and bridges as required on the basis of detailed investigations shall be determined by the Concessionaire in accordance with the Specifications and Standards. Existing water bodies like ponds, lakes etc., which are to be preserved from environment impact mitigation point of view, shall be bridged to the extent of full ponding level at peak rainy season as per requirement of EMP submitted to MoEF&CC at the time of Environmental Clearance. Any variations in the lengths specified in this Schedule-B shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 16.

Appendix B-I (A)

Applicable Stretches of Typical Cross Section					
Sr.No.	Design Chainage		Length (m)	Description	TCS Type
	From	To			
1	45+500	45+786	286.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
2	45+786	46+794	1008.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
3	46+794	47+671	877.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
4	47+671	47+789	118.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
5	47+789	48+989	1200.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
6	48+989	49+017	28.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
7	49+017	49+800	783.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
8	49+800	49+866	66.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
9	49+866	50+052	186.00	TYPICAL CROSS SECTION FOR 6-LANE APPROCH AT VUP/BRIDGE/ROB	TCS-3
10	50+052	50+080	28.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
11	50+080	50+266	186.00	TYPICAL CROSS SECTION FOR 6-LANE APPROCH AT VUP/BRIDGE/ROB	TCS-3
12	50+266	50+330	64.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
13	50+330	51+041	711.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
14	51+041	51+059	18.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
15	51+059	53+480	2421.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
16	53+480	53+792	312.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
17	53+792	53+874	82.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4

Sr.No.	Design Chainage		Length (m)	Description	TCS Type
	From	To			
18	53+874	54+160	286.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
19	54+160	56+240	2080.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
20	56+240	56+260	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
21	56+260	56+860	600.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
22	56+860	56+967	107.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
23	56+967	56+985	18.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
24	56+985	57+135	150.00	TYPICAL CROSS SECTION FOR 6-LANE APPROACH AT VUP/BRIDGE/ROB	TCS-3
25	57+135	57+162	27.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
26	57+162	57+292	130.00	TYPICAL CROSS SECTION FOR 6-LANE APPROACH AT VUP/BRIDGE/ROB	TCS-3
27	57+292	57+356	64.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
28	57+356	57+384	28.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
29	57+384	57+410	26.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
30	57+410	58+600	1190.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
31	58+600	58+916	316.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
32	58+916	59+094	178.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
33	59+094	59+320	226.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
34	59+320	59+710	390.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1

Sr.No.	Design Chainage		Length (m)	Description	TCS Type
	From	To			
35	59+710	59+922	212.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
36	59+922	59+942	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
37	59+942	60+779	837.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
38	60+779	60+921	142.00	TYPICAL CROSS SECTION FOR 6-LANE APPROCH AT VUP/BRIDGE/ROB	TCS-3
39	60+921	61+037	116.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
40	61+037	61+179	142.00	TYPICAL CROSS SECTION FOR 6-LANE APPROCH AT VUP/BRIDGE/ROB	TCS-3
41	61+179	61+200	21.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
42	61+200	61+970	770.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
43	61+970	61+990	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
44	61+990	64+094	2104.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
45	64+094	64+114	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
46	64+114	64+565	451.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
47	64+565	64+608	43.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
48	64+608	66+270	1662.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
49	66+270	66+307	37.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
50	66+307	66+493	186.00	TYPICAL CROSS SECTION FOR 6-LANE APPROCH AT VUP/BRIDGE/ROB	TCS-3
51	66+493	66+521	28.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
52	66+521	66+641	120.00	TYPICAL CROSS SECTION FOR 6-LANE APPROCH AT VUP/BRIDGE/ROB	TCS-3

Sr.No.	Design Chainage		Length (m)	Description	TCS Type
	From	To			
53	66+641	66+710	69.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
54	66+710	69+295	2585.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
55	69+295	69+315	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
56	69+315	69+330	15.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
57	69+330	72+223	2893.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
58	72+223	72+243	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
59	72+243	73+550	1307.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
60	73+550	73+649	99.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
61	73+649	73+672	23.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
62	73+672	73+740	68.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
63	73+740	76+070	2330.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
64	76+070	76+150	80.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
65	76+150	76+293	143.00	TYPICAL CROSS SECTION FOR 6-LANE APPROACH AT VUP/BRIDGE/ROB	TCS-3
66	76+293	76+321	28.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
67	76+321	76+451	130.00	TYPICAL CROSS SECTION FOR 6-LANE APPROACH AT VUP/BRIDGE/ROB	TCS-3
68	76+451	76+570	119.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
69	76+570	77+700	1130.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1

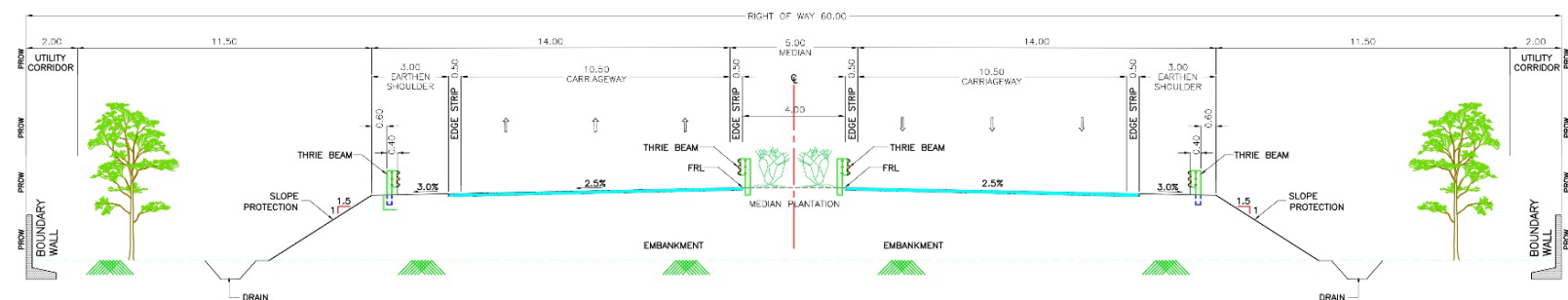
Sr.No.	Design Chainage		Length (m)	Description	TCS Type
	From	To			
70	77+700	77+732	32.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
71	77+732	77+752	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
72	77+752	77+790	38.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
73	77+790	78+810	1020.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
74	78+810	78+840	30.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
75	78+840	78+870	30.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
76	78+870	78+904	34.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
77	78+904	78+924	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
78	78+924	79+010	86.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
79	79+010	80+681	1671.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
80	80+681	80+709	28.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
81	80+709	80+720	11.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
82	80+720	80+754	34.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
83	80+754	80+910	156.00	TYPICAL CROSS SECTION FOR 6-LANE APPROCH AT VUP/BRIDGE/ROB	TCS-3
84	80+910	80+968	58.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
85	80+968	81+124	156.00	TYPICAL CROSS SECTION FOR 6-LANE APPROCH AT VUP/BRIDGE/ROB	TCS-3
86	81+124	81+165	41.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2

Sr.No.	Design Chainage		Length (m)	Description	TCS Type
	From	To			
87	81+165	81+453	288.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
88	81+453	81+473	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
89	81+473	82+240	767.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
90	82+240	82+300	60.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
91	82+300	82+447	147.00	TYPICAL CROSS SECTION FOR 6-LANE APPROACH AT VUP/BRIDGE/ROB	TCS-3
92	82+447	82+495	48.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
93	82+495	82+651	156.00	TYPICAL CROSS SECTION FOR 6-LANE APPROACH AT VUP/BRIDGE/ROB	TCS-3
94	82+651	82+750	99.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
95	82+750	83+120	370.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
96	83+120	83+140	20.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
97	83+140	83+196	56.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
98	83+196	83+234	38.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
99	83+234	83+250	16.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
100	83+250	83+350	100.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE	TCS-2
101	83+350	83+485	135.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1
102	83+485	83+505	20.00	TYPICAL CROSS SECTION FOR 6-LANE FLYOVER/VUP/LVUP//BRIDGE//ROB	TCS-4
103	83+505	84+400	895.00	TYPICAL CROSS SECTION FOR 6-LANE HIGHWAY IN EMBANKMENT	TCS-1

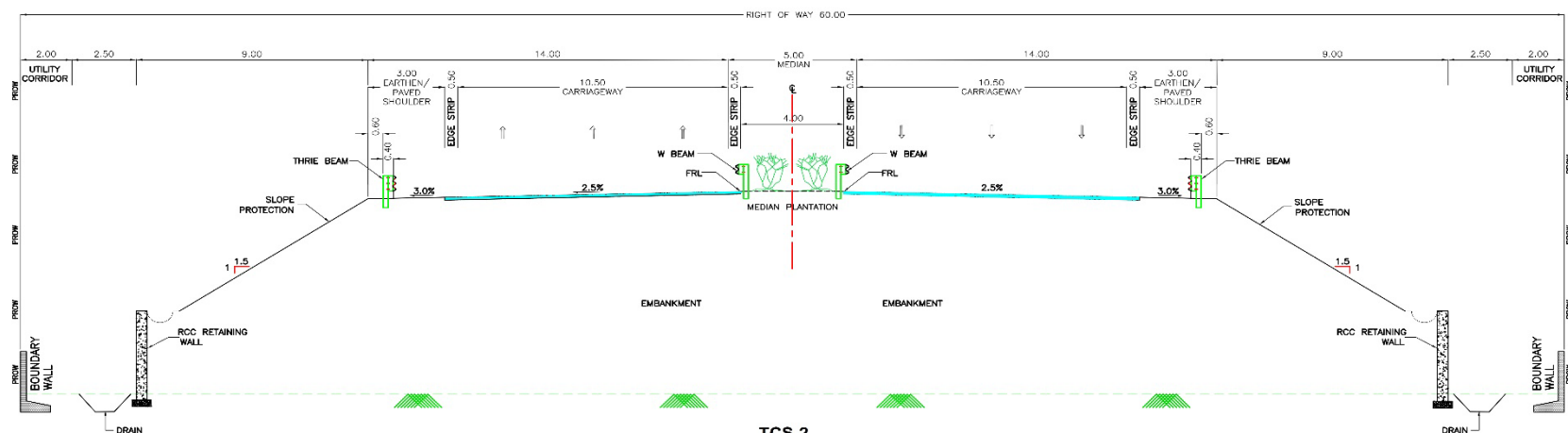
Note:

- i. The lane configuration and width of all structures shall be as per respective paragraph appendices of this schedule.

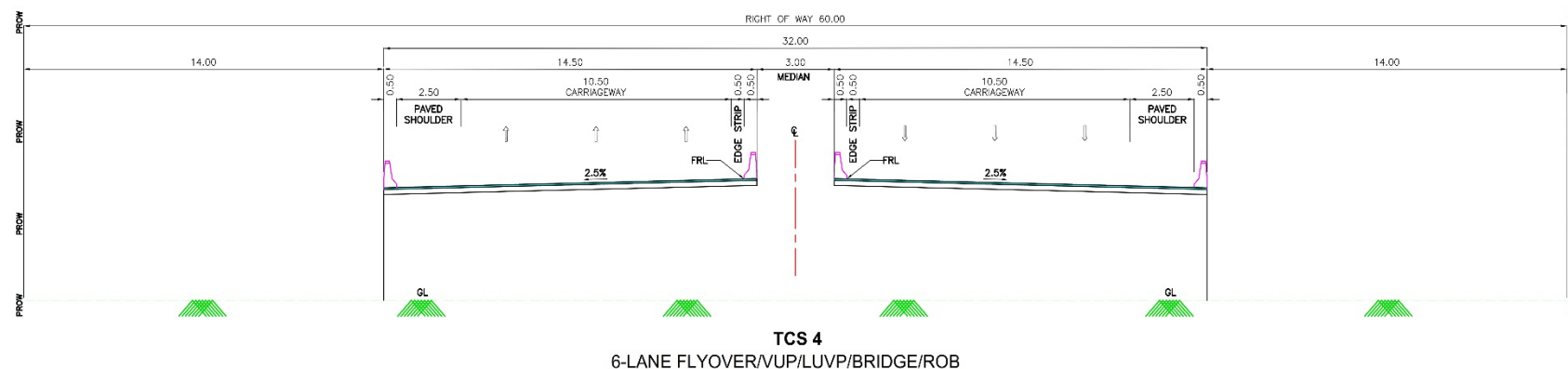
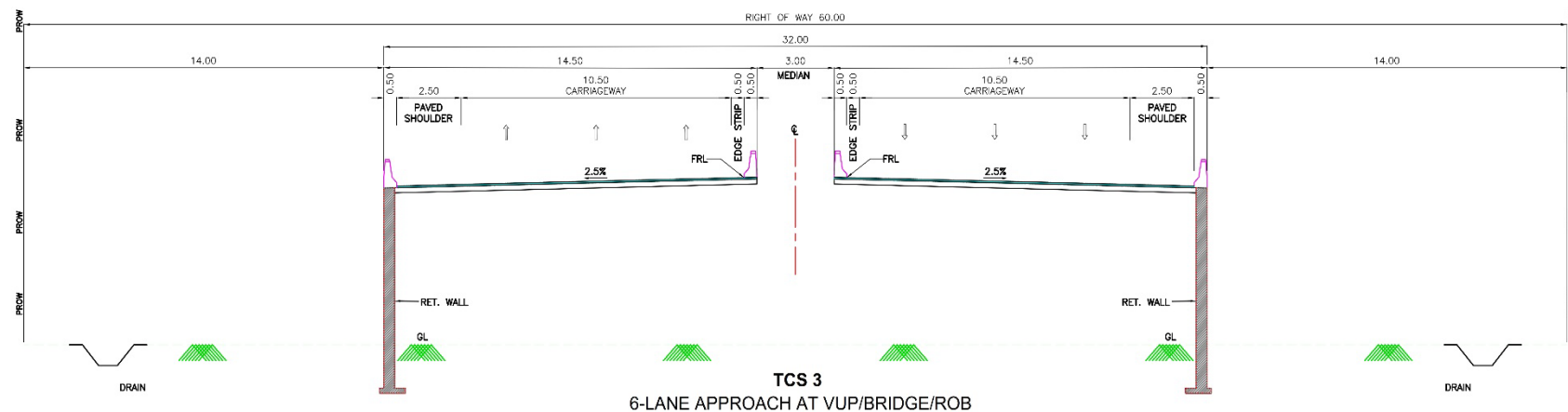
- ii. If the paved carriageway width of structure is more than the carriageway width of approaches, then proper pavement tapering (as per manual) shall be provided.
- iii. TCS schedule as given above shall be treated as an approximate assessment. Actual length of the TCS schedule shall be prepared by the Concessionaire based on detailed investigations and site requirements. Any variation in length of respective TCS specified in Schedule B shall not constitute a change of scope, save and except any variations in the design length arising out of a change of scope expressly undertaken in accordance with the provisions of Article 16.

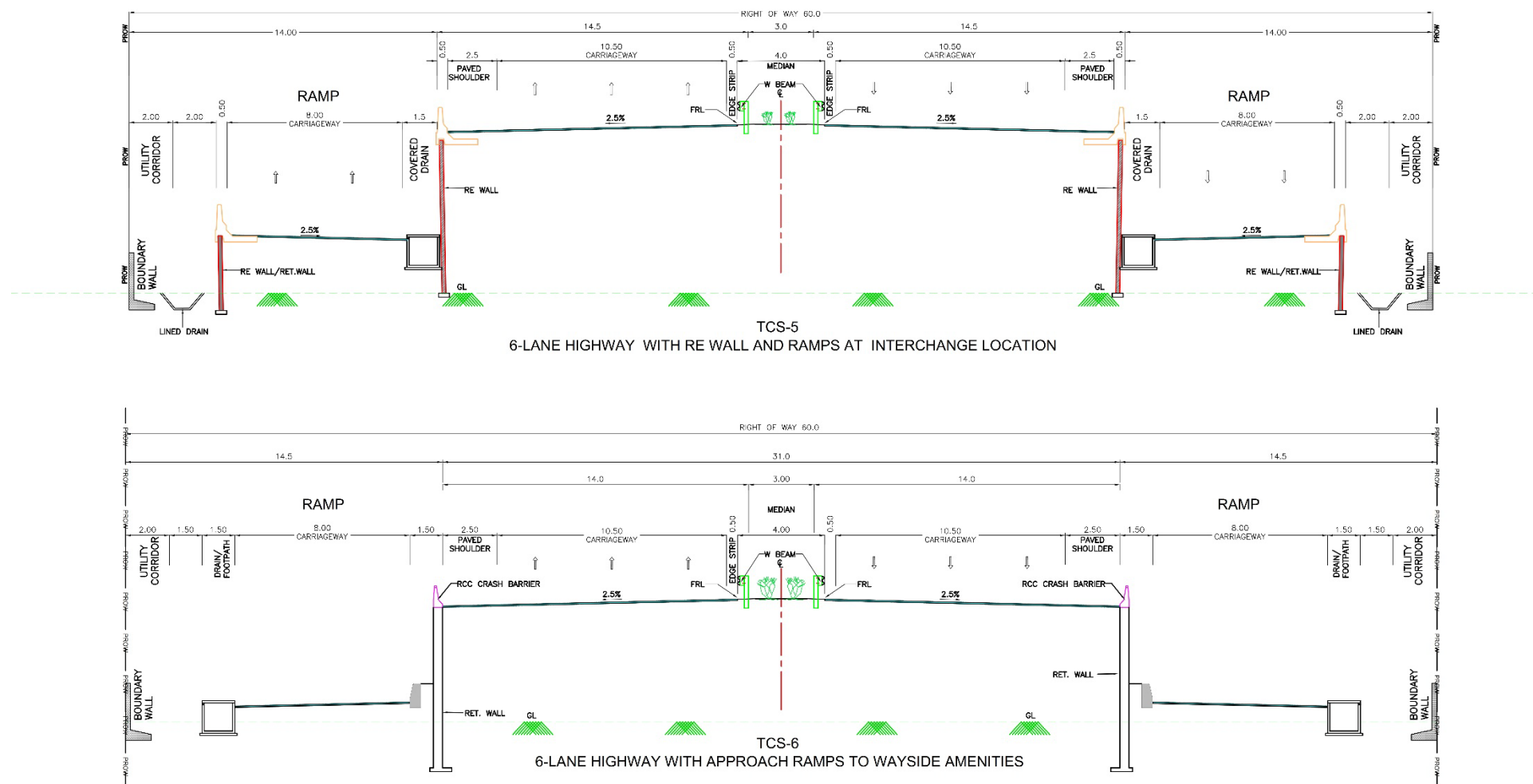


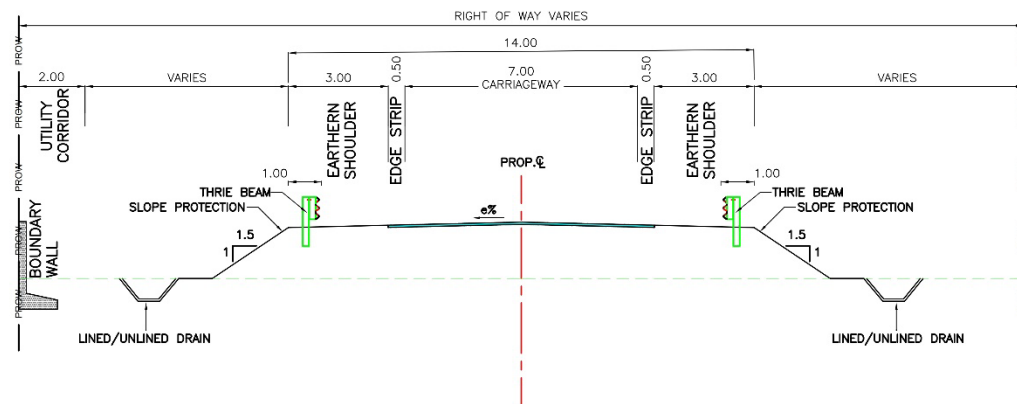
TCS-1
6-LANE HIGHWAY IN EMBANKMENT



TCS-2
6-LANE HIGHWAY IN EMBANKMENT WITH RETAINING STRUCTURE







TCS-7
2-LANE DIRECTIONAL/ SEMI DIRECTIONAL LOOP/RAMP WITH 3M EARTHEN SHOULDER AT INTERCHANGE

Appendix B-I (C)**Applicable Stretches of Typical Cross Section (Crossroad at VOP location)**

The cross road at vehicular overpass locations shall be constructed to the lane configuration as given below:

Location of VOP	Chainage		Length (km)	TCS type
	From	To		
NIL				

Note:

- a) *The width of structures shall be constructed as per respective clauses/ appendices mentioned in this schedule.*

Appendix B-II

Following drawings are enclosed in digital form marked as Appendix B-II

- a) Alignment Plan & Longitudinal Profile.
- b) GAD of Structures
- c) Traffic Signage Plan
- d) Utility Relocation Plan

Appendix B-III (A)

DETAILS OF SERVICE ROAD AND CONNECTING ROADS

A. SERVICE ROAD

Sl. No	LHS				RHS			
	From	To	Length (m)	Width (m)	From	To	Length (m)	Width (m)
1	50+040	50+310	270	5.5	51+630	51+770	140	5.5
2	53+460	53+800	340	5.5	53+460	53+800	340	5.5
3	72+233	72+695	462	5.5	68+730	69+330	600	5.5
4	75+510	75+770	260	5.5	72+233	72+695	462	5.5
5					74+870	75+080	210	5.5
		Total	1332			Total	1752	

B. Connecting Roads – Main Highway

S. no.	Chainage (km)		Length (m)	Side	Connecting road
	From	To			
			Nil		

C. Connecting roads – Interchange location

Sl. No	Interchange with	Chainage	Length (m)
1	Kurukshetra – Yamunanagar (SH-6)	60+979	4310.667

Note:

- The actual length of the connecting roads shall be determined by the Concessionaire in accordance with IRC: SP: 87-2019 and actual site requirements with approval from the Independent Engineer. Any variations in the length specified in this Clause of Schedule-B shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 16.
- The realignment of existing track to the SVUP/LVUP/VUP/Flyover outside the PROW and connecting roads between consecutive underpasses wherever required as per plan & profile uploaded with bid document and specified in this schedule shall be constructed by the Concessionaire as per site requirement in consultation with Independent Engineer. Any variations in the length specified in this Clause of Schedule-B shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 16.
- Entry and exit approaches with slip road shall be provided for all way side amenities/ truck parking (mentioned in Schedule C) with proper acceleration / deceleration lane. The structures

falling within this stretches shall also be constructed and the same shall not constitute a Change of Scope.

- d) Width of connecting road shall not to be less than the width of the existing road subject to minimum width specified in of IRC: SP: 87-2019.
- e) All structures falling along connecting roads shall widened/reconstructed as per concessionaire design in accordance with manual.

Appendix B-III (B)**Details of cross road at vehicular overpass location**

S. no.	VOP location(km.)	Type of crossing	Length (km)	Carriageway Width Including Paved Shoulder
Nil				

Proper tapering/ matching shall be made with the existing road on both ends. The length of approaches specified herein above shall be treated as approximate assessment. Any variations in the length specified in this Clause of Schedule-B shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 16. Structures shall be constructed as per respective appendix given in this schedule.

Appendix B-IV

DETAILS OF PROPOSED ROW

S. No.	Chainage		Length (m)	Width (m)		Total (m)	Remarks
	Start	End		LHS	RHS		
1	45+500	60+400	14.900	30.00	30.00	60.00	Carriageway
2	60+400	60+500	0.100	30.00	30.30	60.30	Interchange
3	60+500	60+600	0.100	35.50	35.50	71.00	
4	60+600	60+700	0.100	35.50	35.50	71.00	
5	60+700	60+800	0.100	39.40	39.88	79.29	
6	60+800	60+900	0.100	44.54	44.66	89.20	
7	60+900	61+000	0.100	37.95	37.17	75.12	
8	61+000	61+100	0.100	60.35	51.60	111.96	
9	61+100	61+200	0.100	41.03	41.56	82.60	
10	61+200	61+300	0.100	43.63	43.24	86.87	
11	61+300	61+400	0.100	37.57	37.19	74.76	
12	61+400	61+500	0.100	35.79	35.79	71.58	
13	61+500	61+600	0.100	34.42	33.78	68.20	
14	61+600	61+600	0.000	30.00	30.00	60.00	
15	61+600	63+300	1.700	30.00	30.00	60.00	Carriageway
16	63+300	63+600	0.300	230.00	230.00	460.00	WSA
17	63+600	84+400	20.800	30.00	30.00	60.00	Carriageway

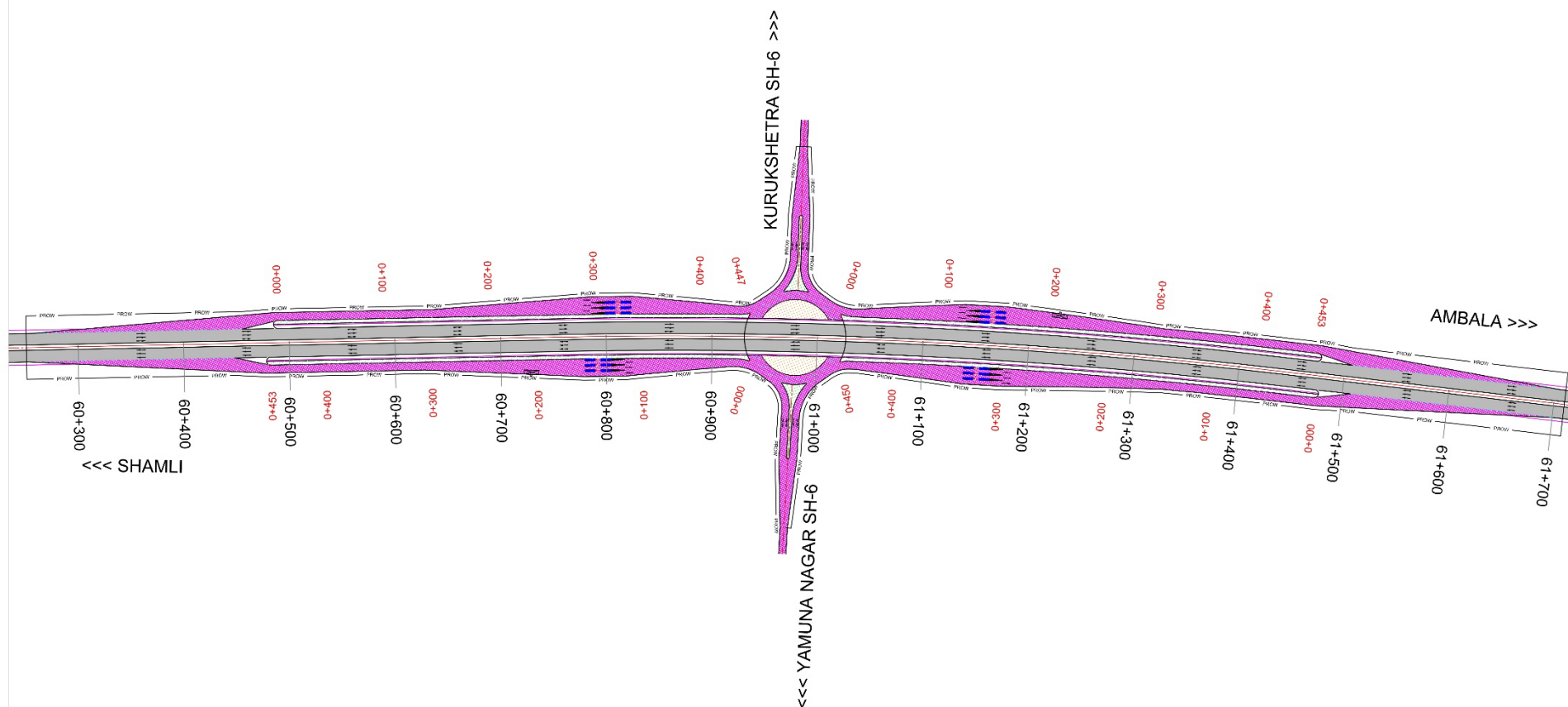
Appendix B-V

MAJOR INTERSECTIONS (INTERCHANGES)

Sl.No	Chainage	Connecting Road	Type of Interchange
1	60+979	Kurukshetra – Yamunanagar (SH-6)	Rotary with Toll Booth on Slip Roads

Note:

- a) Detailed design of all interchange shall be done in accordance with this Schedule, Manual and MoRT&H type design.
- b) Any other junction not mentioned above but observed during the construction of the project shall be improved as per IRC: SP: 87-2019 requirements. The same shall not constitute a Change of Scope, save and except any variations arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 16. However, since the project is access controlled, any additional SVUP/LVUP/VUP at cross road location not provided for in the **Schedule B** but required during the execution of work will be dealt under the provisions of **Article 16**.
- c) The Concessionaire shall take up 'Detailed Engineering study' to ascertain further details of all intersections and treatment of the intersections shall be designed in accordance with the latest guidelines mentioned out in section-3 of IRC: SP: 87-2019. The same shall not constitute a Change of Scope, save and except any variations arising out of a Change of Scope expressly undertaken in accordance with the provisions of **Article 16**.
- d) Junction improvement under grade separators/ interchanges shall be carried out as per IRC: SP:87-2019 and typical layout drawing attached with proper entry/exit and pavement composition as indicated in this **Schedule B**.



Development of Six-Lane Access Controlled Highway from Ranipur Barsi (Saharanpur district) to Adhoya Musalmana (Ambala district) (from Ch. 45+500 to 84+400) of Shamli – Ambala section of Bareilly – Ludhiana Economic Corridor on EPC Mode under Bharatmala Pariyojana Phase-I in the State of Haryana (Package-2).

Appendix B-VI

DETAILS OF FLYOVERS

Sl. No	Chainage	Intersecting Road	Square Span C/C of Exp. Joint (m)	Skew (deg)	Skew Span C/C of Exp.	Length of Structure (m)	Min. Vertical Clearance (m)	Width of Structure (m)
Nil								

Note:

- a) The minimum vertical clearance of all interchange structures shall be 5.5m.
- b) Project Highway is proposed to be constructed to six lane configurations. Special vehicle loading is to be considered in Design of structures. Since, the subject project is Access Controlled therefore Congestion factor is not to be considered in calculation of live load.
- c) Wherever liquefaction is observed in Pile foundation and Raft Structures, Ground improvement shall be done to compact the soil to increase its penetration resistance and satisfy clause 8.4.4 (v) of IRC114.
- d) Any other structures falling within acceleration / deceleration lane /taper shall be constructed to the required width. These changes shall not be treated as change of scope.

Appendix B-VII (A)

DETAILS OF VEHICULAR UNDERPASSES

Sl. No	Chainage	Intersecting Road	Category of Road	Span (Clear Opening) (m)	Skew (deg)	Width of Structure (m)
1	50+066	Karnal - Yamunanagar	Village Road	1x20	43	2x14.5
2	57+148	Dhanaura - Potli	Village Road	1x20	24	2x14.5
3	66+507	Jogi Majra - Dhanupura	Village Road	1x20	29	2x14.5
4	76+307	Alawalpur - Talheri Rangran	Village Road	1x20	28	2x14.5
5	80+954	Adhoya - Kambassi	MDR	1x20	21	2x14.5
6	82+471	SH-4 Shahbaad Markanda - Jagadhri	State Highway	1x40	0	2x14.5

Note:

- a) *The minimum vertical clearance of all VUPs shall be 5.5m.*
- b) *Wherever liquefaction is observed in Pile foundation and Raft Structures, Ground improvement shall be done to compact the soil to increase its penetration resistance and satisfy clause 8.4.4 (v) of IRC114.*
- c) *Project Highway is proposed to be constructed to Six lane configuration. Special vehicle loading is to be considered in Design of structures. Since, the subject project is Access Controlled therefore Congestion factor is not to be considered in calculation of live load.*

Appendix B-VII (B)**DETAILS OF VEHICULAR OVERPASSES**

Sl. No.	Chainage (Km.)	Name of Cross road	Type of structure	Clear Span (m)	Skew Angle	Total length c/c exp. Joint (m)	Deck configuration (m)	Min vertical clearance (m)
Nil								

Appendix B-VII (C)

DETAILS OF LIGHT VEHICULAR UNDERPASSES

Sl. No	Chainage	Intersecting Road	Span (Clear Opening) (m)	Skew Angle (deg)	Width of Structure (m)
1	56+250	Cart Track	1x12	30	2x14.5
2	59+932	Dhaulra - Radaur	1x12	15	2x14.5
3	61+980	Radaur - Sadhura	1x12	19	2x14.5
4	64+104	Bapa - Bubka	1x12	28	2x14.5
5	69+305	Ghillaur Majri - Hartan	1x12	30	2x14.5
6	72+233	Gangori - Gajlana	1x12	30	2x14.5
7	77+742	Talheri - Malakpur	1x12	30	2x14.5
8	78+914	Talheri - Thamber	1x12	0	2x14.5
9	81+463	Kambassi- Adhoya	1x12	13	2x14.5
10	83+495	Raju Kheri - Barara	1x12	7	2x14.5

Note:

- a) *The minimum vertical clearance of all LVUPs shall be 4.0m except LVUP at Ch.78+914 for which minimum vertical clearance of 5.5m.*
- b) *Wherever liquefaction is observed in Raft Structures, Ground improvement shall be done to compact the soil to increase its penetration resistance and satisfy clause 8.4.4 (v) of IRC114.*
- c) *Project Highway is proposed to be constructed to six lane configurations. Special vehicle loading is to be considered in Design of structures. Since, the subject project is Access Controlled therefore Congestion factor is not to be considered in calculation of live load.*

Appendix B-VIII (A)

DETAILS OF MAJOR BRIDGES (OVER RIVERS/STREAMS/NALLAH)

Sl .	Chainage	Name of Stream	Span Arrangement t C/C of Exp. Joint (m)	Total Length C/C of Exp. Joint (m)	Width of Structure (m)	Width of median Opening (m)
1	46+290	Yamuna River	17x60	1020	2x14.5	3
2	47+710	Yamuna Stream	4 x 27.5	110	2x14.5	3

Note:

- a) *The Deck level of the Bridges should be governed by HFL of stream/Navigational HFL and Clearance as per guidelines of Inland Waterways Authority of India.*
- b) *Wherever liquefaction is observed in Pile foundation, Ground improvement shall be done to compact the soil to increase its penetration resistance and satisfy clause 8.4.4 (v) of IRC114.*
- c) *River Training work shall be done according IRC-89 on both side of major bridge Ch. 46+290 with total length of 1160 mtr (minimum), it should be provided with stone boulder pitching with filter media on embankment slope provided with wire crates on upstream side and without wire crates on downstream side.*
- d) *Project Highway is proposed to be constructed to six lane configurations. Special vehicle loading is to be considered in Design of structures. Since the subject project is Access Controlled, therefore, Congestion factor is not to be considered in calculation of live load.*
- e) *Project highway is proposed to be constructed to six lane configuration with provision for widening to ten lane configuration in future. As such, superstructure of all bridges, culverts and structures is to be designed for edge movement of the vehicle considering stitching of new superstructure in future due to widening for additional lane. Special vehicle loading is to be considered in Design of structures.*

Appendix B-VIII (B)

DETAILS OF MAJOR BRIDGES (OVER IRRIGATION CANALS)

Sl. No	Chainage	Name of Stream	Span Arrangement C/C of Exp. Joint (m)	Total Length C/C of Exp. Joint (m)	Skew (deg.)	Width of Structure (m)	Width of median Opening (m)
1	53+833	Augmentation Canal	1x15 + 1x30 + 1x20	65	30	2x14.5	3.00
2	59+005	Western Yamuna Canal	1x35 + 2x50 + 1x35	170	38	2x14.5	3.00

Note:

- a) *The minimum vertical clearance from Canal bund road shall be 4.0 m.*
- b) *The span arrangement and vertical clearance are tentative and the same shall be followed as per approved GAD by the concern Irrigation Authority and any change shall not be treated as change in scope of work.*
- c) *Project Highway is proposed to be constructed to six lane configurations. Special vehicle loading is to be considered in Design of structures. Since the subject project is Access Controlled, therefore, Congestion factor is not to be considered in calculation of live load.*
- d) *Project highway is proposed to be constructed to six lane configuration with provision for widening to ten lane configuration in future. As such, superstructure of all bridges, culverts and structures is to be designed for edge movement of the vehicle considering stitching of new superstructure in future due to widening for additional lane. Special vehicle loading is to be considered in Design of structures.*

Appendix B-IX (A)

DETAILS OF MINOR BRIDGES (OVER RIVERS/STREAMS/NALLAH)

Sl. No	Chainage	Name of Nala	Square Span C/C of Exp.	Skew (deg.)	Width of Structure	Width of median
1	49+003	Stream	1 x 20	0	2 x 14.5	3
2	51+050	Stream	1 x 30	56	2 x 14.5	3
3	56+976	Canal	1 x 10	30	2 x 14.5	3
4	64+586	Nala	2 x 25	30	2 x 14.5	3
5	73+660	Nala	1 x 20	17	2 x 14.5	3
6	83+215	Canal	1 x 30	0	2 x 14.5	3

Note:

- a) *The Deck level of the Bridges should be governed by HFL of stream/Navigational HFL and Clearance as per guidelines of Inland Waterways Authority of India.*
- b) *Wherever liquefaction is observed in Pile foundation, Ground improvement shall be done to compact the soil to increase its penetration resistance and satisfy clause 8.4.4 (v) of IRC114.*
- c) *Project Highway is proposed to be constructed to six lane configurations. Special vehicle loading is to be considered in Design of structures. Since the subject project is Access Controlled, therefore, Congestion factor is not to be considered in calculation of live load.*
- d) *Project highway is proposed to be constructed to six lane configuration with provision for widening to ten lane configuration in future. As such, superstructure of all bridges, culverts and structures is to be designed for edge movement of the vehicle considering stitching of new superstructure in future due to widening for additional lane. Special vehicle loading is to be considered in Design of structures.*

Appendix B-IX (B)**DETAILS OF MINOR BRIDGE CUM LVUP**

Sl. No	Chainage	Name of Bridge	Square Span C/C of Exp. Joint (m)	Skew (deg.)	Width of Structure (m)	Width of median Opening (m)
Nil						

Note:

- a) *The minimum vertical clearance from Canal bund road shall be 4.5m.*
- b) *The span arrangement and vertical clearance are tentative and the same shall be followed as per approved GAD by the concern Irrigation Authority and any change shall not be treated as change in scope of work.*
- c) *Project Highway is proposed to be constructed to six lane configurations. Special vehicle loading is to be considered in Design of structures. Since the subject project is Access Controlled, therefore, Congestion factor is not to be considered in calculation of live load.*

Appendix B-IX (C)

DETAILS OF MINOR BRIDGES OVER GAS/OIL PIPELINES

Sl. No	Chainage	Name of Bridge	Square Span C/C of Exp. Joint (m)	Skew (deg.)	Width of Structure (m)	Width of median Opening (m)
1	57+370	KRNPL Pipe Line	1 x 20	17	2 x 14.5	3
2	80+695	GAIL Pipe Line	1 x 20	51	2 x 14.5	3

Note:

- a) *The minimum vertical clearance from ground level shall be 4.0m.*
- b) *The span arrangement and vertical clearance are tentative and the same shall be followed as per approved GAD by the concern GAS/OIL Authority and any change shall not be treated as change in scope of work.*

Appendix B-X

DETAILS OF ROBs

SI	Design Chainage	Location of crossing	Crossing line	Direction	Railway Chainage	Span C/C of Exp. Joint (m)	Width of Structure (m)	Width of median opening (m)
Nil								

Note:

- The minimum vertical clearance of all ROB structures shall be 6.525m.*
- Wherever liquefaction is observed in Pile foundation, Ground improvement shall be done to compact the soil to increase its penetration resistance and satisfy clause 8.4.4 (v) of IRC114.*
- Project Highway is proposed to be constructed to six lane configurations. Special vehicle loading is to be considered in Design of structures. Since the subject project is Access Controlled, therefore, Congestion factor is not to be considered in calculation of live load.*

Appendix B-XI (A)

DETAILS OF CULVERTS FOR CROSS DRAINAGE**A. Retain with repair of existing culverts**

The existing culverts at the following locations shall be retained with repair:

S. No	Chainage	Type of Culvert	Size	Remarks
			No x Span (m) x Height (m)	
Nil				

B. Reconstruction of existing culverts

The existing culverts at the following locations shall be re-constructed as new culverts:

S. No	Chainage	Type of Culvert	Size	Remarks
			No x Span (m) x Height (m)	
Nil				

C. Widening of existing culverts

All existing culverts which are not to be reconstructed shall be widened to the roadway width of the Project Highway as per the typical cross sections. Repairs and strengthening of existing structures where required shall be carried out.

