FINAL REPORT

COMPREHENSIVE ENVIRONMENTAL MANAGEMENT PLAN (CEMP) FOR TAJ TRAPEZIUM ZONE (TTZ) AREA

Sponsor

Agra Development Authority (ADA)
AGRA

CSIR-National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur - 440 020 (India

December, 2013

Table of Contents

Table of Contents (Contd.)

Table of Contents (Contd.)

Table of Contents (Contd.)

List of Tables

List of Tables (Contd.)

List of Annexures

List of Figures

1.0 Introduction

Agra, located in the State of Uttar Pradesh of Northern India is well known for the TajMahal, one of the sevenwonders of the world. Emperor Shahjahan built TajMahal in 17th Century A.D. in memory of his beloved wife, MumtajMahal. In addition to the TajMahal, there are two more world heritage sites in and around Agra city, viz. Agra Fort and Fatehpur-Sikri. The Akbar's Tomb at Sikandara and the Itmad-ud-daulla's tomb in Agra are also proposed to be World Heritage sites. Agra, once a flourishing capital of ancient Mughals is today the 24th largest city in India and 4th largest city in uttar Pradesh. The city of Agra is spread over an area of 120 sq.kms and has a population about 1.2 millions. Industrialisation and urban growth in the Agra-Mathura region has endangered the world famous TajMahal and other historical monuments which are under constant threat from the ever increasing environmental pollution.

1.1 Taj Trapezium Zone (TTZ), Agra – Status and Chronology of Events

- Ministry of Environment and Forests, Government of India declared Agra-Mathura region as air pollution protected area, namely the Taj Trapezium Zone in the year 1983 which is in the form of trapezium bounded by Longitude $77^0 15'$E on the West $78^0 30'$E on the East and lines joining Latitude $27^0 45'$N to Latitude $27^0 30'$N on the North and Latitude $26^0 45'$ to $27^0 00'$N on the South and prohibited establishment/expansion of polluting industries

- Further, MoEF, GOI in the year 1999 notified Taj Trapezium Zone Pollution (Prevention & Control) Authority, Agra for protection and improvement of the environment in the TTZ area

- The projects of Electric Power Supply Improvement, Solid Waste Management, Sewerage, Forestation etc. are being implemented under Taj Protection Mission

- 1973 : Decision of the Government of India (GOI) to set up a Petroleum Refinery at Mathura, first episode to raise concern regarding the environmental safety of the TajMahal

- 1974: Expert Committee under the Chairmanship of Dr. S. Varadarajan, concluded that there was no danger to the Taj from the proposed Mathura Refinery

- 1978 : Vardarajan Committee recommended the following :

  - Closure of two thermal power plants in Agra
  - Use of diesel in shunting yards in order to stop the use of steam locomotives
  - Shifting of foundries from Agra City to an area south east of the TajMahal
  - Meanwhile, the work on the Mathura Refinery started. This caused the controversy to surface again

- 1979 : The un-acceptance of the conclusions of the Varadarajan Committee necessitated the setting up of a joint Committee of Parliament under the Chairmanship of Dr. Karan Singh

- This Committee suggested that the most polluting units be shifted to Etawah Region. Subsequently, the GOI constituted a High Power Committee (HPC) and an Expert Group (EG) to assist the HPC. The HPC and EG was to make a detailed and indepth study of the whole problem and make suitable recommendations. The Chairman of Central Pollution Control Board was appointed as the Chairman of the EG

- 1981 : The Government took the following steps :

  - Closed two thermal power plants in Agra
  - The use of diesel was adopted in the shunting yards at Agra resulting in stoppage in the use of steam locomotives

- 1981: The monitoring of Ambient Air Quality at the TajMahal was started. The organizations that have been involved in this monitoring are ASI, CPCB (both continue monitoring till date) and NEERI

- 1981-1982: The Central Pollution Control Board demarcated the Taj Trapezium Zone

- 1984 : Mr. M.C. Mehta filed a writ petition before the Supreme Court against GOI, Mathura Refinery, U.P. Govt. and other Govt. departments. The petition requested that they be directed to take suitable measures including the shifting of the Mathura Refinery to conserve the TajMahal from the threat of air pollution caused by Mathura Refinery, started in 1983

- 1993 : MoEF, recognizing the need to preserve precious monuments like the TajMahal from air pollution point of view initiated another study by the National Environmental Engineering Research Institute (NEERI), which suggested a slight modification of the boundary

- NEERI recommended the shifting of small-scale industries out of the TTZ. Guided by this report, the Supreme Court asked industries in Agra to give information relating to shifting vide their order of 11.04.1994, Sensing that such a step would kill the small industries, directly effecting 305 entrepreneurs, 57,800 workers and their families, the Supreme Court disregarded the study done by NEERI in February 1994 and directed GOI, Ministry of Environment to undertake a new study on air pollution in the TTZ

- 1994 : Varadarajan Committee was appointed once again by the GOI with the following TOR :

  - To undertake survey of the Taj Trapezium and sources of pollution
  - To identify the polluting industries
  - To suggest measures to control pollution, which cause danger to the Taj
  - Specific activities of monitoring, analysis and data etc. by Engineers India Ltd., who will take the assistance of specialized agencies of Council for Scientific and Industrial Research
  - The Committee will examine all reports of preceding committees
  - The Committee will also suggest an ongoing institutional mechanism to permanently monitor changes of pollutants in the Taj Trapezium and advice corrective action

- The Central Pollution Control Board delineated the Taj Trapezium Zone on the basis of the weighted mean wind speed in twelve directions from Agra to Mathura and Bharatpur

- The boundaries of the zone were made keeping in mind the possible effect of pollution sources in this zone on the critical receptor – the TajMahal

- This area was declared as an "Air Pollution Protection Area". There was a ban on new units of "High Polluting Nature" or the expansion of the existing units was not to be permitted

1.2 Hon'ble Supreme Court Orders (Air Pollution Control)

- In compliance with the Hon'ble Supreme Court's Orders dated 7.11.2000, the CPCB has set up and is operating four ambient air quality monitoring stations at TajMahal, Itmad-ud-Daulah, Nunhai and Rambagh

- The CPCB has established one Central Analytical –cum-Calibration Laboratory, as was suggested by the Mahajan Committee

- The monitoring is being continued till date as per national ambient air quality monitoring norms at three monitoring locations (min. 104 days yearly), viz. Itmad-ud-Daulah, Rambagh and industrial area Nunhai; however, being a sensitive location, monitoring at TajMahal is being done for six days (i.e. except Fridays and listed national holidays) in compliance of the Hon'ble Supreme Court's orders dated 7.11.2000, 27.11.2001, 11.4.2002, 23.9.2002, 8.1.2003 and 9.4.2003 in the aforesaid matter

- The monitoring data is being submitted to this Hon'ble Court and TTZ Authority (Prevention & Control), Agra at regular intervals

1.3Present Study

NEERI has submitted a report to Ministry of Environment & Forests, New Delhi on "Environmental Post Evaluation of the Projects under the Schemes proposed in the Taj Trapezium Zone" in May 2010. Agra Development Authority requested NEERI in August 2011

to prepare Comprehensive Environmental Management Plan based on the studies conducted earlier and available secondary data.

The main objective of the project is preparation/delineation of Comprehensive Environmental Management Plan (CEMP) to improve Environmental Quality (EQ) in TTZ Area.

1.3.1 Study area

Taj Trapezium Zone (TTZ) Area comprising of Agra, Mathura, Mahamayanagar, Firozabad and Bharatpur districts encompassing a total area of about 10,400 km^2 with special focus on Agra City.

1.3.2 Scope of the Work

- Assessment of baseline environmental quality of TTZ area with respect to major components of the environment – based on secondary data/reports to be provided by ADA / UPPCB/Other concerned agencies/departments.

- Identification of critical areas and key environmental issues in the TTZ area.

- Bench marking of key environmental quality parameters for improvement

- Delineation of comprehensive environmental management plan leading to improvement in environmental quality of TTZ area.

- Evaluation of proposed micro-plans and projects for improvement with respect to identified parameters of major environmental components.

