3. STUDY AREA

3.1 GENERAL

The study area was the city of Varanasi in the state of Uttar Pradesh in the Indian union. Varanasi is believed to be one of the oldest cities in continuous habitation in human history dating back to more than 3000 years. It lies between the 25°15'N to 25°22' N latitudes and 82°57'E to 83°01'E longitudes. The river Ganga only here flows in a South-to-North direction, having the world famous Ghats on the left bank of the river. The environment of the city is tropical with temperature ranging from 5°C in winter to 45°C in summer. The mean annual rainfall lies between 680 mm to 1500 mm with a large proportion of its occurring during the months of July to September. Varanasi is densely populated and has a concoction of old and new habitats, but in general, it appears to be solicitude of a spiritual city that has been nurturing a fine blend of all major human faiths since ages. Its ancient buildings have stood since ages, but the roads are unable to support the exponentially growing traffic of around 10% per annum, since last two decades. Being a place of tourist attraction, educational, cultural and medical hub, this ancient city is facing huge challenges in trying to keep pace with present and future requirements of modern development, particularly in terms of road infrastructure. The arterial roads are narrow and remain congested almost throughout the day. During peak flow periods, the traffic literally crawls or stands still for fairly long durations in the tenure of a traffic jam. Traffic congestion has been a common scene in most parts of the old city for a fairly reasonable time in the recent past. Vehicles like 2-wheelers, 3-wheelers, and other slow-moving modes viz. rickshaws form bulk of the traffic, which reminiscences the traffic composition of developing economies of South-East Asian countries.

3.1 STUDY LOCATIONS

In order to conduct the present study with the stated objectives, a total of 19 intersections were selected based on the reason that they witness traffic jam during morning and evening peak flow periods while remaining congested for the overwhelming tenure of the day. The selected intersections were spread centrally over the old city landscape as shown in Figure 3.1. For the sake of simplicity, a key plan is shown in Figure 3.2. Details of the respective legs of the intersection considered for data collection are shown in Table 3.1. Identification of data collection sites at a distance of 25m away from the intersection of the deceleration lane are shown in Figure 3.3 to Figure 3.21.