The existing culverts at the following locations shall be widened as per para 7.3(iii) of the manual.

S. No	Chainage	Type of Culvert	Size	Remarks
			No x Span (m) x Height (m)	
Nil				

D. Additional new culverts

Additional new culverts shall be constructed as per particulars given in the table below for Cross Drainage purpose.

Sl.No	Chainage	Type of Culvert	Size	Remarks
			No x Span (m) x Min. Vent (m)	
Main Carriageway including Service Road, Ramps and connecting roads				
1	46+920	RCC BOX	1 x 4 x 3	New Culvert
2	47+070	RCC BOX	1 x 4 x 3	New Culvert
3	47+320	RCC BOX	1 x 4 x 3	New Culvert

Sl.No	Chainage	Type of Culvert	Size	Remarks
			No x Span (m) x Min. Vent (m)	
4	47+490	RCC BOX	1 x 4 x 3	New Culvert
5	48+690	RCC BOX	1 x 2 x 2	New Culvert
6	50+700	RCC BOX	1 x 2 x 2	New Culvert
7	52+770	RCC BOX	1 x 2 x 2	New Culvert
8	55+040	RCC BOX	1 x 3 x 2	New Culvert
9	55+940	RCC BOX	1 x 2 x 2	New Culvert
10	57+980	RCC BOX	1 x 2 x 2	New Culvert
11	58+740	RCC BOX	1 x 6 x 3	New Culvert
12	60+190	RCC BOX	1 x 2 x 2	New Culvert
13	62+460	RCC BOX	1 x 2 x 2	New Culvert
14	63+660	RCC BOX	1 x 2 x 2	New Culvert
15	65+780	RCC BOX	1 x 2 x 2	New Culvert
16	67+610	RCC BOX	1 x 2 x 2	New Culvert
17	70+100	RCC BOX	1 x 2 x 2	New Culvert
18	71+850	RCC BOX	1 x 2 x 2	New Culvert
19	73+030	RCC BOX	1 x 2 x 2	New Culvert
20	74+650	RCC BOX	1 x 2 x 2	New Culvert
21	77+060	RCC BOX	1 x 2 x 2	New Culvert
22	78+370	RCC BOX	1 x 2 x 2	New Culvert
23	80+350	RCC BOX	1 x 2 x 2	New Culvert
24	82+900	RCC BOX	1 x 2 x 2	New Culvert
25	84+160	RCC BOX	1 x 2 x 2	New Culvert

Additional 8 (Eight) no. of pipe culverts of 1 x 1.2 m dia shall be provided for facilitating access to farmers field canal as per the site requirement. Location for such culverts shall be finalized in consultation with Independent Engineer and NHAI.

Note:

- a) *Locations of the above culverts are indicative. Exact location of these culverts shall be decided in consultation with Independent Engineer.*
- b) *The overall width of the above culverts shall be equal to Roadway width (including median) In case of connecting road, culvert also to be provided in the gap between main carriageways and connecting road. In cases of the culverts with fill culvert to be provided though out Roadway width and median width. Any additional length required as per site conditions shall not constitute a Change of Scope.*
- c) *Vent way/Span arrangements are minimum specified. The actual vent way/span arrangements of culverts shall be determined on the basis of*

detailed investigations by the Concessionaire in accordance with the Specifications and Standards. Any variations in vent way/span arrangements specified above shall not constitute a Change of Scope.

Appendix B-XI (B)

LIST OF CULVERTS FOR CONNECTING ROADS/ ROAD CUM DRAIN

Sl. No.	Chainage	Type of Culvert	Size	Type of Crossing
			No x Span (m) x Min. Vent (m)	
1	47+217	RCC BOX	1 x 4 x 3	Cart Track
2	48+897	RCC BOX	1 x 4 x 3	Cart Track
3	49+312	RCC BOX	1 x 4 x 3	Cart Track
4	51+770	RCC BOX	1 x 4 x 3	Cart Track
5	52+337	RCC BOX	1 x 4 x 3	Cart Track
6	53+044	RCC BOX	1 x 4 x 3	Chuck Road
7	54+345	RCC BOX	1 x 4 x 3	Chuck Road
8	54+720	RCC BOX	1 x 4 x 3	Chuck Road
9	55+580	RCC BOX	1 x 4 x 3	Chuck Road
10	58+446	RCC BOX	1 x 4 x 3	Cart Track
11	59+143	RCC BOX	1 x 4 x 3	Chuck Road
12	59+517	RCC BOX	1 x 4 x 3	Chuck Road
13	62+586	RCC BOX	1 x 4 x 3	Chuck Road
14	63+298	RCC BOX	1 x 4 x 3	Chuck Road
15	65+035	RCC BOX	1 x 4 x 3	Chuck Road
16	65+372	RCC BOX	1 x 4 x 3	Cart Track
17	66+051	RCC BOX	1 x 4 x 3	Cart Track
18	67+190	RCC BOX	1 x 4 x 3	Chuck Road
19	68+263	RCC BOX	1 x 4 x 3	Chuck Road
20	70+877	RCC BOX	1 x 4 x 3	Chuck Road
21	71+420	RCC BOX	1 x 4 x 3	Cart Track
22	73+400	RCC BOX	1 x 4 x 3	Chuck Road
23	74+873	RCC BOX	1 x 4 x 3	Chuck Road
24	75+757	RCC BOX	1 x 4 x 3	Cart Track
25	77+256	RCC BOX	1 x 4 x 3	Cart Track
26	79+900	RCC BOX	1 x 4 x 3	Chuck Road
27	81+830	RCC BOX	1 x 4 x 3	Cart Track
28	83+150	RCC BOX	1 x 4 x 3	Cart Track
29	84+289	RCC BOX	1 x 4 x 3	Chuck Road

Note:

- Locations of the above culverts are indicative. Exact location of these culverts are specified as culvert type 1 and shall be decided in consultation with Independent Engineer.*
- The overall width of the above culverts shall be equal to Roadway width (including median) In case of connecting road culvert also to be provided in the gap between main carriageway and connecting road. In cases of the culverts with fill culvert to be provided though out Roadway width and median width. Any*

additional length required as per site conditions shall not constitute a Change of Scope.

- c) *Vent height/Span arrangements are minimum specified. Minimum vent height specified above shall be measured from FRL of cross road. The actual vent height/span arrangements of culverts shall be determined on the basis of detailed investigations by Concessionaire in accordance with the Specifications and Standards. Any variations in vent height/span arrangements specified above shall not constitute a Change of Scope.*

Appendix B-XI (C)

LIST OF CULVERTS FOR INTERCHANGES

Sl.No	Chainage	Type of Culvert	Size	Remarks
			No x Span (m) x Min. Vent (m)	
Nil				

Note:

- Location and number of the above culverts are indicative. Exact location and number of these culverts shall be decided in consultation with Independent Engineer.
- The overall width of the above culverts shall be equal to Roadway width (including median) In case of connecting road culvert also to be provided in the gap between main carriageway and connecting road. In cases of the culverts with fill culvert to be provided though out Roadway width and median width. Any additional length required as per site conditions shall not constitute a Change of Scope.
- Vent way/Span arrangements are minimum specified. The actual vent way/span arrangements of culverts shall be determined on the basis of detailed investigations by the Concessionaire in accordance with the Specifications and Standards. Any variations in vent way/span arrangements specified above shall not constitute a Change of Scope.

Appendix B-XI (D)

LIST OF CULVERTS FOR FIELD CANAL/UTILITY CROSSING

Sl. No	Location	Type of Culvert	Size	Remarks
			No x Dia (m)	
1	78 nos	Hume Pipe	1 x 1.2	New Culvert

Additional 78 (Seventy Eight) no. of Pipe culverts of 1200mm (min) diameter shall be provided across the Highway for local canal/ field canal/ utility crossings as per the site requirement. Location for such culverts shall be finalized in consultation with Independent Engineer and NHAI.

Appendix B-XII

A. Stretches for Provision of Reinforced Earth Wall

Sl. No	Chainage			
	From	To	Length (m)	Side
Main Carriageway				
1	49+866	50+052	186.00	Both Sides
2	50+080	50+266	186.00	Both Sides
3	56+985	57+135	150.00	Both Sides
4	57+162	57+292	130.00	Both Sides
5	60+779	60+921	142.00	Both Sides
6	61+037	61+179	142.00	Both Sides
7	66+307	66+493	186.00	Both Sides
8	66+521	66+641	120.00	Both Sides
9	76+150	76+293	143.00	Both Sides
10	76+321	76+451	130.00	Both Sides
11	80+754	80+910	156.00	Both Sides
12	80+968	81+124	156.00	Both Sides
13	82+300	82+447	147.00	Both Sides
14	82+495	82+651	156.00	Both Sides

B. Stretches for Provision of Retaining Wall

Sl. No	Chainage		Length (m)	Side
	From	To		
1	49+800	49+866	66.00	MCW - Both Sides
2	50+266	50+330	64.00	MCW - Both Sides
3	53+480	53+792	312.00	MCW - Both Sides
4	53+874	54+160	286.00	MCW - Both Sides
5	56+860	56+967	107.00	MCW - Both Sides
6	57+292	57+356	64.00	MCW - Both Sides
7	57+384	57+410	26.00	MCW - Both Sides
8	58+600	58+916	316.00	MCW - Both Sides
9	59+094	59+320	226.00	MCW - Both Sides
10	59+710	59+922	212.00	MCW - Both Sides
11	61+179	61+200	21.00	MCW - Both Sides
12	66+270	66+307	37.00	MCW - Both Sides
13	66+641	66+710	69.00	MCW - Both Sides
14	69+315	69+330	15.00	MCW - Both Sides
15	73+550	73+649	99.00	MCW - Both Sides
16	73+672	73+740	68.00	MCW - Both Sides
17	76+070	76+150	80.00	MCW - Both Sides
18	76+451	76+570	119.00	MCW - Both Sides
19	77+700	77+732	32.00	MCW - Both Sides
20	77+752	77+790	38.00	MCW - Both Sides
21	78+810	78+840	30.00	MCW - Both Sides

Sl. No	Chainage		Length (m)	Side
	From	To		
22	78+870	78+904	34.00	MCW - Both Sides
23	78+924	79+010	86.00	MCW - Both Sides
24	80+720	80+754	34.00	MCW - Both Sides
25	81+124	81+165	41.00	MCW - Both Sides
26	82+240	82+300	60.00	MCW - Both Sides
27	82+651	82+750	99.00	MCW - Both Sides
28	83+120	83+140	20.00	MCW - Both Sides
29	83+250	83+350	100.00	MCW - Both Sides

C. Stretches for Provision of Toe wall

Sl. No	Chainage		Length (m)	Side
	From	To		
Nil				

Note:

- In addition to above RE wall/ retaining wall mentioned above, cross wall shall be provided behind each abutment, if required.
- In addition to above, RE wall/Retaining wall shall be provided at other locations to restrict the embankment slope within the right of way.
- The length specified hereinabove shall be treated as an approximate assessment and minimum. The actual lengths as required on the basis of detailed investigations shall be determined by the Concessionaire in accordance with the Specifications and Standards. Any increase in the lengths specified in this Schedule-B shall not constitute a Change of Scope, save and except any variations arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 16.

Appendix B-XIII

STRETCHES FOR REALIGNMENT OF NALLA/DRAIN/CANAL

Concessionaire shall shift the existing irrigation Canal/Nala at the locations detailed below for construction of project highway. The actual cross section to be shifted and length shall be as per the site requirement and approval of concerned irrigation authority.

Sl. No.	Design Chainage (Km)		Side	Length (m)
	From	To		
Nil				

Appendix B-XIV

ADVANCE TRAFFIC MANAGEMENT SYSTEM (ATMS)

Sl. No.	Type of ATMS	Location	Remarks
1	Mobile Communication System	At such locations so as to cover entire length with mobile communications.	--
2	Variable Message Signs	As per Schedule D	--
3	Meteorological Data System	One location (Interchange/near toll plaza)	--
4	Automatic Traffic Counter and Vehicle Classification	At every Toll Plaza	--
5	Video Surveillance System	At each side of all Interchanges on both directions.	--
6	Video Incident Detection System	At each side of all Interchanges on both directions	--

Note:

- a) In addition to above, additional locations shall be identified and provided in accordance to schedule D.

Appendix B-XV

OVERHEAD SIGNS

Traffic Signs (excluding overhead signs at Toll Plaza): Traffic sign boards as per details given below and indicated in the traffic signage plan mentioned in Appendix B-II of this Schedule shall be provided in the project highway in accordance to manual. The traffic signage plan mentioned in **Appendix B-II** shall be deemed to be part of this Schedule-B.

1	One Way Object Hazard Marker (OHM)
2	Two Way Object Hazard Marker (OHM)
3	Height restriction (Regulatory Sign)
4	Speed Limit Signs (Regulatory Sign)
5	Merging Traffic Ahead (Cautionary Sign)
6	Compulsory Keep Left Sign (Regulatory Sign)
7	Compulsory Ahead Sign (Regulatory Sign)
8	U-Turn Prohibited Sign (Regulatory Sign)
9	Give way sign (Regulatory Sign)
10	Chevron Marker (At Curves)
11	Triple Chevron Marker (At roundabout)
12	Reassurance Sign (Direction & Place Identification Sign)
13	Roundabout Sign (Cautionary Sign)
14	Left/ Right Hand Curve (Cautionary Sign)
15	Highway Route Marker Sign
16	Entry/ Exit Highway Sign (Information Sign)
17	End of Highway Sign
18	Map type Advance Direction Sign
19	Flag type Advance Direction Sign
20	Advance Directional Sign (Overhead Cantilever/ Gantry)
21	Rest Area Information Sign (Overhead Cantilever/ Gantry)
22	Slogan Gantry

The type, numbers and location of Traffic Signages shown in Traffic Signage Plan (**Appendix B-II**) are tentative and minimum specified. The actual numbers and location of Traffic Signages shall be determined by the Concessionaire in accordance with the **IRC: SP: 87-2019** requirements with approval from the Independent Engineer. Any increase in the number and type of road sign shall not constitute a Change of Scope, save and except any variations arising out of a Change of Scope expressly undertaken in accordance with the provisions of **Article 16**. Adequate signs for toll plaza shall be provided as given in this schedule and manual.

Appendix B-XVI**Utility Shifting**

Shifting of obstructing existing utilities indicated in **Schedule A** to an appropriate location in accordance with the standards and specifications of concerned Utility Owning Department is part of the scope of work of the Concessionaire. The bidders may visit the site and assess the quantum of shifting of utilities for the project before submission of their bid. Copy of utility relocation plan is enclosed. The specifications of concerned Utility Owning Department shall be applicable and followed.

Note I:

- a) The type/spacing/size/specifications of poles/towers/lines/cables to be used in shifting work shall be as per the guidelines of Utility Owning Department and it is to be agreed solely between the Concessionaire and the Utility Owning Department. No change of scope shall be admissible and no cost shall be paid for using different type/spacing/size/specifications in shifted work in comparison to those in the existing work or for making any overhead crossings to underground as per requirement of Utility owning Department and/or construction of project highway. The Concessionaire shall carry out joint inspection with Utility Owning Department and get the estimates from utility Owning Department. The assistance of the Authority is limited to giving forwarding letter on the proposal of Concessionaire. The decision/approval of Utility owning Department shall be binding on the Concessionaire.
- b) The supervision charges at the rates/charges applicable of the Utility owning Department shall be paid directly by the Authority to the Utility owning Department as and when Concessionaire furnished demand of Utility Owning Department along with a copy of estimated cost given by the latter.
- c) The dismantled material/scrap of existing Utility to be shifted/dismantled shall belong to the Concessionaire who would be free to dispose-off the dismantled material as deemed fit by them unless the Concessionaire is required to deposit the dismantled material to Utility Owning Department as per the norms and practice and, in that case the amount of credit for dismantled material may be availed by the Concessionaire as per the estimate agreed between them.
- d) The utilities shall be handed over after shifting work is completed to Utility Owning Department to their entire satisfaction. The maintenance liability shall rest with the Utility Owning Department after handing over process is complete as far as utility shifting works are concerned.

SCHEDULE – C*(See Clause 2.1)***PROJECT FACILITIES****1. Project Facilities**

1.1 The Concessionaire shall construct the Project Facilities in accordance with the provisions of this Agreement. Such Project Facilities shall include.

- a) Toll plazas
- b) Road side furniture
- c) Operation and Maintenance Centers
- d) Way side amenities / Service Areas
- e) Smaller Parking Places with Toilet Facilities Service Area
- f) Truck Parking Areas
- g) Pedestrian Facilities/ Cattle Crossings/SVUP
- h) Lighting
- i) Environmental Management Plan
- j) Land Scaping and Tree Plantation
- k) Advanced Traffic Management System (ATMS)
- l) Noise Barriers
- m) Utilities
- n) Rain water harvesting

1.2 Project Facilities have been described in **Annex-I** of this **Schedule-C** and the same to be completed on or before project completion date.

Annex - I
(Schedule-C)

1. Project Facilities

The Concessionaire shall construct the Project Facilities described in this Annex-I to form part of the Project Highway. The Project Facilities shall include:

- a) Toll plazas
- b) Road side furniture
- c) Operation and Maintenance Centers
- d) Way side amenities / Service Areas
- e) Smaller Parking Places with Toilet Facilities Service Area
- f) Truck Parking Areas
- g) Pedestrian Facilities/ Cattle Crossings/SVUP
- h) Lighting
- i) Environmental Management Plan
- j) Land Scaping and Tree Plantation
- k) Advanced Traffic Management System (ATMS)
- l) Noise Barriers
- m) Utilities
- n) Rain water harvesting

2. Description of Project Facilities

2.1 Toll plazas

Close tolling system shall be provided in entire length of the project and the same is integrated with the adjoining packages / highway.

The Toll Plazas on loops / ramps / main carriageway shall be provided as per NHAI circular No. 17.5.82 dated 24/5/2021 and Schedule D. Minimum Lane requirement in the opening year are as follows:

Location of toll plaza along main carriageway

Sl. No.	Chainage	No. of Lanes in each direction (All lanes ETC)	Remarks
Nil			

Location of toll plazas along Interchange Ramps

Sl. No./ ID	Interchange Chainage	Ramp ID.	Direction (Entry/Exit)	No. of Lanes (All lanes ETC)
Int. 4	60+970	Ramp 1	Exit	2
		Ramp 2	Entry	2
		Ramp 3	Entry	2
		Ramp 4	Exit	2

Entry approach to each toll plaza shall be having Weigh in Motion equipment for connecting toll booths and toll office for collection of toll fees as per as per **Schedule D**.

Based on the minimum toll lane requirement as given above, toll booths, toll plaza complex, weigh bridges, electrical systems and all other facilities required/mentioned in manual shall be provided as per **Schedule D** with approval from IE and NHAI. All the structures shall be RCC framed structure as per **Schedule D**.

Earth retaining structure shall be provided at toll plaza locations, if required to restrict the embankment slope within the right of way.

No. of toll lanes specified above are minimum indicative. The Concessionaire shall design and provide toll lane as per **IRC: SP: 87-2019** subject to minimum specified above. Any increase in no. of toll lane shall not be treated as change of scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of **Article 16**.

2.2 Road side furniture

2.2.1 Kilometer and Hectometer Stones

Kilometer and Hectometer stones shall be provided in accordance with Schedule D.

2.2.2 Road Signs

Road Signs shall be provided in accordance with Schedule D.

2.2.3 Road Marking

Road Markings shall be provided in accordance with Schedule D. Acrylic water-based road marking paint shall be used for kerb, concrete barrier painting, and to display details of structure number; span arrangement etc. on all culverts and bridges with required description as per MoRT&H guidelines.

2.2.4 Road Delineators

The Road Delineators shall be provided in accordance with Schedule D.

2.2.5 Reflective Pavement Markers & Solar Studs

Reflective Pavement Markers & Solar Studs shall be provided in accordance with Schedule D.

2.2.6 Traffic Impact Attenuators

The Traffic Impact Attenuators on Highway shall be provided in accordance with Schedule D.

2.2.7 Crash Barriers

Three beam metal crash barriers shall be provided in entire length on outer side earthen shoulder of each main carriageway and W- beam metal crash barrier shall be provided in entire length on median side of main carriageway, on both edges of median and Loops/ Loops at interchanges as per TCS referred in schedule-B but excluding stretches covered by bridges and RE wall structures, where concrete barriers to be provided. Concrete barriers shall be provided on bridges/structures, RE Walls/ retaining walls as specified in Schedule B and Schedule D.

2.2.8 Boundary Wall

As the Highway is completely access controlled facility, boundary wall is its integral part to help enforcing of the acquired access rights. Access control extends to the limits of the legal access control on the Loops i.e., along the Loops to the beginning of the taper on the local road.

RCC boundary wall shall be provided along the entire length on either side (including transverse requirements at structure locations) as per typical drawing enclosed with this Schedule and Schedule D.

2.2.9 LED Traffic Blinkers

LED Traffic Blinkers shall be provided at all major & minor junctions, Pedestrian Crossings, Built-up areas and any other locations as specified in Schedule D.

2.3 Operation and Maintenance Centers

Dedicated operation and maintenance center shall be provided in accordance to Schedule D.

2.4 Way side Amenities / Service Areas

2.4.1 Facilities

a) Way side Amenities / Service Areas

Wayside amenities shall be a part of the Highway and shall be constructed with the minimum facilities such as Parking areas (Truck, Buses, Cars, Mini Buses), Fuel Station and garage for minor repair, Hotel/ Motel, Trauma Center, Rest Areas, Fast Food Centre, Travel Information Facilities, Toilets and Bath Facilities, space for Maintenance staff & Vehicle Service Station, Dormitory etc.

Wayside amenities shall be developed at the following locations in accordance to Schedule -D & MoRT&H circular No. RW/NH-33044/14/2003-S& R(R)·Pt. dated 11th Feb. 2021. The layout and minimum number of units per facility and the minimum area per facility to be developed is given in Appendix C-1. However, the provisions given in Appendix C-1 are minimum. The connecting Loops (all Loops shall be constructed with

same specifications of loop/Loops of interchange given in Schedule-B) from/to highway shall be provided.

Sl. No.	Start (Ch.)	End (Ch.)	Area	Side	Type of facility
1	63+300	63+600	8 ha	Both Sides	Road user facility

Apart from the above-mentioned facilities, Traffic Aid Booth (plinth area 25 sqm.) and Medical Aid Booths (including an aid post building and 2 (two) residential quarters) shall be considered as Mandatory facilities over and above the plinth area mentioned. Traffic Aid Booth and Medical Aid Booths shall be constructed with the type designs prescribed for such buildings by the State Government or a substitute thereof within the site premises with easy accessibility and shall vest with the Authority. All the facilities shall be developed by the Concessionaire at its own cost.

Notes: for all facilities mentioned in Para above

- Dhaba shall be an economic and a no-frills facility which serves inexpensive local cuisine and primarily caters to the food requirements of the Truckers.
- Toilet should be provided separately for men, women and physically challenged.
- Concessionaire will not be allowed to charge rents from the customers for drinking water, toilets, parking, first aid box and emergency telephone services.

2.4.2 Specifications and Standards for above facilities

The Project shall be constructed in conformity with the Specifications and Standards specified in this schedule and **Schedule-D**.

2.4.3 Scope of Work

The project scope would include the following major activities:

Design and Construction of the Project

- The Concessionaire will be required to develop the facilities as warm shell structures with detailed conceptual plan, layout plan, detailed architectural and structural designs, engineering drawings, construction methodology, quality assurance procedures, and the procurement, engineering and construction time schedule for all the areas and facilities forming a part of the Project using the basic layout plan provided by the Authority at the time of bidding and/or thereafter. The detailed development proposal for the site shall be submitted to the Independent Engineer and subsequently to the Authority for approval. The Concessionaire shall not deviate from the broad layout. However, the Concessionaire will be allowed to modify the site-specific layout, subject to approval from the Authority, while developing at least the minimum areas and facilities mentioned in this Schedule.
- The land earmarked as future expansion shall, in conformity with Applicable Laws and in conformity with all conditions specified in this document, be utilized for provision of such amenities or facilities which are useful for the Users of the Project

and the local population in future.

- (c) The total covered area of the site after development of any facilities shall not be more than 20% of the total site area. For the Fuel station, the ground coverage shall be considered only for the actual area covered by the administrative buildings, equipment and other such objects and shall not include the open hardstand space for vehicle movement under the canopy.
- (d) Review of all the site-specific information provided along with the bid documents carrying out necessary revisions or additions, preparation of all engineering drawings as required for proper execution and completion of the project as envisaged with the approval of the Authority in compliance with applicable local bye-laws, National Building Code and other standards mentioned in Schedule D. To save time and prevent wastage of effort, it is suggested that the Concessionaire gets the Line Plan of all the buildings in the Project reviewed by the Authority within 15 days of receiving the Letter of Award.
- (e) Site Development, Procurement etc. for construction of the Project as per Design, Codes, Architectural and Engineering Drawings, complying all relevant codal provisions, Standards and Technical Specifications mentioned in schedule D. The Project shall include facilities specified above along with site boundary wall, roads / driveway, parking & pathway, roads marking and rumble strips / speed breakers for parking areas, septic tank/soakage well/sewer line, waste compost plant, water supply, storm water drain, street lighting with LED/CFL lamps, underground sump/overhead tank, firefighting, security features, HVAC, signage, landscaping, horticulture operations / arboriculture etc., RO water plant, rainwater harvesting, provision for tube/bore wells & pumps including water tank, electrical substation / transformer, trenches / ducts for UG cables / pipeline, DG set, shading device, children play area, outdoor furniture, digital display wall system, solar power panel, high mast lamp and hoarding board etc. Actual project facilities to be provided in a particular location will vary.
- (f) Construction of modern user and environment friendly facilities as per the specifications approved by the Authority. The site shall be developed based on green design principles like GRIHA three-star ratings for building norms, zero effluent discharge, use of recycled water, use of renewable energy system as an alternate source of power generation, bio- mechanization technology for generation of cooking gas, rainwater harvesting etc. to make the facility self-sustaining.
- (g) The concessionaire shall provide, construct and maintain the basic infrastructure for the wayside amenities as per the typical layout and requirements specified in Schedule C and Schedule D with prior approval from IE/AE and NHAI. Subsequent establishment and operation of the wayside amenities including fuel stations shall be responsibility of the Authority.

2.4.4 Project Facilities development

The Project Facilities may include the following activities; however, the final detailed set of activities to be performed shall be submitted to the IE/AE and NHAI for approval prior to initiating development on the site:

Sl. No.	Description
I (a)	Site Development
	i. Site clearances & Area development
	a. Leveling, Cutting & Filling Soil (Total Plot Area)
	ii. a. Cutting of Trees - As required to match site Specific Layouts.
	b. Dismantling / Demolishing including disposal
	c. Rerouting of EB, Water & Telephone Services (Above / Below Ground)– including local liasioning charges
	d. Additional Filling/Cutting - To match levels indicated in the Site Specifications Drawings.
	iii. 1. Construction of Retaining wall / Slope Stability Arrangements
	2. Compound Wall, Fencing, Gate, Culvert & Kerb wall, Deceleration Zone, Acceleration Zone, Buffer Zone and Service / Access Road.
	a. Compound Wall
	b. Fencing
	c. Gate - Shall be provided for Entrance to Children Play Area
	d. RCC Slab / Pipe Culvert (Outside the Premises)
	e. Kerb wall - All along the Driveway, Parking Areas, Landscaping and Pathways
	f. Bollards to be provided in front of Dhaba / Food Court / Restaurants / Kiosks
	g. Access Road (outside the premises) / Approach Road
	h. Deceleration Zone (outside the premises)
	i. Acceleration Zone (outside the premises)
	j. Buffer Zone
	k. Service Road (outside the premises) / Exit Road / Existing Service Roads including necessary crash barriers as per codes
I b.	Services: -
	i. Roads & Pathway as per MoRT&H Specifications
	a. Roads / Driveway, Parking & Pathway (BT / CC Paver Block): (All Driveway / Roads / Parking facing Dhaba / Food Court / Restaurants and Kiosks within the premises shall be of CC Paver Blocks. All other areas inside the premises and approach roads outside premises shall be of BT.
	b. Roads marking and Rumble Strips, Speed Breakers (Readymade speed breakers with reflective arrow) for parking area.
	ii. Sewer Line including Chambers, Manholes, Gully Trap, etc.
	iii. Water supply & Distribution System

Development of Six-Lane Access Controlled Highway from Ranipur Barsi (Saharanpur district) to Adhoya Musalmana (Ambala district) (from Ch. 45+500 to 84+400) of Shamli – Ambala section of Bareilly – Ludhiana Economic Corridor on EPC Mode under Bharatmala Pariyojana Phase-I in the State of Haryana (Package-2).

Sl. No.	Description
	iv. Storm water drain with Gratings / Cover Slab
	v. External Electrical Works Including Street Light
	vi. a. Underground Sump / RCC water Retaining Structures
	b. Fire Fighting
	vii. Signages:
	a. External Signages (Building Signages, Parking Signages, Prohibition Signages, Safety Signages, etc.)
	b. Internal Signages
	c. Neon Signages
	d. Key Map Signages
	e. Highway Way finding Signages on the Main Road (on both sides of the project) - 1Km, 500m and 100m
I c.	Landscaping and Arboriculture
	a. Landscaping
	b. Horticulture Operations / Arboriculture
II	Civil Work / Buildings (Including Internal services)
	1. Food Court with Motels
	2. Branded / AC Restaurant
	3. Dhaba
	4. Dormitory
	5. Minor Repair Shop
	6. Kiosks for misc. items
	7. Toilet Blocks
	a. Toilet Block (Near Food Court/ Restaurant)
	Ladies Toilet:
	IWC
	EWC
	Trough
	PC Toilet
	Gents Toilet:
	Urinals
	IWC
	EWC
	Trough
	PC Toilet
	b. Toilet Block (Car & Bus user parking zone)
	Ladies Toilet:
	IWC
	EWC
	Trough

Sl. No.	Description
	Gents Toilet:
	Urinals
	IWC
	EWC
	Trough
	PC Toilet
	Ladies Toilet:
	IWC
	EWC
	Trough
	Gents Toilet:
	Urinals
	IWC
	EWC
	Trough
	PC Toilet
	Parking
	a) Car
	b) Car – PC
	c) Bus
	d) Truck
	e) Trailer
III	Equipment
	a. Special Items of Work
	i. RO Water Plant
	ii. Rainwater Harvesting
	iii. Septic Tank & Soak Pit with Anaerobic Filter
	iv. Tube wells & pumps including overhead water tank and sump
	v. CCTV & Security system
	vi. Electrical substation / Transformer / Panel Board / Earth pit / LT Switch Board / Panel Boards
	vii. Trenches/Ducts for UG cables / Pipe line
	viii. DG Set(s)
	ix. Entertainment - Satellite TV & WIFI
	x. Shading Device As required for operations. (For certain openings / areas requiring protection from sun/rain. Shading device includes Awnings, Tension structures, etc.,)
	xi. Outdoor Furniture

Sl. No.	Description
	xii. Children Play Area Developments
	xiii. Digital Display Wall System
	xiv. Solar Power Panel
	xv. Hoarding Board
	xvi. High Mast Lamp & Lightning Arrester
	b. Additional Green Building Features: -
	i. Solar Lighting
	ii. Provision for Cooking Gas from Food Waste
	iii. All Utility Connections, Deposits etc.,
	c. Other Equipment:
	HVAC

2.5 Pedestrian Facilities / Cattle Crossings/SVUP

Pedestrian Underpasses/SVUP shall be provided at the locations specified in Schedule - B.

2.6 Lighting

The Concessionaire shall provide lighting as per **Schedule - D** at following locations:

- (i) Toll Plazas area
- (ii) Operation and maintenance centers
- (iii) Way side amenities / Service Areas
- (iv) Smaller parking places with toilet facilities
- (v) Truck Parking Areas
- (vi) Interchanges
- (vii) Flyovers
- (viii) Underpasses and Overpasses
- (ix) Traffic aid posts, vehicle rescue posts, medical aid posts and all other facility & service buildings.
- (x) Interior illuminated signs
- (xi) Yellow flashing lights to alert drivers

In addition to the above, the following locations shall have continuous Lighting along main carriageway and service road.

Sl. No.	Locations	Stretches	Remarks
1	Stretches along Highway from start to end of approaches of all Service areas (Way side amenities, Truck parking and smaller parking places with toilet facilities)	Locations as given in Schedule C	--

Minimum level illumination on locations of the Project Highway where exterior lighting is provided shall be 40 lux. In general, 'code of practice for lighting of public thoroughfare IS 1944 shall be followed. All facility buildings shall be illuminated adequately.

The lighting fittings (with LED features) shall be powered by solar system with back up facilities (power and battery both) at all locations.

The solar system will be used for the entire highway. The solar panel at interchange, toll plazas and bridges shall be grid connected whereas the other places shall be battery backup. The electrical connection with all its infrastructures shall be done by the concessionaire. Additional battery backup shall be provided.

2.7 Environmental Management Plan

The Concessionaire shall implement the Environmental Management plan & action Plan for undertaking possible mitigation measures in accordance with guidelines for Highway Projects of the Ministry of Environment and Forests and Wild life Department. The conditions & directions stipulated by the MOEF &CC shall be made available by the Authority.

2.8 Land Scaping and Tree Plantation

The Concessionaire shall plant trees and shrubs of required numbers and types at the appropriate locations within Right of Way and in the land earmarked by the Authority for afforestation as per Schedule D at the following areas.