- Finalization of CEMP in consultation with ADA & UPPCB and other stakeholders

- Identification of primary data requirements (keeping in view the availability of secondary data) for detailed studies

1.3.3 Study Methodology and Report

Keeping in view the scope of work agreed upon as per the TOR of the study, discussions were held with all the concerned agencies/organizations and stakeholders in TTZ area with special focus on Agra. Available secondary data was collected from all the concerned agencies and visits were also made to a few important towns in TTZ by NEERI study team. Based on the information collected and analysed, this report has been prepared. Chapter 2 to 5 deal with (i) Air, (ii) Water Supply, Sewerage and Drainage, (iii) Wastewater Management and (iv) Solid Waste Management respectively. Comprehensive Environmental Management and Action Plan for TTZ is presented in Chapter No. 6.

2.0 Air Environment

2.1 Present Status of Air Environment in TTZ Area

2.1.1 Air Quality Status of Agra City

In all, there are 8 ambient air quality monitoring (AAQM) Stations operational in Agra city. The details are summarized below in **Table 2.1.1**.

Table 2.1.1: Details of Air Quality Stations in Agra

Sr. No.	Monitoring Agency	Number of Stations	AQ M Locations	Type of Location/ Area	Parameters Monitored
1.	CPCB, RO, Agra	4	Taj Mahal,	Sensitive area	SO_2, NO_2, RSPM & SPM
			Etmad-ud-daulah	Sensitive area	
			Rambagh	Residential/ Commercial	
			Nunhai	Industrial area	
2.	ASI, Agra	1	Taj Mahal	Sensitive area	SO_2, NO_2, RSPM & SPM
3.	UPPCB RO, Agra	2	Bodla (UPPCB building)	Residential area	SO_2, NO_2, RSPM & SPM
			Nunhai	Industrial area	
		1 (automatic)	Agra Nagar Nigam Office	Residential area	SO_2, NO_2, PM10

Out of 8 air quality monitoring stations, 7 are monitored using manual systems, whereas one station is equipped with continuous analyzer, which is installed at Agra Nagar Nigam Office. The automatic station is operated and maintained by M/s Envirotech Ltd., New Delhi. The sampling locations of air quality monitoring stations are shown in **Fig. 2.1.1**.

Fig. 2.1.1: Ambient Air Quality Monitoring Stations in Agra

2.1.1.1 Analysis of Air Quality Data (CPCB)

The annual average air quality data provided by the CPCB Agra Office for the years 2002 to 2010 was analyzed to assess the status of air quality with respect to different parameters at different monitoring locations in Agra. The average, maximum and minimum concentrations are calculated for the past 9 years data. Summary of annual average AAQ levels with respect to SO_2, NO_2, RSPM and SPM are summarized in **Table 2.1.2**. Further, average values at all the four locations have been considered as the overall average air quality for the city.

Applicable CPCB Standard for each parameter is also indicated in **Table 2.1.2**. **It is important to note that whole of the TTZ Area is considered under the sensitive area category of CPCB Standards.**

Table 2.1.2: Summary of Annual Average AAQ Levels in Agra City (Monitored by CPCB during 2002-2010)

Pollutant	Monitoring Station	Pollutant Concentration (µg/m^3)				Applicable CPCB Standard (µg/m^3)
		Period Average	Period Minimum	Period Maximum	Standard Deviation	
SO_2	Taj Mahal	6	4	9	1	20
	Itmad-ud-daula	6	4	10	2	
	Rambagh	5	4	8	1	
	Nunhai	6	4	11	2	
	City Average	**6**	**4**	**10**	**2**	
NO_2	Taj Mahal	21	18	23	2	30
	Itmad-ud-daula	26	23	29	2	
	Rambagh	25	22	27	1	
	Nunhai	35	33	38	2	
	City Average	**27**	**24**	**29**	**2**	
RSPM	Taj Mahal	151	133	167	14	60
	Itmad-ud-daula	192	174	214	15	60
	Rambagh	190	157	278	36	
	Nunhai	261	216	306	26	
	City Average	**199**	**170**	**241**	**23**	
SPM	Taj Mahal	325	296	376	26	NA
	Itmad-ud-daula	431	377	519	47	
	Rambagh	441	390	541	47	
	Nunhai	611	514	675	59	
	City Average	**452**	**394**	**528**	**45**	

Note: Revised CPCB Standards does not include SPM

The city average values with respect to SO_2, NO_2, RSPM and SPM are calculated to be 6 µg/m^3, 27 µg/m^3, 199 µg/m^3 and 452 µg/m^3 respectively. The maximum annual average values of SO_2, NO_2, RSPM and SPM are found to be 10

$\mu g/m^3$, 29 $\mu g/m^3$, 241 $\mu g/m^3$ and 528 $\mu g/m^3$ respectively. By considering the whole TTZ area to be under sensitive zone, levels of SO_2 are found to be well below the corresponding CPCB Standard value of 20 $\mu g/m^3$, whereas NO_2 levels are approaching the Standard value of 30 $\mu g/m^3$. City average RSPM (PM_{10}) levels are substantially high (4 times) than the prescribed Standard value of 60 $\mu g/m^3$.

2.1.1.2 Annual Variation in AQ Levels

Annual variation in air quality levels with respect to SO_2, NO_2, RSPM and SPM are depicted in **Figs. 2.1.2 through 2.1.5**, respectively.

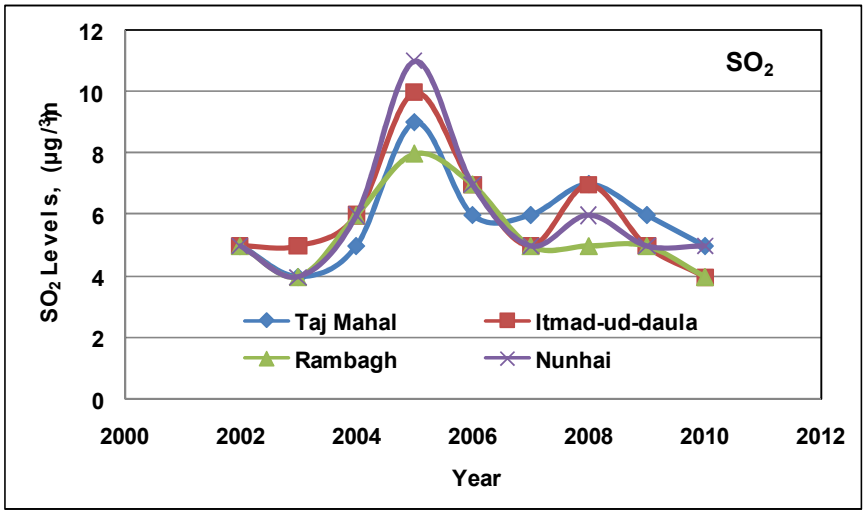


Fig. 2.1.2: Annual Variation in SO_2 Levels: 2002-2010

SO_2 Levels: Perusal of **Fig. 2.1.2** indicates that pattern of variation in SO_2 levels are same at all the four sites, whereas levels were found to be higher in 2005, which declined in subsequent years. The annual average SO_2 level in any year was much below the CPCB Standard of 20 $\mu g/m^3$ for the sensitive area category.

NO_2 Levels: Perusal of **Fig. 2.1.3** indicates higher levels at Nunhai when compared with that of other locations. NO_2 levels were found to be relatively higher in 2007-2008. Declining levels were observed at Taj Mahal beyond 2007 and also at Nunhai and Etmad-ul-daula beyond 2008. The annual average NO_2 level in any year was found to be below the CPCB Standard of 30 $\mu g/m^3$ for the sensitive area category.