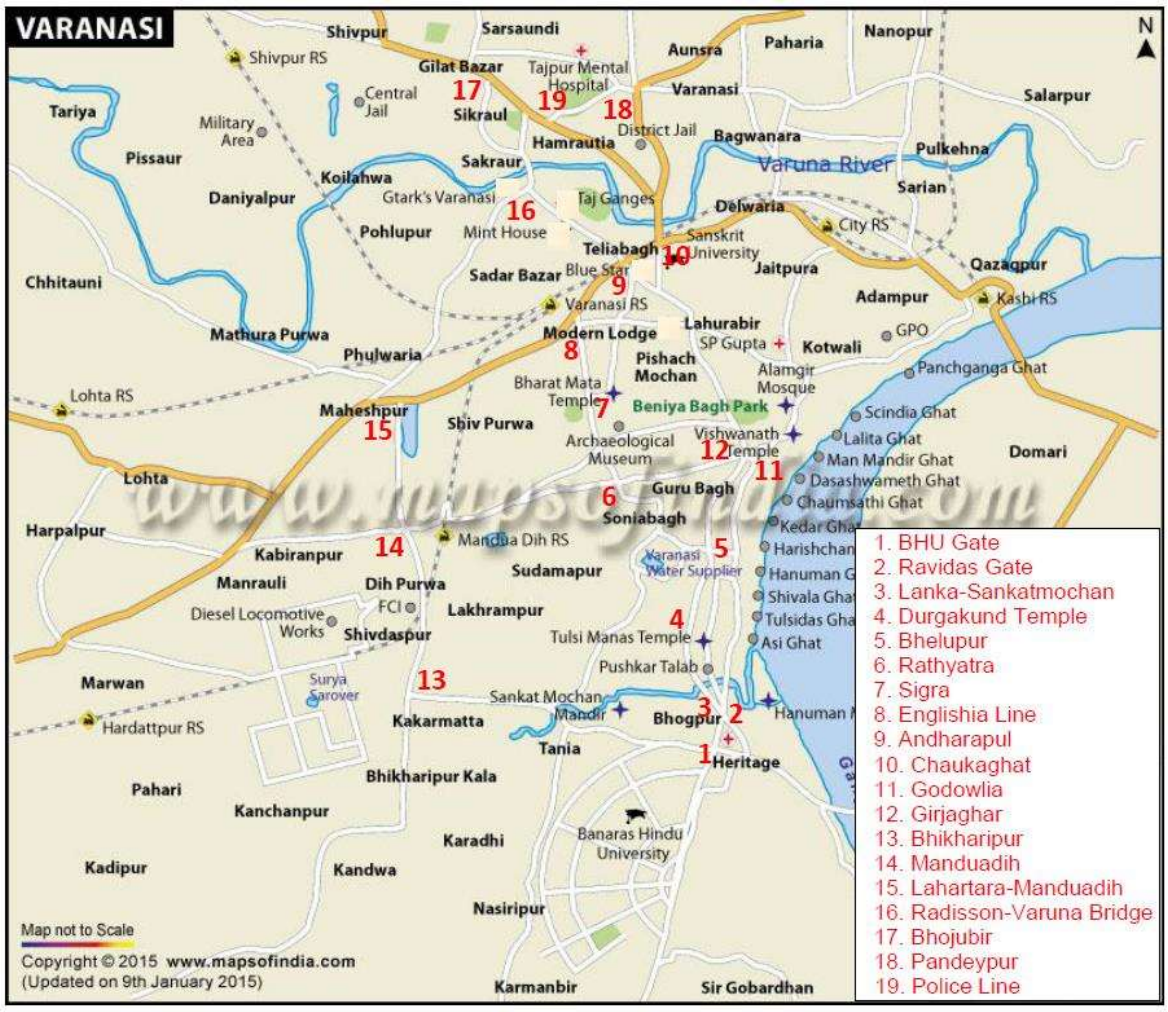


Figure 3.1. Varanasi city map showing selected intersections for study

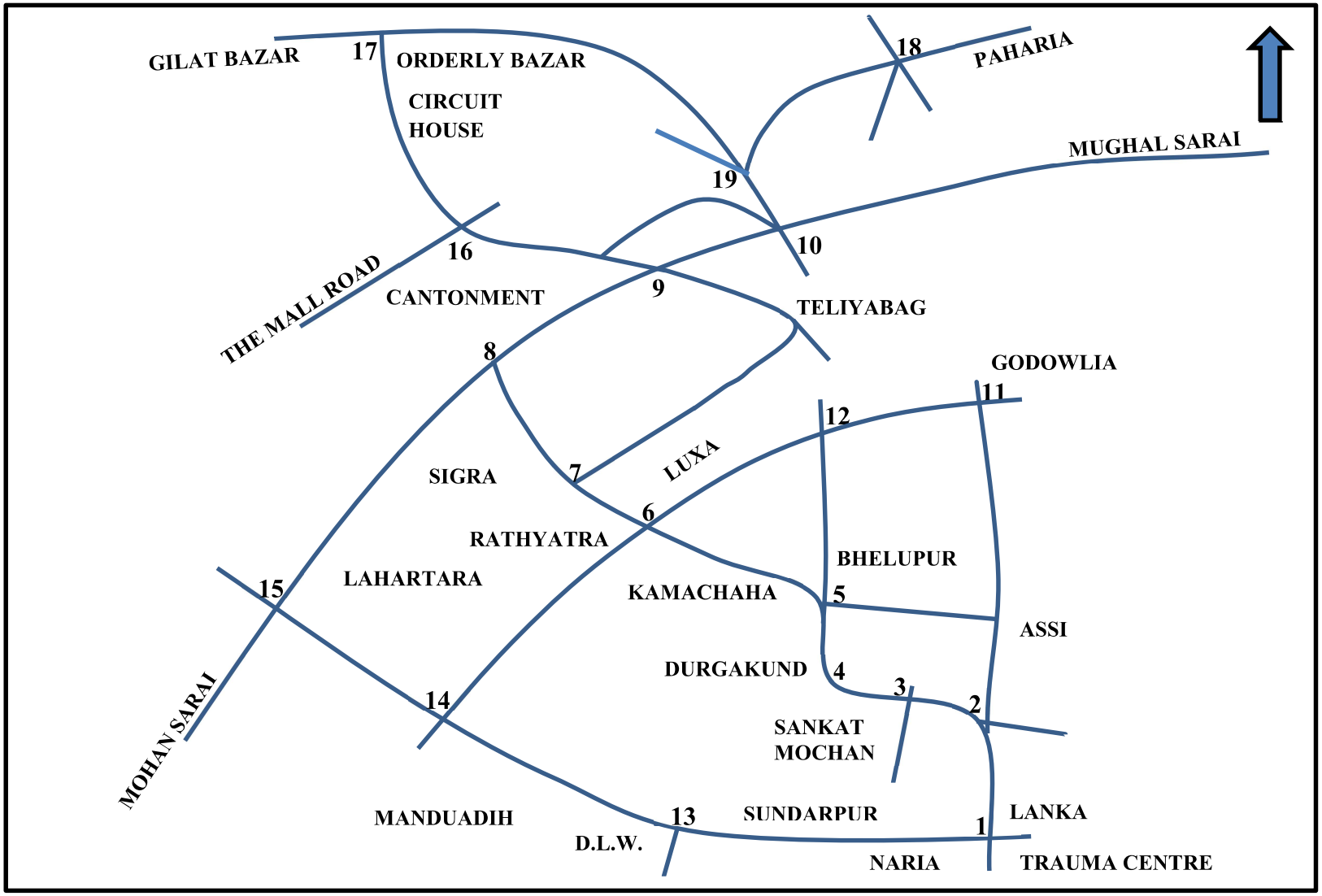


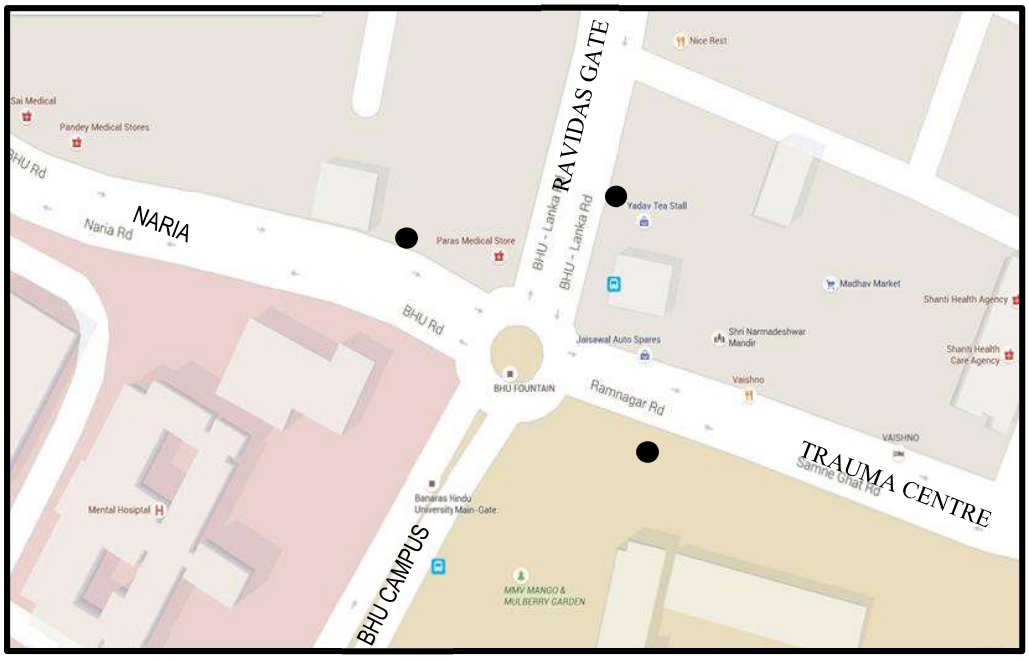
Figure 3.2. Key plan of selected intersections for study (not to scale)

Table 3.1. Details of selected intersections and respective legs for data collection

Sl. No.	Intersection	Leg of intersection for study on deceleration lane
1.	BHU Gate	a) Towards Naria b) Towards Ravidas Gate c) Towards Trauma Centre
2.	Ravidas Gate	a) Towards Assi b) Towards BHU c) Towards Durgakund d) Towards Lanka Thana
3.	Lanka-Sankatmochan Temple	a) Towards Durgakund b) Towards Ravidas Gate c) Towards Sankatmochan Temple
4.	Durgakund Temple	a) Towards Bhelupur b) Towards Ravidas Gate
5.	Bhelupur	a) Towards Assi b) Towards Durgakund c) Towards Kamachcha d) Towards Ramapura
6.	Rathyatra	a) Towards Kamachcha b) Towards Mahmoorganj c) Towards Sigra
7.	Sigra	a) Towards Englishia Line b) Towards Teliyabag c) Towards Rathyatra
8.	Englishia Line	a) Towards Andharapul b) Towards Lahartara c) Towards Sigra
9.	Andharapul	a) Towards Chaukaghat b) Towards Englishia Line c) Towards Nadesar d) Towards Teliyabag
10.	Chaukaghat	a) Towards Andharapul b) Towards City Railway Station c) Towards Maqbool Alam Road d) Towards Nadesar e) Towards Teliyabag
11.	Godowlia	a) Towards Girjaghar b) Towards Lanka

12.	Girjaghar	a) Towards Godowlia b) Towards Lahurabir c) Towards Luxa d) Towards Ramapura
13.	Bhikharipur	a) Towards Chitaipur b) Towards DLW c) Towards Sundarpur
14.	Manduadih	a) Towards DLW b) Towards Lahartara c) Towards Mahmoorganj d) Towards Manduadih Police Station
15.	Lahartara-Manduadih	a) Towards Cantt. Railway Station b) Towards Manduadih c) Towards Mohan Sarai
16.	Radisson-Varuna Bridge	a) Towards PWD Office b) Towards The Mall Road c) Towards TV Tower
17.	Bhojubir	a) Towards Bhojubir b) Towards Circuit House c) Towards Orderly Bazar
18.	Pandeypur	a) Towards Hakul Ganj b) Towards Khajuri c) Towards Lalpur d) Towards Paharia e) Towards Police Line
19.	Police Line	a) Towards Kuchhary b) Towards Maqbool Alam Road c) Towards Orderly Bazar d) Towards Pandeypur

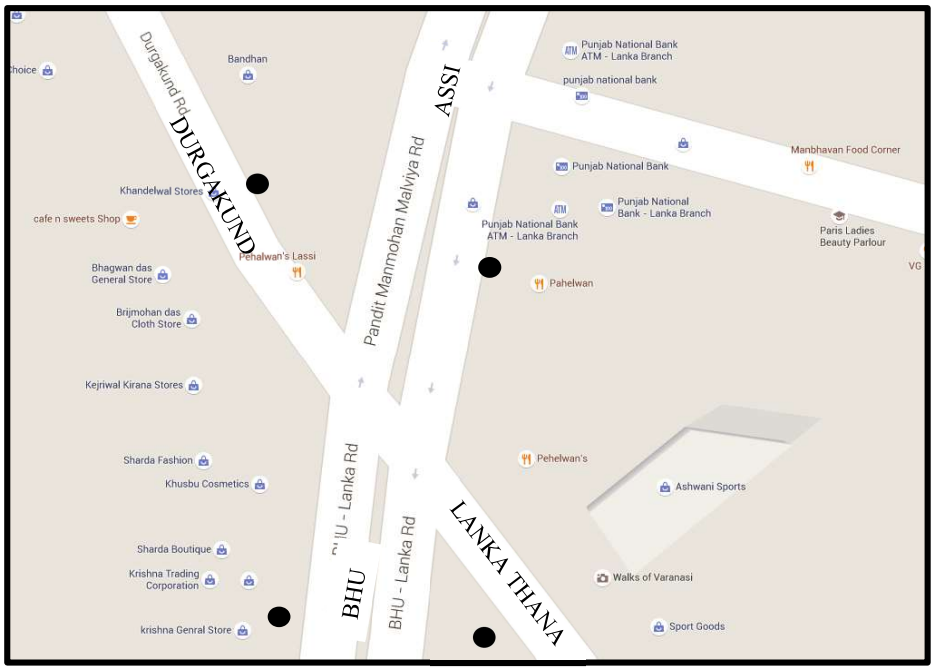
(a)



