Environmental and Social Due Diligence Report

Project Number: 47083-004
September 2021

INDIA: Accelerating Infrastructure Investment Facility in India – Tranche 3

Ashoka Ankleshwar Manubar Expressway Private Limited (Part 6 of 24)

Prepared by India Infrastructure Finance Company Limited for the India Infrastructure Finance Company Limited and the Asian Development Bank.

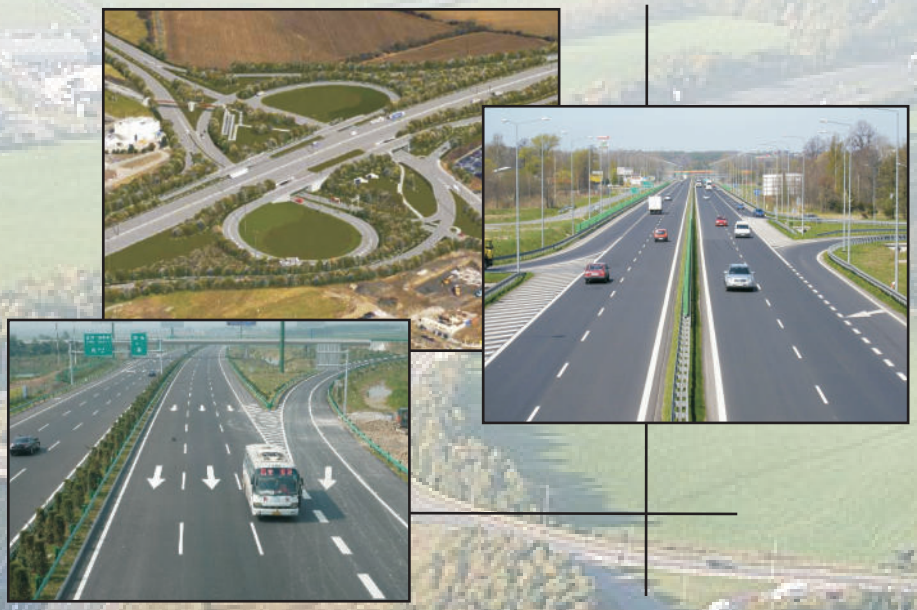
VADODARA-MUMBAI EXPRESSWAY

National Highways Authority of India

(Ministry of Road Transport & Highways)
Government of India

Preparation of Detailed Engineering Design of Vadodara-Mumbai Expressway including Spur to JNPT under NHDP Phase-VI

PHASE I A
Package IV : Km 279.000 to Km 292.000



DETAILED PROJECT REPORT

VOLUME I : MAIN REPORT

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August, 2017

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LIST OF ABBREVIATIONS

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AMC	Annual Maintenance Contract
ATMS	Advanced Traffic Management System (same as HTMS)
ANSI	American National Standards Institute
ATCC	Automatic Traffic Counter cum Classifier
BOT	Built Operate and Transfer
BoQ	Bill of Quantities
CENELEC	Comité Européen de Normalization Electro technique (European Committee for Electro technical Standardization)
CCTV	Closed Circuit Television
CCR	Central Control Room
CIDCO	The City and Industrial Development Corporation of Maharashtra Ltd
CSMA/CD	Carrier Sense Multiple Access / Collision Detect
CPCB	Central Pollution Control Board
CTS	Comprehensive Transportation Study
DBFO	Design Build Finance and Operate
DG	Diesel Generator
DHCP	Dynamic Host Configuration Protocol
DIN	Deutsches Institut fur Normung
DNH	Dadra & Nagar Haveli
DPR	Detailed Project Report
DSP	Digital Signal Processing
DVR	Digital Video Recorder
ECB	Emergency Call Box
ESAL	Equivalent Standard Axle Load
ETC	Electronic Toll Collection
FAT	Factory Acceptance Test
FFR	Final Feasibility Report
FRP	Fiber Reinforced Plastic
ICT	Intercontinental Consultants and Technocrats
IEEE	International Electrical and Electronics Engineers
GoM	Government of Maharashtra
GVW	Gross Vehicle Weight
GUI	Graphic User Interface
GOI	Government of India

HQ	Headquarter
IEC	International Electrotechnical Commission
IGBT	Insulated Gate Bipolar Transistor
IP	Internet Protocol
ISO	International Organisation of Standardisation
JNPT	Jawaharlal Nehru Port Trust
JPEG	Joint Photographic Experts Group
Km	Kilometer
LAN	Local Area Network
LCD	Liquid Crystal Diode
LED	Light Emitting Diode
LSWIM	Low Speed Weigh In Motion (same as SSWIM)
MAN	Metropolitan Area Network
MCA	Model Concession Agreement
Met	Metrological Station (same as Meteorological Data System)
MMC	Multi Media Card
MMR	Mumbai Metropolitan Region
MMRDA	Mumbai Metropolitan Region Development Authority
MOM	Minutes of Meeting
MOSRTH	Ministry of Shipping, Road Transport & Highways
MPEG	Moving Pictures Expert Group
MRCS	Mobile Radio Communication System
MSDS	Material Safety Data Sheet
NHDP	National Highway Development Project
NEMA	National Electrical Manufacturers Association
NECA	National Electrical Contractors Association
NHAI	National Highways Authority of India
NTCIP	National Transportation Communications for ITS Protocol
NMS	Network Management System
OEM	Original Equipment Manufacturer
OFC	Optic Fiber Cable
OS	Operating System
OTDR	Optical Time Domain Reflectometer
PSTN	Public Switched Telephone Network
PWM	Pulse Width Modulation
PCB	Printed Circuit Board

PFD	Patron Fare Display *same as UFD*
PF	Protect Forest
PPR	Preliminary Project report
PROW	Proposed Right of Way
PTZ	Pan Tilt Zoom
PWD	Public Work Department
RF	Reserved Forest
TCE	Toll Collection Equipment
TIA	Telecommunications Industry Association
TCP	Transmission Control Protocol
TFT	Thin Film Transistor
UDP	User Data protocol
QA	Quality Assurance
USEPA	United States Environmental Protection Agency
QAP	Quality Assurance Plan
RFID	Radio Frequency Identification
RH	Relative Humidity
SAT	Site Acceptance Test
SC	Smart card
SSWIM	Slow Speed Weigh In Motion (same as LSWIM)
SWB	Static Weigh bridge
TC	Toll Collector
TCE	Toll Collection Equipment
TOR	Terms of Reference
UFD	User Fare Display (same as PFD)
UL	Underwriters Laboratory
URS	User Requirement Specifications
UPS	Uninterruptible Power Supply
UT	Union Territory
VoIP	Voice over Internet Protocol
VME	Vadodara Mumbai Expressway
VMS	Variable Message Sign
WIM	Weigh-in-Motion

EXECUTIVE SUMMARY

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0.1 GENERAL

National Highways Development Project (NHDP) Phase-VI is for development of 1000 km of expressways and includes construction of about 379 km long Vadodara-Mumbai Expressway proposed to be implemented under Public Private Partnership mode and to be executed as Design, Build, Finance and Operate (DBFO) contracts. The National Highways Authority of India (NHAI) has commissioned the services of Intercontinental Consultants and Technocrats Private Limited (ICT) for carrying out consultancy services for "Preparation of Feasibility cum Preliminary Design Report for Vadodara – Mumbai Expressway under NHDP Phase-VI. The consultants commenced services from 12th February 2009. Subsequently during meetings with NHAI and MoRT&H officials it was decided that since this is a greenfield project being floated on DBFO it would be prudent to prepare a detailed engineering design. This would give a better understanding of scale, specifications and cost of the project to prospective bidders. Therefore NHAI extended the scope of the services to Detailed Engineering Design.

During the feasibility study of the Expressway it was noted that the proposed start point of VM expressway on NH8 at Mumbai end would pose a serious problem of safe and quick dispersal of traffic from the expressway and also would not serve the purpose of connecting to major traffic generators like JNPT port and to Mumbai-Pune expressway. To ensure proper dispersal of traffic a proposal for providing a spur connection to the expressway originating at about km 27 of the expressway and connecting to Mumbai Pune expressway and JNPT port was mooted. A presentation on the alternative alignments for the Spur was made to Chairman and other senior officials of NHAI and the proposal for spur was accepted in principle. Consequently a 94km long spur connection to Mumbai Pune expressway and JNPT was also included in the scope of work vide NHAI letter NHAI/V-M Expressway/DM/2008/216 dated 16th November 2009.

The Draft Feasibility Report was submitted on 17th November 2009 vide ICT letter no. ICT/DPR/NHAI/IND/MUM-VADO/567/11729. A presentation on the Draft Feasibility was made in NHAI, HQ on 18th March 2010 and the Final Feasibility Report was submitted on 31st March 2010 vide ICT letter no. ICT/DPR/NHAI/IND/ MUM-VADO/567/3036. The Draft Feasibility cum Preliminary Design Report was submitted vide ICT letter no. ICT/DPR/NHAI/IND/MUM-VADO/567/3770 dated 12th April 2011. The comments of the PIU-Surat (Expressway), on the Draft Feasibility cum Preliminary Design Report were received vide NHAI letter No. NHAI/PIU/Surat-(Expressway)/C03/432 dated 10th May 2011. The Final feasibility cum preliminary design report was submitted on 09.08.2011 after addressing the comments of NHAI. The draft DPR of the project was submitted vide letter no. ICT/DPR/NHAI/IND/MUM-VADO/567/1796 dated 09.02.2012. The final Detailed Design Report of project was submitted on 10.12.2012.

The proposed Main Expressway passes through the states of Maharashtra, Gujarat and Union territory of Dadra & Nagar Haveli. The total length of the proposed expressway is about 379 km and runs generally parallel to the existing NH-8.

A meeting was held on 7th September 2013 under the Chairmanship of Secretary, MoRT&H and it was decided to divide the project in 3 phases for execution:

Phase I : Km 104.70 to Km 378.740 (Main Exp.)

Phase II : Km 26.32 to Km 104.70 (Main Exp.) & SPUR to JNPT (Km 0.00 to Km 94.39)

Phase III : Km 0.00 to Km 26.32

Further, a meeting was held on 15th December 2015 regarding Vadodara-Mumbai Expressway. During the discussions, NHAI asked repackaging of the project with modified specifications. The existing NH8 which is almost parallel to proposed VME has been clubbed with VME with some value addition works. The value addition includes only provision of some bridges/flyovers/underpasses at selected locations.

(i) Phase I – Km 104.700 to Km 378.740 of VM Expressway and improvement of existing NH-8 from Km 108.700 to Km 390.864

Based on the progress of preconstruction, Phase I is again divided in to two parts as:

Phase IA

Stretches (km)		**Length (Km)**
From	**To**	
VM Expressway		
254.430 (NH-8 Intersection)	378.740 (Vadodara on NE1)	124.310
NH 8 - Value Addition		
108.700 (Vadodara)	233.000	141.300

Phase IB

Stretches (km)		**Length (Km)**
From	**To**	
VM Expressway		
104.700 (Talasari)	254.430 (NH-8 Intersection)	149.730
NH 8 - Value Addition		
233.000	390.864 (Talasari)	140.864

0.2 FURTHER DEVELOPMENT FOR EXECUTION

In reference to NHAI letter no NHAI/NHDP-V/MC-II/BOT/FR/AV/100901 dated 6th June 2017, Phase IA has been further sub-divided in 5 packages for execution on EPC mode standalone without value addition of NH8 including some structure addition and deletion. The Package details are as follows:

Package No.	Packages	Length (Km)
Package I	Construction of Six lane Vadodara Kim Expressway from Km 355.00 to Km 378.740 (Padra to Vadodara Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package I).	23.74
Package II	Construction of Six lane Vadodara Kim Expressway from Km 323.00 to Km 355.00 (Sanpa to Padra Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package II)	32.0
Package III	Construction of Six lane Vadodara Kim Expressway from Km 292.00 to Km 323.00 (Manubar to Sanpa Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package III)	31.0
Package IV	**Construction of Six/Eight Lane Vadodara Kim Expressway from Km 279.00 to Km 292.00 (Ankleshwar to Manubar Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package IV).**	**13.0**
Package V	Construction of Eight Lane Vadodara Kim Expressway from Km 254.430 to Km 279.00 (Kim to Ankleshwar Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package V).	24.57

In addition to above packaging, there are some modification made and the details are as follows:

1. Height of embankment shall be as per IRC SP:99-2013
2. Replacement of Pedestrian underpasses by providing connecting road
3. Provision of Interchange at Km 323+087
4. Provision of Flyover at Km 344+360 by replacing VUP.

Further NHAI has instructed not to delete the Pedestrian Underpasses as these are very essential for crossing of Green field alignment.

This report is for Package IV from Km 279+000 to Km 292+000 (Ankleshwar to Manubar Section of Vadodara Mumbai Expressway).

0.3 SOCIO-ECONOMIC PROFILE OF PROJECT INFLUENCE AREA

The alignment of this package passes mainly through plain cultivated and barren areas. It passes through Vadodara districts in the state of Gujarat. Rice and various types of fruits are main agriculture production of this state. These districts are also rich in industrial production. There are many industrial estates and factories in these states both in public and private sectors. Textiles, chemical, petroleum and petro-chemical, paper & pulp, diamond, are located in state of Gujarat.

0.4 ROUTE ALIGNMENT SELECTION

The identification of the route alignment of this VM expressway was initially taken up in the early 1990s by the Ministry of Road Transport & Highways from a Technical Assistance Programme of Asian Development Bank. The alignment was finalized by M/s Wilbur Smith consultants in association with CES (India) Pvt. Ltd. The Government of Gujarat has frozen a corridor of 600m width based on this alignment.

NHAI in the year 2008 awarded the task of finalization of VME alignment to M/s SECON through a desk study and the Consultant was given the alignment as finalised by M/s SECON to follow. It was stipulated that the consultant might review the alignment and if it passes through problematic area propose alternate solution. Steps like desk study of the SECON's alignment on satellite Imagery/Google imagery, reconnaissance work at site, taking up detailed topographic survey between GPS stations, Environmental reconnaissance, study of the alignment of the dedicated Freight Corridor (DFC) of railways, existence of gas pipe line and crossings of major rivers etc. were taken before finalization and modification of SECON's alignment

The modified alignment was submitted to NHAI for approval. Subsequently during a presentation in Gujarat in September 2009, the Principal Secretary, P.W.D, Government of Gujarat expressed his firm view that the alignment is to be accommodated within the already frozen 600m wide corridor based on the alignment fixed by Wilbur Smith. The deviation from this alignment should be minimal and which must be supported with adequate justification. A presentation was also made in NHAI in September, 2009 and NHAI recommended that the course of action as suggested by Gujarat P.W.D was to be followed. The alignment which was finalized was further reviewed and modified to stay within the frozen 600m corridor in the state of Gujarat. NHAI has accorded approval to the VME alignment.

The Package IV of the Expressway starts from Km 279+000 and ends at Km 292+000. As shown in the below table the entire length falls in Bharuch district In Chapter 3: Route Alignment Selection of the main report, the alignment has been described

The length of alignment in the various districts/States is given in **Table Es 0.1.**

Table Es 0.1: Distribution of Alignment in Administrative Boundaries

Package	Chainage (Km)			District/UT/State
	Start	End	Length (Km)	
Package V	254+430	261+794	7.364	Surat/Gujarat
	261+794	279+000	17.206	Bharuch/Gujarat
Package IV	**279+000**	**292+000**	**13.000**	**Bharuch/Gujarat**
Package III	292+000	323+000	31.000	Bharuch/Gujarat
Package II	323+000	324+294	1.294	Bharuch/Gujarat
	324+294	355+000	30.706	Vadodara/Gujarat
Package I	355+000	378+740	23.740	Vadodara/Gujarat
	Total Length		**124.310**	

0.5 TOPOGRAPHIC SURVEYS

The topographic survey was conducted in a width of 200m either side of the proposed alignment to capture the ground levels and all the existing physical features like rail, road, rivers, canals, houses etc. The main control points for the topographic survey were fixed using Global Positioning System (GPS). Twin Pillars of size 15cmx15cmx45cm were fixed along the proposed ROW at an interval of 2kms and GPS observations were recorded. To cover up the gaps between two consecutive pair of GPS control Points, temporary control points were fixed using pegs/nails at an interval of 100m to 200m. The X and Y grid coordinates of these Bench Marks pillars were fixed by Total Station traverse and the levels were fixed with the help of leveling. The elevations (Z value) of all the GPS control pillars were established by carrying out differential leveling from one GTS Benchmark to another GTS Benchmark. Based on the GPS and Traverse control points, the Easting (X), Northing (Y) and MSL Height (Z) coordinates of all important manmade and natural topographical features along the alignment within a corridor of 200m on either side of alignment were recorded using Total Stations having automatic data recording devices with appropriate feature codes.

0.6 TRAFFIC SURVEYS AND TRAFFIC ASSIGNMENT

Traffic surveys on NH-8 and surrounding road network were conducted in year 2009, and the DPR for VM Expressway was submitted in 2012. On request from NHAI, the Consultants have carried out traffic surveys on selected locations in 2016 to update the traffic figures, analysis and forecast.

To estimate the expected traffic movement on V-M Expressway and the spur, traffic surveys were planned to be conducted on the important roads in the vicinity of the proposed alignment. These are: NH-8, NH-6, NH4, NH4B, Mumbai Pune expressway and state highways cutting across the proposed V-M Expressway and the spur alignments.

In 2009, traffic surveys were conducted at 25 mid-block locations and 27 intersections, whereas in 2016 the traffic surveys have been conducted at 11 mid-block locations and 10 intersections. The survey locations for mid-block counts were chosen on major sections of NH-8 and NH-4 so that the current traffic can be compared with 2009 traffic.

As per the survey conducted in 2016, the correction factors have been established. Using the traffic revision factors, the present and then the future traffic estimates have been revised for Expressway sections.

The section wise revised traffic loadings (in terms of AADT) for expressway, based on traffic estimates originally obtained (in 2009) by regional transport demand model for various horizon years. After discussion with NHAI, the projected traffic on VME has been estimated based on the toll rates, which are about 1.8 times of the notified toll rates for National Highways.

The section wise estimated traffic for the Phase IA and Package IV is given in **Table Es 0.2** and **Es 0.2A.**

Table Es 0.2: Section wise Estimated AADT in PCU (for Combination of 6 and 8 Lane Facility)

Traffic Section			AADT in PCU				
Section	**From**	**To**	**2021**	**2025**	**2030**	**2035**	**2045**
Section 9	**254+430**	**287+385**	**50,453**	**64,833**	**86,226**	**98,426**	**122,795**
Section 10	**287+385**	**323+087**	**35,273**	**45,116**	**59,831**	**68,945**	**87,872**
Section 10A	323+087	353+690	34,077	43,560	57,758	66,550	84,798
Section 11	353+690	374+355	33,534	42,811	56,901	64,794	81,572
Section 12	374+355	378+740	14,158	18,668	24,985	28,226	36,096

Table Es 0.2A: Package wise Estimated AADT in PCU

Traffic Section			AADT in PCU				
Package	**From**	**To**	**2021**	**2025**	**2030**	**2035**	**2045**
Package IV	**279+000**	**287+385**	**50,453**	**64,833**	**86,226**	**98,426**	**122,795**
	287+385	**292+000**	**35,273**	**45,116**	**59,831**	**68,945**	**87,872**

For capacity and service volume of expressway, IRC SP: 99-2013 has been referred. The code specifies design service volume (at LOS-B) for plain and rolling terrain is 1300PCU/Hr./Lane. The design service volume in terms of PCU/day for expressways, as specified in the code mentioned above, is given in **Es 03.** As observed during primary traffic survey along the study corridor, peak hour proportion in daily traffic was just about 6.5%. Hence, the design service volume corresponding to peak hour proportion of 6% has been adopted here for calculation of volume-capacity ratio.

Table Es 0.3: Capacity and Service Volumes at Various LOS for 4 lane, 6 lane and 8 lane Expressway

Peak Hour Proportion	Design Service Volume (LOS B) in PCU/Day		
	4-lane	**6-lane**	**8-lane**
6%	86,000	1,30,000	1,73,000
8%	65,000	98,000	1,30,000

For high speed highways and expressways, it is desirable to maintain LOS 'B'. The Highway Capacity Manual-2010 also suggests that, the ancillary infrastructure facilities of a freeway could even operate at LOS 'C' while the freeway itself should desirably maintain LOS 'B'.

Based on the above, it is observed that all the sections of Expressway from Km 254+430 to km 287+385 should be develop to 8 lane and from Km 287+385 to Km 378+740 to be develop to 6 lane facility at the opening year.

The 8 lane carriageway has been extended from Km 287.385 to Km 287.700 considering the acceleration and deceleration lane of interchange.

Hence from the above discussion, the section from Km 279+000 to Km 287+385 should be developed to 8 lane facility and section from km 287+385 to km 292+000 should be developed to 6 lane facility. However to accommodate acceleration lane and deceleration lane of interchange

loop/ramp, 8 lane provision has been extended upto Km 287+700. Hence the lane configuration at the begining of Package IV is as follows:

Table Es 0.4: Lane configuration of Package IV

Sl No	Stretches (Km)		Lane configuration
1	279+000	287+700	8 lane
2	287+700	292+000	6 lane

0.7 SOIL AND MATERIAL INVESTIGATION

The investigations of soil and material covered all relevant aspects of: investigation for foundation soil of road embankment along proposed alignment and investigation for construction material. Required tests as specified and following relevant BIS standards, TRRL and MORTH specification were carried out on soil, quarry material and water samples available along alignment soil of the main carriageway and the spur and from identified borrow area, quarries and sources to assess the suitability for their use in construction.

A total of 2 borrow areas located on both sides along the project road were identified. The locations, lead, owner and tentative area of borrow soil available is given in Annexure 6.3 of Chapter 6 (Main Report) and the summary is given below:

Table Es 0.5: Summary of Tests and Evaluation of Borrow Soil

Sl. No.	Class of soil	No. of borrow areas	Anticipated lead (km)	Range of CBR at 97% of MDD (%)	Free Swell Index (FSI)	Suitability
1	Silt with low compressibility (ML)	1	2	7	16.6	Suitable for embankment construction. Stabilization of soil is required for use in subgrade
2	Clay with medium compressibility (CI)	1	1.7	4.1	31.8	Suitable for embankment construction. Stabilization of soil is required for use in subgrade

Suitable and sufficient soil from borrow area for construction of embankment and sub-grade are available. Lime soil stabilization, improving subgrade CBR by using geocell technology, or reinforcing the subgrade by using geotextile / geo-grid are the proposed options that can be considered as alternative to obtaining quality fill materials from comparatively high lead distances. The design CBR for the main carriageway is 10 %.

One stone quarries were identified as the potential source of coarse aggregates required for road construction. The quantity available in the identified quarries is adequate meeting the requirements for the construction of the project roads.

Flakiness and Elongation found in majority of the collected samples can be improved considerably by adopting suitable technique of crushing

One sand source has been identified along the main carriageway. Sands of all the sources can be used in any kind of filling work for the main carriageway for pavement works. Stone dust available from crusher plants is suitable for use in concrete and in all the layers of pavement structure.

Manufactured material cement, structural steel and bitumen conforming to the relevant IS codes and complying with the provisions made in the specifications of MoRT&H are available in Gujarat.

0.8 HYDRAULIC AND HYDROLOGICAL INVESTIGATION

The proposed alignment of the expressway runs through regions having varied hydro-meteorological characteristics apart from being distinctly different in terms of land use, land cover and soil parameters. The study area comes under three hydro-meteorologically different subzones namely subzone 3(a), subzone 3(b) and subzone 5(a), as demarcated by CWC for estimating Design Flood. The alignment passes through plain topography. The proposed alignment mostly runs through the agricultural lands of Gujarat.

Hydrological and hydraulic investigation of the study area has covered collection and analyses of field data including past performance of the nearby existing bridges over NH8 and other roads across the streams crossing (upstream / downstream) the proposed alignment, historical flood data (Discharge, HFL etc as available) of major rivers from agencies like CWC, Irrigation Departments of Gujarat. The hydraulic information of the canals likely to cross the proposed alignment has also been collected from Sardar Sarovor Narmada Nigam Limited. Stipulations and provisions of extant IS / IRC Codes, Federal Highway Administration (FHWA) and Guidelines of Inland Waterway Authorities of India (IWAI) have been followed for hydrological and hydraulic design of the bridges. The stipulations of IRC-78:2000 have been adopted for estimating the scour depth. Foundation has been designed on the basis of Q_{50} multiplied by suitable factor as stipulated.

The following table summarizes the return period adopted for design:

Sl. No.	Design Parameter	Adopted Return Period Flood
1.	Waterway for bridges / culverts	100 Years (with 50 Year base flood)
2.	HFL for Bridges	100 Years
3.	Foundation design	50 Year Flood multiplied by suitable factor

After thorough analyses, One major bridge and 3 minor bridges on rivers/nala/drains have been proposed in this Package. Apart from these, Two bridges have been proposed over the existing Irrigation Canal.

0.9 DRAINAGE STUDIES AND PRELIMINARY DESIGN OF CULVERTS

The construction of the expressway embankment will unavoidably obstruct the natural overland flow and to some extent distort the natural flow regime of the local channels. Suitable bridge / culvert openings have, therefore, been proposed across natural drainage channels with a view to pass the discharges with minimal disturbances caused to the natural flow regime. In addition to these bridges / culverts, localized drainage arrangements consisting of longitudinal toe drains

and additional culverts have been proposed to divert the overland flow (which would otherwise meet the natural stream at some downstream point) intercepted by the expressway embankment into the nearest natural drainage channel. Drainage of Embankment has been ensured through the provisions of Shoulder Drains / Chute Drains, Roadside Toe Drains and Median Drains.

Box culverts have been preferred to pipe culverts to get rid of the general shortcomings (number of joints inviting weak points, difficulty in maintenance etc.) of a pipe culvert structure. A total of 13 box culverts have been proposed in this Package. In addition to above culverts 11 nos. have been proposed for Interchanges. The minimum size proposed is 2mx2m.

To meet the demand of the local population for connection of their field channels, 11 nos. pipe culverts of size 1.2m diameter have been provided. The exact location of these culverts will however be decided in consultation with local people at the time of execution.

Taking width between the earthen shoulders as 46m (8–Lane) and an average embankment height of 4m with 2H: 1V slope, the toe to toe width of embankment comes to 62m. If the size of the culvert is determined on the basis of hydraulic requirements only (which may necessitate pipe sections smaller than 900 mm dia.), periodical clearing of the culvert barrels may become a serious problem. The minimum dimension of the culverts has, therefore, been recommended to be 2m for ease of routine maintenance.

The 24 Hour maximum rainfall of 25 Year return Period has been taken as the design rainfall. 100 year discharge has been used as check flood for the culvert structures.

The hydraulic calculations for culverts have been done with the help of Hydraflow extension software of Autodesk, Inc which follows the methodology of hydraulic design of culverts as set forth in Hydraulic Design Series Number- 5 - Hydraulic Design of Highway Culverts that is prepared for the U.S. Federal Highway Administration (FHWA).

The maximum downstream velocity (corresponding to check flood i,e 100 year flood) for the culverts has been considered as 4 m/sec with rip rap / concrete protection. In no case, the Hw/d ratio (governing head water elevation) has been considered more than 1 for the safety of the pavement layers. The estimated carrying capacity of culverts for optimum longitudinal slopes is tabulated below:

Size	**Capacity**	**Longitudinal Slope**
Culvert Capacity		
2 X 2	8.50	0.3% to 0.5%
3 X 2	13	0.3% to 0.5%
3 X 3	19	0.3% to 0.5%
4 X 3	26	0.3% to 0.5%
5 X 3	32	0.30%
6 X 3	39	0.30%

Note: 1. Limiting downstream velocity : 4 m/sec (check flood) with riprap protection.

2. Hw / D Ratio =< 1, for safety of embankment

0.10 GEOMETRIC DESIGN STANDARDS FOR EXPRESSWAY

The Expressway is designed to carry large volumes of traffic at high speeds at the same time being safe. The basic objective of design of expressway is to resolve the inherent conflicts between high speed and safety, even at higher level of traffic. The MoRT&H has issued "Guidelines for Expressways" in April 2010. The geometric design standards for Vadodara – Mumbai (VM) Expressway and the Spur are being finalized taking into consideration these guidelines. The international standards like "A policy on geometric design of street and highways" by AASHTO, the standards prevalent in U.K and Australia have also been studied in formulating the design standards for VM expressway. The standards followed in the two operational expressways i.e. Ahmedabad Vadodara Expressway and the Mumbai Pune expressway have also been considered in framing the design standards. Now the standards are revised as per IRC:SP:99-2013.

The Terms of Reference (TOR) specifies 120kmph design speed for the proposed Expressway. The proposed expressway is passing mainly through plain terrain. The geometric design standards for the proposed expressway and the spur have therefore been developed considering the design speed of 120km/hr which commensurate with this terrain.

NHAI has asked to modify some of the geometric standards adopted in earlier submissions during a meeting held on 15th December 2015.

The geometric standards adopted in earlier submission and in this submission are tabulated below:

Sl. No.	Parameter	Earlier adopted Specification	Modified Specification
1.	Earthen Shoulder	3.0m	2.0m
2	Median Width	19.5m for Six Lane 12.0m for 8 Lane	6.0m
3	Side Slope	3:1	2:1
4	Sight Distance	Stopping Sight Distance	Desirable Sight Distance
5	Vertical Clearance PUP / CUP	3.0m	3.5m
6	Gradient	3.0%	2.5%

The Package IV have about 20 bridges, flyovers, underpasses, VOP and ROB in a length of 13 km and will be running on an embankment of more than 5m on the approaches of these structures. But for locations of high embankment, connecting roads etc. the RoW shall be 120m. The guidelines recommend fencing of the RoW to avoid encroachments hence the RoW shall be fenced.

The interchanges comprise of grade separation structures for straight movement and combination of ramps for direct and semi direct connections and loops to accommodate turning movements. A literature survey on the geometric design of ramps and loops as per various standards and used in different expressways was made. Based on this study the design standards for ramps and loops have been recommended. NHAI has approved these design standards with some modifications.

0.11 PAVEMENT DESIGN

The pavement is designed for construction of new 6/8lane divided carriageway including connecting roads and interchanges.

These are (i) Option 1: Conventional flexible pavement as per the provision of IRC: 37 - 2012 (ii) Option 2: Flexible pavement incorporating a semi-rigid layer like Cement Treated Base (CTB) as per IRC: 37 - 2012, (iii) Option 3: Flexible pavement incorporating a reinforcing layer of 3-D geocell (Reinforced option), and (iv) Option 4: Rigid pavement as per the provision of IRC: 58 - 2015. But for underpasses and connecting lanes of toll plaza, only rigid pavement is suggested and designed accordingly.

The detailed traffic surveys for the entire project road were conducted in March – May 2009 and updated in March 2016. Based on the traffic data and interchange locations, the Phase IA (Vadodara to Kim) is divided into five (5) homogeneous sections. However, Package IV falls in Two Section. Vehicle Damage Factors (VDF) for each vehicle type have been assigned on the basis of axle load survey, standard axle load, legal axle load, legal maximum Gross Vehicle Weight (GVW) and consideration that on expressways there will be control on the vehicle loading. Lane distribution of commercial vehicle has been taken as per IRC: 37-2012.

Design period of the proposed Expressway has been considered as 20 years for the Flexible Pavement (first three options) and 30 years for rigid pavement. The design traffic for the flexible pavement of main carriageway is about 150 to 175 msa. The flexible pavements of connecting roads are designed for a maximum traffic load of 10 msa. Rigid pavement is considered for the ramps/loops of the interchanges of main expressway.

Hence for the project single stage construction for project road is adopted keeping in view the periodic maintenance of road. The flexible pavement is designed as per IRC 37-2012, using IITPAVE software for stress-strain calculations. The design of pavement is done by using 90% reliability fatigue and rutting equations.

The pavement composition is proposed as 50 mm BC, 120-130mm DBM, 250mm WMM and 200 mm GSB.

The pavement composition for connecting road determined as per design chart of IRC: 37 – 2012 is 40mm BC 50 mm DBM, 250mm WMM and 200mm GSB.

Keeping in view the high intensity of design traffic, Cement Treated Base (CTB) may be considered to fully replace the conventional granular base like Wet Mix Macadam (WMM). CTB is a mixture of crushed aggregate with measured amount of Portland cement and water, which is compacted and cured to form a strong and durable paving material. For designing a flexible pavement incorporating CTB as one of the base layers, the design procedure suggested in IRC : 37 - 2012, has been adopted. The pavement composition for the main carriageway for the full design period of 20 years is 50mm BC, 50 mm DBM, 100 mm AIL,170-175 mm CTB and 250mm GSB. The functional overlay is proposed in every 5th year

The Option 3 design philosophy for the reinforced option is similar to that of Option 1. Here, a layer of 3-D geocell infilled with granular materials is introduced to increase the stiffness of the base and sub base layers thus reducing the DBM component of the pavement composition recommended in Option 1. In this case, the base layer shall constitute of 100 mm of WMM along with a reinforcing layer

of 125 mm 3-D geocell filled with select granular material and 25 mm of cover by the same granular fill.

The pavement composition for the main carriageway is 50mm BC, 75mm DBM, 250mm Reinforced WMM (100 mm of WMM along with a reinforcing layer of 125 mm 3-D geocell filled with select granular material and 25 mm of cover by the same granular fill), 200 mm GSB.

The Option 4 of rigid pavement has been designed to withstand the cumulative effect of the axle load repetitions of different commercial vehicles applied over the design life of 30 years.

The thickness of the cement concrete pavement has been calculated as 300mm. In addition, 150mm DLC, 150mm GSB and 500mm selected sub-grade will be provided in all the sections. Dowels and tie bars have been designed according to the codal provisions.

The choice of the appropriate economically advantageous Option is made by carrying out Life Cycle Cost Analysis (LCCA), which includes the initial investment cost as also the maintenance / rehabilitation costs over the design life of the structure. The long-term economic viability of pavement types using Present-Worth method of analysis has been studied. Looking in terms of the investments required for initial construction of the pavement, Option 2 of semi-rigid pavement with CTB turns out to be attractive and advantageous from both economic angle and initial construction cost. However, the performance of both semi-rigid pavement and reinforced pavement does not have a track record in India due to very limited use till date. So, we strongly recommend Option 4 as the best pavement type for the project corridor.

It may appear that the traffic noise impact from rigid pavement may pose a problem. However, diamond grinding is a solution to it. The expected reduction of noise for new construction would be approximately 2 dB to 5 dB at the pure tone frequencies that generate the tire whine noise. At closer distances to the travel lanes, reduction in the same frequencies may be as much as 7 dB.

Due to lack of past experience in India, for a project of this magnitude, it is not advisable to adopt semi-rigid or reinforced pavement type for the entire project corridor. However, we strongly recommend that a test section along a desirable designated stretch be constructed with semi-rigid type and / or reinforced pavement and the performance be monitored for any future use in a large scale.

0.12 STRUCTURES

A total of 20 numbers of different structures comprising of One major bridge, 3 minor bridges,, 2 canal bridges, One Flyover, 2 vehicular underpasses,, 3 light vehicular underpasses and 7 pedestrian/cattle underpasses have been proposed as per hydrological and traffic requirement for railway crossings, road junctions of NH, SH, District/Village roads and local roads crossing the alignment of the main Expressway.

Deck configuration of new bridges / structures has been kept as per proposed road cross section of Expressway keeping in view the guidelines issued by NHAI time to time and. All bridges / structures shall have two independent carriageways of 4-lanes each and 3.5m wide median (except at ROB's) between the two carriageways. Overall deck width of each carriageway has been kept 21.25m to match with the width of approach embankment. However structures having acceleration lane/ deceleration lane shall have additional lane/lanes as per requirement. All structures are proposed to be eight lane in the opening year.

Efforts have been made to ensure that the type of structures selected will be innovative, cost effective and suitable for construction by locally available material and technology in shortest possible time. Keeping this in view the following type of structures have been proposed which may be simply supported or continuous as per site requirement:-

Superstructure

Span upto 10m	:	RCC solid slab / RCC box
Span 10m to 20m	:	RCC voided slab
Span 15m to 25m	:	RCC precast beam and cast in situ slab
Span 24m to 30m	:	PSC Precast girder and cast in situ slab
Span 30m to 60m	:	Pre-cast post tensioned girder or steel plate girder with cast in situ RCC slab / PSC box girder
Span > 60m	:	PSC box girder cantilever type construction/ Extradosed type
Railway Over Bridge (ROB) Railway portion	:	Steel plate girder with RCC deck slab composite type superstructure as per Railways' Circular.
Vehicular Over Bridge (VOB)	:	RCC Integral Structure / PSC Precast Girder with cast in situ RCC deck slab composite type.
Vehicular Underpass (VUP)	:	RCC Box / Portal type
Pedestrian Underpass (PUP)	:	RCC Box

Substructure

Abutment	:	RCC wall type
Pier	:	RCC circular/wall/ornamental type

Foundation

Major Bridges	:	Well / Pile / Open
Minor Bridges	:	Well / Pile / Open
R.O.B. / Flyovers / Interchanges	:	Open / Pile

In deciding the span arrangement and selection of type of superstructure the following points have been given due consideration:-

- Generally single span bridges of long spans have been preferred. However in multi-span bridges of less than 30m individual span deck continuity has been provided for better riding quality of the road.
- Efforts have been made to provide long span or continuous superstructure as far as practicable, for better ridding quality.
- Long span cantilever type segmental PSC box girder or Extradosed type superstructure have been proposed where long span due to navigational requirement are required or where depth of water / subsoil condition are severe to reduce number of foundations.
- Steel girders with RCC slab composite type superstructure have been proposed on ROBs as per Railways' requirement.

- As far as possible precast RCC/PSC/girder and slab or segmental PSC box or pre-fabricated steel girder type superstructure have been adopted for fast track construction.
- Single span RCC/PSC girder type bridges have been provided at the gas pipeline crossings to keep ROW of gas pipeline free from the road embankment / structures.

0.13 DESIGN OF EXPRESSWAY

Based on the design standards and the result of the traffic assignments the following options for the cross-section for the expressway have been considered:

Type 1 : Six lane divided carriageway with 6.0m wide flush median. This option is for stage construction to eventual eight lane divided carriageway. The future widening to eight lanes is considered on outer side of the paved shoulder. The carriageway width is 11.25m with 3.0m wide paved and 2.0m wide earthen shoulder. The inside edge strip is 0.75m wide is proposed.

Type 2 : Eight lane divided carriageway with 6m wide flush median. The carriageway width is 15m with 3.0m wide paved and 2.0m wide earthen shoulders. The inside edge strip is 0.75m wide is proposed.

Since the GAD's of all ROBs has been approved by the concerned Railway Authority with depressed median, the median width at those locations including major bridge at Narmada has been kept unchanged. The expressway will be fully access controlled with access allowed through interchanges only. One interchanges has been proposed in this section of the expressway. The list of interchanges with configuration is given in **Table Es 0.6**.

Table Es 0.6: Configuration of Interchanges

Sl. No.	Location (km)	Connecting Road	Type of Interchange	Remarks
Main Expressway				
1	287.385	Dahej-Baruch (SH-6)	Full Cloverleaf	The expressway at this location intersects the road connecting Dahej Port on west and the Bharuch city on the west. Therefore, full cloverleaf has been proposed to provide conflict free movements for all turning movements.

Flyover at one location and Vehicular underpasses of size 12m x 5.5m have been proposed on 2 Major Road crossings. 3 nos. of light vehicular underpasses of size 10.5mx3.5m and 7 nos of Pedestrian/ Cattle Underpasses (size 7mx3.5m) have been proposed for other village roads and Cart track. The vertical clearance of Pedestrian Underpass has been kept as 3.5m in discussion with NHAI and as per MoRT&H Circular no. RW/NH-35072/04/2004-S&R/(R) dated 27.04.2010.

The expressway is cutting across a number of roads and it will not be possible to provide underpasses at all the locations due to cost consideration and close to nearest cross passage. Therefore connecting roads with a total length of about 0.400 km for this package have been planned for safe movement of local traffic across the expressway.

0.14 TOLLING STRATEGY AND PLANNING OF TOLL PLAZAS

Closed tolling system has been recommended for the expressway. Only ramp toll plazas have been provided at the interchange locations and mainline toll plazas have been proposed only at the start and at the end. The user will register at entry and pay at exist. Hence the user will be charged for the exact distance travelled.

The analysis to determine the number of toll lanes or toll booths in each toll plaza has been done on the basis of Queuing Theory by assuming the closed system of tolling on the expressway and as per requirement of TOR. Smart-card based tolling system, Electronic Toll Collection system – Crawl through and Electronic Toll Collection system- Non stop are to be used to achieve toll transaction speed of less than 10 seconds (per vehicle per lane)

0.15 USER FACILITIES AND ROAD FURNITURE

As per the Terms of Reference (TOR) wayside amenities should be provided at an interval of 50km. However since the expressway is designed for a speed of 120kmph, it will take less than half an hour to cover a distance of 50km. Hence it is proposed to increase the distance between wayside amenities to 75-100km. However, due to short section of VME such facilities have not been proposed in this Package. Operation and Maintenance Centers along the expressway to accommodate spaces for traffic Control Center and administrative building, maintenance base, traffic patrol unit, vehicle parking, emergency medical facilities and restaurants etc. will be provided near the interchanges. Out of total 2 station in Phase IA, there is One operation and maintenance centers have been proposed in this Package.