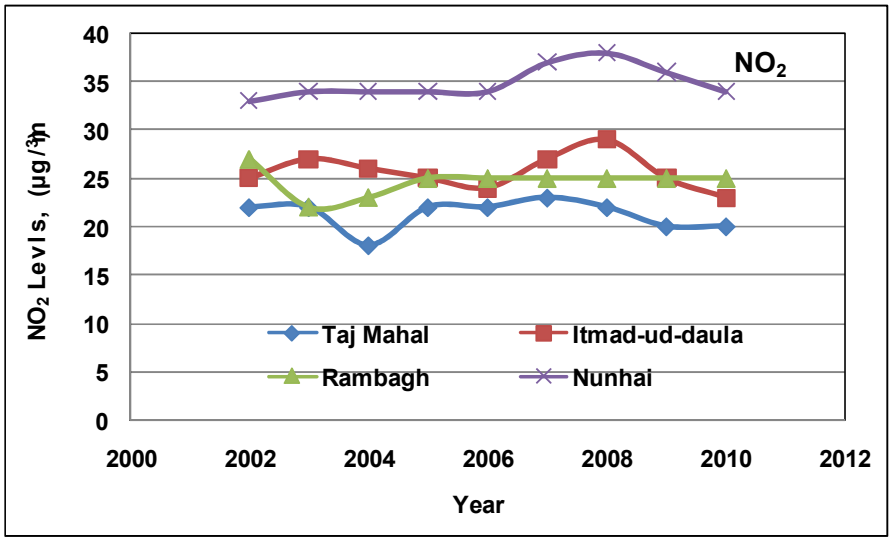


Fig. 2.1.3: Annual Variation in NO_2 Levels: 2002-2010

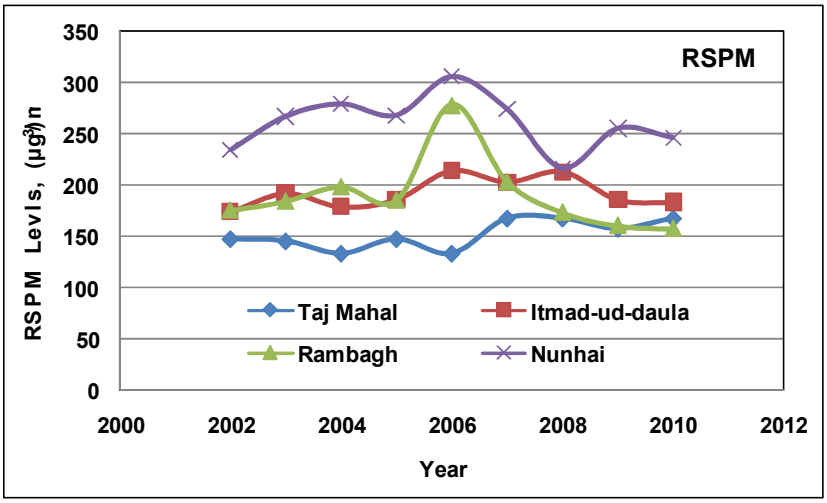


Fig. 2.1.4: Annual Variation in RSPM Levels: 2002-2010

RSPM Levels: Perusal of **Fig. 2.1.4** indicates highest levels at Nunhai as compared to the other locations. Highest levels were recorded in 2006 at all the locations except at the Taj Mahal. The RSPM levels declined at three locations beyond 2006, whereas it increased at the Taj Mahal. The annual average RSPM level in any year was much above (2 to 6 times at different locations in different years) than the CPCB Standard of 60 µg/m^3.

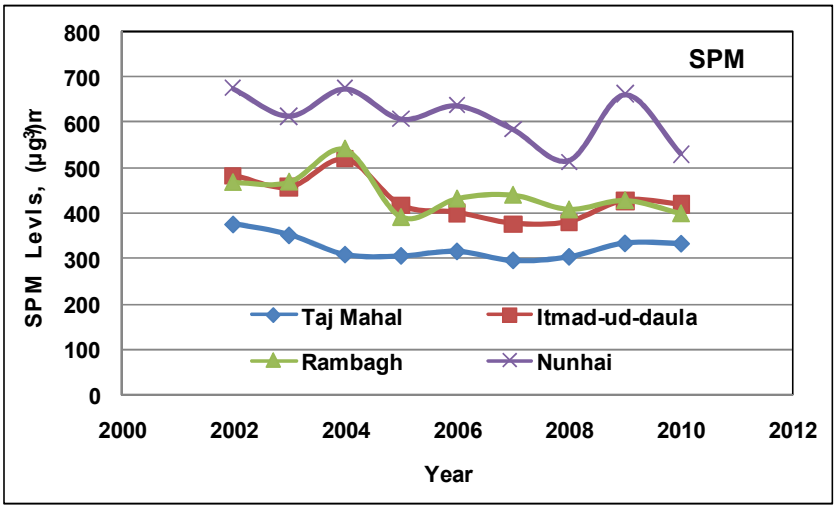


Fig. 2.1.5: Annual Variation in SPM Levels: 2002-2010

2.1.1.3 Analysis of Air Quality Data (UPPCB)

Another set of data being monitored by the UP Pollution Control Board (UPPCB), Agra was also analyzed. Monitoring is carried out at two locations, namely Bodla (representing residential area) and Nunhai (representing industrial area) in Agra. The annual average air quality data provided by the UPPCB Agra Office has also been analyzed for the years 2002 to 2010. Same period of data is chosen for comparison with the CPCB database. The average, maximum and minimum concentrations are calculated for the past 9 years data. Summary of annual average AAQ levels with respect to SO_2, NO_2, RSPM and SPM are summarized in **Table 2.1.3**.

Analysis of air quality data indicates that average levels of SO_2 and NO_2 are much below the CPCB Standard of 20 µg/m^3 and 30 µg/m^3 respectively for the sensitive area category. RSPM levels are considerably high (6-7 times) as compared to the CPCB standard of 60 µg/m^3 at both the sampling locations, Bodla and Nunhai.

2.1.1.4 Analysis of Air Quality Data (ASI)

Archaeological Survey of India (ASI), Agra has also installed one air quality monitoring station in the Taj Mahal premises. The data available for the year 2005 to 2009 indicates that the annual average concentrations of SO_2, NO_2 and SPM vary in the range of 3-4 µg/m^3, 6-16 µg/m^3 and 247-275 µg/m^3 respectively.

Table 2.1.3: Summary of Annual Average AAQ Levels (Monitoring by UPPCB during 2002-2010)

Pollutant	Monitoring Station	Pollutant Concentration (µg/m^3)				Applicable CPCB Standard (µg/m^3)
		Period Average	Period Minimum	Period Maximum	Standard Deviation	
SO_2	Bodla	8	7	9	1	20
	Nunhai	9	7	10	1	
NO_2	Bodla	10	9	11	1	30
	Nunhai	10	8	12	1	
RSPM	Bodla	161	138	179	19	60
	Nunhai	187	165	213	19	
SPM	Bodla	351	272	458	55	NA
	Nunhai	409	350	498	54	

2.1.1.5 Monthly Mean Values at UPPCB Monitoring Stations (2011)

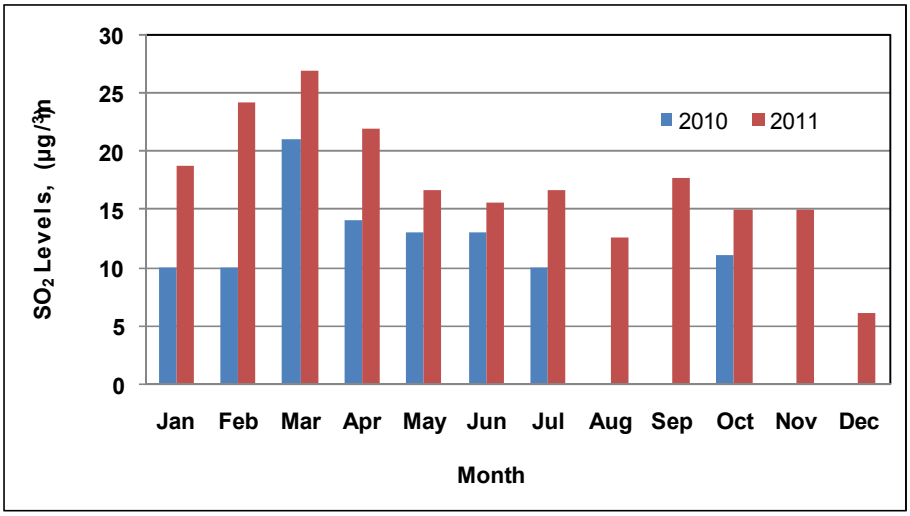
Monthly mean values of SO_2, NO_2, RSPM and SPM at the two UPPCB monitoring stations, namely Bodla and Nunhai are given in **Table 2.1.4**. Perusal of the data indicates that air quality levels (all 4 parameters) are slightly higher at Nunhai industrial area as compared to the Bodla area. Further, the air quality levels are slightly higher during summer months (April-June) as compared to the winter months (January-March).