(b)

Figure 3.3. Location of data collection sites [●] at BHU gate intersection

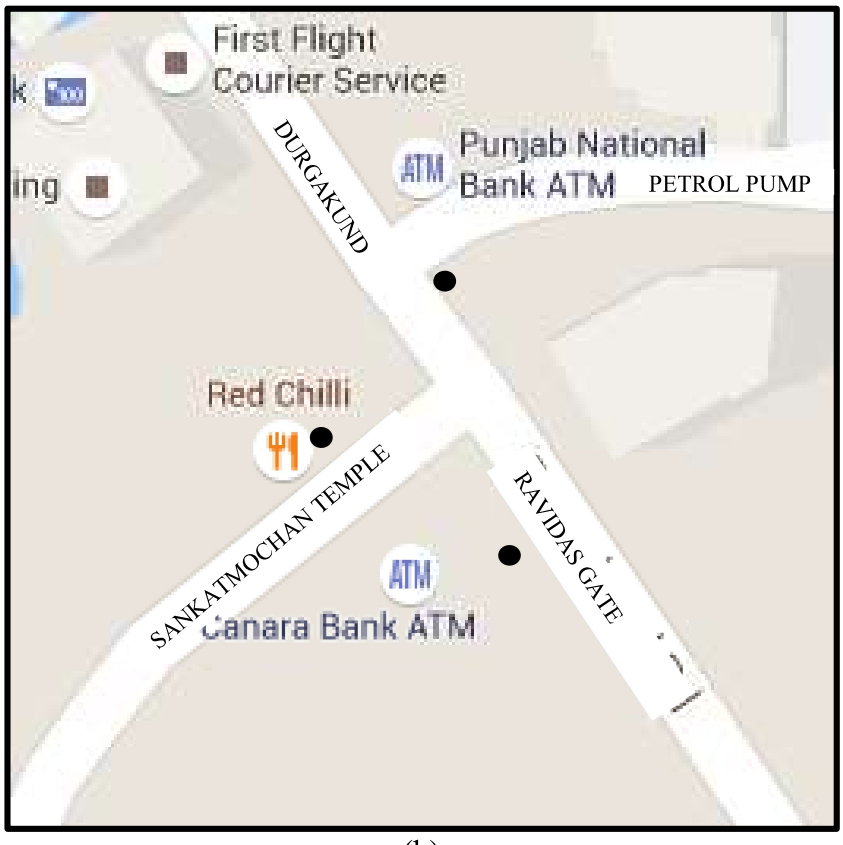
(a)



(b)

Figure 3.4. Location of data collection sites [●] at Ravidas gate intersection

(a)



(b)

Figure 3.5. Location of data collection sites [●] at Lanka-Sankatmochan intersection

(a)

(b)

Figure 3.6. Location of data collection sites [●] at Durgakund temple intersection

(a)

(b)

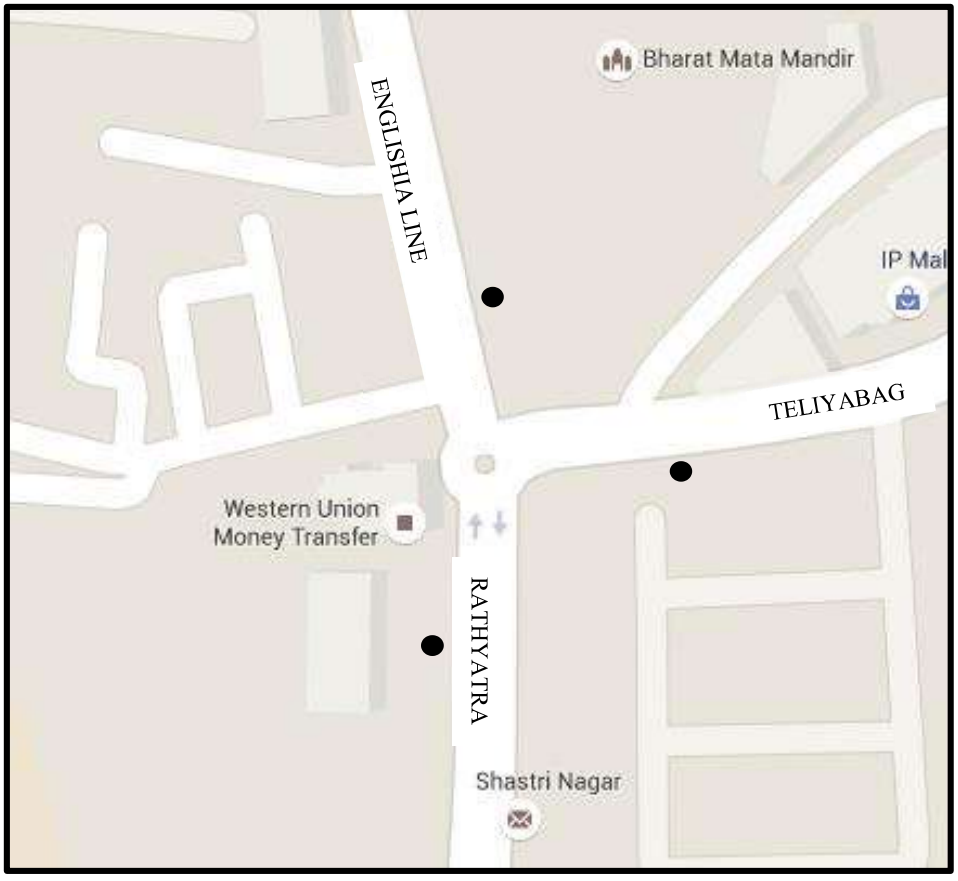
Figure 3.7. Location of data collection sites [●] at Bhelupur intersection

(a)

(b)

Figure 3.8. Location of data collection sites [●] at Rathyatra intersection

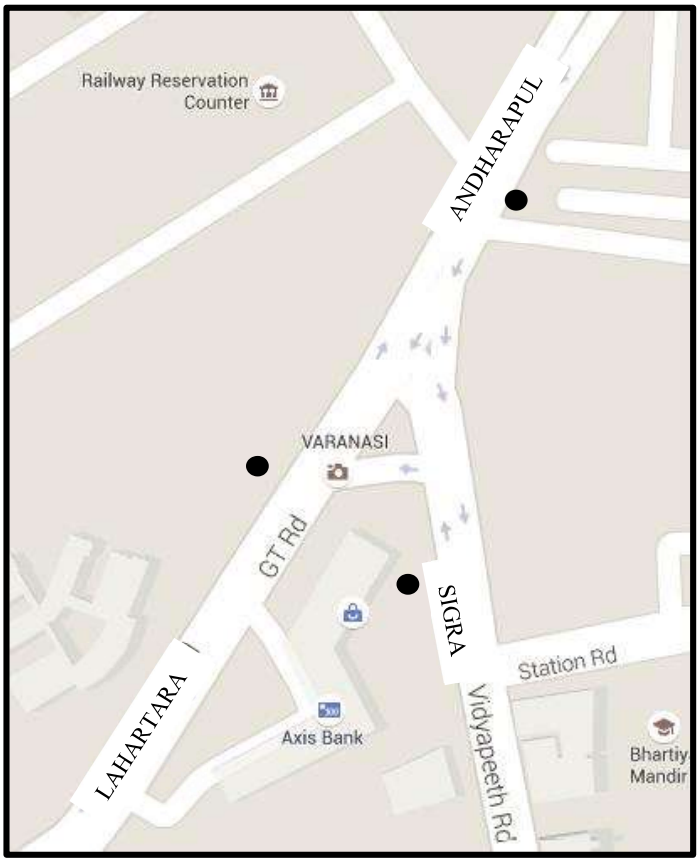
(a)