The traffic signs and markings to provide information, guidance, warning and mandated requirements to the users of the expressways will be provided on the basis of the IRC: SP: 99-2013 and the Manual on Uniform Traffic Control Devices (MUTCD), FHWA, USA.

Thrie Beam-type metal beam longitudinal edge barriers will be provided on outer edges at the top of embankment throughout the length to protect any out of control vehicle from falling. Thrie beam metal barriers are also proposed in median for both side carriageways.

0.16 ADVANCED TRAFFIC MANAGEMENTS SYSTEM (ATMS)

The Expressway is expected to be provided with ATMS facilities to acquire data automatically and utilize the same for managing traffic as well as facilitate the travel through the corridor with least hazard, as the motorists will be informed in advance about the situation ahead. Basically, the ATMS will have the complete capability of incident management and to meet the requirements of the safety of users. ATMS will provide information to the users on real time basis for the traffic flow conditions and incidents ahead, and for this purpose, there would be a control centre and outdoor equipment located at strategic locations along the entire corridor and connected through a transmission medium.

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

i. Communication backbone
ii. Emergency Communication System
iii. Mobile Communication System
iv. Variable Message Sign System
v. Meteorological Data System
vi. Automatic traffic counter-cum-classifier system

vii. Video Surveillance System
viii. Video Incident Detection System (VIDS)
ix. Central Control Room (CCR)
x. Weigh in motion for axle load measurement
xi. Power Supply System

0.17 DETAILED COST ESTIMATE

The cost of construction of Expressway for Civil Works and Total Project cost works out as given in **Table Es 0.7**.

Table Es 0.7: Summary of Cost

Description	Total Cost (Rs.)
Total Civil Cost (A)	**11,783,300,967.98**
Add tentative cost for GST@ 10% on (A)	**1,178,330,096.80**
Total Civil Cost including GST (B)	**12,961,631,064.78**
Civil Cost in Crores	**1,296.16**
Cost per Km (Length = 13 Km.) in Crores	**99.70**
Add Contingencies @ 2.8% on B (C.)	362,925,670.00
Sub Total (A+B+C) =	13,324,556,734.78
Cost in crores	**1,332.46**
Construction Supervision Charges @ 2% on (B)	259,232,621.00
Administration Charges @ 1% on (B)	129,616,311.00
Quality Control Charges @ 1% on (B)	129,616,311.00
Road safety cell audit Charges @ 0.5% on (B)	64,808,155.00
Maintenance Cost for 4 Years @ 5% on (B)	648,081,553.24
Escalation @ 5% per annum for 2 years i.e. 10% on (B)	1,296,163,106.48
Total	**15,852,074,792.49**
Environment and Mitigation cost	7,589,277.00
Land Acquisition ,Resettlement and Rehabilitation Cost	1,569,100,000.00
Cost for Shifting of Utilities	180,765,879.00
Grand Total	**17,609,529,948.49**
Cost in crores	**1,760.95**
Project Cost per km	**135.46 Cr**

0.18 ECONOMIC ANALYSIS

The economic analysis was carried out to assess the economic viability of the proposed Expressway by comparing the total transport costs with that of 6 lane NH8. The economic appraisal is carried out by using the 'Highway Development and Management (HDM 4) Model. The results indicate the Development of Expressway is economically viable with time savings with an EIRR of about 30.8%.Sensitivity analysis has been carried out for the variations in costs and

benefits. Sensitivity analysis has been performed for both with time saving. The sensitivity scenarios take into account possible construction costs overrun, traffic volume, revenue shortfalls, interest rate volatility, non-compliance or default by contractors, and political risks. The EIRRs and the NPVs under the sensitivity analysis showing different adverse situations for the economic appraisal of the investment in the Project Roads give acceptable results, i.e. the EIRRs are well above the cut-off rate of 12%, and the NPVs are positive at the discount rate of 12%. Phase IA has been divided in 5 packages and the expressway is a green field project. Hence package wise benefits could not ascertain for Economic analysis without exact comparison of NH 8 (competing road). Hence the analysis has been carried out for Phase IA (Kim to Vadodara). The following results are for Phase IA.

The summary of the sensitivity analysis results are given below

Sensitivity Analysis: Values of EIRR

Phase	Base Case	Cost 15% up	Benefit 15% down	Cost 15% up and Benefit 15% down
Phase-IA	30.8%	27.8%	26.8%	24.0%

Sensitivity Analysis: Values of NPV (Rs. in million)

Option	Base Case	Cost 15% up	Benefit 15% down	Cost 15% up and Benefit 15% down
Phase-IA	154,105.02	142,434.65	112,234.64	100,564.32

0.19 CONCLUSIONS AND RECOMMENDATIONS

With rapid economic development taking place in the States of Gujarat and the planned Delhi-Mumbai industrial corridor there is a need to develop a high speed corridor wherein the movement of large volumes of passenger and goods vehicles can take place at a fast pace. The proposed expressway will fulfill the objective and also reduce the travel time.

1) Based on the traffic estimates and the volume to capacity ratios it is recommended that this package be developed to six/eight lane facility on the opening year.
2) To minimize delays to the through traffic a closed type tolling system is recommended with toll plazas at the entry and exit of the interchanges. Mainline toll plazas are recommended only at the start and at the end.
3) Based on life cycle costing rigid pavement is recommended for the entire length of the Expressway.
4) The expressway gives us an opportunity to build innovative structures and the General Arrangement Drawings (GAD) presented with this report are recommended.
5) It is recommended that, the project be undertake on EPC mode for Implementation.

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INTRODUCTION

1

1. INTRODUCTION

1.1 BACKGROUND

India has about 3.3 million kilometers of road network, which is one of the largest road network in the world. The roads in the country are either under administrative control of the Union Government or the State Government concerned. Roads in the country carry about 65 percent of freight traffic and 87 percent of passenger traffic. National Highways, the primary road network of the country, are under the Union Government. The aggregate length of National Highways is, at present, 70548 kms which is about 2 percent of the road network but carries about 40 percent of road traffic.

Keeping in view of the importance of the National Highways for the economic development, the Government of India has taken up an ambitious program of development of the National Highways under different phases of National Highway Development Project (NHDP). One of the phases of NHDP, namely, NHDP Phase-VI is for development of 1000 km of expressways. The expressways carry large volumes of traffic at high speed and are access controlled.

The National Highways Authority of India (NHAI) has been entrusted with the implementation of, inter-alia, NHDP Phase-VI. This project has been proposed to be implemented under Public Private Partnership mode and to be executed as Design, Build, Finance and Operate (DBFO) contracts. The 400 km long Vadodara - Mumbai (VM) Expressway is one of the expressways which have been identified for implementation in the first phase.

The NHAI, as the employer and the executing agency has commissioned the services of Intercontinental Consultants and Technocrats Private Limited (ICT) for carrying out consultancy services for “Preparation of Feasibility cum Preliminary Design Report for Vadodara – Mumbai Expressway under NHDP Phase- VI”.

1.2 CONSULTANCY APPOINTMENT

In pursuance of the above, ICT has been appointed as a Consultant by agreement dated 29th January, 2009 for carrying out the consultancy services for “Preparation of Feasibility cum Preliminary Design Report for Vadodara Mumbai Expressway under NHDP Phase-VI”. The consultants mobilized its team and commenced services from 12th February 2009.

1.3 BRIEF SCOPE OF SERVICES

The scope the consultancy services as per the original contract is to carry out the feasibility cum preliminary design of the Vadodara Mumbai expressway. As per the TOR of the original contract, the feasibility of the expressway has to be established by a comprehensive transport demand study for the corridor, on a suitable alignment selected by NHAI for the purpose, assessment of the investment needs for construction of the expressway, revenue generation potential of the facility and financial return from the project if constructed and maintained on a BOT format. As per original TOR the feasibility study will be followed by preparation of Feasibility cum Preliminary Design Report, which shall contain detailed planning of the expressway facility including operational planning, detailed survey and investigation, design and costing. Eventually, the BOT bids under DBFO format will be called on the basis of the Feasibility cum Preliminary Design Report.

Subsequently during meetings with senior NHAI and MoRTH officials it was decided that since this is a greenfield project being floated on BOT it would be prudent to conduct a detailed engineering design. This would give a better understanding of scale and cost of the project to prospective bidders and also reduce the time for bidding. Therefore NHAI extended the scope of the services to Detailed Engineering Design vide its letter NHAI/NHDP-V/MCII/BOT/FR/AV/240 dated 3rd November 2010.

During the draft feasibility study of the Expressway it was felt that the proposed start point of VM expressway on NH8 at Mumbai end would pose a serious problem of safe and quick dispersal of traffic from the expressway and also would not serve the purpose of connecting to major traffic generators like JNPT port and to Mumbai-Pune expressway. Currently the traffic bound for Gujarat and further north from JNPT and NH4 follows Thane-Ghodbandar road which is already congested. This traffic has to pass through congested road network of Mumbai Metropolis from southward destination and the goods earmarked for export and import also find difficulty in commuting to and from JNPT, New Mumbai. Therefore it would be prudent to connect the proposed VM expressway to major traffic generators like JNPT and to Mumbai – Pune expressway through a Spur. The spur will not only connect to these major traffic generators but will also result in better dispersal of traffic in the Mumbai Metropolitan Region.

A presentation on the alignment for the spur was made before Chairman, Member and other senior officer of NHAI and the recommendation of the consultant for a spur alignment connecting the VM expressway to JNPT and Mumbai Pune expressway was accepted in principle. The formal approval for the same was accorded by NHAI vide letter No. NHAI/V-M Expressway/DM/2008/216 dated 16th November, 2009.

Subsequently on 9th April 2010 a presentation of the alignment of the expressway and the Spur was made to the Chief Secretary (CS), Government of Maharashtra in which senior officials of the NHAI, MoRTH, State PWD, Officials from State Revenue and Forest Department, City and Industrial Development Corporation(CIDCO) and the Mumbai Metropolitan Region Development Authority (MMRDA) were present. In the presentation the Spur to JNPT was approved in principle. The CS appointed a committee under the Chairmanship of Divisional Commissioner Konkan Region to look into any modifications if any required in the alignment. The committee recommended the alignment of the VM expressway in Maharashtra and the outer alignment for the Spur to JNPT. The committee has since submitted its report and the Government of Maharashtra has accepted the recommendations of the committee. A formal approval of the alignment was communicated by the Government of Maharashtra vide their letter NHP2010/CR81/NH1 dated 3/02/2011 addressed to Chairman NHAI. Hence the scope of services has been further extended with inclusion of the 94 km long Spur to JNPT.

The supplementary agreement covering the Detailed Engineering Design of the Vadodara Mumbai Expressway including the Spur to JNPT was signed between NHAI and ICT on 5th September 2011.

1.4 PROJECT DESCRIPTION

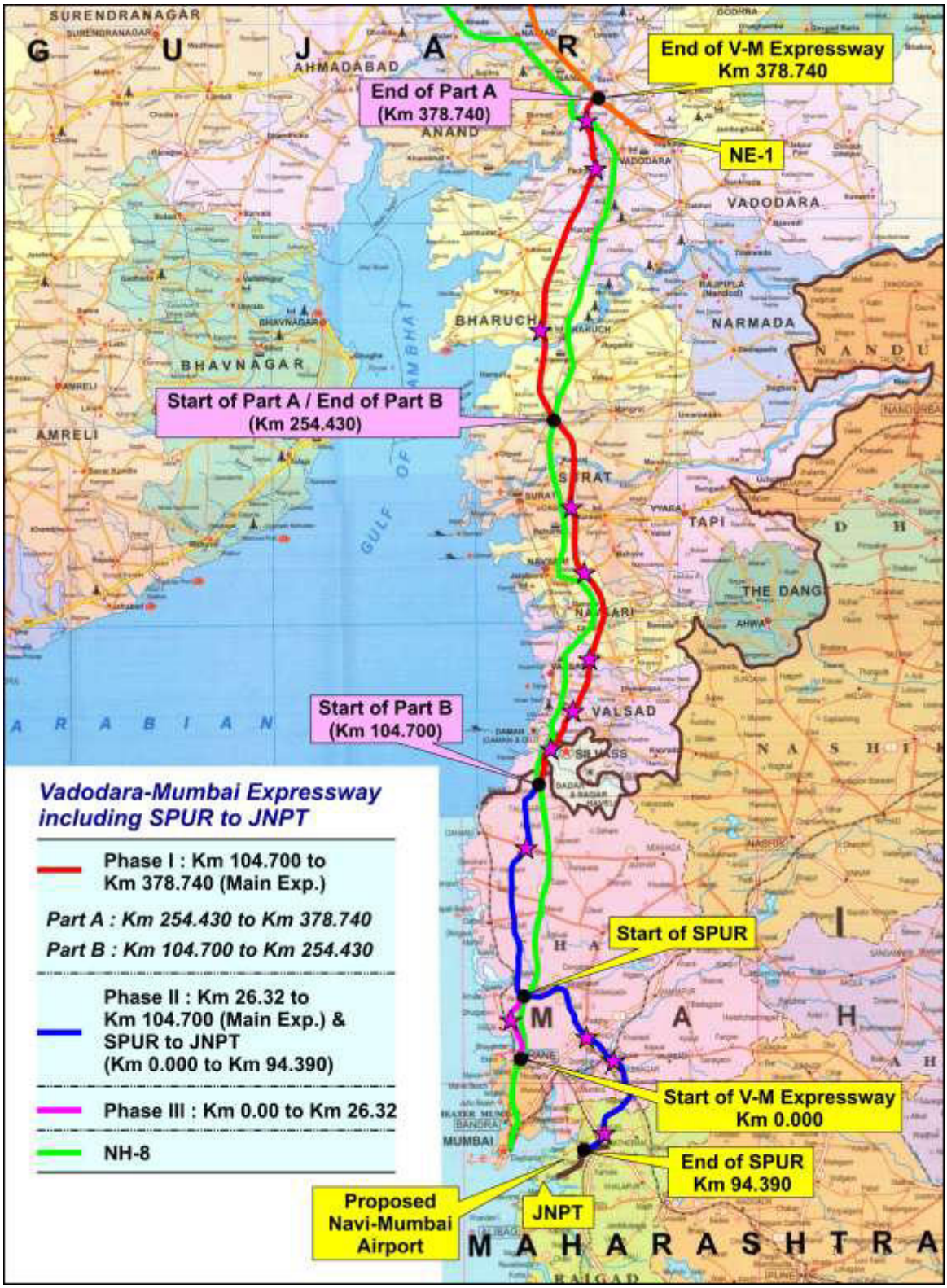
The Mumbai–Ahmedabad Corridor in the western part of the country is one of the important transport corridors of the country. On one side of this corridor is Mumbai which is the financial capital of the country and on the other side is Ahmedabad, an important commercial and business city. There are many industrial centers on this route. Industries like, textile industry, gems and

jewelries, petrochemical & fertilizer and other industrial complexes have been established along this corridor. This corridor also serves SEZ areas and ports situated along this part of the country. Development works of these corridors like improvement of National Highways, construction of expressways, construction of dedicated railway freight corridors, modernization of airports located along this corridor etc have been taken up. The project road lies within the proposed Delhi Mumbai Industrial corridor which is being planned as hub of industrial and urban activity

The Mumbai-Ahmedabad road corridor along NH-8 is one of the busiest corridors of National Highways which carries highest range of volume of traffic. As per recent traffic data the traffic on NH8 varies from 50,000 PCU to 85,000 PCU per day. Number of steps has been taken for development of this NH-8 to facilitate high speed and safe travel along this corridor. Already a 93 km long four lane access controlled expressway has been constructed between Ahmedabad & Vadodara in addition to existing two/four lane NH-8 section between these two cities. The portion of NH-8 between Mumbai (Dahisar) and Vadodara is also being six laned under NHDP V. In addition, the present proposal is for construction of Vadodara Mumbai Expressway with a Spur to JNPT. The spur to JNPT will act as a bypass to the Mumbai Metropolitan Region (MMR) and will thus facilitate decongestion of the MMR with faster movement of traffic to and from JNPT and further south to Pune.

The proposed expressway passes through the states of Maharashtra, Gujarat and union territory of Dadra & Nagar Haveli. The alignment of spur is in Maharashtra only. The total length of the proposed VM expressway as per the proposed alignment is about 379 km while the Spur to JNPT is about 94km long. This project will be a green field project along a new alignment. The Index Map of the Project is given in **Fig. 1.1.**

Fig. 1.1 Index Map



1.5 DELIVERABLES

As per the original ToR the Consultant have so far submitted the following:

a) Inception Report and Quality Assurance Plan

b) Final Feasibility Report and Social Impact Assessment Report

c) Final Feasibility cum Preliminary Design Report and Resettlement Action Plan

d) Draft Detailed Project Report

e) Final Detailed Project Report

A meeting was held on 15th December 2015 regarding Vadodara-Mumbai Expressway (VME). During the discussions, NHAI asked repackaging of the project with modified specifications as detailed below. The existing NH8 which is almost parallel to proposed VME has been clubbed with VME project with some value addition works. The value addition includes only provision of some bridges/flyovers/underpasses at selected locations.

(i) **Phase I** – Km 104.700 to Km 378.740 of VM Expressway and improvement of existing NH-8 from Km 108.700 to Km 390.864

Phase I is again divided in to two parts as:

Phase IA

Stretches (km)		Length (Km)
From	To	
VM Expressway		
254.430 (NH-8 Intersection)	378.740 (Vadodara on NE1)	124.310
NH 8 - Value Addition		
108.700 (Vadodara)	233.000	141.300

Phase IB

Stretches (km)		Length (Km)
From	To	
VM Expressway		
104.700 (Talasari)	254.430 (NH-8 Intersection)	149.730
NH 8 - Value Addition		
233.000	390.864 (Talasari)	140.864

(ii) **Phase II** – Km 26.320 to Km 104.700 VM Expressway and Km 0.000 to Km 94.390 of SPUR including improvement of existing NH-8 from Km 390.864 to Km 473.000.

(iii) **Phase III** – Km 0.00 to Km 26.320 of Main VM Expressway.

1.6 REVISED SCOPE OF WORK

The revised scope of work is as follows:

1.6.1 Phase IA

1.6.1.1 Vadodara Mumbai Expressway

1) The median width has to be changed from 12m/19.5m to 6.0 m except at ROB locations. Crash barriers shall be provided on both sides of median.
2) The vertical clearance of all Pedestrian Underpasses (PUP) shall be increased to 3.5m in place of 3.0m. The invert level of PUP may be lowered by 0.5m wherever feasible.
3) Optimization of Earthwork
    - The embankment slope shall be reduced to 2 (H):1 (V) in place of 3 (H):1(V).
    - RE wall shall be provided at Flyover, VOB and VUP approaches.
4) Drip irrigation system shall be provided on median.
5) Ornamental type avenue plantation shall be provided.
6) Provision of solar light shall be made.
7) HTMS shall be provided.
8) Way side amenities shall have the following provisions
    - Unloading platform
    - 5 Star Trauma center and Hotel
    - Weigh Bridge

1.6.1.2 NH 8 from Vadodara to Talasari

1) Study of existing black spot and inventory study of existing NH8
2) Provision for additional structures shall be made to provide the 6 lane facility. The provision includes preparation of GAD only for the additional structures.
3) Median opening shall be closed by providing underpasses.
4) Provision of service road shall be made wherever required.
5) The above provisions are to be proposed within available ROW. Hence environment and social impact studies not required.

1.6.1.3 Project Cost Estimate

To be updated and modified.

1.6.1.4 Schedules for DBFO

To be updated and modified.

1.6.2 Phase II

1.6.2.1 Vadodara Mumbai Expressway - Realignment

1) Provision of additional Interchange at Km 60.240 of Main Expressway on Boisor road for connectivity to proposed Port at Alibari- Nandgaon
2) Change of alignment near NH 3 crossing for SPUR (from Km 37.0 to 42.0) including Interchange at Km 39.750.
3) Change of alignment from km 64.000 to 71.600 for Sape village on SPUR.
4) Merging of SPUR and Multi Model Corridor (MMRDA) alignment (from Km 45.500 to Km 65.500 of MMC).

- The SPUR alignment will follow the alignment fixed by MMRDA for MMC.
- The alignment will involve alignment approval from MMRDA, CIDCO and Govt. of Maharashtra.
- The cross section will include SPUR and MMC.
- There will be interchange of Mumbai Pune Expressway, NH 4 and NH 4B with 5 Km elevated structure.
- Due to change in alignment from SPUR, the alignment will involve approval from Matheran Eco Sensitive Zone.

5) The median width has to be changed from 12m/19.5m to 6.0 m except at ROB locations. Crash barriers shall be provided on both sides of median.

6) The vertical clearance of all Pedestrian Underpasses (PUP) shall be increased to 3.5m in place of 3.0m. The invert level of PUP may be lowered by 0.5m wherever feasible.

7) Optimization of Earthwork
   - The embankment slope shall be reduced to 2 (H):1 (V) in place of 3 (H):1(V).
   - RE wall shall be provided at Flyover, VOB and VUP approaches.

8) Drip irrigation system shall be provided on median.

9) Ornamental type avenue plantation shall be provided.

10) Provision of solar light shall be made.

11) HTMS shall be provided.

12) Way side amenities shall have the following provisions
   - Unloading platform
   - 5 Star Trauma center and Hotel

   Weigh Bridge

1.6.2.2 NH 8 from Talasari to Khanivadi

1) Study of existing black spot and inventory study of existing NH8

2) Provision for additional structures shall be made to provide the 6 lane facility. The provision includes preparation of GAD for the additional structures.

3) The median opening shall be closed by providing underpasses.

4) Provision of service road shall be made wherever required.

5) The above provisions are to be proposed within available ROW. Hence environment and social impact studies not required.

1.6.2.3 Project Cost Estimate

To be updated and modified.

1.6.2.4 Schedules for DBFO

To be updated and modified.

1.6.3 Traffic Survey and Analysis

The purpose of this study is to update the estimated traffic of various sections of VME. The traffic surveys were conducted in year 2009. The traffic likely to be diverted from NH-8 and other competing routes to the proposed expressway was estimated with the help of travel demand model. NHAI wishes to update the traffic estimates and hence the consultant propose to carry out traffic surveys on a sample basis.

Traffic Surveys

Traffic surveys will be conducted on NH-8 and other major roads on a sample basis to cover for approximate 30% of original survey locations. The following traffic surveys will be conducted,

- Mid-block traffic volume count (duration: 7 days)
- Mid-block traffic volume count (duration: 3 days)
- Turning movement count at intersections (duration: 24hrs)

Data analysis and updating estimated traffic for expressway sections

The traffic volume data collected from field surveys will be analyzed to get ADT and AADT for new base year (current year). These AADT will be compared with projected AADT of corresponding section of NH-8 to study the difference in projected and actual traffic. Based on this, a conversion factor (ratio of new observed AADT and projected AADT of current year) will be calculated for each section of NH-8. These conversion factors (updation factors) will be applied section-wise to earlier estimated traffic of various sections of expressway to get the updated traffic volumes.

1.7 FURTHER DEVELOPMENT FOR EXECUTION

In reference to NHAI letter no NHAI/NHDP-V/MC-II/BOT/FR/AV/100901 dated 6th June 2017, Phase IA has been further sub-divided in 5 packages for execution on EPC mode standalone without value addition of NH8 including some structure addition and deletion. The Package details are as follows:

Package No.	Packages	Length (Km)
Package I	Construction of Six lane Vadodara Kim Expressway from Km 355.00 to Km 378.740 (Padra to Vadodara Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package I).	23.74
Package II	Construction of Six lane Vadodara Kim Expressway from Km 323.00 to Km 355.00 (Sanpa to Padra Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package II)	32.0
Package III	Construction of Six lane Vadodara Kim Expressway from Km 292.00 to Km 323.00 (Manubar to Sanpa Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package III)	31.0

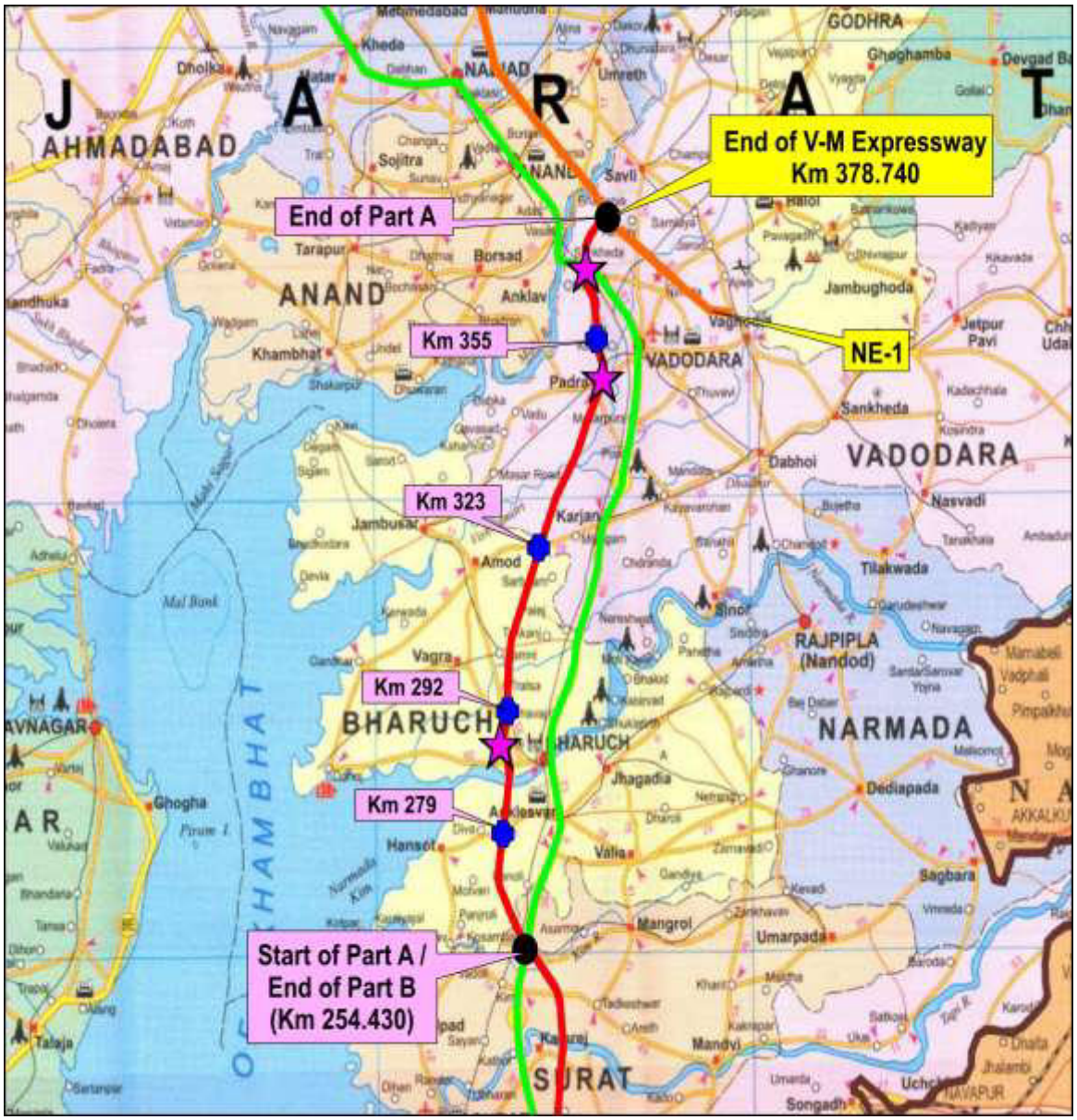
Package No.	Packages	Length (Km)
Package IV	**Construction of Six/Eight Lane Vadodara Kim Expressway from Km 279.00 to Km 292.00 (Ankleshwar to Manubar Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package IV).**	**13.0**
Package V	Construction of Eight Lane Vadodara Kim Expressway from Km 254.430 to Km 279.00 (Kim to Ankleshwar Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package V).	24.57

In addition to above package there are some modification made and the details are as follows:

1. Height of embankment shall be as per IRC SP:99-2013
2. Replacement of Pedestrian underpasses by providing connecting road
3. Provision of Interchange at Km 323+087
4. Provision of Flyover at Km 344+355 by replacing VUP.

The revised Index Map of the Project (Phase IA) with details of packages is given in **Fig. 1.2.**

Fig. 1.2: Revised Index Map



1.8 FINAL DETAILED PROJECT REPORT

In addition to above packaging, there are some modification made and the details are as follows:

1. Height of embankment shall be as per IRC SP:99-2013
2. Replacement of Pedestrian underpasses by providing connecting road
3. Provision of Interchange at Km 323+087
4. Provision of Flyover at Km 344+360 by replacing VUP.

Further NHAI has instructed not to delete the Pedestrian Underpasses as these are very essential for crossing of Green field alignment.

As mentioned above, in reference to NHAI letter no NHAI/NHDP-V/MC-II/BOT/FR/AV/100901 dated 6th June 2017, Phase IA has been divided in 5 packages for execution on EPC mode**.** This Final Detailed Project Report is for

Phase 1A- Package IV : Km 279.000 to Km 292.000 has been prepared. This Report contains following volumes:

Volume I	:	Main Report
Volume I (A)	:	Annexures to Main Report
Volume II	:	Drawings
Volume III	:	Rate Analysis
Volume IV	:	Cost Estimate
Volume V	:	Bidding Documents

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SOCIO-ECONOMIC PROFILE OF PROJECT AREA

2

2. SOCIO-ECONOMIC PROFILE OF PROJECT AREA

2.1 INTRODUCTION

In general, any project intervention is targeted to development of the people as a whole, while directed to some specific target groups and sectors. Hence, data pertaining to people and their growth status have become significant in assessing the benefit impacts as it depicts existing scenario of the project influence area and provides the baseline for future assessment. The proposed VME alignment passes through the states of Maharashtra, Gujarat and Union territory of Dadra & Nagar Haveli while the Spur to NH-4B lies completely in Maharashtra. The proposed VME corridor and the Spur alignment are passing through the following districts as indicated in **Table 2.1.**

Table 2.1: Details of Affected Villages

Name of State/ Union Territory	Name of Districts	Number of affected Villages
VME Corridor		
Maharashtra	Thane	75
Dadra & Nagar Haveli	Dadra & Nagar Haveli	5
Gujarat	Valsad	28
	Navsari	22
	Surat	37
	Bharuch	31
	Vadodara	29
	Total (A)	**227**
Spur Alignment		
Maharashtra	Thane	61
	Raigarh	21
	Total (B)	**82**
	Grand Total (A+B)	**309**

In order to understand the demography and socio-economic background, a micro-level analysis has been done for the project affected villages comprising of population characteristics, workforce, share of workers in major economic activities and other socio-economic features.

The description of the socio-economic profile of the project influence area is discussed into two main sections viz. profile of project districts and profile of demographic and socio-economic features of project affected villages. Main socio-economic and demographic features of these project affected districts and villages have been delineated in the subsequent paragraph.

This chapter presents the Socio-economic Profile of the Project Influence Area of the entire Expressway including the 'Spur'.

2.2 THANE - THE PHYSICAL FEATURES AND THE DISTRICT PROFILE

2.2.1 Area and Location

Thane District forms a part of North Konkan Region, which lies between the Sahyadri hills in the east and the Arabian Sea in the West. It has coastal line of about 113 kms. District headquarter Thane is about 25 kms from the international airport and 35 kms from the main down town of Mumbai City. The total geographical area of the district is 9558 sq. kms, which is 3.11% of the total area of Maharashtra.

2.2.2 Climate and Rainfall

The climate of the district is distinctly different on the coastal plains and on the eastern slopes. Being fully tropical, the climate on the coast, the coastal strip including Thane, Vasai, Palghar and Dahanu tehsils is very humid and warm. On the other hand, the climate on the eastern slopes and in the plains at the foot of the slopes is comparatively less humid. However, variation in temperature in the eastern region is more than that on the coastal strip. The maximum temperature ranges from 28.0° to 35.2° centigrade and the minimum temperature remains between 16.3° and 26.5° centigrade.

The district gets average rainfall of 2000 to 4000 mm. from the South-West monsoons during the months of June to September. Generally highest rainfall is recorded in the month of July.

2.2.3 Agriculture

Rice is the main crop of the district. It is grown mainly in Palghar, Bhiwandi, Murbad, Shahapur, Wade, Vikramgad and Dahanu talukas. Vari and Nachani are grown in the hilly region of the east. These crops are grown mainly in Jawhar, Murbad, Vikramgad, Shahapur and Mokhade talukas.

2.2.4 Industries

From the point of view of industries, Thane is an important district of Maharashtra state. There are many large scale and small scale industries in the district. There are different types of textile industries at Thane and in the neighbouring areas. The first nuclear power plant in India was set up at Tarapur in Thane district. In addition, there are a number of factories manufacturing electrical equipment at Thane and Ulhasnagar. There are industrial estates at Ambarnath, Kalyan, Bhiwandi, Thane-Belapur, Badlapur, Mira, Tarapur and Murbad in Thane district.

2.3 RAIGARH - THE PHYSICAL FEATURES AND THE DISTRICT PROFILE

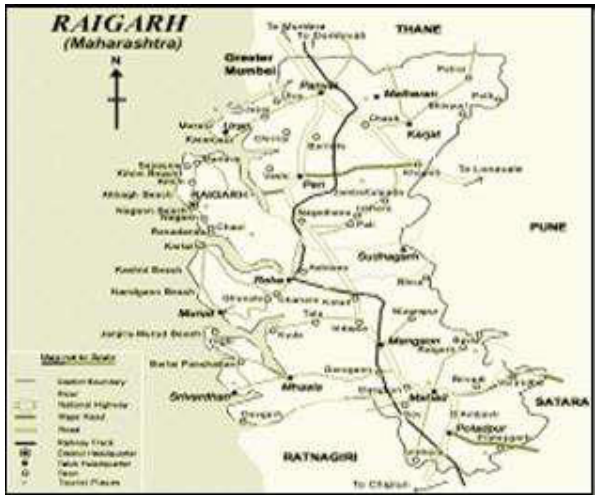
2.3.1 Area and Location

Raigarh district is located in south-western side of Maharashtra State. The District Head Quarter of Raigarh is Alibagh. Alibagh is situated on western coast of India & on shore of Arabian Sea. The total geographical area of the district is 7,148sq. kms. The district had a population of 2,207,929 of which 24.22% were

urban as of 2001. It is located between 72.51° to 73.40° longitude and 17.51° to 19.80° latitude.

2.3.2 Climate and Rainfall

This area has sub-tropical monsoon climate of humid to semiarid & sub humid type. Overall climate is equable with high rainfall days & very few days of extreme temperatures. The mean annual temperature ranges from 25ºC to 28ºC. The mean maximum temperature of the hottest month in this area varies from 30ºC to 33ºC in April-May while mean minimum temperature of coldest month varies from 16ºC to 20ºC. The rainy season is mostly confined to southwest monsoon with 80% of the rainfall received during June-October. The district gets average rainfall of 3884.3 mm.



2.3.3 Agriculture

Raigarh district is mostly agrarian, with majority of people dependent on rain-fed agriculture. The important kharif crops of the district are rice, vari. The pulses like Urad, Moong & Kulith are also grown in this season. Rice is the staple crop of the district. Vegetables & seasonal fruits are also grown in this district. Of the working population about 51.65% are farmers & 20.02% were farm-labours.

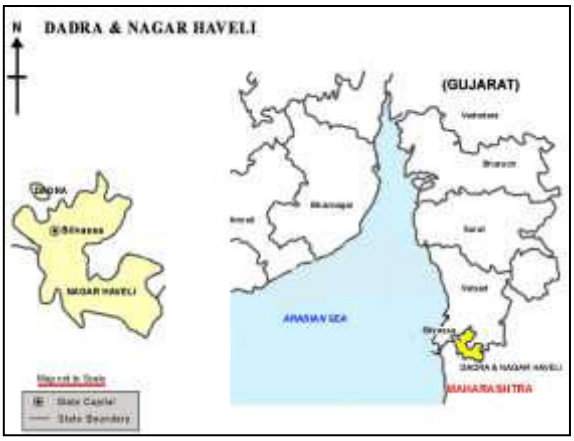
2.3.4 Industries

The district being in close proximity to Mumbai, Thane & Pune is rapidly getting industrialized with industrial areas located in Rasayani-Patalganga, Roha, Mahad and Nagothane. The district has quite a few large industrial undertakings in the public sector, namely ONGC Gas Terminal, Uran Jawaharlal Nehru Port Trust, Nhava Shewa, RCF ltd. There are some private sector industries like Reliance Polyesters at Patalganga, Indian Petrochemicals Ltd at Nagothane, Vikram Ispat (Birla group). Raigarh district has 1,757 small-scale industries registered, with the largest investment in the chemical sector.

2.4 DADRA AND NAGAR HAVELI - THE PHYSICAL FEATURES AND THE DISTRICT PROFILE

2.4.1 Area and Location

The Union territory of Dadra and Nagar Haveli has an area of 491 sq. km, and it is surrounded by Gujarat and Maharashtra. It consists of two regions namely, Dadra and Nagar Haveli. The land under forest cover (20359 hectares) in this territory constitutes about 40 percent of the geographical area. The central region of the land is almost plain and the soil is fertile and rich.



Dadra and Nagar Haveli are in the watershed of the Daman Ganga River, which flows through the territory. The towns of Dadra and Silvassa both lie on the north bank of the river. The Western Ghats range rises to the east, and the foothills of the range occupy the eastern portion of the district. The territory is landlocked, although the Arabian Sea coast lies just to the west in Gujarat.

2.4.2 Climate and Rainfall

The climate is moderate and generally healthy in the central zone, though hot and humid during the summer months but less warm during the monsoon season from June – September. The area is referred to as Cherrapunji of the West India, receiving an annual rainfall between 200-250cm.

2.4.3 Culture

Hinduism is the religion of the vast majority (95%) of the population though religious observances may differ. The territory is least urbanised with less than 20 percent population living in towns. The farming community has very small land holdings and most of them are agricultural labourers as there is hardly any mechanised farming. The houses are generally thatched huts roofed with tiles near agricultural fields.

The people are simple hard working class and a close knit community. The rituals play a predominant role in the life of tribal communities of Dadra and Nagar Haveli, particularly the Varlis. The sun and the moon are regarded as two eyes of God. The stone images of these deities are found in the midst of tree groves which are considered sacred. A bhagat performs rituals singing prayers of deities while playing Ghangal, a musical instrument made from gourd, bamboo and iron strings. Almost every village has a temple of traditional God and a local deity.

2.4.4 Agriculture

Dadra and Nagar Haveli is a predominantly rural area with about 79 percent tribal population. It has about 21,115 hectares under cultivation. Major crop is paddy (Kharif), while Nagli and other hill millets are crops of the area. Among fruits, Mango, Chiku, and Banana, etc., are also produced. Forests cover 40 per cent of the total geographical area.

2.4.5 Industries

Prior to 1965-66, there was no industry in the Union Territory. There were a few traditional craftsmen who used to make pots, leather items, viz., chappals, shoes and some other items of bamboo. Industrial development started on a low-key with the establishment of an industrial estate under the cooperative sector by Dan Udyog Sahkari Sangh Ltd. Thereafter, three Government Industrial Estates have been developed at Silvasa, Masat and Khadoli in the Union territory. There are more than 1,600 Small Scale Industrial units, which include Cottage, Village Industries and 430 Medium Scale/Large Scale Industries in Textiles, Engineering, Plastics, Electronics, Chemicals, Pharmaceuticals, etc., employing more than 43,100 persons.

2.5 VALSAD - THE PHYSICAL FEATURES AND THE DISTRICT PROFILE

2.5.1 Area and Location

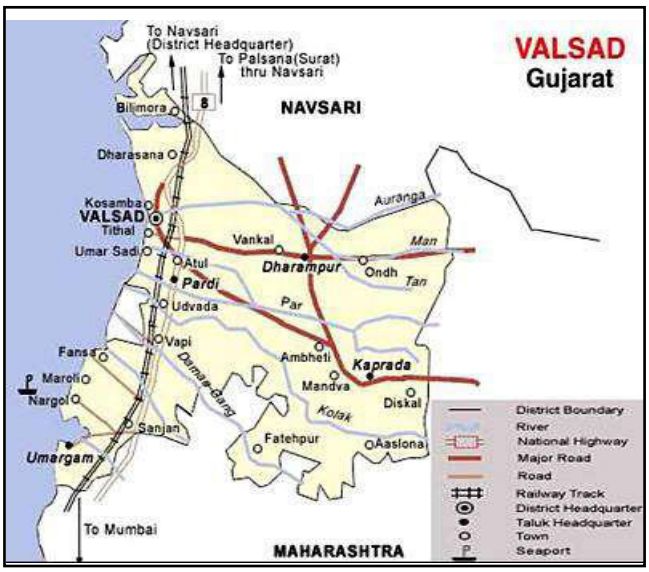
Valsad is bounded by Navsari district to the north, Dang district to the east and the State of Maharashtra to the south. The Arabian Sea lies west of the district. The district's largest city and administrative capital is Valsad. The district covers 5,244 sq. kms.

2.5.2 Climate and Rainfall

The climate of Valsad is temperate. The summer season is from March to middle of June and the winter is from October to February. The monsoon season is from June to middle of October. The average rainfall in the district is 1500 to 2200 mms annually.

2.5.3 Agriculture

Total production of food crops in Valsad in 2006-07 was 3.6 lakhs MT. Major horticulture crops being produced in the district are mango, cucurbits, chiku, banana and sugarcane. In 2006-07, Valsad had the highest production of mango in the State, accounting for 2, 03,112 MT. The district was the 2nd highest producer of Cucurbits with a production of 47,960 MT during 2006-07.