Sl. No.	Types of Plantations	Location (Km)	Remarks
1	Shrubs	In median except Structures	Ornamental type plantation shall be provided
2	Land Scaping	All interchanges/ Service Areas / Toll plazas / O & M Centers	Ornamental type plantation shall be provided
3	Plantations	Available open land within ROW	Minimum 7459 no. of trees shall be planted as per Schedule D. The type of species of tree shall be finalized in consultation with IE/Authority.
4	Compulsory Afforestation	-	-

Drip irrigation system for median plantation by gravity/pressure sources with all necessary components / systems and emitting devices at plants shall be provided.

The Concessionaire shall maintain the trees and shrubs in good condition during maintenance period as per the maintenance schedule.

2.9 Advanced Traffic Management System (ATMS)

Advance Traffic Management System (ATMS) shall be provided for entire length of project road in accordance with the Manual of Specifications and Standards and as referred in Schedule-D. The Concessionaire shall coordinate / integrate / interface closely

adjoining packages/highways/expressways concessionaire/contractor for effective and efficient work of ATMS.

The ATMS shall inter alia include:

- a) Video Surveillance System (CCTV) /TMCS / Video Incident Detection System (VIDS)/ VSDS Camera, PTZ Camera, Road-side Housing and Support Structure
- b) Vehicle Actuated Speed Display along with support system;
- c) Variable Message Signs (VMS) [Fixed and Portable] with Road-side Housing and Support Structure;
- d) ATMS Control Centre: Ergonomic design of Control rooms & Ingress design of the projection of Graphics display
- e) Cable and conduits

The ATMS shall be integrated with Central Control Room (CCR) provided at toll plaza location.

In addition to above the provision required to implement robust and efficient ATMS in accordance to schedule D in consultation with Independent Engineer / NHAI. The same shall not constitute a Change of Scope, save and except any variations in the length arising out of a Change of Scope expressly undertaken in accordance with the provisions of Article 16.

2.10 Noise Barriers

The Concessionaire shall provide Noise barriers at the following locations:

Sl. No.	Chainage	
	From	To
	Nil	

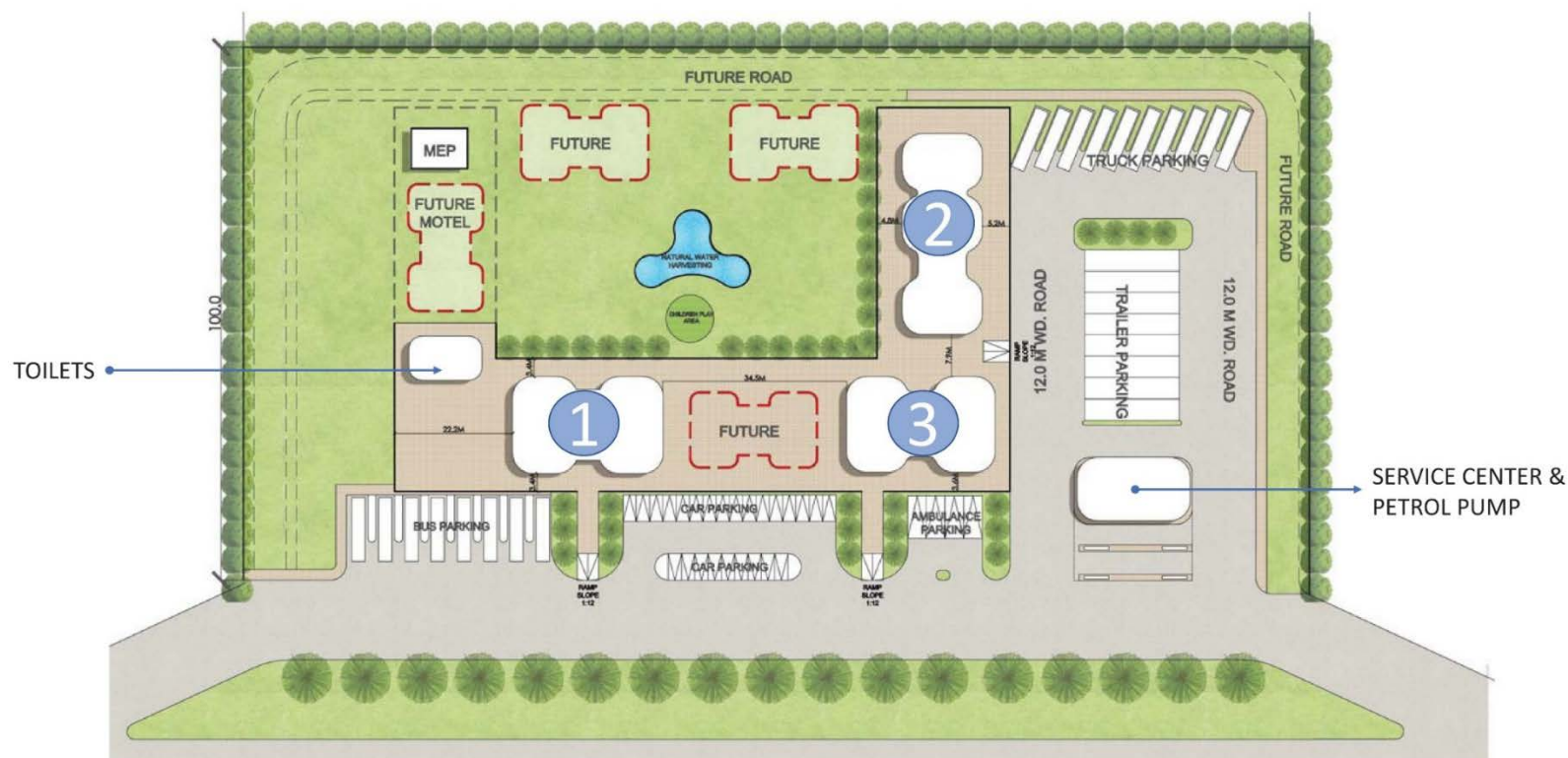
2.11 Utility Duct

Provision of accommodating utilities shall be made within utility corridor on either side of Project highway. Box/HP culverts proposed in Schedule B shall be used for crossing of underground utilities, wherever required. If the distance between two adjacent box culverts is more than 1 km, utility ducts in form of NP-4 Hume Pipe 1.2m diameter shall be provided across the Project Highway along with inspection chamber. Location for such utility crossing shall be finalized in consultation with Authority Engineer.

2.12 Rain Water Harvesting

As per Ministry of Environment and Forests Notification, New Delhi dated 14.01.1997 (as amended on 13.01.1998, 05.01.1999, 6.11.2000, 08.10.2009, 23.04.2010 & 03.09.2019), the construction of rain water harvesting structure is mandatory in and around Water Crisis area, notified by the Central Ground Water Board. The provision of rain water harvesting shall be provided at every 500m in the entire project length and shall be executed as per requirement of IRC SP: 42-2014 and IRC SP:50-2013.

Annexure C-1



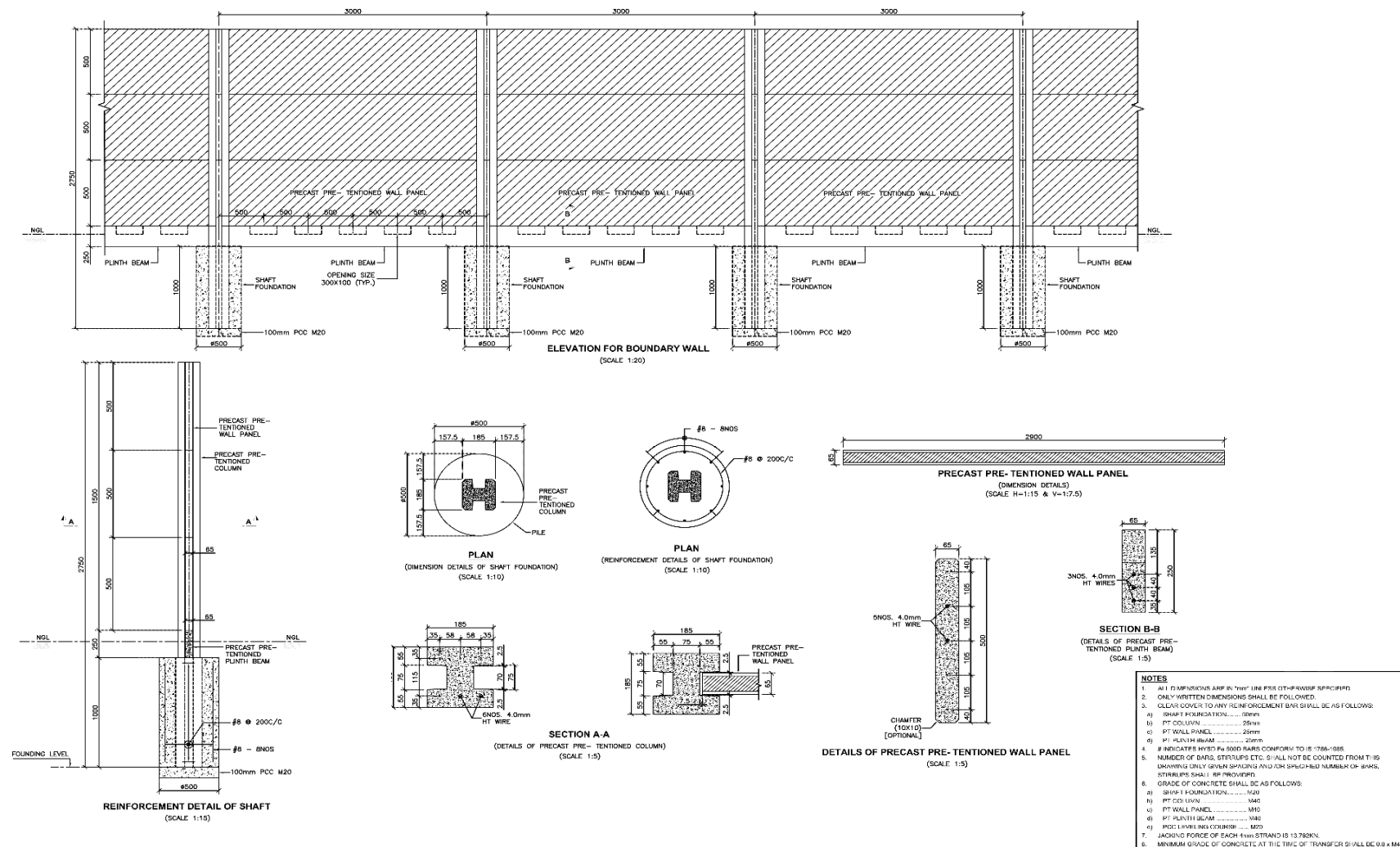
BLOCK NO.	Block Category	Item	Block Area
1	Visitor Block	1 Restaurant	467.5
		2 Travel Info & Passenger Facility	
		3 Telephone Kiosk	
		4 Toilet	
		5 Parking - Car	1081
		6 Parking - Bus	847
		7 Car service station	483.5
		8 Bus service station	
		9 Service Station & Repair Shop	
		10 Spare Part Shop	
		11 Fuel Station	
		12 Children Play area	
		Sub Total	2879.00

2	Truckers Block	13 Dormitory	264.5
		14 Dhaba	
		15 Telephone Kiosk	
		16 Toilet	
		17 Parking Truck	2432
		18 Parking - Extra large Trailer	1005
		19 Service Station & Repair Shop	288.5
		20 Spare Part Shop	
		21 HCV / LCV service station	
		22 Fuel Station	
		Sub Total	3990.00

3	Office Block	23 Trauma	590
		24 Parking Ambulance	
		25 Maintenance Office	
		Sub Total	590.00
4	Miscellaneous	26 Waste Dump & Treatment	130
		27 ESS	
		28 Water Reservoir Tank	
		29 Soak pit / Septic Tank	130.00
		30 Solar Plant	
		Sub Total	130.00
		Total	7589.00

Typical Drawing of Wayside Amenity/Rest Area

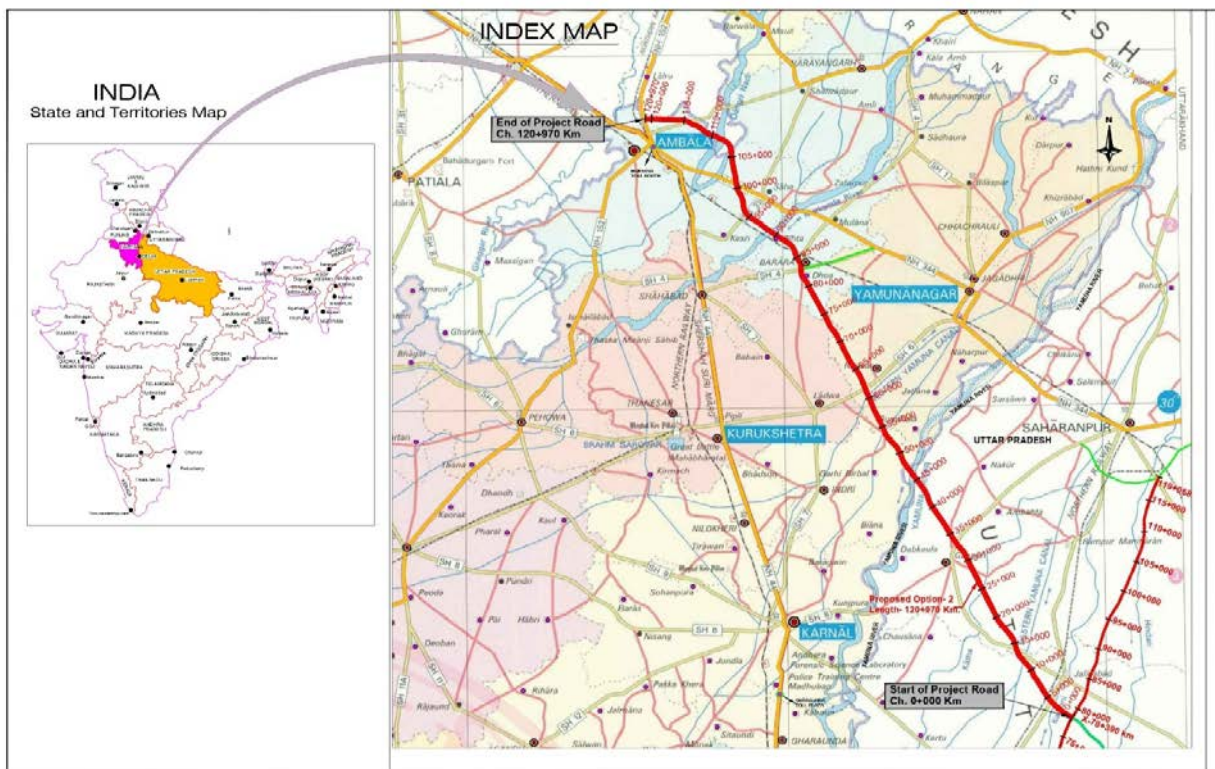
Annexure C-2



Typical Drawing of Boundary Wall

NATIONAL HIGHWAY AUTHORITY OF INDIA

Consultancy services for preparation of DPR for development of Economic corridor, Inter corridor, Feeder routes & Coastal roads to improve the efficiency of freight movement in India under Bharatmala Pariyojana (Lot-9/Package-1)



SHAMLI- AMBALA 6-LANE ACCESS CONTROLLED HIGHWAY

PACKAGE- 2 (Ch. 45+500 To Ch. 84.400)

TECHNICAL SCHEDULE – D
JANUARY 2022

Submitted by

M/s Egis India Consulting Engineers Pvt Ltd

in Joint Venture with

M/s K & J Projects Private Limited

SCHEDULE – D

(See Clause 2.1)

SPECIFICATIONS AND STANDARDS

1. Construction

The Concessionaire shall comply with the Specifications and Standards set forth in **Annex-I** of this **Schedule-D** for construction of the Project Highway.

2. Design Standards

The Highway including Project Facilities shall conform to design requirements set out in the following documents.

Annex - I*(Schedule-D)***SPECIFICATIONS AND STANDARDS FOR HIGHWAY****1. Manual of Specifications and Standards to apply**

- I. Six laning of the Project Highway shall conform to the 'Manual of Specifications and Standards for Highway' published as SP: 87-2019 with all amendments and additions *up to Bid date* (Referred to as "Manual" in this Schedule) and MORTH Specifications for Road and Bridge Works (5th revision). Where the specification for a work is not given, Good Industry Practice shall be adopted to the satisfaction of the Independent Engineer.
- II. As regards, the work of utility shifting, the relevant specifications, relevant rules, regulations and acts of Utility Owning Department/Agencies shall be applicable.

2 Deviations from the Manual

Notwithstanding anything to the contrary contained in the aforesaid Manual, the Specifications and Standards shall apply to the Project Highway, and for purposes of this Agreement, the aforesaid Manual shall be deemed to be amended to the extent set forth below:

Sl. No.	IRC:SP: 87-2019 Clause No.	Details of Item	Description of Deviation
1	2.5.1	Median	The median shall be as given in Schedule B (TCS). Median shall include 0.50m wide edge strip on each side, which shall have same pavement configuration of Main Carriageway as per Clause no. 2.5.3 of Manual.
2	2.6.1	Shoulders	The shoulders shall be as given in Schedule B (TCS).
3	2.10.2	Lateral & vertical clearance at VUP /LVUP	The lateral and vertical clearance of all underpasses shall be as given in Schedule B.
4	2.17	Typical Cross Section	The typical cross section as given in Schedule B.
5	5.2 and 5.5	Type of Pavement and Design Requirements	The type of pavement and Design Requirements as specified in Schedule B.

Sl. No.	IRC:SP: 87-2019 Clause No.	Details of Item	Description of Deviation
6	5.11	Earthen Shoulders	For main carriageway, 3.0 m wide hard earthen shoulder on each side as shown in TCS, Schedule B. Edge strip shall have same pavement configuration of the Main carriageway. Hard Earthen Shoulder shall be to prevent erosion as well as to provide a stable platform for occasional parking of errant vehicles. Hard Earthen shoulders shall meet the following strength parameters: (i) Unconfined Compressive Strength (UCS) equivalent to the strength defined for the bound sub-base layers as per IRC: 37. (ii) CBR of laboratory mix at 97% MDD and 7 days cure+7 days soak: Minimum CBR 60.
7	7.3	Overall width of structures	The Overall Deck Configuration of all structures shall be as per Schedule B and all Road Over Bridges shall be as per the GAD approved by Railways Authority.
8	6.2	Surface Drains	Lined/Unlined Side Drains shall be provided throughout the Project as per typical cross section except cross drainage (River, nala, canal etc.)
9	6.4.2	Drainage where Embankment Height is more than 6 meters	Adequate Continuous RCC Surface drain (Except Structures having approach slabs) shall be provided on both side Earthen Shoulder including Chutes at designed intervals with energy dissipation basin irrespective of Height of embankment. The drainage system shown in TCS shall be treated as minimum.
10	9.7.5	Median Barriers	W-beam metal crash barriers as mentioned in Schedule B (TCS).
11	9.7.1	Road side safety barriers	Three beam metal crash barriers shall be provided in entire length on outer side earthen shoulder of each main carriageway and Loops/ Ramps of interchanges as per TCS referred in Schedule-B but excluding stretches covered by bridges and RE wall structures, where concrete barriers to be provided.

Sl. No.	IRC:SP: 87-2019 Clause No.	Details of Item	Description of Deviation
12	Section 9	Traffic Management System	Additional specification for Traffic Management System shall be as given in Annex II of Schedule D.
13	Section 12	Project Facilities	The project facilities and building structures shall be constructed in accordance to Annex I of Schedule-C.
14	Section 9	Addition of New Clause to Structures in Marine /Aggressive Environment	Additional protection measures shall be taken as per IRC: SP: 80 with all amendments considering all structures in Marine/Aggressive Environment.
15	12.5	Street lighting	Swaged steel tabular pole with swan neck shall be used for roadside lighting conforming to IS 2713-1980 controlled by suitable digital time switch and other specifications shall be as per Clause no 12.5 of IRC:SP:87-2019. The average level of Illumination shall be 40 Lux.
16	4.2.3	Embankment Fill Side Slopes	In fill section the embankment side slope shall be designed for minimum 1.5(H): 1(V). The embankment height >6m shall be designed in accordance with IRC: 75.
17	Section 4	Geo-Grid	Geo-grid shall be provided for slope protection work.

Annex - II*(Schedule-D)***ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)**

The following Specifications and Standards shall be applied in addition to 'Manual on Specifications and Standards for Highway' published as IRC: SP: 87-2019 with all amendments and additions up to Bid date.

1. Advanced Traffic Management Systems (ATMS)**1.1 General**

The work would cover design, supply, installation, commissioning and/or operation and maintenance of Advance Traffic Management Systems (which is one of the components of Intelligent Transport Systems - ITS). The system would include

- 1) Traffic Monitor Camera System (TMCS)
- 2) Video Incident Detection System (VIDS)
- 3) Automatic Traffic Counter and Classifier (ATCC)
- 4) Travel Time Measurement System (TTMS)
- 5) Central Processing System
- 6) Variable Message Sign (VMS)
- 7) Vehicle Speed Detection System (VSD)
- 8) Digital Transmission System and Communication Cable
- 9) Power and Other Cables
- 10) Facility Monitoring System, etc
- 11) Adaptive Traffic Signal Control System

Any new technology, meeting the requirements specified in these specifications should not be excluded. The systems shall meet following objectives:

- Smooth and uninterrupted traffic flow
- Enhance road safety
- Real time information and guidance to users
- Emergency assistance round the clock
- Alerts for abnormal road and weather conditions
- Reduced journey time and inconvenience

1.2 System Requirement

ATMS shall provide the following facilities to highway users:

- make emergency calls to Control Centre in case of accidents, breakdown, fire and ambulance.
- pre-warn the highway users about unusual condition on the road.

ATMS shall provide the following information/data to traffic managers for efficient and effective handling of traffic.

- information regarding location of any incident, incoming calls, help required and messages to be passed to third parties.
- Information regarding traffic congestion, speed and weather conditions.

ATMS shall provide the following controls to traffic managers:

- change the variable message signs from the Control Centre.
- mobilize the movement of ambulances, cranes & patrolling vehicles.

ATMS shall provide online recording and reviewing of the voice & visual information for record and analysis.

Value Added Systems in information dissemination to users of the Project, may be taken up in future. These shall include the following:

- (i) Value Added Systems in the form of real time information on traffic conditions, unusual events, congestion levels, weather conditions etc.; to facilitate project users as also the operator.
- (ii) Through relevant websites including that for the Project SPV/Concessionaire
- (iii) Subscription based alert systems
- (iv) Dedicated TV channels pertaining to traffic movement
- (v) Tie ups with FM radio channels or creation of dedicated AM radio channel
- (vi) Dedicated Toll Free Telephone Systems

Note: Local language is emphasized in above systems.

The ATMS shall among many things comprise following sub-systems:

- i. Communication backbone
- ii. Mobile Communication System
- iii. Variable Message Sign System
- iv. Meteorological Data System
- v. Automatic traffic counter-cum-classifier system
- vi. Video Surveillance System
- vii. Video Incident Detection System (VIDS)
- viii. Central Control Room (CCR)
- ix. Weigh in motion for axle load measurement
- x. Power Supply System

These systems shall have outdoor equipment consisting of ECBs, VMS panels, weather sensors, traffic sensors, video camera etc. The outdoor equipment shall be connected to the control centre through transmission system preferably comprising optical fibre cable, copper cable and interface equipment. There shall be one control centre in this package and shall be located at main toll plaza or administrative building and shall have monitoring equipment, on line information acquisition equipment, processing equipment etc. It shall also have graphic display board showing the highway and the locations of equipment and of incidents.

- 1.3** TMCS cameras shall be installed at every 1 km in order to monitor road, traffic and weather conditions on the highway/expressway visually on real time basis from the Traffic Management Centre, detect abnormal conditions on the highway/ expressway within the coverage of PTZ camera in order to take necessary actions such as lane

control, etc. in case any incident occurs, confirm traffic flows on the highway/expressway by live camera images to provide drivers with re-route information when a congested area is identified. The TMCS collects real-time camera image from each PTZ camera located at roadside and monitor and control the camera images in the Traffic Management Centre (TMC). The TMCS can monitor the real-time images at accident prone areas and/or traffic congestion prone areas. The camera is equipped with zoom and pan-tilt functions (PTZ functions) to secure wider area and longer distance coverage. These cameras shall have functionality to take images even in night-time up to a distance of 500m.

The proposed TMCS system shall enable seamless monitoring of the entire stretch of the highway/expressway, as a result each and every portion of the highway/expressway shall be covered and provide better and real-time monitoring of each and every incident happening on the stretch.

- 1.4** VIDS shall be installed to detect abnormal conditions on the highway/expressway such as accident, broken-down vehicle, stationary vehicle/object, wrong direction movement, fire, low visibility in order to take urgent actions in case such incident occur. The VIDS shall detect incidents by fixed camera with image processing function. The VIDS shall transmit an incident information to Traffic Management Centre on real time basis.

VIDS shall be installed at the location to identified by the Concessionaire/Contractor and approved by the ITS Engineer. The VIDS shall be installed at a suitable location from the connecting / merging road to monitor the sectional traffic volume on the main carriageway and at every 5km interval along the main road. The exact location of VIDS shall be finalized in consultation with IE/NHAI.

- 1.5** VSIDS to be provided for detection of over speeding vehicles, data collection and enforcement purpose. The software shall be configurable to provide the required details of defaulters and errant drivers to the state authorities for enforcement. Vehicle actuated speed displays shall be provided to display the speed of the vehicle in real time thereby alerting the road users of over speeding and acting as speed calming device.

1.6 Central Control Room (CCR)

Purpose and General Information

The purpose of the CCR is to monitor the highway and to provide information to the road user. The CCR also houses the central servers and data processing equipment. The CCR shall provide the real-time information and assistance to the highway users, collect data for the use of highway authorities and to monitor and control the Traffic on the highway as per the requirements.

The CCR shall be designed for round the clock operations of monitoring, on-line information acquisition and processing the same for decision making. The CCR shall be the repository of all the data acquired from the field and their processing, storing, and archiving. All the information for real time monitoring oh highway shall be

generated at the CCR and the relevant information shall be disseminated to the users through VMS, and to O&M teams through mobile radio.

Location

The Central Control Room (CCR) shall be provided at the Toll Plaza location. The Concessionaire shall coordinate / integrate / interface closely with Package III and other adjoining packages/highways/expressways concessionaire for effective and efficient work of ATMS.

Major Components

- Emergency Call Operator Station (Emergency calls from ECB"s)
- Mobile Call Operator Station (Mobile radio calls)
- Integrated Highway Management / Traffic Manager station (Operating Variable Message Signs, Traffic Counting & Classifying System, Meteorological Data System, CCTV & Video Incident Detection)
- Video Wall
- Servers
- Switches
- Administration Computer and Network Printer
- Computer for NMS for fiber Optic Communication system.
- CCTV console equipment
- VIDS control equipment
- Computers for VMS, AVCC, Met, Traffic Control
- A network printer
- An office computer (administration terminal)
- A power supply and backup system

Functional Specification

The CCR shall have the following functions and capabilities:

- 1) Real time images of the highway locations (from camera locations) to the control centre.
- 2) Emergency communication system for communication from the predefined ECB locations to the control centre.
- 3) Real time information to the users from control centre (about the route conditions, traffic situation, etc.) using variable message signs installed on gantries.
- 4) Real time monitoring of the traffic situation and collection of traffic data using traffic counting and classifying system
- 5) Monitoring of the weather conditions

- 6) Dedicated Mobile Radio system for communication between the control centre, ambulances, patrol vehicles, etc.
- 7) Traffic Control System at the interchanges
- 8) Monitoring and control of the highway traffic from the main control centre using integrated highway system
- 9) Compilation, recording, analysis, processing, storage of traffic information and data
- 10) Monitoring and control of the various sub-systems and devices installed on the highway
- 11) The following shall be the servers at CCR:
 - Server for Emergency Call System
 - Server for Video Surveillance system, VIDS system
 - Common server for VMS, ATCC, Meteorological Data
 - Server for Mobile Radio Communication System

1.7 Event management method

1) Event entry and release

The system shall have the function to associate the location (Up/Down lane), the event type, and the event detection time with TMCS camera which detect event. And it also shall provide event management method to register and release traffic events.

e.g. Register and Release events by pull down operation, specifying the type of event and the number of cameras which detected the event.

2) Supporting function

In general, the events (e.g. car incident) are supposed to be released by the operator manually. But to prevent neglecting release of events, the system shall provide notification function to ask confirmation of operator for events which keeps ongoing after specified time period.

e.g. Alarm is raised for the event which keeps ongoing more than 30 min

1.7.1 Relationship with another agency

1) Integration on related information of another agency

Supposing that the same level traffic information as Project in the future from the connected roads, traffic information status both for Project and the connected roads shall be integrated as one seamless traffic information.

2) Increased capacity of connecting roads

The system shall be prepared for the expansion of the connected roads and information service area.

1.7.2 Call recording

Conversation of all Emergency calls including the call transferred to other telephone shall be automatically recorded in the storage device of the Emergency Telephone Console workstation with time stamp and operator details. It shall be possible to assign type of call for each record and search the recorded messages with type of call, date, operator, and location.

1.7.3 Internet Server and Project website

- a. Information of road and traffic condition will be disseminated to the public via

Internet. A website of Highway/expressway-traffic-information will be set up and the Contractor/Concessionaire shall design the website layout and prepare the contents.

- b. The site shall present the Highway/expressway graphically and the existing events such as congestion, maintenance work, lane closure and others that affect normal operation. They shall be indicated on the map by icons and colour. The map shall be updated, when there is any change in the event status without delay.
- c. The highway map shall show also camera-icon at the installation points of TMCS camera. If a camera-icon is clicked, the site shall be designed to display in another window, live video taken by the selected camera with clicking. Resolution and frame rate of live video shall be variable to reduce the bandwidth required to access the site.
- d. The Website shall be hosted on the NIC only and the link of this website shall be provided on the NHAI and MoRTH websites. The Contractor/Concessionaire shall be responsible for coordinating with the concerned agencies and shall the cost of hosting and development charges shall be in the scope of the Contractor/Concessionaire.
- e. At least following information (Road and Traffic condition) shall be provided via Internet:
 1. GIS Map
 2. Live Video from TMCS camera
 3. Traffic Condition like congestion
 4. Traffic Event using Image Icon (Type and Location)
 5. Traffic Violation details with an option to search by vehicle number
 6. Traffic guidance in the form of alternate routes
- f. SMS Server shall be set up for sending the SMS alerts to the road users and violators. The mobile number of the user shall be obtained from the NPCI FASTag Mapper and/ or Vaahan database. In case the mobile number is available / fetched from both mapper and database, the number obtained from NPCI FASTag Mapper shall be preferred. All the messages sent shall contain the emergency helpline number '1033' and other details specific for the project. The Concessionaire/Contractor shall coordinate with the telecom service providers for sending the welcome message to the commuters entering the project stretch. The format shall be finalised in consultant with the Authority and ITS Engineer.

1.7.4 Information Exchange with Another agencies

Traffic information must be created including road traffic condition of other agencies. For that purpose, Concessionaire/Contractor must introduce dedicated device to make information exchange with other organizations. Moreover, the system must include conversion/integration functions of data formats in order to recognize exchanged data as of continuous roads for the integrated traffic information provision.

2. Software

1) General

- a. The ATMS software integrates the field equipment like CCTV cameras, VIDS & VMS with the Integrated Traffic Management (ITM) console to ensure the availability of an effective system for Traffic monitoring & incident / accident management. In addition, it shall also have the capability to integrate and exchange data (using standard protocols) with multiple IoT (Internet of Things) devices that have been temporarily / permanently located on the project highway for Traffic study / Traffic management / Road safety purposes.
- b. The ATMS software shall be based on a modern architecture and shall optimally execute on the ITM workstation and the ATMS server to ensure that
 - i. The system response times are instantaneous to support effective Traffic Management (i.e. Traffic monitoring and incident / accident management) actions on the ITM workstation.
 - ii. No information (data, video stream & audio stream) from any source is lost. Further all such information is made available on the Integrated Traffic Terminal, with no delay, precisely at the time they are required.
 - iii. Effective integration with the CCTV system, VIDS system, VMS system and other relevant ATMS equipment is carried out in a seamless manner with no disruption of / disturbance to the Traffic management function (i.e. Traffic monitoring and incident / accident management). For such integration, standard interfaces (e.g. NTCIP) shall be used wherever available.
 - iv. All information (Data, video and audio streams) collected from various sources shall be archived in the ATMS server for quick retrieval by authorized personnel. However, the performance of the ATMS software in terms of response times shall not be affected during such a retrieval process.
- c. The ATMS software shall be a modular system comprising of at least the following modules:
 - i. Data acquisition module for acquiring data, video streams and audio streams from field equipment
 - ii. Highway Traffic Monitoring module
 - iii. Incident / Accident Management Module
 - iv. Integrated audio communication module
 - v. Report generation module
 - vi. System Administration module
 - vii. Communication module for authorized access by external systems (e.g. NHAI's Regional control centre & the Main control centre)
- d. The Concessionaire/Contractor shall provide a set of software to operate on the servers, workstations, terminal equipment, and other components and devices to be provided under the Contract. The software shall function as a system to provide end results required in the Contract.
- e. The software will be either the software that the Concessionaire/Contractor has, modification of the existing software, or the new software to be developed for the Project. The copyright of the software specifically developed for the project shall

remain with the Concessionaire/Contractor.

- f. The set of the software to be provided shall consist of those provided by third party and those specifically developed for the project. All third-party software shall be legally licensed and there shall be no restriction on the use in the Advanced Traffic Management System. They shall be registered under the name of NHAI and any supports and services provided by the software developer including update and revision shall be available to the NHAI.
 - g. The software to be specifically developed for the Project shall be fully tested and shall be free from bugs. The Concessionaire/Contractor shall include in the Technical Proposal and design document the software quality assurance program that he intends to adopt in developing the software.
 - h. The programming of the applications shall be arranged in such a way that maximum flexibility is afforded by the design to allow the NHAI to implement modifications or additional equipment which may become available or desirable during the working life of the system. Such future modifications or changes shall not be the part of the current scope of the contract and shall be estimated and paid time to time by the NHAI if required but comprehensive documentation of the software and source codes shall be provided under the Contract to allow such changes to be implemented by the NHAI without recourse to the Concessionaire/Contractor.
 - i. The NHAI may wish to implement additional software packages to run concurrently with the software provided under the Contract. These packages may include but will not be limited to the following:
 - 1) Programs allowing the TMC system to operate with other systems such as Toll Management System / ETC/ HES interfaced to the data network and involving bi- directional transfer of files.
 - 2) Analytical and statistical program to process the data collected by the system.
 - 3) Software that offers new service to the road users through Internet.
 - j. The Concessionaire/Contractor shall be responsible for Integration of ATMS system and sub-systems with the NHAI Mobile App for the road users as per the requirement raised from time to time by the Electronics department of NHAI or its authorized agency.
 - k. The Concessionaire/Contractor shall be responsible for Integration of ATMS system and sub-systems with the NHAI Command Centre in NHAI HQ as per the requirement raised from time to time by the Electronics department of NHAI or its authorized agency.
 - l. The video stream captured and displayed at any location under this project shall be authenticated through Digital Watermarking containing NHAI logo. The purpose of Digital Watermarking is to ensure following:
 - 1) Copyright protection
 - 2) Source tracking
 - 3) Broadcast monitoring
 - 4) Video authentication
- 2) **Third Party Software**
- a. The third-party software to be provided shall include but not be limited to the

following:

- 1) Server operating system
 - 2) Storage device operating system
 - 3) Client operating system
 - 4) Database management software
 - 5) Firewall and antivirus program
 - 6) Network Management System
 - 7) Facility Management System
 - 8) Network Video Management Software
 - 9) Microsoft office Pro 2016 or latest license for all workstations
- b. All third-party programs to be provided shall be widely used and suitable for the application of Advanced traffic management system in terms of functions, capacity, speed, and interface with other software, maintenance and user friendliness. The Concessionaire/Contractor shall state in the Technical Proposal of the Tender, the third-party software that he proposes. If the Concessionaire/Contractor proposes the third-party program that is of limited use, he shall explain the reason for using it in the Technical Proposal of the Tender.
- c. If the third-party software is provided in CD or DVD, the original CD or DVD shall be submitted as part of documentation. The requirement is not applicable to the software preinstalled in the server or workstation.
- d. If the cost of the operating system is included in the Server and Workstation hardware price, the same may not be mentioned in the schedule of prices.
- 3) **Advance Traffic Management Centre software**
- a. The Concessionaire/Contractor shall develop new software or modify the existing software to provide the Advance traffic management system functions specified herein and as per the General Technical Specifications and Particular Technical Specifications.
 - b. The software to be provided as Advance traffic management system software shall include but not be limited to the following:
 - 1) Core Advance Traffic Management Centre software
 - 2) Utility software
 - 3) Maintenance activity tracking and logging software
 - 4) Enterprise web enabled GIS and Image Processing module
 - c. The actual configuration of software modules may not be limited to as listed above; but it shall fulfil the General Technical Specifications and Particular Technical Specifications.
 - d. All software shall be of modular construction and the interaction between the modules shall be kept minimum. They shall be designed to operate continuously, and no periodical maintenance of the software shall be required.
 - e. All the display on the display monitor and printed report shall be in English.
 - f. The utility software shall include but not be limited to the system backup and restoration, database backup and restoration, and access control and operation log functions. Usage of the server and workstations shall be controlled by log in/out procedure and different levels of access control shall be provided to restrict the use of certain software by unauthorized persons. All operations shall be

recorded as log together with staff identification number.