(b)

Figure 3.9. Location of data collection sites [●] at Sigra intersection

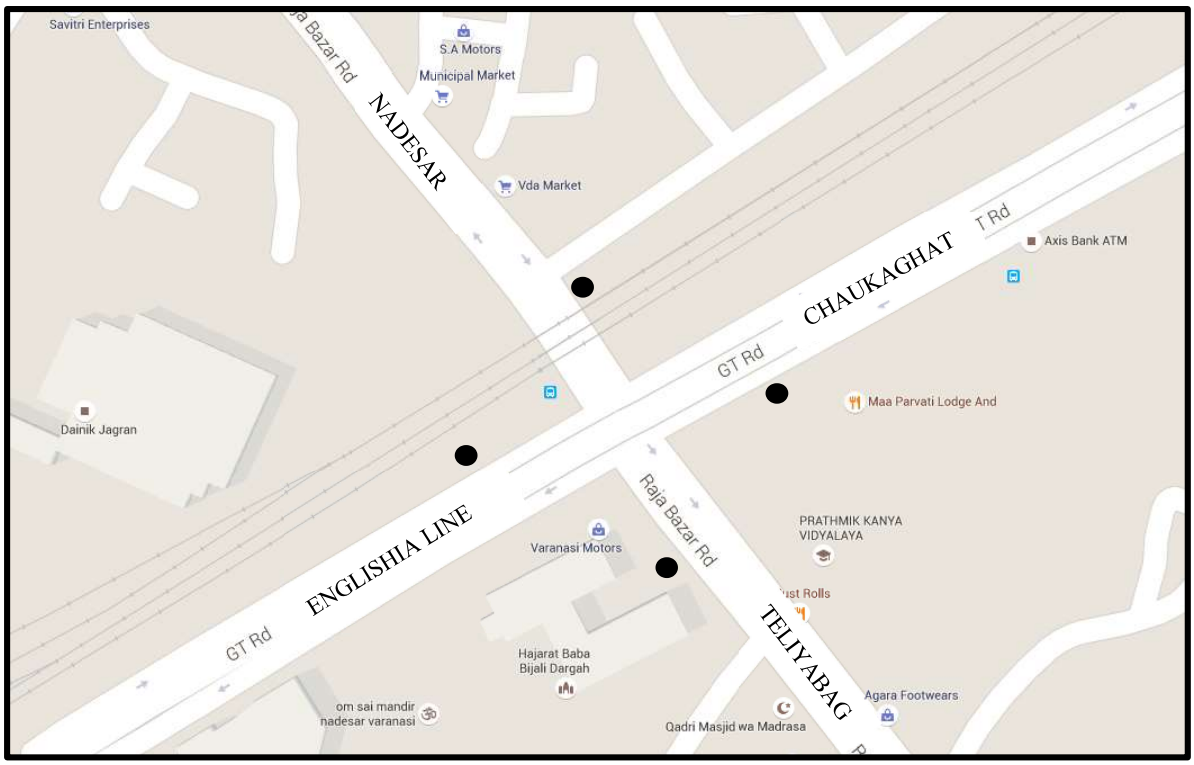
(a)



(b)

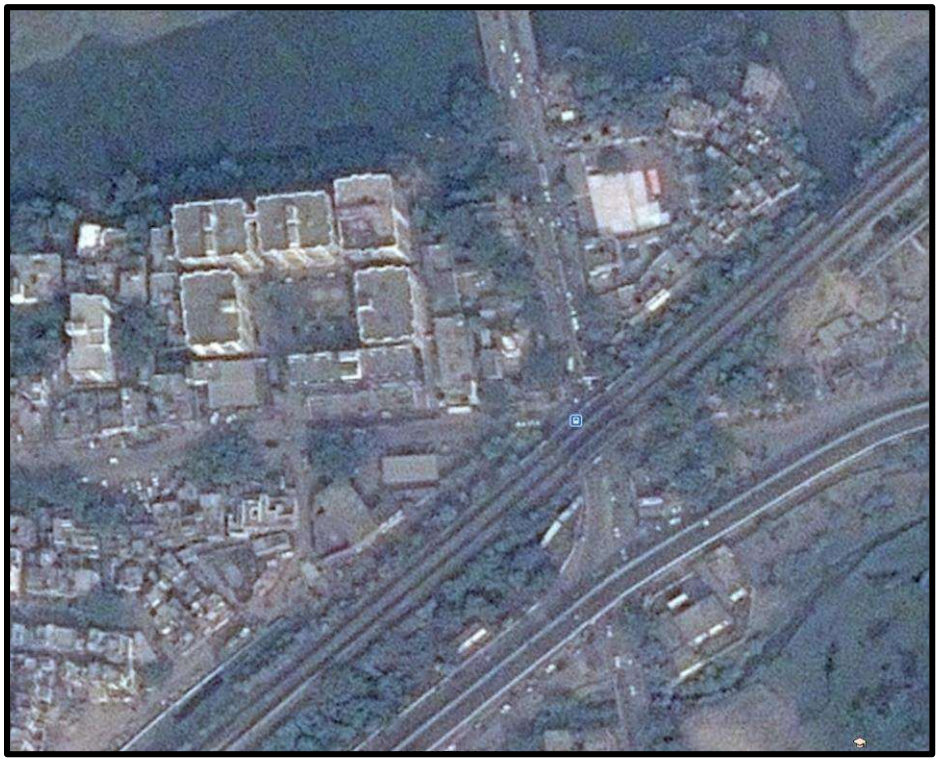
Figure 3.10. Location of data collection sites [●] at Englishia Line intersection

(a)



(b)

Figure 3.11. Location of data collection sites [●] at Andharapul intersection



(a)

(b)

Figure 3.12. Location of data collection sites [●] at Chaukaghat intersection

(a)

(b)

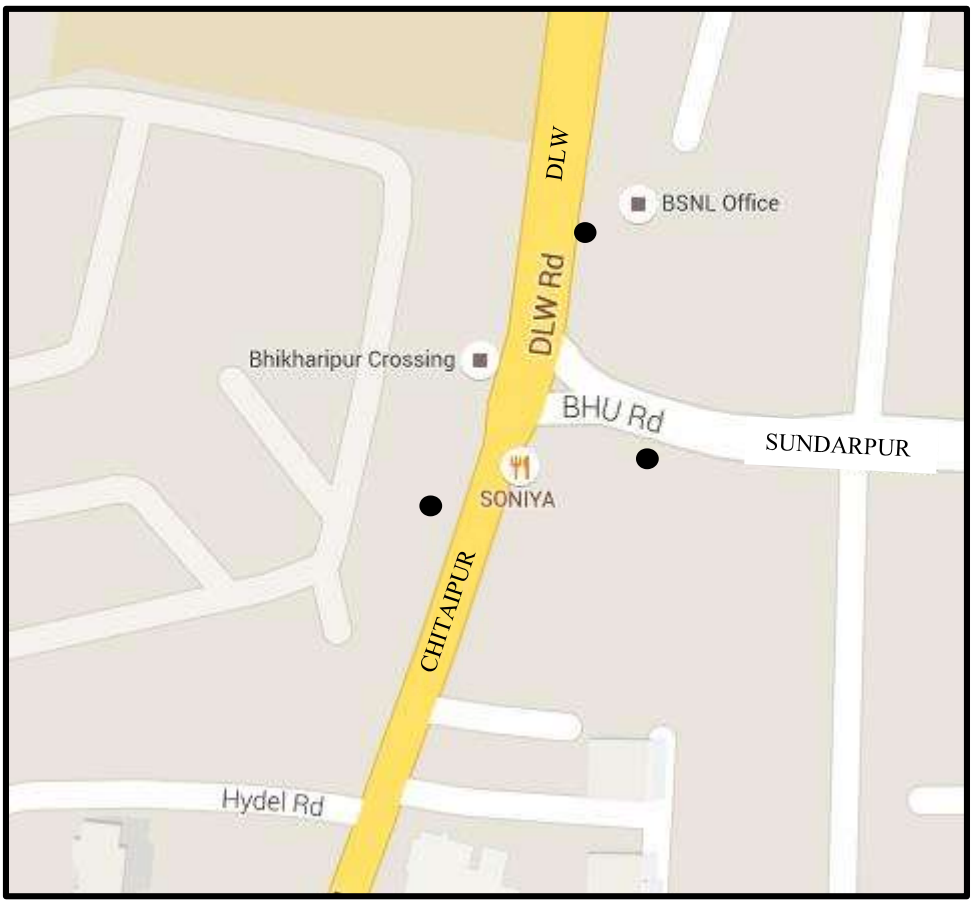
Figure 3.13. Location of data collection sites [●] at Godowlia intersection