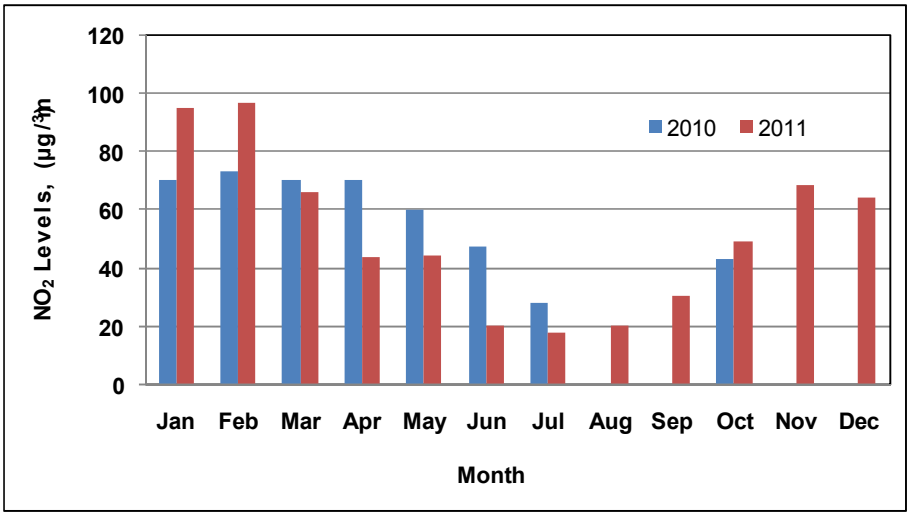
Table 2.1.4: Monthly Mean Values at Bodla and Nunhai during 2011 (UPPCB Monitoring Stations)

Month	Bodla (Residential area)				Nunhai (Industrial area)			
	SO_2	NO_2	RSPM	SPM	SO_2	NO_2	RSPM	SPM
January	9	10	163	267	10	12	180	312
February	10	11	162	285	11	13	189	336
March	9	11	169	297	11	13	210	355
April	11	13	159	321	12	15	199	387
May	12	15	175	315	14	22	209	384
June	10	14	151	286	12	18	177	326
July	12	16	140	229	13	19	165	296
August	10	15	146	258	14	21	179	309

2.1.1.5 Monthly Variation in Air Quality Data Measured using Continuous Analyzer

Three major pollutants, viz. SO_2, NO_2 and PM_{10} are being monitored at Agra Nagar Nigam Office using continuous analyzer. The monthly average data available for the years 2010 and 2011 is depicted for all the three parameters in **Fig. 2.1.6**.





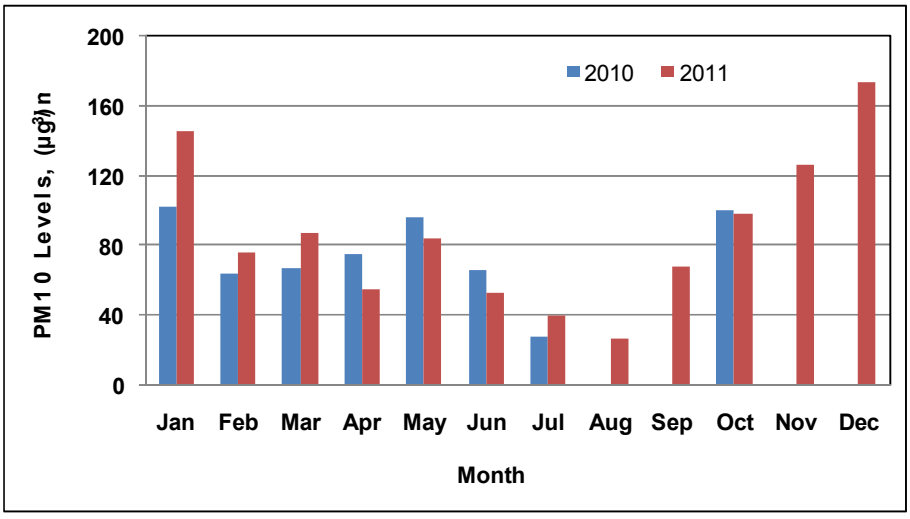


Fig. 2.1.6: Monthly Average Levels of SO_2, NO_2 and PM_{10} Monitored using Continuous Air Quality Analyzer installed at Agra Nagar Nigam Office (2010 & 2011)

SO_2 Levels: Analysis of air quality data indicates that SO_2 levels were considerably high in 2011 as compared to the corresponding month of 2010. SO_2 levels are high in winter than in summer and this may be attributed to the burning of coal and other materials for heating purpose during winter. Further, it is observed that the levels monitored at ANN were much higher (almost twice) in comparison to other 2 monitoring locations in Agra.

NO_2 Levels: In general, NO_2 levels were high in 2010 as compared with that of 2011 (except during January and February). Further, NO_2 levels were found to be higher in winter (up to 96 $\mu g/m^3$ in 2011) than summer (up to 73 $\mu g/m^3$ in 2010). The NO_2 levels monitored using automatic analyzer were much higher (2-3 times) than the levels measured at other two locations (monitored manually).

PM_{10} Levels: Contrary to the pattern of SO_2 and NO_2 levels during different months, PM_{10} levels were found to be high in 2011 as compared to 2010 during winter (Jan-March), whereas during summer (April-June), the levels were higher in 2010. RSPM/PM_{10} levels were found to be low at the ANN site, as compared to other 2 sites, because of the difference in the height of the monitoring site locations.

BTX Levels : In addition, Benzene, Toluene and Xylene (BTX) are also monitored simultaneously along with PM_{10}, SO_2 and NO_2 at the Agra Nagar Nigam site using continuous air monitoring system. Monthly variations (maximum and average values) in these parameters during January to September, 2011 are depicted in **Fig. 2.1.7**.

Highest concentration levels of BTX (maximum and average values) were recorded during January, 2011 which in general reduced in subsequent months till September, expect in May, 2011. Air quality standards promulgated by CPCB for benzene is 5 $\mu g/m^3$ (annual average). The benzene levels recorded were found much below the CPCB standards for benzene. National standards for toluene and xylene are not available at present.

2.1.2 Air Quality Status of Firozabad City

Air quality data is being monitored at three locations in Firozabad city. These locations are Raja-ka-Tal (residential area), Tilak nagar (mixed use area) and CDGI (industrial area). Air quality data available for the period from September, 2004 to August, 2011 has been analyzed. The 7 year data for each month has been averaged to get the monthly average value for that month, for each of the monitoring locations. Four

major pollutants, viz. SO_2, NO_2, RSPM and SPM are monitored at all the locations. Monitoring station-wise comparison has been done for each pollutant (SO_2, NO_2, RSPM and SPM) as presented in **Fig. 2.1.7**.

Analysis of air quality data indicates similar pattern in variation in gaseous pollutants (SO_2 and NO_2) and particulate matter (RSPM and SPM). In general, highest pollution is observed at industrial area site followed by the residential area and the lowest at the mixed used area site. This pattern is more or less similar for all the pollutants.

In general, highest levels of pollutants are observed during winter (December-March), followed by the summer (April-June), and the lowest during monsoon (July-September).

In all, the monthly average levels of SO_2 in the city ranged between 12 $\mu g/m^3$ and 27 $\mu g/m^3$. NO_2 levels ranged between 24 $\mu g/m^3$ and 44 $\mu g/m^3$. RSPM levels have shown considerable variation among the months, the values being 60 $\mu g/m^3$ in August to 300 $\mu g/m^3$ in December-January.

The data for the Firozabad city is further analyzed to get the overall summary of the data, which is presented in **Table 2.1.5**. Average value for the city (average of all the three locations) has been estimated. Overall average air quality value for the city in terms of SO_2, NO_2, RSPM and SPM is estimated to be 19 $\mu g/m^3$, 32 $\mu g/m^3$, 202 $\mu g/m^3$ and 407 $\mu g/m^3$ respectively.

2.1.3 Air Quality Status of Mathura City

Ambient air quality in Mathura was assessed by CPCB, RO, Agra at three locations representing industrial (CETP), residential (Kishna Nagar) and sensitive (Shri Krishn Janmsthan) area on random sampling days during 2009, 2010 and 2011. The random sampling day is represented by the season for better comparison. Date wise analyzed air quality data is presented in **Fig. 2.1.8** for SO_2 and NO_2 and in **Fig. 2.1.9** for RSPM and SPM. The figures indicate that gaseous levels are much below the standards (each 80 $\mu g/m^3$), whereas PM_{10} concentration levels are much above the standards (100 $\mu g/m^3$).

Subsequently, UPPCB, Mathura has started air quality monitoring on regular basis from November 2010 onwards. The monitoring is being carried out at two

locations, at an industrial site and at the Regional Office, Baldev Puri. SPM, RSPM, SO_2 and NO_2 are being monitored twice a week as per the guidelines of CPCB, Delhi.