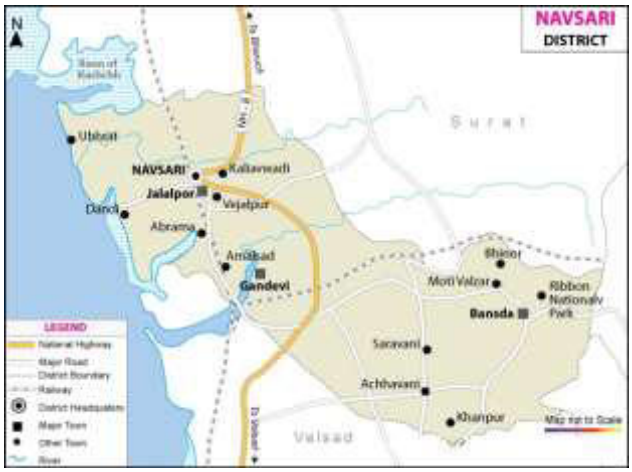
2.5.4 Industries

Valsad is an industrial base for sectors such as chemicals, textiles, and paper & pulp industries since 1980's. Textile and Chemicals have been the major sectors of investments and employment in the district. Valsad is emerging as a horticulture hub of the State, witnessing significant production in food grains and crops. With over 300 medium and large scale industries, Vapi is a major industrial center in Valsad witnessing tremendous business activities. One of the Asia's largest Common Effluent Treatment Plant (CETP) is present in Vapi. Over 10,716 units of small and medium enterprises (SMEs), involved in different sectors, such as chemicals, textiles, engineering, and paper industry etc., are present in the district.

2.6 NAVSARI - THE PHYSICAL FEATURES AND THE DISTRICT PROFILE

2.6.1 Area and Location

Navsari district is situated on Arabian coast line at southern border of Gujarat state. The geographical area of district is 2196 sq. kms. The population of district is 12, 29,250 (2001). The main headquarter of district Navsari, is included in city taluka. Apart from Navsari (city) taluka, there are five more talukas.



2.6.2 Climate and Rainfall

The Climate is moderate. The maximum temperature rises to 40° Centigrade and the minimum temperature is 10° Centigrade. The average rainfall is 2000 mm annually.

2.6.3 Major Crops and their Production

The district has well developed floriculture and horticulture. Navsari district is the largest producer of chiku in the State and the largest exporter of the fruits in India. The district has huge sugarcane fields as a result of which sugar manufacturing industry is a major business in Maroli and Gandevi talukas of the district.

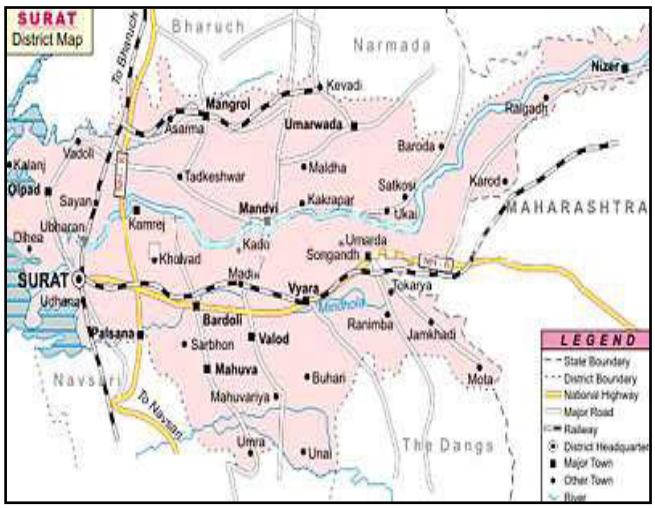
2.6.4 Industries

There are approximately 23 medium and large scale industries present in Navsari with a total investment of INR 377 crore (USD 90 million) generating employment for 9,057 persons. Most of these units are concentrated in Navsari and Gandevi talukas. Textiles, diamond business, sugar industry, agro & food processing, paper, engineering and chemicals are some of the key business sectors in Navsari.

2.7 SURAT - THE PHYSICAL FEATURES AND THE DISTRICT PROFILE

2.7.1 Area and Location

Surat is the largest district of south Gujarat. The Bharuch district is situated to the north of Surat, Navsari district to the south, Maharashtra state to the east and the Arabian Sea to the west. Rivers like Tapi, Kim, Midhola, Jhankhri and Purna runs through the district. The geographical area of Surat district is 776161 hectares out of which 475900 hectares are under cultivation.



2.7.2 Climate and Rainfall

Surat experiences tropical wet and dry climate, moderated strongly by the Arabian Sea. The summer begins in early March and lasts till June. April is the hottest month, the average temperature being 30°C. The monsoon begins in late June and the city receives about 800 mm of rain by the end of September, with the average temperature being around 28°C during those months. October and November see the retreat of the monsoon and a return of high temperatures till late November. Winter starts in December.

2.7.3 Major Crops and their Production

In the year 2006-07, Surat produced more than 8 Lakh Metric Tones (MT) of fruit crops, around 2.75 lakh MT of vegetable crops and approximately 14,000 MT of spices. The district captured a share of 15.24% of the total fruit production in Gujarat by becoming the largest producer of papaya and second largest producer of banana in the State. Surat is the largest producer of Okra (Lady Finger) in Gujarat with a share of 19% of the total production. The region contributes 10.39% to the total production of spices in Gujarat as it is the largest producer of turmeric and second largest producer of ginger and chilly in the State.

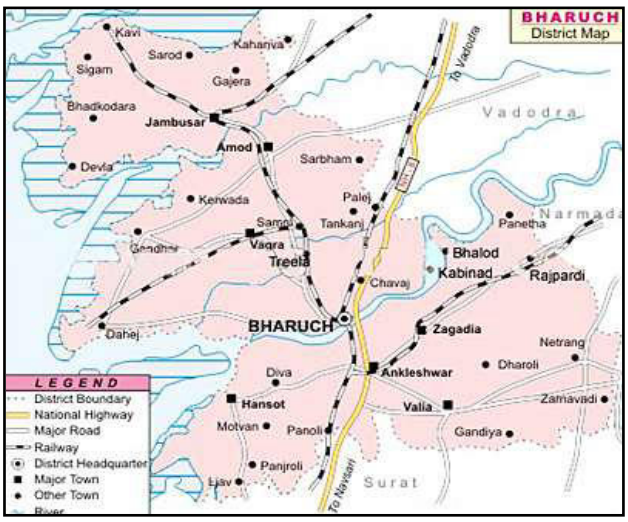
2.7.4 Industries

Major industries in Surat play an important role in shaping the economy of India. Most of the important industries of the country are located in this part. The

industrial area in Surat is mainly occupied by textile industries. The textile industries in Surat are associated with production of yarn as well as manufacturing of textiles. Many of the textile industries mainly produce synthetic textiles. These industries of Surat are engaged in exporting of textiles from India to other countries.

2.8 BHARUCH - THE PHYSICAL FEATURES AND THE DISTRICT PROFILE

2.8.1 Area and Location



Bharuch is an administrative district of Gujarat located in the southern portion of the state. There are 7 talukas in the district and the district head quarter is located at Bharuch town. The district covers an area of 5253 sq. kms with total population of 13,70,656 according to 2001 census.

2.8.2 Climate and Rainfall

Climate of Bharuch district is warm and dry from mid-March to June, during season of summer, while during rainy season, from mid-June to end of September climate is humid and pleasant. From October to November mild warm climate prevails, and from December to February climate is cold. According to information of average rain during 1995 to 2005, 835 mm rain was recorded in Bharuch district. Normal rain of Bharuch district is 850 mm to 990 mm.

2.8.3 Agriculture

Major horticulture crops being produced in the district are banana, mango, cucurbits, papaya and brinjal. In 2006-07, Bharuch had the highest production of Banana accounting for 8,18,940 metric tones (MT), followed by cucurbits with a production of 22,720 MT. Total production of cotton in Bharuch district was 257100 Bales (in 2006-07).

2.8.4 Industries

Bharuch is a formidable industrial base in sectors as diversified as chemicals & petrochemicals, textiles, drugs & pharmaceuticals and ports & ship building. Several private business conglomerates have their presence in Bharuch. Some of them include Guardian Corporation, Videocon, Badische Anilinund Soda Fabrik (BASF), Reliance, Tatas, Aditya Birla Group, Welspun-Stahl Rohrren, Aventis, Wockhardt, Rallis, Pfizer, Larsen & Toubro (L&T), Bayer, Glenmark, Lupin and Gujarat Fluoro chemicals Ltd. Excellent port connectivity with the presence of Dahej port makes it an investment destination in port & ship building activities. Several key private players have developed their facilities in and around Dahej port, including Indo-Gulf, Gujarat Chemical Port Terminal Company Limited (GCPTCL) and Petronet LNG Ltd. Over 11,500 units of small and medium enterprises, involved in different sectors, such as chemicals and petrochemicals, textiles etc. are present in the district. With over 70 medium and large scale industries, Ankleshwar is the major industrial center in Bharuch witnessing a large number of business activities.

2.9 VADODARA - THE PHYSICAL FEATURES AND THE DISTRICT PROFILE

2.9.1 Area and Location

Vadodara District is a district in the eastern part of the state of Gujarat in western India. It is located between 21 degree to 23 degree longitude and 73 degree to 74 degree latitude. The city of Vadodara (Baroda), in the western part of the district, is the administrative headquarters. Vadodara District covers an area of 7,794 km². It had a population of 3,641,802 of which 45.20% were urban as of 2001 census.

The district is bounded by Panchmahal and Dahod districts to the north, Anand and Kheda districts to the west, Bharuch and Narmada districts to the south, and the state of Madhya Pradesh to the east. The tallest point in the region is the hill of Pavagadh. The Mahi River passes through the district.

2.9.2 Climate and Rainfall

The weather is hot through the months of March to July — the average summer maximum is 36 °C (97 °F), and the average minimum is 23 °C (73 °F). From November to February, the average maximum temperature is 30 °C (85 °F), the average minimum is 15 °C (59 °F), and the climate is extremely dry. The average rainfall is 93 cm (36.7 inches), but infrequent heavy torrential rains cause the river to flood.

2.9.3 Major Crops and their Production

Vadodara is a leading agriculture district. In Kharif Season mainly crops like Rice, Maize, Tuver, Cotton and Ground Nut are grown. In Ravi Season crops like Wheat, Chana, Juvar, Maize, Sugarcane, and vegetables are grown while Summer Season crops are Ground Nut and Bajri.

2.9.4 Industries

In Vadodara various large-scale industries such as Gujarat State Fertilizers & Chemicals (GSFC), Indian Petrochemicals Corporation Limited (IPCL, now owned by Reliance Industries Limited) and Gujarat Alkalies and Chemicals Limited (GACL) have come up in the vicinity of Gujarat Refinery and all of them are dependent on it for their fuel and feedstock. Other large-scale public sector units are Heavy Water Project, Gujarat Industries Power Company Limited (GIPCL), Oil and Natural Gas Corporation (ONGC) & Gas Authority of India Limited (GAIL). In addition to these public sector enterprises, a number of other large-scale enterprises have come up in the private sector. The establishment of large industrial units in a region automatically brings into existence a number of smaller enterprises.

2.10 DEMOGRAPHIC AND SOCIO-ECONOMIC FEATURES OF PROJECT DISTRICTS

2.10.1 Total Population

The total population of project impacted districts is nearly 23 million in which a majority of population falls in the district of Thane (35.04%) followed by Surat

(21.52%), Vadodara (15.69%), Raigarh (9.51%), Valsad (6.08%), Bharuch (5.91%), Navsari (5.30%) and Silvassa (0.95%). The population percentage of the project influence districts is reflected in the following **Table 2.2**.

Table 2.2: Total Population of Project Impacted District

Name of State/Union Territory	Name of Districts	Population	Percentage
Maharashtra	Thane	8131849	35.04
	Raigarh	2207929	9.51
Dadra & Nagar Haveli	Silvassa	220490	0.95
Gujarat	Valsad	1410553	6.08
	Navsari	1229463	5.30
	Surat	4995174	21.52
	Bharuch	1370656	5.91
	Vadodara	3641802	15.69
	Total	**23207916**	**100.00**

Source: Census of India, 2001.

2.10.2 Population Density

Population density of the seven affected districts varies considerably as per the census data of 2001, which clearly suggests that the density of population in the project influenced area, has increased during 1991-2001. Maharashtra had an overall 22.18% rise in its population density in last one decade. The population density of Thane has increased by 54.83% and Raigarh had overall 12.98%. Dadra and Nagar Haveli had overall 59.22% rise in population. Any significant increase in population density brings in two demographic factors that determines it i.e. natural increase in population and migration. Further, natural increase depends on the fertility and mortality rates. Increase in density in Thane district can be attributed to the spillover effect of Mumbai. In Gujarat, percentage of increased population from 1991 to 2001 is 22.27%. The percentage of increased population density in Bharuch district is highest (47.07%) among all the project districts located in Gujarat.

2.10.3 Rural and Urban Population

In the state of Maharashtra, 57.57% of total population is rural and 42.43% is urban. In Thane district 72.58% of total population is urban. In Dadra and Nagar Haveli, 77.11% of the population lives in the rural areas. Similarly in Gujarat state nearly 63% of the population is rural and majority of the population in the affected districts is dependent on agriculture. The percentage of urban and rural people is slightly different in Surat and Vadodara. The figures make it evident that the proposed expressway will pass through and cater to the needs of highly urbanized parts of our country.

2.10.4 Sex Ratio

Sex ratio of Thane district (858 females per 1000 males) is lower than that of Maharashtra State. However the sex ratio of children between 0-6 years of age of the district is higher than that of state (931 females per 1000 males). In Dadra and Nagar Haveli sex ratio (812 females per 1000 males) is lowest in comparison to other concerned districts. Figures are presented in **Table 2.3**.

Table 2.3: Sex Ratio

States / District	Overall Sex Ratio	Sex Ratio of child population in the age group of 0-6 yrs.
Maharashtra	922	913
Thane	858	931
Raigarh	976	939
Dadra and Nagar Haveli	812	979
Dadra and Nagar Haveli	812	979
Gujarat	920	883
Valsad	920	933
Navsari	955	915
Surat	835	871
Bharuch	921	918
Vadodara	919	886

Source: Census of India, 2001.

2.10.5 Decadal Growth Rate

It is evident from 2001 census that there has been a significant change in decadal growth rate in Dadra and Nagar Haveli. However, in Maharashtra the growth rate has decreased slightly as briefed in **Table 2.4**. In case of the affected districts, Dadra and Nagar Haveli have witnessed a much higher decadal growth rate (from 33.57 in 1981-91 to 59.20 in 1991-2001) than any other districts. This is followed by Surat which has a growth rate of 47.04. Decadal growth corresponds to the increase in population density.

Table 2.4: Decadal Growth Rate

State / District	1981-91	1991-2001
Maharashtra	25.73	22.57
Thane	56.62	54.86
Raigarh	20.00	21.56
Dadra and Nagar Haveli	33.57	59.20
Dadra and Nagar Haveli	33.57	59.20
Gujarat	21.19	22.48
Valsad	25.87	29.66
Navsari	19.34	13.22
Surat	36.29	47.04
Bharuch	18.36	19.32
Vadodara	21.07	19.8

Source: Census of India 2001

2.10.6 Tribal and SC Population

The census data, 2001 reveals that the percentage of SC population is more or less equal in all the affected districts except Dadra and Nagar Haveli where the percentage of ST is much higher than any other district (62.24%). **Table 2.5** provides details for all project districts**.**

Table 2.5: Tribal and SC Population

State / District	Total Population	SC Population	Tribal Population	Percentage of SC out of Total Population	Percentage of Tribal out of Total Population
Maharashtra	**96878627**	**9881656**	**8577276**	**10.20**	**8.85**
Thane	8131849	339720	1199290	4.18	14.75
Raigarh	2207929	53667	269124	2.4	12.2
Dadra and Nagar Haveli	**220490**	**4104**	**137225**	**1.86**	**62.24**
Dadra and Nagar Haveli	220490	4104	137225	1.86	62.24
Gujarat	**50671017**	**3592715**	**7481160**	**7.09**	**14.76**
Valsad	1410553	37304	772405	2.64	54.76
Navsari	1229463	39574	591164	3.22	48.08
Surat	4995174	169324	1408270	3.39	28.19
Bharuch	1370656	61491	444943	4.49	32.46
Vadodara	3641802	204285	967393	5.61	26.56

Source: Census of India 2001

2.10.7 Literacy Rate

Literacy rate of the affected districts is either at par or higher than the literacy rate of the respective states. Out of the eight impacted districts, Thane has the highest literacy rate of 80.7%. It is also clear from the **Table 2.6** that the literacy rate of other districts is also higher than the national literacy rate of 63%, except for Dadra and Nagar Haveli which is only 57.6%. Economic backwardness may be given as the reasons for low level of literacy rate in Dadra and Nagar Haveli.

Table 2.6: Literacy Rate

State / District	Literacy Rate (Percentage)
Maharashtra	**76.9**
Thane	80.7
Raigarh	60.4
Dadra and Nagar Haveli	**57.6**
Dadra and Nagar Haveli	57.6
Gujarat	**69.1**
Valsad	69.2
Navsari	75.8
Surat	74.6
Bharuch	74.4
Vadodara	70.8

Source: Census of India 2001

2.10.8 Distribution of Population by Workers and Non-Workers and Occupation

Agriculture is the main occupation of its inhabitants in the project-influenced districts. As evident from **Table 2.7**, Non-workers exceed main-workers, showing relatively high dependency ratio.

Table 2.7: Distribution of Population by Workers and Non-workers

State / District	Population	Male	Female	Total
Maharashtra	Main Workers	24416295	10331758	34748053
	Marginal Workers	2435800	3989498	6425298
	Non- Workers	23548501	32156775	55705276
	Total	**50400596**	**46478031**	**96878627**
Thane	Main Workers	2257126	524878	2782004
	Marginal Workers	186201	211776	397977
	Non- Workers	1934420	3017448	4951868
	Total	**4377747**	**3754102**	**8131849**
Raigarh	Main Workers	484273	180416	664689
	Marginal Workers	104670	144636	249306
	Non- Workers	528685	765249	1293934
	Total	**1117628**	**1090301**	**2207929**
Dadra and Nagar Haveli	Main Workers	71156	25028	96184
	Marginal Workers	4679	13259	17938
	Non- Workers	45831	60537	106368
	Total	**121666**	**98824**	**220490**
Gujarat	Main Workers	13480566	3544508	17025074
	Marginal Workers	996720	3233727	4230447
	Non- Workers	11908291	17507205	29415496
	Total	**26385577**	**24285440**	**50671017**
Valsad	Main Workers	380471	122862	503333
	Marginal Workers	41232	105692	146924
	Non- Workers	313096	447200	760296
	Total	**734799**	**675754**	**1410553**
Navsari	Main Workers	334708	122294	457002
	Marginal Workers	20848	67365	88213
	Non- Workers	273432	410816	684248
	Total	**628988**	**600475**	**1229463**
Surat	Main Workers	1599704	381562	1981266
	Marginal Workers	52414	148829	201243

State / District	Population	Male	Female	Total
	Non- Workers	1070421	1742244	2812665
	Total	**2722539**	**2272635**	**4995174**
Bharuch	Main Workers	374567	94984	469551
	Marginal Workers	29090	72052	101142
	Non- Workers	310019	489944	799963
	Total	**713676**	**656980**	**1370656**
Vadodara	Main Workers	977232	225388	1202620
	Marginal Workers	82629	233596	316225
	Non- Workers	837507	1285450	2122957
	Total	**1897368**	**1744434**	**3641802**

Source: Census of India 2001

Table 2.8 contains occupational structure of workforce in the project affected districts. State wise breakup suggests that occupation in agricultural sector is greater than other sector in Maharashtra. More than 50% of workforce is engaged in agriculture in Gujarat, similarly about 55% in Maharashtra. However, the state average does not apply for districts. All project affected districts in Gujarat have less than 40% of workforce engaged in agriculture, reflecting significance of other economic activities.

Table 2.8: Categories of Workers

State / District	Categories	Male	Female	Total
Maharashtra	Cultivators	6680696	5132579	11813275
	Agricultural Labourers	4924034	5891228	10815262
	HH industries	566861	522457	1089318
	Other Workers	14680504	2774992	17455496
	Total	**26852095**	**14321256**	**41173351**
Thane	Cultivators	198244	190431	388675
	Agricultural Labourers	144337	162306	306643
	HH industries	42631	36997	79628
	Other Workers	2058115	436920	2495035
	Total	**2443327**	**826654**	**3269981**
Raigarh	Cultivators	105057	88222	193279
	Agricultural Labourers	41817	34250	76067
	HH industries	10732	4558	15290
	Other Workers	326667	53386	380053
	Total	**484273**	**180416**	**664689**
Dadra and Nagar Haveli	Agricultural Labourers	5429	9286	14715
	HH industries	492	358	850

State / District	Categories	Male	Female	Total
	Other Workers	51842	7245	59087
	Total	**75835**	**38287**	**114122**
Gujarat	Cultivators	3906697	1895984	5802681
	Agricultural Labourers	2509651	2652007	5161658
	HH industries	243835	185847	429682
	Other Workers	7817103	2044397	9861500
	Total	**14477286**	**6778235**	**21255521**
Valsad	Cultivators	102619	82776	185395
	Agricultural Labourers	66846	86245	153091
	HH industries	5565	4628	10193
	Other Workers	246673	54905	301578
	Total	**421703**	**228554**	**650257**
Navsari	Cultivators	76503	52273	128776
	Agricultural Labourers	88872	91343	180215
	HH industries	5814	3489	9303
	Other Workers	184367	42554	226921
	Total	**355556**	**189659**	**545215**
Surat	Cultivators	171176	91078	262254
	Agricultural Labourers	224074	249686	473760
	HH industries	26797	22040	48837
	Other Workers	1230071	167587	1397658
	Total	**1652118**	**530391**	**2182509**
Bharuch	Cultivators	71581	16825	88406
	Agricultural Labourers	121036	104601	225637
	HH industries	6253	2326	8579
	Other Workers	204787	43284	248071
	Total	**403657**	**167036**	**570693**
Vadodara	Cultivators	240500	94090	334590
	Agricultural Labourers	232602	238654	471256
	HH industries	13468	9177	22645
	Other Workers	573291	117063	690354
	Total	**1059861**	**458984**	**1518845**

Source: Primary Census Abstract, 2001

2.10.9 Demographic Profile of the Affected Villages

The population composition of any village is important to anticipate the extent of project impact. Keeping in view the importance of demographic profile of the villages falling in direct influence area, their profiles were computed accordingly. About 221 villages are likely to be affected in VME and 86 villages are likely to be affected in Spur Alignment. Profile of the affected villages was computed separately for VME and Spur Alignment as summarized in **Table 2.9**.

In addition, it is very important to identify vulnerable population during social assessment process. Census data 2001 was reviewed in order to assess vulnerable population in the affected villages belonging to SC/ST groups.

Presence of general population and SC/ST males and females in project affected villages has been computed district wise and put together in **Table 2.9**, which reveals that the share of ST population is greater than SC population in the project influence area.

Table 2.9: Population of Affected Villages in Project Districts

District	Village Name	Population			Scheduled caste Population			Scheduled Tribe Population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Vadodara Mumbai Expressway										
Thane	Ghodbandar	286391	233997	520388	3147	2788	5935	3450	3179	6629
Thane	Malaji Pada	740	712	1452	26	23	49	155	178	333
Thane	Juchandra	3214	2697	5911	30	34	64	62	68	130
Thane	Tivari	665	600	1265	17	11	28	209	207	416
Thane	Rajavali	1172	1147	2319	37	39	76	825	859	1684
Thane	Gokhivare	11439	8636	20075	294	233	527	947	963	1910
Thane	Gavraipada	3302	2506	5808	19	16	35	488	460	948
Thane	Dhaniv	2236	1736	3972	19	10	29	520	552	1072
Thane	Bhoyapada	-	-	-	-	-	-	-	-	-
Thane	Bhatpada	798	750	1548	0	0	0	404	402	806
Thane	Bawkhalpada	545	444	989	7	3	10	341	341	682
Thane	Kaner	643	613	1256	30	26	56	517	501	1018
Thane	Bhoyapada	-	-	-	-	-	-	-	-	-
Thane	Karadi	425	447	872	0	0	0	21	19	40
Thane	Wadhiv Saravali	589	500	1089	0	0	0	92	8	100
Thane	Navghar	555	539	1094	0	0	0	133	140	273
Thane	Ghatim	290	292	582	0	0	0	141	143	284
Thane	Penand	483	477	960	0	0	0	462	451	913
Thane	Sonave	953	925	1878	4	6	10	646	642	1288
Thane	Pargaon	682	663	1345	19	14	33	201	187	388
Thane	Girale	444	436	880	36	26	62	200	196	396
Thane	Nagave	104	105	209	0	0	0	73	85	158

District	Village Name	Population			Scheduled caste Population			Scheduled Tribe Population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Thane	Navaze	873	808	1681	4	4	8	271	252	523
Thane	Dahisar	985	963	1948	47	47	94	500	505	1005
Thane	Sakhare	683	692	1375	10	8	18	220	233	453
Thane	Khamloli	709	737	1446	12	9	21	226	240	466
Thane	Dhuktan	1270	1246	2516	52	38	90	871	873	1744
Thane	Gowade	660	490	1150	4	3	7	428	311	739
Thane	Maswan	803	710	1513	22	22	44	539	459	998
Thane	Wasaroli	134	117	251	0	0	0	116	107	223
Thane	Wakadi	151	141	292	6	7	13	125	112	237
Thane	Katale	604	541	1145	1	1	2	200	199	399
Thane	Nihe	991	950	1941	0	0	0	726	714	1440
Thane	Wandivali	190	177	367	0	0	0	183	169	352
Thane	Loware	442	445	887	7	7	14	235	248	483
Thane	Nagzari	845	736	1581	5	4	9	431	427	858
Thane	Lalonde	831	641	1472	10	4	14	536	427	963
Thane	Kirat	983	1000	1983	0	0	0	791	815	1606
Thane	Borsheti	862	895	1757	0	0	0	747	790	1537
Thane	Ravate	287	282	569	0	0	0	253	250	503
Thane	Chinchare	279	337	616	0	0	0	279	337	616
Thane	Morambi	370	333	703	2	2	4	142	120	262
Thane	Dabhon	1635	1594	3229	3	6	9	1608	1558	3166
Thane	Aine	540	515	1055	1	0	1	509	486	995
Thane	Rankol	1329	1296	2625	0	0	0	1315	1280	2595
Thane	Raitali	525	568	1093	0	0	0	525	568	1093
Thane	Chandwad	792	872	1664	0	0	0	785	869	1654
Thane	Somanath	546	527	1073	0	0	0	530	514	1044
Thane	Navnath	696	718	1414	4	3	7	569	617	1186
Thane	Kohadi	708	709	1417	2	2	4	675	686	1361
Thane	Ganjad	858	801	1659	0	0	0	767	719	1486
Thane	Awadhani	351	389	740	0	0	0	348	387	735
Thane	Ganeshbag	310	333	643	0	0	0	310	333	643
Thane	Dhaniwari	334	421	755	0	0	0	334	421	755
Thane	Ibhadpada	775	728	1503	4	6	10	597	624	1221
Thane	Chinchale	733	719	1452	0	0	0	733	718	1451
Thane	Talothe	278	296	574	0	0	0	278	296	574
Thane	Punjave	161	154	315	4	7	11	95	89	184

District	Village Name	Population			Scheduled caste Population			Scheduled Tribe Population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Thane	Bramhanwadi	269	275	544	0	0	0	265	273	538
Thane	Dapchari	1762	1685	3447	62	46	108	1205	1195	2400
Thane	Vadavali	2218	2384	4602	5	4	9	2149	2339	4488
Thane	Sawane	1296	1016	2312	3	2	5	1260	979	2239
Thane	Kawade	861	983	1844	0	0	0	860	983	1843
Thane	Talasari	1673	1771	3444	0	0	0	1663	1763	3426
Thane	Sutrakar	3177	3279	6456	33	35	68	3098	3198	6296
Thane	Sawroli	1401	1417	2818	2	0	2	1307	1405	2712
Thane	Ambeshetgaon	332	309	641	0	0	0	332	309	641
Thane	Masanpada	481	501	982	0	0	0	481	501	982
Thane	Kochai	1361	1506	2867	0	0	0	1349	1497	2846
Thane	Bormal	659	682	1341	0	0	0	596	629	1225
Dadra	Dadra	4164	2450	6614	148	144	292	830	945	1775
Dadra	Demani	1238	689	1927	214	188	402	340	350	690
Dadra	Tighra	322	312	634	0	1	1	284	284	568
Dadra	Kharadpada	2098	1477	3575	21	22	43	1109	1101	2210
Dadra	Naroli	5455	4541	9996	460	467	927	2019	2011	4030
Valsad	Borigam	1520	1463	2983	18	15	33	1299	1267	2566
Valsad	Lavachha	3761	2472	6233	59	55	114	1341	1337	2678
Valsad	Nani Tambadi	1602	1607	3209	156	144	300	1363	1383	2746
Valsad	Beman Karvad	2652	2381	5033	278	254	532	1189	1170	2359
Valsad	Bhat Karvad	-	-	-	-	-	-	-	-	-
Valsad	Vankachh	239	219	458	0	0	0	239	219	458
Valsad	Koparli	2260	2079	4339	27	22	49	1497	1465	2962
Valsad	Pandor	1205	1135	2340	42	53	95	828	791	1619
Valsad	Ambach	3354	3264	6618	9	9	18	3111	3036	6147
Valsad	Paria	3915	3797	7712	87	86	173	3111	3091	6202
Valsad	Dashwada	238	231	469	6	7	13	140	146	286
Valsad	Amli	1051	1005	2056	22	18	40	841	808	1649
Valsad	Velparva	792	775	1567	20	28	48	664	635	1299
Valsad	Pardi	222242	183660	405902	5750	5315	11065	79800	78986	158786
Valsad	Sukhlav	1087	1149	2236	28	32	60	975	1036	2011
Valsad	Khobadi	121	125	246	0	0	0	121	125	246
Valsad	Kumbhariya	742	696	1438	46	48	94	146	151	297
Valsad	Balda	1810	1715	3525	91	81	172	895	875	1770
Valsad	Binwada	1173	1074	2247	10	6	16	620	545	1165

District	Village Name	Population			Scheduled caste Population			Scheduled Tribe Population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Valsad	Chanvai	2794	2636	5430	65	67	132	2067	1945	4012
Valsad	Anjlav	1227	1253	2480	42	35	77	457	465	922
Valsad	Pathri	622	622	1244	0	0	0	356	372	728
Valsad	Jujwa	1703	1660	3363	1	2	3	985	952	1937
Valsad	Ghadoi	1166	1097	2263	12	7	19	562	560	1122
Valsad	Ovada	750	609	1359	128	137	265	351	245	596
Valsad	Muli	673	603	1276	20	20	40	253	233	486
Valsad	Fanaswada	737	665	1402	25	29	54	329	322	651
Valsad	Atgam	4491	4340	8831	167	152	319	2917	2892	5809
Navsari	Maliadhara	1288	1188	2476	38	38	76	298	252	550
Navsari	Chari	1349	1258	2607	33	39	72	1096	1131	2227
Navsari	Ghej	4021	3939	7960	54	60	114	2476	2488	4964
Navsari	Talavchora	2658	2501	5159	42	35	77	508	482	990
Navsari	Sadakpor	4590	4429	9019	108	101	209	3215	3123	6338
Navsari	Khundh	3454	3563	7017	185	201	386	1562	1771	3333
Navsari	Alipor	3451	3203	6654	58	57	115	1537	1547	3084
Navsari	Degam	3202	3070	6272	78	79	157	1663	1585	3248
Navsari	Barolia	572	595	1167	3	2	5	444	444	888
Navsari	Gandeva	3393	3283	6676	151	156	307	2457	2435	4892
Navsari	Kharel	2210	2146	4356	32	36	68	1966	1942	3908
Navsari	Sunthwad	730	683	1413	19	16	35	609	573	1182
Navsari	Matwad	885	892	1777	76	68	144	493	557	1050
Navsari	Butlav	228	214	442	0	0	0	149	150	299
Navsari	Sarpor	660	646	1306	15	16	31	324	296	620
Navsari	Kanbad	261	251	512	11	12	23	180	168	348
Navsari	Ambada	1333	1222	2555	13	14	27	807	720	1527
Navsari	Kambada	497	482	979	0	0	0	487	470	957
Navsari	Toli	646	647	1293	12	17	29	484	491	975
Navsari	Ugat	1330	1350	2680	70	72	142	785	825	1610
Navsari	Shahu	663	672	1335	3	2	5	534	534	1068
Navsari	Vachharvad	361	370	731	21	17	38	231	243	474
Surat	Chhitra	257	257	514	8	6	14	177	182	359
Surat	Kuvadiya	92	93	185	0	0	0	92	93	185
Surat	Tarbhon	1362	1303	2665	46	53	99	1122	1067	2189
Surat	Pardi Vagha	342	351	693	31	33	64	249	253	502
Surat	Naugama	217	228	445	3	3	6	197	204	401

District	Village Name	Population			Scheduled caste Population			Scheduled Tribe Population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Surat	Dindoli	7299	5715	13014	113	99	212	744	686	1430
Surat	Bhuvasan	380	410	790	1	1	2	301	330	631
Surat	Puni	1188	1168	2356	53	60	113	680	685	1365
Surat	Amalsadi	917	826	1743	2	1	3	830	752	1582
Surat	Vanzolia	602	569	1171	0	0	0	595	563	1158
Surat	Gotiya	136	133	269	0	0	0	136	133	269
Surat	Ghaluda	218	192	410	3	1	4	92	94	186
Surat	Ena	2152	2046	4198	160	147	307	1026	972	1998
Surat	Tundi	1289	1251	2540	107	90	197	671	663	1334
Surat	Kareli	1791	1525	3316	84	80	164	715	622	1337
Surat	Dastan	1057	1087	2144	248	263	511	500	552	1052
Surat	Haldharu	1566	1556	3122	89	85	174	731	748	1479
Surat	Pali	719	723	1442	25	22	47	342	347	689
Surat	Segva	637	611	1248	13	15	28	375	369	744
Surat	Asta	976	961	1937	52	47	99	488	504	992
Surat	Jat Bharthana	407	395	802	0	0	0	312	303	615
Surat	Digas	2162	2094	4256	82	101	183	1147	1078	2225
Surat	Dhatva	697	685	1382	35	36	71	494	483	977
Surat	Ghala	2435	2278	4713	124	124	248	609	582	1191
Surat	Karjan	1277	1252	2529	87	68	155	614	625	1239
Surat	Virpor	625	599	1224	18	17	35	329	310	639
Surat	Rosvad	1224	1141	2365	8	8	16	678	658	1336
Surat	Limodara	919	863	1782	75	77	152	178	176	354
Surat	Karanj	763	714	1477	21	21	42	247	248	495
Surat	Chhamuchhal	456	439	895	39	38	77	124	127	251
Surat	Kothva	743	735	1478	6	8	14	174	165	339
Surat	Velachha	1091	1047	2138	243	218	461	301	282	583
Surat	Moti Naroli	545	515	1060	22	25	47	149	142	291
Surat	Siyalaj	857	854	1711	83	78	161	222	217	439
Surat	Kosamba	6982	6561	13543	448	416	864	1254	1223	2477
Surat	Tarsadi	9889	8859	18748	969	900	1869	1333	1282	2615
Surat	Kumvarda	1322	1197	2519	326	307	633	417	375	792
Bharuch	Ghodadara	547	517	1064	31	25	56	259	249	508
Bharuch	Utiyadara	459	429	888	0	0	0	243	241	484
Bharuch	Karmali	375	410	785	0	0	0	186	190	376
Bharuch	Piludara	488	420	908	13	10	23	303	294	597

District	Village Name	Population			Scheduled caste Population			Scheduled Tribe Population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Bharuch	Adol	801	743	1544	45	40	85	347	304	651
Bharuch	Nangal	801	736	1537	24	24	48	395	375	770
Bharuch	Pungam	969	964	1933	16	11	27	660	652	1312
Bharuch	Diva	3024	2975	5999	69	76	145	553	474	1027
Bharuch	Sakkarpor	1411	1293	2704	21	29	50	1062	974	2036
Bharuch	Kukarwada	996	907	1903	30	27	57	268	200	468
Bharuch	Dahegam	1256	1212	2468	59	62	121	266	255	521
Bharuch	Manubar	1968	3593	5561	109	100	209	373	355	728
Bharuch	Kanthariya	3640	2093	5733	61	48	109	544	523	1067
Bharuch	Tham	1016	1205	2221	53	50	103	241	229	470
Bharuch	Mahudhala	711	659	1370	80	66	146	159	147	306
Bharuch	Derol	1460	1444	2904	93	112	205	400	360	760
Bharuch	Tralsi	365	347	712	30	25	55	181	173	354
Bharuch	Dayadra	2182	2075	4257	30	27	57	623	623	1246
Bharuch	Tralsa	1394	1316	2710	63	71	134	554	499	1053
Bharuch	Kelod	961	903	1864	49	42	91	486	451	937
Bharuch	Pipalia	449	431	880	37	26	63	133	137	270
Bharuch	Karela	636	591	1227	32	29	61	302	275	577
Bharuch	Padariya	299	270	569	6	8	14	61	54	115
Bharuch	Kurchan	1194	1139	2333	37	33	70	303	279	582
Bharuch	Vantarsa	420	407	827	13	9	22	171	173	344
Bharuch	Simartha	235	210	445	36	29	65	71	66	137
Bharuch	Dora	1448	1315	2763	45	41	86	737	725	1462
Bharuch	Danda	1026	997	2023	66	71	137	544	547	1091
Bharuch	Telod	602	565	1167	23	21	44	264	226	490
Bharuch	Sunthodra	239	212	451	6	4	10	66	60	126
Bharuch	Matar	1704	1582	3286	76	80	156	241	236	477
Vadodara	Sanpa	1130	1002	2132	90	82	172	371	312	683
Vadodara	Bodaka	753	685	1438	36	25	61	182	176	358
Vadodara	Kanabha	654	624	1278	52	51	103	20	14	34
Vadodara	Handod	1057	982	2039	121	123	244	225	220	445
Vadodara	Sambhoi	654	571	1225	49	39	88	158	139	297
Vadodara	Surwada	634	630	1264	15	22	37	136	139	275
Vadodara	Sadad	334	326	660	32	31	63	48	56	104
Vadodara	Husepur	351	316	667	66	69	135	154	138	292
Vadodara	Amla	1051	964	2015	114	95	209	27	21	48

District	Village Name	Population			Scheduled caste Population			Scheduled Tribe Population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Vadodara	Saras Vani	1262	1129	2391	144	128	272	228	186	414
Vadodara	Goriyad	969	890	1859	98	98	196	71	87	158
Vadodara	Ghayaj	1299	1132	2431	206	187	393	114	108	222
Vadodara	Patod	1238	1099	2337	91	82	173	110	110	220
Vadodara	Sokhdakhurd	1035	941	1976	162	173	335	74	77	151
Vadodara	Darapura	1529	1435	2964	218	214	432	40	32	72
Vadodara	Samiyala	3191	2882	6073	186	182	368	73	66	139
Vadodara	Gokalpura	466	438	904	75	73	148	37	27	64
Vadodara	Bhayli	3682	3414	7096	525	493	1018	337	355	692
Vadodara	Mahapura	710	625	1335	19	22	41	36	36	72
Vadodara	Sevasi	3214	2893	6107	222	200	422	326	289	615
Vadodara	Ampad	706	622	1328	17	14	31	0	0	0
Vadodara	Sherkhi	4425	4000	8425	159	128	287	35	26	61
Vadodara	Koyli	4988	4592	9580	271	245	516	137	118	255
Vadodara	Anagadh	6931	6600	13531	232	215	447	27	20	47
Vadodara	Nandesari	3878	3392	7270	70	65	135	16	13	29
Vadodara	Fajalpur	2104	1900	4004	70	66	136	11	7	18
Vadodara	Rayaka	927	793	1720	86	44	130	0	0	0
Vadodara	Dodka	1603	1374	2977	122	106	228	4	3	7
Spur Alignment										
Thane	Kopar	536	468	1004	11	14	25	0	0	0
Thane	Bhatane	2291	2110	4401	58	44	102	1720	1613	3333
Thane	Telchapada	597	585	1182	0	0	0	26	23	49
Thane	Adne	877	788	1665	15	10	25	446	407	853
Thane	Bhinar	305	301	606	0	0	0	166	172	338
Thane	Ambote	212	205	417	0	0	0	104	101	205
Thane	Nimboli	955	747	1702	49	41	90	353	345	698
Thane	Nimbavali	347	340	687	0	0	0	273	267	540
Thane	Kochechapada	569	549	1118	23	12	35	335	335	670
Thane	Kelthan	881	796	1677	16	19	35	570	569	1139
Thane	Akaloli	1386	1314	2700	46	53	99	514	490	1004
Thane	Ghotgaon	623	594	1217	0	0	0	395	384	779
Thane	Dugad	989	1019	2008	22	16	38	516	565	1081
Thane	Mohli	363	372	735	0	0	0	256	259	515
Thane	Malbidi	343	335	678	5	4	9	167	168	335
Thane	Nandithane	571	528	1099	22	31	53	307	273	580
Thane	Lamaj	280	263	543	8	7	15	20	15	35

District	Village Name	Population			Scheduled caste Population			Scheduled Tribe Population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Thane	Supegaon	497	468	965	0	0	0	41	42	83
Thane	Pundas	541	489	1030	0	0	0	83	64	147
Thane	Khandape	540	483	1023	18	12	30	19	13	32
Thane	Khandval	222	211	433	0	0	0	25	22	47
Thane	Anhe	325	327	652	0	0	0	65	61	126
Thane	Songode	465	470	935	32	35	67	88	87	175
Thane	Rayate	1105	1078	2183	22	25	47	94	76	170
Thane	Vaholi	696	596	1292	71	69	140	503	441	944
Thane	Dapivali	212	191	403	0	0	0	18	18	36
Thane	Heranjad	410	425	835	0	0	0	251	270	521
Thane	Sonavale	188	173	361	0	4	4	91	78	169
Thane	Badlapur	51859	46089	97948	2835	2672	5507	2481	2360	4841
Thane	Karav	819	690	1509	7	8	15	608	512	1120
Thane	Bendshil	346	345	691	2	1	3	214	211	425
Thane	Kanhor	755	676	1431	0	0	0	88	83	171
Raigarh	Chinchawali	247	229	476	0	0	0	0	0	0
Raigarh	Nere	1678	1543	3221	26	34	60	188	165	353
Raigarh	Bhingar	729	691	1420	0	0	0	0	0	0
Raigarh	Karanjade	1517	1304	2821	52	59	111	128	120	248

Source: Primary Census Abstract, 2001

2.10.10 Literacy in Project Villages

Literacy is one of the important indicators of human development. Therefore, it is essential to assess this aspect in the project affected villages. An insight into **Table 2.10** would reveal that literacy rate of the potentially affected villages is at par with the national level. The literacy is higher among males.