(a)

(b)

Figure 3.14. Location of data collection sites [●] at Girjaghar intersection

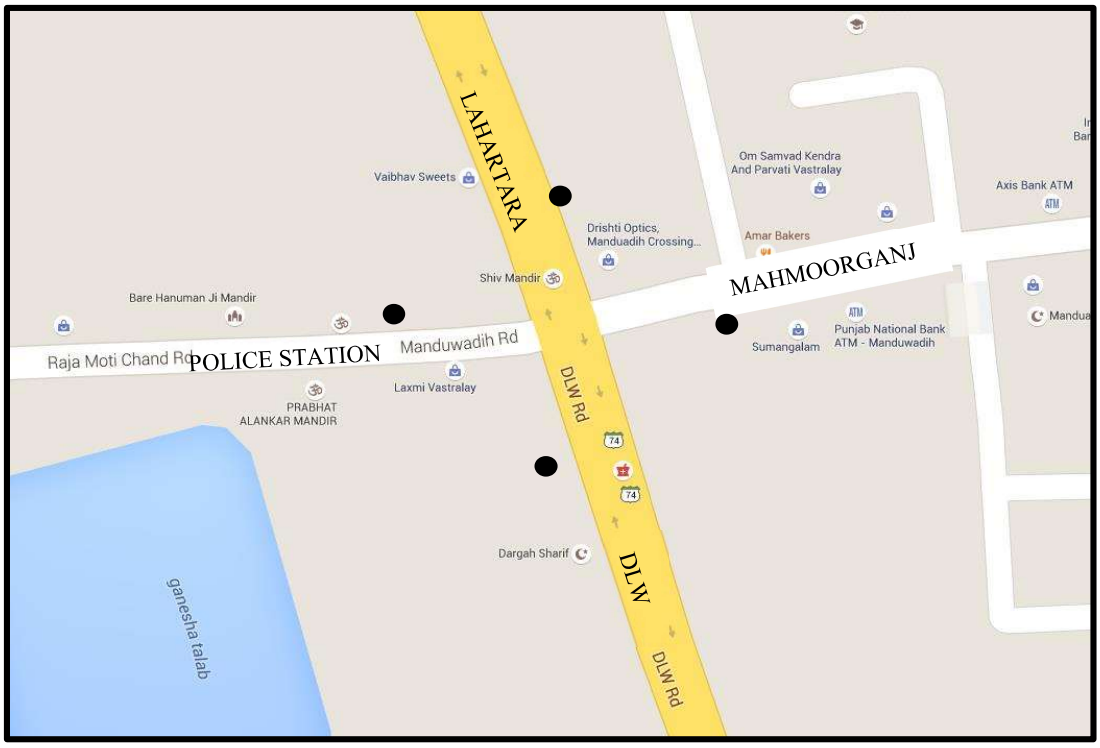
(a)



(b)

Figure 3.15. Location of data collection sites [●] at Bhikharipur intersection

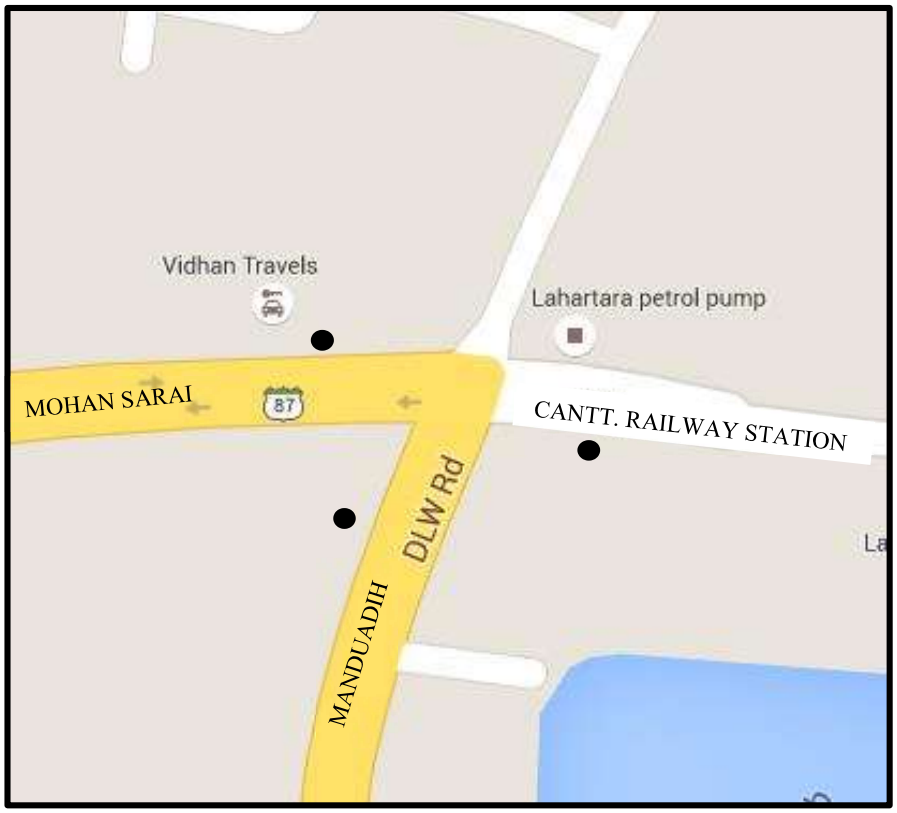
(a)



(b)