- g. The software that interacts with the system operator shall be provided with fault tolerant functions and access control functions. They shall be designed in such a way that any operation error shall not cause damage to the system, loss of data or system shut down.
- h. All software shall be tested under the different conditions and cases including incorrect operation by the system operator and erroneous data to verify the sturdiness of the software. The software testing shall also include appropriate load and stress testing.
- i. The ATMS software shall be a modular system comprising of at least the following modules:
 - 1) Data acquisition module for acquiring data, video streams and audio streams from field equipment
 - 2) Highway Traffic Monitoring module
 - 3) Incident / Accident Management Module
 - 4) Integrated audio communication module
 - 5) Report generation module
 - 6) System Administration module
 - 7) Communication module for authorized access by external systems (e.g. NHAI's Regional control centre & the Main control centre)

1. Data Acquisition module

- a) The Data Acquisition enables the acquiring of data from the various field equipment in the form of data strings, video streams and audio streams. Examples include
 - Data strings from VID system, VSDS system
 - Video Streams from TMCS Camera, VID Camera
 - Audio Streams related to conversations on the 1033 Emergency Telephone,
Road-side Emergency Telephone
- b) The module allows the user to configure the acquisition conditions as follows:
 - At regular intervals of time with the interval being user
 - On the occurrence of Traffic related events in the field (e.g. data from the VID system, instances of calls from Emergency helpline number and 1033)
 - On demand (e.g. Video stream from a Camera)
 - On the occurrence of system related events like equipment failure and restoration, user login / logout
- c) The above information thus acquired shall be stored in the ATMS server using an established database package like Oracle and MS SQL.

2. Highway Traffic Management module

- a) This module shall support effective Traffic monitoring on the highway including the display of the road on the Large display and Integrated Traffic

Management (ITM) workstation, in the form of animated screens including Graphic User interfaces specified under Clause 816.1 to 816.17 of Specifications for Road and Bridge Works of MoRTH and including locations of all ATMS field devices on a GIS map with the ability to display alongside the current information (e.g. CCTV video Images, VMS messages) relevant for each field device, either permanently or on selecting the device with a mouse. The details of the project-specific composition of the GUI will be finalized during the project execution phase between the Concessionaire/Contractor and ITS Engineer in consultant with NHAI.

- b) The module shall display the events acquired by the system (Traffic related, and system related) on a window at the bottom of the ITM / Graphic display, with the window size in terms of the number of events displayed being user configurable. Further the system shall provide a feature for the user to acknowledge such events and the subsequent display of the same.
- c) In addition to the above, the module shall also display the related event (where relevant e.g. a road-side emergency helpline call, VIDS event) on the GIS map using suitable animated icons. The animation shall suitably change when the event has been acknowledged and when the condition causing the event has disappeared.

3. Incident / Accident Management module

This module shall support Incident / Accident Management by

- a) Allowing the Traffic Management console operator to locate and mark (with a mouse) an accident / incident on the GIS map of the highway and initiate the Incident management actions.
- b) Displaying a contextual on-line checklist for the operator to follow in sequence. Further the clicking on each item of the checklist shall automatically activate the related ATMS equipment to aid in the management viz.,
 - i) seamless audio connection for the Traffic Management console operator, via the integrated audio communication unit, irrespective of the communication media (Mobile radio, Mobile phone/landline, road-side Emergency telephone), to the ambulance, Trauma Care Centres, Patrol & other O&M vehicles
 - ii) automatic Pan, Tilt and Zoom of the nearby camera to view the accident
 - iii) Bringing on the VMS –wise message edit screen (by interfacing with the VMS Control software) to create and dispatch messages to VMS boards and mobile apps of registered road users). The checklist itself shall be derived from the relevant Traffic Management and rescue procedures captured either in the Operation (O&M) manual of the highway or based on world-class practices relevant for the highway.
- c) Logging the timestamp of the operator operating each element of the checklist to aid in 'post-mortem' analysis of the operator's performance towards establishing his /her efficiency and further

training needs.

- d) Automatically performing pre-defined actions related to each of the above elements (e.g. Identification of the accident spot on the road shall control the nearby cameras to 'look' in the direction of the accident spot)
- e) Aiding on-line tracking (via GPS) of the various O&M vehicles like the Ambulance, Tow-vehicle and the Patrol vehicle supported with dynamic display of information like shortest route, travel time to the accident spot, Trauma Care Centre etc.
- f) Providing a user-programmable facility, as an aid, for the automatic generation of VMS messages depending on incidents based on e.g. information measured by the MET sensors and sensors installed on the highway (e.g. the generation of a Visibility Alert signal in the event of visibility going below 1 km). This module shall alert the operator on generating the message which shall then be deployed on the operator's approval.

4. Integrated audio communication module

This module shall interface with and control the integrated audio communication unit to aid the operator seamlessly communicate with various stakeholders via a host of communication media like telephone landlines, mobile telephony, mobile wireless etc. The Integrated Audio communication unit enables the Traffic Manager / operator to communicate with all stakeholders in a seamless manner irrespective of the medium of communications. Using a hardware like a digital telephone exchange that supports software control, this unit allows the Traffic manager wearing a headset with a microphone (or a handset) to seamlessly communicate with the stakeholders in traffic operations using various audio communication media like Mobile wireless radios, Mobile (GSM) telephones, Telephone landlines as well as the road-side Emergency Telephone. The communication is initiated on selection of a context sensitive checklist element or by selection of suitable icons on the ITM workstation screen during the Traffic monitoring or accident / incident management. This unit shall support communication between the Traffic manager and a single stake holder or a group of stakeholders. As a back-up option this unit shall also enable such communication via physical pushbuttons located on the unit.

5. Report generation module

- a. This module shall generate periodic as well as on-demand statistical reports using data received from WIM, Automatic Traffic counter cum Classifier and Met sensors for traffic planning and management, Accurate forecasting. There shall also be a provision to generate reports to aid planning and strategizing enforcement.
- b. The module shall provide a range of reports on demand including those
 - Related to the acquired data,
 - VMS messages edited and sent,
 - Equipment availability,
 - System related events including those related to

- System malfunction and restoration
 - User login – logout
 - VIDs events detected
 - Mobile App messages received
- c. The module shall further provide detailed performance reports on all aspects ranging from detection of incidents, through the field Operations team (Patrol vehicles, Break-down cranes and Ambulances) actions, Traffic Management Console operator and other ATMS Control Centre operator actions.
- d. Detailed formats of each report shall be provided by the ITS Engineer during Detail Design Phase.

6. System Administration module

This module shall essentially enable the definition and maintenance of user accounts.

7. Communication module

This module will manage authorized access to the ATMS system by

1. Authorized NHAI personnel / representatives / ITS Engineer
2. Other authorized NHAI systems like the Regional office Control Centre ATMS system and the Main Control centre ATMS system
3. Any other system authorized by NHAI

Based on requests from the above entities the communication module shall provide the following information to the requesting entity:

- i. Video Streams (Live and Archived)
- ii. Audio streams (Live and Archived)
- iii. Data strings and Data elements (Live and Archived)

The standard data exchange protocols for the above will be shared by NHAI with the successful Concessionaire/Contractor.

Enterprise web enabled GIS and Image Processing module shall be deployed at the TMC and sub-centres that shall form the part of the Dashboard and shall have following functionalities:

- a. Map analysis of ATMS planning and operations.
- b. Asset Management of ATMS like TMCS, VIDS, VSDS, Route Patrol, Maintenance, Recovery vehicle location, and Route to reach the incident spot.
- c. Identify surrounding development by other Authorities or illegal development which can potentially be a hazardous to road using temporal satellite imagery for example detection of queue length at the toll plazas, detecting the changes around highway like unauthorised structure built nearby highway or unauthorised occupancy on ROW/buffer area, nearby water body analysis, agriculture land and green belt analysis etc. This will help the NHAI to identify gaps and improve those by implementing various strategies like position of barricading at unauthorised access points, identifying the congestion at toll plazas, identifying water logging probability, removal of illegal encroachment, positioning of CCTV surveillance etc.
- d. Demarking area of highway which is more susceptible to potential hinderances on

- highway like by cattle, wildlife, prohibited vehicle entry from etc. from nearby inhabitations.
- e. Road condition analysis on Map and satellite imagery for regular monitoring, improvement planning and implementation. Along with monitoring of implementation/ upgradation works.
 - f. GIS based road maintenance planning and monitoring by marking them on Map and monitoring the activity through GIS enabled mobile app by tagging location and photographs of respective location of road asset and work in progress.
 - g. GIS enabled planning of diversions for safety of vehicle movement on maintenance area, installation area, and work in progress. This feature shall be made available by the Concessionaire/Contractor to NHAI and ITS Engineer before the start of the installation of roadside equipment at the site, for planning of the diversion and monitoring of the work in progress.
 - h. The Software should have capability of visualising GIS layers, attribute integration and analysis of layers.
 - i. The software should support GPS data for showing emergency and maintenance vehicle on Map
 - j. The web module should have out of box standard GIS functions like: Pan, Zoom, Identify, Measurement (Line, Area), Search, query, etc.
 - k. The software should have tool for creation of topology. Symbology tools for visualizing the spatial data as per the defined colour scheme and annotation tools facility for visualizing the spatial data as per defined label placements or placing the labels from attribute table.
 - l. Software should have facility of advanced rule base labelling for dynamic placement of labels as per the extent, defined position and priority of layers by defining the different classes and should have the option to set the scale labels at specified scale.
 - m. Geo-Processing feature and functions like Buffer, Union, Intersection, Identity, Update, Eliminate, Dissolve, Clip/Erase, Convex Hull, Thiessen, Merge, simplify should be available.
 - n. It should have CAD tools for 2D & 3D GIS data conversion, CAD tool for Raster to vector (R2V) and topology creation.
 - o. The software CAD functionality should support native drawing file formats like DWG, DXF, DGN and should have capability to render photo-realistic 3D rendering.
 - p. The software should be COTS based and OGC certified.
 - q. It should have Image processing capability georeferencing, visual interpretation of the satellite imagery and classification tools to helps in classifying images in user defined classes. image enhancement algorithm such as Linear, Logarithmic, Histogram Equalize, Histogram Matching, Density Slice, Gaussian, Squire root, Tone Balancing, and Raster Vector Analysis,
 - r. The software should have image filtering, vegetation indices calculation, linear algebraic combination, band Math, change detection, image extraction, mosaicking, image visualization, filtering, georeferencing, atmospheric correction, transformation tools, change management, feature extraction, classification etc.
 - s. The software should support all type of Standard GIS Data format, Imagery formats, and RDBMS.
 - t. GIS Tools functionalities such as Data creation, Import/Export tools, Transformation

- Techniques, Theme management, Geometric correction.
- u. The software should have feature to identify and query various spatial Data.
- v. The software should have Map composer, report module and Map print layout functionality.

2.1 ATCC and TTMS Modules of ATMS Control centre software

ATCC and TTMS modules shall be provided with ATMS Control centre software. The ATCC functionality shall be provided for collection of traffic data and TTMS functionality shall be provided for estimation and calculation of traffic data. No additional hardware or field equipment shall be installed on the Project for ATCC and TTMS functionalities. The ATMS Software shall process the data from ANPR and VIDS cameras for traffic counting and classification, and travel time estimation.

2.1.1 Automatic Traffic Counter and Classifier (ATCC) Module

The ATCC module shall be provided in the ATMS Software for automatic traffic counting and classification of vehicle class based on the data collected through ANPR camera and VIDS camera.

The system shall identify and record all types of vehicles on the highway for effective monitoring and data collection at ATMS Control Centre. Besides, the system shall be capable of classifying any other vehicle category as per user needs. Vehicle classification should be user selectable based on length of vehicle and / or detuning of the loop inductivity. The software module shall be robust and be capable of operating with minimum maintenance.

Software and manuals to analyse the data from output of vehicle counts, classifications speeds and headways shall be provided. Capability of graphic/tabular presentation of analysed data shall also be offered.

System Accuracy Requirements

Parameter	Accuracy	Conditions
Average Speed	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph and the vehicles conform to normal highway driving behavior.
Average Headway	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph, individual vehicle head-ways are between 1 and 10 seconds and the vehicles conform to normal highway driving behavior.
Flows	5 percent	There are at least 100 vehicles of each category in group and vehicles conform to normal highway driving behavior.

Parameter	Accuracy	Conditions
Vehicle classification	5 percent	Out of a group of 100 vehicles, conforming to normal highway driving behavior, at least 95 shall be accurately classified as per the classification scheme as per MoRTH guidelines.
Occupancy	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph, individual vehicle headway are between 1 and 10 seconds and the vehicles conform to normal highway driving behavior.

The ATCC module shall be cross-verify the vehicle class fetched by the VSIDS system through integrated with the Vaahan Database. In case of any discrepancy, such transactions shall be audited by the operator using the ANPR image / video available in the ATCC central system.

The data shall be segregated and provided in the report format on the bases of Section wise, direction wise, class wise, etc. as approved by the ITS Engineer.

2.1.2 Travel Time Measurement System (TTMS) Module

Travel Time Measurement System (TTMS) module shall be provided for measuring required travelling time between major section of the project. The ANPR cameras shall be installed at VSIDS locations on the entire stretch. TTMS shall use these ANPR data to detect the current vehicle location. Using this location data, TTMS module shall calculate the actual travelling time per section for each vehicle and derive the average travelling time by the statistics process.

The ANPR cameras will capture the image of each vehicle crossing the VSIDS location and shall extract the vehicle number. The image and vehicle number shall be stamp with

time and location for the purpose of section speed calculation of each vehicle. The same data shall be used for travel time estimation.

TTMS module shall calculate the actual travel time and velocity (speed) of each vehicle between every checkpoint (VSIDS location). Speed data from all vehicles shall be processed statistically by TTMS module to calculate the average travel time between two consecutive check points (VSIDS location), to calculate the average speed and average travel time for each section and the entire project stretch in both the directions. Route Travel Time Estimation Models in IRC:SP:110-2017 shall be referred for estimation of travel time.

Integration with Vaahan Database, NPCI FASTag Mapper, Police Control Rooms, Dial 112, Smart City ICC and other systems

The ATMS Software shall be integrated with Vaahan Database and NPCI FASTag Mapper for fetching the Vehicle owner contact details of errant commuters detected by the ATMS System (ANPR, VIDS, TMCS, etc.) or reported by the route patrolling

team with an evidence under violation of any traffic and safety rule / law on the project stretch.

In case the incident/ violation is reported manually, the evidence received from the ground staff/ enforcement agency shall be verified by the control room manager and upon authentication from manager, the operator shall create an event in the ATMS application.

The data fetched from the Vaahan database or NPCI FASTag Mapper shall be done only at the backend through the ATMS software and only the relevant fetched result shall be displayed on the operator screen or in the reports. The ATMS software shall fetch the data for events generated and audited by the operator. The vehicle numbers shall be audited by the operator by matching the system generated vehicle number with the vehicle number on the image captured by the camera. The operator shall have the option to edit the vehicle number. The logs shall be maintained for each such correction done by the operator and shall be 100% audited by the manager for each operator to minimize human and system errors.

Following actions shall be taken automatically by the ATMS Software after the violation is detected and audited.

- i) Generate e-challan
- ii) Send SMS regarding violation on the registered mobile number of the vehicle fetched from Vaahan database and NPCI FASTag mapper.
- iii) Email the daily e-challan report to the concerned enforcement agency(ies) as applicable for each state, district, etc. the project crosses through, so the e-challans shall be sent accordingly to the concerned enforcement agency under whose jurisdiction the incident / violation detection point / spot / section falls.
- iv) To avoid any discrepancy in section based overspeed enforcement, the VSDS (ANPR camera) location shall be selected such that the one section is not falling in jurisdiction of two different agencies. In case if the same can't be avoided, the section based overspeed e- challan shall be sent to the agency under which the end point/2nd checkpoint of the section falls.

The formats of e-challan, warning/ information messages (SMS), emails, etc shall be finalised in consultation with ITS Engineer / NHA and concerned enforcement agency.

ATMS Software shall be integration with police control rooms of the state, district as applicable, as well as the ICCC of smart city projects (as applicable), and National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA), the District Disaster Management Authority (DDMA), etc.

The police control room shall be provided with the limited access of the ATMS application through On-line Access Facility and shall be able to perform the functions are described in the On-line Access Facility section. The functions specified there are the minimum requirement and the application shall be designed to meet the actual requirement of the Police and Enforcement agencies in consultation with ITS Engineer and the concerned agency and any additional information shall be

approved by the NHA.

2.3 Outline of TMC Software

The Concessionaire/Contractor shall describe in his Technical Proposal application software to be provided to the servers and workstation in the Traffic Management Centre required hereunder.

- 1) Graphical presentation of module and components comprising application of servers and workstation.
- 2) Data processing flow in the form of class diagram, use case diagram, sequence diagram, or data flow diagram
- 3) GIS and Image Processing module
- 4) Scale or size of the module and components, and programming language used
- 5) Extent of the development required for the Project.

3. Video Analytics and Management System (VAMS)

- a) The Video Analytics and Management System (VAMS) software shall be provided to view live and recorded video from all the cameras connected to local and wide area network.
- b) The VAMS software shall have a client/server-based architecture that can be configured as a standalone VAMS system with the client software running on the server hardware and/or the client running on any network-connected TCP/IP workstation. It shall support all major of operating systems (windows, Linux, Mac). It shall support web client interface and shall operate without requirement of installation of any software.
- c) The contractor shall obtain the license for the total number of cameras to be provided for the project based on the MAC address of each NIC. The VAMS shall have a single page that displays the status of all servers and cameras currently connected. This page shall display any alarms, events, MAC addresses, camera configuration, format and frame rate from each individual camera.
- d) The VAMS system shall have the ability to record an audit trail of when users log in that shows what changes they have made, what video they have viewed and what they have exported.
- e) The VAMS shall allow for the configuration of what drives to use for recording video. Those drives may be local drives, direct attached storage drives or iSCSI drives.
- f) VAMS shall support the mobile application for both iOS and Android platform capable of viewing multiple simultaneous live video streams and playing a recorded video stream.
- g) The VAMS software shall have an open architecture supporting IP cameras and encoders from multiple manufacturers providing high-resolution megapixel features.
- h) Multiple control room consoles/workstations shall be able to simultaneously view live video and audio and/or recorded video and audio from the storage/video server. All storage / video servers shall also be able to simultaneously provide live and/or recorded video to one or more consoles. Its operator shall be able to

push the video to another operator console seamlessly.

- i) The VAMS software shall be able to send a predefined email based on an event trigger. The VAMS software shall also support SSL and TLS connections for transmissions of the mail.
- j) The VAMS shall be capable of multi streaming on all connected workstations/ consoles in the entire network of the project stretch as well as minimum 20 remote users simultaneously. The remote users shall have full functionalities as are available for the control centre operators.
- k) It shall be possible to configure multiple monitors on one workstation / console i.e. multiple VAMS application simultaneously on one workstation.
- l) Recording of all video transmitted to the VAMS shall be continuous, uninterrupted and unattended.
- m) The VAMS system shall have video motion detection recording, such that video is recorded when the VAMS detects motion within a region of camera's view.
- n) VAMS shall have Suspect Tracking feature to configure camera links between cameras to follow a suspect between different camera scenes.
- o) Inactivity timeout feature shall be provided to save the bandwidth
- p) Archive bookmarks feature shall be available to specifically archive bookmarked video and create a second copy of important video.
- q) VAMS shall automatically generate alarm / alert in case of any video loss or failure.
- r) The VAMS software shall be used to connect different types of events, such as input triggers, to a desired action such as recording video or triggering an alarm. The VAMS software shall recognize the following event types: video motion, video loss, input trigger, health monitoring, IP camera connection, software trigger and analytics, camera preview style, hovering, server disconnect, archive alarm - failure on archiving target, such as bad mount point. The VAMS shall provide the search and display analytic meta data when searching analytic event linkages etc.

4. Emergency Telephone console

- a. There shall be a Control System with a Control Software to receive all Emergency Communication from the NHAI 24X7 National Highways helpline and Route Patrol.
- b. All the Calls coming on NHAI 24x7 helpline for this section shall be automatically routed to the TMC. The required integration with the telecom operator and 1033 helpline services shall be in the scope of the Concessionaire/Contractor.
- c. The Software shall be integrated with all the Telecom operators for obtaining live location of the caller and the same shall be plotted automatically on the GIS Map, so that the location of the caller can be identified automatically for providing required service. This will also enable the software to identify the fake callers and the caller calling outside the Highway ROW.
- d. The software shall operate on open architecture and integrate with other subsystem software that are installed to manage Cameras, VMS, and Speed Display, apart from the Traffic Management module (where applicable) etc.
- e. The software shall store configuration Emergency call ID, Location on the

- highway stretch etc.) of each Emergency call received. There shall be options to generate reports of stored device configuration.
- f. The system shall record all calls on to a dedicated server with adequate indexing to retrieve the same on a later date.
 - g. The help desk will be manned by call managers / operators. The administrator should be able to create, add, edit & delete users (call managers/ operators). He should be able to administer access rights of the entire highway or a section thereof to the call manager.
 - h. The administrator should be able to place call managers in a hierarchy. The higher priority manager should inherit the rights of a lower priority manager automatically when he is taking overriding control of Emergency calls, which are already being controlled by a lower priority manager. There should be minimum 3 hierarchical levels of security for providing user level log in.
 - i. The system shall provide activity log (audit trail) with user id, time stamp, and action performed, etc.
 - j. The system shall perform communication health check (link quality check) on all the connected communication devices and report errors if any on the administrator console.
 - k. ATMS Control Centre will have dedicated workstations for Call management. For monitoring purposes, Video monitors shall be setup and would show the location of originating calls clearly on GIS map sections of the highway.
 - l. The user shall have the facility to request for control of any section of highway outside his rights for a reservation period. Control of the said section is released after the reservation period (Request enhanced control rights for a short duration).
 - m. ATMS Control Centre may have one or more Operators simultaneously logged in to the communication software to manage their respective sections of the highway.
 - n. Each workstation and the associated software should allow up to nine calls to be maintained on hold while the current call is being serviced.
 - o. Call manager/operator logoff shall be allowed only when no call is in progress or on hold.
 - p. System should ensure that once recorded, the audio cannot be altered; ensuring the audit trail is intact for evidential purposes.
 - q. System shall provide sufficient storage of all call recordings for the entire Contract period or more.
 - r. The call manager/operator shall have the facility to call back the caller.
 - s. The call manager/ operator shall also have the facility to patch any call on Emergency helpline to an external telephone line (fixed and mobile), local intercom at the ATMS Control Centre, sub-centre, and the local mobile radio network (if applicable).
 - t. The call manager/operator shall have the facility to initiate communication health check on any device within his section of the highway.
 - u. It shall be possible to switch calls. That is, if a call # 1 is in progress, the call manager can open any other call that is in hold status. Call # 1 shall go hold status.

- v. The offered system shall have facility to retrieve/export/ backup (on CD, DVD or Blu-ray recorders) the desired portion of call record (from a desired date/time to another desired date/time) through the search functionality of the application software.
- w. It shall be possible to archive old call records and logs on CD, DVD, Blu-ray recorders, or RAID backup devices. Log of any such activity should be maintained by the system for audit purposes.
- x. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.
- y. All the workstations shall be provided with software to play recordings, archive and manage calls. However, managers would require sufficient access rights to use play and archive modules.

5. Probe Data System

- 1) A probe car system is envisaged that receives and processes location data from the project vehicles equipped with GPS device and show the location of GPS devices attached to patrol vehicle or another management vehicle as one of the components of ATMS.
- 2) The system will use the vehicle location data of maintenance, patrol and emergency vehicles fitted with GPS device and deployed on the project.
- 3) The supply and installation of GPS devices is not under the scope of this Contract except for the maintenance vehicles to be provided by the Concessionaire/Contractor on the project during O&M period of this Contract. The Concessionaire/Contractor shall only be required to establish the data communication system between vehicles and Probe Data System console in TMC under the scope of work of this Contract.
- 4) However, the Concessionaire/Contractor shall provide the GPS devices for the vehicles and portable VMS provided by the Concessionaire/Contractor.
- 5) It shall be the responsibility of the Concessionaire/Contractor to furnish all necessary hardware, software and database, install equipment at the specified location, provide necessary cabling, integrate all system components, and deliver a complete operational system including such works as required for the transmission of the probe data on 24/7 basis.
- 6) The probe car system will be prepared for generating traffic condition information and utilising the cumulated data as statistics for the measures on transport such as traffic management etc.
- 7) It collects vehicle location information dynamically. A probe sensor installed in vehicle consists of Global Positioning System (GPS) unit, processor unit, communication unit and power supply unit.
- 8) The satellites send time signals. The time signals are received by the GPS unit on the earth. The GPS unit receives the signals from several satellites and identifies its location on the earth.
- 9) The accuracy of the location generally ranges 10 to 100 m, depending on such factors as quality of GPS unit, high-rise buildings around etc. The probe sensor periodically sends the recorded data such as vehicle location in terms of longitude/latitude and recording time to the TMC.

- 10) The vehicle locations shall be displayed on the GIS map in real-time in TMS and all sub-centres.
- 11) The probe data will be received periodically at the TMC and shall be analysed to show the location of maintenance vehicle on the road network of digital road map.
- 12) The analysed data is converted into traffic congestion information and provided to the road users. The cumulated probe data is processed as historical data for higher accuracy of congestion information.
- 13) **Data List** - The vehicle location data shall be generated at an interval of 10 seconds in each GPS device on board vehicle. The probe car system shall receive all vehicle location data as they are sent from vehicles. The data includes the following items:
 - i. Device ID
 - ii. Vehicle type
 - iii. Location (Longitude and Latitude)
 - iv. Date & time of data
 - v. More detailed structure of the GPS data will be provided to the Concessionaire/Contractor.
- 14) Data validation: The system shall scrutinize the data received and any abnormal data such as data without time stamp, data value outside of the range, and data with longitude and latitude outside of the vehicle coverage area shall be removed from the data.
- 15) Map matching: The system shall have map matching function to project the location of vehicle onto the nearest point along the vehicle route. If the distance between original point and projected point is longer than the pre-set threshold, the data shall be disregarded.
- 16) Data storage and retrieval function
 - i. All data shall be recorded and stored in the probe car server for analysis and future usage. The raw vehicle location data sent from GPS device and processed location data after map matching shall be kept for three (3) months.
 - ii. Data retrieval and presentation software shall be provided that shows the original location data, location data after map matching.
- 17) Screen Display Functions
 - i. The information display shall be schematic map-based interface and as well in the form of a list. The schematic map-based display shall cover the entire Project and be able to enlarge individual locations on the map when selected. The enlarged view shall be able to display the details for each selected location.
- 18) Reporting functions
 - i. Probe Data System Server shall publish/print as a minimum the reports listed below. The reports shall be produced as pre-scheduled or on-demand by system operator. It shall be possible to produce the reports in a portable file format.

- ii. Operation and error log List of roadside equipment those are operational or malfunctioned
 - iii. Error record
- 19) Communication Network
- i. The data transmission of vehicle tracking data shall be made through IP based network provided by communication provider. The network equipment of the system shall have high reliable and secure connectivity.
- 20) All the third-party GPS on board Unit shall be subjected to test before Acceptance test, during installation work and upon completion depending on the test item.
- 21) Two types of tests, function and performance test and general test shall be conducted. They include (as a minimum):
- i. Communication and performance of GPS On Board Unit.
 - ii. Probe Data System Server application and reports.
 - iii. Locating function on map.
 - iv. Data logging function.

6. Hardware for Central Processing System

The Central Processing System shall comprise of following minimum components:

1. TMC Central Processing Servers in hot standby configuration (Primary + Secondary)
2. Video Recording Server with 120 TB inbuilt storage
3. Backup Video Recording (Only Incidents) Server with 120 TB inbuilt storage
4. Internet and SMS Server
5. Operations Laser Printer (Colour)
6. Operations Laser Printer (Black)
7. Operator Consoles each with 4 nos. 21" touchscreen monitors
8. Emergency Telephone Console 2 nos. 21" touchscreen monitors
9. ATSC Console 2 nos. 21" touchscreen monitors
10. RLVD Console 2 nos. 21" touchscreen monitors
11. Graphic Display with Graphics Display management software and Controller
12. Firewall, IDS, IPS and other network security components
13. Core Switch
14. Routers
15. Network Equipment – Layer 3 Switch, Layer 2 Switch etc.
16. Network Management System (NMS)

6.1 TMC Central Processing Servers and Sub-Centre Servers

The Traffic Management Centre (TMC) application server system shall consist of two servers with cluster configuration, one primary server and one stand-by server. Each of the two servers in the cluster shall meet or exceed the minimum requirements stated hereunder.

The TMC server and workstation computer hardware shall be standard models manufactured by organizations of international repute. Custom built or non-

standard equipment will not be acceptable. All the servers and computing shall be UL, CE, FCC, BIS certified.

Full maintenance support services and ready availability of consumables, spare parts or replacement units shall also be assured from a third party, based in India, who is not connected with the Concessionaire/Contractor and his agent.

The specifications in this section are provided as reference. The workstations to be provided by the Concessionaire/Contractor shall materially comply with these specifications and shall be subject to the approval by the ITS Engineer.

- a. Each server shall have a minimum of four numbers of latest generation Intel Xeon 14-Core processor 2.2 Ghz CPU of 19.25 MB Cache, 105W.
- b. The server shall have 256 GB RAM memory using 32GB Module scalable to at least up to 1.5TB, using DDR4 2666MHz DIMM (RDIMM) memory modules.
- c. Server shall have 4* 1.6 TB SSD HDD bays with each SSD having minimum endurance of 3 DPWD
- d. One optical drive DVD-RW shall be provided in each server.
- e. Server should have RAID controller with 4GB Lithium-ion battery backed write cache (onboard or in a PCI Express slot).
- f. Server should support 1Gb 2-port network adaptor supporting advanced features and 10Gb 2- port with dual SFP+
- g. Server shall have Dual 16GB single port PCIe Fibre Channel Host Bus Adapter with Optical Module and Minimum 6 PCIe Gen 3.0 x4 Slots
- h. The power supply shall be Redundant 1500W Platinum hot plug and redundant hot-plug system fans. The display controller should support VGA.
- i. The server should be provided along with the out-of-band remote management and maintenance capability. Remote management should be possible by using API and Web based GUI.

6.2 Video Recording Server (VRS)

The Video Recording servers shall be provided at TMC and sub-centres for recording the live video feed from all the cameras (TMCS, VIDS, ANPR). The VMS (Video Analytics and Management System) software shall be installed on the VRS. The inbuilt storage prescribed for VRS herewith are estimated for 60 days @ 25 FPS, 2 MP at 80% load. The Concessionaire/Contractor shall propose the storage capacity of VRS as per its own calculation and proposed solution to provide video recording of all the cameras for minimum of 60 days keeping 20% buffer. The specified storage here is the minimum requirement to be provided by the Concessionaire/Contractor. Minimum 2 nos. VRS shall be provided at each location (TMC and sub-centres).

- a) Each server shall have a minimum one latest generation Intel Xeon 4-Core processor 3.5 Ghz CPU of 8 MB Cache, 256 SSD for the preloaded operating system and video management software. Each server shall support at least 128 channels at full HD along with 2-way audio feature.
- b) The server shall have 16 GB RAM memory DDR3 memory.
- c) Server shall have 12* 12 TB SSD HDD bays such that minimum 120 TB useable storage space is available after applying RAID 6 configuration. The

- server shall support up to 200 TB internal storage.
- d) One optical drive DVD-RW shall be provided in each server.
 - e) Server should support 1Gb 2-port network adaptor supporting advanced features and 10Gb 2- port with dual SFP+
 - f) The power supply and fan shall be Redundant
 - g) The display controller should support VGA, HDMI, DVI.
 - h) The server shall support minimum 1000 Mbps bandwidth for read and write the video recording and shall support 8 input and 4 output alarm.

8. Note: Total number servers required at each location / Sub-system shall be as per the solution design of the Concessionaire/Contractor. The Quantity mentioned in the BOQ is the minimum requirement and shall be provided by the Concessionaire/Contractor.

All the Servers shall come with 5 years OEM Warranty with 24X7 support and Next Business Day (NBD) resolution.

6.3 Graphic Display for TMC

- j. The Concessionaire/Contractor shall provide Graphic Display cubes with DLP based technology with Laser light source. Graphic Display shall show large-scale presentation of central server monitor screen and live video streaming from the all the cameras (TMCS, VIDS, ANPR), ATMS Dashboard and GIS Map.
- k. Number of cubes and configuration shall be based on the space available in the TMC to achieve the required resolution. It should be based on suitable architecture with controller and Graphics Display management software.
- l. It shall be able to show multiple screens at a time and the number of screens on the display shall be flexible.
- m. It should not have end of life for at least next 7 years.
- n. The Graphic Display shall be made up of several units. It should have automatic and continuous color calibration and uniform brightness amongst all cubes. Each cube should be able to take HD signal and the total cubes shall be finalised such that minimum 23040 x 4320-pixel resolution is achieved from the entire graphic display wall i.e. suitable to display minimum 30 cameras along with GIS Map and ATMS dashboard in full high definition. The size of the display shall be calculated on the basis of the project requirement, such that at least 50% of the TMCS cameras can be viewed in full high definition at same time along with GIS Map and ATMS dashboard.
- o. The brightness of the cube shall be 400 nits and should be adjustable for lower or even higher brightness requirements with brightness uniformity of more than 95%. The dynamic contract ratio shall be 1000000:1 or more.
- p. The ingress design of the projection unit shall be conforming to IEC-60529 standard. Test certificate shall be submitted by the Concessionaire/Contractor in the Technical Proposal.
- q. The depth of the cube shall not more than 750mm to avoid wastage of space in the TMC and sub-centres.
- r. Graphic Display Controller and management software shall be from the same

OEM. The number of output shall be equal to the number of cubes required to achieve the resolution.

- s. The Operator shall be able to see multiple source in one window and shall be able to specify time interval and sequence. The software shall provide the option to split the entire display in multiple sections and layouts. The operator shall be able to define multiple layouts that can be launched based on time schedule or sequence as defined by the operator or control room Manager. The layouts shall be finalised in consultation with the ITS Engineer and NHAI.
- t. The software shall have self health diagnostics function and shall raise alert or popup in case of any error is diagnosed in the graphic display. The operator shall notify the maintenance engineer regarding such alerts through FMS.
- u. At least following information (Road and Traffic condition) shall be provided on Graphic Display:
 - 1) GIS Map of the Stretch with each lane
 - 2) TMCS Camera live video streaming
 - 3) VIDS live video streaming and Incident Pop-ups
 - 4) ANPR and speed radar live data
 - 5) Traffic Condition
 - 6) Traffic count and classification
 - 7) Travel time
 - 8) Traffic Event using Image Icon (Type and Location)
 - 9) Emergency call status
 - 10) Information Provision by VMS
 - 11) Status of each equipment plotted on the GIS Map
 - 12) NMS

6.4 Graphic Display for Sub Centre

- a. The information terminal to be installed at the sub-centre shall be a Laser DLP Graphics Display made of suitable diagonal cubes of depth no more than 750mm such that the resolution of the graphic display is minimum of 15360 x 4320 pixel i.e. suitable to display minimum 30 cameras in full HD mode at a time.
- b. The Concessionaire/Contractor shall supply and install the information terminal at the specified location in the sub centre and connect it with the central server system through the digital transmission system. Software required to operate the information terminal shall also be provided.
- c. Information (Road and Traffic condition) as below shall be provided on Display as same as in main centre but **only of the stretch and equipment covered under that Sub-Centre**:
 - 1) GIS Map of the Stretch with each lane
 - 2) TMCS Camera live video streaming
 - 3) VIDS live video streaming Incident Pop-ups
 - 4) ANPR and speed radar live data
 - 5) Traffic Condition
 - 6) Traffic count and classification
 - 7) Travel time

- 8) Traffic Event using Image Icon (Type and Location)
- 9) Emergency call status
- 10) Information Provision by VMS
- 11) Status of each equipment plotted on the GIS Map
- 12) NMS

Note: For the ergonomic design of the TMS and the Sub Centres ISO 11064 shall be followed.