Table 2.10: Literacy in Project Affected Villages (District wise)

District	Village Name	Literates			Illiterates		
		Male	Female	Total	Male	Female	Total
Vadodara Mumbai Expressway							
Thane	Ghodbandar	231236	171254	402490	55155	62743	117898
Thane	Malaji Pada	570	390	960	170	322	492
Thane	Juchandra	2679	2068	4747	535	629	1164
Thane	Tivari	499	345	844	166	255	421
Thane	Rajavali	588	364	952	584	783	1367
Thane	Gokhivare	8165	4479	12644	3274	4157	7431
Thane	Gavraipada	2530	1435	3965	772	1071	1843
Thane	Dhaniv	1604	960	2564	632	776	1408
Thane	Bhoyapada	-	-	-	-	-	-

District	Village Name	Literates			Illiterates		
		Male	Female	Total	Male	Female	Total
Thane	Bhatpada	489	327	816	309	423	732
Thane	Bawkhalpada	404	208	612	141	236	377
Thane	Kaner	330	243	573	313	370	683
Thane	Bhoyapada	-	-	-	-	-	-
Thane	Karadi	376	367	743	49	80	129
Thane	Wadhiv Saravali	410	303	713	179	197	376
Thane	Navghar	391	268	659	164	271	435
Thane	Ghatim	200	165	365	90	127	217
Thane	Penand	270	140	410	213	337	550
Thane	Sonave	601	388	989	352	537	889
Thane	Pargaon	526	466	992	156	197	353
Thane	Girale	282	196	478	162	240	402
Thane	Nagave	62	47	109	42	58	100
Thane	Navaze	605	380	985	268	428	696
Thane	Dahisar	630	429	1059	355	534	889
Thane	Sakhare	500	385	885	183	307	490
Thane	Khamloli	504	386	890	205	351	556
Thane	Dhuktan	849	587	1436	421	659	1080
Thane	Gowade	502	262	764	158	228	386
Thane	Maswan	614	429	1043	189	281	470
Thane	Wasaroli	65	33	98	69	84	153
Thane	Wakadi	83	44	127	68	97	165
Thane	Katale	436	293	729	168	248	416
Thane	Nihe	461	271	732	530	679	1209
Thane	Wandivali	136	71	207	54	106	160
Thane	Loware	299	183	482	143	262	405
Thane	Nagzari	403	202	605	442	534	976
Thane	Lalonde	508	256	764	323	385	708
Thane	Kirat	347	184	531	636	816	1452
Thane	Borsheti	330	173	503	532	722	1254
Thane	Ravate	120	53	173	167	229	396
Thane	Chinchare	89	40	129	190	297	487
Thane	Morambi	276	215	491	94	118	212
Thane	Dabhon	679	290	969	956	1304	2260
Thane	Aine	249	101	350	291	414	705
Thane	Rankol	561	261	822	768	1035	1803
Thane	Raitali	194	96	290	331	472	803
Thane	Chandwad	246	81	327	546	791	1337
Thane	Somanath	215	65	280	331	462	793
Thane	Navnath	259	104	363	437	614	1051

District	Village Name	Literates			Illiterates		
		Male	Female	Total	Male	Female	Total
Thane	Kohadi	443	187	630	265	522	787
Thane	Ganjad	459	254	713	399	547	946
Thane	Awadhani	101	23	124	250	366	616
Thane	Ganeshbag	106	32	138	204	301	505
Thane	Dhaniwari	93	49	142	241	372	613
Thane	Ibhadpada	357	156	513	418	572	990
Thane	Chinchale	185	84	269	548	635	1183
Thane	Talothe	87	44	131	191	252	443
Thane	Punjave	78	34	112	83	120	203
Thane	Bramhanwadi	98	44	142	171	231	402
Thane	Dapchari	1123	640	1763	639	1045	1684
Thane	Vadavali	1138	629	1767	1080	1755	2835
Thane	Sawane	648	138	786	648	878	1526
Thane	Kawade	427	201	628	434	782	1216
Thane	Talasari	661	302	963	1012	1469	2481
Thane	Sutrakar	1492	695	2187	1685	2584	4269
Thane	Sawroli	877	438	1315	524	979	1503
Thane	Ambeshetgaon	149	56	205	183	253	436
Thane	Masanpada	138	56	194	343	445	788
Thane	Kochai	650	298	948	711	1208	1919
Thane	Bormal	223	115	338	436	567	1003
Dadra	Dadra	3164	1282	4446	1000	1168	2168
Dadra	Demani	902	323	1225	336	366	702
Dadra	Tighra	193	120	313	129	192	321
Dadra	Kharadpada	1382	517	1899	716	960	1676
Dadra	Naroli	3911	2245	6156	1544	2296	3840
Valsad	Borigam	1124	762	1886	396	701	1097
Valsad	Lavachha	3030	1460	4490	731	1012	1743
Valsad	Nani Tambadi	1190	919	2109	412	688	1100
Valsad	Beman Karvad	1935	1394	3329	717	987	1704
Valsad	Bhat Karvad	-	-	-	-	-	-
Valsad	Vankachh	196	162	358	43	57	100
Valsad	Koparli	1543	986	2529	717	1093	1810
Valsad	Pandor	742	540	1282	463	595	1058
Valsad	Ambach	2352	1711	4063	1002	1553	2555
Valsad	Paria	2720	2025	4745	1195	1772	2967
Valsad	Dashwada	181	139	320	57	92	149
Valsad	Amli	805	587	1392	246	418	664
Valsad	Velparva	629	483	1112	163	292	455
Valsad	Pardi	171098	112682	283780	51144	70978	122122
Valsad	Sukhlav	817	661	1478	270	488	758

District	Village Name	Literates			Illiterates		
		Male	Female	Total	Male	Female	Total
Valsad	Khobadi	5	9	14	116	116	232
Valsad	Kumbhariya	587	459	1046	155	237	392
Valsad	Balda	1428	1127	2555	382	588	970
Valsad	Binwada	970	882	1852	203	192	395
Valsad	Chanvai	2161	1635	3796	633	1001	1634
Valsad	Anjlav	958	783	1741	269	470	739
Valsad	Pathri	474	406	880	148	216	364
Valsad	Jujwa	1278	1040	2318	425	620	1045
Valsad	Ghadoi	871	681	1552	295	416	711
Valsad	Ovada	592	371	963	158	238	396
Valsad	Muli	499	394	893	174	209	383
Valsad	Fanaswada	516	376	892	221	289	510
Valsad	Atgam	3454	2786	6240	1037	1554	2591
Navsari	Maliadhara	967	759	1726	321	429	750
Navsari	Chari	887	760	1647	462	498	960
Navsari	Ghej	3088	2534	5622	933	1405	2338
Navsari	Talavchora	2174	1768	3942	484	733	1217
Navsari	Sadakpor	3004	2330	5334	1586	2099	3685
Navsari	Khundh	2441	2294	4735	1013	1269	2282
Navsari	Alipor	2126	1574	3700	1325	1629	2954
Navsari	Degam	2037	1643	3680	1165	1427	2592
Navsari	Barolia	321	259	580	251	336	587
Navsari	Gandeva	2399	1903	4302	994	1380	2374
Navsari	Kharel	1501	1216	2717	709	930	1639
Navsari	Sunthwad	568	388	956	162	295	457
Navsari	Matwad	566	472	1038	319	420	739
Navsari	Butlav	177	125	302	51	89	140
Navsari	Sarpor	499	439	938	161	207	368
Navsari	Kanbad	173	137	310	88	114	202
Navsari	Ambada	952	700	1652	381	522	903
Navsari	Kambada	303	192	495	194	290	484
Navsari	Toli	400	294	694	246	353	599
Navsari	Ugat	777	636	1413	553	714	1267
Navsari	Shahu	327	247	574	336	425	761
Navsari	Vachharvad	218	170	388	143	200	343
Surat	Chhitra	147	103	250	110	154	264
Surat	Kuvadiya	74	59	133	18	34	52
Surat	Tarbhon	544	400	944	818	903	1721
Surat	Pardi Vagha	169	142	311	173	209	382
Surat	Naugama	102	72	174	115	156	271
Surat	Dindoli	5201	3152	8353	2098	2563	4661

District	Village Name	Literates			Illiterates		
		Male	Female	Total	Male	Female	Total
Surat	Bhuvasan	235	185	420	145	225	370
Surat	Puni	538	498	1036	650	670	1320
Surat	Amalsadi	669	502	1171	248	324	572
Surat	Vanzolia	353	224	577	249	345	594
Surat	Gotiya	71	54	125	65	79	144
Surat	Ghaluda	110	73	183	108	119	227
Surat	Ena	1140	939	2079	1012	1107	2119
Surat	Tundi	558	477	1035	731	774	1505
Surat	Kareli	1281	830	2111	510	695	1205
Surat	Dastan	556	427	983	501	660	1161
Surat	Haldharu	1021	868	1889	545	688	1233
Surat	Pali	435	362	797	284	361	645
Surat	Segva	366	323	689	271	288	559
Surat	Asta	480	385	865	496	576	1072
Surat	Jat Bharthana	213	136	349	194	259	453
Surat	Digas	1129	975	2104	1033	1119	2152
Surat	Dhatva	304	245	549	393	440	833
Surat	Ghala	1581	1206	2787	854	1072	1926
Surat	Karjan	697	596	1293	580	656	1236
Surat	Virpor	380	274	654	245	325	570
Surat	Rosvad	677	449	1126	547	692	1239
Surat	Limodara	665	486	1151	254	377	631
Surat	Karanj	543	427	970	220	287	507
Surat	Chhamuchhal	363	308	671	93	131	224
Surat	Kothva	392	275	667	351	460	811
Surat	Velachha	686	592	1278	405	455	860
Surat	Moti Naroli	357	267	624	188	248	436
Surat	Siyalaj	541	438	979	316	416	732
Surat	Kosamba	5017	3945	8962	1965	2616	4581
Surat	Tarsadi	7523	5596	13119	2366	3263	5629
Surat	Kumvarda	904	651	1555	418	546	964
Bharuch	Ghodadara	336	235	571	211	282	493
Bharuch	Utiyadara	309	223	532	150	206	356
Bharuch	Karmali	232	208	440	143	202	345
Bharuch	Piludara	292	178	470	196	242	438
Bharuch	Adol	478	349	827	323	394	717
Bharuch	Nangal	567	385	952	234	351	585
Bharuch	Pungam	657	503	1160	312	461	773
Bharuch	Diva	2181	1894	4075	843	1081	1924
Bharuch	Sakkarpor	863	542	1405	548	751	1299
Bharuch	Kukarwada	683	409	1092	313	498	811

District	Village Name	Literates			Illiterates		
		Male	Female	Total	Male	Female	Total
Bharuch	Dahegam	857	696	1553	399	516	915
Bharuch	Manubar	1449	2860	4309	519	733	1252
Bharuch	Kanthariya	2792	1173	3965	848	920	1768
Bharuch	Tham	703	801	1504	313	404	717
Bharuch	Mahudhala	553	396	949	158	263	421
Bharuch	Derol	1134	924	2058	326	520	846
Bharuch	Tralsi	232	165	397	133	182	315
Bharuch	Dayadra	1408	1029	2437	774	1046	1820
Bharuch	Tralsa	907	601	1508	487	715	1202
Bharuch	Kelod	627	436	1063	334	467	801
Bharuch	Pipalia	302	210	512	147	221	368
Bharuch	Karela	508	376	884	128	215	343
Bharuch	Padariya	247	158	405	52	112	164
Bharuch	Kurchan	939	772	1711	255	367	622
Bharuch	Vantarsa	329	262	591	91	145	236
Bharuch	Simartha	190	126	316	45	84	129
Bharuch	Dora	740	520	1260	708	795	1503
Bharuch	Danda	692	453	1145	334	544	878
Bharuch	Telod	344	235	579	258	330	588
Bharuch	Sunthodra	110	45	155	129	167	296
Bharuch	Matar	1219	851	2070	485	731	1216
Vadodara	Sanpa	742	471	1213	388	531	919
Vadodara	Bodaka	489	295	784	264	390	654
Vadodara	Kanabha	499	287	786	155	337	492
Vadodara	Handod	788	534	1322	269	448	717
Vadodara	Sambhoi	437	242	679	217	329	546
Vadodara	Surwada	405	214	619	229	416	645
Vadodara	Sadad	165	126	291	169	200	369
Vadodara	Husepur	240	105	345	111	211	322
Vadodara	Amla	787	495	1282	264	469	733
Vadodara	Saras Vani	843	601	1444	419	528	947
Vadodara	Goriyad	736	462	1198	233	428	661
Vadodara	Ghayaj	956	579	1535	343	553	896
Vadodara	Patod	817	489	1306	421	610	1031
Vadodara	Sokhdakhurd	810	529	1339	225	412	637
Vadodara	Darapura	1199	891	2090	330	544	874
Vadodara	Samiyala	2478	1686	4164	713	1196	1909
Vadodara	Gokalpura	320	195	515	146	243	389
Vadodara	Bhayli	2812	2184	4996	870	1230	2100
Vadodara	Mahapura	523	280	803	187	345	532
Vadodara	Sevasi	2482	1814	4296	732	1079	1811

District	Village Name	Literates			Illiterates		
		Male	Female	Total	Male	Female	Total
Vadodara	Ampad	533	322	855	173	300	473
Vadodara	Sherkhi	3186	1933	5119	1239	2067	3306
Vadodara	Koyli	3850	2717	6567	1138	1875	3013
Vadodara	Anagadh	4873	2909	7782	2058	3691	5749
Vadodara	Nandesari	3029	2063	5092	849	1329	2178
Vadodara	Fajalpur	1554	973	2527	550	927	1477
Vadodara	Rayaka	673	390	1063	254	403	657
Vadodara	Dodka	1002	533	1535	601	841	1442
Spur Alignment							
Thane	Kopar	428	278	706	108	190	298
Thane	Bhatane	1299	841	2140	992	1269	2261
Thane	Telchapada	521	481	1002	76	104	180
Thane	Adne	657	460	1117	220	328	548
Thane	Bhinar	208	160	368	97	141	238
Thane	Ambote	141	95	236	71	110	181
Thane	Nimboli	664	357	1021	291	390	681
Thane	Nimbavali	164	101	265	183	239	422
Thane	Kochechapada	331	238	569	217	332	549
Thane	Kelthan	518	300	818	363	496	859
Thane	Akaloli	933	678	1611	453	636	1089
Thane	Ghotgaon	375	257	632	248	337	585
Thane	Dugad	510	361	871	479	658	1137
Thane	Mohli	146	97	243	217	275	492
Thane	Malbidi	215	154	369	128	181	309
Thane	Nandithane	278	203	481	293	325	618
Thane	Lamaj	215	168	383	65	95	160
Thane	Supegaon	407	302	709	90	166	256
Thane	Pundas	395	278	673	146	211	357
Thane	Khandape	426	281	707	114	202	316
Thane	Khandval	143	102	245	79	109	188
Thane	Anhe	214	183	397	111	144	255
Thane	Songode	365	233	598	100	237	337
Thane	Rayate	839	643	1482	266	435	701
Thane	Vaholi	447	304	751	249	292	541
Thane	Dapivali	144	100	244	68	91	159
Thane	Heranjad	236	149	385	174	276	450
Thane	Sonavale	115	76	191	73	97	170
Thane	Badlapur	41254	32682	73936	10605	13407	24012
Thane	Karav	556	328	884	263	362	625
Thane	Bendshil	155	92	247	191	253	444
Thane	Kanhor	590	460	1050	165	216	381

District	Village Name	Literates			Illiterates		
		Male	Female	Total	Male	Female	Total
Raigarh	Chinchawali	180	131	311	67	98	165
Raigarh	Nere	1146	827	1973	532	716	1248
Raigarh	Bhingar	544	378	922	185	313	498
Raigarh	Karanjade	1126	704	1830	391	600	991

Source: Primary Census Abstract, 2001

Overall, it can be concluded that the project influence has three distinct features viz., high level of industrialization, concentration of Scheduled Tribes and higher population density. These revelations will have bearing on the proposed expressway in terms of positive and adverse impacts. The Consultants verified the locations on ground and found out that the proposed Vadodara-Mumbai expressway passes through 221 villages and proposed Spur Alignment passes through 86 villages and the profile of typical villages are computed. These villages are mentioned above tables. Therefore, it is of utmost importance to assess the likely resettlement impacts that would be caused due to the proposed project.

2.10.11 Workforce in Project Affected Villages

Majority of work force belongs to the category of main workers followed by the category of marginal workforce. The details of workforce of the affected villages are summarized in **Table 2.11.**

2.10.12 Category wise Distribution of Workforce

It is evident from the below table that people of the likely affected villages are either engaged in agriculture or other works. Most of the population engaged in other workforce is shown in **Table 2.12**.

Table 2.11: Workers in the Project Affected Villages

District	Village Name	Working Population			Main Workers			Marginal Workers		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Vadodara Mumbai Expressway										
Thane	Ghodbandar	193158	167847	25311	163676	22258	185934	4171	3053	7224
Thane	Malaji Pada	612	438	174	333	100	433	105	74	179
Thane	Juchandra	2286	1895	391	1725	315	2040	170	76	246
Thane	Tivari	524	385	139	353	120	473	32	19	51
Thane	Rajavali	1029	659	370	476	143	619	183	227	410
Thane	Gokhivare	7628	6497	1131	6206	893	7099	291	238	529
Thane	Gavraipada	2360	1972	388	1874	332	2206	98	56	154
Thane	Dhaniv	1531	1283	248	1246	202	1448	37	46	83
Thane	Bhoyapada	-	-	-	-	-	-	-	-	-
Thane	Bhatpada	577	452	125	400	89	489	52	36	88
Thane	Bawkhalpada	536	348	188	338	144	482	10	44	54
Thane	Kaner	523	344	179	125	52	177	219	127	346

District	Village Name	Working Population			Main Workers			Marginal Workers		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Thane	Bhoyapada	-	-	-	-	-	-	-	-	-
Thane	Karadi	378	232	146	225	143	368	7	3	10
Thane	Wadhiv Saravali	380	345	35	51	1	52	294	34	328
Thane	Navghar	582	322	260	292	154	446	30	106	136
Thane	Ghatim	237	160	77	156	68	224	4	9	13
Thane	Penand	629	315	314	245	60	305	70	254	324
Thane	Sonave	1113	575	538	545	409	954	30	129	159
Thane	Pargaon	852	460	392	393	280	673	67	112	179
Thane	Girale	511	270	241	245	69	314	25	172	197
Thane	Nagave	109	52	57	52	10	62	0	47	47
Thane	Navaze	1019	517	502	500	445	945	17	57	74
Thane	Dahisar	1045	593	452	517	385	902	76	67	143
Thane	Sakhare	783	417	366	365	234	599	52	132	184
Thane	Khamloli	667	425	242	286	127	413	139	115	254
Thane	Dhuktan	1312	715	597	530	260	790	185	337	522
Thane	Gowade	487	270	217	251	130	381	19	87	106
Thane	Maswan	667	352	315	263	219	482	89	96	185
Thane	Wasaroli	134	69	65	47	48	95	22	17	39
Thane	Wakadi	179	94	85	88	25	113	6	60	66
Thane	Katale	658	357	301	289	142	431	68	159	227
Thane	Nihe	1059	583	476	542	405	947	41	71	112
Thane	Wandivali	206	110	96	94	73	167	16	23	39
Thane	Loware	549	277	272	242	223	465	35	49	84
Thane	Nagzari	804	519	285	474	198	672	45	87	132
Thane	Lalonde	603	350	253	337	64	401	13	189	202
Thane	Kirat	1207	597	610	349	136	485	248	474	722
Thane	Borsheti	1011	502	509	253	171	424	249	338	587
Thane	Ravate	335	175	160	138	110	248	37	50	87
Thane	Chinchare	347	159	188	149	134	283	10	54	64
Thane	Morambi	399	212	187	176	65	241	36	122	158
Thane	Dabhon	1609	750	859	673	557	1230	77	302	379
Thane	Aine	607	298	309	291	282	573	7	27	34
Thane	Rankol	1163	629	534	568	472	1040	61	62	123
Thane	Raitali	633	302	331	293	323	616	9	8	17
Thane	Chandwad	810	428	382	378	232	610	50	150	200
Thane	Somanath	568	283	285	236	190	426	47	95	142

District	Village Name	Working Population			Main Workers			Marginal Workers		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Thane	Navnath	771	384	387	363	349	712	21	38	59
Thane	Kohadi	716	355	361	355	358	713	0	3	3
Thane	Ganjad	610	369	241	185	62	247	184	179	363
Thane	Awadhani	431	196	235	146	143	289	50	92	142
Thane	Ganeshbag	341	155	186	136	117	253	19	69	88
Thane	Dhaniwari	441	192	249	121	113	234	71	136	207
Thane	Ibhadpada	741	430	311	116	7	123	314	304	618
Thane	Chinchale	712	323	389	192	256	448	131	133	264
Thane	Talothe	306	150	156	149	145	294	1	11	12
Thane	Punjave	157	83	74	42	20	62	41	54	95
Thane	Bramhanwadi	317	149	168	120	132	252	29	36	65
Thane	Dapchari	1462	898	564	740	444	1184	158	120	278
Thane	Vadavali	2309	1124	1185	366	236	602	758	949	1707
Thane	Sawane	910	469	441	51	10	61	418	431	849
Thane	Kawade	926	410	516	342	297	639	68	219	287
Thane	Talasari	1875	904	971	404	275	679	500	696	1196
Thane	Sutrakar	2867	1423	1444	930	649	1579	493	795	1288
Thane	Sawroli	1494	720	774	634	536	1170	86	238	324
Thane	Ambeshetgaon	356	175	181	36	31	67	139	150	289
Thane	Masanpada	411	205	206	46	17	63	159	189	348
Thane	Kochai	1424	666	758	540	457	997	126	301	427
Thane	Bormal	722	356	366	5	0	5	351	366	717
Dadra	Dadra	3678	3131	547	3070	321	3391	61	226	287
Dadra	Demani	1189	950	239	931	195	1126	19	44	63
Dadra	Tighra	374	189	185	142	132	274	47	53	100
Dadra	Kharadpada	1630	1339	291	1319	256	1575	20	35	55
Dadra	Naroli	4969	3554	1415	3325	912	4237	229	503	732
Valsad	Borigam	1501	952	549	873	327	1200	79	222	301
Valsad	Lavachha	3596	2748	848	2538	607	3145	210	241	451
Valsad	Nani Tambadi	1838	1002	836	979	673	1652	23	163	186
Valsad	Beman Karvad	2654	1584	1070	1402	373	1775	182	697	879
Valsad	Bhat Karvad	-	-	-	-	-	-	-	-	-
Valsad	Vankachh	227	122	105	110	51	161	12	54	66
Valsad	Koparli	2191	1303	888	1239	636	1875	64	252	316
Valsad	Pandor	1381	707	674	567	294	861	140	380	520
Valsad	Ambach	3877	2077	1800	1815	1170	2985	262	630	892

District	Village Name	Working Population			Main Workers			Marginal Workers		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Valsad	Paria	3734	2342	1392	2168	829	2997	174	563	737
Valsad	Dashwada	278	146	132	145	117	262	1	15	16
Valsad	Amli	1253	653	600	585	213	798	68	387	455
Valsad	Velparva	933	469	464	367	245	612	102	219	321
Valsad	Pardi	189277	136847	52430	127929	31120	159049	8918	21310	30228
Valsad	Sukhlav	1343	666	677	579	346	925	87	331	418
Valsad	Khobadi	159	79	80	66	60	126	13	20	33
Valsad	Kumbhariya	768	446	322	432	181	613	14	141	155
Valsad	Balda	1430	997	433	897	331	1228	100	102	202
Valsad	Binwada	1240	705	535	531	255	786	174	280	454
Valsad	Chanvai	2132	1530	602	1363	284	1647	167	318	485
Valsad	Anjlav	1322	687	635	614	249	863	73	386	459
Valsad	Pathri	600	351	249	346	139	485	5	110	115
Valsad	Jujwa	1890	977	913	851	398	1249	126	515	641
Valsad	Ghadoi	1204	705	499	689	375	1064	16	124	140
Valsad	Ovada	825	498	327	445	147	592	53	180	233
Valsad	Muli	601	385	216	367	138	505	18	78	96
Valsad	Fanaswada	799	432	367	420	203	623	12	164	176
Valsad	Atgam	4846	2705	2141	2639	1548	4187	66	593	659
Navsari	Maliadhara	1194	722	472	714	250	964	8	222	230
Navsari	Chari	1190	735	455	721	82	803	14	373	387
Navsari	Ghej	4255	2356	1899	2258	588	2846	98	1311	1409
Navsari	Talavchora	2419	1511	908	1495	684	2179	16	224	240
Navsari	Sadakpor	4934	2781	2153	2418	704	3122	363	1449	1812
Navsari	Khundh	2698	1940	758	1873	567	2440	67	191	258
Navsari	Alipor	2671	1657	1014	1649	628	2277	8	386	394
Navsari	Degam	2495	1773	722	1767	550	2317	6	172	178
Navsari	Barolia	618	345	273	339	174	513	6	99	105
Navsari	Gandeva	3257	1907	1350	1832	1177	3009	75	173	248
Navsari	Kharel	2392	1367	1025	1348	807	2155	19	218	237
Navsari	Sunthwad	805	408	397	380	33	413	28	364	392
Navsari	Matwad	826	483	343	470	331	801	13	12	25
Navsari	Butlav	236	151	85	148	73	221	3	12	15
Navsari	Sarpor	515	341	174	337	162	499	4	12	16
Navsari	Kanbad	277	164	113	162	110	272	2	3	5
Navsari	Ambada	1175	721	454	708	428	1136	13	26	39

District	Village Name	Working Population			Main Workers			Marginal Workers		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Navsari	Kambada	607	324	283	317	265	582	7	18	25
Navsari	Toli	628	398	230	396	230	626	2	0	2
Navsari	Ugat	1177	745	432	733	423	1156	12	9	21
Navsari	Shahu	682	392	290	392	290	682	0	0	0
Navsari	Vachharvad	412	236	176	219	162	381	17	14	31
Surat	Chhitra	310	181	129	181	129	310	0	0	0
Surat	Kuvadiya	102	57	45	55	42	97	2	3	5
Surat	Tarbhon	1619	877	742	877	740	1617	0	2	2
Surat	Pardi Vagha	355	215	140	212	130	342	3	10	13
Surat	Naugama	255	134	121	134	121	255	0	0	0
Surat	Dindoli	4664	4240	424	4093	271	4364	147	153	300
Surat	Bhuvasan	540	274	266	133	15	148	141	251	392
Surat	Puni	1163	672	491	664	471	1135	8	20	28
Surat	Amalsadi	832	488	344	437	59	496	51	285	336
Surat	Vanzolia	732	383	349	375	191	566	8	158	166
Surat	Gotiya	160	85	75	85	71	156	0	4	4
Surat	Ghaluda	197	126	71	126	71	197	0	0	0
Surat	Ena	1984	1273	711	1199	356	1555	74	355	429
Surat	Tundi	1268	799	469	756	265	1021	43	204	247
Surat	Kareli	1288	943	345	906	326	1232	37	19	56
Surat	Dastan	1096	652	444	652	443	1095	0	1	1
Surat	Haldharu	1423	919	504	916	487	1403	3	17	20
Surat	Pali	644	417	227	415	222	637	2	5	7
Surat	Segva	592	385	207	384	201	585	1	6	7
Surat	Asta	982	609	373	595	354	949	14	19	33
Surat	Jat Bharthana	449	242	207	242	207	449	0	0	0
Surat	Digas	2258	1382	876	1348	831	2179	34	45	79
Surat	Dhatva	814	443	371	411	272	683	32	99	131
Surat	Ghala	2106	1396	710	1333	522	1855	63	188	251
Surat	Karjan	1503	806	697	774	513	1287	32	184	216
Surat	Virpor	571	377	194	377	194	571	0	0	0
Surat	Rosvad	1300	753	547	750	545	1295	3	2	5
Surat	Limodara	844	549	295	373	147	520	176	148	324
Surat	Karanj	740	449	291	445	213	658	4	78	82
Surat	Chhamuchhal	468	272	196	272	196	468	0	0	0
Surat	Kothva	483	406	77	406	51	457	0	26	26

District	Village Name	Working Population			Main Workers			Marginal Workers		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Surat	Velachha	1043	639	404	639	400	1039	0	4	4
Surat	Moti Naroli	301	275	26	272	24	296	3	2	5
Surat	Siyalaj	617	465	152	455	142	597	10	10	20
Surat	Kosamba	4370	3472	898	3436	883	4319	36	15	51
Surat	Tarsadi	6086	5201	885	5097	755	5852	104	130	234
Surat	Kumvarda	885	713	172	697	121	818	16	51	67
Bharuch	Ghodadara	563	350	213	345	204	549	5	9	14
Bharuch	Utiyadara	394	289	105	279	90	369	10	15	25
Bharuch	Karmali	323	202	121	183	33	216	19	88	107
Bharuch	Piludara	427	306	121	283	42	325	23	79	102
Bharuch	Adol	760	522	238	522	238	760	0	0	0
Bharuch	Nangal	629	454	175	442	175	617	12	0	12
Bharuch	Pungam	821	541	280	532	228	760	9	52	61
Bharuch	Diva	2462	1731	731	1620	532	2152	111	199	310
Bharuch	Sakkarpor	1550	881	669	878	618	1496	3	51	54
Bharuch	Kukarwada	717	509	208	293	26	319	216	182	398
Bharuch	Dahegam	924	643	281	609	231	840	34	50	84
Bharuch	Manubar	1216	986	230	969	220	1189	17	10	27
Bharuch	Kanthariya	1432	1039	393	912	292	1204	127	101	228
Bharuch	Tham	650	472	178	470	174	644	2	4	6
Bharuch	Mahudhala	564	382	182	381	174	555	1	8	9
Bharuch	Derol	936	768	168	713	66	779	55	102	157
Bharuch	Tralsi	322	217	105	217	105	322	0	0	0
Bharuch	Dayadra	1531	1054	477	1015	385	1400	39	92	131
Bharuch	Tralsa	1361	855	506	843	426	1269	12	80	92
Bharuch	Kelod	959	596	363	578	258	836	18	105	123
Bharuch	Pipalia	431	317	114	304	88	392	13	26	39
Bharuch	Karela	670	399	271	398	232	630	1	39	40
Bharuch	Padariya	304	186	118	175	16	191	11	102	113
Bharuch	Kurchan	909	672	237	668	223	891	4	14	18
Bharuch	Vantarsa	373	242	131	228	117	345	14	14	28
Bharuch	Simartha	234	168	66	167	50	217	1	16	17
Bharuch	Dora	1429	951	478	847	148	995	104	330	434
Bharuch	Danda	909	686	223	685	223	908	1	0	1
Bharuch	Telod	609	371	238	369	229	598	2	9	11
Bharuch	Sunthodra	154	142	12	134	10	144	8	2	10

District	Village Name	Working Population			Main Workers			Marginal Workers		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Bharuch	Matar	1648	1083	565	1021	309	1330	62	256	318
Vadodara	Sanpa	902	638	264	484	102	586	154	162	316
Vadodara	Bodaka	833	470	363	445	72	517	25	291	316
Vadodara	Kanabha	550	360	190	347	76	423	13	114	127
Vadodara	Handod	1334	749	585	715	552	1267	34	33	67
Vadodara	Sambhoi	605	398	207	396	207	603	2	0	2
Vadodara	Surwada	677	380	297	261	26	287	119	271	390
Vadodara	Sadad	211	205	6	183	4	187	22	2	24
Vadodara	Husepur	379	238	141	225	115	340	13	26	39
Vadodara	Amla	929	627	302	625	300	925	2	2	4
Vadodara	Saras Vani	1087	818	269	816	233	1049	2	36	38
Vadodara	Goriyad	803	569	234	568	234	802	1	0	1
Vadodara	Ghayaj	1112	845	267	831	34	865	14	233	247
Vadodara	Patod	943	784	159	780	158	938	4	1	5
Vadodara	Sokhdakhurd	589	537	52	535	50	585	2	2	4
Vadodara	Darapura	1003	887	116	863	105	968	24	11	35
Vadodara	Samiyala	1933	1790	143	1675	79	1754	115	64	179
Vadodara	Gokalpura	483	283	200	158	21	179	125	179	304
Vadodara	Bhayli	2986	2121	865	2100	372	2472	21	493	514
Vadodara	Mahapura	670	455	215	429	53	482	26	162	188
Vadodara	Sevasi	2445	1859	586	1750	396	2146	109	190	299
Vadodara	Ampad	664	397	267	365	80	445	32	187	219
Vadodara	Sherkhi	3747	2494	1253	2201	528	2729	293	725	1018
Vadodara	Koyli	3150	2729	421	2482	204	2686	247	217	464
Vadodara	Anagadh	4824	3487	1337	2815	474	3289	672	863	1535
Vadodara	Nandesari	2935	2112	823	1954	169	2123	158	654	812
Vadodara	Fajalpur	1957	1136	821	1013	118	1131	123	703	826
Vadodara	Rayaka	807	512	295	467	220	687	45	75	120
Vadodara	Dodka	1194	896	298	679	35	714	217	263	480
SPUR Alignment										
Thane	Kopar	310	36	346	304	36	340	6	0	6
Thane	Bhatane	1220	863	2083	885	258	1143	335	605	940
Thane	Telchapada	307	166	473	300	160	460	7	6	13
Thane	Adne	550	499	1049	524	400	924	26	99	125
Thane	Bhinar	176	172	348	35	16	51	141	156	297
Thane	Ambode	129	84	213	37	16	53	92	68	160

District	Village Name	Working Population			Main Workers			Marginal Workers		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Thane	Nimboli	589	246	835	503	122	625	86	124	210
Thane	Nimbavali	225	214	439	183	140	323	42	74	116
Thane	Kochechapada	334	263	597	279	139	418	55	124	179
Thane	Kelthan	516	377	893	481	315	796	35	62	97
Thane	Akaloli	792	567	1359	627	235	862	165	332	497
Thane	Ghotgaon	377	351	728	133	20	153	244	331	575
Thane	Dugad	585	490	1075	398	190	588	187	300	487
Thane	Mohili	255	250	505	204	152	356	51	98	149
Thane	Malbidi	195	189	384	179	160	339	16	29	45
Thane	Nandithane	328	214	542	242	135	377	86	79	165
Thane	Lamaj	136	58	194	130	47	177	6	11	17
Thane	Supegaon	244	59	303	214	28	242	30	31	61
Thane	Pundas	290	265	555	221	141	362	69	124	193
Thane	Khandape	265	8	273	205	6	211	60	2	62
Thane	Khandval	118	47	165	111	40	151	7	7	14
Thane	Anhe	169	143	312	135	51	186	34	92	126
Thane	Sangode	244	240	484	154	34	188	90	206	296
Thane	Rayate	562	295	857	489	102	591	73	193	266
Thane	Vaholi	362	137	499	345	129	474	17	8	25
Thane	Dapivali	105	33	138	94	14	108	11	19	30
Thane	Heranjad	210	167	377	205	129	334	5	38	43
Thane	Sonavale	112	63	175	97	55	152	15	8	23
Thane	Badlapur	27917	6097	34014	26785	5344	32129	1132	753	1885
Thane	Karav	352	136	488	282	84	366	70	52	122
Thane	Bendshil	204	123	327	174	73	247	30	50	80
Thane	Kanhor	404	125	529	366	109	475	38	16	54
Raigarh	Chinchavali	112	44	156	67	2	69	45	42	87
Raigarh	Nere	915	403	1318	623	128	751	292	275	567
Raigarh	Bhingar	368	204	572	284	43	327	84	161	245
Raigarh	Karanjade	845	197	1042	803	146	949	42	51	93

Source: Census of India, 2001

Table 2.12: Distribution of Workforce in Project Affected Villages

District	Village Name	Cultivators			Agricultural Labourers			Household Industries			Other Workers			Non Workers			Total		Grand Total
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Vadodara Mumbai Expressway																			
Thane	Ghodbandar	200	116	316	445	340	785	2147	1461	3608	165055	23394	188449	118544	208686	327230	286391	233997	520388
Thane	Malaji Pada	77	18	95	70	54	124	3	3	6	288	99	387	302	538	840	740	712	1452
Thane	Juchandra	107	73	180	59	39	98	155	48	203	1574	231	1805	1319	2306	3625	3214	2697	5911
Thane	Tivari	40	11	51	26	14	40	5	1	6	314	113	427	280	461	741	665	600	1265
Thane	Rajavali	33	6	39	89	92	181	0	0	0	537	272	809	513	777	1290	1172	1147	2319
Thane	Gokhivare	33	8	41	97	110	207	39	24	63	6328	989	7317	4942	7505	12447	11439	8636	20075
Thane	Gavraipada	91	67	158	55	29	84	35	13	48	1791	279	2070	1330	2118	3448	3302	2506	5808
Thane	Dhaniv	100	24	124	97	85	182	117	11	128	969	128	1097	953	1488	2441	2236	1736	3972
Thane	Bhoyapada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thane	Bhatpada	99	16	115	74	35	109	21	9	30	258	65	323	346	625	971	798	750	1548
Thane	Bawkhalpada	27	24	51	105	93	198	3	0	3	213	71	284	197	256	453	545	444	989
Thane	Kaner	27	22	49	214	114	328	6	8	14	97	35	132	299	434	733	643	613	1256
Thane	Bhoyapada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thane	Karadi	41	33	74	8	7	15	25	2	27	158	104	262	193	301	494	425	447	872
Thane	Wadhiv Saravali	15	2	17	139	22	161	2	1	3	189	10	199	244	465	709	589	500	1089
Thane	Navghar	113	147	260	62	99	161	6	4	10	141	10	151	233	279	512	555	539	1094
Thane	Ghatim	32	17	49	91	53	144	0	0	0	37	7	44	130	215	345	290	292	582
Thane	Penand	75	172	247	31	125	156	1	0	1	208	17	225	168	163	331	483	477	960
Thane	Sonave	195	219	414	128	203	331	1	3	4	251	113	364	378	387	765	953	925	1878
Thane	Pargaon	206	226	432	171	152	323	23	6	29	60	8	68	222	271	493	682	663	1345

District	Village Name	Cultivators			Agricultural Labourers			Household Industries			Other Workers			Non Workers			Total		Grand Total
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Thane	Girale	158	168	326	41	47	88	2	7	9	69	19	88	174	195	369	444	436	880
Thane	Nagave	17	16	33	33	40	73	0	0	0	2	1	3	52	48	100	104	105	209
Thane	Navaze	335	376	711	74	100	174	34	5	39	74	21	95	356	306	662	873	808	1681
Thane	Dahisar	233	186	419	120	194	314	43	31	74	197	41	238	392	511	903	985	963	1948
Thane	Sakhare	224	251	475	66	82	148	6	4	10	121	29	150	266	326	592	683	692	1375
Thane	Khamloli	195	91	286	120	104	224	11	7	18	99	40	139	284	495	779	709	737	1446
Thane	Dhuktan	196	203	399	255	311	566	19	19	38	245	64	309	555	649	1204	1270	1246	2516
Thane	Gowade	57	70	127	123	102	225	5	3	8	85	42	127	390	273	663	660	490	1150
Thane	Maswan	90	98	188	127	154	281	5	5	10	130	58	188	451	395	846	803	710	1513
Thane	Wasaroli	13	12	25	31	36	67	1	0	1	24	17	41	65	52	117	134	117	251
Thane	Wakadi	20	14	34	46	53	99	2	0	2	26	18	44	57	56	113	151	141	292
Thane	Katale	193	206	399	44	49	93	6	7	13	114	39	153	247	240	487	604	541	1145
Thane	Nihe	162	82	244	237	291	528	2	5	7	182	98	280	408	474	882	991	950	1941
Thane	Wandivali	51	55	106	16	37	53	0	1	1	43	3	46	80	81	161	190	177	367
Thane	Loware	93	99	192	132	138	270	6	4	10	46	31	77	165	173	338	442	445	887
Thane	Nagzari	41	27	68	62	86	148	5	7	12	411	165	576	326	451	777	845	736	1581
Thane	Lalonde	73	24	97	74	170	244	5	6	11	198	53	251	481	388	869	831	641	1472
Thane	Kirat	74	93	167	222	273	495	7	3	10	294	241	535	386	390	776	983	1000	1983
Thane	Borsheti	118	174	292	214	273	487	7	4	11	163	58	221	360	386	746	862	895	1757
Thane	Ravate	85	104	189	36	45	81	7	3	10	47	8	55	112	122	234	287	282	569
Thane	Chinchare	28	18	46	98	163	261	9	0	9	24	7	31	120	149	269	279	337	616
Thane	Morambi	27	65	92	29	63	92	1	3	4	155	56	211	158	146	304	370	333	703