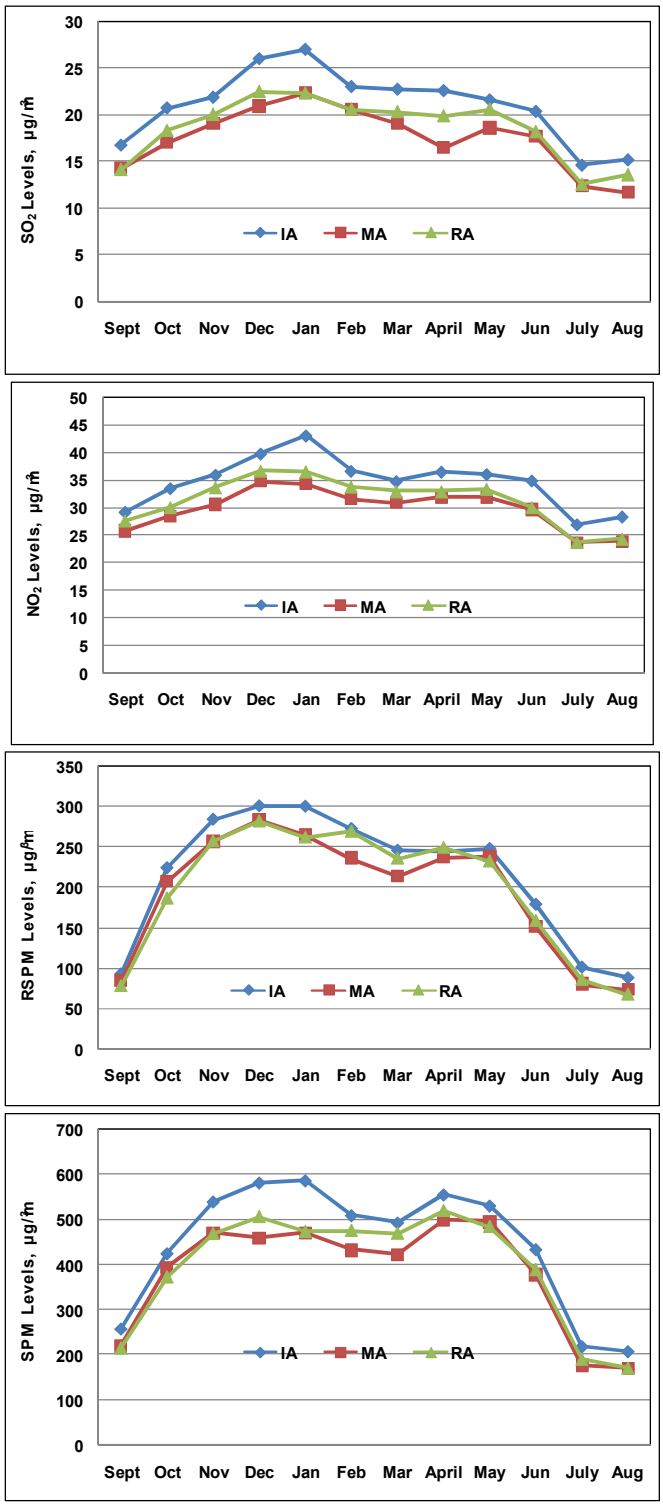


Fig. 2.1.7: Monthly Variation in Ambient Air Quality Parameters of Firozabad City: September 2004 – August 2011

Table 2.1.5: Summary of Monthly Average Air Quality Data of Firozabad City (September 2004 to August 2010)

Pollutant	Parameter	Industrial Area (IA)	Mixed Area (MA)	Residential Area (RA)	City Average
SO_2	Average	21	17	19	**19**
	Minimum	15	12	13	13
	Maximum	27	22	22	24
	Std. Deviation	4	3	3	4
NO_2	Average	35	30	31	**32**
	Minimum	27	24	24	25
	Maximum	43	35	37	38
	Std. Deviation	5	4	4	4
RSPM	Average	215	194	197	**202**
	Minimum	89	74	67	77
	Maximum	301	284	282	289
	Std. Deviation	80	77	80	79
SPM	Average	445	383	394	**407**
	Minimum	208	171	170	183
	Maximum	586	498	519	535
	Std. Deviation	140	122	129	131

(Average of monthly average values)

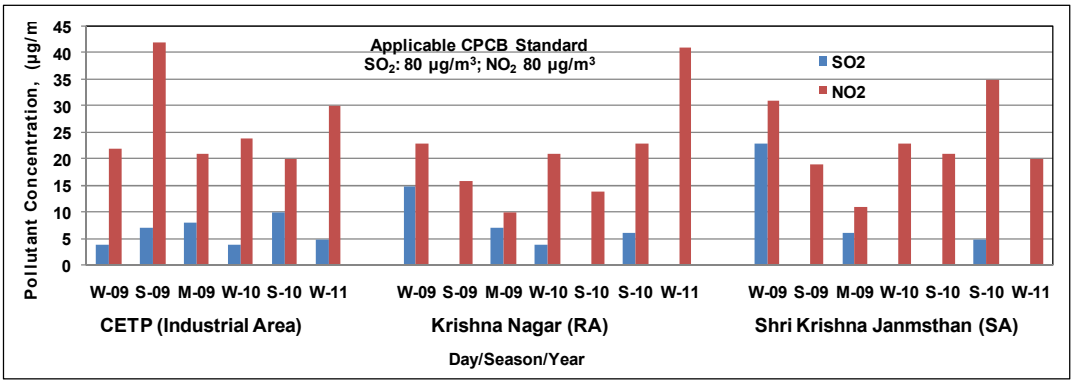


Fig. 2.1.8: Daily Ambient Air Quality Levels of SO_2 and NO_2 Monitored in Mathura during 2009-2011 (Random Day Sampling by CPCB, Agra)

2.1.4 Air Quality Status of Bharatpur City

Similar to Mathura city, air quality monitoring was carried out in Bharatpur at three locations (RIICO, Keoladeo National Park and Jila Parishad Office) on some random sampling days, which are represented here by season and year for inter-comparison of data. The analyzed data is presented in **Fig. 2.1.10** for NO_2 and in **Fig. 2.1.11** for RSPM and SPM. Most of the time, concentration levels of SO_2 were found to be below the detectable limits.

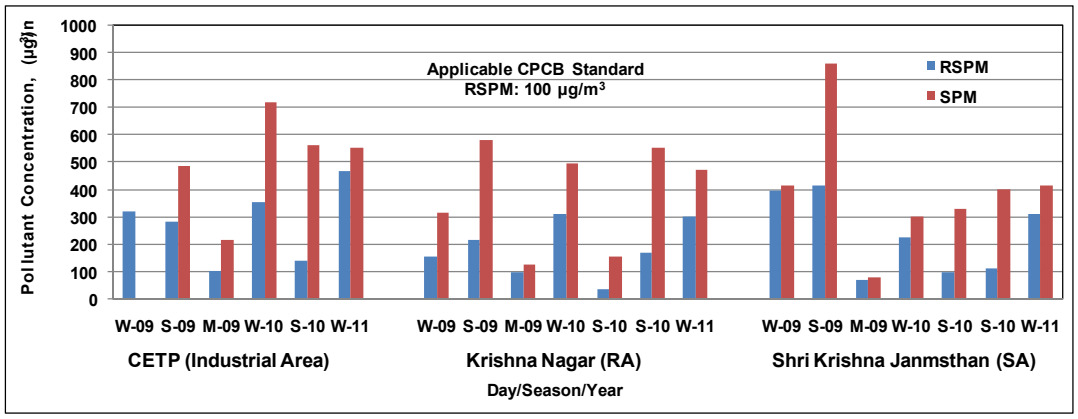


Fig. 2.1.9: Daily Ambient Air Quality Levels of RSPM and SPM Monitored in Mathura during 2009-2011 (Random Day Sampling by CPCB, Agra)