6.5 Network Equipment

6.5.1 General

- a. The Concessionaire/Contractor shall supply and install network equipment at each location to connect each peripheral to the TMC systems. The Concessionaire/Contractor shall supply and install all equipment, cables, connectors, terminals and other miscellaneous materials necessary to establish a working local area network connecting these systems.
- b. The network between the TMC and sub-systems shall either use the optical fibre cable network or high-end Wireless Access Points along the stretch and a data communication network shall be established using layer 3 switch to be supplied by the Concessionaire/Contractor. The Concessionaire/Contractor shall supply and install the network equipment suitable for interfacing the layer 2 switch to the layer 3 switch.
- c. The type and the number of the network equipment proposed by the Concessionaire/Contractor as per the network design shall be mentioned by the Concessionaire/Contractor in the BOQ. The network configuration shall be determined by the Concessionaire/Contractor. The cost of the network devices and materials that is not explicitly listed in the BOQ of the Bid submitted by the Concessionaire/Contractor or supplied by the Concessionaire/Contractor during the installation works but deemed necessary for the system during any stage of this Contract shall be included in the cost of appropriate items and the Contract Price, and no separate payment shall be made.

6.5.2 Network design

- a. The Concessionaire/Contractor shall undertake the detailed design of the digital transmission system. The design work shall include but not be limited to transmission protocol, network and transmission equipment, type and size of cable, cable splicing, conduit and cable installation work, manhole, hand-hole and pull box at bridge and earth sections.
- b. Digital transmission system shall adopt IP. Suitable media and transmission protocol at Layers 1 and 2 shall be decided type of digital station equipment shall be selected. In developing the design, various factors such as amount and type of data, transmission distance, quality of service (QoS), reliability, latency, and changeover time to backup route shall be considered. Type of optical fibre cable shall also be considered in the design. Packet based transmission system will be preferred than circuit-based transmission system such as Gigabit Ethernet.
- c. Loop topology based on resilient packet ring (RPR) shall be adopted for local line transmission system for redundant operation. A cut in the communication at a

point in the loop shall not affect the normal operation of the communication system.

- d. Physically separate optical fibre cables shall be used to for a ring topology and for back up route in the future trunk line transmission system. Compressed image data and data from other devices must be separately allocated to the optical fibre core.
- e. Layer 2 switch will be used at each node to connect local network or device to the local line network. Layer 2 switch will also be used to connect devices to the local network. The switches used at the field nodes shall only be of industrial grade for operations under extreme weather and outdoor conditions.
- f. In addition to the equipment listed above, the system requires fibre distribution frame and main distribution frame for cable termination, surge arrester or similar surge protection device to protect the equipment from the lightening, and accessories necessary for cable installation. The Concessionaire/Contractor shall supply and install these devices and accessories.

6.5.3 Reliability

Digital transmission system shall have high reliability to ensure continuous operation of the system. Bit error rate for the end to end data communication must be 1×10^{-6} or better.

6.5.4 Capacity and Quality of service

- a. The digital transmission shall have a sufficient capacity in terms of speed and bandwidth to meet the demands to be decided based on the estimated amount of data including digitized voice data at each facility such as Traffic Management Centre, and service area. Video signal from the TMCS camera shall be transmitted in H.264/H.265 format and the digital transmission system shall provide sufficient capacity for it. The Concessionaire/Contractor shall estimate the type, amount and location of data transmission need and design the system, equipment and cables that satisfy the demand.
- b. Quality of service (QoS) capability shall be provided to the digital transmission system to ensure smooth and uninterrupted delivery of data for voice and video image transmission required for emergency telephone system and TMCS camera system.

6.5.5 System supervision

The digital transmission system shall be equipped with a supervisory function which continuously monitors the system operation and issues an alarm in case malfunction is found. The supervisory shall have the following functions:

- 1) Management of occurrence and recovery of malfunction
- 2) Registration and modification of system configuration
- 3) Registration and modification of network configuration
- 4) Testing of equipment and circuit
- 5) Logging of equipment operation and cable performance
- 6) Changeover between primary and backup routes

7. Closed Circuit Television (CCTV) and Access Control System (ACS) for TMC and Sub-Centre Building and Security

7.1 General

- a. This part of the RFP covers the equipment and services to be supplied under this Contract for CCTV equipment and Access Control System (ACS) to be installed at the Traffic Management Centre and Sub-Centres. The CCTV and ACS equipment shall be categorized as two types, CCTV and ACS for Building and CCTV for Security.
- b. All the cameras shall be IP based and shall be connected to the Video server. The cameras shall support ONVIF profile S&G and shall be FCC Class A, UL, CE, BIS certified. The NVMS installed on video server shall provide the facility to control the cameras at the Supervision workstation in the Control room Buildings. The video recording of each camera shall be stored at the Video server/storage for a period of minimum 60 days at 2MP (full HD), and 25 FPS and incident video clips shall be stored for the entire Contract period.
- c. All Cameras shall have inbuilt IR illuminator for night vision functionality. External IR illuminator shall be acceptable for PTZ and box type cameras, however inbuilt IR shall be preferred for these types of cameras also.
- d. The Video Server of each location shall be interfaced to TMC system and NHAI HQ Command Centre to be able to watch and control the cameras for the PTZ activities from the TMC control room, NHAI HQ Command Centre, and On-line access facility. The priority shall be given to the local control room staff.
- e. The functionality of the CCTV cameras provided by the Concessionaire/ Contractor shall be described as follows:
 - i. Building Surveillance CCTV cameras – These cameras installed on a sufficient height mast shall be intended for general surveillance of the building area and field activity outside the building and walkways. These cameras shall also be linked for remote monitoring. As both the traffic control room staff and sub-control room staff can control the pan, tilt and zoom function, the priority shall be given to the local control room staff.
 - ii. Building Security CCTV cameras – These cameras shall be intended for monitoring of security areas such as the building compound, general parking area, Control Room, supervisor room, building lobby, walkway, server room, UPS room, and emergency vehicle parking area.
 - iii. These cameras shall have inbuilt voice recording and Class 10 SD memory card of minimum 128GB for local storage of videos and voice recordings.
 - iv. These cameras shall be of two types
 - 1) Motorised Bullet/Box colour cameras.
 - 2) Motorised Dome colour cameras
 - v. The box cameras installed outdoor shall be installed in the weatherproof enclosure.
- f. The design of the CCTV system shall consider the following: -
 - i. Provide effective supervision and control
 - ii. Easy to use
 - iii. Self-contained system

- iv. Increase span of management
 - v. Reduce unnecessary travel
 - vi. View / evaluate situations quickly
 - vii. Motion detection
 - viii. Savings on time and manpower
 - ix. Easy access to video information and quick playback
 - x. Minimize the use of security guards
 - xi. Eliminate unnecessary responses to false alarms
 - xii. Provision for future scalability
- g. The camera and VAMS shall be capable of triggering alarms in case of Video motion detection, manual trigger, digital input, periodical trigger, system boot, recording notification, camera tampering detection and audio detection. The triggering alerts can be controlled by the control room operator.
- h. The system should support intelligent video motion detection to track objects, learn the scene and adapt to a changing outdoor environment. Environmental changes such as rain, hail, wind, swaying trees and gradual light changes should have minimum effect on the settings.
- i. The control software should provide for alarms and alarm log. Alarm settings need to be individually configurable for each alarm and each camera prerecord duration. The duration shall be selectable from a list of values ranging between 2 seconds or less to 5 minutes or more. There shall be provision to achieve, print and display the log using device filter, device group filter and/or a time window.
- j. The administrator should be able to create, add, edit & delete users. He should be able to administer access rights to system resources and functionality as well as access permissions to a list of cameras a user can view and control.
- k. The system shall provide User activity log (audit trail) with user id, time stamp, health monitoring, etc.
- l. ATMS Control Centre will have workstations along with controllers for Camera operation.
- m. The Workstation Frontend Software should also be working on a browser-based system and mobile application for remote users to allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.

7.2 CCTV Specifications

7.2.1 Dome Camera

- a) A surveillance camera of 2MP at 25 FPS shall be provided. The IP camera shall be POE powered dome type with inbuilt IR of 30 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port and audio I/O.

- b) The face detection function shall be activated as soon as the motion detection is triggered.
- c) The camera shall also detect any object addition, object removal, and line crossing.
- d) Whenever any event is triggered, the camera shall record the event on SD card.

7.2.2 Bullet Camera

- a) A surveillance camera of 2MP at 25 FPS shall be provided. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port and audio I/O.
- b) The face detection function shall be activated as soon as the motion detection is triggered.
- c) The camera shall also detect any object addition, object removal, and line crossing.
- d) Whenever any event is triggered, the camera shall record the event on SD card.

7.2.3 Access Control System

- a. Door / premises entry Access control system shall be provided in each TMC and sub-centre building and rooms including server room, UPS room, generator room, etc.
- b. The system shall provide an integral software tool designed to reduce or eliminate tailgating.
- c. Restricting or denying access to a card holder shall happen automatically if they have entered a zone without a valid card transaction.
- d. The access control system should be modular in nature, with the below mentioned modules-
 - i. Card Management and enrolment module
 - ii. Alarm Management Module
 - iii. Rolling Transaction Display Module
 - iv. Web Dash Board
 - v. Zone Management and Broadcast
 - vi. Time & Attendance Module
 - vii. Visitor Management System Module
 - viii. Reporting module
- e. The dashboard shall display data in multiple formats such as bar, line, and pie charts, and tabular formats and shall provide following information:
 - i. Card Swipes & Zones Swipes
 - ii. Cards Parked
 - iii. Zone Occupancy & Muster zone swipes

- iv. Type of Cards Issued and their status
- v. Licensing
- vi. Diagnostics
- vii. Users logged on
- viii. Invalid Swipe Analysis
- ix. Average Alarm Acknowledgement/Cancel Locked Out Accounts
- x. Top current alarms
- xi. System and capacity & software licensing information
- xii. Alarm acknowledgment analysis
- xiii. Locked out workstation user accounts
- xiv. Users currently logged on
- xv. System Time and Date
- xvi. Last backup status and Backup history report
- f. Reporting Module shall provide the following information:
 - i. Access Level changes
 - ii. Alarm Reports
 - iii. Transaction Reports
 - iv. First & Last transaction report
 - v. Device Reports
 - vi. Device Access Report
 - vii. Device configuration reports
 - viii. Personnel Reports
 - ix. Card parking Reports
 - x. Absentee Report
- g. The ACS shall have following features:
 - i. Record cardholder personal and access information.
 - ii. Control card verification (i.e. the recording of cards on the system).
 - iii. Control data flow to the Ethernet Reader Controllers - card and configuration information.
 - iv. Provide automatic updates of Ethernet Reader Controllers and field device changes, so that the system is continually updated.
 - v. Pass alarm and status information in real-time to client PC workstation computers being used for system monitoring.
 - vi. Pass alarms to an integrated Short Message Service (SMS) for a text messaging service to user defined recipients.
 - vii. Issue broadcast messages to the Ethernet Reader Controllers.
- h. The ACS shall be integrated with following sub-systems of the building
 - i. Video Analytics and Management System (VAMS)
 - ii. Fire Systems (FS)
 - iii. Intrusion Detection Systems (IDS)
 - iv. Perimeter Intrusion Detection Systems (PIDS)
 - v. Generic Lift or Elevator interface
 - vi. Building Management Systems (BMS)
 - vii. Time and Attendance (T&A) Module
 - viii. Visitor Management System
- i. The ACS system shall be CE certified and designed for UL294, with IP 20 rating.

The readers shall be RS485 OSDP compliant, communicate through encrypted OSDP RS485 Wiegand, and encrypted host communications with TLS and AES encryption.

- j. The single door and true four door ACS shall have touch screen terminals for easy access with 12 keys (10 numeric keys, 2 context sensitive function keys), capacitive, light touch and 10/100 Mbps ethernet port.
- k. The system shall have sufficient offline data storage capacity of minimum 500,000 cardholders transactions and 75,000 offline events (transactions and alarms).
- l. Shall have inbuilt battery and charging system. It shall automatically switch over on detection of power supply.
- m. The system shall have tamper detection capabilities and shall raise alarm that shall be configurable as per site requirement.

Section 1 - Traffic Monitor Camera System (TMCS)

1. General

The Concessionaire/Contractor shall provide and construct Traffic Monitor Camera System (TMCS) as a closed-circuit television system that meets the requirements stated herein for the surveillance of the traffic and vehicle on the project. Digital type system shall be used and video signal output from the camera shall be digitized and compressed to reduce the bandwidth requirement for digital transmission system. The system and its component devices shall be of rugged construction for outdoor industrial use capable of continuous operation.

2. System Configuration and Main Function

The system shall consist of camera at site, and control equipment and VMS at the Traffic Management Centre / Sub-centres, and digital transmission system shall transmit video signal from the camera to the TMC/Sub-centres.

3. Equipment Location and Type

- a. TMCS camera shall be installed in the median or shoulder (as per the availability of space and OFC cable and chamber location) approximately at every 1 Km such that the monitoring of the entire route is ensured. In addition to this TMCS Camera shall be installed beneath all the vehicular underpasses/flyovers/interchange structures to monitor cross road traffic movement. The number of cameras shall be sufficient to monitor the key location, accident prone areas, junctions, major median openings, major structures, urban areas, major villages junctions etc. through entire journey of every vehicle on the road.
- b. The Concessionaire/Contractor shall propose the actual locations to satisfy the above requirement. The exact location will be determined based on the alignment, geometry, viewing area (based on site visit) and shall be approved by the ITS Engineer.
- c. The TMCS camera shall be supplied power from the solar panel attached to Camera Pole. The UPS and Lithium-ion battery bank shall be able to provide the power backup for minimum of 72 hours.

4. System Function

4.1 Camera

Camera shall be for industrial use, capable of continuous operation under harsh environment on the highway. Camera shall be IP based full HD colour type with 1/1.9" image sensor (CMOS) or better. It shall have frame rate of up to 60 frames per second in all compression mode and shall have 3 simultaneous streams and live view for more than 5 users.

4.1.1 Lens

Motorized zoom lens with minimum 36x Optical zoom and minimum 16x digital zoom having optical defog feature and auto focus covering suitable range of focal length shall be provided and mounted on the camera. The lens size shall be approx.

5.7-205 mm suitable to achieve the required optical zoom.

4.1.2 Night vision capability

Cameras shall have inbuilt IR illuminator of 500 meters for night vision functionality. External IR illuminator shall be acceptable for PTZ cameras, however inbuilt IR shall be preferred. The minimum illumination shall be of 0.002 lux for colour and 0.0002 lux for black and white image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0 lux with IR up to a distance of 500 meters.

4.1.3 Image enhancement capability

Camera shall have electronically image stabilisation, hue light compensation, back light compensation, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 120 dB.

4.1.4 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. An inbuilt wiper shall be provided with the housing to permit cleaning of the camera gimble during a rainstorm/ dust etc. The field of view of the camera shall not be obstructed by the housing nor by the wiper, which shall automatically park out of view. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-66 or higher rating for Weather-proof, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof. The housing shall have inbuilt heater and blower function.

4.1.5 Pan-tilt Head

Camera housing shall be mounted on a motorized pan-tilt head. The angles of the head and rotating and tilting speed shall be as follows:

Rotating angle: 360 degrees endless with pre-set pan and tilt speed of 200° per second faster.

4.1.6 Camera Control

- a. The following control functions shall be provided to the system to cover wider area and longer distance:
 - 1) Pan (right – left)
 - 2) Tilt (up – down)
 - 3) Zoom (wide – telescope)
 - 4) Focus (near – far)
 - 5) Wiper (on – off)
- b. The Concessionaire/Contractor shall state the angle range of pan and tilt movements and their speed.
- c. The TMCS Camera shall support H.264/H.265 video compression and shall support latest ONVIF S&G protocol. The camera shall have auto motion detection and shall be capable of auto tracking the moving object, wrong direction detection, stationary object detection, face detection, 300 plus pre-set, patrolling mode, audio I/O ports, alarm I/O, privacy masking

features.

- d. The Camera shall have applicable CE, UL and FCC class A certifications.

4.2 Quality

- a. TMCS camera system shall be designed to operate 24 hours a day and 7 days a week without shutdown. Thus, high reliability and availability shall be achieved.
- b. Design target of MTBF shall be 3×10^4 hours or better except the mechanical part of pan- tilt head. Expected MTBF shall be calculated based on the announced reliability of parts and component, or operation record of similar products.
- c. Availability of the system and each camera shall be 99% or better.

4.3 Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.
- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and camera pole to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.
- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at height of 8 meters to prevent vandalism.
- h. The camera shall be mounted on 1-meter cantilever arm attached to the pole.

- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

4.4 Power supply system

- a. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium- ion battery bank shall be provided at each TMCS camera location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same cabinet as TMCS camera controller or in a separate cabinet. The solar panel shall have sufficient size to generate the power required. The Concessionaire/Contractor shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage. The solar panel shall be installed at the minimum height of 8 meters.
- b. The Lithium-ion battery shall be custom built so that it cannot be used for any other application / purpose. It shall be designed such that the terminals/ cells get damaged upon unauthorised removal of battery from the enclosure / cabinet to prevent pilferage.
- c. The Lithium-ion battery shall provide power for Camera at least for 3 days even if solar power cannot be generated due to the weather condition. The Concessionaire/Contractor shall present the calculation of power consumption and capacity of solar power supply system to be used for the TMCS system. The Concessionaire/Contractor shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
- d. Proper earthing shall be provided at each equipment location.

5. Installation

TMCS camera shall be mounted on a tilt pole installed beside the Highway/expressway on the shoulder as specified. Height of camera shall be 12 meters. Pole shall be rigid enough so as not to vibrate under strong wind and passage of heavy vehicle. Optical fibre cable and power cable shall be extended from the nearest hand-hole at the shoulder where branch connection of cable is possible. The TMCS camera shall be connected to the nearest Wireless Access-point through repeater / access point / transceiver appropriately.

6. Acceptance test

- a. Camera, camera housing, pan-tilt head, TMCS camera station, Solar power system, and TMCS camera system central equipment shall be subjected to test at all stages of Acceptance tests i.e. Factory Acceptance Test, during installation work and upon completion depending on the test item. Three types of test i.e. function, performance test and general test shall be conducted.
- b. Details of the test item, test procedure and criteria to judge test result shall

be proposed by the Concessionaire/Contractor subject to the approval by the ITS Engineer / NHAI.

- c. In principle, function and performance requirement stated above shall be tested. More specifically, the following tests shall be conducted as minimum:
- 1) Resolution
 - 2) Colour
 - 3) Wiper control
 - 4) Maximum pan and tilt angle and speed
 - 5) Control desk and remote controlVideo switching function
 - 6) Video recording
 - 7) Solar Power system charging and backup performance

Section 2 - Video Incident Detection System (VIDS)

1. General

Video Incident Detection System (VIDS) will be installed at the accident-prone and other essential areas identified by the enforcement agency and other vulnerable locations. The images taken by VIDS camera shall be transmitted to the Traffic Management Centre (TMC) / sub- centres through Optic Fibre cable in real time. In the TMC, images are selectively shown on the monitor display of VIDS workstation and VIDS monitor screen. If an incident occurs within the coverage area of camera, operator shall be able to control VIDS camera remotely and check the status visually. At the same time, images from all cameras shall be recorded on the storage device in specified period.

2. System Configuration

- a. The VIDS system shall consist of the following components:
 - 1) VIDS image sensor and LPU at roadside.
 - 2) Network equipment.
- b. No periodical manual adjustment shall be required in camera and local processing unit.
- c. The VIDS application shall be provided to the Traffic Management Centre and Sub- centres for receiving pre-processed data from VIDS LPU on the Project. The data collection interval shall not be more than 60 seconds.

3. Equipment Location

- a. VIDS shall be installed at the location to identified by the Concessionaire/Contractor and approved by the ITS Engineer. The VIDS shall be installed at a suitable location from the connecting / merging road to monitor the sectional traffic volume on the main carriageway and at every 5km interval along the main road. The exact location of VIDS shall be finalized in consultation with IE/NHAI.
- b. The Concessionaire/Contractor shall examine and select the VIDS location and obtain the approval from the ITS Engineer.
- c. The VIDS shall be installed on a dedicated pole to be provided by the Concessionaire/Contractor. The clearance of 8 meter shall be secured.
- d. The VIDS shall be supplied power from the solar panel attached to Camera Pole. The UPS and Lithium-ion battery bank shall be able to provide the power backup for minimum of 72 hours.

4. System Function

VIDS system shall be provided with the functions described below.

4.1 Monitoring function

- a. The road and traffic condition video and images taken by VIDS cameras on the project shall be transmitted as video signal to the Traffic Management Centre through the communication network. The ATMs Software shall be capable of selecting video signal from any VIDS camera

to be displayed on the monitor and graphics display.

- b. Sequential display function shall be provided to the ATMS Software. The sequential display function shall allow the video image from the multiple cameras to be sequentially displayed at a pre-set interval. It shall be possible to select the cameras for sequential display and to set the display time of the image from each camera.
- c. The VIDS console and graphics display shall have multiple screen capability and shall display either one image or four images at a time. The image on the Graphics Display shall be controlled by the ATMS Software.

4.2 Incident detection

- a. The VIDS system shall have an incident detection function and automatically detect incident occurred within its viewing area when the camera is set at home position. Incident refers to those occurrences of slow-moving vehicle, stopped vehicle, reverse traffic, fallen object, poor visibility, vehicle running in opposite direction, etc.
- b. If an incident is detected, ATMS Software shall issue an alarm and incident image shall be automatically displayed on the VIDS operator console monitor display and Graphics Display. The GIS Map shall show the location of the incident with a red dot and popup of the video.
- c. The Concessionaire/Contractor shall describe the incident detection mechanism in the technical proposal that the Concessionaire/Contractor proposes together with its limitation.

4.3 Image recording and retrieval

All images shall be automatically recorded in the VRS at TMC/Sub-centre with camera ID and time stamp. Frame rate of the video signal can be configured to one frame to 60 frames per second to optimise the storage capacity as per the site requirements. Images shall be stored for minimum 60 days.

4.4 Diagnosis

- a. The VIDS system shall have a diagnosis function. The ATMS Software shall check the connection with the VIDS camera and the status of VIDS camera by sending the diagnosis signal every five (5) minutes. If VIDS camera fault signal is received or there is no response from the VIDS camera, the ATMS Software shall issue an alarm on the Graphics display and operator console. The fault shall also be recorded in the log.
- b. The Concessionaire/Contractor shall state in his Technical Proposal, the types of error and malfunction of the VIDS System that can be diagnosed from the ATMS Software.

5. Camera

5.1 General

- a. The IP camera shall be POE powered bullet type with inbuild IR of 120 meters.
- b. The Camera shall have inbuild SD card slot and shall be provided with at

least 128 GB class 10 SD card.

- c. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.

5.1.1 Lens

2 MP Full HD motorized varifocal lens with minimum 6-90 mm motorized auto-focus function having optical defog feature and auto focus covering suitable range of focal length shall be provided and mounted on the camera. The range of the camera shall be minimum 150 meters. The resolution shall be full HD at 60 FPS.

5.1.2 Night vision capability

Cameras shall have inbuilt IR illuminator of 120 meters for night vision functionality. External IR illuminator shall be acceptable in case of box cameras, however inbuilt IR shall be preferred. The minimum illumination shall be of 0.005 lux for colour image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0 lux with IR up to a distance of 120 meters.

5.1.3 Image enhancement capability

Camera shall have hue light compensation, back light compensation, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 120 dB.

5.1.4 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. The field of view of the camera shall not be obstructed by the housing. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-66 or higher rating for Weather-proof, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof.

5.2 VIDS LPU

VIDS LPU (Local Processing Unit) shall be housed in a cabinet together with power supply and network equipment. The cabinet shall be electrically and mechanically isolated and shall have a degree of protection of IP 55 or higher specified in IEC 60529. If necessary, the cabinet may be provided with a ventilation fan for controlling internal temperature, but the protection code requirements shall be met. A right hinged door shall be provided on the front to realize easy maintenance work. The turning direction of the handle shall be counter clockwise. The power supply unit shall be provided with a circuit breaker. The anti-lightning and surge protection

complying with the IEC 61643-1 shall be provided. The cabinet shall be finished with the anticorrosive treatment. The Concessionaire/Contractor shall state the details of the anticorrosive treatment and painting. The Cabinet shall have door open alert feature and alarm.

5.3 Local warning flashing lights and Alarm

The local VIDS controller shall be enabled to provide appropriate local warnings (in the interest of road safety) to vehicles on the main carriageway on detection of incidents like reverse traffic (along with warning to the Traffic Management Control Centre).

- a. Pole mounted flashing lights of minimum 300mm diameter with a visibility of at least 500m shall be used for local warning.
- b. There shall be at least five such warning lights each mounted typically at a distance of 100 meters and 200 meters before the incidence monitoring point when seen from the direction of travel. The above distances shall be suitably optimized during detailed engineering. Two warning lights shall be installed in the median and three on the shoulder side.
- c. The lights shall be powered by a local solar PV based power supply within built Li-ion battery and shall be interconnected with the incident detection system either by cable or by wireless (GSM based).
- d. During periods of poor visibility, as detected by the VIDS or TMC / Sub-centre operator, the lights shall go into a flashing mode until visibility improves to a level for adequate incident detection. The TMC / Sub-centre operator shall have the option to turn on/off the lights remotely.
- e. The above lights shall stop flashing either on the event of the disappearance of the detected incident(s) or on the occurrence of a reset from the TMC / Sub-centre operator.
- f. In case of failure of the VIDS LPU the above lights shall, by default, switch to the flashing mode.

5.4 Solar powered Amber Flasher Light

Apart from the local warning flashing light mentioned above, a set of two standalone Solar powered Amber Flasher Lights (FL) / Solar Blinkers of 300 mm Dia with at least 96 hours power backup shall be provided at each location mentioned in the equipment location list. The FL shall be installed such that it is visible to the merging traffic as well as the traffic plying on the main carriageway. The set of FL shall be installed at each median opening (also at the location even if the median opening has been closed, as these are the points where two-wheelers, pedestrians etc. frequently use for road crossing and may be potential accident prone areas even after the closure of the median opening), junctions, merging / diverging points near the flyovers, major bridges, railway over bridges, villages, accident prone areas, location identified as frequent animal crossing etc.

The Solar panel and Lithium-ion battery (in lockable and theft proof housing/ enclosure) shall be installed on the top of the FL pole, at a suitable height to prevent theft.

5.5 Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.
- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and camera pole to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.
- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at height of 8 meters to prevent vandalism.
- h. The camera shall be mounted on 1-meter cantilever arm attached to the pole.
- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

6. Quality

- a. The system shall operate on a 24x7 basis. The VIDS shall be capable of taking clear images of road and traffic conditions under any brightness conditions during the daytime and night- time.
- b. It shall be the responsibility of the Concessionaire/Contractor to furnish and install all necessary hardware, software, and database, integrate all system components and deliver a complete operational VID.

7. Power Supply

- a. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium- ion battery bank shall be provided at each location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same stainless-steel cabinet as controller or in a separate stainless-steel cabinet. The solar panel shall have sufficient size to generate the power required. The Concessionaire/Contractor shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage. The solar panel shall be installed at the minimum height of 8 meters.
- b. The Lithium-ion battery shall provide power for Camera at least for 3 days even if solar power cannot be generated due to the weather condition. The Concessionaire/Contractor shall present the calculation of power consumption and capacity of solar power supply system to be used for the system. The Concessionaire/Contractor shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
 - a. Proper earthing shall be provided at each equipment location.
 - b. Power consumption of all types of VIDS shall be 100VA or less regardless of the type of power supply.

8. Installation

- a. VIDS Camera device shall be installed on the top of individual supporting tilt pole. The supporting structure with enough length must be provided to keep good visibility.
- b. VIDS camera station (local control electronics) shall be installed in VIDS cabinet at the bottom of supporting pole for VIDS camera. VIDS cabinet is a shelter made of stainless steel or aluminium.

Section 3 - Variable Message Sign (VMS)

1. General

- a. Variable Message Sign (VMS) is intended to provide the road and traffic condition information to the commuters. It will help users travel on the project smoothly without much stress. In case of incident like congestion drivers can judge whether to take detour or not, or make other decision based on the information provided through VMS. VMS system shall be provided at all entry/exit locations, exact locations shall be finalized in consultation with IE/NHAI.
- b. The Concessionaire/Contractor shall supply and construct a VMS system that can achieve the purpose of the system mentioned above. The Concessionaire/Contractor shall be responsible for the detailed design, procurement, software development, installation, adjustment, and commissioning of the VMS. Portable VMS is mounted on the trolley towable by the patrol vehicle to display the maintenance/ incident related information on it.
- c. The VMS shall be capable of playing videos, messages in all font size, graphics, etc, and shall be configurable to divide the single screen into multiple sections to display multiple contents at the same time in each section.

2. System Configurations

The VMS system will consist of the following equipment.

- 1) Full matrix outdoor LED panel and control unit in VMS with supporting structure (gantry type) at roadside.
- 2) VMS centre controller with application software installed in Traffic Management Centre.
- 3) Power supply equipment and peripheral.

2.1 Outdoor LED Panel

- a. High intensity LED (light emitting diode) shall be used as light source for VMS. At least three colour elements, blue, red and green, shall be provided and a total of seven (7) colours including white, yellow, green, red and blue shall be displayed. Brightness and colour shall be uniform throughout the surface.
- b. The panel shall have 6 mm $\pm 10\%$ pixel pitch, suitable for outdoor operations. The Pixel density shall not be less than 22,000 pixels per square meter.
- c. The VMS shall have automatic brightness sensors and shall have minimum brightness of 5500 cd/sqm and refresh rate shall be more than 1920 Hz.
- d. The thickness of the panel shall not be more than 150mm and shall be light weight.
- e. Life of LED unit shall be long enough to withstand the severe environmental conditions in which the signboard operates. The Concessionaire/Contractor shall submit the results of high temperature high moisture biased test of LED to be used to the satisfaction of the ITS Engineer.
- f. Display panel of VMS shall be of unit/ modular construction using LED matrix. The size of the LED matrix unit shall be as per the manufacturer's design. The

unit shall be easily replaceable from backside or front without affecting other units. Display unit shall be capable of detecting open circuit condition of each LED.

- g. Malfunction of an LED, a pixel, and a display unit shall not affect the normal operation of other LEDs, pixels and display units.
- h. VMS designs, components, and enclosures primarily designed for commercial, advertising, billboard or other display purposes shall not be accepted.
- i. VMS should be CE certified as per EN 12966 by EU approved notified body only.
- j. VMS should be BIS certified.
- k. Message / video shall be sufficiently bright and directed to indicate to a motorist approaching the VMS, at a distance of 300m on a bright cloud free day.
- l. The enclosure shall be made from a corrosion resistant material. The enclosure shall have an IP65 rating for front and IP 54 rating for back.
- m. The LED chip used for the display shall be from internationally acceptable OEM only. Post supply the LED chip shall be verified by the ITS Engineer with the manufacturer at the cost of the Concessionaire/Contractor, in order to confirm the genuineness of the LED chip used in the VMS LED Panel.
- n. The Concessionaire/Contractor shall submit the EN 12966 and BIS certifications of the VMS in the Technical Proposal.

2.2 Type of LED Signboard

Three (3) types of variable message signboard, Types L, M, and Portable shall be provided depending on the location where VMS is installed and VMS display size. Different support structures shall be suitably adopted. However, they shall be identical in terms of VMS function

Type	Support Type	Message Input	Installed Location
Type L	Gantry type	Remotely	Locate on the main carriageway (only 6/8 lane highway and expressway projects)
Type M			- Locate on the main carriageway (2/4 lane highway projects) - Service/ approach roads / ramps/ connecting roads etc. (6/8 lane highways and expressway projects)
Portable	Mounted on Trolley	On the vehicle, manually as well as remotely	Portable mounted on the trolley and moved by the patrol vehicle.

2.3 VMS Controller

VMS controller will have the following functions:

- 1) Communication control
- 2) Display control
- 3) Monitoring
- 4) Local operation

The VMS control unit will communicate with the VMS centre controller in the TMC through the fibre optic network using TCPIP or GPRS or other equivalent international protocols. It will receive display data from the VMS centre controller and send back the operating status data to the centre controller.

Display data received from the VMS centre controller will be stored in the buffer until all the data have been correctly received without error. Upon confirmation of correctness of data, display will be changed to the new message. Changeover shall be fast, and no irregular display shall be shown during the transition. Under any circumstances, the changeover of message shall be completed within 3 -5 seconds after the system operator in the TMC has issued a message changeover command.

Several test patterns will be provided to the VMS control unit, with which defect of LED can be tested by indicating one of them sequentially.

Operating condition of the VMS will be monitored regularly by VMS itself and the control unit. If any abnormality is detected, error signal will be issued to the VMS centre controller together with the type of error.

It will be possible to operate the control unit and the VMS board manually at the site. The manual control panel will be provided to the VMS control unit. Alternatively, manual control will be made with a notebook computer connected to the VMS control unit through serial port or network port.

2.4 VMS Application

VMS central application will have following minimum functions.

- 1) To compose message by three method, manual input, combination of pre-set words, and selection of pre-set message.
- 2) To have interface with operator through data input device.
- 3) To convert text and symbol message to be displayed on VMS into dot image data to control LED display matrix.
- 4) Shall display time at the top right corner of the display in HH:MM:SS (24 hour) format at all the times, even if no message is being displayed on the VMS.
- 5) To communicate with VMS controller unit at roadside for message data and operating status data transmission.
- 6) To display and store operating status and issue alarm in case of abnormal condition; and
- 7) To record operation log.

The VMS centre controller and operation console shall be standard models manufactured by organizations of international repute.

3. Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm

motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.

- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and the Gantry to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.
- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at the gantry to prevent vandalism.
- h. The camera shall be mounted on at a suitable location on the Gantry such that it focuses on the enclosure / cabinet housing the LPU and Li-ion battery bank.
- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

4. Equipment Location

- a. The location of M and S type of VMS shall be proposed by the Concessionaire/Contractor and approved by the ITS Engineer.
- b. Portable VMS is installed on the trolley and moved by the patrol vehicle at the incident location.

5. System Function

5.1 General

5.1.1 Power Supply

- a. The power supply shall be connected from communication rack using the POE or Adaptor.
- b. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium- ion battery bank shall be provided at each location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same stainless-steel cabinet as controller or in a separate stainless-steel cabinet. The solar panel shall have sufficient size to generate the power required. The Concessionaire/Contractor shall

provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage.

- c. The Lithium-ion battery shall provide power for at least for 3 days even if solar power cannot be generated due to the weather condition. The Concessionaire/Contractor shall present the calculation of power consumption and capacity of solar power supply system to be used for the system. The Concessionaire/Contractor shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
- d. Proper earthing shall be provided at each equipment location.

5.1.2 Communication

The data transmission of the VMS system will be made through the fibre optic and GSM.

5.2 Message Indication Function

- a. Message to be displayed on the VMS shall be concise and clear as drivers driving a vehicle have to read and understand the message in a short time. Messages shall have uniform structure and simple words shall be used. Messages on the VMS shall be expressed in English, Hindi and Regional. Messages in different language will be separately managed and automatic translation is not required.
- b. In principle, a message to be displayed on the variable message signboard shall be composed of three parts, “location”, “event”, and “instruction or regulation”.
- c. Location
- d. Location indicates the relationship between the VMS location and the event location. They can be expressed as section (between Interchange A to Interchange B), distance (ahead, xx km ahead), or specific location (near Interchange A).
- e. Event
- f. Event is a thing that has happened or taken place. It includes traffic conditions (accident, congestion, car on fire), traffic regulation (lane closure, road maintenance work), road condition (wet road surface, fallen object, damaged pavement), and weather condition (fog, rain, strong wind).
- g. Instruction / Regulation
- h. The instruction is the action to be taken by the project users such as “slow down”, “cautious”, “exit here”, “exit at next interchange”, and “use right/left lane”. The regulation is the traffic regulation being enforced like “lane closure” or “Highway closed”.
- i. The three components are not necessarily required all the time. Messages consisting of one or two components described above or simple message will also be displayed.

5.2.1 Message Creation and Editing Function

Three message composition methods shall be provided: (1) manual input, (2) combination of pre-defined phrase, and (3) selection of ready-made message. The functions specified herein shall be possible in three languages. In addition, a set of graphic symbols shall be provided to complement the text message.

5.2.2 Manual composition

In the manual input, it shall be possible to display on the VMS any text message input by the system operator through the keyboard of the VMS operator console. There shall be no restriction as to the contents of the message, but the length of message is limited to the display capacity of the variable message signboard. If manual composition mode is selected, the VMS Server shall show the image of the signboard and the message as it is input by the system operator.

5.2.3 Combination of pre-defined phrase

In the case of combination of pre-defined phrase, frequently used words or phrases such as “accident”, “congestion”, “construction work”, “slow down” and so on are used to compose a message. It shall be possible to insert a word into the message composed by combination method. There shall be sets of pre-defined words. They shall contain words indicating location, event and instruction or regulation. Each set shall have a capacity of 100 words in each language. In this mode, the VMS operator console shall show the categories and the words or phrases in each category for the system operator to select. It shall be possible to alter the pre-defined words by the system operator.