District	Village Name	Cultivators			Agricultural Labourers			Household Industries			Other Workers			Non Workers			Total		Grand Total
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Thane	Dabhon	504	449	953	174	389	563	18	2	20	54	19	73	885	735	1620	1635	1594	3229
Thane	Aine	113	211	324	32	50	82	8	14	22	145	34	179	242	206	448	540	515	1055
Thane	Rankol	492	414	906	71	84	155	11	13	24	55	23	78	700	762	1462	1329	1296	2625
Thane	Raitali	250	289	539	11	12	23	3	0	3	38	30	68	223	237	460	525	568	1093
Thane	Chandwad	192	113	305	97	175	272	10	0	10	129	94	223	364	490	854	792	872	1664
Thane	Somanath	144	194	338	29	55	84	5	1	6	105	35	140	263	242	505	546	527	1073
Thane	Navnath	167	203	370	93	102	195	6	9	15	118	73	191	312	331	643	696	718	1414
Thane	Kohadi	264	298	562	38	41	79	0	0	0	53	22	75	353	348	701	708	709	1417
Thane	Ganjad	41	40	81	111	120	231	26	6	32	191	75	266	489	560	1049	858	801	1659
Thane	Awadhani	172	215	387	7	16	23	5	1	6	12	3	15	155	154	309	351	389	740
Thane	Ganeshbag	101	112	213	39	62	101	0	0	0	15	12	27	155	147	302	310	333	643
Thane	Dhaniwari	153	189	342	29	56	85	1	1	2	9	3	12	142	172	314	334	421	755
Thane	Ibhadpada	124	140	264	142	167	309	0	1	1	164	3	167	345	417	762	775	728	1503
Thane	Chinchale	170	148	318	144	237	381	1	0	1	8	4	12	410	330	740	733	719	1452
Thane	Talothe	109	8	117	40	147	187	0	0	0	1	1	2	128	140	268	278	296	574
Thane	Punjave	47	44	91	11	21	32	0	0	0	25	9	34	78	80	158	161	154	315
Thane	Bramhanwadi	90	113	203	13	21	34	2	4	6	44	30	74	120	107	227	269	275	544
Thane	Dapchari	142	66	208	403	424	827	4	11	15	349	63	412	864	1121	1985	1762	1685	3447
Thane	Vadavali	366	546	912	428	456	884	5	4	9	325	179	504	1094	1199	2293	2218	2384	4602
Thane	Sawane	121	127	248	292	300	592	0	0	0	56	14	70	827	575	1402	1296	1016	2312
Thane	Kawade	248	311	559	40	186	226	0	0	0	122	19	141	451	467	918	861	983	1844
Thane	Talasari	553	526	1079	192	393	585	14	11	25	145	41	186	769	800	1569	1673	1771	3444

District	Village Name	Cultivators			Agricultural Labourers			Household Industries			Other Workers			Non Workers			Total		Grand Total
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Thane	Sutrakar	849	935	1784	249	437	686	23	32	55	302	40	342	1754	1835	3589	3177	3279	6456
Thane	Sawroli	278	341	619	119	326	445	4	8	12	319	99	418	681	643	1324	1401	1417	2818
Thane	Ambeshetgaon	58	58	116	111	122	233	1	1	2	5	0	5	157	128	285	332	309	641
Thane	Masanpada	56	15	71	12	189	201	0	0	0	137	2	139	276	295	571	481	501	982
Thane	Kochai	373	447	820	108	258	366	8	1	9	177	52	229	695	748	1443	1361	1506	2867
Thane	Bormal	122	3	125	231	359	590	0	0	0	3	4	7	303	316	619	659	682	1341
Dadra	Dadra	120	130	250	32	38	70	24	30	54	2955	349	3304	1033	1903	2936	4164	2450	6614
Dadra	Demani	122	115	237	18	57	75	5	4	9	805	63	868	288	450	738	1238	689	1927
Dadra	Tighra	82	91	173	48	72	120	3	3	6	56	19	75	133	127	260	322	312	634
Dadra	Kharadpada	126	53	179	142	121	263	2	2	4	1069	115	1184	759	1186	1945	2098	1477	3575
Dadra	Naroli	419	260	679	289	319	608	25	23	48	2821	813	3634	1901	3126	5027	5455	4541	9996
Valsad	Borigam	455	392	847	99	96	195	4	1	5	394	60	454	568	914	1482	1520	1463	2983
Valsad	Lavachha	295	373	668	54	37	91	20	2	22	2379	436	2815	1013	1624	2637	3761	2472	6233
Valsad	Nani Tambadi	623	568	1191	63	97	160	6	3	9	310	168	478	600	771	1371	1602	1607	3209
Valsad	Beman Karvad	314	191	505	75	341	416	30	5	35	1165	533	1698	1068	1311	2379	2652	2381	5033
Valsad	Bhat Karvad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Valsad	Vankachh	59	69	128	1	22	23	0	2	2	62	12	74	117	114	231	239	219	458
Valsad	Koparli	309	224	533	529	564	1093	44	1	45	421	99	520	957	1191	2148	2260	2079	4339
Valsad	Pandor	202	228	430	152	283	435	2	3	5	351	160	511	498	461	959	1205	1135	2340
Valsad	Ambach	833	909	1742	523	790	1313	40	5	45	681	96	777	1277	1464	2741	3354	3264	6618
Valsad	Paria	503	319	822	759	730	1489	69	16	85	1011	327	1338	1573	2405	3978	3915	3797	7712
Valsad	Dashwada	19	12	31	61	67	128	7	2	9	59	51	110	92	99	191	238	231	469

District	Village Name	Cultivators			Agricultural Labourers			Household Industries			Other Workers			Non Workers			Total		Grand Total
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Valsad	Amli	212	233	445	188	302	490	19	1	20	234	64	298	398	405	803	1051	1005	2056
Valsad	Velparva	110	117	227	107	245	352	12	4	16	240	98	338	323	311	634	792	775	1567
Valsad	Pardi	17376	14263	31639	13990	17527	31517	1778	780	2558	103703	19860	123563	85395	131230	216625	222242	183660	405902
Valsad	Sukhlav	184	83	267	218	521	739	13	4	17	251	69	320	421	472	893	1087	1149	2236
Valsad	Khobadi	79	80	159	0	0	0	0	0	0	0	0	0	42	45	87	121	125	246
Valsad	Kumbhariya	134	129	263	92	148	240	0	8	8	220	37	257	296	374	670	742	696	1438
Valsad	Balda	74	50	124	186	175	361	35	1	36	702	207	909	813	1282	2095	1810	1715	3525
Valsad	Binwada	122	154	276	210	343	553	4	0	4	369	38	407	468	539	1007	1173	1074	2247
Valsad	Chanvai	189	79	268	376	404	780	27	14	41	938	105	1043	1264	2034	3298	2794	2636	5430
Valsad	Anjlav	157	139	296	215	373	588	21	13	34	294	110	404	540	618	1158	1227	1253	2480
Valsad	Pathri	90	107	197	102	99	201	3	18	21	156	25	181	271	373	644	622	622	1244
Valsad	Jujwa	178	128	306	326	431	757	31	11	42	442	343	785	726	747	1473	1703	1660	3363
Valsad	Ghadoi	153	209	362	176	207	383	28	27	55	348	56	404	461	598	1059	1166	1097	2263
Valsad	Ovada	131	148	279	72	107	179	10	24	34	285	48	333	252	282	534	750	609	1359
Valsad	Muli	117	82	199	98	91	189	6	2	8	164	41	205	288	387	675	673	603	1276
Valsad	Fanaswada	111	52	163	179	208	387	0	1	1	142	106	248	305	298	603	737	665	1402
Valsad	Atgam	1100	566	1666	672	1094	1766	58	6	64	875	475	1350	1786	2199	3985	4491	4340	8831
Navsari	Maliadhara	162	48	210	163	316	479	16	47	63	381	61	442	566	716	1282	1288	1188	2476
Navsari	Chari	356	219	575	252	211	463	8	2	10	119	23	142	614	803	1417	1349	1258	2607
Navsari	Ghej	1083	782	1865	907	959	1866	9	2	11	357	156	513	1665	2040	3705	4021	3939	7960
Navsari	Talavchora	501	233	734	394	497	891	13	4	17	603	174	777	1147	1593	2740	2658	2501	5159
Navsari	Sadakpor	754	562	1316	1157	1410	2567	25	14	39	845	167	1012	1809	2276	4085	4590	4429	9019

District	Village Name	Cultivators			Agricultural Labourers			Household Industries			Other Workers			Non Workers			Total		Grand Total
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Navsari	Khundh	282	200	482	289	285	574	59	12	71	1310	261	1571	1514	2805	4319	3454	3563	7017
Navsari	Alipor	155	49	204	788	763	1551	17	12	29	697	190	887	1794	2189	3983	3451	3203	6654
Navsari	Degam	228	33	261	558	459	1017	50	2	52	937	228	1165	1429	2348	3777	3202	3070	6272
Navsari	Barolia	126	69	195	155	188	343	1	0	1	63	16	79	227	322	549	572	595	1167
Navsari	Gandeva	246	194	440	1211	1090	2301	35	4	39	415	62	477	1486	1933	3419	3393	3283	6676
Navsari	Kharel	422	92	514	738	845	1583	10	2	12	197	86	283	843	1121	1964	2210	2146	4356
Navsari	Sunthwad	145	40	185	157	350	507	0	0	0	106	7	113	322	286	608	730	683	1413
Navsari	Matwad	40	4	44	185	302	487	3	1	4	255	36	291	402	549	951	885	892	1777
Navsari	Butlav	40	11	51	63	57	120	0	0	0	48	17	65	77	129	206	228	214	442
Navsari	Sarpor	90	3	93	149	139	288	4	0	4	98	32	130	319	472	791	660	646	1306
Navsari	Kanbad	31	0	31	111	102	213	1	1	2	21	10	31	97	138	235	261	251	512
Navsari	Ambada	143	12	155	415	390	805	11	3	14	152	49	201	612	768	1380	1333	1222	2555
Navsari	Kambada	42	31	73	191	219	410	39	7	46	52	26	78	173	199	372	497	482	979
Navsari	Toli	85	9	94	251	213	464	4	0	4	58	8	66	248	417	665	646	647	1293
Navsari	Ugat	53	2	55	444	379	823	12	6	18	236	45	281	585	918	1503	1330	1350	2680
Navsari	Shahu	30	0	30	294	262	556	1	1	2	67	27	94	271	382	653	663	672	1335
Navsari	Vachharvad	34	3	37	99	122	221	0	0	0	103	51	154	125	194	319	361	370	731
Surat	Chhitra	38	8	46	128	117	245	0	0	0	15	4	19	76	128	204	257	257	514
Surat	Kuvadiya	24	17	41	23	22	45	2	1	3	8	5	13	35	48	83	92	93	185
Surat	Tarbhon	61	10	71	744	707	1451	1	0	1	71	25	96	485	561	1046	1362	1303	2665
Surat	Pardi Vagha	25	4	29	143	125	268	0	0	0	47	11	58	127	211	338	342	351	693
Surat	Naugama	9	0	9	108	115	223	0	0	0	17	6	23	83	107	190	217	228	445

District	Village Name	Cultivators			Agricultural Labourers			Household Industries			Other Workers			Non Workers			Total		Grand Total
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Surat	Dindoli	35	2	37	259	173	432	27	47	74	3919	202	4121	3059	5291	8350	7299	5715	13014
Surat	Bhuvasan	49	2	51	218	221	439	2	4	6	5	39	44	106	144	250	380	410	790
Surat	Puni	70	4	74	432	433	865	10	2	12	160	52	212	516	677	1193	1188	1168	2356
Surat	Amalsadi	92	54	146	190	249	439	10	2	12	196	39	235	429	482	911	917	826	1743
Surat	Vanzolia	0	0	0	335	345	680	4	0	4	44	4	48	219	220	439	602	569	1171
Surat	Gotiya	2	2	4	77	73	150	0	0	0	6	0	6	51	58	109	136	133	269
Surat	Ghaluda	38	0	38	72	71	143	0	0	0	16	0	16	92	121	213	218	192	410
Surat	Ena	235	11	246	815	631	1446	0	0	0	223	69	292	879	1335	2214	2152	2046	4198
Surat	Tundi	119	12	131	495	426	921	1	1	2	184	30	214	490	782	1272	1289	1251	2540
Surat	Kareli	64	7	71	227	230	457	71	6	77	581	102	683	848	1180	2028	1791	1525	3316
Surat	Dastan	96	2	98	423	429	852	3	1	4	130	12	142	405	643	1048	1057	1087	2144
Surat	Haldharu	164	16	180	375	424	799	10	3	13	370	61	431	647	1052	1699	1566	1556	3122
Surat	Pali	95	1	96	184	212	396	0	0	0	138	14	152	302	496	798	719	723	1442
Surat	Segva	103	6	109	221	192	413	0	2	2	61	7	68	252	404	656	637	611	1248
Surat	Asta	131	23	154	357	332	689	8	10	18	113	8	121	367	588	955	976	961	1937
Surat	Jat Bharthana	24	6	30	189	195	384	0	0	0	29	6	35	165	188	353	407	395	802
Surat	Digas	256	24	280	801	743	1544	5	7	12	320	102	422	780	1218	1998	2162	2094	4256
Surat	Dhatva	59	2	61	306	311	617	1	1	2	77	57	134	254	314	568	697	685	1382
Surat	Ghala	347	138	485	469	475	944	6	8	14	574	89	663	1039	1568	2607	2435	2278	4713
Surat	Karjan	214	178	392	453	453	906	4	3	7	135	63	198	471	555	1026	1277	1252	2529
Surat	Virpor	81	12	93	267	179	446	0	0	0	29	3	32	248	405	653	625	599	1224
Surat	Rosvad	238	135	373	402	406	808	2	0	2	111	6	117	471	594	1065	1224	1141	2365

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		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Surat	Limodara	170	20	190	195	252	447	7	2	9	177	21	198	370	568	938	919	863	1782
Surat	Karanj	133	39	172	152	149	301	6	0	6	158	103	261	314	423	737	763	714	1477
Surat	Chhamuchhal	103	88	191	44	78	122	0	0	0	125	30	155	184	243	427	456	439	895
Surat	Kothva	37	1	38	128	59	187	11	8	19	230	9	239	337	658	995	743	735	1478
Surat	Velachha	128	8	136	208	172	380	1	3	4	302	221	523	452	643	1095	1091	1047	2138
Surat	Moti Naroli	34	0	34	158	22	180	2	0	2	81	4	85	270	489	759	545	515	1060
Surat	Siyalaj	115	3	118	144	120	264	4	0	4	202	29	231	392	702	1094	857	854	1711
Surat	Kosamba	139	8	147	506	462	968	31	13	44	2796	415	3211	3510	5663	9173	6982	6561	13543
Surat	Tarsadi	133	23	156	236	174	410	38	25	63	4794	663	5457	4688	7974	12662	9889	8859	18748
Surat	Kumvarda	93	8	101	150	71	221	0	0	0	470	93	563	609	1025	1634	1322	1197	2519
Bharuch	Ghodadara	92	15	107	177	183	360	1	2	3	80	13	93	197	304	501	547	517	1064
Bharuch	Utiyadara	69	22	91	122	77	199	1	1	2	97	5	102	170	324	494	459	429	888
Bharuch	Karmali	41	18	59	94	86	180	0	2	2	67	15	82	173	289	462	375	410	785
Bharuch	Piludara	127	3	130	121	116	237	0	0	0	58	2	60	182	299	481	488	420	908
Bharuch	Adol	166	13	179	259	198	457	0	0	0	97	27	124	279	505	784	801	743	1544
Bharuch	Nangal	107	13	120	236	153	389	2	1	3	109	8	117	347	561	908	801	736	1537
Bharuch	Pungam	128	8	136	304	249	553	11	5	16	98	18	116	428	684	1112	969	964	1933
Bharuch	Diva	444	122	566	543	480	1023	34	14	48	710	115	825	1293	2244	3537	3024	2975	5999
Bharuch	Sakkarpor	353	254	607	449	398	847	1	0	1	78	17	95	530	624	1154	1411	1293	2704
Bharuch	Kukarwada	103	10	113	205	169	374	1	2	3	200	27	227	487	699	1186	996	907	1903
Bharuch	Dahegam	98	31	129	180	180	360	10	6	16	355	64	419	613	931	1544	1256	1212	2468
Bharuch	Manubar	184	2	186	308	148	456	7	1	8	487	79	566	982	3363	4345	1968	3593	5561

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		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Bharuch	Kanthariya	143	16	159	301	258	559	43	21	64	552	98	650	2601	1700	4301	3640	2093	5733
Bharuch	Tham	24	1	25	163	71	234	51	5	56	234	101	335	544	1027	1571	1016	1205	2221
Bharuch	Mahudhala	78	13	91	140	124	264	2	1	3	162	44	206	329	477	806	711	659	1370
Bharuch	Derol	86	3	89	252	130	382	12	7	19	418	28	446	692	1276	1968	1460	1444	2904
Bharuch	Tralsi	35	1	36	124	100	224	0	0	0	58	4	62	148	242	390	365	347	712
Bharuch	Dayadra	152	8	160	517	390	907	42	1	43	343	78	421	1128	1598	2726	2182	2075	4257
Bharuch	Tralsa	213	32	245	425	442	867	5	1	6	212	31	243	539	810	1349	1394	1316	2710
Bharuch	Kelod	105	83	188	312	268	580	22	2	24	157	10	167	365	540	905	961	903	1864
Bharuch	Pipalia	86	10	96	163	96	259	4	1	5	64	7	71	132	317	449	449	431	880
Bharuch	Karela	132	5	137	205	208	413	14	9	23	48	49	97	237	320	557	636	591	1227
Bharuch	Padariya	57	45	102	32	49	81	2	3	5	95	21	116	113	152	265	299	270	569
Bharuch	Kurchan	229	39	268	276	175	451	7	3	10	160	20	180	522	902	1424	1194	1139	2333
Bharuch	Vantarsa	78	7	85	131	119	250	0	0	0	33	5	38	178	276	454	420	407	827
Bharuch	Simartha	43	1	44	116	52	168	0	0	0	9	13	22	67	144	211	235	210	445
Bharuch	Dora	174	1	175	516	427	943	2	1	3	259	49	308	497	837	1334	1448	1315	2763
Bharuch	Danda	192	3	195	420	208	628	2	3	5	72	9	81	340	774	1114	1026	997	2023
Bharuch	Telod	93	4	97	196	220	416	1	5	6	81	9	90	231	327	558	602	565	1167
Bharuch	Sunthodra	66	2	68	64	10	74	0	0	0	12	0	12	97	200	297	239	212	451
Bharuch	Matar	407	32	439	433	401	834	23	6	29	220	126	346	621	1017	1638	1704	1582	3286
Vadodara	Sanpa	170	5	175	369	241	610	24	5	29	75	13	88	492	738	1230	1130	1002	2132
Vadodara	Bodaka	182	9	191	196	272	468	2	3	5	90	79	169	283	322	605	753	685	1438
Vadodara	Kanabha	139	82	221	153	70	223	1	0	1	67	38	105	294	434	728	654	624	1278

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		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Vadodara	Handod	213	49	262	357	444	801	13	2	15	166	90	256	308	397	705	1057	982	2039
Vadodara	Sambhoi	100	19	119	268	186	454	1	0	1	29	2	31	256	364	620	654	571	1225
Vadodara	Surwada	153	39	192	206	256	462	1	1	2	20	1	21	254	333	587	634	630	1264
Vadodara	Sadad	103	2	105	102	4	106	0	0	0	0	0	0	129	320	449	334	326	660
Vadodara	Husepur	46	0	46	169	141	310	1	0	1	22	0	22	113	175	288	351	316	667
Vadodara	Amla	132	8	140	385	271	656	7	1	8	103	22	125	424	662	1086	1051	964	2015
Vadodara	Saras Vani	170	0	170	419	253	672	5	1	6	224	15	239	444	860	1304	1262	1129	2391
Vadodara	Goriyad	129	3	132	188	175	363	3	0	3	249	56	305	400	656	1056	969	890	1859
Vadodara	Ghayaj	267	5	272	410	257	667	20	1	21	148	4	152	454	865	1319	1299	1132	2431
Vadodara	Patod	116	3	119	461	125	586	1	0	1	206	31	237	454	940	1394	1238	1099	2337
Vadodara	Sokhdakhurd	124	4	128	185	36	221	4	0	4	224	12	236	498	889	1387	1035	941	1976
Vadodara	Darapura	111	2	113	297	34	331	28	2	30	451	78	529	642	1319	1961	1529	1435	2964
Vadodara	Samiyala	139	21	160	544	98	642	34	2	36	1073	22	1095	1401	2739	4140	3191	2882	6073
Vadodara	Gokalpura	59	21	80	87	101	188	1	0	1	136	78	214	183	238	421	466	438	904
Vadodara	Bhayli	273	12	285	905	668	1573	2	50	52	941	135	1076	1561	2549	4110	3682	3414	7096
Vadodara	Mahapura	231	42	273	54	111	165	0	0	0	170	62	232	255	410	665	710	625	1335
Vadodara	Sevasi	438	40	478	513	415	928	37	25	62	871	106	977	1355	2307	3662	3214	2893	6107
Vadodara	Ampad	120	4	124	109	124	233	18	132	150	150	7	157	309	355	664	706	622	1328
Vadodara	Sherkhi	702	98	800	675	870	1545	9	61	70	1108	224	1332	1931	2747	4678	4425	4000	8425
Vadodara	Koyli	303	25	328	736	255	991	13	2	15	1677	139	1816	2259	4171	6430	4988	4592	9580
Vadodara	Anagadh	582	140	722	564	496	1060	47	13	60	2294	688	2982	3444	5263	8707	6931	6600	13531
Vadodara	Nandesari	224	171	395	143	301	444	0	15	15	1745	336	2081	1766	2569	4335	3878	3392	7270

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		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Vadodara	Fajalpur	246	116	362	362	552	914	4	7	11	524	146	670	968	1079	2047	2104	1900	4004
Vadodara	Rayaka	105	26	131	101	139	240	3	6	9	303	124	427	415	498	913	927	793	1720
Vadodara	Dodka	379	29	408	249	96	345	8	5	13	260	168	428	707	1076	1783	1603	1374	2977
Spur Alignment																			
Thane	Kopar	6	3	9	0	0	0	3	2	5	301	31	332	226	432	658	536	468	1004
Thane	Bhatane	238	115	353	422	343	765	262	213	475	298	192	490	1071	1247	2318	2291	2110	4401
Thane	Telchapada	13	6	19	12	11	23	20	7	27	262	142	404	290	419	709	597	585	1182
Thane	Adne	233	219	452	141	133	274	14	3	17	162	144	306	327	289	616	877	788	1665
Thane	Bhinar	83	92	175	49	63	112	0	0	0	44	17	61	129	129	258	305	301	606
Thane	Ambode	12	11	23	57	29	86	0	0	0	60	44	104	83	121	204	212	205	417
Thane	Nimboli	124	85	209	73	79	152	2	4	6	390	78	468	366	501	867	955	747	1702
Thane	Nimbavali	49	63	112	18	44	62	1	1	2	157	106	263	122	126	248	347	340	687
Thane	Kochechapada	50	80	130	84	128	212	5	10	15	195	45	240	235	286	521	569	549	1118
Thane	Kelthan	177	167	344	140	124	264	7	4	11	192	82	274	365	419	784	881	796	1677
Thane	Akaloli	166	167	333	158	228	386	21	11	32	447	161	608	594	747	1341	1386	1314	2700
Thane	Ghotgaon	97	125	222	206	219	425	5	2	7	69	5	74	246	243	489	623	594	1217
Thane	Dugad	104	84	188	82	104	186	16	18	34	383	284	667	404	529	933	989	1019	2008
Thane	Mohili	76	85	161	73	72	145	0	0	0	106	93	199	108	122	230	363	372	735
Thane	Malbidi	31	39	70	114	120	234	1	0	1	49	30	79	148	146	294	343	335	678
Thane	Nandithane	64	28	92	70	72	142	5	2	7	189	112	301	243	314	557	571	528	1099
Thane	Lamaj	21	31	52	12	14	26	2	1	3	101	12	113	144	205	349	280	263	543
Thane	Supegaon	72	19	91	35	30	65	3	0	3	134	10	144	253	409	662	497	468	965

District	Village Name	Cultivators			Agricultural Labourers			Household Industries			Other Workers			Non Workers			Total		Grand Total
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
Thane	Pundas	143	128	271	72	126	198	0	2	2	75	9	84	251	224	475	541	489	1030
Thane	Khandape	111	2	113	40	2	42	3	0	3	111	4	115	275	475	750	540	483	1023
Thane	Khandval	44	23	67	15	14	29	2	1	3	57	9	66	104	164	268	222	211	433
Thane	Anhe	24	1	25	89	112	201	0	0	0	56	30	86	156	184	340	325	327	652
Thane	Sangode	68	58	126	65	170	235	1	2	3	110	10	120	221	230	451	465	470	935
Thane	Rayate	102	137	239	37	44	81	0	4	4	423	110	533	543	783	1326	1105	1078	2183
Thane	Vaholi	124	1	125	120	64	184	62	53	115	56	19	75	334	459	793	696	596	1292
Thane	Dapivali	61	12	73	21	14	35	0	0	0	23	7	30	107	158	265	212	191	403
Thane	Heranjad	75	83	158	78	71	149	1	2	3	56	11	67	200	258	458	410	425	835
Thane	Sonavale	25	28	53	32	19	51	5	1	6	50	15	65	76	110	186	188	173	361
Thane	Badlapur	640	241	881	736	536	1272	363	280	643	26178	5040	31218	23942	39992	63934	51859	46089	97948
Thane	Karav	38	1	39	57	34	91	6	11	17	251	90	341	467	554	1021	819	690	1509
Thane	Bendshil	29	15	44	96	44	140	0	0	0	79	64	143	142	222	364	346	345	691
Thane	Kanhor	68	48	116	67	32	99	4	3	7	265	42	307	351	551	902	755	676	1431
Raigarh	Chinchavali	35	38	73	6	3	9	0	2	2	71	1	72	135	185	320	247	229	476
Raigarh	Nere	218	105	323	122	124	246	56	8	64	519	166	685	763	1140	1903	1678	1543	3221
Raigarh	Bhingar	157	31	188	121	157	278	15	2	17	75	14	89	361	487	848	729	691	1420
Raigarh	Karanjade	38	12	50	18	11	29	32	13	45	757	161	918	672	1107	1779	1517	1304	2821

Source: Census of India, 2001

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ROUTE ALIGNMENT SELECTION

3

3. ROUTE ALIGNMENT SELECTION

3.1 INTRODUCTION

The proposed green field alignment of Vadodara - Mumbai Expressway (VME) is in continuation of Ahmedabad-Vadodara Expressway which is in operation. It has been planned to take up construction of this proposed expressway under NHDP Phase VI.

The identification of the route alignment of this expressway was initially taken up in the early 1990s by the Ministry of Road Transport & Highways (MoRT&H) from a Technical Assistance Programme of Asian Development Bank. The alignment was finalized by M/s Wilbur Smith consultants in association with CES (I) Pvt. Ltd. Based on this alignment the Government of Gujarat has frozen a land corridor of 600m width for the expressway.

NHAI in the year 2008 awarded the task of finalization of VME alignment to M/s SECON through a desk study. As per the terms of the study SECON was to study Wilbur-Smith's alignment on satellite imagery and modify it based on the present site conditions by carrying out a desk study.

In the current consultancy assignment, the Consultant was asked to follow the alignment finalised by M/s SECON. It was however stipulated that the consultant might review the alignment based on existing conditions at site if it passes through problematic area and propose alternate solutions.

3.2 FINALIZATION OF ALIGNMENT OF VM EXPRESSWAY

In accordance with the terms of reference, the consultants studied the alignment finalized in the previous desk study and the following steps were followed in arriving at the final alignment:

STEP 1 – Desk study of the SECON's alignment on Satellite Imagery/Google Imagery and proposing tentative deviations where it is passing through habitation areas or through other obstructions.

STEP 2 – Taking up reconnaissance work at site along the alignment finalized in Step-1. Points on the alignment were approached from village road/state highway/transverse roads originating from NH-8 with the help of hand held GPS. The observations made in Step-1 were confirmed at site and an alignment prepared for topographic survey.

STEP 3 – Fixing of GPS primary reference control stations (at approx. 2 km interval) along the proposed alignment firmed up in Step-2.

STEP 4 – Taking up detailed topographic survey between GPS stations. It was noted that at some places the alignment was crossing habitations. During survey, the alignment was suitably modified to avoid the habitations. This was also incorporated in the alignment plan.

STEP 5 – Environmental reconnaissance of the whole area was undertaken so as to identify whether the alignment is passing through wild life area or reserved forest area. Efforts were made to minimize its length in reserve forest area, and to avoid wild life area and other environmental hotspots.

STEP 6 – The Railways have planned a Dedicated Freight Corridor (DFC), the alignment of which falls along the proposed Expressway in Vadodara, Bharuch and Thane districts. The alignment of DFC has already been frozen. The DFC will be on an embankment varying from 6 m to 7 m height. A vertical clearance of

8m is required to be provided over the DFC. The SECON alignment crosses DFC alignment at 6 locations. In order to avoid numerous crossings, the alignment of Expressway was modified to minimize the number of crossings to two only.

STEP 7 – In certain sections, it was noted that SECON's alignment was along the gas pipeline, such that eventually the pipeline will be under the road embankment for a long length. The alignment was shifted to avoid any complications keeping in view safety concerns of both the highway as well as gas authorities.

STEP 8 – The alignment crosses four major rivers having waterways more than 300 m. The most suitable site of bridges on these rivers were selected in the vicinity of the alignment of SECON, based on technical considerations and adopted. These required minor modifications in the alignment in approaches. Besides, wherever possible, the bridges of length 200 m or more were so aligned that the skew angle is either avoided or minimized so as to reduce cost. This needed slight modifications in the nearby approaches. In case of proposed bridge across river Narmada the Wilbur Smith alignment is on the west (downstream) of proposed DFC line while the alignment proposed by SECON alignment is on east (upstream) side. It was noted that if SECON alignment is followed, the VME will have to cross DFC at two locations and shall also need raising the height of the bridge by about 8m. Therefore at Narmada river Wilbur Smith alignment has been adopted which will be about 300 m on the West (d/s side) of DFC alignment and will avoid crossing the DFC at this location.

Following the above steps SECON's alignment was modified and the modified alignment marked on satellite imagery was submitted to NHAI for approval. Thereafter, a presentation of the modified alignment was made in September, 2009 in Gandhi Nagar before the Principal Secretary and Chief Engineer (NH) of Gujarat P.W.D and the Project Director, NHAI. The Principal Secretary, P.W.D, Gujarat mentioned that the alignment of VME was finalized by Wilbur Smith in 1992.The Gujarat Government had frozen a 600m wide corridor along this identified alignment. Therefore the alignment of VME should be accommodated within the already frozen 600m wide corridor to avoid any difficulty in acquisition of land for execution of the project. The deviation from the frozen corridor, if any, should be minimal and justified with valid reasons.

Thereafter, a presentation was also made in NHAI in September, 2009 and NHAI agreed that the course of action as suggested by Gujarat P.W.D was to be followed.

Detailed maps indicating Wilbur Smith alignment were collected from PWD Gujarat and the Wilbur Smith alignment was transferred on Google and Satellite images. A site verification of this alignment was carried out by locating some ground pillars fixed in 1992 and by local village inquiry. Therefore the alignment modified after studying SECONs alignment as per TOR has been further modified to stay in general within the frozen 600m corridor in the state of Gujarat. However the alignment deviates from the frozen corridor at six locations in Gujarat and Dadra Nagar Haveli for valid reasons as explained in the **Table 3.1**.

As can be seen from this **Table 3.1**, the proposed alignment deviates from the frozen corridor in a length of about 21km in Naroli in Dadar Nagar Haveli (DNH) and Vapi district of Gujarat**.** This is due to the fact that lot of development has taken place in the Wilbur Smith corridor in this section and there will be serious Resettlement and Rehabilitation consequences if this corridor is followed. Therefore in this section the Consultants have generally followed the alignment finalized by SECON with a few modifications based on ground conditions.

The next major deviation of the alignment from the Wilbur Smith corridor is of about 5.0km length in two different sections in Vadodara District. In these sections the Vadodara Urban Development Authority (VUDA) has frozen a corridor of 600m for the expressway in its Master Plan. This corridor does not match exactly with the Wilbur Smith corridor. A joint site survey of the VUDA corridor was carried out with their officials and the boundaries of this corridor were picked up using GPS. The alignment was modified to stay within the VUDA corridor to avoid any public unrest in the area. In this section the alignment crosses the Dedicated Freight Corridor at a skew angle which has resulted in a slight impact on the geometry of the expressway.

Table 3.1: Deviations of Recommended Alignment from Wilbur Smith Corridor in DNH and Gujarat

Sl. No.	Design Chainage (km)		Length (km)	Reason for alignment Deviating the WS Corridor
	From	To		
1	113.440	135.100	21.60	The WS corridor passing over densely built up area of Naroli in DNH and Vapi in Gujarat
2	286.300	288.500	2.2	WS corridor passing very close to proposed DFC leaving no space for interchange on Bharuch-Dahej road.
3	355.400	358.300	2.9	The alignment follows the corridor frozen by VUDA in its Master Plan which is at variance with the Wilbur Smith Corridor.
4	363.500	365.600	2.1	
5	369.200	370.300	1.1	WS corridor is too close to Mahi River
6	378.000	378.740	0.48	WS corridor ends right in front of the Reliance service station on NE-1which will have to be acquired to build an interchange.

The Maharashtra PWD has also conducted detailed study during 1997-98 for the Mumbai - Talasari Expressway. Even after lot of persuasion - both from the Consultants and NHAI, the Maharashtra PWD has refused to share the study information. Therefore in Maharashtra the consultants have followed a combination of SECON's and Wilbur Smith alignment according to the ground conditions.

A presentation of the alignment was made to the Chief Secretary (CS), Government of Maharashtra on 9th April 2010 in Mumbai. The Secretary RT&H, senior officials of MoRT&H, NHAI,CIDCO,MMRDA,PWD Maharashtra, Forest and the Land Revenue Department were also present in the presentation. During the presentation the alignment of the VM expressway was agreed in principle. The CS appointed a committee to look into minor modifications in the alignment if required. The committee held several meetings and in its final report submitted to the CS in Nov 2010, it approved the alignment in Maharashtra.

The consultants have completed the topographic survey along the entire alignment and the alignment has been further fine-tuned to avoid any major obstructions.

The proposed VME alignment starts at Km 499 of Ahmedabad-Mumbai National Highway-8 (VME Chainage 0.000) at Ghodbunder and ends at Km 80 of Ahmedabad-Vadodara Expressway (VME Chainage 378.740)

As per the advice, of NHAI, Vadodara Mumbai Expressway is to be repackaged as detailed below.

Based on the land acquisition progress, the project has been divided into three phases viz-

Phase-I: Km 104+700 to Km 378+740

Phase-II: Km 26+320 to Km 104+700 including Spur to JNPT from Km 0+000 to Km 94+390

Phase-III: Km 0+000 to Km 26+320

VME Phase-I is further proposed for repackaging into following two parts

Phase IA – Km 254+430 to Km 378+740

Phase IB – Km 104+700 to Km 254+430

Further, for implementation of Phase IA on EPC mode, the Phase IA has been divided in 5 packages.

The details of Packages are as follows:

Package No.	Packages	Length (Km)
Package I	Construction of Six lane Vadodara Kim Expressway from Km 355.00 to Km 378.740 (Padra to Vadodara Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package I).	23.74
Package II	Construction of Six lane Vadodara Kim Expressway from Km 323.00 to Km 355.00 (Sanpa to Padra Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package II)	32.0
Package III	Construction of Six lane Vadodara Kim Expressway from Km 292.00 to Km 323.00 (Manubar to Sanpa Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package III)	31.0
Package IV	Construction of Six/Eight Lane Vadodara Kim Expressway from Km 279.00 to Km 292.00 (Ankleshwar to Manubar Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package IV).	13.0
Package V	Construction of Eight Lane Vadodara Kim Expressway from Km 254.430 to Km 279.00 (Kim to Ankleshwar Section of Vadodara Mumbai Expressway) in the State of Gujarat under NHDP Phase - VI on EPC mode (Phase IA-Package V).	24.57

3.3 ADMINISTRATIVE UNITS

The proposed Phase IA from Km 254.430 to Km 378.740 of VME alignment passes through the Surat, Bharuch and Vadodara districts of Gujarat.

The distribution of alignment among the above districts is given in **Table 3.2**.

Table 3.2: Administrative Boundaries

Package	Chainage (Km)			District/UT/State
	Start	End	Length (Km)	
Phase IA from Km 254.430 to Km 378.740				
Package V	254+430	261+794	7.364	Surat/Gujarat
	261+794	279+000	17.206	Bharuch/Gujarat
Package IV	**279+000**	**292+000**	**13.000**	**Bharuch/Gujarat**
Package III	292+000	323+000	31.000	Bharuch/Gujarat
Package II	323+000	324+294	1.294	Bharuch/Gujarat
	324+294	355+000	30.706	Vadodara/Gujarat
Package I	355+000	378+740	23.740	Vadodara/Gujarat
	Total Length		**124.310**	

As shown in **Table 3.2,** most of the alignment passes through Bharuch (50.28%) & Vadodara (43.81%) districts of Gujarat.

3.4 SECTIONS OF THE ALIGNMENT

In terms of terrain, which has significant bearing on the road geometrics standards, the alignment passes through plain terrain in Gujarat.

Phase IA of expressway has been provided with 6 interchanges (after addition of new interchange at 323+087 for entry/exit to/from the expressway. Hence based on traffic and other parameters as stated in Chapter 4, the expressway has been divided in to 5 homogeneous sections each separated by a grade separated interchange. These sections are listed in **Table 3.3** and are used for alignment descriptions in the subsequent sections.

Table 3.3: List of Main Expressway Interchanges and Sections: Phase IA from Km 254.430 to Km 378.740

Interchange		Intersecting / Merging Road		
ID	**Location (km)**	**Road ID**	**West / North End**	**East / South End**
I-9	254+430	NH 8	NH 8 towards Ahmedabad	NH8 towards Mumbai
I-10	287+385	SH 6	Dahej	Bharuch on NH 8
I-10A	323+087	SH 161	Amod	Karjan (SH 161)
I-11	353+690	SH 6	Padra	Vadodara on NH8
I-12	374+355	NH 8	NH 8 towards Ahmedabad	NH8 towards Mumbai
I-13	378+740	NE 1	NE 1 towards Ahmedabad	NE 1 towards Vadodara

Note: The new interchange at Km 323+087 has been introduced.

3.5 DESCRIPTION OF THE ALIGNMENT OF VM EXPRESSWAY

In this section of the report, the proposed **Phase IA from Km 254.430 to Km 378.740** alignment has been described by 4 expressway sections. Such description covers start and end points, terrain, land use, intersecting roads, crossing of railway lines, major rivers enroute, reference to NH 8 in direction and distance, and other salient features with current chainages.

3.5.1 Section from NH- 8 Interchange (Ch 254.430) to Dahej - Bharuch (SH-6) Road (Ch 287.385)

As explained earlier, the proposed VME starts from Mumbai and ends at Vadodara (on NE1 at km 80). This stretch of VME starts from NH8 (Km 233+000) near Kim.

This section, falling between Kim and Narmada Rivers in Gujarat, the land is fertile and irrigated. The proposed interchange at the end leads to Bharuch on the east - an industrial hub and to Dahej on the west - an important port town. The terrain is plain. The population density is high and paddy fields are more common in the corridor.

Crossing of Narmada River in km 284+428

The proposed expressway alignment crosses the following State Highways:

1. Kosamba-Hansot Road (SH-166) at three locations (Ch.265.900,Ch 266.800, Ch 269.153) and
2. Hansot-Ankleswar Road (SH-6) at Ch 279.353

   At km 258.420 the alignment crosses the Vadodara - Mumbai Section of Main Western Railway Line (north-south) which will also carry in its right of way the proposed Dedicated Freight Corridor (DFC) line.

Crossing of Dahej –Bharuch Road. at km 287.385

At km 259, part of a real estate development has recently come up within the PROW. The issue was discussed in NHAI in the meeting on 29.06.2012 and it was agreed to find a solution to minimize the impact on this development. Accordingly the consultants have modified the alignment to minimize the impact on the development and the proposal has been submitted to NHAI for approval.