Figure 3.16. Location of data collection sites [●] at Manduadih intersection

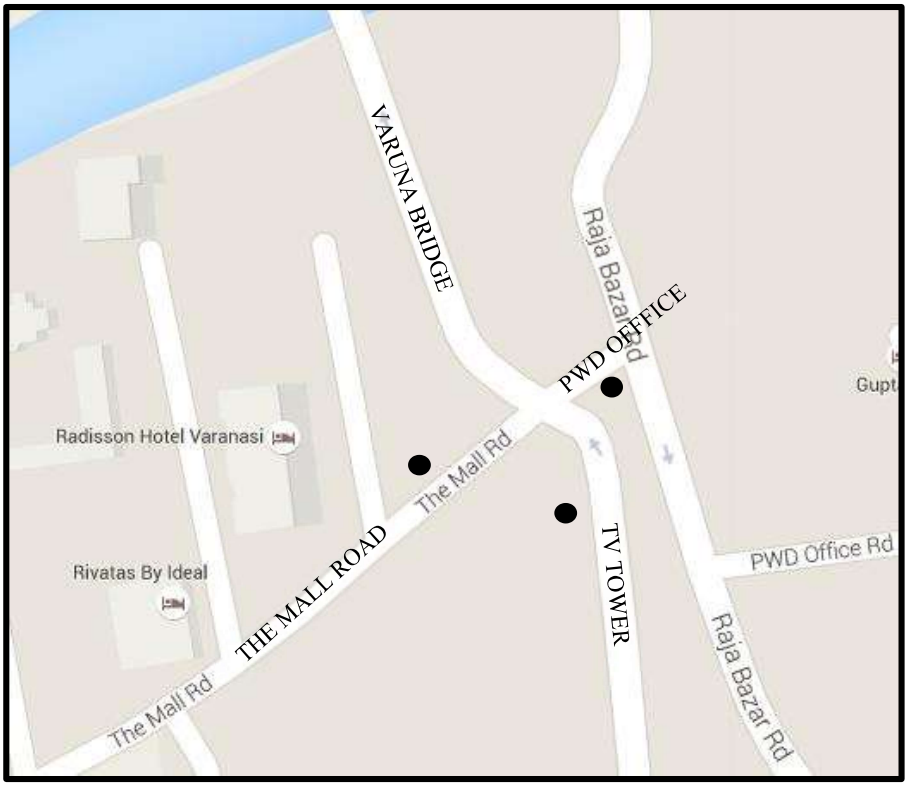
(a)



(b)

Figure 3.17. Location of data collection sites [●] at Lahartara-Manduadih intersection

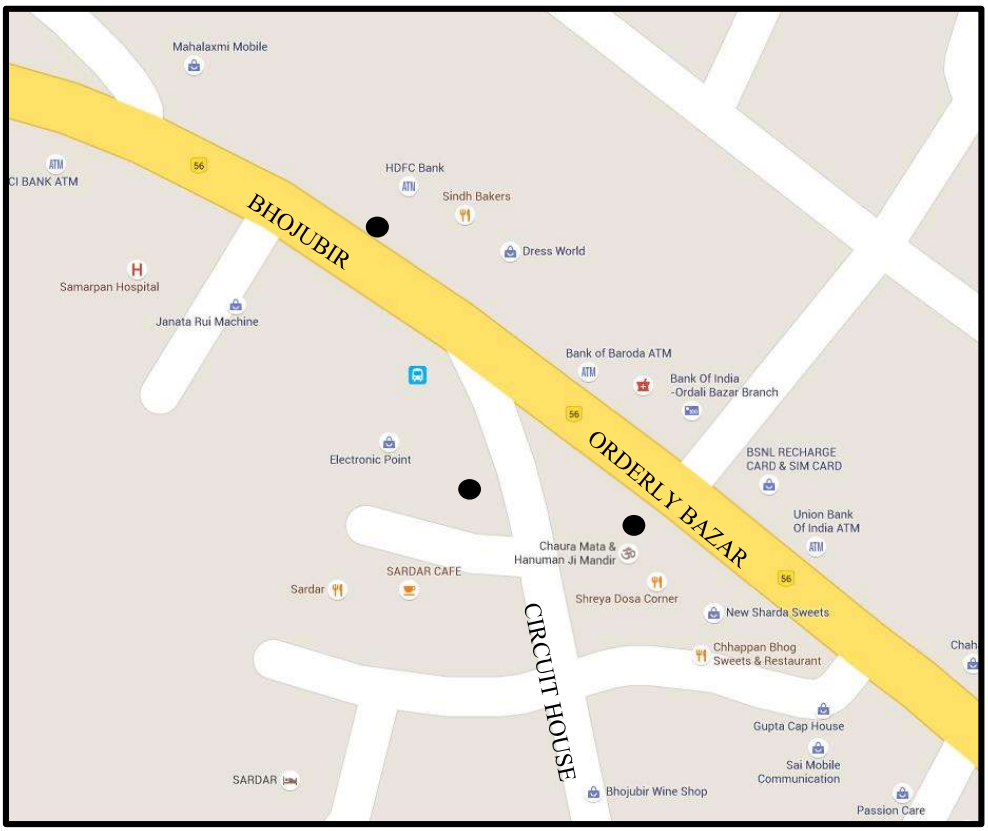
(a)



(b)

Figure 3.18. Location of data collection sites [●] at Radisson-Varuna Bridge intersection

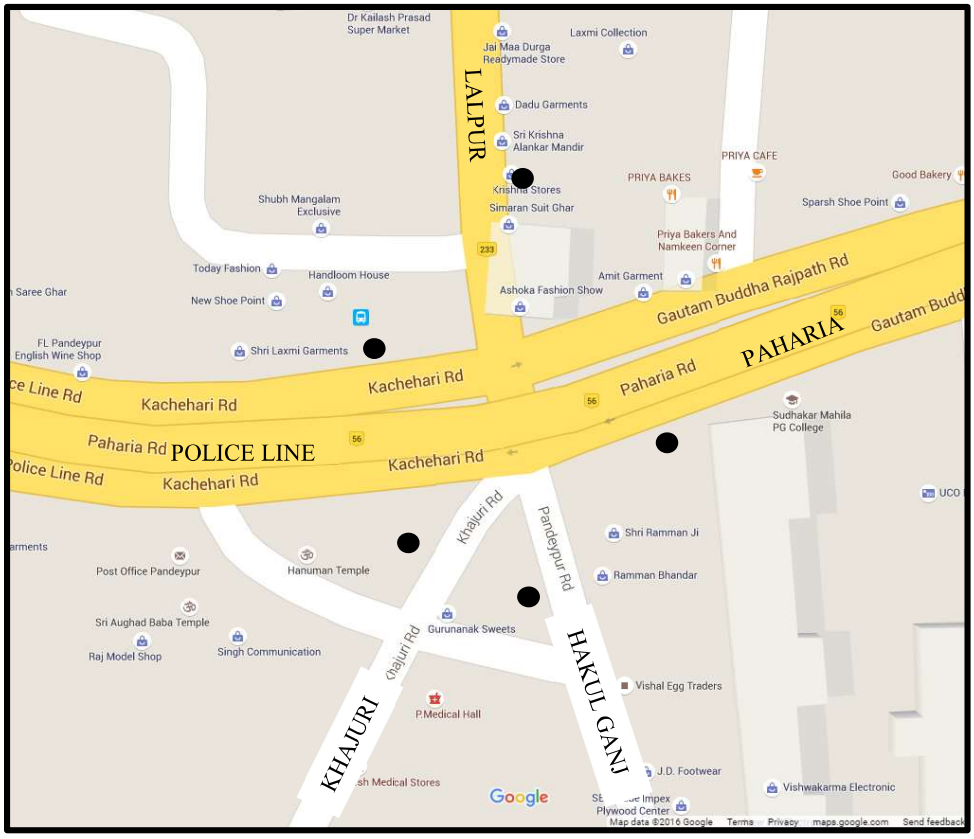
(a)



(b)

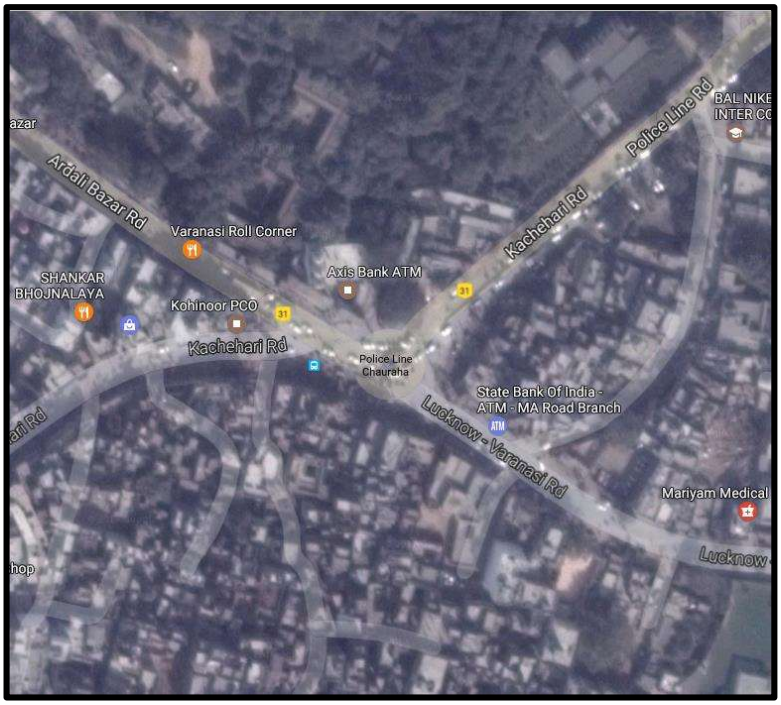
Figure 3.19. Location of data collection sites [●] at Bhojubir intersection