5.2.4 Ready-made message

Ready-made message selection method shall allow the system operator to choose one of the ready-made messages. If the ready-made message mode is selected, the VMS Server shall indicate the list of ready-made messages grouped into categories for the system operator to select. Message set shall have the capacity of 100 messages in each language.

5.2.5 Video and Graphic symbols

Video and Graphic symbols that show typical incidents such as highway closure, construction work, and rain graphically shall be provided to complement the text message. The sample graphic symbols are provided in these RFP for reference. The design of graphic symbols shall be subject to the NHAI's approval.

5.2.6 Dot matrix pattern

The VMS system shall be provided with a function to create a display pattern by specifying the on/off status and colour of each pixel comprising the display area of the signboard. It shall be possible to mix the dot matrix pattern and character message on the signboard.

5.2.7 Automatic message creation from incident information

If an incident is detected through other system, the system shall send an alarm to the

VMS system. VMS system shall then create a warning message indicating the location, type of incident and action to be taken. The message thus created shall not be displayed automatically on the signboard. Instead, a recommendation shall be displayed on the VMS operator console indicating the contents of the message and the location of VMS for which message is recommended. Upon confirmation of the recommendation, the message will be displayed on the specified message.

The VMS centre controller console will be provided with updating and editing functions of pre-defined word, phrase, message and symbol mark. Editing of symbol mark will be possible on a pixel basis.

The console will communicate with the operator through monitor and keyboard for message composition and operation monitoring. Message composition will be made interactively with one of the methods described above. Graphic user interface will be adopted in the interface as much as possible for user friendly operation and fail-safe mechanism will be incorporated to prevent VMS system from showing inadequate message. The system will be equipped with a text input method in Hindi and Regional languages commonly used in the Project area through the standard keyboard.

The VMS system will be provided with an automatic message selection function based on the priority or severity of the events and coefficient that represents the importance of event to each VMS as described in the following tables. The function will select and recommend the message to be shown separately for each VMS when there are two or more incidents to be informed to the road users.

Each message being displayed on the VMS will be assigned with a time-to-live (TTL) value, during which message is displayed, to prevent inadvertently displaying false message after incident has been removed. Upon expiration of TTL, message will be automatically extinguished, if no response is made to the warning within the pre-set time limit. A warning will be issued to the operator console before TTL expires for operator to choose extension of TTL or termination of the display as scheduled.

The VMS system will have an alternate display function, in which a maximum of two sets of messages can be displayed alternately. The function is intended to display a message in three different languages (Hindi, English and Regional) but not necessarily limited to the same message.

5.3 Data Transmitting Function

Text and symbol mark messages to be displayed will be converted to pixel image data to control display unit before transmitting to the variable message sign.

The VMS centre controller will communicate with the VMS control unit at roadside through the fibre optic network. It will send out message converted to dot pattern for display. It will also send out command data to control the VMS control unit and to confirm normal operation of the VMS board. In return, the centre controller shall receive status data from the control unit.

5.4 Operation Monitoring and Logging Function

Operating status of the VMS will be checked periodically. Status (message on, no message, fault, local control, test and switch off) will be collected from the VMS control unit at roadside. If any abnormality is reported, an alarm will be issued. The collected operation monitoring data will be recorded as part of operation log. It will be possible for the VMS centre controller console to send a command to the control unit and collect the dot pattern data being displayed on the VMS board upon system operator's initiative.

Message displayed together with the starting and ending time will be recorded as operation log. Status or malfunction of the VMS and the control unit will also be recorded. Data retrieval software will be provided, and operation log can be retrieved for display on monitor and as printed report.

5.5 Data Storage Function

All data transmitted from the VMS roadside equipment and processed data in the TMC will be recorded and stored in the VMS centre controller for analysis and future usage. Data retrieval and presentation software will be provided that can easily retrieve and show the recommended message automatically generated against event and message indicating on each VMS of the specified roadside equipment location at the hour or day.

Status of roadside equipment (normal or malfunctioned) will be recorded in the VMS centre controller as operation log and for future reliability analysis together with error code and date & timestamp.

Data Sub-system	Storage Data	Type	Storage Period
VMS system	Recommended message automatically generated against event	Raw data	2 years
	Manual input operation record	Raw data	
	Equipment operational status	Raw data	
	Current message indicating on each VMS	Processed data	

5.6 Display and Reporting Function

The VMS centre controller will be capable of showing the following screens.

Item	Contents
Route map	Schematic road map of project and access road Detailed VMS location map Name and station number of interchanges and toll barrier
Equipment location and status	Location of VMS and their condition (message / no message and normal / error)

Message	Message being displayed at selected VMS with starting time and scheduled end time Pre-defined words and phrases Pre-defined messages Graphic symbol marks
Operation	List of VMS currently not in operation Operation log and error record
Date and Time	Current date and time

The VMS centre controller will produce the reports listed below. The reports will be output according to the schedule or upon the system operator's request. It will be possible to output the report as a file in portable document file format.

Item	Contents
VMS operation	Daily report summarizing VMS location, message displayed, start time, end time
Error log	List of VMS currently not in operation Error record

6. Specifications

VMS must have LED pixel failure detection, door open sensor and temperature & humidity sensors.

6.1 VMS board (Type-L)

- I. The L-VMS board size shall be 10,000 mm (W) x 2,000 mm (H) ± 50 mm
- II. The LED configuration shall be 3 in 1 SMD and the pixel pitch shall be 6mm outdoor or better. Lower pixel pitch shall be considered better.
- III. The VMS board shall have the capacity to display any content, graphics, videos, symbols, text in full matrix, with multiple font size and character height, and multiple languages.
- IV. The brightness of the board shall not be less the 5500 mcd with option to adjust the brightness manually as well as auto brightness adjustment feature.

6.2 VMS board (Type-M)

- I. The M-VMS board size shall be 5,000 mm (W) x 2,000 mm (H) ± 50 mm
- II. The LED configuration shall be 3 in 1 SMD and the pixel pitch shall be 6 mm outdoor or better. Lower pixel pitch shall be considered better.
- III. The VMS board shall have the capacity to display any content, graphics, videos, symbols, text in full matrix, with multiple font size and character height, and multiple languages.
- IV. The brightness of the board shall not be less the 5500 mcd with option to adjust the brightness manually as well as auto brightness adjustment feature.

6.3 Portable VMS

- I. The Portable-VMS board size shall be 1,650 mm (W) x 1000 mm (H) ± 100 mm
- II. The LED configuration shall be 3 in 1 SMD and the pixel pitch shall be 6mm

outdoor or better. Lower pixel pitch shall be considered better. The pixel density shall be more than 2500 pixels per square meters.

- III. The VMS board shall have the capacity to display any content, graphics, videos, symbols, text in full matrix, with multiple font size and character height, and multiple languages.
- IV. The brightness of the board shall not be less than 5500 mcd with option to adjust the brightness manually as well as auto brightness adjustment feature.
- V. The DC power supply with suitable power backup shall be provided.

6.4 Movable Trolley (for Portable VMS)

Portable VMS shall be mounted on this trolley. It is used for security measurement to display maintenance information on the portable VMS while maintenance of the system equipment's.

This trolley shall be moved by the vehicle which will be used to patrol on the highway to locate damage, to implement countermeasures such as highway closure or lane closure, and to undertake emergency action such as removing obstacle on the Highway/Expressway. As such, the vehicle must have high driving performance, short stopping distance, high safety features, large loading capacity and environmentally friendly features. It shall be equipped with an on-board signboard specified elsewhere in these specifications on the rooftop. The body of the trolley shall have sufficient strength and durability as signboard or other objects will be loaded on the trolley.

2. 6.4.1 Warning light with Siren

A yellow / Red warning light and siren system shall be provided to the trolley and placed firmly on the roof. It shall be LED type and shall be ECE R65 Compliant.

6.5 VMS Controller

- a. VMS controller will have the following functions:
 - 1) Communication control
 - 2) Display control
 - 3) Monitoring
 - 4) Local operation
- b. The VMS control unit will communicate with the VMS centre controller in the TMC through the fibre optic network using NTCIP / GPRS / TCP/IP or other equivalent international protocols. It will receive display data from the VMS centre controller and send back the operating status data to the centre controller.
- c. Display data received from the VMS centre controller will be stored in the buffer until all the data have been correctly received without error. Upon confirmation of correctness of data, display will be changed to the new message. Changeover shall be fast, and no irregular display shall be shown during the transition. Under any circumstances, the changeover of message shall be completed within 3 seconds after the system operator in the TMC has issued a message changeover command.
- d. Several test patterns will be provided to the VMS control unit, with which defect of LED can be tested by indicating one of them sequentially.

- e. Operating condition of the VMS will be monitored regularly by VMS itself and the control unit. If any abnormality is detected, error signal will be issued to the VMS centre controller together with the type of error.
- f. It shall be possible to operate the control unit and the VMS board manually at the site. The manual control panel will be provided to the VMS control unit. Alternatively, manual control will be made with a notebook computer connected to the VMS control unit through serial port or network port.

7. Supporting Structure

- a. The VMS board will be fixed on gantry type supporting structure. A mechanism to adjust the tilting angle of VMS will be provided to the VMS housing or fixture used to attach the VMS to the support. It shall be possible to adjust the tilting between 0 degree (vertical) and 10 degrees (tilted forward).
- b. There shall be proper and safe walkway provision at the rear side so that the maintenance engineer can easily walk and sit behind the board for maintenance and repair works. the width of the walkway shall be minimum 3 feet or at least 1 foot more than the width of the backdoor of the VMS board. The floor of the walkway shall be designed suitably so that no tool or equipment part may fall on the road.
- c. The walkway shall be rugged and shall bearing capacity of at least 4-5 persons.

8. TMC Equipment

8.1 VMS Application

VMS central application will have following minimum functions.

- 1) To compose message by three methods - manual input, combination of pre-set words, and selection of pre-set message.
- 2) To have interface with operator through data input device.
- 3) To convert text and symbol message to be displayed on VMS into dot image data to control LED display matrix.
- 4) To communicate with VMS controller unit at roadside for message data and operating status data transmission.
- 5) To display and store operating status and issue alarm in case of abnormal condition; and
- 6) To record operation log.

8.2 Installation

- a. VMS sign on the Highway/Expressway shall be mounted on a Gantry installed between the median and shoulder. Clearance of minimum 6 meters above the ground level shall be secured. Gallery shall be provided to the support / walkway at the back of signboard for maintenance purpose.
- b. Face of VMS shall be slightly rotated inner side so that the line perpendicular to VMS front panel shall extend toward a point on the carriageway about 120 meters from the VMS location. The face shall also be tilt down slightly for better recognition of message.
- c. Foundation and other civil works required for the VMS installation shall be

completely in the scope of the Concessionaire/Contractor.

- d. Communication cable shall be extended from the nearest hand-hole at to the VMS through the conduit to be installed by the Concessionaire/Contractor. No aerial cable shall be allowed.

9. Design Principle of VMS Foundation

9.1 Design Strength

The VMS foundation shall be of reinforced concrete with the concrete having the compressive strength of $2,500 \text{ N/cm}^2$ (250kg/cm^2) after 28 days (cylinder type), or when made with a high rapid strength Portland Cement, it shall acquire the same strength after 7 days.

9.1.1 Concessionaire/Contractor's Detailed Survey and Design

Before commencing the actual work, Concessionaire/Contractor shall carry out the field detailed survey/design of the VMS facilities. The detailed drawings including the calculation data based on the survey/design shall be prepared and shall be submitted to NHAI for approval.

9.2 Construction of VMS Foundation

9.2.1 VMS Location

The VMS foundation shall be constructed at locations specification in the general layout of ATMS location or construction drawings to be approved by NHAI and/ or other location as dictated by The ITS Engineer.

9.2.2 VMS Foundation

- a. Concessionaire/Contractor shall comply with the following specifications for preparing and mixing concrete.
- b. All VMS foundations shall be constructed with a ready-mixed or site-mixed, M20 Grade

Or if made manually then the concrete, when made with a normal Portland Cement, shall attain a minimum compressive strength of $2,500\text{N/cm}^2$ (250kg/cm^2) in 28 days (cylinder type) , or when made with a high rapid strength Portland Cement, it shall acquire the same strength in 7 days (Test to be performed on cylindrical type concrete specimen of size 150mm x 300mm).

- c. The slump range for the concrete used in the construction of foundation shall be between 8 and 15cm.
- d. NHAI may order three (3) test pieces (cylinder type) from any batch of the concrete to be taken and properly marked for the laboratory test a required.
- e. The concrete shall be slowly poured around the moulds or forms up to adequate level evenly and tamped into all parts of the moulds or forms by using a vibrator until a densely solid mass without cavities is obtained.

- f. The concrete, once mixed, shall be used within 60 minutes. After one hour, any remaining concrete shall be removed and shall not be used.
- g. Cement mortar shall consist of one (1) measure of Portland Cement and two (2) measures of sand.
- h. The concrete shall be covered with saturated sackcloth or similar materials and shall be sprinkled water to keep the sufficient moisture, adequate times a day for 7 days.

9.2.3 Excavation for VMS Foundation

- a. The Concessionaire/Contractor shall take all countermeasures necessary for safety of the public and for protecting and preserving any and all temporary or permanent utilities.
- b. Concessionaire/Contractor shall obtain all permissions, right-of-way and/or permits necessary for the execution. The permissions shall include property owners' approvals for necessary work on their properties.
- c. Concessionaire/Contractor shall obtain all permissions, right-of-way and/or permits necessary for the execution. The permissions shall include property owners' approvals for necessary work on their properties.
- d. Concessionaire/Contractor shall be directly responsible for all damages to existing utilities and shall restore these services immediately at his own expense.

9.2.4 Backfilling

- a. Backfilling shall commence after notifying The Engineer.
- b. Upon completion of the backfilling, all remaining soil shall be removed and the road surface, pavement and the area concerned shall be immediately cleaned.
- c. Before backfilling, all foreign objects shall be removed from the excavation.

9.3 Material for VMS Foundation

9.3.1 Cement

- a. All cement used in underground construction shall be Portland Cement and in accordance with BS 12 or equivalent.
- b. The cement shall be stockpiled in such a manner as to afford easy access for inspection. Cement shall be kept dry at all times prior to use in order to prevent deterioration. Open air storage of cement shall not be permitted.
- c. Deteriorated cement, such as cement containing lumps that are too difficult to powder by hand, shall not be used.

9.3.2 Water

- a. All water used for mixing and curing of concrete shall be supplied by the waterworks.
- b. Water from other sources may be used only if authorized by NHA after tests have shown the quality to be or better than that supplied by the waterworks.

- c. Water from any source which has been contaminated with dirt, oil, salt or other foreign substances shall not be used.

9.3.3 Fine Aggregate

- a. The fine aggregate for concrete shall consist of natural river sand or equivalent material.
- b. The fine aggregate shall be uniformly graded and shall meet the grading requirements as follows:

Sieve Designation	Percentage by Weight Passing square mesh sieve
(10.0mm)	100
No.4 (5.0mm)	95 to 100
No.16 (1.2mm)	45 to 80
No.50 (0.3mm)	10 to 30
No.100 (0.15mm)	2 to 10

- c. The fine aggregate shall be stored in such a manner as to prevent mixture with other aggregate prior to the use and also to prevent inclusion of foreign materials.

9.3.4 Coarse Aggregate

- a. The coarse aggregate for concrete shall consist of crushed stones having hard, strong and durable pieces free from adherent coatings such as mud or other foreign materials. The coarse aggregate shall be graded between a maximum size of 25mm and a minimum size corresponding to No.4 sieve size. It must be free from dirt, flourey stone dust, earth or any similar materials.
- b. The coarse aggregate shall be stored in such a manner as to prevent mixture with other aggregate prior to the use and also to prevent inclusion of foreign materials.

9.3.5 Reinforcing Bar

Reinforcing bars shall be deformed steel bars. The bars shall be free from dirt, oil, paint, grease, thick rust and other defects and shall conform to the following requirements:

Item	Unit	Specific Value
Tensile Stress at Minimum	N/mm ²	500 (49 kg/mm ²)
Yield Point at Minimum	N/mm ²	300 (30kg/mm ²)
Elongation at Minimum	%	14
Design Stress	N/cm ²	160 (1,600kg/mm ²)

10. Acceptance test

VMS, VMS local controller, VMS central controller, and operator console shall be subjected to the test. Tests shall be conducted at the factory (before Site

Acceptance test), during installation work and upon completion depending on the test item. Two types of test, function and performance test and general test shall be conducted.

Details of the test item, test procedure and criteria to judge test result shall be proposed by the Concessionaire/Contractor subject to the approval by the NHAI.

10.1 Function and performance test

In principle, function and performance requirement stated above shall be tested. More specifically, the following tests shall be conducted as minimum:

- 1) Message composition
- 2) Data exchange
- 3) Central control
- 4) Local control
- 5) Colour and brightness
- 6) Response time
- 7) Display off function
- 8) Error detection

10.2 General test

The following tests shall be conducted as minimum:

- 1) Appearance
- 2) Power supply fluctuation
- 3) Instantaneous power interruption
- 4) Insulation resistance
- 5) Dielectric strength
- 6) Temperature variation
- 7) Waterproof test (field equipment)
- 8) Amount of zinc coating (field equipment and support)

Section 4 - Vehicle Speed Detection System (VSDS)

1. General

The Concessionaire/Contractor shall install the ANPR camera-based solution for over speed detection and enforcement, and radar sensor-based speed detection system for speed display on LED panel. The ANPR system should correctly link the vehicle number plate with the vehicle speed.

The ANPR camera shall be mounted permanently to monitor a single lane of a highway. Multiple ANPR cameras shall be placed on an overhead gantry to get the complete picture of traffic flow for each lane including hard & earthen shoulder in the location.

The ANPR system shall be capable of detection both spot over speeding as well as section based over speeding.

The ATMS Software shall be capable of generating e-challan automatically and integrated with the Vaahan database and NPCI FASTag mapper for obtaining the vehicle registration details for e-challaning and cross-verification of the vehicle class. The Concessionaire/Contractor shall be responsible for integration of AMTS software with the Vaahan Database and NPCI FASTag Mapper as part of this Contract.

In addition to ANPR based VSDS, 2D radar triggered Vehicle Actuated Speed Display (VASD) shall be installed in each lane. The purpose of the VASD is to display the speed of the vehicle to the driver and alert about his speed and prevent him/her from over-speeding, hence shall act as speed calming device.

2. System Configuration

The Radar Speed Sensor can be used in traffic monitoring situation to give input to the VADS for vehicle speed display in real-time. The ANPR camera shall be used to capture the vehicle speed and estimate of vehicle length to identify vehicle class, reverse vehicle detection, and wrong lane driving (on the bases of the vehicle classification, e.g., Bus/truck driving in the car/overtaking lane, car driving in over taking lane, etc.). both VSDS and VASD systems shall work independent to each other.

The 2D radar shall be capable for monitoring three lanes lane including hard & earthen shoulder simultaneously and send the command to each VASD display for displaying the real-time speed of the vehicle in each lane. Precise tracking and video overlaying in difficult situations like

- Multiple cars tailgating Parallel motion,
- High occlusion target scenarios – e.g., small car or bike next to a large truck

The system shall be capable of capturing all type and classes of vehicles, including but not limited to 2-wheelers, three wheelers, tractor, etc.

The Concessionaire/Contractor shall be responsible for Integration of ATMS system

and sub-systems with the NHAI Mobile App for the road users as per the requirement raised from time to time by the Electronics/ IT department of NHAI or its authorized agency.

3. Location

VSDS and VASD shall be installed at suitable locations as identified during the survey by the Concessionaire/Contractor and approved by the ITS Engineer in consultation with IE/NHAI. The VSDS and VASD shall be installed in the section where the over speeding chances are higher, such that at least one set is installed at suitable location at every 10 Kms. Minimum of 3 sets in each direction on the project stretch for obtaining sufficient data for section-based speeding, ATCC, and TTMS functionalities.

Both the system shall be installed in both the directions (LHS & RHS) of the road at each location

4. Roadside Equipment

- a. ANPR Camera
- b. LPU
- c. Vehicle Actuated Speed Display integrated with Speed Radar
- d. Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

5. TMC Equipment

Speed Enforcement Application module (part of the ATMS software) and console.

6. System Function

6.1 Radar System

- a) The radar Sensor must have the high accuracy and detection range. The operational range should be 100 meters.
- b) The Sensor shall be Capable for the tracking up to 32 vehicles simultaneously.
- c) The accuracy of speed detection shall be more than 97% at a speed range of 0.5 to 200 km/hr.
- d) Inbuilt radar in VASD shall also be acceptable if the accuracy level and speed range of 0.5 to 200 km/hr can be achieved by the inbuilt radar and displayed on the VASD in real-time with read range of 100 meters.
- e) The radar shall be calibrated and tested by the third-party for speed detection. Test and calibration certificates shall be submitted by the Concessionaire/ Contractor along with the Technical Proposal and commissioning. The commissioning certificate shall only be issued after authentication of the test reports and calibration certificates.

6.2 ANPR Camera

- a) The ANPR camera shall be installed at site independent of the radar system.
- b) Success rate of number plate recognition and associating with transaction shall not be less than 90% during night-time. The vehicle image capturing, and processing zone shall be within 40 meters for higher accuracy.

- c) The night vision should not affect the accuracy.
- d) The camera shall capture the image of each over speeding vehicle for spot speeding and each vehicle for section speeding and send to the control room. In case the ANPR/OCR is unable to read/recognize the number plate, the system shall create an incident and send an alert to the operator. The operator shall be able to zoom the vehicle image to read the registration number plate and manually enter the vehicle number in the system for further processing. The Concessionaire/Contractor shall be responsible to propose the system capable of processing all over speeding vehicles, irrespective of the accuracy, read rate of the ANPR.
- e) The video recording of each ANPR camera shall be stored for a period of 60 days in N.264/N.265 format and the video clip of over speeding vehicles shall be stored for the entire period of the Contract i.e. for minimum of 5 years. The length of the video clip shall be proposed by the Concessionaire/Contractor such that the same can be produced to the enforcement agency as and when required as an evidence of speed violation. It shall be solely the responsibility of the Concessionaire/Contractor to prove the evidence and provide required support to the Authority and enforcement agency for justifying the speed violation.
- f) The software and cameras shall be calibrated on monthly basis and the certified test report shall be submitted to the Authority and ITS Engineer. In addition to the monthly testing and calibration, the Authority or Enforcement agency may instruct the Concessionaire/Contractor so test the cameras and software at any time to ascertain the accuracy of the cameras, software and radars.
- g) The ANPR Cameras and VSDS Software shall be calibrated and tested by the third-party for speed detection. Test and calibration certificates shall be submitted by the Concessionaire/Contractor along with the Technical Proposal and commissioning. The commissioning certificate shall only be issued after authentication of the test reports and calibration certificates.

6.3 Specifications

- a. The system shall perform during day and night as well as in adverse weather conditions.
- b. It shall have built in diagnostic functions to quickly assess the validity of speed calibration.

6.3.1 General

- a. The IP camera shall be POE powered box type with inbuilt IR of 100 meters.
- b. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card.
- c. The shutter speed of the camera shall be 1 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image.
- d. The Camera shall have Ethernet port, RS-485, and RS-232 interface.

6.3.2 Lens

2 MP Full HD manual varifocal lens with minimum 5-50 mm C/CS mount DC drive. The range of the camera shall be up to 100 meters. The resolution shall be full HD at 60 FPS.

6.3.3 Night vision capability

Cameras shall have inbuilt IR illuminator of 100 meters for night vision functionality. External IR illuminator shall be acceptable, however inbuilt IR shall be preferred. The minimum illumination shall be of 0.005 lux for colour image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0 lux with IR up to a distance of 100 meters.

6.3.4 Image enhancement capability

Camera shall have hue light compensation, back light compensation, hue light compensation, defog, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 140 dB.

6.3.5 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. The field of view of the camera shall not be obstructed by the housing. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-67/IP-68 rating for Weather-proof with better dust & dirt protection, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof. The housing shall have built-in heater and blower.

6.4 VSDS LPU

VIDS LPU (Local Processing unit) shall be housed in a cabinet together with power supply and network equipment. The cabinet shall be electrically and mechanically isolated and shall have a degree of protection of IP 55 or higher specified in IEC 60529. If necessary, the cabinet may be provided with a ventilation fan for controlling internal temperature, but the protection code requirements shall be met. A right hinged door shall be provided on the front to realize easy maintenance work. The turning direction of the handle shall be counter clockwise. The power supply unit shall be provided with a circuit breaker. The anti-lightning and surge protection complying with the IEC 61643-1 shall be provided. The cabinet shall be finished with the anticorrosive treatment. The Concessionaire/Contractor shall state the details of the anticorrosive treatment and painting. The Cabinet shall have door open alert feature and alarm.

6.5 Vehicle Actuated Speed Display (VASD)

6.5.1 Function

The speed display shall display the speed of the vehicle in real-time and provide textual or graphical warning to the vehicles exceeding the pre-set speed limit. The speed shall be displayed in green colour if the speed is within the permissible limit for the vehicle class, orange colour if the speed is matching the speed limit, and red if the vehicle is over-speeding. The display shall blink continuously if the speed of

vehicle is more than 120% of the permissible speed limit, along with the message “Over-Speed – Slow down” in the first row of the display. One speed display shall be installed for each lane on both the sides of the road.

Time shall be displayed at the top section of the display in HH:MM:SS (24 hour) format at all the times, even if no speed is being displayed on the VASD. The font size shall be suitable and visible from 100 meters distance. The time on all the displayed shall be synced with the central server.

6.5.2 Specifications

- a. The system shall perform during day and night as well as in adverse weather conditions.
- b. It shall have built in diagnostic functions to quickly assess the validity of speed calibration.
- c. It shall adjust display intensity automatically to suit the ambient light conditions.
- d. It shall be modular in construction for ease of maintenance.
- e. It shall display numeric speed data as well as graphical (standard IRC road warning sign) (preferably) / textual warning.
- f. Measurement:
 - i. Speed range: 0.5 km/h to 200 km/h
 - ii. Maximum Measuring errors: Up to 100 km/h $\pm$ 3 km/h, Above 100 km/h $\pm$ 5 km/h
 - iii. Minimum Monitored section length: 100m
- g. It shall have the facility to log vehicle speed of over- speeding vehicles and transfer them to the ATMS control centre.
- h. The speed display shall be formed using individual modules.
- i. Speed display must be constructed using corrosion resistant panel with LED pixels in row: column matrix.
- j. Scanning/Multiplexing ratio shall be 1/8 or better.
- k. The LED Cluster shall consist of individual LED's rated for out-door use.
- l. Shall support an industry standard communication interface such as TCP/IP on copper, Wi-Fi, and/or fibre optic to help setting the pre-set speed and retrieve log data.
- m. Shall maintain time stamped record (speed and vehicle image) of each case of over speeding in a log file that can be retrieved over the connected network or using a locally connected laptop.
- n. It shall optionally be possible to configure the display to send real time violation event record (speed, and time stamp) over the connected network while recording the same
- o. It shall be possible to control the brightness of displays automatically using built-in light sensors.
- p. All PCB's shall be of FR4 material, 1.6mm thick and LED matrix PCB shall be 2.4mm thick. PCBs shall be of the quality suitable for use in environment conditions specified.
- q. The equipment shall allow local diagnostics via laptop connected to its

communication port.

- r. Display size shall be suitable to display both the speed of the vehicle and warning message simultaneously in two rows.
- s. Brightness intensity shall be 7500 cd per sq.m.
- t. Fault diagnostics shall be provided to include the following as a minimum:

i. Radar Failure

ii. LED Failure

7. Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.1 lux for colour image and black& white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and dual streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.
- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and the Gantry to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.
- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at the gantry to prevent vandalism.
- h. The camera shall be mounted on at a suitable location on the Gantry such that it focuses on the enclosure / cabinet housing the LPU and Li-ion battery bank.
- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

8. Power Supply

- a. The power supply shall be connected from communication rack using the POE or Adaptor.
- b. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium- ion battery bank shall be provided at each location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same stainless-steel cabinet as controller or in a separate stainless-steel cabinet. The solar panel shall have sufficient size to generate the power required. The Concessionaire/Contractor shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage.
- c. The Lithium-ion battery shall provide power for at least for 3 days even if solar power cannot be generated due to the weather condition. The Concessionaire/Contractor shall present the calculation of power consumption and capacity of solar power supply system to be used for the system. The Concessionaire/Contractor shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
- d. Proper earthing shall be provided at each equipment location.

9. Installation

The system will be installed on the gantry at specified locations.

10. Acceptance test

Acceptance test shall be conducted for speed system at the factory (before Site Acceptance test), during installation work and upon completion depending on the test item. Test will be classified into two types, functional and performance test, in addition, trial operation shall be conducted after the Acceptance test.

Section 5 - Digital Transmission System and Communication Cable

1. Digital transmission system

The field / roadside equipment deployed under the scope of this Contract shall be connected with the central equipment at the Traffic Management Centre and sub-centres and data and voice are exchanged between them. Digital transmission system is required to perform the service of data and voice communication. IP based digital transmission system over optical fibre cable shall be provided for this purpose.

The Concessionaire/Contractor shall design, supply, install and test a digital transmission system that satisfies the needs of the component systems in terms of speed, bandwidth and reliability.

2. System configuration

Digital transmission system shall consist of local line transmission system and access line transmission system. The former connects between nodes established along the Highway/ Expressway and uses optical fibre cable while the latter connects roadside facility to the node using optical or metallic cable.

It is specifically noted that when the Highway / Expressway is extended, trunk line transmission system will be introduced for long distance data transmission between the Traffic Management Centre and the offices on the highway / expressway. Digital transmission equipment for trunk line transmission system will not be installed under this project. The local line transmission system to be provided shall be compatible with the standard digital transmission system commonly used in trunk line transmission. The optical fibre cable to be installed along the Project shall have minimum 48 cores to accommodate trunk line system.

All transmission cables shall be optical fibre cable having suitable number of cores except the metallic cable to be used to connect roadside emergency telephones to the nearest exchange or line concentrators.

3. System design

The Concessionaire/Contractor shall undertake the detailed design of the digital transmission system. The design work shall include but not be limited to transmission protocol, network and transmission equipment, type and size of cable, cable splicing, conduit and cable installation work, manhole, hand-hole and pull box at bridge and earth sections.

Digital transmission system shall adopt IP. Suitable media and transmission protocol at Layers 1 and 2 shall be decided type of digital station equipment shall be selected. In developing the design, various factors such as amount and type of data, transmission distance, quality of service (QoS), reliability, latency, and changeover time to backup route shall be considered. Type of optical fibre cable shall also be considered in the design. Packet based transmission system will be preferred than circuit-based transmission system such as Gigabit Ethernet.

Loop topology based on resilient packet ring (RPR) shall be adopted for local line

transmission system for redundant operation. A cut of communication at a point in the loop shall not affect the normal operation of the communication system.

Physically separate optical fibre cables shall be used to for a ring topology and for back up route in the future trunk line transmission system. Compressed image data and data from other devices must be separately allocated to the optical fibre core.

Layer 3 switch will be used at each node to connect local network or device to the local line network. Layer 2 switch will also be used to connect devices to the local network.

In addition to the equipment listed above, the system requires fibre distribution frame and main distribution frame for cable termination, surge arrester or similar surge protection device to protect the equipment from the lightening, and accessories necessary for cable installation. The Concessionaire/Contractor shall supply and install these devices and accessories.

4. Reliability

Digital transmission system shall have high reliability to ensure continuous operation of the system. Bit error rate for the end to end data communication must be 1×10^{-6} or better.

5. Capacity and quality of service

The digital transmission shall have a sufficient capacity in terms of speed and bandwidth to meet the demands to be decided based on the estimated amount of data including digitized voice data at each facility such as Traffic Management Centre, Toll Plazas, sub-centres and service area/wayside amenities. Video signal from the TMCS camera shall be transmitted in H.264/H.265 format and the digital transmission system shall provide sufficient capacity for it. The Concessionaire/Contractor shall estimate the type, amount and location of data transmission need and design the system, equipment and cables that satisfy the demand.

Quality of service (QoS) capability shall be provided to the digital transmission system to ensure smooth and uninterrupted delivery of data for voice and video image transmission required for VIDS, VSDS, and TMCS camera system.

6. System supervision

The digital transmission system shall be equipped with a supervisory function which continuously monitors the system operation and issues an alarm in case malfunction is found. The supervisory shall have the following functions:

- Management of occurrence and recovery of malfunction
- Registration and modification of system configuration
- Registration and modification of network configuration
- Testing of equipment and circuit
- Logging of equipment operation and cable
- Changeover between primary and backup routes

7. Communication Cable

7.1 General

The type of cable for digital transmission system shall be as stipulated below. The cable having suitable number of cores for optical cable and pairs for metallic cable shall be selected.

Two types of cable, optical fibre cable and metallic cable shall be used for digital transmission system along the Highway/ Expressway. In addition, power cable will be installed to provide power to the roadside equipment.

Application	Cable type
Outdoor cable	
Trunk line system	Optical fibre cable
Local line system	Optical fibre cable
Access line system	CCP cable (colour coded polyethylene cable)
Indoor cable	
Data / voice	PVC, SWVP or Ethernet cable

7.2 Specification

Optical fibre cable (OFC) to be installed along the Highway/ expressway (main duct route) shall have a minimum of 48 cores. Branching of optical fibre cable shall be made in such a way that only the cores connected to the facility are taken into the facility and other cores will be bypassed. Splicing of optical fibre cable shall be made with the method that allows re-opening of splicing housing and change of connection. The connection of core shall be made with fusion splicing.

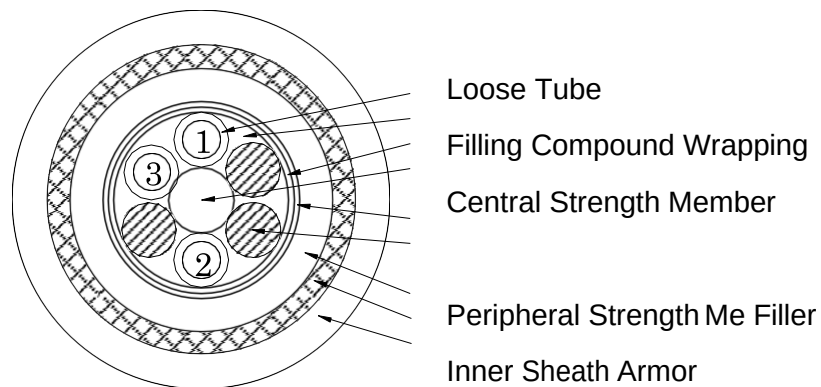
Other materials not specified in this Part shall be based on the Concessionaire/Contractor's own technical specifications, subject to the approval of ITS Engineer. In this connection, Concessionaire/Contractor shall submit, together with Technical Proposal, the technical specifications of main and other materials.

7.2.1 OFC Specification

The optical fibre cable to be supplied and installed under the Concessionaire/ Contractor shall be single- mode fibre optic cable having characteristics meet ITU-T G.652B, or equivalent and specification as below.

No.	Item	Specifications
1.	Cable type	OF-SM 48C OF-SM 8C
2.	Number of cores	OF-SM 48C: 48 cores OF-SM 8C: 8 cores
3.	Mode	Single mode
4.	Cladding diameter	125.0 $\mu\text{m} \pm 1.0$
5.	Coated fibre diameter	245 $\mu\text{m} \pm 10$

6.	Core/cladding concentricity error	$\leq 0.8\mu\text{m}$
7.	Coating/cladding concentricity error	$\leq 12\mu\text{m}$
8.	Cladding non-circularity	$\leq 1.0 \%$
9.	Mode Field Diameter	$9.3\mu\text{m} \pm 0.5$ at 1310nm
10.	Attenuation (cable)	0.36dB/Km at 1310nm 0.25dB/Km at 1550nm,
11.	Zero-Dispersion Wavelength	1300 to 1322 nm
12.	Zero-Dispersion Slope	$\leq 0.092 \text{ ps/Sq. Nm .km}$
13.	Cut-off Wavelength	$\leq 1260 \text{ nm}$
14.	Polarization Mode Dispersion Coefficient	≤ 0.2 at 1310nm
15.	Fibre macro bend loss	$\leq 0.05\text{dB}$ at 1550 nm with 75 mm dia, 100 turns
16.	Fibre macro bend loss	$\leq 0.5\text{dB}$ at 1550 nm with 32 mm dia, 1 turn
17.	Coating Strip Force	$1.3 \leq F \leq 8.9$
18.	Minimum Proof Strength	0.70 (100kpsi) Gpa
19.	Strain	1 %



Specifications for Fiber Optic Armored Cable

7.3 Packing and Delivery

- Packing and delivery of fibre optic cables shall conform to the following:
- Each length of cable shall be coiled on a substantial wooden or steel drum. Standard cable peace length shall be 1000 to 3000 meters.
- After completion of the optical tests, both ends of the cable shall be sealed by a suitable method to prevent the entrance of moisture.
- The starting end of the cable shall be secured on the inside of the drum flange.
- Due care shall be taken during the transportation of the cable drum so as not to cause damage the cable.