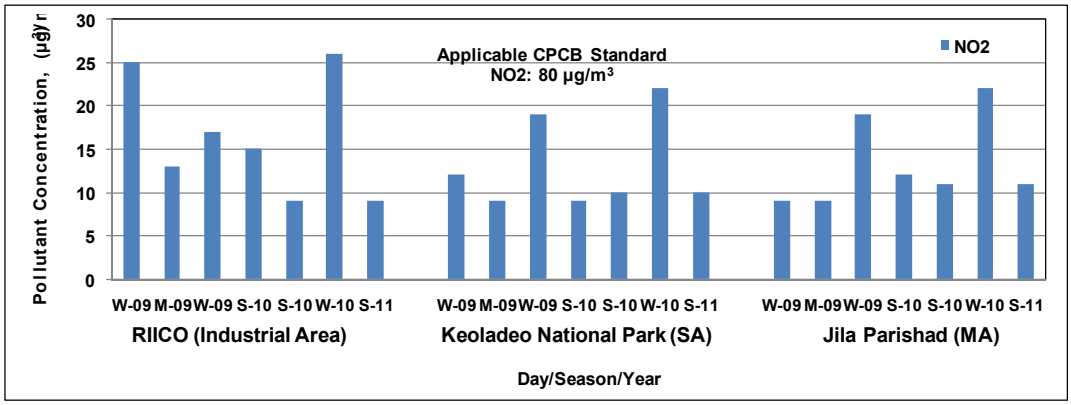


Fig. 2.1.10: Daily Ambient Air Quality Levels of SO_2 and NO_2 Monitored in Bharatpur during 2009-2011 (Random Day Sampling by CPCB, Agra)

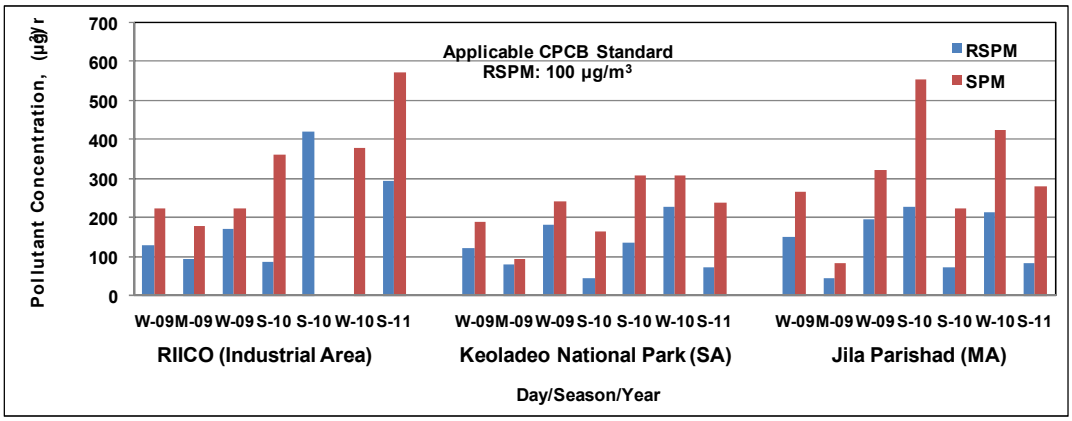


Fig. 2.1.11: Daily Ambient Air Quality Levels of RSPM and SPM Monitored in Bharatpur during 2009-2011 (Random Day Sampling by CPCB, Agra)

Analysis of data indicates that NO_2 levels were much below the applicable CPCB standard (80 µg/m^3), maximum being 26 µg/m^3, whereas RSPM levels were found to be almost all the time above the standard (100 µg/m^3), maximum being about 580 µg/m^3.

2.2 Meteorology of the Region

Meteorological data relevant from the air pollution studies point of view is being collected by the UPPCB through an automatic weather monitoring station installed along with the continuous air quality monitoring system at the Agra Nagar Nigam office. The meteorological parameters recorded include wind speed, wind direction, ambient temperature, relative humidity, barometric pressure, solar radiation and rainfall.

Daily average values of all these parameters is available, which is further summarized to get the mean, minimum and maximum values for the month, along with the data capture rate. A typical example of data available for the month of January 2011 is shown in **Table 2.2.1**.

2.2.1 Analysis of Meteorological Data

The meteorological data with respect to the monthly average wind speed has been analyzed for different months during 2010 and 2011. Monthly variation in wind speed as shown in **Fig. 2.2.1**, indicates that in 2010, the average wind speed increased from January till June and then decreased till November. In 2011, considerable fluctuations are observed among the months. In general, average wind speed is observed to be high during summer months (April-June) as compared to the winter months (Dec-March). Overall analysis of data indicates that the average wind speed is considerably high, in the range of 2.3 m/s to 4.3 m/s during different months of 2010-2011.

2.3 Sources of Air Pollution in TTZ Area

2.3.1 Industrial Sources

The major air polluting industries (127 units) in Agra include Cupola, Induction furnace, Rubber, Chemical and Engineering industries, which are currently using CNG supplied by GAIL and are reported to comply with the standards laid down by MoEF. Appropriate air pollution control systems (APCS) have been installed in all these air polluting units. List of all the 127 units is given in **Annexure 2.1**, along with the type of process and fuel used.

Envirotech Online Air Monitoring Station,UPPCB,Agra

Table 2.2.1.: Typical Example of Meteorological Data Summary Sheet

January 2011

Day	WS	WD	AT	RH	BP	SR	RF	VWS
	m/s	Degrees	C	%	mmHg	W/m2	mm	m/s
01 (Sat)	3.8	282	8.7	80.6	750	122	0.0	-0.3
02 (Sun)	3.3	260	7.0	77.9	750	139	0.0	-0.3
03 (Mon)	1.8	220	6.4	76.1	750	115	0.0	-0.3
04 (Tue)	2.8	277	5.6	79.1	750	138	0.0	-0.3
05 (Wed)	3.5	292	4.0	80.3	750	112	0.0	-0.3
06 (Thu)	2.8	254	4.8	80.6	750	131	0.0	-0.3
07 (Fri)	1.8	145	2.2	87.2	750	71	0.0	-0.3
08 (Sat)	1.8	134	4.0	81.6	750	147	0.0	-0.3
09 (Sun)	2.5	284	3.8	84.6	750	88	0.0	-0.3
10 (Mon)	4.2	287	6.9	74.6	750	162	0.0	-0.4
11 (Tue)	3.3	272	11.2	54.4	750	202	0.0	-0.3
12 (Wed)	2.0	201	13.4	56.5	750	185	0.0	-0.3
13 (Thu)	1.9	101	12.8	65.7	750	131	0.0	-0.2
14 (Fri)	3.0	109	15.3	64.1	750	165	0.0	-0.3
15 (Sat)	4.1	229	15.1	54.8	750	185	0.0	-0.3
16 (Sun)	6.0	287	9.7	57.4	750	176	0.0	-0.4
17 (Mon)	4.3	261	11.8	47.6	750	200	0.0	-0.4
18 (Tue)	2.0	243	13.6	52.9	750	187	0.0	-0.3
19 (Wed)	4.3	292	12.0	52.1	750	193	0.0	-0.4
20 (Thu)	2.7	264	12.8	50.2	750	185	0.0	-0.3
21 (Fri)	2.5	263	14.3	52.0	750	175	0.0	-0.3
22 (Sat)	1.7	233	16.4	53.9	750	172	0.0	-0.3
23 (Sun)	2.7	247	16.6	53.9	750	184	0.0	-0.3
24 (Mon)	3.5	294	14.4	52.6	750	184	0.0	-0.3
25 (Tue)	2.4	109	14.3	52.1	750	159	0.0	-0.3
26 (Wed)	2.9	173	15.1	53.5	751	177	0.0	-0.3
27 (Thu)	4.3	300	12.6	56.0	751	184	0.0	-0.4
28 (Fri)	2.2	243	12.5	54.2	750	197	0.0	-0.3
29 (Sat)	1.9	126	13.3	55.0	750	178	0.0	-0.3
30 (Sun)	2.1	150	14.6	56.6	750	162	0.0	-0.3
31 (Mon)	3.6	287	14.3	59.3	750	174	0.0	-0.3
Average	2.9	230	11.0	63.1	750	161	0.0	-0.3
Minimum	1.7	101	2.2	47.6	750	71	0.0	-0.4
Maximum	6.0	300	16.6	87.2	751	202	0.0	-0.2
Capture	100.0	100	100.0	100.0	100.0	100	100.0	100.0

Rainfall shows the total value of that day.

There are about 180 glass based industries manufacturing mainly glass bangles, glass beads, glass rods, glass tubes/shell, glass wares and glass blocks. DG sets are installed in almost all the glass industries in Firozabad District, which are mostly based on natural Gas. Details of industries in Firozabad are given in Section 2.3.3.

Mathura Refinery is the largest source of air pollution in Mathura. Besides, there are other small & medium scale industries in the region.