Proposed expressway will be crossing over the above SHs and Railway lines. NH8 remains on the east of the alignment and is about 13 km away at the end of the Section. The alignment crosses river Narmada in km 284+428. Considering the requirement of Inland Waterways Authority of India, the relevant stipulations have been followed in design of the bridge.

3.5.2 Section from Dahej - Bharuch (SH-6) Road (Ch 287.385) to Padra - Vadodara Road (Ch 353.690)

This Section starts from Dahej - Bharuch Road crossing and ends at Padra-Vadodara Road crossing. The terrain is plain. The population density is high with lands put agricultural use.

In this Section the alignment crosses over Jambusar - Bharuch Road (Ch 293.030) which has recently been upgraded to a National Highway NH-228. At this location, Jambusar - Bharuch Section of Western Railway, which is being upgraded to broad gauge from current narrow gauge, is also crossing the alignment. Therefore a combined overbridge is proposed for the NH and Railway line. Padra - Vadodara Road falling within Vadodara district in fact starts from Jambusar which is second important town in Bharuch district.

Crossing of the Bhuki River at km 302.732.

Crossing of Dhadhar river at km 336.830.

Crossing of Railway line at km 293.050.

Except the above railway line, the alignment crosses a narrow gauge railway line at Km 352+988 Viswamitri-Jambusar Section of Western Railway. The alignment cross Amod-Karjan Road (SH 161) at km 323+087.

NH 8 remains on the east of the alignment in this section and is 13 km away at start point of the section. The distance increases towards the end of the section where NH8 and the expressway are 18.2 km apart - partly due to the fact that NH 8 itself bypasses Vadodara. The section ends with a partial clover leaf interchange proposed at the Padra- Vadodara Road (SH 6).

3.5.3 Section from Padra - Vadodara Road (Ch 353.690) to NH 8 Crossing (Ch 374.355)

The Section between Padra - Vadodara Road and NH-8 on the north of Vadodara runs in Vadodara district. The alignment runs parallel and comes close to Mahi River and is 250m east of the River at the closest point. The terrain is plain/rolling. The population density is high with land having agricultural and Industrial use due to proximity to Vadodara.

Crossing of NH 8 at km 374.355

Crossing of Padra Road at km 353.690

In this section the alignment crosses over Gotri Road (Ch 360.720). The alignment also crosses over the following railway lines:

1. At Ch 361.034, proposed Dedicated Freight Corridor (DFC) railway line.
2. At Ch3 73.608, Vadodara - Mumbai Section of Main Western Railway line (north-south)

NH 8 remains on the east side of the Expressway alignment. In this section the alignment deviates from the Wilbur Smith Alignment for reasons enumerated in previous sections of this chapter. In some parts of this section the alignment goes over ravines with unstable strata which will need special slope protection measures.

3.5.4 Section from NH-8 Crossing (Ch 374.335) to End Point (Ch 378.740) on NE 1 (Ch 80.000)

This section, which is the last and shortest of all the sections, connects NH-8 with Ahmedabad - Vadodara Expressway (NE 1). The section runs perpendicular to both NH 8 and NE 1 between the two interchanges.

The alignment is placed about 1.0km away from the left bank of Mahi River. The population density ininfluence area is high with land is mostly under agricultural use. The proposed expressway alignment terminates at Ahmedabad-Vadodara Expressway (at Ch 80.00 of NE1) about 1 km south of the existing Reliance Service Area on NE 1. The alignment deviates from the Wilbur Smith Alignment in the end as the Wilbur Smith Alignment connects directly in front of Reliance rest area and construction of interchange will involve acquisition of this service area. The alignment connects to NE1 with a trumpet interchange.

Location of Reliance service area falling on Wilbur Smith alignment.

End point of VME on NE 1

3.6 COMPARISON OF PREVIOUS ALIGNMENTS

As stated earlier, the following alignments have been studied by the Consultants for review and finalization of the expressway alignment:

1. Alignment suggested by Wilbur Smith;
2. Alignment modified by SECON, which was originally based on Wilbur Smith's alignment; and

The comparison of the above mentioned alignments with the recommended alignment for proposed Phase IA from Km 254+430 to Km 378+740 in the state of Gujarat is as follows:

3.6.1 Comparison of Alignment in State of Gujarat

As mentioned before, the Govt. of Gujarat is firmly of the view that the expressway alignment should follow the frozen 600m corridor which is based on Wilbur Smith alignment. Therefore the consultants have procured the Wilbur Smith alignment from Gujarat PWD and have followed the frozen corridor to a large extent. However at certain locations the recommended alignment has deviated from the Wilbur Smith corridor due to site constraints. These locations and the reasons for deviation have been described in the previous sections of this Chapter.

3.7 APPROVAL OF ALIGNMENT

After a series of presentations in NHAI headquarters in front of senior NHAI officials, approval has been granted to the alignment by NHAI vide their letter No. NHAI/V-M Expressway/DM/2008/30 dated 8th February 2010.

Subsequently during field visits for updating the site information some new impediments were noticed which needed minor changes to the alignment. These changes are listed in **Table 3.4**.

Table 3.4: Changes in the Alignment

S. No.	Chainage (km)		Reason
	To	From	
Phase I A from Km 254.430 to Km 378.740 of VME Corridor			
1	257+300	260+200	To avoid the real estate development in Koshamba, the alignment has been shifted 100m to LHS.
2	262+500	267+300	To keep the alignment away from Graveyard in village Godadara the alignment has been shifted 60m to RHS
3	273+800	275+200	To avoid new ONGC wells that have come up recently on the alignment
4	289+500	292+400	To avoid a religious structure which has recently been constructed the alignment has been shifted 100m on RHS
5	320+000	324+000	To avoid new ONGC wells that have come up recently on the alignment

The above changes have been approved in principle by NHAI in minutes of the meeting issued vide NHAI/NHDP-V/MCII/BOT/FR/AV dated 16th July 2012.

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TRAFFIC SURVEYS AND ANALYSIS

4

4. TRAFFIC SURVEYS AND ANALYSIS

4.1 INTRODUCTION

Vadodara-Mumbai Expressway (VME) has been proposed to be built as a virgin alignment under NHDP Phase-VI. The proposed expressway, when operational, will provide a continuous access controlled high speed corridor from Ahmedabad to Pune connecting other cities in the vicinity of its alignment. It will also reduce travel time to significant extent due to access control, and hence it is expected to attract a lot of traffic from the regional road network from the entire project influence area.

The proposed VME alignment starts at Km 499 of Ahmedabad - Mumbai National Highway-8 (VME Chainage 0) at Godbunder and ends at Km 80 of Ahmedabad - Vadodara Expressway (VME Chainage 378.740). Also, a spur has been proposed to connect major traffic generators like JNPT and to provide better dispersal of traffic in the Mumbai Metropolitan Region; this spur will connect Mumbai-Pune expressway in Panvel.

This chapter presents the data analysis of traffic surveys conducted on NH-8 and NH-4 in year 2016, and revised traffic estimates for expressway sections corresponding to Phase I A (Km 254+430 to Km 378+740).

Traffic surveys on NH-8 and surrounding road network were conducted in year 2009, and the DPR for VME was submitted in 2012. As instructed by NHAI, the Consultants have carried out traffic surveys on selected locations in 2016 to update the traffic figures, analysis and forecast.

In 2009, traffic surveys were conducted at 25 mid-block locations and 27 intersections, whereas in 2016 the traffic surveys have been conducted at 11 mid-block locations and 10 intersections. The survey locations for mid-block counts were chosen on major sections of NH-8 and NH-4 so that the current traffic can be compared with 2009 traffic. The sections of NH-8 and NH-4 and corresponding survey locations chosen for 2016 survey are shown below in **Table 4.1.**

Table 4.1: Survey locations on major sections of NH-8 and NH-4 in year 2009 and 2016

Sections of NH8/NH4		Year 2009	Year 2016
-	Ahmedabad-Vadodara, NH-8	MCC-1	-
A	Vadodara – Bharuch, NH-8	MCC-3, MCC-4	MCC-3
B	Bharuch – Kosamba, NH-8	MCC-6	MCC-6
C	Kosamba – Surat, NH-8	MCC-7	MCC-7
D	Surat – Bilimora, NH-8	MCC-9	MCC-9
E	Bilimora – Vapi, NH-8	MCC-10	MCC-10
F	Vapi – Dahanu, NH8	MCC-11, MCC-12	MCC-12
G	Dahanu – Virar, NH-8	MCC-13	MCC-13
H	Virar – Dahisar, NH-8	MCC-14	MCC-14
I	Thane Ghodbander Road	MCC-16	MCC-16
J	Thane – Panvel, NH-4	MCC-17	MCC-17
K	Panvel – Rasayani, NH-4	MCC-20	MCC-20

4.2 TRAFFIC SURVEY SCHEDULE

The schedule of traffic surveys conducted in Feb-Mar 2016 is presented below in **Table 4.2**.

Table 4.2: Schedule of Traffic Surveys

Type of Survey	Survey Code	Survey Location/ Section	Chainage (Km)	Duration	Date
Manual Classified Counts	MCC-3	Near Karjan (NH-8)	156+000	7 Days	24Feb – 1Mar 2016
	MCC-6	Near Bharuch (NH-8)	198+000	3 Days	24-26 Feb 2016
	MCC-7	Near Kamrej (NH-8)	242+000	3 Days	28Feb – 1Mar 2016
	MCC-9	Near Boriach Toll Plaza (NH-8)	297+000	7 Days	1-7Mar 2016
	MCC-10	Near Bagwada Toll Plaza (NH-8)	355+700	3 Days	3-5Mar 2016
	MCC-12	Near Amgaon (NH-8)	390+000	3 Days	24-26 Feb 2016
	MCC-13	Near Khanivade Toll Plaza (NH-8)	473+000	3 Days	25-27 Feb 2016
	MCC-14	Near Sasunavghar (NH-8)	494+500	7 Days	27Feb – 4Mar 2016
	MCC-16	SH-42 (MH), Near Gaimukh Village	7+000	3 Days	28Feb – 1Mar 2016
	MCC-17	NH-4, Near Shil Phata	130+000	3 Days	2-4Mar 2016
	MCC-20	NH-4, Near Rasayani Village	97+000	3 Days	2-4Mar 2016
Turning Movement Counts	TMC-6	Dahej Junction	191+000	1 Day	26Feb 2016
	TMC-10	Walia Junction	208+500	1 Day	29Feb 2016
	TMC-14	Intersection of NH-8 with NH-6	259+000	1 Day	2Mar 2016
	TMC-16	Nasik-Gandevi Road Junction	300+000	1 Day	4Mar 2016
	TMC-17	Valsad Road Junction	328+000	1 Day	7Mar 2016
	TMC-19	Bhilad - Silvassa Road Junction	376+500	1 Day	25Feb 2016
	TMC-21	Tarapur /Boisar Road Junction	436+000	1 Day	27Feb 2016
	TMC-24	Bhiwandi Road Junction	486+500	1 Day	1Mar 2016
	TMC-25	Thane-Ghodbunder Junction	497+000	1 Day	1Mar 2016
	TMC-27	Palaspe Phata/Junction	111+200	1 Day	3Mar 2016

The survey locations are shown in the form of a line diagram in **Figure 4.1.**

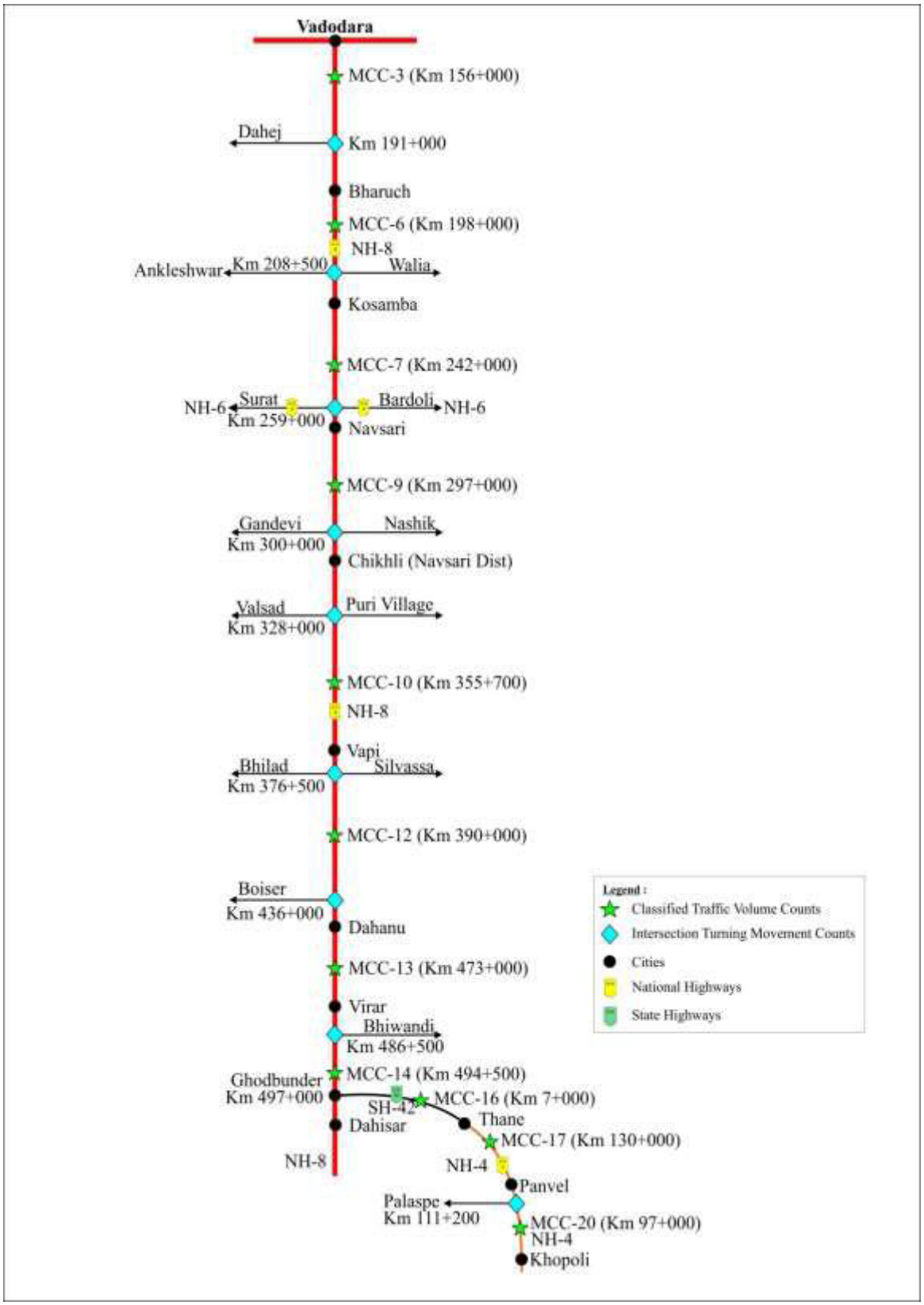


Figure 4.1: Traffic survey locations (year 2016)

4.3 SURVEY METHODOLOGY AND CONDUCT OF SURVEYS

4.3.1 Classified Traffic Volume Counts

Classified Traffic Volume Count Survey was conducted at 11 locations, each location representing mid-block count station for different homogeneous sections of the major roads in the influence area network. The count was conducted in both directions for successive 15 minute periods over 24 hours of the day. Classified counts were made for seven days in three locations, and for three days at eight locations. The counts were conducted at same chainage/location as in year 2009 to match the traffic volume observed in the year 2009 with latest traffic volume.

For carrying out the counts, the vehicles were grouped under the following categories as shown in **Table 4.3** as per **IRC: 64-1990** with minor modification as per the requirement of TOR.

Table 4.3: Vehicle Classification System

Motorized Vehicles			**Non-motorized Vehicles**
Two wheelers			Bicycle
Three wheelers			Cycle Rickshaw
Passenger Car	Car & Taxi		Hand Cart
Jeep	Jeep & Van		
Bus	Mini Bus		
	Private Bus, Govt. Bus		
Light Goods Vehicle (LGV)	Freight carrying light vehicles		
Truck	2 – Axle Truck		
	3 – Axle Truck		
	Container Truck		
	MAV	4 to 6 Axle Truck	
		7 and more Axle Truck	
Toll Exempted	Passager Vehicles : Emergency Vehicles, Ambulance, Post Office Van, Army Vehicles, Police Vehicles, Ministry's Convoy etc.		
Vehicles	Goods Vehicles: Fire Engine, Army Trucks etc.		

For the purpose of counts, a day was divided into two shifts of 12 hours each and different groups of enumerators with supervisors were assigned for each shift. Trained enumerators were deployed for counting and recording the data by making tally-marking system. Survey Performa for recording the data is presented in **Annexure 4.1.**

4.3.2 Intersection Turning Movement Survey

The intersection turning movement survey was conducted at major intersections to obtain information on turning movements of traffic at intersections along the highway. Classified traffic volume counts of all vehicle types were made separately for all turning movements from each approach as per guidelines given

in IRC SP-41:1994 and also as per the requirements of the ToR. The survey was conducted by recording traffic for each successive 15-minute interval, for 24 hours on a working day with the help of trained enumerators. A total of 10 important junctions were covered in the survey of turning movement counts. Each turning movement at the intersection was recorded by deploying enumerators in sufficient numbers at suitable locations. The data on peak hour volume with turning movement flows was used to analyze and understand the flow pattern in the network. Survey Proforma used for the study is given in **Annexure 4.1.**

4.4 TRAFFIC CHARACTERISTICS

4.4.1 Analysis of Traffic Volume Count

Manual classified count was conducted at eleven locations, at the mid-block sections of VME influence area road network, which will be competing. The survey locations for MCC were selected based on the criteria, that it represented the average traffic volume of the respective section, in which it was located. The data collected was fed to computer and was checked to remove inconsistency and errors.

4.4.1.1 Conversion of Observed Traffic into PCUs

The various vehicle types having different sizes and characteristics were converted into a standard unit called Passenger Car Unit (PCU). Passenger car equivalents for various vehicles are adopted based on recommendations of Indian Road Congress prescribed in “Guidelines for Capacity of Roads in Rural Areas”, IRC-64-1990. The passenger car unit (PCU) values used are presented in **Table 4.4.**

Table 4.4: PCU Factors Adopted for the Study (IRC: 64-1990)

Fast Vehicles		Slow Vehicles	
Vehicle Group	**PCU Factor**	**Vehicle Group**	**PCU Factor**
Car, Jeep, Van and Taxi	1.0	Bicycle	0.5
Auto Rickshaw / Tempo	1.0	Cycle Rickshaw	2.0
Two Wheelers	0.5	Animal Drawn	6.0
Mini Bus	1.5		
Standard Bus	3.0		
Light Goods Vehicle (LGV)	1.5		
2 – Axle Truck	3.0		
3 – Axle Truck	3.0		
Multi Axle Truck	4.5		
Agriculture Tractor	1.5		
Agriculture Tractor & Trailer	4.5		

4.4.1.2 Average Daily Traffic (ADT)

The average daily traffic was computed for various locations, where the mid-block volume count survey was done. Daily traffic volumes were averaged to find the Average Daily Traffic (ADT). Further, the ADT was also converted to PCUs using the conversion factors given in **Table 4.4.** Location wise and mode wise ADT values are given in **Table 4.5** below, and the peak hour and peak hour proportion of total daily traffic (over average 24-hour volume count) are also presented**.**

Table 4.5: Average Daily Traffic (ADT)
Measured at Various Traffic Count Locations

Station No.	Chainage (km)	ADT		Peak Hour Flows		Peak Hour proportion in daily Vehicle Vol.	Peak Hour proportion in daily PCU Vol.
		Vehi.	PCUs	Vehi.	PCUs		
MCC-3	156+000	44,706	92,335	2,504	4,482	5.6%	4.9%
MCC-6	198+000	41,871	104,095	1,912	5,239	4.6%	5.0%
MCC-7	242+000	63,966	124,000	4,003	6,857	6.3%	5.5%
MCC-9	297+000	49,124	109,376	2,334	5,134	4.8%	4.7%
MCC-10	355+700	58,222	106,576	3,175	5,165	5.5%	4.9%
MCC-12	390+000	31,025	66,525	2,081	4,345	6.7%	6.5%
MCC-13	473+000	38,648	75,358	1,384	4,227	3.6%	5.6%
MCC-14	494+500	71,674	107,416	2,536	5,888	3.5%	5.5%
MCC-16	7+000	64,036	93,001	2,964	5,117	4.6%	5.5%
MCC-17	130+000	40,130	65,445	1,521	3,388	3.8%	5.2%
MCC-20	97+000	23,114	40,840	1,645	2,582	7.1%	6.3%

It can be seen from **Table 4.5** that the traffic volumes recorded at survey stations MCC-7 at Km 242+000 near Kamrej on NH-8 and MCC-9 at Km 297+000 near Boriach Toll Plaza falling in Phase IA are having the highest daily traffic volumes in the range of 124,000 PCUs and 109,376 PCUs (63,966 and 49,124 vehicles) respectively. High traffic volume at the above two locations can be attributed to the proximity of these locations to urban areas like Surat, Olpad and industries settled around Hazira.

4.4.1.3 Composition of Traffic

The composition of traffic, for various modes, was worked out from the traffic volume count data. **Table 4.6** shows the mode wise composition of total traffic at each survey location. The graph showing average composition of traffic at each location is given in **Figure 4.2 to Figure 4.12.**

The share of car/jeep/van is highest (45%) on Thane-Ghodbunder Road section (SH-42), 26% on Panvel road of NH-4 section, whereas on NH-8 it varies from 17% to 41% on different locations. The share of three-wheelers in the total ADT, across all the survey locations on NH-8, varies from 0.5% to 12.4%. On the roads other than NH-8, maximum share of three wheelers is observed at location near Taloja road of NH-4 section, which is 11%. Similarly, on SH-42 near Thane-Ghodbunder it is only 6%. The share of goods traffic on NH-8 varies from 35% to 66% on different locations. On the roads other than NH-8, maximum share of goods vehicles is observed at locations near Panvel road of NH-4 section as 42%, whereas on SH-42 it is 27%.

The traffic composition is discussed in detail for each survey location as below.

At MCC-03 (km 156+000 of NH-8 near Karjan Toll Plaza), the share of motorized traffic is 99.9%. Combined share of the different categories of freight vehicles is 46.7% of the total traffic. Of the total freight vehicles, LGV accounts for 14.6%, 2/3 axle trucks constitute 51.5%, MAVs contribute 33.3%, while the remaining 0.6% is contributed by tractor/tractor with trailer. Passenger vehicles account for 53.2% of the total traffic of which the share of cars/van/jeep is 71.1%, 2 wheelers constitute 21.1% and buses have a share of 4.9%. Mini buses and three-wheeler contribute a share of 0.4% and 3.6% respectively. Non-motorised vehicles have a share of 0.1%.

At MCC-06 (km 198+000 of NH-8 near Bharuch), the share of motorized traffic is 99.9%. Combined share of the different categories of freight vehicles is 65.5% of the total traffic. Of the total freight vehicles, LGV accounts for 12%, 2/3 axle trucks constitute 61.6%, MAVs contribute 26.4%. Passenger vehicles account for 34.4% of the total traffic of which the share of cars/van/jeep is 49.7%, 2 wheelers constitute 32.8% and buses have a share of 13.1%. Mini buses and three-wheeler contribute a share of 0.6% and 3.7% respectively. Non-motorised vehicles have a share of 0.1%.

At MCC-07 (km 242+000 of NH-8 near Kamrej), the share of motorized traffic is 99.9%. Combined share of the different categories of freight vehicles is 48.5% of the total traffic. Of the total freight vehicles, LGV accounts for 20.9%, 2/3 axle trucks constitute 55.7%, MAVs contribute 23.2%, while the remaining 0.2% is contributed by tractor/tractor with trailer. Passenger vehicles account for 51.4% of the total traffic of which the share of cars/van/jeep is 55.7%, 2 wheelers constitute 32.7% and buses have a share of 3.5%. Mini buses and three-wheeler contribute a share of 0.4% and 7.6% respectively. Non-motorised vehicles have a share of 0.1%.

At MCC-9 (km 297+000 of NH-8 near Boriach Toll Plaza), the share of motorized traffic is 99.9%. Combined share of the different categories of freight vehicles is 55.4% of the total traffic. Of the total freight vehicles, LGV accounts for 11.1%, 2/3 axle trucks constitute 60.7%, MAVs contribute 27.9%, while the remaining 0.3% is contributed by tractor/tractor with trailer. Passenger vehicles account for 44.5% of the total traffic of which the share of cars/van/jeep is 64.7%, 2 wheelers constitute 28.5% and buses have a share of 4.7%. Mini buses and three-wheeler contribute a share of 0.5% and 1.6% respectively. Non-motorised vehicles have a share of 0.1%.

At MCC-10 (km 355+700 of NH-8 near Bagwada Toll Plaza), the share of motorized traffic is 100%. Combined share of the different categories of freight vehicles is 39.6% of the total traffic. Of the total freight vehicles, LGV accounts for 12.3%, 2/3 axle trucks constitute 59.2%, MAVs contribute 28.4%, while the remaining 0.1% is contributed by tractor/tractor with trailer. Passenger vehicles account for 60.3% of the total traffic of which the share of cars/van/jeep is 59.4%, 2 wheelers constitute 31.7% and buses have a share of 3%. Mini buses and three-wheeler contribute a share of 0.6% and 5.4% respectively.

Table 4.6: Average Composition of Traffic (in %)

Traffic Survey Location		Car	Mini Bus	Bus	LGV	2-Axle Truck	3-Axle Truck	4-6 Axle Truck	>6 Axle Truck	3-Wheeler	2-Wheeler	LCV 3-Wheeler	Tractor	Tractor with trailer	Cycle	Cycle Rickshaw	Hand Cart	Animal Drawn	Total vehicles
MCC-3	Km 156	37.8%	0.2%	2.6%	6.2%	12.9%	11.2%	15.4%	0.1%	1.9%	10.7%	0.6%	0.1%	0.2%	0.1%	0%	0%	0%	**100%**
MCC-6	Km 198	17.1%	0.2%	4.5%	7.5%	20%	20.3%	17.3%	0%	1.3%	11.3%	0.3%	0%	0%	0.1%	0%	0%	0%	**100%**
MCC-7	Km 242	28.7%	0.2%	1.8%	9.2%	13.4%	13.6%	11.2%	0.1%	3.9%	16.8%	1.0%	0.1%	0%	0.1%	0%	0%	0%	**100%**
MCC-9	Km 297	28.8%	0.2%	2.1%	5.7%	16.7%	17.0%	15.4%	0%	0.7%	12.7%	0.4%	0.1%	0.1%	0.1%	0%	0%	0%	**100%**
MCC-10	Km 355+700	35.8%	0.3%	1.8%	4.4%	11.7%	11.8%	11.2%	0%	3.2%	19.1%	0.4%	0%	0%	0%	0%	0%	0%	**100%**
MCC-12	Km 390	31.3%	0.3%	2.0%	12.4%	12.6%	10.4%	18.1%	0.1%	2.3%	10.3%	0.1%	0%	0%	0.4%	0%	0%	0%	**100%**
MCC-13	Km 473	40.1%	0.5%	1.8%	13.4%	8.1%	7.2%	15.7%	0%	0.5%	7.6%	5.0%	0%	0%	0.1%	0%	0%	0%	**100%**
MCC-14	Km 494+500	40.7%	0.3%	1.5%	15.5%	7.5%	5.0%	6.1%	0%	7.6%	15.2%	0.6%	0%	0%	0%	0%	0%	0%	**100%**
MCC-16	KM 7	45.1%	0.6%	3.5%	9.6%	6.3%	4.4%	5.8%	0%	5.6%	18.4%	0.4%	0%	0%	0%	0%	0%	0%	**100%**
MCC-17	Km 130	22.7%	0.4%	1.2%	10.2%	8.4%	7.0%	10.6%	0%	12.4%	26.1%	0.9%	0%	0%	0.1%	0%	0%	0%	**100%**
MCC-20	Km 97	26.3%	0.3%	1.9%	15.8%	4.7%	4.7%	16.5%	0%	4.8%	24.4%	0.5%	0%	0%	0%	0%	0%	0%	**100%**

At MCC-12 (km 390+000 of NH-8 near Charoti Toll Plaza), the share of motorized traffic is 99.6%. Combined share of the different categories of freight vehicles is 53.5% of the total traffic. Of the total freight vehicles, LGV accounts for 23.2%, 2/3 axle trucks constitute 42.9%, MAVs contribute 33.9%. Passenger vehicles account for 46.1% of the total traffic of which the share of cars/van/jeep is 67.8%, 2 wheelers constitute 22.3% and buses have a share of 4.3%. Mini buses and three-wheeler contribute a share of 0.5% and 5.1% respectively. Non-motorised vehicles have a share of 0.4%.

At MCC-13 (km 473+000 of NH-8 near Khanivade Toll Plaza), the share of motorized traffic is 99.9%. Combined share of the different categories of freight vehicles is 49.4% of the total traffic. Of the total freight vehicles, LGV accounts for 37.1%, 2/3 axle trucks constitute 31.1%, MAVs contribute 31.8%. Passenger vehicles account for 50.5% of the total traffic of which the share of cars/van/jeep is 79.4%, 2 wheelers constitute 15.1% and buses have a share of 3.5%. Mini buses and three-wheeler contribute a share of 0.9% and 1% respectively. Non-motorised vehicles have a share of 0.1%.

At MCC-14 (km 494+500 of NH-8 near Sasunavghar), the share of motorized traffic is 100%. Combined share of the different categories of freight vehicles is 34.6% of the total traffic. Of the total freight vehicles, LGV accounts for 46.3%, 2/3 axle trucks constitute 36%, MAVs contribute 17.6%. Passenger vehicles account for 65.4% of the total traffic of which the share of cars/van/jeep is 62.3%, 2 wheelers constitute 23.3% and buses have a share of 2.3%. Mini buses and three-wheeler contribute a share of 0.5% and 11.6% respectively.

At MCC-16 (km 7+000 of SH-42), the share of motorized traffic is 100%. Combined share of the different categories of freight vehicles is 26.7% of the total traffic. Of the total freight vehicles, LGV accounts for 37.7%, 2/3 axle trucks constitute 40.4%, MAVs contribute 21.9%. Passenger vehicles account for 73.3% of the total traffic of which the share of cars/van/jeep is 61.5%, 2 wheelers constitute 25.2% and buses have a share of 4.8%. Mini buses and three-wheeler contribute a share of 0.9% and 7.6% respectively.

At MCC-17 (km 130+000 of NH-4 near Taloja), the share of motorized traffic is 99.9%. Combined share of the different categories of freight vehicles is 37.1% of the total traffic. Of the total freight vehicles, LGV accounts for 29.9%, 2/3 axle trucks constitute 41.5%, MAVs contribute 28.5%. Passenger vehicles account for 62.7% of the total traffic of which the share of cars/van/jeep is 36.1%, 2 wheelers constitute 41.6% and buses have a share of 1.9%. Mini buses and three-wheeler contribute a share of 0.7% and 19.7% respectively. Non-motorised vehicles have a share of 0.1%.

At MCC-20 (km 97+000 of NH-4 near Panvel), the share of motorized traffic is 100%. Combined share of the different categories of freight vehicles is 42.3% of the total traffic. Of the total freight vehicles, LGV accounts for 38.6%, 2/3 axle trucks constitute 22.2%, MAVs contribute 39.1%. Passenger vehicles account for 57.7% of the total traffic of which the share of cars/van/jeep is 45.6%, 2 wheelers constitute 42.3% and buses have a share of 3.3%. Mini buses and three-wheeler contribute a share of 0.6% and 8.3% respectively.

4.4.1.4 Hourly Variation of Traffic

Traffic volume count was conducted in both directions for successive 15-minutes periods, for 24 hours a day. The 15-minute count was compiled to get the hourly variation of traffic for each survey location. The graph showing hourly variation for each location is given in **Figure 4.2 to Figure 4.12** Peak hour traffic for all the

locations on NH-8 is found to be between 4.7% to 6.5% of the ADT, which is quite normal for intercity roads because of high percentage of regional traffic movement of freight traffic on the road.

4.4.1.5 Daily Variation of Traffic

Volume count at each survey location was conducted continuously for three to seven days. Daily variation in traffic was found by analyzing the volume count data. It was observed that the daily variation does not exceed more than ±7% of ADT at all the survey locations on NH-8. Figure 4.2 to Figure 4.12 shows the daily variation both in vehicles and PCUs for all the survey locations. Traffic volume count data and summary sheets for various locations are presented in **Annexure 4.2.**

4.4.1.6 Annual Average Daily Traffic (AADT)

The Annual Average Daily Traffic (AADT) is calculated by multiplying ADT with a seasonality factor. Seasonal variation factors by vehicle types are required to account for variations in the pattern of traffic volume on the sections of project road over different months or seasons of the year. Theref are various methods of determining the seasonality factor. The most direct method is by using the past traffic counts, if traffic surveys are carried out round the year. But year round counts are seldom done in India on any road. Therefore, the seasonality factors are mostly calculated based on traffic related secondary data (surrogate data representing the traffic on road) like fuel sales or toll collections etc. The petrol and diesel sale data has been collected from fuel stations most representative for the project road for the past years to account for the monthly variations. The toll traffic data has been collected from Khanivade Toll Plaza on NH8 in Maharashtra and has been used to estimate seasonal variation factors. The seasonality factors derived for the survey month to calculate AADT for different modes has been given in **Table 4.7.**

Table 4.7: Adopted Mode wise Seasonal Variation Factors for Different Sections

Sections	Car/Jeep	LCV	Truck/ Bus	MAV
Month of Feb - March				
Vadodara-Bharuch	0.93	1.03	1.03	1.03
Bharuch-Kosamba	0.93	1.03	1.03	1.03
Kosamba-Surat	0.95	1.02	1.02	1.02
Surat-Bilimora	0.98	1.01	1.01	1.01
Bilimora-Vapi	1.06	1.02	1.02	1.02
Vapi-Dahanu	1.06	1.05	1.05	1.05
Dahanu-Virar	1.06	1.05	1.05	1.05
Virar-Dahisar	1.06	1.05	1.04	1.05
Thane Ghodbander Road	1.01	1.03	1.03	1.03
NH-4 (Near Taloja)	1.01	1.03	1.03	1.03
NH-4 (Near Panvel)	1.01	1.03	1.03	1.03

This seasonality factor presented above is used to convert Average Daily Traffic to Annual Average Daily Traffic (AADT) for various survey locations which are shown in **Table 4.8.**

Table 4.8: Annual Average Daily Traffic (AADT) at Various Surveyed Locations

Station No.	Chainage (km)	Survey locations	Car	Mini Bus	Bus	LGV	2-Axle ruck	3-Axle Truck	4-6 Axle Truck	>6 Axle Truck	3-Wheeler	2-Wheeler	LCV 3-Wheeler	Tractor	Tractor with trailer	Cycle	Cycle Rickshaw	Hand Cart	Animal Drawn	AADT (in Veh)	AADT (in PCUs)
MCC-3	156+000	Near Karjan (NH-8)	15723	92	1189	2848	5944	5135	7098	59	791	4443	297	47	87	35	5	0	0	**43792**	**93090**
MCC-6	198+000	Near Bharuch (NH-8)	6725	96	1948	3245	8626	8755	7455	8	549	4399	132	10	6	34	2	0	0	**41989**	**106316**
MCC-7	42+000	Near Kamrej (NH-8)	17458	136	1184	5978	8774	8856	7308	37	2562	10221	629	52	0	38	6	0	0	**63239**	**124850**
MCC-9	97+000	Near Boriach Toll Plaza (NH-8)	13877	111	1035	2847	8266	8411	7655	12	347	6107	190	33	49	51	1	0	1	**48993**	**109940**
MCC-10	55+700	Near Bagwada Toll Plaza (NH-8)	22089	207	1058	2642	6931	7001	6665	16	1923	11801	255	13	21	17	4	3	0	**60646**	**109744**
MCC-12	90+000	Near Amgaon (NH-8)	10271	82	639	4023	4089	3399	5893	18	765	3380	20	0	0	112	0	0	0	**32693**	**69954**
MCC-13	73+000	Near Khanivade Toll Plaza (NH-8)	16423	186	726	5432	3302	2937	6365	13	206	3126	2010	0	5	28	0	0	5	**40763**	**79293**
MCC-14	94+500	Near Sasunavghar (NH-8)	30928	257	1101	11643	5616	3773	4598	1	5740	11570	438	5	0	26	0	0	0	**75698**	**113151**
MCC-16	7+000	SH-42 (MH), Near Gaimukh Village	29216	420	2322	6324	4158	2920	3830	3	3661	11925	281	1	6	19	0	0	0	**65085**	**94863**
MCC-17	130+000	NH-4, Near Shil Phata	9196	178	497	4204	3440	2892	4343	15	5091	10567	369	5	7	40	2	7	0	**40853**	**66879**
MCC-20	97+000	NH-4, Near Rasayani Village	6138	80	446	3737	1120	1108	3921	1	1133	5692	127	5	3	6	0	0	0	**23517**	**41729**

It can be seen from the above table that maximum AADT for NH-8 is estimated at km 242+000 near Kamrej, which is of the order of 124,850 PCUs (63239 vehicles) and the lowest AADT volume is found at km 390+000 near Amgaon, which is 69954 PCUs (32693 Vehicles).