7.4 Metallic Cable

The size of CCP cable shall be 0.65 mm or larger. The number of pairs shall be decided taking the future demand after 10 years into consideration. At least spare capacity of 100 % shall be reserved for future use. The minimum number of pairs shall be 50 pairs for the cable to be installed along the Highway/expressway and 10

pairs for the cable other than the above. In case of metallic cable, all pairs shall be connected to the MDF at each facility.

8. Conduit and Cable Work

8.1 General

- a. Conduit work includes underground conduit, conduit attached to bridge and culvert, handhole, manhole, cable rack and associated accessories necessary for cable installation.
- b. The Concessionaire/Contractor shall undertake the detailed design of conduit and cable work including preparation of plain plan of conduit and cable route showing type and length of conduit, number of conduits, type and length of cable, and type of handhole, manhole. The detailed design shall be submitted to the ITS Engineer for his approval.
- c. For the section where electromagnetic induction or electrostatic induction caused by high power transmission line is expected, countermeasures such as use of steel conduit or used of aluminium sheath shall be taken.

8.2 Conduit Works

Scope of work shall cover the following.

Installation of conduit (HDPE PLB duct $\Phi 40\text{mm} \times 2$), Excavation and back filling, onstruction of cable trench, Construction of manhole (as required), Temporary reinstatement of road surface, Safety measures and warning signs during installation works, Power cable duct to be included, Site clean-up and disposal of excess materials.

8.2.1 Installation of Cables

Scope of cable installation work shall cover the following.

installation of cable rack (vertical part of inside building) and ODF (Optical Distribution Frame).

laying of cable into HDPE pipe,

splicing of optical fibres and jointing of cables, splicing of metallic cables and jointing of cables, termination of optical fibre cable and metallic cable, testing of optical fibre cable and metallic cable, preparation of as-built documents,

site clean-up and disposal of excess materials, safety precaution where necessary, preparation of as-built documents, Acceptance test.

8.3 Cable Works

Conduit works facilities built under this Project shall have satisfied to conduit works acceptance before cable are pulling in, specially to cable test piece for conduit (ducts). Conduits shall be rodded by an acceptable method and cleaned before cables are pulled in.

Duct assignment shall be always done carefully to avoid crossing of cables between the duct entrance and cable bearer, and blockage of future access to vacant duct.

In general, placing shall start at the bottom row and handhole/ manhole wall side of

the duct arrangement.

Splicing shall be carried out as soon as possible after placing of the cables.

The extension of fibre optic cable shall be carried out at a constant speed and suitable back tension shall be applied to the drum to prevent hunching.

While under tension, a minimum bend radius of 20 times the outside cable diameter shall be maintained through the use of pulleys and sheaves where required. After pulling, no bend may have a radius, at rest, of less than 10 times the outside cable diameter.

At the splicing point, slack of minimum 3 meter shall be kept on each side of splicing kit. The slack shall be neatly arranged and the requirement for the minimum radius shall be met.

8.3.1 Type and Size of Conduit

Main materials to be supplied by the Concessionaire/Contractor for the implementation of the duct installation shall be in accordance with, or better in quality than, the specification stipulated hereinafter.

8.3.2 Application of Conduit

In general, HDPE (high density polyethylene) pipe having nominal inside diameter of 40mm shall be used. Galvanized steel pipe shall be used in the following cases and in accordance with Concessionaire/Contractor's own specification subject to the approval of ITS Engineer.

Bridge Attachment, b) Culvert Crossing, c) Highway/Expressway road crossing and d) etc.

8.3.3 Warning Tape

"CAUTION: NHA F.O CABLE BELLOW" caution marks in English and Hindi should be printed in every two meters of the yellow warning tape to be placed in the cable trench (100mm width and 0.15mm thickness).

8.3.4 Cable Tag

Cable tag (plastic plate) describing the name of the cable and the origin of cable (cable name, type of cable, interchange name & etc.) shall be attached to the cable

All other materials not specified in this Functional and Technical Specifications shall be in conformity with the Concessionaire/Contractor's own technical specification, subject to the approval of the ITS Engineer.

8.3.5 Depth of Conduit

The covering depth from the top of HDPE pipes and GI pipes to the surface of ground shall be as follows:

Location	Depth
Side-shoulder	165cm
Carriageway	100cm or more

Location	Depth
Highway road crossing, Main road crossing and Interchange area	120cm or more

However, in special case, the depth shall be determined in consultation with ITS Engineer, as per the site conditions and soil type.

8.4 Installation and Construction

Conduit installation works shall be performed in accordance with the specification stipulated hereinafter.

Other installation and/or construction works, the detail of which is not specified in this section, shall be based on this specification and/or the Concessionaire/Contractor's own Technical Specifications, subject to the approval by ITS Engineer.

NHAI / ITS Engineer shall, at any time when deemed necessary during the construction period, carry out inspection and/or tests on the facility under construction and/or the portions of facilities completed by the Concessionaire/Contractor.

Upon completion of conduit section, loose materials such as concrete, mud, dirt, sand, etc. shall be cleaned out from new ducts before testing. 6.0 m cable test piece may be used for main duct sections (cable test piece diameter 35mm) with sharp curve under the condition of the prior approval of the ITS Engineer.

The Concessionaire/Contractor shall apply the Area Log Book in order to facilitate a full supervision on the construction work.

8.5 Handhole and Manhole

The internal sizes of the standard type of Handhole and Manhole shall be as follows:

Type	Number of Ducts	Length (m)	Width (m)	Depth (m)	Cable Bracket
Handhole					
HH-1	1-8	1.20	0.60	0.85	One side
Manhole					
MH-1	1-9	1.80	1.00	1.50	One side

Handhole and Manhole shall be equipped with covers, duct plug, ladders, steps, cable bearers, cable brackets, name plates and pulling irons according to detailed drawings.

8.6 Excavation for Handhole, Manhole and/or Conduit

All excavation shall be done in a thorough and workmanlike manner in accordance with the detailed drawings and the Specifications.

The Concessionaire/Contractor shall obtain all pertinent records from the Electric, Water Supply, and Sewage pipe and other organizations for underground utilities in order to proceed his work and safeguard to other utilities.

During the execution of the work, existing underground facilities are damaged, or any part thereof is disturbed, the Concessionaire/Contractor shall immediately notify of the facts to NHA and owner of the utility and shall be responsible for the rectification of the damaged utility at its own cost. The Concessionaire/Contractor shall indemnify the NHA and its representatives from any loss or damaged caused by the Concessionaire/Contractor during execution of the works. The Concessionaire/Contractor shall cart away all excavated materials except that to be used for backfilling.

9. Inspection and Acceptance test

Site inspection specified herein shall be performed throughout installations and constructions of the various type of conduit facilities.

Should any errors in construction, faulty materials or other evidence of unsatisfactory construction and installation are found in the course of test, the Concessionaire/Contractor shall immediately repair, replace and/or remedy such unsatisfactory items.

The Concessionaire/Contractor shall perform the conduit facility inspection by himself every time to see if the work meets the requirement before the Acceptance test.

Acceptance test specified shall be performed by the Concessionaire/Contractor under the supervision of the ITS Engineer. Necessary equipment and materials for the site inspection and the Acceptance tests shall be provided by the Concessionaire/Contractor at his own expense. Written report including the test results shall be prepared by the Concessionaire/Contractor and verified by the ITS Engineer.

During interim inspection, at least the following test and inspection items shall be performed: Visual inspection of location, dimension, accessories and workmanship of handhole/manhole, Number and type of conduit, Cable test piece passage test, Check of new conduit, Backfilling and temporary reinstatement Acceptance test.

During Acceptance test, at least the following test and inspection item shall be performed: Acceptance test item for handhole, manhole, conduit and optical fibre cable on-site inspection are as follows:

No.	Item	Contents
1	Visual Check	Handhole, Manhole & Conduit Construction/Cable Installation Workmanship/ Installation Practice Compliance to Drawings
2	Optical Line Performance Test	Optical Fibre Attenuation Test (Transmission Loss Measurement by Laser Source & Power meter)/ OTDR (Optical Time Domain Reflectometer) Test (OTDR Measurement both direction and Splice Loss)

3.	As-built Drawings	Verification
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Section 6 - Power and Other Cables, Power conditioning equipment

1. Power Cable

1.1 Type of Power Cable

The types of cables shall be as follows:

No.	Item	Specifications
1.	Outdoor Power Cable	Minimum 1.5 square mm - 22 square mm, 3 cores

1.2 Specification of Outdoor Power Cable

Outdoor power cable shall meet the following specifications:

- 1) Bright annealed, 99.97% electrolytic grade
- 2) Copper conductor (solid/stranded),
- 3) Voltage grade 1100 V,
- 4) Single or multi core cable,
- 5) Flame retardant low smoke (FRLS),
- 6) PVC / XLPE insulated,
- 7) With high oxygen and temperature index
- 8) Armored,
- 9) IS 8130, IS 5831, IS 3975, IS 1554 (Part I) / IS 7098 (Part I) or BS 6346/ IEC 60502

2. Power Conditioning Equipment System

2.1.1 General

- a. This specification lays down the general, functional and technical requirements of the power conditioning equipment.
- b. Power supply rated at 440V, 3 phases will be made available at the Essential Supply Board of the TMC and Sub Centre Building. This supply will be backed up by standby generators to be provided by others; should there be an absence of electrical power.
- c. A power distribution board (PDB) as detailed in the drawing shall be supplied and installed under this Contract. The Concessionaire/Contractor shall provide power distribution board at other locations where necessary and the cost of such power distribution board shall be considered included in the Contract Price.
- d. The Concessionaire/Contractor shall supply and install UPS systems indicated below. All equipment except the equipment with solar power supply shall be provided power through this UPS to make sure that the power is continuously available to all equipment during the interruption of commercial power.

2.1.2 System Configuration

The UPS system shall consist of the following components:

- 1) UPS at TMC, Sub Centers and all Road-side equipment
- 2) Power distribution board at TMC center, sub centers and all Road-side

equipment

3. Type of UPS

- Rating of UPS Type for TMC and Sub-Centers shall be 10KVA, 15KVA or 20KVA.
- The suggested rating of the UPS at each location shall be submitted in the proposed design and BOQ. The Concessionaire/Contractor shall make his own calculation of the rating based on the power requirement of the equipment he supplies and the sound engineering practice. The Concessionaire/Contractor shall submit the calculation and the rating to the ITS Engineer for his approval before the supply of the UPS.

3.1 Installation Location

- All UPS provided shall be online type UPS only with minimum 4 hour back for TMC and sub- centers and 72 hours for roadside equipment. The minimum UPS rating for each system and sub-system shall be as shown in the table below:

No.	Position	For ATMS		Remarks
		UPS Rating (minimum)	Quantity	
1	For Server Rack	10 KVA	4	1 at TMC and 1 at each Sub-center (4 hours backup each)
2	TMC	20 KVA	2	In Parallel Hot Standby configuration (4 hours backup combined)
3	Sub Centres	10 KVA	6	In Parallel Hot Standby configuration (4 hours backup combined)
4	Road-Side Equipment	ATMS Contractor to Propose	1 at each location	With solar panel
				Minimum 72 hours backup

- The Concessionaire/Contractor shall be responsible to calculate the UPS rating required for each location in the configuration mentioned in the table above based on the load of the equipment being proposed. The load calculation for each location shall be submitted in the tender document.

4. Cabinet

4.1 Fabrication

Panel or distribution board shall be wall mounted. It shall be fabricated or readymade with 14/16SWG CRCA Sheet, compartmentalized, double door hinged type. Gasket shall be provided to prevent the ingress of dust and vermin conforming to degree of protection IP- 54 (panel) and IP-43 (distribution board), IP-65 (outdoor) with suitable space & direction for cable entry. Distribution board shall be cleaned with 7 Tank process, powder coated with primer and epoxy paint as per IS 2174/1962 as amended.

4.2 Switchgears & Meters

Construction of 6-Lane Access Controlled Highway from Gogwan Jalalpur village of Shamli district to Dala Majra village of Saharanpur district (Ch. (000+600) to 44+300) total length of 44.9 Km of section Shamli – Ambala Greenfield Alignment on EPC Mode under Bharatmala Pariyojana in the State of Uttar Pradesh.

All switchgears (MCCB / MCB / fuses/ measuring instruments / meters/ indicating lamps / relays / switches) rating, capacity, make, kA rating, dimension shall be as per the type of DB with quick make & break type operating mechanism suitable for rotary operation with suitable extended operating handles with capacity and position marking on door, flush mounted, with suitable spreaders / links for cable connection as per IS 1248, 2208, 4237, 8623, 10118 (Parts I to IV).

4.3 Wiring

All power wiring within panel and distribution board shall be with suitable size flexible copper wire of 1.1kV grade, C.T. & control wiring with 2.5 square mm and 1.5 square mm, respectively with 1.1kV grade with proper lugging, ferruling, and connection with SS Nut - Bolt with adjustable and fixed washer.

4.4 Indication and Marking

All distribution board and panel shall have suitable main name plate, feeder name plate, danger board plate engraved or anodized aluminium type as per IS 2551. All panels and distribution boards shall have earthing node, point or strip similar to busbar as per IS 3043.

4.5 UPS Specification

The UPS system to be provided under the Contract shall comply with the specifications below.

No.	Item	Specifications
1.	Rating in KVA	10KVA, 15KVA or 20KVA
2.	Rectifier design	IGBT charger - Advanced rectifier
3.	Nominal voltage	440 VAC (-20% to +15%) 3 Phase and neutral
4.	Nominal Frequency	50 Hz (+/- 6%) (60 Hz optional)
5.	Waveform	True Sine Wave
6.	Total Harmonic Distortion	<2% on linear load and <5% on non-Linear load (Reference IEC 62040-3)
7.	Crest Factor	3:1

5. Cable Installation Work

5.1 Cable Pulling

- Sufficient care shall be taken, and measures shall be applied during the loading, transportation and unloading of cable drum so as to avoid shock and damage to the cable.
- Appropriate surplus of cable shall be required at inside of handhole/ manhole.
- Cable shall be connected only inside the handhole/ manhole.
- Cable tag (plastic plate) describing the name of the cable (power cable or earthing cable) and the origin of cable (cable name, type of cable, interchange name & etc.) shall be attached to the cable.
- During the installation of cable, the following constraints shall be observed:
- The maximum tension allowed.

- g. The minimum curvature radius allowed: When installing cable at the handhole/ manhole, curvature radius shall be more than 6 times of the diameter of the cable being laid at all times. After cable laying work, minimum radius of more than 20 time of the diameter shall be ensured.
- h. Extension speed of laying:
- i. Towing cable shall be made smoothly without any excessive tension intermittently at the time of laying, and calibration of appropriate apparatus for setting up allowable tension shall be required.
- j. The extension of cable shall be carried out at a constant speed and it shall apply the suitable back tension for a drum to avoid hunching.
- k. Cable in the point in a handhole/ manhole shall have at least 3 m margin complied with curvature radius at every handhole/ manhole and the point of handhole/ manhole terminal equipment shall have the 3 m margin at both sides of branch.
- l. Winding up of Insulating tape for the connecting point of electric wire shall be required.
- m. Connection between electric wire and terminal equipment shall be connected using terminal lug or a screw.

6. Inspection and Acceptance test

Acceptance test specified shall be performed by the Concessionaire/Contractor under the supervision of ITS Engineer.

Necessary equipment and materials for the site inspection and the Acceptance tests shall be provided by the Concessionaire/Contractor at his own expense. Written report including the test results shall be prepared by the Concessionaire/Contractor and verified by the ITS Engineer.

6.1 Interim Inspection

- a. During interim inspection, at least the following test and inspection items shall be performed:
- b. Visual inspection of cable route, cable location, dimension, accessories, cable terminations and cable joints.

6.2 Acceptance test

During Acceptance test, at least the following test and inspection item shall be performed: Acceptance test item for power cable on-site inspection are as follows:

No.	Item	Contents
1	Visual Check	Cable Installation/Workmanship/ Installation Practice Compliance to Drawings
2	Power Cable Performance Test	insulation resistance test, Inductance Capacitance
3	As-built Drawings	Verification

Details of the test item, test procedure and criteria to judge test results shall be proposed by the Concessionaire/Contractor subject to the approval by the Engineer.

Section 7 - Facility Monitoring System

1.Function

Facility monitoring system shall be provided to monitor the operation of facilities on the Highway/ Expressway. The system shall monitor the operation of the following component systems:

- 1) Traffic Monitor Camera System (TMCS)
- 2) Video Incident Detection System (VIDS)
- 3) Probe Data System
- 4) Central processing System
- 5) Variable Message Sign (VMS)
- 6) Vehicle Speed Detection System (VSIDS)
- 7) Adaptive Traffic Signal Control System (ATSC)
- 8) Digital Transmission System
- 9) Power supply system (at building and field)

The functions of facility monitoring system may not be integrated in a single system. They may be achieved by the operation monitoring function of the component systems. The role of the facility monitoring system is to consolidate the monitoring function undertaken by component system, present the system status in a concise manner to the operator and keep the record of system operation. In case any abnormality or malfunction is detected, the system shall issue an alarm together with the information regarding type and location of the trouble so that remedial action can be taken swiftly.

The Concessionaire/Contractor shall design, procure, manufacture, install, test and commission the facility monitoring system that meets the concept and functions stated herein.

2. Operating Status

- a. Items to be monitored and its content differ from one system to another system to be monitored. In general, the condition of the system and device such as 'Normal', 'Error' and 'No Reply' shall be classified in detail.
- b. The system shall have a function to test itself without affecting normal operation of the system being monitored by the system.
- c. Each error or malfunctioned status shall be assigned with severity level for each system. Depending on the severity level, different action shall be taken by the system. For minor errors such as abnormal data from vehicle detector for one interval, error is recorded in the log and no alarm will be issued. For severe errors such as interruption of communication circuit, alarm signal shall be automatically displayed on the system supervisory server overwriting the display being shown.

3. Monitoring

The manner of monitoring shall differ depending on the system and device to be monitored. In general, normal operation shall be confirmed periodically by the monitoring system by sending inquiry command. The time interval of inquiry shall be

adjustable for each component system and its devices. But alarm signal shall be issued immediately by the component system and their devices comprising it to minimize delay.

4. Recording and logging

The facility monitoring system shall keep record of its operation and status of the various systems and devices in a unified manner in the database. All incident and events shall be recorded. Data retrieval software shall be provided to retrieve and display the operating history of the specified systems and devices. The database thus stored will be used to calculate the reliability indicators of the system and device including MTBF (mean time between failures) and MTTR (mean time to repair).

Availability calculation shall be reported in a quarter.

The Formula of calculation of availability is shown as follows.
$$\text{Availability} = \{1 - [(A)/(B-C)] * 100\}$$

Where,

A= Time for which system is down

B = Total Time

C= Scheduled downtime

5. Monitoring signal interface

- a. The Concessionaire/Contractor shall provide necessary number of monitoring signal interface units to receive operating condition and alarm signal from the system or device to be monitored. The interface shall be provided with sufficient number of analog, digital and pulse interfaces. It shall be capable of receiving operating condition signals through interface and sending them to the Traffic Management Centre using FTP, SNMP or DATEX-ASN protocol.
- b. The interface shall be provided with an optical hub or switcher and can be connected to optical fiber cable directly.
- c. The interface shall be equipped with a clock and the clock shall be adjusted using network time protocol (NTP) or simple network time protocol (SNTP).
- d. Some of the monitoring signal interface shall be installed outdoor. The device to be used outdoor shall be capable of withstanding the environmental conditions for outdoor equipment.

Section 8 - Adaptive Traffic Signal Control System

1. General

ATSC system shall be deployed at intersection/ crossing / junction locations along the Highway stretch, such as junctions formed under the flyover, VUP, and underpasses. The locations shall be identified during the site survey by the Concessionaire/Contractor.

ATSC shall be provided at every junction under the VUP and Flyover where signalling system is not available and required by the Traffic Police. In case Traffic signals are available and doesn't require replacement, only RLVD and Automatic pedestrian Detection system shall be deployed.

The quantity provided in the BOQ/indicative list of equipment is tentative and the final quantity shall be derived as per the actual project requirement during the site survey and Detail Design phase and the quantity shall be reduced or increased accordingly.

The primary purpose of these signals will be to provide traffic and transit management services in support of improving congestion and reducing delays at the intersections.

The proposed system shall comply with the functional requirement stipulated in IRC:SP:110:2017.

Training shall be provided to all the concerned stakeholders such as traffic police, NHAI representatives, etc. as per the requirement. The training schedule and procedure shall be finalized in consultant with the ITS Engineer and Traffic Police.

2. ATSC Components

The ATSC to be provided as part of this contract encompass the following components:

1. Traffic Signaling System
2. Red light violation detection system (RLVD)
3. Automatic Pedestrian Detection system (APDS)
4. Traffic Signal System monitoring, control, analytics and management module at TMC integrated with ATMS Software
5. Traffic Signal Controller Cabinets to accommodate traffic signal hardware or red-light enforcement, surveillance cameras, switches, emergency preemption equipment, etc.
6. Vehicular and pedestrian signal heads at every signalized intersection.
7. Traffic Signal Poles – high poles, cantilever poles (mast arms) and gantries
8. Camera based Traffic Detectors
9. Digital Communication System
10. Solar based Power supply with 72-hour backup
11. SPD, Lighting protection, etc.
12. Foundation, conducting, etc.
13. Integration with NMS and FMS
14. Integrate with Smart City ITS Control Rooms/ ICCC, as applicable.

15. Automatic generation of e-challan and SMS service, same as in case of violation detection from VSDS and VIDS system.

Dismantling of existing equipment and installation of new ATSC system shall be in the scope of the Concessionaire/Contractor and no additional cost shall be payable for any dismantling of existing equipment is required at any intersection / location.

3. Operations & Maintenance of ATSC

The Contract shall perform following tasks during the O&M phase:

- a. Finalize the Maintenance SOP developed as part of the proposal using stakeholders' inputs.
- b. provide comprehensive maintenance of the System as mentioned in the Maintenance SOP including cleaning of the Solar panels regularly.
- c. provide comprehensive maintenance of the System as mentioned in the Maintenance SOP including cleaning of the Solar panels regularly.
- d. monitor & evaluate the efficiency of the adaptive control system on a regular basis and developing strategies for enhanced operation.
- e. monitor the ATSC system performance with respect to the entire stretch and traffic management module targets.

4. System Design

The Concessionaire/Contractor shall submit the detail design of following components during the detail design phase for the approval of the ITS Engineer. The design of each component shall be on the bases of the system required for each type of junction / intersection.

- a. Traffic signal design
- b. Traffic signal poles, mast arms and gantries
- c. Traffic signal Heads – vehicular and pedestrian
- d. Traffic Signal Cabinet Assembly
- e. Detection system
- f. TMC Controlled Adaptive Software
- g. Conduits and Junction Boxes

The system shall be designed and installed in accordance with relevant National (Indian) and International technical, safety and environmental standards, specifications and type approvals, including but not limited to current versions of the following documents:

1. Guidelines on Design and Installation of Road Traffic Signals – The Indian Roads Congress, (IRC: 93-1986).
2. Guidelines for Pedestrian Facilities – The Indian Roads Congress, (IRC: 103-2012)

The proposed system shall be fully compatible and seamlessly integrate with the current ATSC and RLVD system being deployed in the concerned smart city or city ITS project or traffic police project, as applicable.

4.1 Design Drawings

The traffic signal design drawings shall specify the location of the following component for every junction:

1. Traffic signal heads
2. Traffic signal cabinet
3. Traffic signal poles
4. Traffic signal conduits and pull boxes
5. Detection system (RLVD, APDS, etc.)
6. Other installed intersection technologies

Following minimum information shall be provided in the traffic signal design drawings:

1. Electrical circuit schedule/table
2. Pole schedule/table
3. Detector assignment schedule/table
4. Phasing Diagram
5. Pole foundation
6. Traffic controller foundation
7. Conduit and pull boxes installation

Traffic signal drawings shall be supplemented with any necessary documents to comply with requirements of the project and prevailing standards.

5. RLVD (Red Light Violation Detection) System

- a. System should be totally digital
- b. The system shall detect and capture vehicle details when: i) It violates the stop line/zebra crossing, ii) It violates the red-light signal
- c. System shall be Non-Intrusive. It shall have the option of working without integration with traffic controllers but Concessionaire/Contractors should also provide undertaking that their system also works with integration of controllers.
- d. Red light system shall be a completely fair system with all evidence captured before and after the red-light jumping infraction has happened.
- e. Each camera system shall cover road width of 3.5 meter or 7 meter or 10.5 meter and above.
- f. The Camera specifications shall be same as specified in the VIDS section for bullet/box camera and VSDS section for ANPR camera.
- g. Red light system should detect vehicle presence to act as input to control the Traffic Controller.
- h. System can be a composite unit with all components inside the IP66 box OR comprised of camera or other units mounted on poles or gantries with controller and processors at side poles to make sure all lanes of the road are covered.
- i. System should be able to recognize the entire event by which the same can be justified automatically by fetching the number plate of cars in violation.
- j. The system shall have alert generation feature as per the requirement of the Traffic Police, the same shall be finalized after discussion with the concerned

enforcement agencies of the state in consultant with the ITS Engineer.

- k. Certification: UL (Underwriters Laboratories), BIS (Bureau of Indian Standards) and RoHS compliant certificate.

6. ATSC and RLVD Module in TMC

- a. The system should provide function to the Operator to manually check the entry in application and edit the numbers which may be wrongly OCR- read, before the numbers are fed to the e- Challan generating sub-system. An audit trail should be maintained to record such editing activities.
- b. No deletion or addition of data without validation, proper password protection. Deleted data if any to be inserted automatically in a separate table.
- c. The system should provide facilities to search for the cases of violations that occurred during any specific span of time and provide a statistical analysis of the number of such incidents occurring during various days of the month.
- d. A customized web-based dashboard to be developed for all types of master data entry and for customized reports with graphical analysis.
- e. System can be integrated with existing e-Challan generating systems with fine generated for each infraction with multiple images clearly showing color of red-light signal and violation (i.e. color image of context camera), date, time, vehicle registration number, classification of offence etc. Image having water mark of Date & time, Place, Latitude & Longitude to be uploaded.
- f. Integration with RTO database, Vaahan databased, and police control rooms etc. to be integrated by the Concessionaire/Contractor.
- g. It is desirable that the proposed solution should already be in use with enforcement authorities and is used for generating fines. End user certificates for proper working shall be submitted, if applicable.

Operation and Maintenance of ATMS

1. General

1.1 General Requirements

Operation and Maintenance of Advance Traffic Management System (ATMS) shall be executed in the manner originally intended, that is to collect road, traffic and weather condition data, process and analyse the data into useful information, disseminate the information to road users in accordance with the procedures as set forth herein and instructions given by the Engineer. The system shall be in operation for 24 hours a day and 7 days a week without interruption. The Concessionaire/Contractor shall not divert and modify the procedure without written approval by the NHAI.

The purpose of Operation and Maintenance of ATMS is to keep the traffic management system and related facilities in operation in the manner originally intended, that is to collect road, traffic and weather condition data, process and analyse the data into useful information, disseminate the information to road users and to prolong the life of the system and the equipment. Therefore, time is of essence. Repair must be done in a timely manner.

The specifications described herein shall be considered the minimum standards to be followed for the maintenance and repair of all equipment and software covered under the Contract. Unless otherwise specified, the standards for equipment and equipment performance shall be in accordance with the Technical Specification.

1.2 Scope of Work

Apart from installation of ATMS system, the scope of contract also includes Operation and Maintenance of ATMS for a period of 5 years from the date of Completion of ATMS system. Except otherwise specified in the Operation & Maintenance Specifications of NHAI's Requirements, it is the Concessionaire/Contractor's responsibility to provide sufficient manpower to implement flawless execution of ATMS in operation in the manner originally intended, that is to collect road, traffic and weather condition data, process and analyse the data into useful information, disseminate the information to road users and undertake the Services that are not specifically mentioned in these requirements but essential for the safe and efficient traffic operation on the Project. The Concessionaire/Contractor shall maintain qualified staff at the Traffic Management Centre (TMC), Sub Centre and other places wherever required necessary, tools, shop facilities, equipment, consumables, transportation and materials and perform all works necessary to maintain in good working manner all Advanced traffic management system and associated equipment.

The scope shall also include the following:

1. House Keeping of Traffic Management Centre and Sub Centre by a house keeping supervisor, housekeeper, security guard, cleaner, gardener and miscellaneous workers.

2. Administrative work such as purchases, account, human resource, public relation
3. Building maintenance and recurring charges such as electricity bills, water bill,

Operation & Maintenance services are required to cover the system of Traffic Management Centre, Sub Centre system and following sub system.

- 1) Traffic Monitor Camera System (TMCS)
- 2) Video Incident Detection System (VIDS)
- 3) Automatic Traffic Counter and Classifier (ATCC)
- 4) Travel Time Measurement System (TTMS)
- 5) Central Processing System
- 6) Variable Message Sign (VMS)
- 7) Vehicle Speed Detection System (VSD)
- 8) Adaptive Traffic Signal Control System (ATSC)
- 9) Digital Transmission System and Communication Cable
- 10) Power and Other Cables
- 11) Facility Monitoring System

Apart from above scope of operation and maintenance of ATMS, following works are out of scope from Operation and Maintenance of ATMS, but scope of NHAI and/or their Concessionaire/Contractor.

- 1) Operation and Maintenance of TMS (Toll Management System)
- 2) Traffic Management work on the road such as patrol by patrol-vehicle, maintenance of road, recovery of accident, cleaning of road.
- 3) Civil and Electrical work other than for ATMS TMC, Sub-centres, and field equipment.

2. Operation & Maintenance Service Proposal

The Concessionaire/Contractors shall describe the methodology and outline to execute proposed Services both Operation & Maintenance in sufficient detail in his Services Proposal to enable the NHAI to evaluate the technical capability and qualification of the Concessionaire/Contractor and to judge whether the proposal is adequately responsive or not.

The Concessionaire/Contractor shall update and furnish the Service Proposal two (2) months before expected starting date of Operation period for approval by NHAI.

The Services Proposal shall describe the operation and maintenance activities taking Manufacturer or OEM recommendations for all hardware and software into consideration and shall be written in the same sequence as the NHAI's Requirement. Where the supporting documents such as brochure, article, report, or paper are provided, they shall be attached at the end of the proposal or in a separate volume and a cross reference shall be prepared. The Services Proposal shall be written in English.

The Concessionaire/Contractor shall prepare a list of equipment to be covered by

the maintenance based on the actual configuration and quantity of the equipment. If the Concessionaire/Contractor provides any additional equipment not specifically mentioned in the NHAI's Requirements to complete the Advanced traffic management system required under the Contract, they shall be included in the scope of maintenance work and the Concessionaire/Contractor shall prepare and submit to the Engineer the revised list for his approval.

This plan shall be updated as necessary during the O&M period so as to reflect the actual conditions of O&M.

2.1 Operation Service Proposal

The contents of the Services Proposal shall include but not limited to the following:

1. Scope of services to be rendered
2. System coverage area and list of equipment
3. Concessionaire/Contractor's general obligation
4. Organization of operation team
5. Operation procedure of sub-systems
6. Records and reports to be prepared by the Concessionaire/Contractor
7. Concessionaire/Contractor's personnel and personnel management
8. Operation manual
9. Training of Concessionaire/Contractor's personnel
10. Safety, security and protection of environment
11. Ability to track performance and operation activities
12. Inspection and evaluation

No cost information of the services and operation shall be included in the Services Proposal.

2.2 Maintenance Service Proposal

The contents of the Maintenance Services Proposal shall include but not limited to the following:

1. Scope of services to be rendered
2. System coverage area and list of equipment
3. Concessionaire/Contractor's general obligation
4. Organization of maintenance team
5. Maintenance manual
6. Checklist for Preventive Maintenance tasks on each device
7. Inventory of devices
8. Work order management capabilities
9. Level of Service and device inventory
10. Ability to track performance and maintenance activities
11. Establishing criteria for devices, equipment and systems regarding mean time failure
12. Equipment needed for performing diagnosis on ITS field devices
13. Schedule cross training activities to improve the overall skill level of ATMS technicians

3. Requirements for ATMS Operation Services

The various type of operation related services to be performed by the Concessionaire/Contractor shall include the following:

3.1 ATMS Operation

The ATMS Operation shall be executed in accordance with the procedures as set forth herein and instructions given by the NHAI. The system shall be in operation for 24 hours a day and 7 days a week without interruption. The Concessionaire/Contractor shall not divert and modify the procedure without written approval by the NHAI.

3.2 Briefing at shift change

Shift time of operators shall be arranged in such a way that there will be an overlapping period of at least 15 minutes. During the overlapped period, new operation team shall be briefed by the previous operation team as to the following:

- 1) General traffic condition
- 2) Weather condition
- 3) Existing incidents and accident being disposed of
- 4) On-going and scheduled work on the Project
- 5) On-going and scheduled event on the Project and radial roads connected with the Project interchange
- 6) Messages being displayed on VMS
- 7) Equipment malfunctioned and the status of maintenance work
- 8) Other matters that need attention of the operation team

3.2.1 Confirmation of equipment condition

At the start of a shift, operators shall confirm the condition of all equipment through operation or through the consoles. If there is a new failure that was not reported by the previous shift team, the operator shall record it and report it to the maintenance team for proper maintenance action.

During the operation of the system, if the operator detects any abnormality of the equipment, software, or database, he shall report it to the maintenance team for proper maintenance action. The operator shall refrain from manipulating equipment, modifying operating parameters, reloading software or other action without instruction by the maintenance staff when abnormal or defective behaviour of the equipment or software is found.

If the fault signal or no diagnosis signal response from roadside equipment is received at Traffic Management Centre, operator shall contact the maintenance team and report the location and status of equipment with failure.

3.3 Operation of Emergency Telephone (“1033”)

3.3.1 System Setup

The system shall be set to automatic recording mode and all calls shall be recorded automatically. No recorded conversation shall be deleted without the written consent

of the NHAI.

3.3.2 Operation

3.3.2.1 Call reception

When operator receives a call from “1033”, he shall confirm the following information from the caller:

1. Caller’s ID
2. Type of incident (accident, break-down, puncture, out of fuel, fallen object, etc.)
3. Location (kilo post and direction)
4. Request for action

In the case of accident, the followings shall be confirmed in addition to items (1) through (4) above.

1. Type and severity of accident
2. Number of persons injured
3. Necessity of ambulance, wrecker and/or fire brigade
4. Possibility of drivability of vehicle involved in the accident

In the case of breakdown, the followings shall be confirmed in addition to items (1) through (4) above.

1. The lane where that broken-down vehicle is stopping
2. Vehicle type
3. Reason of breakdown
4. Necessity of wrecker or crane

The operator shall inform the caller to implement temporary safety measures such as placing safety triangle or waving flag to prevent secondary incident and advise the caller to stay at a safe place.

In the case of simple inquiry such as location of exit for specific destination, the operator shall provide necessary information to the caller.

3.3.1.2 Countermeasure

The operator shall inform the patrol team of the incident so that they can take proper actions at site. If a call involves request for assistance such as dispatching wrecker, the operator shall inform the relevant agencies and request appropriate action to be taken.

3.3.1.3 Message on variable message sign

If the incident reported is the type that affects traffic flow or traffic safety on the Project, the operator shall provide incident information and display the incident information on the VMS of suitable location as per the operating procedure of VMS.

3.3.1.4 Reporting

The operator shall fill up the prescribed incident form for every incident that requires

actions to be taken by the NHAI, operator or other agencies.

When operator receive a call from patrol team or other related agencies regarding completion or clearing of incident, operator shall remove the incident message.

3.3.1.5 Mobile communication

The operating procedure from the mobile communication shall be same as that for “1033” emergency call system. If operator receives a call from a road user or patrol team through mobile phone, the operator shall act in a same manner as a call from “1033”.

3.4 Operation of Traffic Monitor Camera System (TMCS)

3.4.1 System Setup

Under normal condition of the Project, the TMCS system shall be set to sequential display mode in which video image from all TMCS cameras is sequentially displayed on the multiple video monitors. The number of monitors used and scanning interval of each video camera is user selectable.

Under normal condition of the Project, the TMCS cameras shall be set at home position to enable automatic incident detection.

Image recording function shall be set to ON and image from all TMCS cameras shall be recorded automatically.

3.4.2 Operation

3.4.2.1 Monitoring

The operator shall from time to time watch the TMCS monitor which sequentially displays video image from all cameras at pre-set interval to monitor and confirm normal traffic flow.

If any abnormality is found in the video image, the operator shall discontinue sequential changeover mode and select and fix the camera that captures the scene of incident and observe the incident. If the incident is the type that requires assistance, the operator shall inform relevant agencies of the incident and request appropriate action to be taken.

If a report of incident is received and incident location is within the coverage area of a TMCS camera, the operator shall select the TMCS camera of incident location, operate the camera and focus on the incident to monitor to get first-hand information of the incident.