(a)

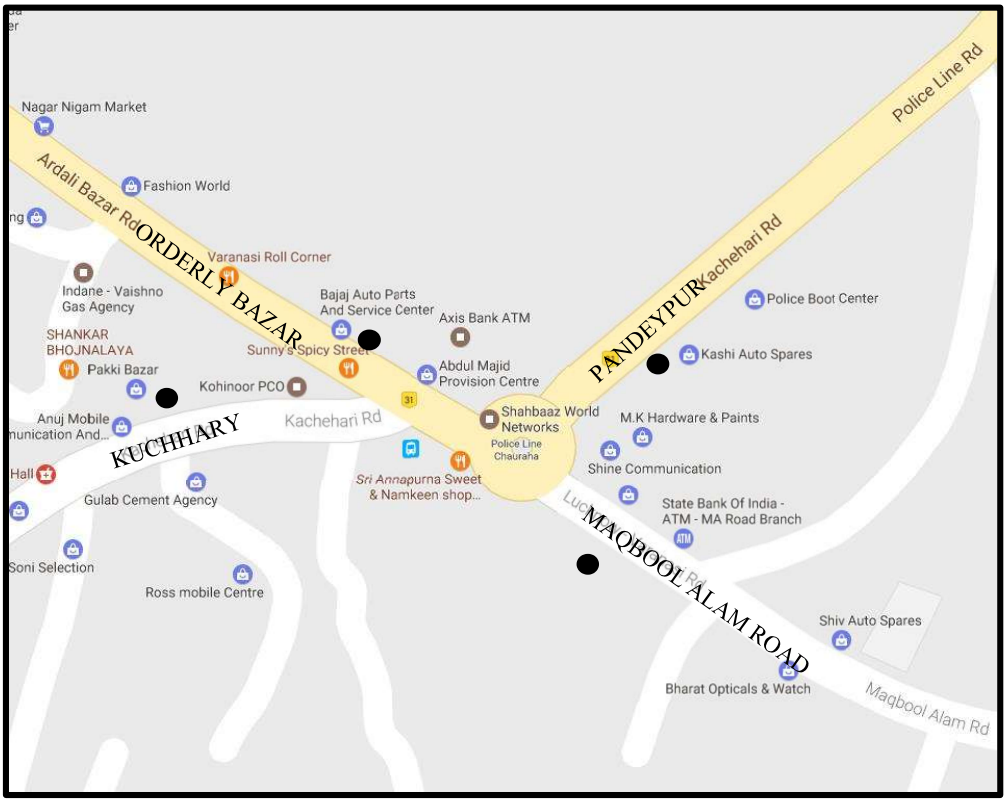


(b)

Figure 3.20. Location of data collection sites [●] at Pandeypur intersection



(a)



(b)

Figure 3.21. Location of data collection sites [●] at Police Line intersection

3.2 SITE DETAILS OF STUDY LOCATION

Every intersection has its unique characteristics in terms of location; traffic handling; traffic mix; traffic speed; presence or absence of traffic signals; carriageway type; presence or absence of median/divider; status and level of encroachment on the carriageway; presence or absence of drains and its cross-section, lining etc.; presence or absence of footpath/shoulder and its type and height from the carriageway; distance of façade line from edge of footpath/shoulder; presence or absence of vegetation and its type (dense/sparse/barren); presence or absence of electric or telephone poles; number of peak flows and its timing; height of various floors of adjoining buildings above footpath level and their use; maximum reported queue length of vehicles etc. These features render a unique aura to an intersection and the complex intermix of various affiliating and interfacing physical elements exert significant influence on the production of traffic-induced environmental pollutants and their dissipation patterns.

In order to further the study, documentation of physical details of the data collection sites was made as a component of the reconnaissance survey and placed in Table 3.2. Those legs of the intersection involving one-way traffic movement were not considered for data collection. The data of site details reveal that, in many cases, the available carriageway for traffic movement was less than the constructed carriageway. This was due to the encroachment of the footpath and the carriageway for various purposes like temporary vending, parking of vehicles, cordoning for service line/cable etc., one of which is shown in Photograph 3.1, while Photograph 3.2 shows the traffic jam of mixed traffic composition in the mid-sized city of Varanasi.

Photograph 3.1. Reduction of available carriageway for traffic movement due to encroachment for parking

Photograph 3.2. A traffic jam of mixed traffic composition in the mid-sized city of Varanasi

Table 3.2. Site details of study location on deceleration lane

Intersection and its leg	Median/Divider			Pavement details of deceleration lane at 25m from intersection				Drain				Footpath			Face line from shou / foot oute egde (m)
	Yes/ **N**o	**CC** / **S**tone / **B**rick / **O**thers	**H**eight & Top **W**idth (m)	Type (**BT**/ **CC**)	**D**ivided/ **U**ndivided	Carriage way width (m)	Available CW for traffic movement (m)	Shape (**R**ect / **T**rapez / **V**) (**C**overed/ **Open**)	**L**ined / **U**nlined	**CC** / **S**tone/ **B**rick/ **O**thers	Top Width (m)	**E**arthen / **CC** / **BT** / **B**rick/ **O**thers	Width (m)	Ht. from pavement surface (m)	
1. BHU Gate a) Towards Naria	Y	CC	H=0.75 W=0.2	BT	D	8.8	4.0	RC	L	B	1.15	BT	2.0	0	1.0
b) Towards Ravidas Gate	Y	CC	H=0.8 W=0.2	BT	D	8.85	5.0	VO	L	CC	0.6	CC	4.5	0.1	2.0
c) Towards Trauma Centre	Y	CC	H=0.7 W=0.25	BT	D	5.9	3.5	RC	L	CC	1.7	E	1.7	0	1.0
2. Ravidas Gate a) Towards Assi	Y	CC	H=0.4 W=0.2	BT	D	5.85	5.25	RC	L	CC	0.7	E	1.15	0	2.1
b) Towards BHU	Y	CC	H=0.8 W=0.2	BT	D	8.85	7.0	RC	L	CC	0.6	CC	4.5	0.1	1.0
c) Towards Durgakund	N	_	_	BT	U	3.75	3.5	VO	L	CC	0.65	_	0.0	_	1.2
d) Towards Lanka Thana	N	_	_	BT	U	7.5	7.0	RC	L	CC	0.3	E	2.8	0	7.0
3. Lanka-Sankatmochan a) Towards Durgakund	N	_	_	BT	U	9.2	7.0	VO	L	CC	0.6	BT	1.4	0	1.0
b) Towards Ravidas Gate	N	_	_	BT	U	9.2	7.0	VO	L	CC	0.6	BT	1.2	0	1.0
c) Towards Sankatmochan Temple	N	_	_	BT	U	8.2	7.0	VO	L	CC	0.4	B (Interlinking)	3.8	0	1.8