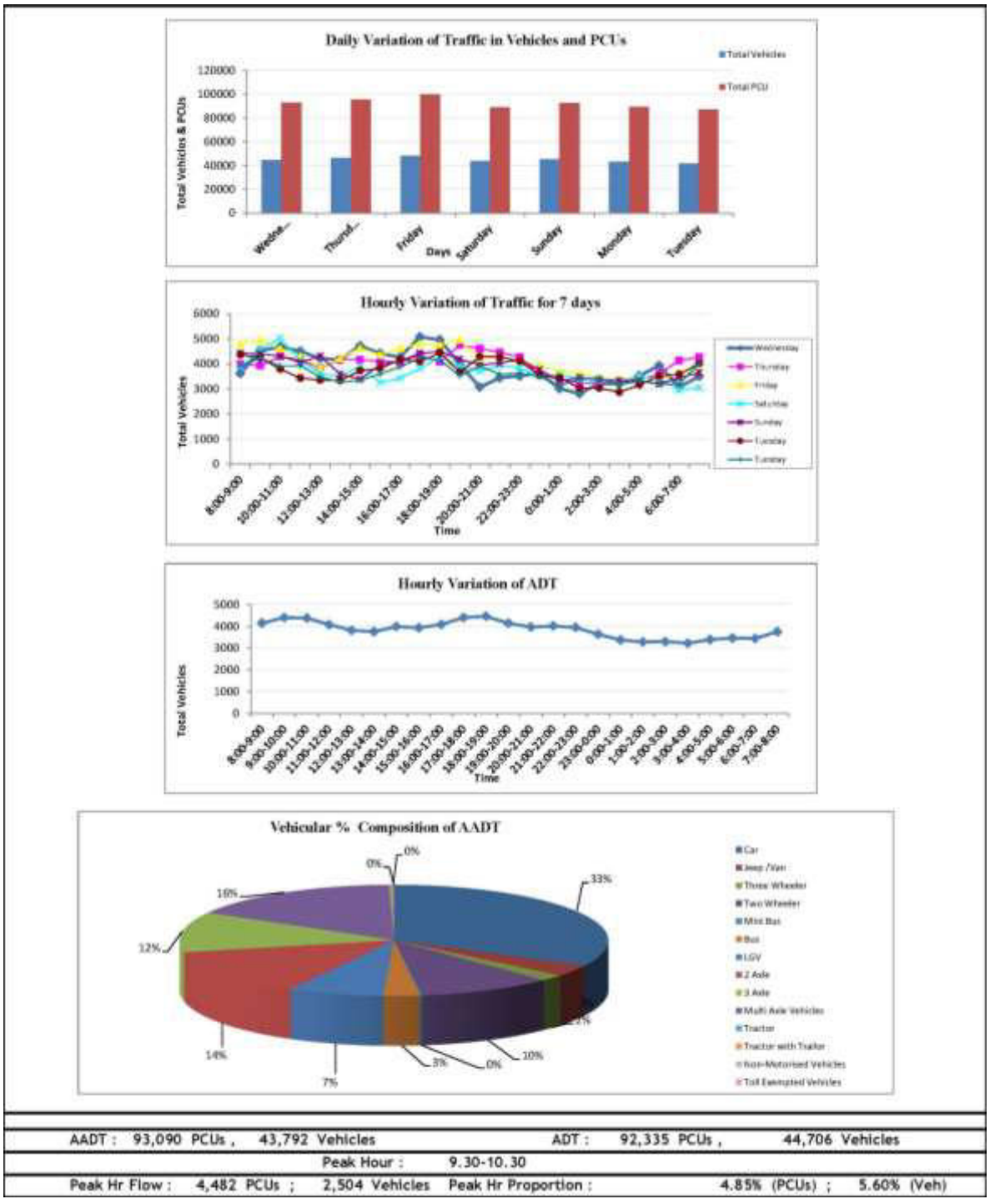


Figure 4.2: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-03 (Km 156+000) of NH-8

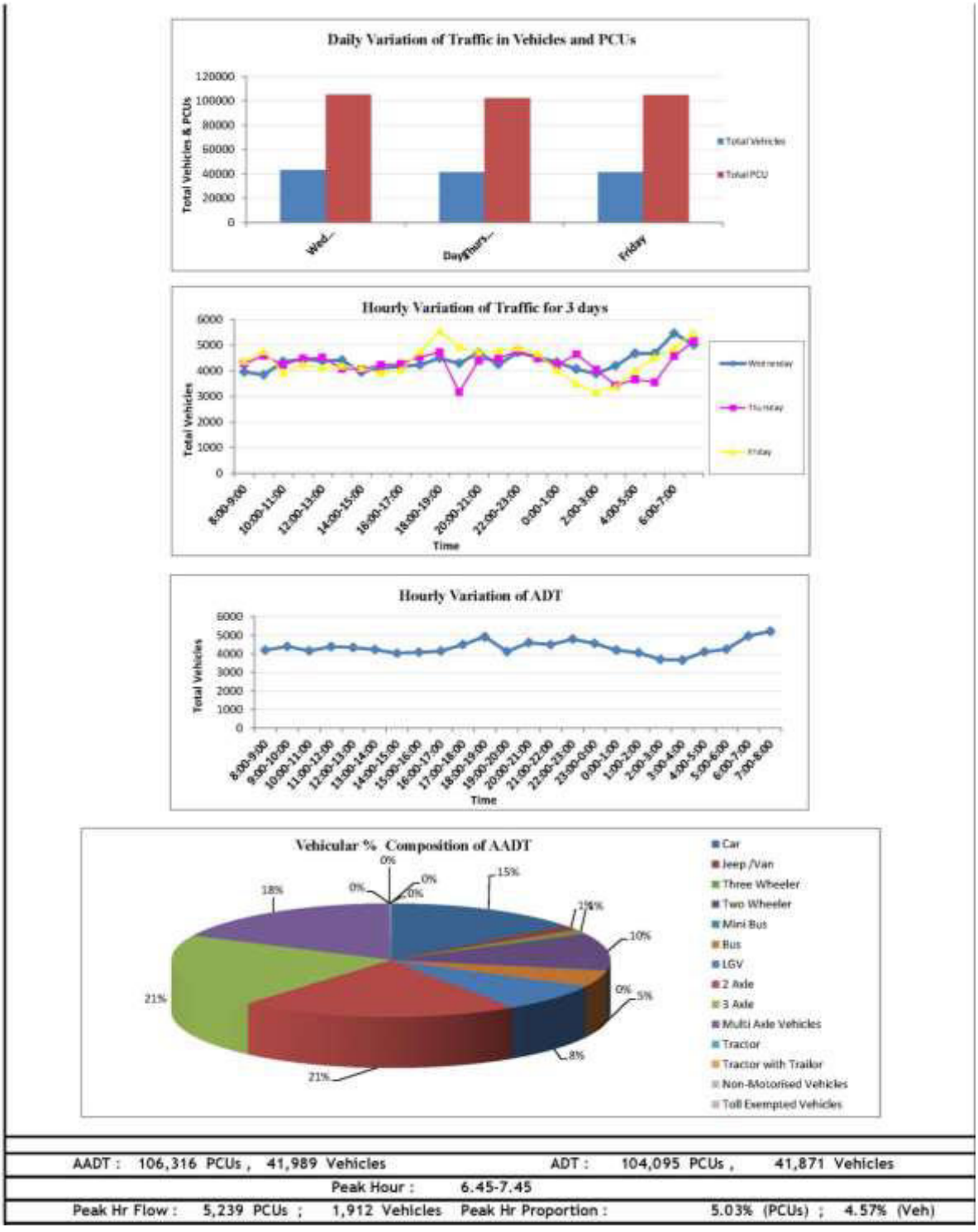
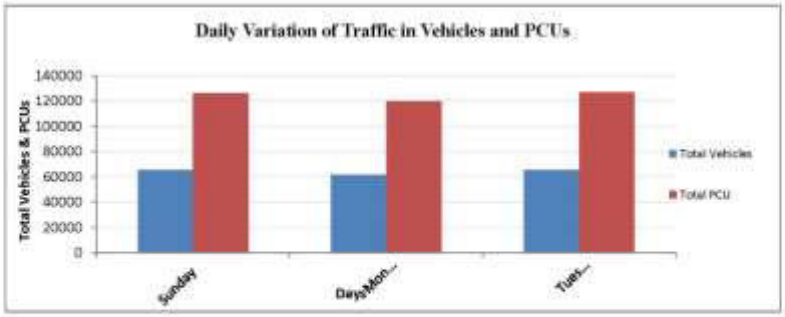
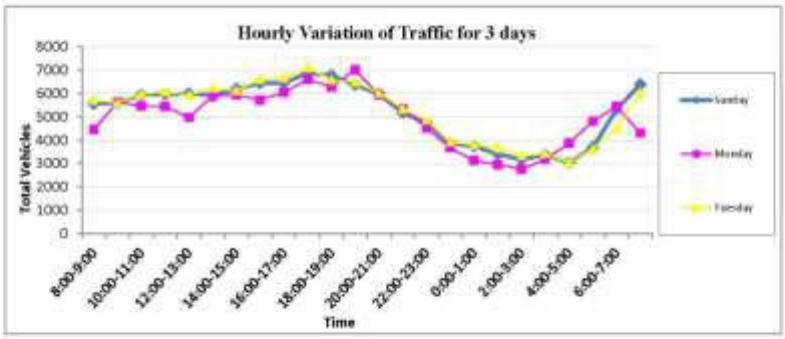
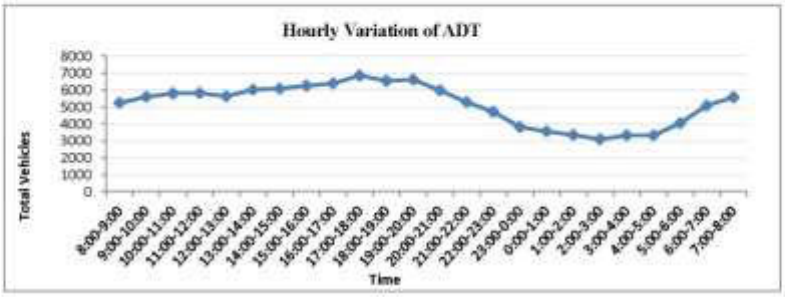
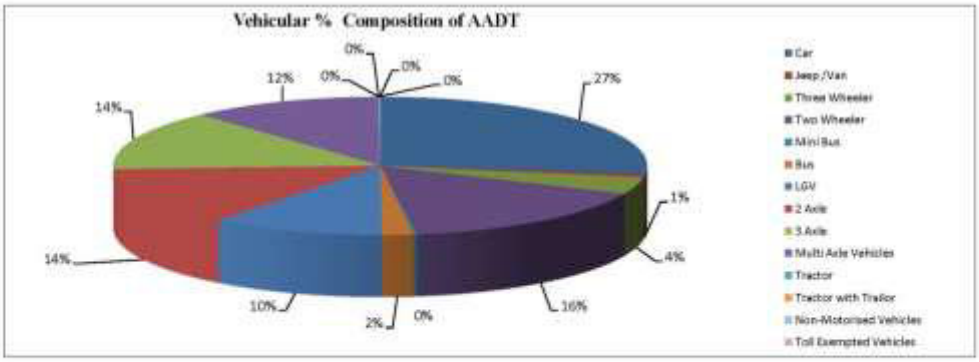


Figure 4.3: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-06 (Km 198+000) of NH-8









AADT :	124,850 PCUs ,	63,239 Vehicles		ADT :	124,000 PCUs , 63,966 Vehicles
		Peak Hour :	17.00-18.00		
Peak Hr Flow :	6,857 PCUs ;	4,003 Vehicles	Peak Hr Proportion :		5.53% (PCUs) ; 6.26% (Veh)

Figure 4.4: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-07 (Km 242+000) of NH-8

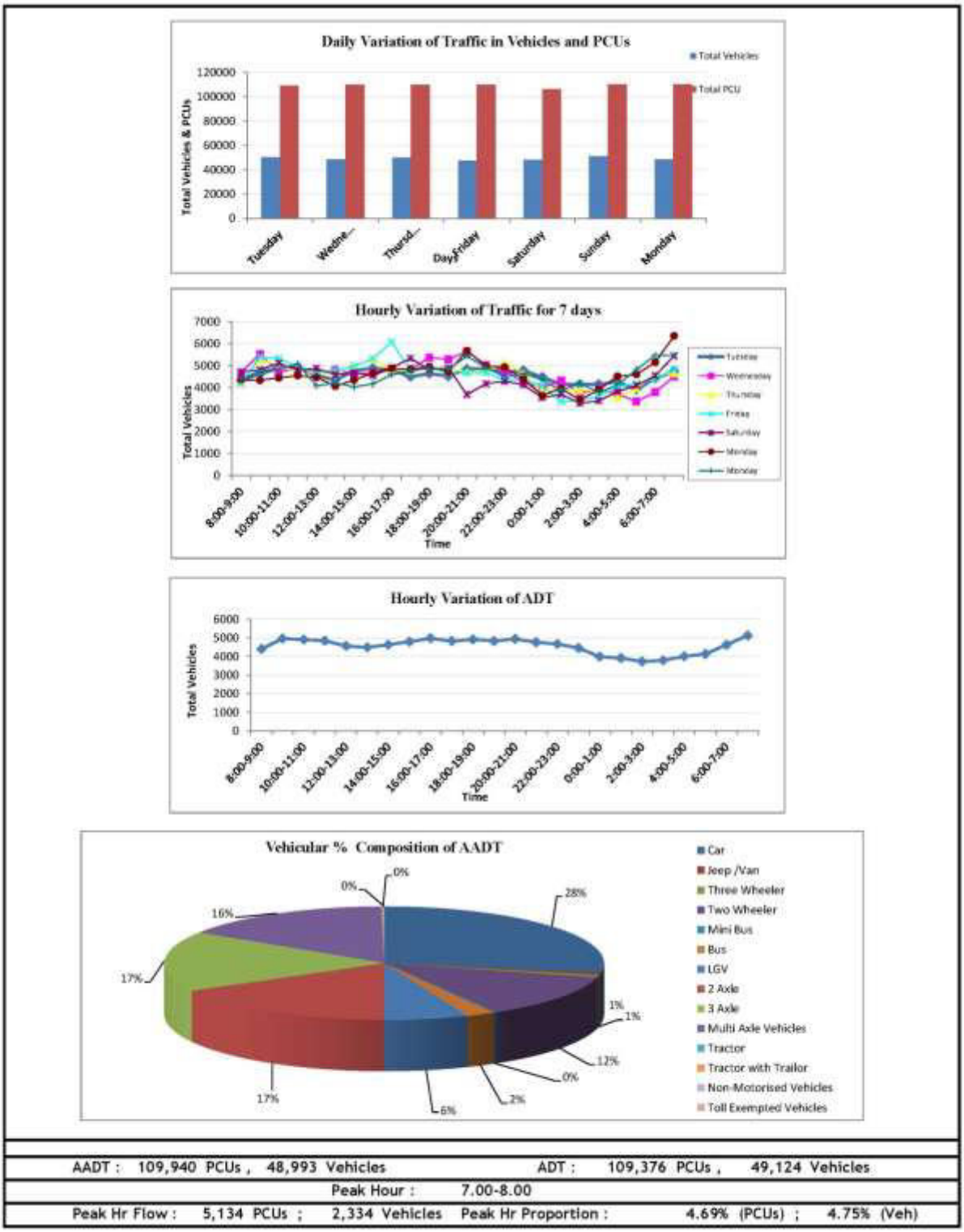
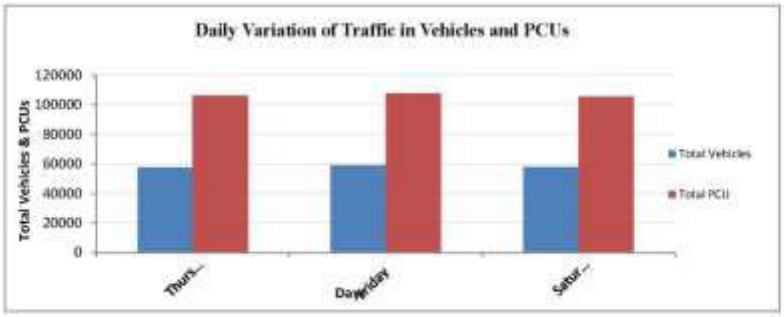
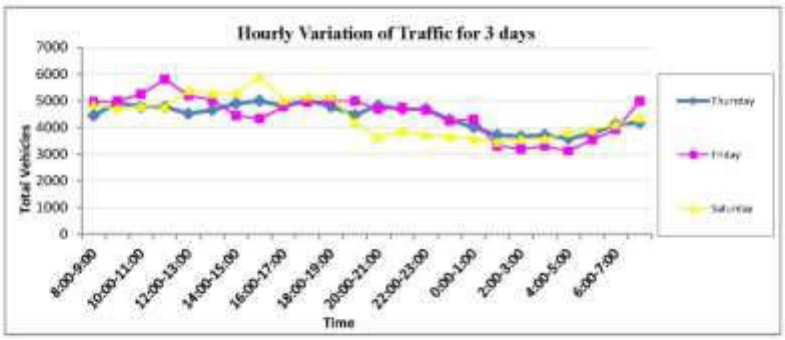
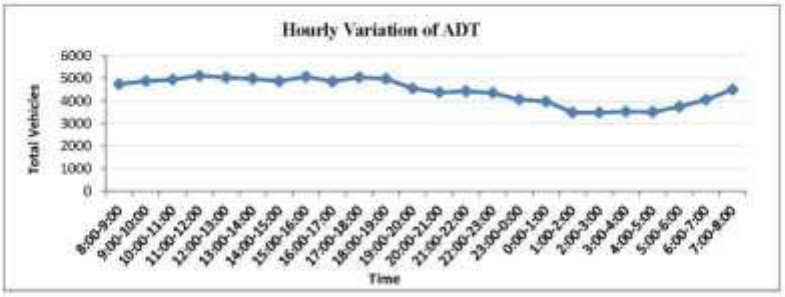
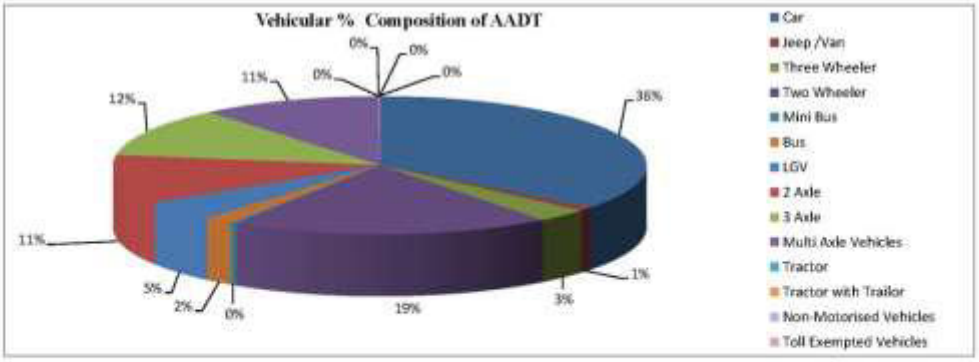


Figure 4.5: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-09 (Km 297+000) of NH-8









AADT :	109,744 PCUs , 60,646 Vehicles	ADT :	106,576 PCUs , 58,222 Vehicles
	Peak Hour :	10.45-11.45	
Peak Hr Flow :	5,165 PCUs ; 3,175 Vehicles	Peak Hr Proportion :	4.85% (PCUs) ; 5.45% (Veh)

Figure 4.6: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-10 (Km 355+700) of NH-8

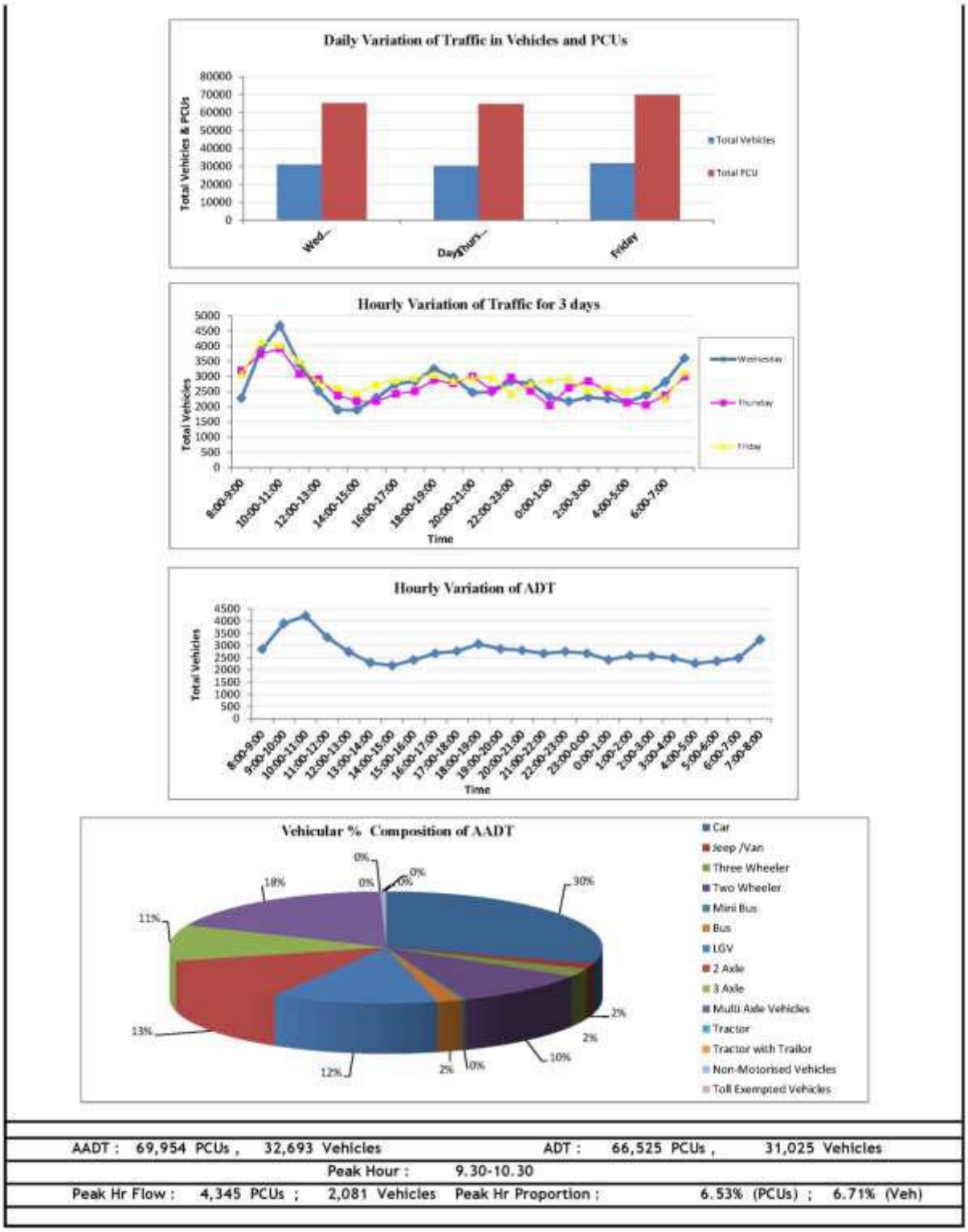
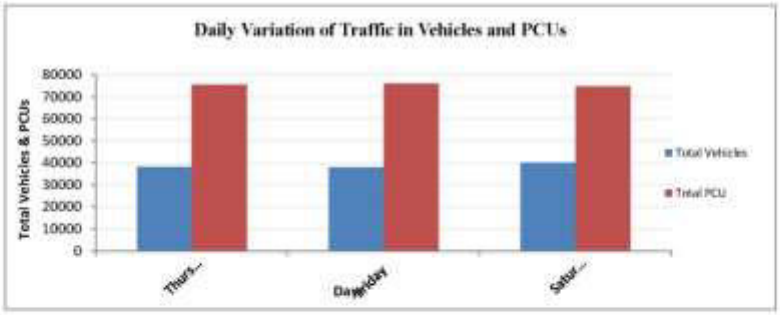
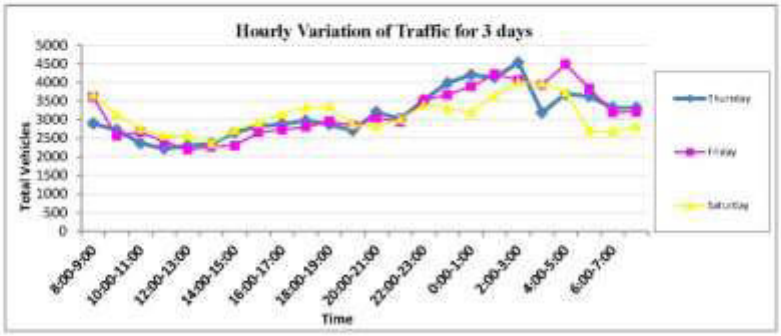
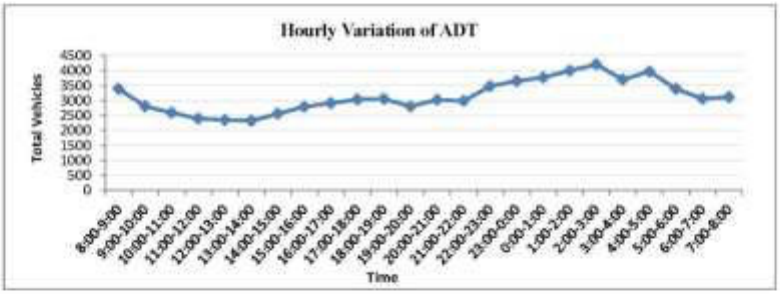
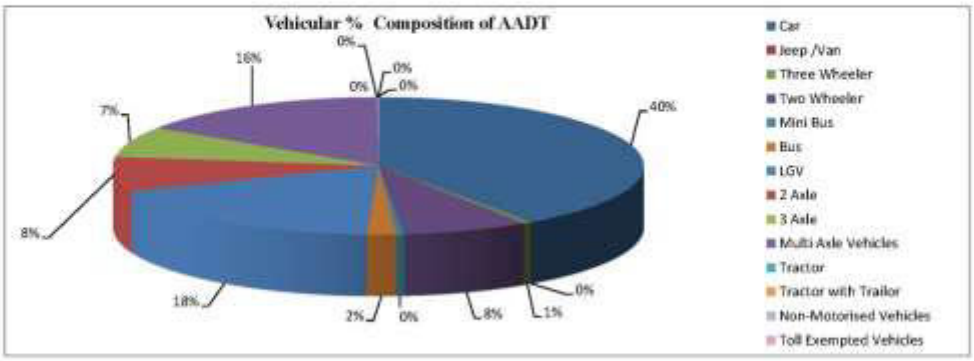


Figure 4.7: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-12 (Km 390+000) of NH-8



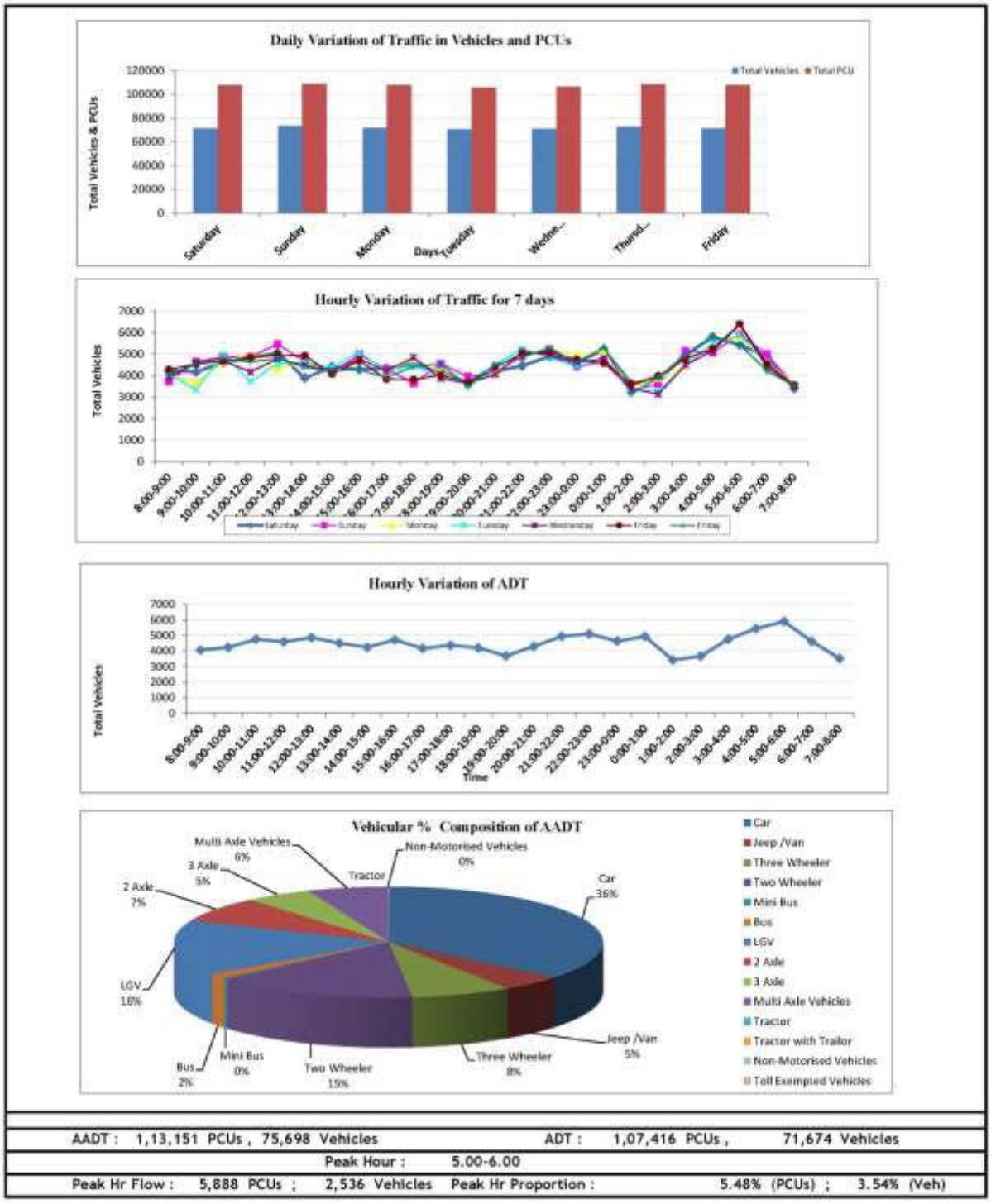






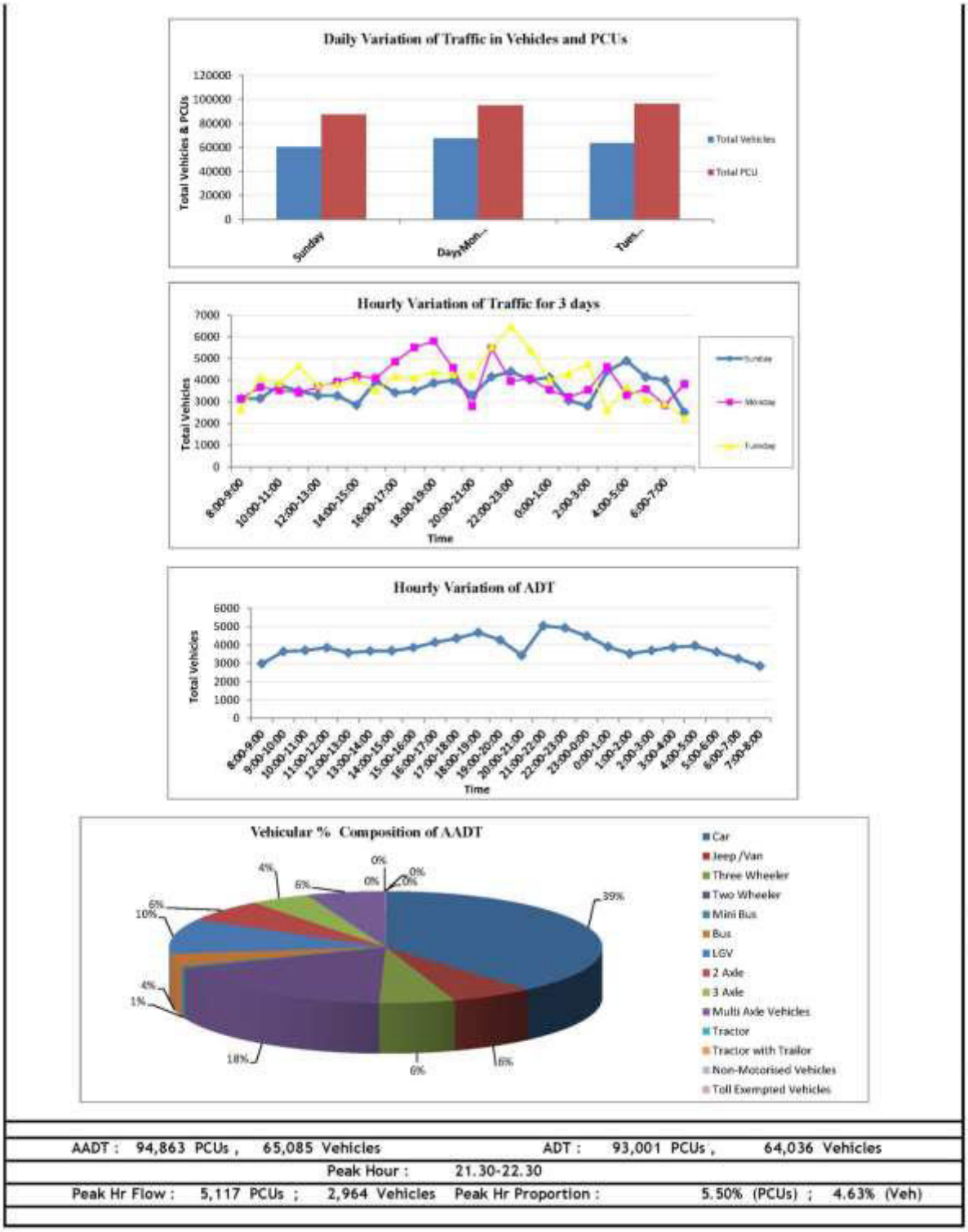
AADT :	79,293 PCUs ,	40,763 Vehicles		ADT :	75,358 PCUs , 38,648 Vehicles
		Peak Hour :	1.45-2.45		
Peak Hr Flow :	4,227 PCUs ;	1,384 Vehicles	Peak Hr Proportion :		5.61% (PCUs) ; 3.58% (Veh)

Figure 4.8: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-13 (Km 473+000) of NH-8



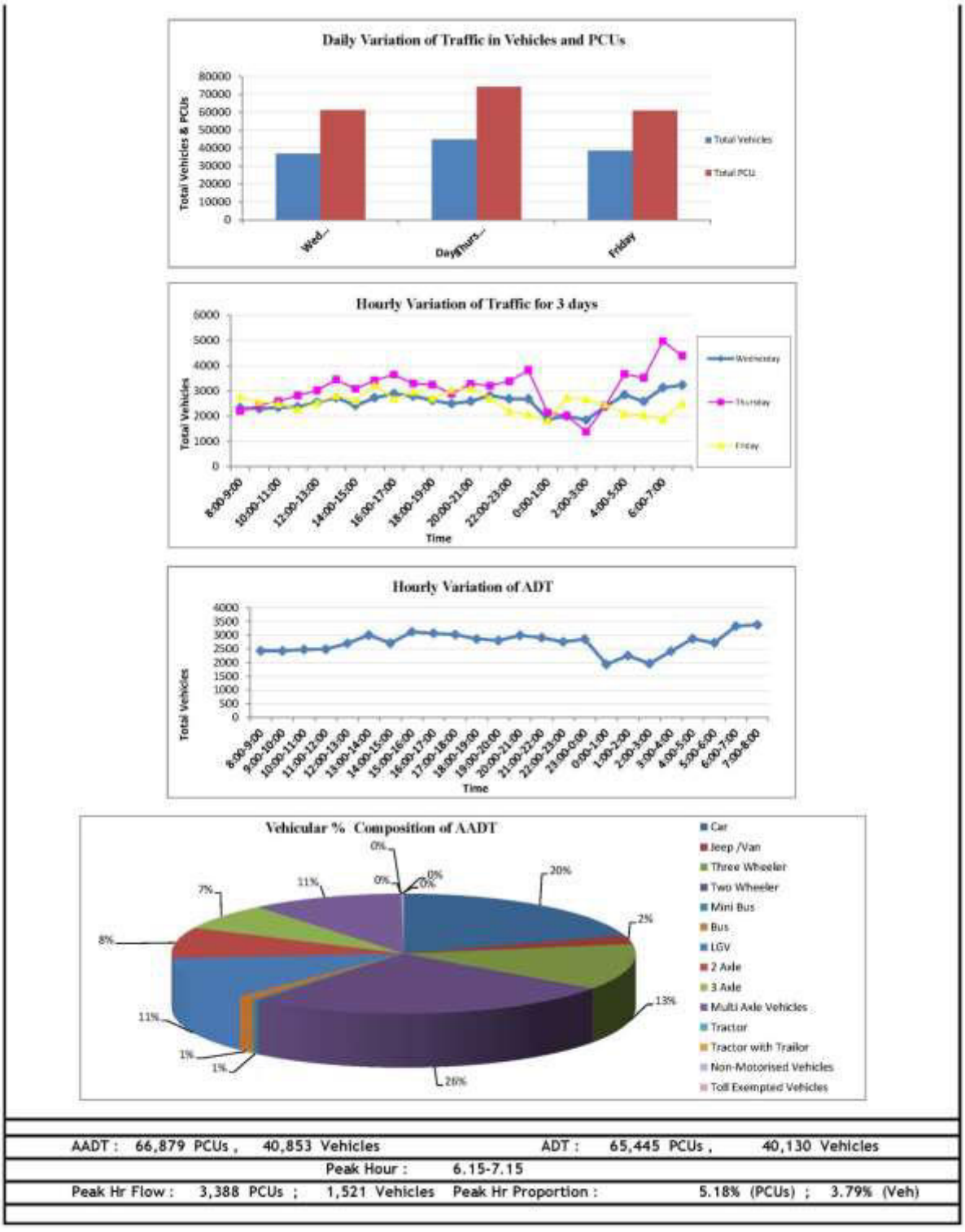
AADT :	1,13,151 PCUs ,	75,698 Vehicles	ADT :	1,07,416 PCUs ,	71,674 Vehicles
		Peak Hour : 5.00-6.00			
Peak Hr Flow :	5,888 PCUs ;	2,536 Vehicles	Peak Hr Proportion :		5.48% (PCUs) ; 3.54% (Veh)

Figure 4.9: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-14 (Km 494+500) of NH-8



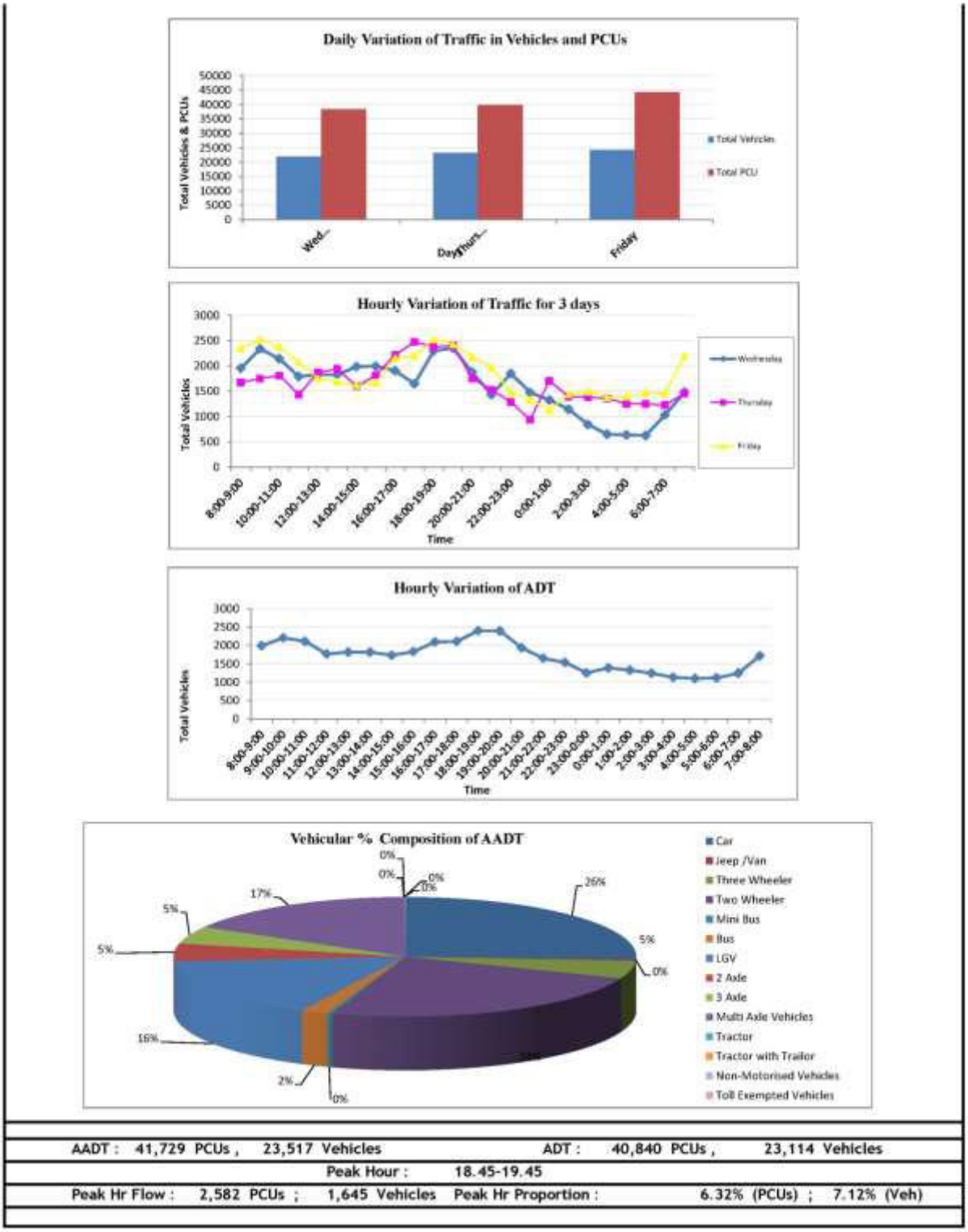
AADT :	94,863 PCUs ,	65,085 Vehicles	ADT :	93,001 PCUs ,	64,036 Vehicles
		Peak Hour :	21.30-22.30		
Peak Hr Flow :	5,117 PCUs ;	2,964 Vehicles	Peak Hr Proportion :		5.50% (PCUs) ; 4.63% (Veh)

Figure 4.10: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-16 (Km 7+000) of SH-42



AADT :	66,879 PCUs ,	40,853 Vehicles		ADT :	65,445 PCUs , 40,130 Vehicles
		Peak Hour :	6.15-7.15		
Peak Hr Flow :	3,388 PCUs ;	1,521 Vehicles	Peak Hr Proportion :		5.18% (PCUs) ; 3.79% (Veh)

Figure 4.11: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-17 (Km 130+000) of NH-4



AADT :	41,729 PCUs ,	23,517 Vehicles		ADT : 40,840 PCUs ,	23,114 Vehicles
		Peak Hour :	18.45-19.45		
Peak Hr Flow :	2,582 PCUs ;	1,645 Vehicles	Peak Hr Proportion :		6.32% (PCUs) ; 7.12% (Veh)

Figure 4.12: Vehicular Composition and Daily/Hourly Variation of Traffic at MCC-20 (Km 97+000) of NH-4

4.4.2 Analysis of Turning Movement Count Data

Turning Movement Count Surveys were carried out at ten intersections along the project stretch, of which nine were on NH-8 and one intersection on NH-4. The total traffic flow for all the surveyed junctions, are presented in **Table 4.9** and detailed daily and peak hour flow diagrams are given in **Annexure 4.3**.

The daily total approach volumes vary from 89819 PCUs (47388 vehicles) to 171036 PCUs (131644 vehicles) at different intersections along NH-8. The highest total approach volume along NH-8, in terms of PCUs has been observed at Thane-Ghodbunder Road Junction (KM 497+000). The lowest total approach volume is found at Valsad Road Junction (KM 328+000).

Table 4.9: Daily Traffic Flows at Major Intersections

Sl. No.	Name of Intersection	Chainage km)	Count Station No.	Total Traffic (in Vehicles)	Total Traffic (in PCUs)
1	Dahej Junction	191+000	TMC-6	67,913	1,46,624
2	Walia Junction	208+500	TMC-10	77,554	1,26,296
3	Intersection of NH-8 with NH-6	259+000	TMC-14	97,002	1,50,306
4	Nasik-Gandevi Road Junction	300+000	TMC-16	65,149	1,30,875
5	Valsad Road Junction	328+000	TMC-17	47,388	89,819
6	Silvassa Road Junction (A)	376+500 (A)	TMC-19 (A)	67,816	1,13,047
	Bhilad Road Junction (B)	376+550 (B)	TMC-19 (B)	68,376	1,06,475
7	Tarapur /Boisar Road Junction	436+000	TMC-21	43,983	92,364
8	Bhiwandi Road Junction	486+500	TMC-24	91,542	1,35,507
9	Thane-Ghodbunder Junction	497+000	TMC-25	1,31,644	1,71,036
10	Palaspe Phata/Junction (NH-4)	111+150	TMC-27-A	72,446	82,269
		111+250	TMC-27-B	66,554	83,154

Peak hour is the most important time period for any intersection. The ability of the intersection to accommodate traffic during peak hours is the measure of its level of service. The junction turning flows during peak hour will be useful in planning and design for the intersections/interchanges. Peak hour traffic details (peak hour proportions of daily traffic) of all the junctions are presented in **Table 4.10.**

It is observed that along NH-8, the total approach volumes during peak hour vary from 5,552 PCUs (3,657 vehicles) at Valsad Road Junction at KM 328+000 to a volume of 11,124 PCUs (7,028 vehicles) at the intersection of NH-8 with NH-6 (KM 259+000). The peak hour proportion at different intersections varies from 4.7% to 7.4%.