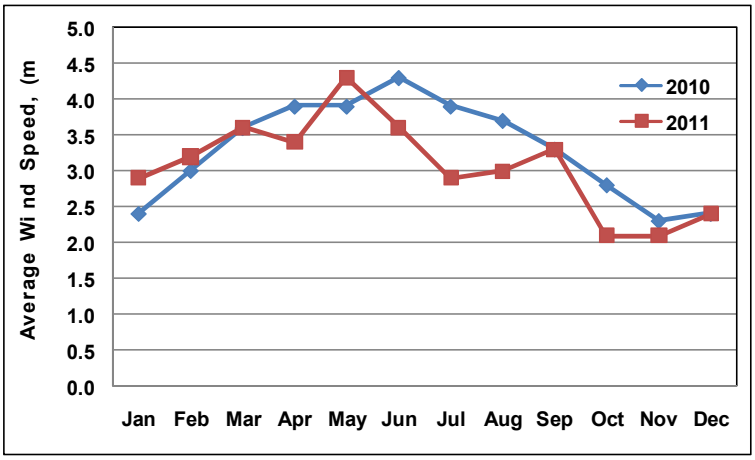


Fig. 2.2.1: Variation in Monthly Mean Wind Speed at Agra during 2010 and 2011

Due to proximity to the Keoladeo National Park, industries could not be developed in the Bharatpur region. Major industries like Central India machine Manufacturing Company (CIMCO), established in 1956-57, General Engineering Works and Dalmia Dairy Project have been closed for a long time. Presently, Perfect Sanitary Pipe and other small and medium scale industries manufacturing/producing agricultural equipments, tin container, animal fodder etc. are operating in Bharatpur. For systematic industrial development, Rajasthan Industrial Development and Investment Corporation (RIICO) was established in 1984. However, industrial development in the region is yet to be achieved.

Apart from the organized sectors of air pollution, there are a large number of small scale/ cottage/household activities which contribute towards air pollution. As in Agra, besides Foundries, there are nearly 120 Petha (sweet item) manufacturing units, and also more than 2000 halwaiis, 500 kumhars and bharbhujas, which use coal, cow dung, wood and agro-wastes. Average wood consumption in each Petha unit is found to be 5 kg/day, whereas coal used is about 4 kg/hr. Thus, the total daily consumption of all the Petha units is estimated to be about 500 kgs of wood and 4.7 tons of coal.

2.3.2 Vehicular Sources

Vehicle Growth in Agra District

Other than industries, vehicular population is the major contributor to air pollution in Agra. As per the records of RTO, Agra, total number of vehicles in Agra district have increased from about 4.0 lakhs to 6.4 lakhs in a span of 8 years (from 2003-04 to 2010-

11) with an overall annual average growth rate of about 7.6%. Year-wise growth of total number of commercial and non-commercial vehicles is presented in **Table 2.3.1**.

Table 2.3.1: Number of Total Registered Vehicles and Yearly Growth Rate (as on March 31)

Year	Number of Vehicles			Annual Growth Rate (%)		
	Commercial	Non-Commercial	Total	Commercial	Non-Commercial	Overall
2003-04	18232	379781	398013	--	--	--
2004-05	20012	416617	436629	9.76	9.70	9.7
2005-06	18184	456001	474185	-9.13	9.45	8.6
2006-07	20068	501554	521622	10.36	9.99	10.0
2007-08	22487	531488	553975	12.05	5.97	6.2
2008-09	23882	573249	597131	6.20	7.86	7.8
2009-10	26766	552934	579700	12.08	-3.54	-2.9
2010-11	29226	610034	639260	9.19	10.33	10.3

Commercial vehicles: Trucks/lorries, multi-axle – articulated, Buses (stage/contract carriages/ private), light vehicles (4W), delivery vans (3W)

Non-Commercial/private vehicles: 2W (Scooter, moped, motorcycles), 4W (cars, jeeps, gypsy, Omni, tractor, trailers etc.)

Presently, there are more than 6.7 lakh vehicles registered in Agra. Of the total vehicles, as much as 95.25% vehicles are non-transport vehicles (private vehicles, 80.43% 2-Wheelers and 14.85% 4-Wheelers). The number of registered commercial transport vehicles is only about 4.75%. Total number of registered vehicles under different categories in Agra is presented in **Table 2.3.2**. Percent share of different categories of vehicles is shown in **Fig. 2.3.1**.

Besides the movement of registered vehicles in the Agra and TTZ area, a large number of all categories of vehicles come from nearby states/cities like Delhi, Rajasthan (Jaipur, Alwar, Dholpur etc.), Madhya Pradesh (Gwalior), UP (Mathura, Firozabad, Aligarh etc.). Movement of all these vehicles for tourist as well as commercial activities also result in significant air pollution through vehicle exhausts.

According to the study carried out by CRRI (2002), the total number of vehicles entering and leaving the Agra city was 72300 (81%), whereas 19% vehicles (16950) passed through the city. The total pollution load generated from the vehicles in 2002 was estimated to be 17.93 tons/day of CO, 10.28 tons/day of HC, 3.61 tons/day of NO_x and 0.91 tons/day of PM. This was observed to be much less as compared to the other mega-cities like Delhi, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad and Kanpur.

Table 2.3.2: Number of Registered Vehicles in Agra (Sept 30, 2011)

	Vehicle Category	Total Vehicles	Break up of Vehicles
A.	**Non-Transport Vehicles**		
1.	2-Wheelers	5,39,455	Scooters: 26188, Moped: 6201, Motorcycles: 507066
2.	4-Wheelers	99,636	Cars: 54178, Jeeps: 3284, Omni Buses: 3444, Tractors: 36935, Tailors: 130, Others: 1665
	Total (1-2)	6,39,091	
B.	**Transport Vehicles**		
3.	Heavy Duty Trucks	4,026	Trucks & Lorries: 3774, Multi-axled articulated vehicles: 252
4.	Light Commercial Vehicles (LCVs)	13,422	4-Wheeler: 4191, 3-Wheelers: 9231
5.	Buses	1,798	Stage carriages: 790, Contract carriages: 362, Pvt. Serv. Vehicles: 314, Other buses: 332
6.	Taxies	3,623	Motor cabs: 3494, Maxi cabs: 129, Other taxies: 0
7.	Light Passenger Vehicles (LPVs)	8,770	3- Seaters: Nil, 4-6 Seaters: 8770
	Total (3-8)	31,639	--
	Grand Total	**6,70,730**	All category vehicles

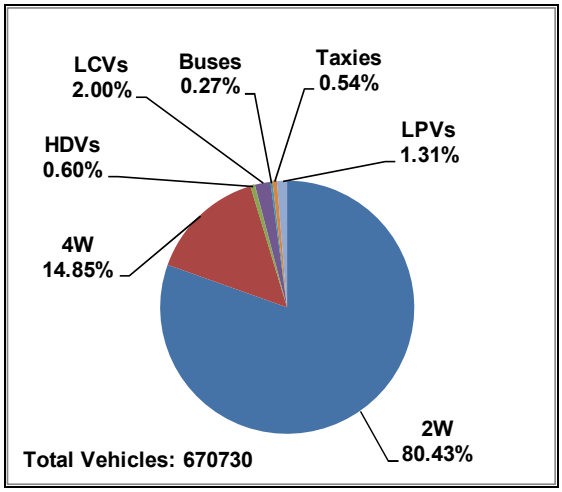


Fig. 2.3.1: Percent Share of Different category Registered Vehicles in Agra

2.3.2.1 Traffic Count at Important Locations

Recently traffic count was carried out by RTO, Agra at three locations in Agra (Fatehpur Sikri & Saiyan) and Mathura (Kotwan) on November 12-13, 2011. The categorized traffic data is presented in **Table 2.3.3** and **Fig. 2.3.2**.