5. Bhelupur a) Towards Assi	N	_	_	BT	U	5.6	5.6	T C	L	CC	0.7	BT	0.6	0	1.2
b) Towards Durgakund	N	_	_	BT	U	8.5	7.00	V O	L	CC	0.7	E	0.6	0	1.0
c) Towards Kamachha	N	_	_	BT	U	6.5	5.0	V O	L	CC	0.4	BT	0.6	0	1.0
d) Towards Ramapura	N	_	_	BT	U	5.4	4.5	V O	L	CC	0.3	BT	0.4	0	3.0
6. Rathyatra a) Towards Kamachha	Y	CC	H=0.6 W=0.15	BT	D	3.1	3.0	V O	L	CC	0.6	BT	0.5	_	3.5
b) Towards Mahmoorganj	Y	CC	H=0.7 W=0.17	BT	D	3.5	3.5	T C	L	CC	1.0	E	1.2	0	2.5
c) Towards Sigra	Y	CC	H=0.45 W=0.15	BT	D	4.6	4.0	_	_	_	_	E	0.7	0	2.2
7. Sigra a) Towards Englishia Line	Y	CC	H=0.62 W= 0.17	BT	D	5.2	4.0	V O	L	CC	0.3	B	3.7	0	3.7
b) Towards Teliyabag	Y	CC	H=0.10 W=0.18	BT	D	7.1	7.1	V O	L	CC	_	CC	2.4	0.15	1.0
c) Towards Rathyatra	Y	CC	H=0.34 W=0.19	BT	D	4.7	4.7	V O	L	CC	0.6	_	0.0	_	1.0
8. Englishia Line a) Towards Andharapul	Y	CC	H=0.78 W=0.16	BT	D	5.3	4.0	_	_	_	_	E	2.2	0	1.3
b) Towards Lahartara	Y	O	Flyover construction	BT	D	3.6	3.6	T O	U	BT	1.0	E	2.7	0	3.7
c) Towards Sigra	Y	B	H=0.32 W=0.2	BT	D	4.7	4.0	_	_	_	_	E	2.8	0	1.1

9. Andharapul a) Towards Chaukaghat	Y	O	CC Fly Over	BT	D	7.0	7.0	R C	L	CC	1.8	BT	2.3	0.05	4.1
b) Towards Englishia Line	Y	O	CC Fly Over	BT	D	3.1	3.0	_	_	_	_	E	1.4	0	3.2
c) Nadesar	N	_	_	BT	U	7.2	7.0	_	_	_	_	_	0.0	_	1
d) Towards Teliyabag	Y	CC	H=0.65 W=0.18	BT	D	4.9	4.5	V O	L	CC	0.3	CC	0.7	0	5.0
10. Chaukaghat a) Towards Andharapul	Y	O	CC Fly Over	BT	D	6.7	6.00	V O	L	CC	0.6	E	2.2	0.0	3.0
b) Towards City Railway Station	Y	O	CC Fly Over	BT	D	7.0	7.0	R C	L	CC	0.9	B	2.5	0.0	4.0
c) Towards Maqbool Alam Road	Y	B	H=0.30 W=0.45	BT	D	5.7	5.0	_	_	_	_	_	0.0	_	4.0
d) Towards Nadesar	N	-	-	BT	U	5.1	4.5	V O	L	CC	0.7	E	2.9	0.1	1.0
e) Towards Teliyabag	Y	O	H= 0.75 (Steel pipe post)	BT	D	8.7	7.5	R O	U	B	0.9	BT	1.6	0	2.2
11. Godowlia a) Towards Girjaghar	Y	CC	H=0.8 W=0.21	BT	D	5.1	4.5	V O	U	CC	0.4	BT	0.4	0	1.5
b) Towards Lanka	N	_	_	BT	U	5.6	4.5	V O	U	CC	0.6	BT	0.5	0	1.4
12. Girjaghar a) Towards Godowlia	Y	CC	H=0.78 W=0.19	BT	D	5.2	3.5	R	L	CC	1.1	BT	1.1	0	1.3
b) Towards Lahurabir	Y	CC	H=0.76 W=0.17	BT	D	5.1	4.0	R	L	CC	0.8	BT	0.7	0	1.6
c) Towards Luxa	Y	CC	H=0.8 W=0.17	BT	D	5.4	4.5	V O	U	CC	0.3	CC	0.7	0.3	1.4
d) Towards Ramapura	N			BT	U	4.9	3.5	V	U	CC	0.5	BT	0.3	0	1.5

13. Bhikharipur a) Towards Chitaipur	N	_	_	BT	U	7.8	7.0	_	_	_	_	BT	4.1	0	1.0
b) Towards DLW	Y	CC	H=0.81 W=0.21	BT	D	6.5	6.0	_	_	_	_	BT	0.95	0	1.91
c) Towards Sundarpur	Y	CC	H=0.8 W=0.21	BT	D	5.1	4.5	_	_	_	_	BT	3.4	0	2.1
14. Manduadih a) Towards DLW	N	_	_	BT	D	7.4	7.0	V O	U	CC	0.7	_	0.0	_	3.0
b) Towards Lahartara	Y	CC	H=0.76 W=0.17	BT	D	4.9	4.0	_	_	_	_	E	2.4	0	1.0
c) Towards Mahmoorganj	N	_	_	BT	U	6.2	5.5	_	_	_	_	B	0.9	0	2.2
d) Towards Manduadih Police Station	N	_	_	BT	U	4.2	3.5	_	_	_	_	_	0.0	_	1.4
15. Lahartara-Manduadih a) Towards Cantt. Railway Station	Y	B	H=0.61 W=0.40	BT	D	10.4	7.5	R	L	B	0.3	E	1.2	0	1.0
b) Towards Manduadih	Y	CC	H=0.7 W=0.17	BT	D	5.2	4.5	R C	U	S	0.3	E	0.6	0	1.2
c) Towards Mohan Sarai	Y	B	H=0.30 W=0.22	BT	D	5.1	4.5	R C	L	B	0.3	E	2.9	0	1.5
16. Radisson-Varuna Bridge a) Towards PWD Office	N	_	_	BT	U	5.4	5.0	R C	L	CC	0.6	E	2.5	0	1.4
b) Towards The Mall Road	N	_	_	BT	U	5.4	5.0	R C	L	CC	0.7	BT	1.8	0	1.0

17. Bhojubir a) Towards Bhojubir	Y	CC	H=0.78 W=0.15	BT	D	7.3	7.0	_	_	_	_	CC	2.1	0.25	1.0
b) Towards Circuit House	N	_	_	BT	U	6.4	5.5	R C	L	CC	0.9	BT	2.8	0	2.2
c) Towards Orderly Bazar	N	_	_	BT	U	6.9	6.0	V O	L	CC	0.3	E	1.3	0	1.4
18. Pandeypur a) Towards Hakul Ganj	N	_	_	BT	U	3.7	3.5	R C	L	CC	0.9	E	0.3	0	5.0
b) Towards Khajuri	N	_	_	BT	U	5.5	5.0	R C	L	CC	0.7	E	0.9	0	1.0
c) Towards Lalpur	N	_	_	BT	U	5.9	5.0	R C	L	CC	0.9	E	0.9	0	1.0
d) Towards Paharia	Y	O	CC Fly Over	BT	D	3.75	3.75	R C	L	CC	0.6	BT	1.0	0	1.0
e) Towards Police Line	Y	O	CC Fly Over	BT	D	8.1	7.0	_	_	_	_	E	2.9	0	1.0
19. Police Line a) Towards Kuchhary	N	_	_	BT	U	7.5	7.5	R C	L	B	0.3	E	0	0	4
b) Towards Maqbool Alam Road	Y	CC	H=0.75 W=0.20	BT	D	5.0	5.0	R C	L	CC	0.3	E	0	0	5
c) Towards Orderly Bazar	N	_	_	BT	U	7.0	7.0	R C	L	CC	0.3	CC	0.9	0	1.6
(d) Towards Pandeypur	Y	CC	H=0.75 W=0.20	BT	D	3.0	3.0	_	_	_	_	E	0	0	5