Table 4.10: Peak Hour Traffic Flows at Major Intersections

Sl. No.	Name of Intersection	Chainage (km)	Count Station No.	Total Traffic (in Vehicles)	Total Traffic (in PCUs)	Peak Hour Proportion (in Vehicles)	Peak Hour Proportion (in PCUs)
1	Dahej Junction	191+000	TMC-6	3,930	7,356	5.8%	5.0%
2	Walia Junction	208+500	TMC-10	5,234	7,920	6.7%	6.3%

Sl. No.	Name of Intersection	Chainage (km)	Count Station No.	Total Traffic (in Vehicles)	Total Traffic (in PCUs)	Peak Hour Proportion (in Vehicles)	Peak Hour Proportion (in PCUs)
3	Intersection of NH-8 with NH-6	259+000	TMC-14	7,028	11,124	7.2%	7.4%
4	Nasik-Gandevi Road Junction	301+000	TMC-16	4,532	7,757	7.0%	5.9%
5	Valsad Road Junction	328+000	TMC-17	3,657	5,552	7.7%	6.2%
6	Silvassa Road Junction (A)	376+500 (A)	TMC-19 (A)	4351	5,712	7.6%	7.0%
	Bhilad Road Junction (B)	376+550 (B)	TMC-19 (B)	5,173	7,963	6.4%	5.4%
7	Tarapur /Boisar Road Junction	436+000	TMC-21	2,716	5,658	6.2%	6.1%
8	Bhiwandi Road Junction	486+500	TMC-24	6,018	7,992	6.6%	5.9%
9	Thane-Ghodbunder Junction	497+000	TMC-25	7,566	8,016	5.7%	4.7%
10	Palaspe Phata/Junction (NH-4)	111+150	TMC-27-A	4709	5347	6.5%	6.5%
		111+250	TMC-27-B	4326	5405	6.5%	6.5%

Based on the observed traffic flow from various surveys conducted on the project road, a flow diagram has been prepared showing the mid-block and intersection turning flows on the project road as shown in **Figure 4.13.**

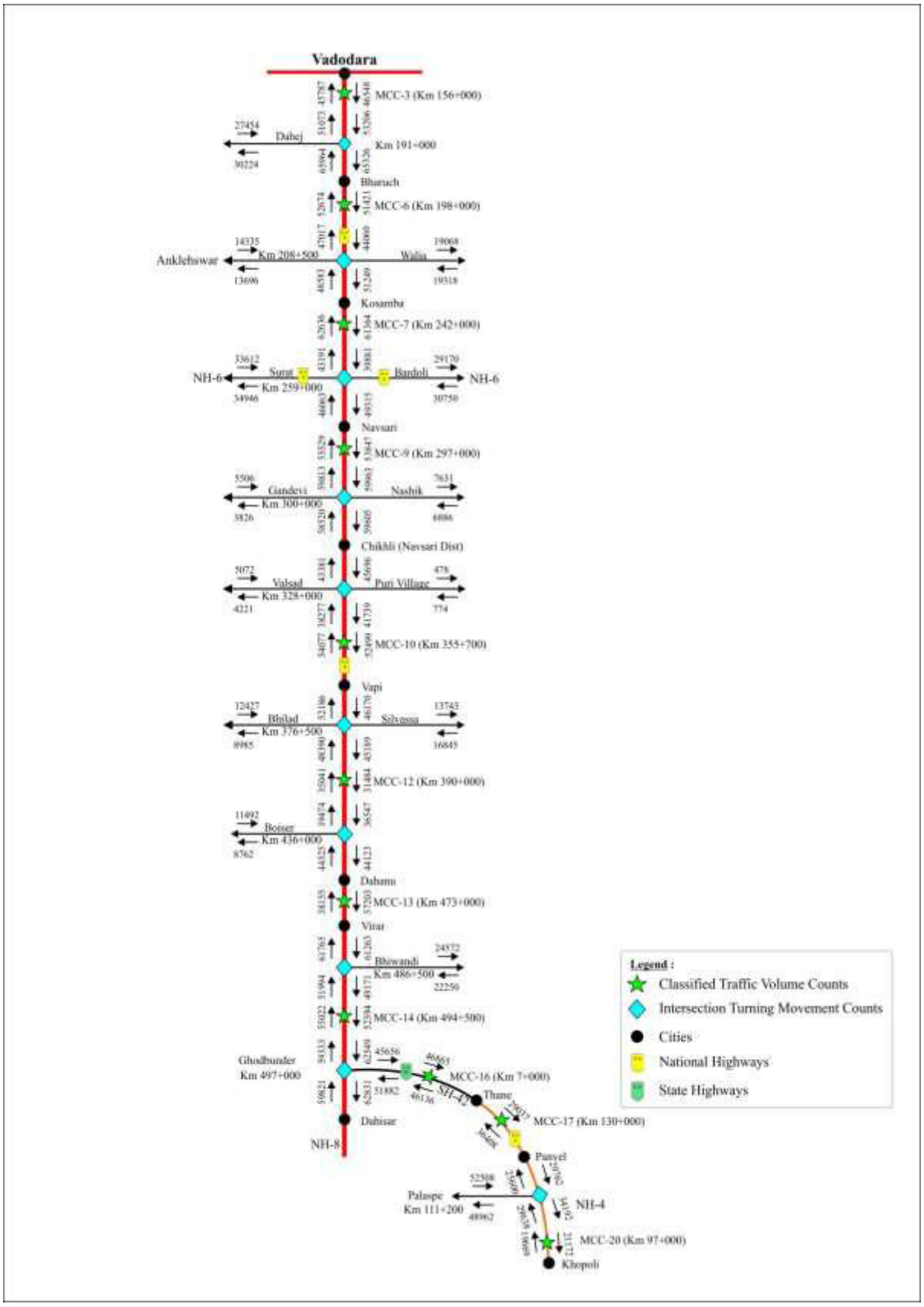


Figure 4.13: Flow Diagram

4.5 COMPARISON OF AADT OBSERVED IN 2009 AND 2016

The traffic surveys were conducted in Feb-Mar 2016 at 11 mid-block locations out of which 8 locations were on NH-8 and remaining 3 on NH-4. The AADT observed in current year was compared with 2009 data to understand the traffic growth during this period. The observed AADT in 2009 and 2016 along with growth rates is presented in **Table 4.11.**

Table 4.11: Comparison of 2009 and 2016 AADT Volumes

Survey location and Chainage (NH8 and NH4)	Year	Car	LGV	Bus & Mini Bus	2-Axle Truck	3-Axle Truck	MAV+ Container	Total
MCC-3 Km 156+000, NH-8	2009	7130	1223	1748	5749	6757	2093	**24700**
	2016	15723	2848	1281	5944	5135	7157	**38088**
	CAGR	12.0%	12.8%	-4.3%	0.5%	-3.8%	19.2%	**6.4%**
MCC-6 Km 198+000, NH-8	2009	4039	1708	2055	6767	8423	2974	**25966**
	2016	6725	3245	2044	8626	8755	7463	**36858**
	CAGR	7.6%	9.6%	-0.1%	3.5%	0.6%	14.0%	**5.1%**
MCC-7 Km 242+000, NH-8	2009	10298	3656	2340	6575	6296	2459	**31624**
	2016	17458	5978	1320	8774	8856	7345	**49731**
	CAGR	7.8%	7.3%	-7.9%	4.2%	5.0%	16.9%	**6.7%**
MCC-9 Km 297+000, NH-8	2009	8085	650	880	6658	4236	2374	**22883**
	2016	13877	2847	1145	8266	8411	7667	**42213**
	CAGR	8.0%	23.5%	3.8%	3.1%	10.3%	18.2%	**9.1%**
MCC-10 Km 355+700, NH-8	2009	9630	1276	1090	5528	3869	2812	**24205**
	2016	22089	2642	1265	6931	7001	6681	**46609**
	CAGR	12.6%	11.0%	2.1%	3.3%	8.8%	13.2%	**9.8%**
MCC-12 Km 390+000, NH-8	2009	6572	640	672	5542	3978	3702	**21106**
	2016	10271	4023	721	4089	3399	5911	**28414**
	CAGR	6.6%	30.0%	1.0%	-4.3%	-2.2%	6.9%	**4.3%**
MCC-13 Km 473+000	2009	9288	1003	779	9209	3522	2931	**26732**
	2016	16423	5432	912	3302	2937	6378	**35384**
	CAGR	8.5%	27.3%	2.3%	-13.6%	-2.6%	11.7%	**4.1%**
MCC-14 Km 494+500, NH-8	2009	18932	2250	938	12844	3418	2603	**40985**
	2016	30928	11643	1358	5616	3773	4599	**57917**
	CAGR	7.3%	26.5%	5.4%	-11.1%	1.4%	8.5%	**5.1%**
MCC-16 KM 7+000, SH-42	2009	16727	3263	2497	5075	2735	4704	**35001**
	2016	29216	6324	2742	4158	2920	3833	**49193**
	CAGR	8.3%	9.9%	1.3%	-2.8%	0.9%	-2.9%	**5.0%**
MCC-17 Km 130+000, NH-4	2009	5351	1078	744	2145	2060	2487	**13865**
	2016	8090	3947	531	2896	2609	3910	**21983**
	CAGR	6.1%	20.4%	-4.7%	4.4%	3.4%	6.7%	**6.8%**
MCC-20 Km 97+000, NH-4	2009	5335	2320	931	1997	1489	2524	**14596**
	2016	6138	3737	526	1120	1108	3922	**16551**
	CAGR	2.0%	7.0%	-7.8%	-7.9%	-4.1%	6.5%	**1.8%**

It is to be noted that the average annual growth rates (CAGR) are highest with cars, light goods vehicles and multi-axle trucks whereas least with buses and 2-

axle trucks. The new truck models of light commercial vehicles are becoming more popular among freight transporters as they are capable of carrying more loads and have to pay toll of lesser amount than 2-axle trucks. Hence, among goods vehicles, a shift from 2-axle trucks to LGV has been observed. Similarly, at some of the locations shift from 3-axle truck to multi-axle trucks has also been observed, and thus the low growth rates in 3-axle trucks are accompanied by high growth of multi-axle trucks, e.g. at Km 156.

The overall growth in number of vehicles has been observed in the range of 4.1% to 9.8% per year on NH-8, which is normal. However, at Km 97+000 on NH-4 very low growth rate of 1.8% has been observed which is because of traffic being diverted to other parallel roads. **Table 4.12** gives observed growth of passenger and goods vehicles at all the eleven survey locations.

Table 4.12: Observed growth rates in passenger and goods vehicles, 2009-2016

Survey location and Chainage (NH-8 and NH-4)	Passenger Vehicles	Goods Vehicles	Total Vehicles
MCC-3 Km 156+000, NH-8	9.7%	4.2%	6.4%
MCC-6 Km 198+000, NH-8	5.3%	5.1%	5.1%
MCC-7 Km 242+000, NH-8	5.8%	7.2%	6.7%
MCC-9 Km 297+000, NH-8	7.7%	10.0%	9.1%
MCC-10 Km 355+700, NH-8	11.8%	8.1%	9.8%
MCC-12 Km 390+000, NH-8	6.1%	3.3%	4.3%
MCC-13 Km 473+000, NH-8	8.1%	1.1%	4.1%
MCC-14 Km 494+500, NH-8	7.2%	2.8%	5.1%
MCC-16 KM 7+000, SH-42	7.5%	1.3%	5.0%
MCC-17 Km 130+000, NH-4	5.1%	8.1%	6.8%
MCC-20 Km 97+000, NH-4	0.9%	2.5%	1.8%

4.6 TRAFFIC FORECAST

Based on the observed traffic volumes in the year 2016, the estimated traffic of VME sections and competing road links have been revised. The traffic estimates for VME were carried out earlier by adopting toll rates for expressway 1.25 times that of NH toll rates. However, during the meetings held with NHAI in April 2017 it was discussed that the Base Toll Rates of Expressway are 1.25times that of NH toll rates. The effective toll rates of VME including the structures is 1.8times that of NH8. Hence, the traffic estimates for VME have been revised by considering higher toll rates. This has been resulted into lesser traffic being diverted on VME as compared to the previous traffic estimates. This section presents the methodology adopted to revise the estimated traffic, section wise revised traffic estimates and its capacity analysis.

4.6.1 Estimation of traffic revision factors

The AADT observed in the year 2016 has been compared with projected AADT of corresponding sections of NH-8 to study the difference in projected and actual traffic. Based on this, a conversion factor (ratio of new observed AADT and projected AADT of current year) has been calculated for each section of NH-8. This conversion factor has been applied to estimate the revised traffic of all sections of expressway.

The **Table 4.13** below presents, (a) the estimated traffic for year 2016 based on traffic studies conducted in year 2009, (b) observed traffic in year 2016, and (c) factor calculated, i.e. (b)/(a),for Phase IA.

Table 4.13: Comparison of forecast traffic with observed traffic for year 2016 for Phase IA

Section Name	Car	LGV	Bus & Mini Bus	2-Axle Truck	3-Axle Truck	MAV	Total
(a) Traffic Volume on NH-8, estimated for year 2016 (Vehicles/day) – Using 2009 Survey & Growth Factors							
MCC-3 Km 156+000, NH-8	13366	1937	2908	7403	8237	5941	**39,793**
MCC-6 Km 198+000, NH-8	13501	2036	3298	8631	9105	7027	**43,598**
MCC-7 Km 242+000, NH-8	13418	2089	3415	8906	9461	7520	**44,810**
(b) Traffic Volume on NH-8, observed in year 2016 (Vehicles/day) – Actual Survey in 2016							
MCC-3 Km 156+000, NH-8	15723	2848	1281	5944	5135	7157	**38,088**
MCC-6 Km 198+000, NH-8	6725	3245	2044	8626	8755	7463	**36,857**
MCC-7 Km 242+000, NH-8	17458	5978	1320	8774	8856	7345	**49,732**
(c) Factor for estimation of revised traffic (B/A)							
MCC-3 Km 156+000, NH-8	1.18	1.47	0.44	0.80	0.62	1.20	**-**
MCC-6 Km 198+000, NH-8	0.50	1.59	0.62	1.00	0.96	1.06	**-**
MCC-7 Km 242+000, NH-8	1.30	2.86	0.39	0.99	0.94	0.98	**-**

The factors given in the table above are multiplicative; hence factors >1 will increase the revised traffic whereas those <1 will reduce the estimated traffic of NH-8 and corresponding sections of expressway. The factors for cars are generally >1 or close to 1 (except Km 198+000). For buses and mini-buses the factors are <1 as the growth rates from year 2009 to 2016 are very low or even negative at some locations. Among goods vehicles the factors are >1 for light goods and multi-axle vehicles, whereas for 2-axle trucks the factors <1 match with negative growth observed. In 3-axle trucks the factors are close to 1.

At Km 198+000, the number of cars observed in year 2016 are half of the forecast made earlier in 2009. This is because of the ongoing construction of bridge over river Narmada as significant number of small vehicles are diverted to old bridge in the city of Bharuch. This traffic diversion shall be effective till completion of bridge construction works, hence the effective factor for cars at this location should be 1.0. It is also to be noted that higher multiplying factors for LGV (in the range of 1.5 to 2.9) will result into high number of LGVs for expressway sections. This may not be the actual case, as owing to shorter trip lengths by LGVs the actual diversion to expressway may be less. Hence, about 70% of LGV traffic revision factor has been adopted for estimation of expressway traffic. The factors adopted for estimation of revised traffic in 2016 on NH-8 are presented in **Table 4.14.**

Table 4.14: Traffic revision factors for NH-8 sections

NH-8 Sections		Car	LGV	Bus & Mini Bus	2-Axle Truck	3-Axle Truck	MAV
A	Vadodara – Bharuch, NH8	1.18	1.47	0.44	0.80	0.62	1.20
B	Bharuch – Kosamba, NH8	1.00	1.59	0.62	1.00	0.96	1.06

For expressway sections, the traffic revision factors have been adopted from corresponding or sections parallel to NH-8 as given in **Table 4.15.**

Table 4.15: Traffic revision factors for expressway sections

Expressway Sections (from/to chainage)			Correspon-ding NH-8 sections	Car	LGV	Bus & Mini Bus	2-Axle Truck	3-Axle Truck	MAV	Con-tainer
VM Expressway										
Section 8	254+430	287+385	B	1.00	1.12	0.62	1.00	0.96	1.06	1.06
Section 9	287+385	353+690	A	1.18	1.03	0.44	0.80	0.62	1.20	1.20
Section 10	353+690	374+355	A	1.18	1.03	0.44	0.80	0.62	1.20	1.20
Section 11	374+355	378+740	A	1.18	1.03	0.44	0.80	0.62	1.20	1.20

Using the traffic revision factors given above the present and then the future traffic estimates have been revised for Expressway sections as presented in the next sub-section.

4.6.2 Revised traffic for Expressway Sections (Phase IA)

The section wise revised traffic loadings (in terms of AADT) for expressway, based on traffic estimates originally obtained (in 2009) by regional transport demand model for various horizon years is shown in **Table 4.16** which presents the traffic corresponding to VME toll = 1.25times NH8 toll rate.

It is to be noted that the Base Toll Rates of Expressway are 1.25times that of NH toll rates. The effective **toll rates of VME** including the structures are **1.8times** that of **NH8.** Hence, the traffic estimates for VME have been revised by considering higher toll rates. This has been resulted into lesser traffic being diverted on VME as compared to the previous traffic estimates. The revised traffic estimate with higher toll rate on Expressway (i.e. 1.8times NH8 toll rates) is given in **Table 4.17.** The mode wise and section wise traffic for various horizon years are tabulated in **Annexure 4.4**.

It may be noted that, as

Explained in Chapter 1, one new interchange at km 323+087 has been introduced.

Table 4.16: Revised traffic for expressway sections for year 2021 (vehicles per day for VME toll = 1.25times NH toll)

Expressway Sections 2021			Car	LGV	Bus & Mini Bus	2-Axle Truck	3-Axle Truck	MAV	Container	Total
Section 9	254+430	287+385	15,417	2,674	1,573	6,880	8,346	3,711	3,055	**41,657**
Section 10	287+385	323+087	13,208	1,889	824	4,110	4,169	3,065	2,847	**30,111**
Section 10A	323+087	353+690	12,547	1,832	799	3,987	4,044	2,973	2,761	**28,944**
Section 11	353+690	374+355	11,103	1,447	774	3,975	3,819	3,246	2,868	**27,232**
Section 12	374+355	378+740	9,874	67	199	1,103	1,095	1,145	1,278	**14,762**

The final traffic for VME sections corresponding to toll rates of VME equivalent to 1.8times NH toll rates are given in **Table 4.17**.

Table 4.17: Revised traffic for expressway sections for year 2021 (vehicles per day for VME toll 1.8times NH toll)

Expressway Sections 2021			Car	LGV	Bus & Mini Bus	2-Axle Truck	3-Axle Truck	MAV	Container	Total
Section 9	254+430	287+385	8,141	1,403	798	3,478	4,217	1,871	1,544	**21,452**
Section 10	287+385	323+087	6,891	988	420	2,080	2,114	1,543	1,434	**15,469**
Section 10A	323+087	353+690	6,546	958	407	2,018	2,050	1,496	1,391	**14,867**
Section 11	353+690	374+355	5,825	765	394	2,011	1,937	1,633	1,444	**14,010**
Section 12	374+355	378+740	5,029	48	102	559	557	576	643	**7,514**

The estimated traffic of the Expressway sections for horizon years corresponding to the Expressway toll 1.8times NH notified toll rates is given in vehicles per day and PCU per day in **Table 4.18** and **Table 4.19** respectively.

Table 4.18: Revised traffic for expressway sections for horizon years (vehicles per day for VME toll 1.8times NH toll)

Expressway Sections			2021	2025	2030	2035	2045
Section 9	254+430	287+385	21,452	28,972	39,039	44,978	57,130
Section 10	287+385	323+087	15,469	20,766	27,956	32,458	42,094
Section 10A	323+087	353+690	14,867	19,941	26,839	31,157	40,393
Section 11	353+690	374+355	14,010	18,884	25,625	29,300	37,410
Section 12	374+355	378+740	7,514	10,217	13,763	15,540	20,053

Table 4.19: Revised traffic for expressway sections for horizon years (PCU per day for VME toll 1.8times NH toll)

Expressway Sections			2021	2025	2030	2035	2045
Section 9	254+430	287+385	50,453	64,833	86,226	98,426	1,22,795
Section 10	287+385	323+087	35,273	45,116	59,831	68,945	87,872
Section 10A	323+087	353+690	34,077	43,560	57,758	66,550	84,798
Section 11	353+690	374+355	33,534	42,811	56,901	64,794	81,572
Section 12	374+355	378+740	14,158	18,668	24,985	28,226	36,096

4.6.3 Capacity Analysis for Expressway Sections

For capacity and service volume of expressway, IRC SP: 99-2013 has been referred. The code specifies design service volume (at LOS-B) for plain and rolling terrain is 1300PCU/Hr/Lane. The design service volume in terms of PCU/day for expressways, as specified in the code mentioned above, is given in **Table 4.20.** As observed during primary traffic survey along the study corridor, peak hour proportion in daily traffic was just about 6.5%. Hence, the design service volume corresponding to peak hour proportion of 6% has been adopted here for calculation of volume-capacity ratio.

Table 4.20: Design Service Volumes for 4 lane, 6 lane and 8 lane Expressway (IRC:SP:99-2013)

Peak Hour Proportion	Design Service Volume (LOS B) in PCU/Day		
	4-lane	6-lane	8-lane
6%	86,000	1,30,000	1,73,000
8%	65,000	98,000	1,30,000

For high speed highways and expressways, it is desirable to maintain LOS 'B'. The Highway Capacity Manual (US, 2010) also suggests that, the ancillary infrastructure facilities of a freeway could even operate at LOS 'C' while the freeway itself should desirably maintain LOS 'B'.

Based on the above discussion and with reference to **Table 4.19 and Table 4.20**, it is recommended that,

- Section 8 (from Km 254+430 to Km 287+385) of proposed expressway should be improved to 8-lane facility from the opening year. All other sections should be built as 6-lane facility at the beginning.
- Section 9 to Section 11 (Km 287+385 to Km 378+740) should be widened to 8 lanes by year 2035. Although Section-11 does not require 8-lanes, owing to its short length of around 4km it is also recommended to be widened to 8-lanes so that the entire segment of expressway beyond Km 287+385 becomes consistent in lane configuration.

The recommended lane requirements for the expressway are shown in **Table 4.21**.

Table 4.21: Recommended lane requirement and capacity augmentation plan for VM Expressway

Section No.	Chainage (Km)		Lane requirements				
	Start	End	2020	2025	2030	2035	2045
Section 9	254+430	287+385	8-lane	8-lane	8-lane	8-lane	8-lane
Section 10	287+385	323+087	6-lane	6-lane	6-lane	8-lane	8-lane
Section 10A	323+087	353+690	6-lane	6-lane	6-lane	8-lane	8-lane
Section 11	353+690	374+355	6-lane	6-lane	6-lane	8-lane	8-lane
Section 12	374+355	378+740	6-lane	6-lane	6-lane	8-lane	8-lane

4.6.4 Traffic on Competing Road Network

The traffic flows of cars, buses, LGV, trucks and MAVs on the competing roads, mainly NH-8, has less volumes of such traffic in comparison to the proposed expressway. However, NH-8 will also have other traffic comprising of two wheelers, three wheelers and slow moving modes which will keep on plying on these national highways to satisfy their local travel needs. A tabular representation of the traffic flows on different sections of NH-8 for various horizon years is also given in **Table 4.22**, when expressway will be built**.**

Table 4.22: Estimated AADT (in PCUs) of Tollable Modes on Various Sections of Competing Roads (VME Toll = 1.8times NH8 toll)

Road Name (Sections)	2021	2025	2030	2035
NH-8 (Bharuch - Kosamba)	**83772**	**90593**	**103227**	**117675**
NH-8 (Vadodara – Bharuch)	**74685**	**79516**	**88225**	**98008**

Capacity Analysis of NH-8

Manual of specification and standards for four laning of highways (IRC SP 84: 2014) defines the threshold value of widening the highway from four laning to six laning as 60,000 PCUs per day at LOS 'C'. However, the manual does not provide a threshold value for further widening, in case of a National Highway, though similar values have been provided in the case of expressways in IRC SP 99: 2013.

Highway Capacity Manual (HCM) 2010, provides methodology to determine capacity for both freeways and multi-lane highways. While freeways are completely access controlled and matches with expressways in Indian context, multi-lane highways in HCM context, operates in restricted speed conditions and partial access control, which to a certain extent matches with the traffic operating conditions on NH-8. Therefore, capacity analysis of NH-8 has been done using the methodology provided in HCM-2010, for multilane highways.

V/C ratios were worked out for each section of the NH8 for horizon year 2025, and 2030 for six lane facility and the same are tabulated in **Table 4.23.**

Table 4.23: V/C Ratio for NH8 Sections with Expressway

Road Name (Sections)	2025	2030
NH-8 (Bharuch - Kosamba)	0.75	0.86
NH-8 (Vadodara – Bharuch)	0.66	0.74

It may be observed from the v/c ratio presented in Table 4.22 that all the sections of NH8 will cross LOS-C by year 2030. This is due to higher toll rate of VME which is causing more traffic to use NH8.

The NH-8 traffic in case of *'without expressway scenario'* has been estimated and given in **Table 4.24.** The traffic volume in sections of NH-8 between Vadodara and Mumbai clearly indicates the need of a parallel facility with high capacity as most of the sections of NH-8 are fast reaching or will have crossed the capacity (service volume at LOS E) of 6 lane NH (i.e. 120,000 PCU/day) in the period 2017 to 2020 itself.

Table 4.24: Estimated AADT (in PCUs) of Tollable Modes on Various Sections of Competing Roads without the Proposed Expressway

Road Name (Sections)	2017	2020	2025	2030	2035	2045
NH-8 (Vadodara – Bharuch)	93452	112131	142026	170136	196457	246298
NH-8 (Bharuch – Kosamba)	114795	136413	171323	204167	233175	289633
NH-8 (Kosamba – Surat)	121908	145153	182874	218065	249319	310236

The above analysis indicates that a substantial portion of the tollable traffic is expected to shift from NH-8 to the expressway, which find the usage of expressway beneficial than the existing roads in terms of saving of travel time and VOC. The mode wise traffic on various sections of NH-8 is presented in **Annexure 4.5 (A)** and **4.5 (B)** for "with" and "without expressway" scenarios respectively.

4.6.5 Traffic Estimates for Expressway Interchanges

The expressway has been provided with 14 interchanges for entry/exit to/from the expressway. List of Interchanges under Phase IA is given in **Table 4.25**.

Table 4.25: List of Main Expressway Interchanges (Phase IA)

Interchange		Intersecting / Merging Road		
ID	**Location (km)**	**Intersecting Road**	**West / North End**	**East / South End**
I-9	254+430	NH 8	NH 8 towards Ahmedabad	NH8 towards Mumbai
I-10	287+385	SH 6	Dahej	Bharuch on NH 8
I-10A	323+087	SH 161	Amod	Karjan
I-11	353+690	SH 6	Padra	Vadodara on NH8
I-12	374+355	NH 8	NH 8 towards Ahmedabad	NH8 towards Mumbai
I-13	378+740	NE 1	NE 1 towards Ahmedabad	NE 1 towards Vadodara

The revised future traffic for each interchange in terms of ramp traffic is given in **Table 4.26.**

Table 4.26: Interchange Ramp Traffic (AADT in PCU)

Interchange & Chainage	Ramp No	Description	2025	2030	2035	2045
Interchanges on V-M Expressway						
Int. 9	I9EMRL	From Mumbai (VME) to Surat & Ankleshwar (NH-8)	2,339	2,878	3,366	4,180
(254+430)	I9EVRL	From Vadodara (VME) to Surat &Ankleshwar(NH-8)	7,801	9,284	10,248	12,150
	I9HRLM	From Surat & Ankleshwar (NH-8) to Mumbai (VME)	2,849	3,473	4,104	5,169
	I9HRLV	From Surat &Ankleshwar (NH-8) to Vadodara (VME)	3,317	4,029	4,384	5,052
Int. 10 (287+385)	I10EML	From Mumbai (VME) To Dahej (SH-6)	2,039	2,642	2,610	2,560
	I10EMR	From Mumbai (VME) To Bharuch (SH-6)	5,315	6,321	7,410	9,593
	I10EVL	From Vadodara (VME) To Dahej (SH-6)	*TNA**	*TNA**	*TNA**	*TNA**
	I10EVR	From Vadodara (VME) To Bharuch (SH-6)	980	1,217	1,464	1,919
	I10HLM	From Dahej (SH-6) To Mumbai (VME)	3,215	3,961	3,893	3,846
	I10HLV	From Dahej (SH-6) To Vadodara (VME)	*TNA**	*TNA**	*TNA**	*TNA**
	I10HRM	From Bharuch (SH-6) To Mumbai (VME)	6,905	8,054	9,191	11,460
	I10HRV	From Bharuch (SH-6) To Vadodara (VME)	740	876	1,025	1,316
Int. 10A (323+087	I10A EMRL	From Mumbai (VME) to Amod and Karjan (SH161)	1,899	2,283	2,612	3,227
	I10A EVRL	From Vadodara (VEM) to Amod and Karjan	655	794	839	941
	I10A HRLM	From Karjan and Amod (SH161) to Mumbai (VME)	1,996	2,330	2,631	3,197
	I10A HRLV	From Karjan and Amod (SH161) to Vadodara (VME)	792	971	1,004	1,078
Int. 11 (353+690)	I11EML	From Mumbai (VME) To Padra (SH-6)	*TNA**	*TNA**	*TNA**	*TNA**
	I11EMR	From Mumbai (VME) To Vadodara (SH-6)	2,088	2,511	2,873	3,550

Interchange & Chainage	Ramp No	Description	2025	2030	2035	2045
	I11EVRL	From Ahmedabad (VME) To Vadodara (SH-6)	720	873	922	1,035
	I11HRM	From Vadodara (SH-6) To Mumbai (VME)	2,195	2,563	2,894	3,516
	I11HLM	From Padra (SH-6) To Mumbai (VME)	*TNA**	*TNA**	*TNA**	*TNA**
	I11HLV	From Padra (SH-6) To Ahmedabad (VME)	871	1,068	1,104	1,185
	I11HRV	From Vadodara (SH-6) To Ahmedabad (VME)	*TNA**	*TNA**	*TNA**	*TNA**
Int. 12 (374+355)	I12EML	From Mumbai (VME) To Ahmedabad (NH-8)	12,165	14,213	16,063	19,707
	I12EMR	From Mumbai (VME) To Vadodara (NH-8)	0	0	0	0
	I12HLM	From Ahmedabad (NH-8) To Mumbai(VME)	14,475	16,754	18,828	22,980
	I12HRM	From Vadodara (NH-8) to Mumbai (VME)	*TNA**	*TNA**	*TNA**	*TNA**
Int. 13 (378+740)	I13EML	From Mumbai (VME) To Ahmedabad (AVE)	10,546	12,928	14,942	18,929
	I13EMR	From Mumbai (VME) To Vadodara (AVE)	*TNA**	*TNA**	*TNA**	*TNA**
	I13HLM	From Ahmedabad(AVE) To Mumbai (VME)	10,776	13,385	15,833	20,807
	I13HRM	From Vadodara (AVE) To Mumbai (VME)	*TNA**	*TNA**	*TNA**	*TNA**

**TNA: Ramps or loops where no turning traffic could be predicted by RTDM, as it is only a macro level model and locally generated traffic may not be completely represented.*

Based on the ramp and loop traffic in the interchanges, the toll lane requirements in accordance with the closed system of tolling are estimated using the traffic arrival and service rates adopted. The Tolling Strategy and toll lane requirements are given separately in **Chapter 13**.

4.7 CONCLUSION

The traffic estimates on Vadodara – Mumbai Expressway have been obtained by assignment of horizon year transport demand on the horizon year networks based on traffic surveys conducted in year 2009 and transport demand model updated in year 2012. The traffic forecasts have now been revised, using a factorization method, by comparing estimated traffic (forecast made earlier) for year 2016 with actual traffic observed on NH-8 sections by conducting surveys in Feb-March 2016.

The traffic on the expressway will mostly comprise of diverted traffic from the competing road network. The expressway traffic has been obtained at sectional levels where a section represents the length of the expressway between any two adjacent interchanges proposed on this facility. A total of 6 interchanges have been planned on Phase IA of expressway to facilitate the accessibility of various localities, cities and industrial hubs located all along the expressway.

The capacity and level of service analysis shows that a few sections of six-lane Expressway will approach LOS ‘C’ by year 2030, and by year 2035 a few more sections will also approach LOS ‘C’. Hence, it is recommended that section 8 (from Km 254+430 to Km 287+385) shall be built as eight lane facility from the opening year itself, and section 10 to section 12 (Km 287+385 to Km 378+740) shall be improved to 8 lanes by year 2035.

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TOPOGRAPHIC SURVEY

5

5. TOPOGRAPHICAL SURVEY

5.1 INTRODUCTION

M/s Intercontinental Consultants & Technocrats Pvt. Ltd. (ICT), New Delhi, has been assigned to carry out the Topographical Survey required for preparation of Detailed Design Report through an identified corridor for proposed Vadodara-Mumbai Expressway including spur alignment to be executed as BOT (Toll) project in the states of Gujarat and Maharashtra and UT of Dadra & Nagar Haveli.

5.2 SCOPE OF WORK

The scope of services includes detailed topographic survey of the alignment to be carried out using total station and GPS and produce data in both electronic format (in X, Y, Z coordinate system) and hard copies and prepared plans, longitudinal sections and cross-sections to the scale prescribed in IRC/MoRT&H standards. Detailed topographical survey shall include all natural and manmade features within the specified corridor.

This report covers the technical aspects of establishment of control framework and subsequent detailed Topographical Surveys carried out.

5.3 OBJECTIVE

The basic objective of topographical survey is to pick up X, Y, Z coordinates of all ground features along the alignment within the specified corridor so as to have digital terrain model of the surveyed corridor for preparation of strip plan and design Vadodara-Mumbai Expressway to facilitate high speed travel in this corridor.

5.4 AVAILABLE MAPS AND DATA

The following maps and data are made available by the NHAI:

I. The centerline coordinates of the identified corridor of the main Vadodara Mumbai expressway alignment in UTM coordinate system. However, the spur alignment was completely conceived, reconnoitered, improved and finalized by ICT in consultation with various concerned organizations and NHAI

II. CARTO SAT 1 Satellite Image of the area covering the alignment

III. Survey of India topographical maps of the area on scale 1:50000

IV. 10 Numbers GTS BM data purchased from Survey of India by ICT through NHAI

5.5 GENERAL TERRAIN

The main Vadodara Mumbai expressway alignment passes through the plain green field areas of coastal Gujarat, Dadra & Nagar Haveli and Maharashtra. It passes through five districts in Gujarat viz. the districts of Vadodara, Bharuch, Surat, Navsari and Valsad. Alignment also passes through the rolling terrain of district Thane in Maharashtra. The spur alignment emanates from outer vicinity of Virar (chainage 26+320 of the main alignment) and passes through northern outers of Ganeshpuri, Bhiwandi, Kalyan, Ulhas Nagar, MIDC and pierces through Matheran Hills by a Tunnel and ends at NH4B at Panvel traversing a length of about 94 kilometers.

5.6 IDENTIFICATION OF PROPOSED ALIGNMENT

The proposed alignment of main expressway and spur alignment was traced on ground with the help of navigational GPS based on UTM coordinates of the alignment at regular interval of 50/100 meters. This alignment was draped on the Google image to identify important land marks such as towns, villages and cross roads. Based on Google image, a route plan was prepared to approach the alignment from different places broadly from NH8 and also from other cross roads. The proposed alignment with chainage was loaded on navigational GPS units. The preliminary reconnaissance survey team used these GPS units to identify the proposed alignment on the ground and traced the actual track to lead to different points on the alignment and marked these tracks on the route plans to facilitate easy access to the alignment by other teams. Location and crossing of the proposed expressway alignment on all existing roads/tracks was marked on the road with paint showing directions of the alignment.

5.7 METHODOLOGY FOR TOPOGRAPHICAL SURVEY

The complete methodology adopted for conducting topographical survey for the project alignment comprises of the following activities.

5.8 ESTABLISHMENT OF MAIN CONTROL BY GPS

In principle it was planned to establish permanent GPS control on all intersecting roads, tracks, canals etc. to have the pairs of main control point every 1 to 2 kilometer apart along the entire proposed alignment.

(a) Fixing of GPS Control Pillars

Keeping in view the importance and stability of control points, RCC pillars of specified dimensions (20cm x 20cm base, 45cm high with 15cm x 15cm top surface) and structural designs were got pre-casted. After proper curing, these pre cast RCC pillars with an iron nail at center of each pillar were fixed in ground projecting about 15 cm above ground level. The balance 30cm was embedded in ground with concrete cement layer all around to ascertain stability of the pillars. The top projected part of the pillar was painted yellow. All pillars were uniquely numbered representing the approximate chainage of the proposed alignment with red paint. The locations of pillars were arranged in such a way that twin inter-visible pillars about 200-250m apart are available at an interval of every 2 km on almost all intersecting roads / tracks/ canals along the entire alignment. The location of the alignment intersection with the roads/tracks was identified with the help of navigational hand held GPS sets. Pair of twin GPS pillars has the advantage that every 2 km stretch can be independently used for starting and closing the traverse and topographical survey without affecting other part of the alignment and that helps control propagation of errors.

The location of the pillars was suitably chosen at locations where the proposed expressway alignment crossed the existing roads/tracks/canals etc. and as far as possible near the proposed ROW so that it is not disturbed during construction. Also the site was selected in an open area so that the signals from the satellite are received from all around above 15-degree altitude from the horizon.

(b) GPS Observations

Keeping in view the length of the alignment and subsequent propagation of observational errors in the process of fixing GPS control for the main alignment, the start point of the GPS observations was chosen midway of the alignment at approximate chainage of KM190. For the purpose of fixing starting control point to the best possible absolute accuracy, continuous GPS observations were taken

at GPS190 midway of the alignment for a period of about 6 hours. Based on this long observation, the coordinates of GPS190 were computed in "single point positioning" mode. Accepting GPS190 as the fixed point, the other points were observed in continuity in both directions. One team of two surveyors proceeded towards Vadodara end of the alignment with 2 DGPS receivers and similarly another team of two surveyors with 2 DGPS receivers headed towards Mumbai end of the alignment. GPS observations were carried out in continuation of the observations carried out at GPS190 for a period of 15 minutes to 45 minutes depending upon the length of measured Base Line. Two GPS receivers were used for recording simultaneous satellite signals at both ends of the base line. Observations recorded in common time by both the receivers were used for measurement of the base line. Observations were taken on all GPS control pillars using two receivers in a Leap-Frog manner using dual frequency Leica GPS receivers and computed in "base line" mode to get precise geodetic coordinates of all the GPS pillars fixed along the alignment. GPS field observations were downloaded to the computer everyday and the data was processed using Leica Geo Office Software to get latitude and longitude of the control points. These latitude and longitude values were suitably projected on Universal Transverse Mercator Projection Zone 43 to get X and Y Grid Coordinates which were used for subsequent detailed topographical survey.

The GPS control established for main expressway alignment was extended to provide GPS control for spur alignment also which basically emanates from control point GPS20A on the main alignment. Coordinates of GPS20A were used as base coordinates for the series of GPS control points established for the spur alignment of 94 kilometer length.

Following are the specifications of the GPS instrument used for providing main control for the project surveys.

GPS Set: LEICA 1230

Sensor : GX 1230

Antenna: AX 1202

Controller: RX 1210

Planimetric accuracy of GPS control points (baseline): 5mm +0.5 ppm

List of spherical coordinates of GPS Control Points is given in **Annexure 5.1** and list of UTM grid coordinates of the same GPS control points is given in **Annexure 5.2**.

5.9 ESTABLISHMENT OF SUBSIDIARY CONTROL BY GPS / TOTAL STATION

To cover up the gaps between two consecutive pair of GPS control Points, temporary control points were fixed using pegs/nails at an interval of 100m to 200m. The X and Y grid coordinates of these Bench Marks pillars were fixed by Total Station traverse and the levels were fixed with the help of levelling. This is a green filed alignment and it was not possible to fix pillars in private land at closer interval hence all subsidiary control points were fixed temporarily to carryout detailed topography with Total Station.

5.10 ESTABLISHMENT OF HEIGHT CONTROL BY AUTO LEVEL

Since the elevations (ellipsoidal heights as obtained by GPS observations) are not accurate and cannot be used to provide height control for the highway projects. Therefore, the elevations (Z value) of all the GPS control pillars were established by carrying out differential levelling from one GTS Benchmark to