3.4.2.2 Incident detection

If the Video Incident Detection System (VIDS) detects an incident such as a vehicle moving in reverse direction, VIDS console issues an alarm and incident image will be displayed on the VIDS console monitor and Graphics Display.

The operator shall request Mobile operator to contact the relevant agencies such as patrol team, traffic police, fire brigades, ambulance or wrecker service, explain briefly

the incident, and request them to take necessary action immediately.

3.4.2.3 Variable message sign

If the incident detected and reported is the type that affects traffic flow or traffic safety on the Project, the operator shall operate VMS console and display the incident information on the VMS of suitable location as per the operating procedure of VMS.

3.5 Operation of Automatic Traffic Counter-cum-Classifier (ATCC) System and Travel Time Measuring System (TTMS)

3.5.1 System Setup

No specific system setup is required for ATCC and TTMS once its normal operation is confirmed at the time of system commissioning, as no additional hardware or filed equipment has been installed on the Project for ATCC and TTMS functionalities. The ATMS Software processes the data from ANPR and VIDS cameras for traffic counting and classification, and travel time estimation. However, threshold values that are used to detect abnormal traffic conditions shall be reviewed from time to time to confirm that the values are appropriate.

3.5.2 Operation

3.5.2.1 Monitoring

Operator shall from time to time but at least once an hour checks the ATCC and TTMS data for any abnormality. If abnormal data are found, the operator shall confirm whether the actual traffic flow is different from the normal, or the data is erroneous. If the data is found erroneous, the operator shall inform the maintenance team for further investigation.

3.5.2.2 Abnormal traffic condition

If the ATCC and TTMS module detects a traffic flow parameter at a lane or section is lower or higher than the predetermined threshold, the ITS console issues an alarm to the monitor display as abnormal traffic condition.

If an alarm is issued, the operator shall capture the image of traffic by TMCS at the sensing area and confirm whether the abnormal data is caused by the abnormal traffic condition or by ANPR equipment failure.

If any incident is identified by the TMCS system and requires attention or help, the Traffic operator shall contact the relevant agencies such as patrol team, traffic police, fire brigades, ambulance etc. for their action.

After the contact with the relevant agencies, operator shall display adequate messages on the VMS at adequate location and direction.

When Traffic operator confirms that the traffic condition has become normal, operator to remove the messages or change the message with second priority. Operator shall also inform the relevant agencies of the termination of the incident.

3.5.2.3 Monthly review

At the end of every month, the operator shall go through the data collected by the ATCC and TTMS for any abnormality that could have been overlooked during daily operation. If an abnormal data is found, the operation shall further examine the data and determine whether the traffic condition became abnormal due to an incident or the ANPR equipment was defective. If any abnormality that is attributable to erroneous system operation is found, the operator shall inform the maintenance team for further investigation.

3.6 Operation of Variable Message Sign (VMS) System

3.6.1 Type of information provided

Different types of message will be displayed on the VMS. These types are summarized below. With regard to the message format, the sample messages presented in “IRC:SP: 85-2010, Guidelines for Variable Message Signs, Annex-B” can be referred.

Social messages shall not be displayed on the VMS at any time. Only the messages useful for the user to provide them the information / alert / warning for any incident, road closure, traffic jam, over-speeding alerts etc. or travel time shall be displayed on the VMS. Travel advisory or travel time shall be displayed when there is no alert / warning is required to be disseminated to the commuters.

3.6.2 Advance warning message

Advance warning message gives the road users running at upstream section an advance notice of the incident at downstream section. The incident includes traffic congestion, slow traffic, accident, stalled vehicle, lane closure, fallen object, work zone and weather conditions. The message is effective in reducing possibility of secondary incidents.

3.6.3 Advisory message

Advisory message provides the road users with useful information about a specific problem along their route. This information allows the road users to change their speed or lane in advance of the problem area, or the road users may elect to voluntarily take an alternative route to their destination.

3.6.4 Early notice

Early notice informs the road users of a planned event such as road work on the Project or the closure of an interchange. This type of message has lower priority than other types of message and will be displayed only when there is no real-time message to be shown.

3.6.5 Language used

Three languages, English, Hindi, and another one local language will be used for VMS. Thus, the VMS operator shall be fluent in these languages. Except short message, messages will be displayed in one of the three languages. Message shall carry the same meaning regardless of the language used. For short message that

can be expressed in one line, the same message may be displayed simultaneously in three lines.

3.6.6 Message Layout

Standard layout shall be followed consistently to express information for easier understanding by the road users.

3.6.7 Message Composition Method

TCC operator can choose message creation from three (3) methods as indicated below.

1) Combination of pre-defined message

The word which are frequently used such as “accident”, “congestion”, “construction work”, “slow down” and so on are used to compose a message combination by selection at VMS console. They contain words indicating location, event and instruction.

2) Ready-made message

VMS operator may select one of the ready-made messages stored in VMS console.

3) Manual composition

Any message which VMS operator cannot select from VMS console; operator can create any message through keyboard.

4) Graphic symbols

VMS operator may provide a graphic symbol that graphically represent an incident and help Project road users to understand instantly without reading messages.

3.6.8 Message display

Upon reception of incident information from other operators or directly from other agencies, the VMS operator shall display proper message on the VMSs at adequate locations and direction without undue delay.

If the VMS on which new message is to be displayed is already showing a message, the operator shall evaluate the priority of the current and new incidents and decide whether the message being displayed is replaced with the new message or not.

The incident that exists at immediate downstream section shall have higher priority than the incident that is located more than one section away in general. If there are two incidents in a same section between two interchanges, incident of higher severity will take precedence over the incident with lower severity. If there are two incidents of same severity, incident nearer to the VMS shall be selected.

3.6.9 Message removal

Upon reception of the notice that an incident for which a message is displayed has been resolved, the operator shall remove the message or replace with another message immediately. The message of the incident that has been resolved shall not be displayed unnecessarily.

The operator shall check the effectiveness of all the messages being displayed at every 15 minutes and confirm the message needs to be continued or removed. The operator shall remove the message or replace with another message if the message being displayed is no longer applicable.

3.6.10 Message Providing Area

For an incident occurred, not all VMSs are required to display the message related to the incident. The message of an incident shall be displayed on one or more VMSs starting from the VMS located immediately upstream of the incident location. The higher severity of incident, the more VMSs will display the message about the incident. In other words, the number of VMSs on which message about an incident is displayed depends on the severity of incident and distance from the incident location to VMS location.

3.7 Security & related Incident Management Service

The ATMS Project shall be designed for an end-to-end multi-layer security blanket to protect applications, services, data and the infrastructure from malicious attacks or theft from external (through internet) and internal (through intranet) hackers. Using Firewalls and Intrusion detection systems such attacks and theft should be controlled and well supported (and implemented) with the security policy. The virus and worms attacks should be well defended with Gateway level Anti-virus system, along with console level Anti-virus mechanism. ATMS should be designed to make use of the Secure Socket Layer (SSL)/Virtual Private Network (VPN) technologies to have secured communication between Applications and its end users. Furthermore, all the system logs should be properly stored & archived for future analysis and forensics whenever desired.

These Service Levels would be calculated for each of the following types of incidences:

a) Virus Attack

Any virus infection and passing of malicious code shall be monitored at the gateway level or user complains of virus infection shall be logged at the help desk system and collated every quarter.

b) Denial of Service (DoS) Attack

Non-availability of any services shall be analysed and forensic evidence shall be examined to check whether it was due to external DoS attack.

c) Intrusion

Intrusion is an illegal act of entering, seizing, or taking possession of data hosted by ATMS. Compromise of any kind of data hosted by ATMS.

d) SPAM

SPAM is an unsolicited bulk message, especially advertising, indiscriminately. SPAM statistics on monthly basis shall be monitored through reports generated by Anti-SPAM software.

3.8 Records and Reports

The Concessionaire/Contractor shall prepare and submit the various reports as stipulated herein in a form mutually agreed. Each report shall contain as a minimum the information listed.

For every incident reported, the operator in the TMC shall gather the information about the details of incident and site condition. List of Incident summarized the information to be collected for different type of incident shall be prepared by Concessionaire/Contractor.

Operator shall prepare the following reports:

- a) Daily report
 - 1) List of incidents responded by incident category
 - 2) Contact summary (numbers by category) with Emergency caller, patrol team, traffic police and other relevant agencies
- b) Monthly report
 - 1) Number of contacts with Emergency caller, patrol, police, NHAI and others for each day.
 - 2) Number of incidents occurred by category for each day
 - 3) Number of road closure each day by reason for closure
 - 4) Number of emergency contact call
 - 5) Number of other contacts

Operators who responded to a call (such as emergency call) shall prepare the reports listed below. The report shall be compiled immediately after responding to the call and shall not be left unrecorded.

- c) Emergency Response Report
 - 1) Incident location
 - 2) Weather
 - 3) Road condition
 - 4) Vehicle condition
 - 5) Contact record
 - 6) Dispatch record
 - 7) Traffic regulation implemented
- d) Call Record
 - 1) Time
 - 2) Party contacted
 - 3) Incoming or outgoing
 - 4) Call content
- e) Clearing/Recovering Record of Object on Road
 - 1) Time when information is received
 - 2) Receiver
 - 3) Contact source
 - 4) Caller
 - 5) Type or kind and name of object

- 6) Location and direction (clockwise/counter clockwise)
 - 7) Lane number
 - 8) Time cleaning is ordered
 - 9) Name of person instructed
 - 10) Concessionaire/Contractor to which clearing is requested
 - 11) Time of arrival at site
 - 12) Time of clearing work completion
- f) Record of Traffic Regulation
- 1) Time when information is received
 - 2) Location and direction (clockwise/counter clockwise)
 - 3) Lane number
 - 4) Regulation applied
 - 5) Time started and time restored
 - 6) Other information
- g) Ambulance Dispatching Report
- 1) Date and time
 - 2) Reason for dispatch
 - 3) Location and direction (clockwise/counter clockwise)
 - 4) ID of ambulance dispatched
 - 5) Service rendered
 - 6) Entry and exit interchange
- h) Fire Engine Dispatching Report
- 1) Date and time
 - 2) Reason for dispatch
 - 3) Location and direction (clockwise/counter clockwise)
 - 4) ID of fire engine dispatched
 - 5) Service rendered
 - 6) Entry and exit interchange

Operator at day shift shall hand over all reports to the night shift except daily report. When night shift finishes the duty, all reports shall be filed, and their copy shall be submitted to the NHAI.

The Concessionaire/Contractor shall also prepare and submit to the NHAI as minimum the following deployment reports:

- a) Duty plan of the operation team with the name of traffic management chief and operators on a weekly basis.
- b) Daily attendance record with In-time and Out-Time for all Concessionaire/Contractor's staff working at Traffic Control Centre.
- c) Daily report of operation as stipulated in the operation manual and as agreed with between NHAI and Concessionaire/Contractor.

The reports mentioned above are a minimum requirement. The NHAI reserves the right to reasonably demand more reports other than those listed above after the commencement of Services by the Concessionaire/Contractor

3.9 Customer Assistance and Close coordination with other organizations

ATMS operator shall provide such information as to the road condition, traffic condition, expected travel time, and route guidance to the Project user through Emergency call or mobile phone if requested by the Project user as part of customer service.

ATMS management (operation and maintenance) must be conducted with close coordination and cooperation with other agencies concerned. Liaison and coordination among related agencies such as traffic police, ambulance and fire brigades must be maintained all the time.

4 Concessionaire/Contractor's Personnel

4.1 Concessionaire/Contractor's Key Personnel

For the purpose of discharging its obligations under the Contract, the Concessionaire/Contractor shall recruit and deploy the specified number of key personnel of suitable qualification and experience. The Concessionaire/Contractor shall ensure that the key personnel deployed are of good health, of highest integrity, punctual, well dressed, well behaved and of qualification and experience prescribed hereunder.

The frequent replacement of key personnel is not desirable unless they are found involved in malpractices or non-compliances. However, a permission of replacement of key personnel shall be obtained from the ITS Engineer / NHAI in advance together with the request for approval of replacement. The ITS Engineer / NHAI, if satisfied with the reasons submitted to him, may allow such replacement after verifying the CVs strictly in accordance with the requirements.

4.2 Deployment of Personnel

The Concessionaire/Contractor shall recruit and deploy the suitable number of traffic management chief and operator. The minimum number of the staff that the Concessionaire/Contractor shall deploy is presented in the preceding section of these NHAI's Requirements.

The Concessionaire/Contractor shall furnish to the NHAI, in addition to the list of key personnel provided with the tender, a list of persons deployed for the purpose of discharging its obligations under the Contract, containing all the details like their educational qualifications, experience, training undergone, health condition, personal residential addresses and recent photograph.

The personnel to be appointed shall not have any previous criminal record. A certificate to this effect from concerned State Police Authorities shall be made obligatory for verification prior to appointment at Traffic Control Centre.

The NHAI reserves its right to object to the deployment of any personnel for any reason. In such case, the person or persons being objected to by the NHAI shall be removed by the Concessionaire/Contractor forthwith and replaced within a day from such removal.

The NHAI shall not be liable for any misconduct or misdeeds or any act or incident

involving the Concessionaire/Contractor or any of its personnel in any criminal or civil case. The Concessionaire/Contractor shall be responsible for consequences and if any such incident takes place, the Concessionaire/Contractor shall forthwith intimate the said incident to the NHAI.

4.3 Relationship between Concessionaire/Contractor's staff and NHAI

The Concessionaire/Contractor specifically agrees that the personnel deployed by it, will not in any way claim employment with the NHAI. The Concessionaire/Contractor shall be solely responsible for any dispute raised by the personnel deployed by him either during the term of the Concessionaire/Contractor or thereafter.

In all circumstances it is clearly understood by the parties that the personnel deployed by the Concessionaire/Contractor shall have no connection whatsoever with the NHAI and the relationship of NHAI and Employee shall be only between the Concessionaire/Contractor and the personnel deployed by it.

4.4 Welfare of Concessionaire/Contractor's Employee

The Concessionaire/Contractor shall be solely responsible and liable for complying with statutory liability for welfare of the employees such as ESI, EPF, workmen's compensation, wages, bonus medical leave, etc.

However, if considered necessary, the NHAI shall have every right to enquire and seek documentary evidence from the Concessionaire/Contractor to confirm, whether all the statutory dues like ESI, EPF, minimum wages, weekly offs, bonus, medical leave, workman compensation and any other entitlements, in accordance with the statutory dues applicable in the area are being paid.

4.5 Uniform and Name-plate

The Concessionaire/Contractor shall provide uniforms to the persons engaged in ATMS Operation Services at Traffic Control Centre as approved by NHAI. All staff personnel of the Concessionaire/Contractor shall wear the uniform and nameplate when on duty without exception. The nameplate shall bear the name and designation along with the name of toll collecting Concessionaire/Contractor.

4.6 Operation Manual

The Concessionaire/Contractor shall prepare and submit to the ITS Engineer / NHAI for approval, the following operation manuals for their staff two (2) months before the expected starting date of O/M period:

- 1) Emergency call /mobile operating manual
- 2) TMCS/VMS operating manual
- 3) Traffic/System operating manual
- 4) Control Room (TMC) and Sub-centre operating manual

The manual shall describe the organizational setup of the Concessionaire/Contractor, the authority and responsibility of each position, person to report, operation procedure of equipment comprising ATMS, report to be prepared and other details that staff at each position must follow.

4.7 Training

The Concessionaire/Contractor shall conduct training of the staff as specified herein at the time of new recruitment and also from time to time to ensure high quality ATMS Operation Services. The training shall consist of classroom lecture using manual and hands-on training using the Advanced Traffic Management System equipment.

The training shall include but not be limited to the following subjects:

- a) Basic of traffic engineering
- b) Standard incident disposal procedure
- c) System log-in, log-out procedure of ATMS
- d) Each console and console operation
- e) Printer operation
- f) Access Control System operations and maintenance
- g) Storage device operation
- h) Network equipment operation
- i) Power supply equipment operation

The Concessionaire/Contractor shall describe the contents and the expected duration (number of hours) of the training in his Service Proposal.

4.8 Safety, Security and Protection of Environment

4.8.1 Safety of Staff Deployed

Throughout the period of Contract, the Concessionaire/Contractor shall have full regard for safety of all persons entitled to be upon the Traffic Control Centre area and for the avoidance of danger to such persons specially from moving traffic.

All staff employed by the Concessionaire/Contractor shall receive the training on the work area safety before assigned to the position. The Concessionaire/Contractor shall provide all necessary safety equipment such as reflective vests, hardhats to the persons.

5 NHAI's Equipment and Property

5.1 Provision of Equipment and Property

In order to enable the Concessionaire/Contractor to discharge its duties of ATMS Operation Services efficiently and uninterruptedly, the NHAI shall provide such infrastructural facilities including Advanced Traffic Management System hardware and software as may be considered appropriate by the NHAI.

5.2 Care of Equipment

The Concessionaire/Contractor shall use the NHAI's equipment and property that the Concessionaire/Contractor is allowed to use with utmost care and attention. If the equipment or property under custody of the Concessionaire/Contractor becomes inoperative or defective due to the inappropriate operation or use of them by the Concessionaire/Contractor's staff, the Concessionaire/Contractor shall repair or replace them at his own cost after obtaining the instruction from the NHAI as to the remedial measure to be taken.

If any liability or obligation with regard to the repair or replacement of NHAI's equipment and property is remained unfulfilled by the Concessionaire/Contractor at the time of return upon termination of the Contract, the amount necessary for the repair or replacement shall be deducted to the payment due to the Concessionaire/Contractor.

All consumables including but not limited to the printer paper and printer toner shall be arranged and purchased by the Concessionaire/Contractor at his own cost.

6 Inspection and Evaluation

6.1 Inspection

The NHAI / ITS Engineer reserves the right to conduct inspection of the Concessionaire/Contractor's work at any time without prior notice, to check, observe, and witness the activities of the Concessionaire/Contractor at Traffic Control Centre.

The Concessionaire/Contractor shall permit the NHAI's Representative at any time or times during the execution of the Contract to enter upon any place where the Concessionaire/ Contractor is allowed to access within the NHAI's premises for the purpose of inspection or for any other legitimate purpose. The Concessionaire/ Contractor shall give all required information and inspection of records to the Engineer regarding the operation of the Advanced Traffic Management System, if asked for.

The purpose of the inspection is to monitor the Concessionaire/Contractor's activities and to ensure that all the activities required under the Contract are being carried out properly by the personnel deployed by the Concessionaire/Contractor.

The NHAI may exercise any check control to ensure discharge of various obligations by the Concessionaire/Contractor under the Contract including but not limited to following:

- a) Adherence to operation procedure stipulated in the operation manuals;
- b) Promptness and responsiveness to Emergency call;
- c) Promptness and adequateness to communicate with other organizations;
- d) Handling of the system and equipment;
- e) Adequateness and promptness of VMS message;
- f) Adequateness of record keeping;
- g) Cleanness and tidiness of the Traffic Management Centre and the rooms that are used by the Concessionaire/Contractor's staff;
- h) Manner and politeness of Concessionaire/Contractor's operator toward Emergency callers and Project users;
- i) Traffic safety awareness; and
- j) Any other check or control as considered appropriate by the NHAI.

6.2 Evaluation by NHAI

The NHAI will conduct from time to time the evaluation of the ATMS Operation Service provided by the Concessionaire/Contractor under the Contract based on the

performance of service level parameters specified in Service level Table.

7. Requirements for ATMS Maintenance Services

The various type of maintenance and repair works and related services to be performed by the Concessionaire/Contractor shall include the following:

7.1 Preventive Maintenance

The Concessionaire/Contractor shall perform the preventive maintenance of all equipment and software supplied under the Contract in accordance with the preventive maintenance schedule to be developed by the Concessionaire/Contractor and approved by the Engineer.

7.1.1 Inspection Item for Preventive Maintenance

The Concessionaire/Contractor shall prepare and submit to the Engineer a list of inspection items for all preventive maintenance work under the Contract two (2) months before the expected starting date of O&M period. The inspection item list shall indicate the type of inspection to be performed daily/weekly, monthly, bi-annually and annually. The inspection item shall cover all the equipment to be supplied under the Contract.

7.1.2 Schedule for Preventive Maintenance

The Concessionaire/Contractor shall prepare and submit to the NHAI a schedule for all preventive maintenance work under the Contract two (2) months before the expected starting date of O&M period.

The schedule shall be in sufficient detail to indicate which part of the monthly inspections is to be performed in each week and which part of the bi-annual and annual inspections is to be performed in each month and the number of maintenance engineers and technicians to be assigned to the work.

The Concessionaire/Contractor will be required to revise the schedule if the workload and the manpower assignment are unbalanced or unrealistic. Failure to submit an acceptable schedule within the specified time shall be a sufficient cause for suspension of the Contract and / or withholding of payments due the Concessionaire/Contractor.

7.1.3 Check List

The Concessionaire/Contractor shall develop and prepare check lists to be used for preventive maintenance for each type of equipment and software and submit them for the Engineer for his approval. The checklists shall include the type of equipment, equipment ID, location, date of inspection, name of inspector, check item, and remarks.

The check list shall be used every time a periodical inspection of the equipment is made, and results of the inspection shall be recorded together with other details.

The Concessionaire/Contractor is required to submit a copy of all recorded check lists every month and as requested by the Engineer at any time. Failure to maintain

or submit the check lists shall be a sufficient cause for suspension of the Contract and / or withholding of payments due the Concessionaire/Contractor.

7.1.4 Software Preventive Maintenance

The Concessionaire/Contractor shall perform preventive maintenance of the software to be provided under the Contract as part of the maintenance work. The Contractor shall exert the utmost care not to inadvertently damage the software and database and cause erroneous or abnormal operation of the Advanced traffic management system.

The items for software maintenance shall include but not be limited to the following:

- 1) Monitoring of CPU, memory and disk space utilization
- 2) Monitoring of system availability over TCP/IP
- 3) Monitoring of anti-virus and system security software operation
- 4) Backup of the system and restoration of the system when necessary.
- 5) Monitoring and review of system and event logs.
- 6) System modification

The work to be done consists of modifying the system, system parameter and other operating conditions and to improve the operation or to conform to new operational requirements. The work shall be done as directed by the Engineer.

7.2 Corrective Maintenance and Accident Repair

The Concessionaire/Contractor shall provide corrective maintenance and accident repair on a 24-hour a day, 7-day a week basis. Upon reception of a failure notice by the contact person, the Concessionaire/Contractor shall log the notice and determine the nature and severity of the failure, prepare the repair plan and dispatch the maintenance crew to the site. Immediate action shall be taken to safeguard the public at any time if the failure is of nature that causes hazardous condition.

If the fault cannot be permanently repaired immediately, a temporary repair or remedial measure sufficient to safeguard the operation of the Advanced traffic management system shall be affected by the Concessionaire/Contractor and the NHAI shall be so notified.

The cost of corrective maintenance of the failure that is not attributable to the Concessionaire/Contractor will be determined by mutual negotiation. The Concessionaire/Contractor shall assess the extent of the damage, prepare the remedial plan and estimate the cost.

7.2.1 Response Time and Resolution Time

For all cases, the failure shall be classified into three severity levels, critical, major and minor. The Concessionaire/Contractor shall satisfy the response time and resolution time specified for each type of failure as presented hereunder.

Severity	Response time	Resolution time
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Critical failure	30 minutes	2 hours
Major failure	60 minutes	6 hours
Minor failure	2 hours	48 hours

Critical failure is defined as follows:

- 1) Halt of both active and backup server systems at TMC or sub-Centre.
- 2) Failure of Internet server.
- 3) Interruption of active or backup route of communication link to TMC system.
- 4) Failure of two or more console at TMC.
- 5) System failure of a server system of each sub-system
- 6) Failure of uninterruptible power supply. Major problem is defined as follows:
 - a. Failure of a console at TMC.
 - b. Failure of large display at TMC.
 - c. Failure of two or more units of TMCS display monitor.
 - d. Loss of control of VMS.

Minor failure is defined as those failures other than critical and major failures listed above.

7.2.2 Inspection of Faulty Parts

The Concessionaire/Contractor shall inspect the faulty part retrieved from the equipment repaired and prepare and submit a report describing the nature of the failure to the Engineer together with his opinion whether the failure is caused by defect, inadequate operation, act by the third party, normal wear and tear or other reasons.

7.2.3 Fault Report and Work Order

Each and every corrective maintenance and accident repair work shall be documented on the fault report form and work order form by the Concessionaire/Contractor. The Concessionaire/Contractor shall prepare and submit the form together with the list of inspection items for the approval of the Engineer. A copy of completed work order forms shall be submitted with the monthly invoice. No payment shall be made without submitting the completed work order forms. The Fault Reports shall be kept in a logbook and shall be made available to the Engineer upon request at any time.

7.2.4 Maintenance and repair records

The Concessionaire/Contractor shall maintain a comprehensive record of all maintenance and repair activities and spare parts consumptions and inventory. The records shall include as a minimum maintenance check list, fault reports, spare parts receiving and consumption records, and work orders. These records shall be kept in a database and various operations including but not limited to search and retrieval of

fault record by specified key, statistical processing of records into performance index, and calculation of MTBF, MTTR and other parameters shall be possible.

8 Reporting

The Concessionaire/Contractor shall prepare and submit a monthly report in the form and contents as specified herein and as agreed with the Engineer

9 Operation & Maintenance Personnel

The Concessionaire/Contractor shall employ traffic management chief and the suitable number of operators. It shall be noted that the number indicated in the table is the minimum requirements by NHAI and it is the Concessionaire/Contractor's responsibility to provide high quality service seamlessly and effective staff arrangement shall be recruited if necessary. International Staff shall carry out the technology transfer as an important aspect including Advance traffic management technology through operation and maintenance works to NHAI officers and Concessionaire/Contractor's local staffs.

The staff member shown in the table is the persons directly engaged in the ATMS Operation and Maintenance Services and the Concessionaire/Contractor shall recruit and deploy the necessary number of managers, operators and technicians.

The Concessionaire/Contractor shall provide all personnel necessary for performing the ATMS operation and maintenance by the personnel listed in Table. The Concessionaire/Contractor shall submit curriculum vitae of the candidate key person for the Engineer's approval two (2) months in advance of the start of operation and maintenance work. These engineers shall be involved in the installation, adjustment, test on completion and training of the NHAI's staff of the Advanced traffic management system to be supplied under the Contract.

The Concessionaire/Contractor shall submit the list of all ATMS Operation and maintenance staff with name, birth date and address together with copy of ID every month to the ITS Engineer. If there is any change in the composition of the operation and maintenance staff, it shall be reported immediately to the NHAI. The NHAI will issue an ID to each staff member. The Concessionaire/Contractor shall be responsible for the proper use of the ID to gain the access to the access- controlled places and system facilities and return it immediately if a staff member no longer works for the ATMS Operation and maintenance.

Three-shift (+1 backup) system shall be adopted for ATMS operation. The candidate shift is as shown below.

First shift: 05:45 -14:00 hours

Second shift: 13:45 - 22:00 hours

Third shift: 21:45 - 06:00 hours

9.1 Position and responsibility for position

- 1) The position, responsibility, and number are estimated by NHAI as follows;

S. No.	Position	Number	Responsibility
1	*Traffic Management Chief	1	Supervising and managing of highway traffic management with Traffic Management Chief
2	*Traffic Management Engineer	1 at TMC & 1 at each sub-centre	Technical aspect of Advanced traffic Management system
3	*Asst Manager – Operations	1 at TMC & 1 at each sub-centre	Management of Control room
4	Control Room Operator	5 at TMC & 3 at each sub-centre in each shift	Operating activity of the system (Three Shift)
5	*System Maintenance Engineer	1 for every 50 kms	Management of System maintenance
6	System IT Engineer	1 for every 50 kms	Management of IT System
7	System Maintenance Technicians	1 for every 50 kms in each shift	Actual Maintenance activity (Three Shift)
8	Support Staff	1 at TMC & 1 at each sub-centre	
9	Office Assistant	1 at TMC & 1 at each sub-centre in each shift	
10	Security Guard	1 at TMC & 1 at each sub-centre in each shift	
11	Maintenance Vehicle with Driver and helper	1 for every 50 kms	
12	Man-hoist vehicle with Driver and helper	1 for each project of up to 100 kms	Add 1 for every 2 nd sub-centre

Note; Position with asterisk (*) is identified as Key Staff

2) The minimum experience of each position is shown as follows;

Position	Minimum Experience
*Traffic Management Chief	Total Professional experience ; 15 years Similar works [#] ; 7 years Manager of similar works ; 3 years
*Traffic Management Engineer (BE/B tech Only)	Total Professional experience ; 10 years Similar works [#] ; 5years
*Asst Manager	Total Professional experience; 7 years Similar works [#] ; 5 years

Construction of 6-Lane Access Controlled Highway from Gogwan Jalalpur village of Shamli district to Dala Majra village of Saharanpur district (Ch. (000+600) to 44+300) total length of 44.9 Km of section Shamli – Ambala Greenfield Alignment on EPC Mode under Bharatmala Pariyojana in the State of Uttar Pradesh.

Control Room Operator	Similar works [#] ; 2 years
*System Maintenance Engineer (BE/B tech Only)	Total Professional experience; 10 years Similar works [#] ; 7 years
*System IT Engineer (BE/B tech Only)	Similar works [#] ; 5 years
System Maintenance Technicians	Similar works [#] ; 2 years

Note; The position with asterisk (*) shall be at least a graduate in electronics, information technology, systems engineering, computer science, civil engineering, highway engineering or traffic engineering.

#Similar works shall mean that the candidate shall have working experience in ATMS/ ITS/ HTMS/ Traffic Management on a 4 lane/6 lane expressway/ highway project/ urban ITS project.

10. Maintenance Facilities

10.1 Maintenance Equipment and Tools

The Concessionaire/Contractor shall maintain required set of maintenance equipment and tool, and monitoring and testing software normally required for the maintenance of the electrical and server system. The maintenance equipment and tools shall be maintained in good workable condition so that they shall be available all the time. If periodical calibration is required, it shall be calibrated at the regular interval as specified by the supplier of the maintenance equipment. The maintenance staff shall be trained as to the use of the maintenance equipment and tools. The purchase or depreciation cost of the maintenance equipment and tools shall be deemed to be included in the appropriate cost item in the Tender and no separate payment shall be made.

10.2 Maintenance Office

The Concessionaire/Contractor will be allowed to occupy and use the maintenance room in the TMC/Sub centre free of charge for operation & maintenance purpose. The Concessionaire/Contractor shall observe the regulations regarding use of the maintenance office. Only persons authorized by the Engineer shall be allowed to use the office and the office shall be used solely for the operation & maintenance of the ATMS. The Concessionaire/Contractor shall prepare at his cost desks, chairs, shelves, cabinets, telephone, Internet access and other furniture and facilities necessary for the efficient maintenance operation.

10.3 Maintenance Vehicle

The Concessionaire/Contractor shall provide the suitable number of vehicles for their operation & maintenance use. The vehicle shall be of the type suitable for maintenance work in terms of the number of passengers and load carrying capacity. The vehicle shall meet the relevant government regulations and registered under the name of the Concessionaire/Contractor. The vehicles shall be maintained in good condition to run on the Project. The vehicle shall clearly indicate as maintenance vehicle on the side of the vehicle and a yellow flashing light shall be provided on the

roof of the vehicle. A set of traffic safety devices consisting of safety cones, stand-alone flashing light, and reflective guide and warning signs shall be provided to the maintenance vehicle. The cost of obtaining, operating and maintaining the maintenance vehicle shall be included in the contract and no separate payment shall be made.

11 Service Level Requirements (SLR)

Service level means the service delivery criteria established for the services specified in Service Level Table. The purpose of Service Levels specified in the Service Levels Tables is to clearly define the levels of service which shall be provided by the Concessionaire/Contractor to NHAI during O&M period i.e. Five Years from the date of Completion of ATMS. The service level parameters mentioned in the service level table shall be measured on a quarterly basis as per the individual service level parameter requirements, through appropriate service level measurement tool of Facility Monitoring System (FMS) and Network Management System (NMS). Measurement of service levels for systems shall be automatic using reports from appropriate management tool of FMS. Measurement of service levels for services, which are not delivered using a dedicated tool, will be carried out using appropriate and relevant reports from the Service Desk tool.

Measurement of Service Level parameters will be carried out on cumulative basis in a quarter. The Concessionaire/Contractor needs to try to ensure that the service levels as per service level table. Concessionaire/Contractor needs to submit service level report in a quarter

If the performance of the system/services is degraded significantly at any given point in time during the contract and if the immediate measures are not implemented and issues are not rectified to the complete satisfaction of NHAI, then NHAI will have the right to take appropriate corrective actions including termination of the Agreement.

The Concessionaire/Contractor and NHAI shall regularly review the performance of the services being provided by the Concessionaire/Contractor and the effectiveness of this Service Levels. The ATMS Contractor is responsible for development and implementation of appropriate management tools of FMS. which shall be basis for all project reviews.

For all cases, the failure shall be classified into three severity levels, critical, major and minor. The Concessionaire/Contractor shall satisfy the Service Levels specified for each type of service as presented in Service Levels table.

- 1) The Formula of calculation of availability is shown as follows.

$$\text{Availability} = \{1 - [(A)/(B-C)] * 100\}$$

Where

A= Time for which system is down B = Total Time and

C= Scheduled downtime

Note: Total Time shall measure on 24x7 basis

2) Service Level Requirement Table is shown below

No	Parameter	severity levels	Target
1. Traffic Management Centre Equipment & Sub-centre equipment			
1.1	Server Availability (TMC and internet servers including the OS, database and any other application running on it)	Critical	99%
1.2	Console Availability (TMCS)	Critical	99%
1.3	Console Availability (TTMS, ATCC)	Major	97%
1.4	Console Availability (FMS)	Minor	95%
1.5	Console Availability (VMS, Internet)	Major	97%
1.6	Operational Availability (VIDS)	Critical	99%
1.7	Operational Availability (1033)	Critical	99%
1.8	Operational Availability (VSDS)	Minor	95%
1.9	Operational Availability (FMS)	Minor	95%
1.10	Storage Availability (Including power availability, network availability, availability of links to applications and databases)	Critical	99%
1.11	Graphic Display	Major	97%
1.12	Camera Monitor	Major	97%
1.13	Network Connectivity Between Main TCC – Sub centre – Roadside equipment	Critical	99%
2. Field Equipment			
2.1	Average Uptime Timeperiod of the TMCS Camera.	Major	97%
2.2	Average Uptime Time period of the VIDS Camera .	Major	97%
2.3	Average Uptime Timeperiod of the VMS	Major	97%
2.4	Average Uptime Timeperiod of the VSDS	Minor	95%
2.5	Average Uptime Timeperiod of the ATSC and RLVD	Minor	95%

11.1 Service Levels Review Process

- 1) Either NHAI or Concessionaire/Contractor may raise an issue by documenting the business or technical problem, which presents a reasonably objective summary of both points of view and identifies specific points of disagreement with possible solutions.
- 2) A meeting or conference call will be conducted to resolve the issue in a timely manner. The documented issues will be distributed to the participants at least 24 hours prior to the discussion if the issue is not an emergency requiring immediate attention.
- 3) The NHAI and the Concessionaire/Contractor shall develop an interim solution, if required, and subsequently the permanent solution for the problem at hand. The Concessionaire/Contractor will then communicate the resolution to all interested parties.
- 4) In case the issue is still unresolved, the arbitration procedures described in the “Draft format of Contract agreement” will be applicable.

12 Performance Damages / Penalty

The Service Provider would be penalized for non-compliance in meeting SLR for Operations as well as Maintenance of the Project. Any penalty levied by NHAI or NHAI's representative shall be applicable and deducted from the quarterly payable

amount. The Service Provider should enable and facilitate continuous measurement of all-round performance of the ATMS System and not just event-based performance. The penalties are detailed here under:

- a. For non-compliance of SLR under maintenance requirement, penalty @ 120% of per day rate shall be imposed if the down time exceeds the maximum permissible on each instance.
- b. For non-compliance of SLR under operations requirement, the penalty of INR 10,000 per event shall be imposed.
- c. The amount against manpower will be payable only for the duration the O&M personnel will be available at site. In case the required manpower is not available at any location for more than 15 days in a month, no payment shall be made against manpower (as quoted in the financial bid) for that location for whole month, apart from other deductions / penalties as applicable.
- d. Total cap on each of the Operations & Maintenance related penalties would each be 10% of the quarterly payment. NHAI may also consider termination of contract and forfeiture of performance bank guarantee if the number of non-compliance events exceeds 50 during any quarter, OR the total penalty exceeds the maximum penalty.

13. Spare Parts and Consumables

The Concessionaire/Contractor shall maintain required spare parts to maintain required service levels. An undertaking to be submitted along with technical bid that the Concessionaire/Contractor has the sufficient infrastructure and capability to keep/store spares required for maintenances and will at all times during the contract period maintain sufficient inventory of spares and consumables for operating and maintaining the ATMS and to meet the Service Level requirements.