Table 2.3.3: Traffic Count at 3 Major Locations in Agra and Mathura (Number of vehicles in 24 hours)

Vehicle Category	Vehicle Type	Fatehpur Sikri (Agra)	Saiyan (Agra)	Kotwan (Mathura)
2-Wheelers	All types	2265	1108	5165
3-Wheelers	All types	29	12	758
4-Wheelers	Private	745	1226	4940
	Taxi	392	109	815
Buses	Minibus	68	96	55
	Bus	180	210	402
Trucks	LGV	71	87	400
	MGV	65	488	725
	HGV	667	1708	830
Tractors		67	58	324
Total		**4549**	**5102**	**14414**

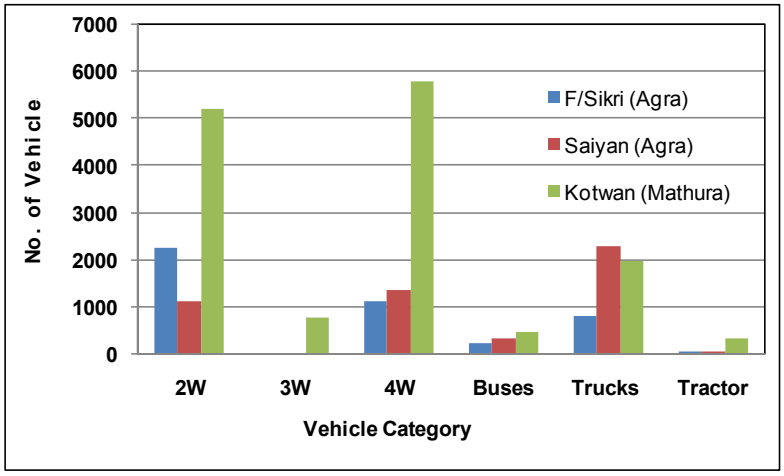


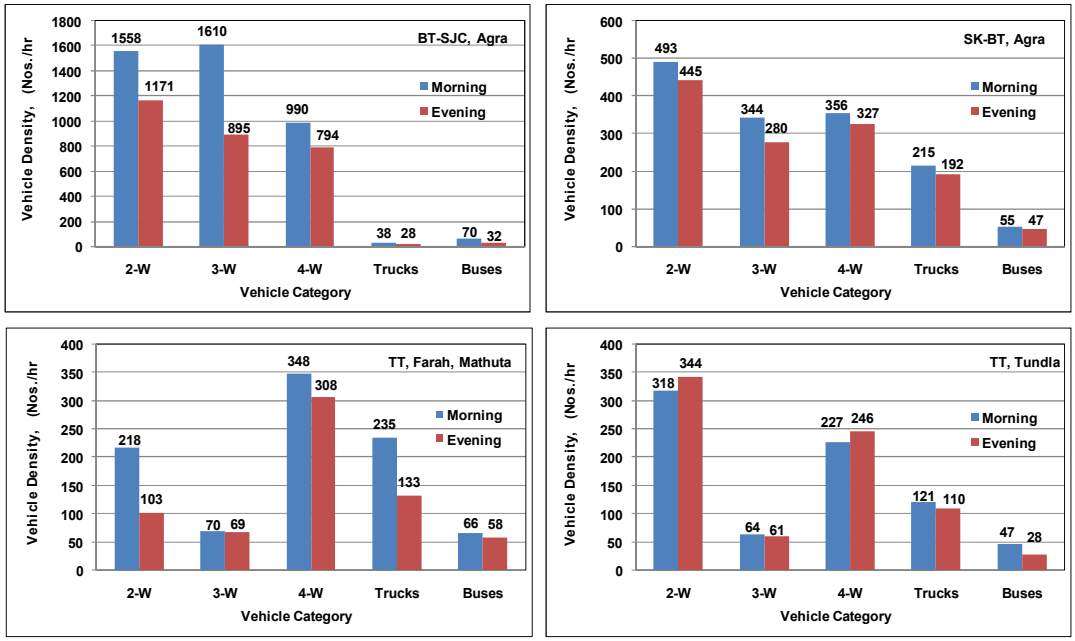
Fig. 2.3.2: Category-wise Traffic Movement at Certain Locations in Agra and Mathura (Source: RTO, Agra)

A perusal of the figure indicates high movement of vehicles at Kotwan (Mathura), as compared to Fatehpur Sikri and Saiyan. Secondly, movement of trucks is also high, particularly at Saiyan and Kotwan.

Traffic Count during Morning and Evening Peaks at Important Locations

Further, traffic was counted at some important roads/locations during morning (between 9-11 am) and evening (5-7 pm) peak hours on Dec 1, 2011. The roads selected were, (a) Bhagwan Talkies to St. John's Chouraha, (b) Sikandara to Bhagwan Talkies, (c) Toll Tax Centre at Farah, Mathura and (d) Toll Tax Centre at Tundla. Traffic

was counted under ten categories as light, medium and heavy goods vehicles (trucks), minibus and large bus (buses), private cars and taxies (4 wheelers), all types of 2-wheelers, tractors and 3-wheelers. Accordingly, these categories are further classified under five major classes as: 2-wheelers (2-W), 3-wheelers (3-W), 4-wheelers (4-W), Trucks and Buses. Hourly traffic density has been estimated as presented in **Fig. 2.3.3.,** which shows the comparison in traffic density during morning and evening peak hours.



a. BT-SJC: Bhagwan Talkies to St. Jhon's Chouraha, Agra, b. SK-BT: Sikandara to Bhagwan Talkies , Agra, c. TT-Toll Tax, Farah, Mathura, d. TT-Tundla - Toll Tax, Tundla

Fig. 2.3.3: Traffic Density during Morning and Evening Peak Hours at some Important Locations

A perusal of the above figure shows significant variation in traffic density of all categories of vehicles at BT-SJC Road and Toll Tax, Farah, whereas at other two locations, SK-BT, Agra and Toll Tax, Tundla, traffic density in morning and evening hours is more or less comparable. Another important observation is that the traffic density is more during morning peak hours as compared to the evening hours at all the locations for all types of vehicles (except for 2 & 4 W at Toll Tax, Tundla).

Movement of large number of vehicles in the TTZ area contributes not only air pollution through the exhaust pipes but also due to their movement on roads. Further, conditions of roads add substantially to re-suspension of road dust in large quantity and contribute to the total particulate matter (SPM/PM_{10}). The conditions of the roads in the

TTZ, in general, are either not adequate or not in proper condition, thus movement of traffic on such roads leads to significant dust pollution.

2.3.3 Status of DG Sets in TTZ Area

Apart from industrial and vehicular sources, a large number of other activities like agriculture, combustion of various fuels in houses (for cooking and heating), hotels & restaurants, bakeries, crematoria, biomass/refuse burning, DG sets etc. can significantly contribute to various types of air pollutants. Further, construction activities will also contribute significantly to the dust pollution.

Use of DG Sets, in whole TTZ area, especially in Agra is considered as a major source of air pollution. Irregular supply of electricity in the region forces the consumers to use DG sets for commercial as well as domestic purposes. Present status of DG Sets operation in TTZ area is presented here.

2.3.3.1 Status of DG Sets in Agra

As per the Environmental Management Plan of CPCB (2002) of Agra, it was estimated that about 32000 DG sets are operated in the city. As per the survey, number of DG sets, their capacity and daily operating hours along with average fuel consumption (per DG set and daily total) is given in **Table 2.3.4**.

Table 2.3.4: Details of DG Sets in Agra (CPCB - 2002)

Sector	No. of DG Sets	Capacity (KVA)	Average fuel Consumption (ltr./DG set/ day)	Daily Operation (hr/day)	Total Fuel Consumption (ltr./day)
Residential	25300	5 - 10	2-3	2 - 4	75900
Commercial Shops	5500	5 - 62	3.5	2	18374
Industry	800	5 - 625	6	2 - 3	4979
Hotels, Hospitals, Labs	430	5 - 800	6	3 - 5	2717
Total	**32030**	-	-	-	**101970**

Source: EMP-Agra, CPCB, 2002

The actual data regarding DG sets operating in the different sectors of the city is not available. Therefore, appropriate assumptions have been made to arrive at the estimated number of DG sets and the fuel consumption by the DG sets for an average power breakdown of 2-4 hrs per day. The average fuel consumption of DG sets has been taken on the basis of information available and discussion with DG sets owners in

various sectors. This could be taken as approximate projection with respect to the number of DG sets and quantity of fuel consumed by the DG sets in 2011. This data is based on assumed percentage growth (2001 to 2011) as mentioned in column 6 of the **Table 2.3.5**, along with the estimated details with respect to other parameters.

Table 2.3.5: Projected Details of DG Sets in Agra (2011)

Sector	No. of DG Sets	Capacity (KVA)	Average Fuel Consumption (ltr./ DG Set/ day)	Total Fuel Consumption (litres/day)	% Growth Rate in 2011 against 2001
Residential	31600	5 - 10	3	94800	25
Commercial (Shops)	15300	5 - 300	11	168300	178
Industry	1150	5 - 380	13	14950	44
Hotels	190	5 - 300	9	1710	-
Hospitals, Labs	640	5 - 150	8	5120	49
Total (Estimated)	**48880**	**-**	-	**284880**	-

2.3.3.2 Status of DG Sets in Firozabad

DG sets are installed in almost all the glass based industries in district Firozabad. There are about 180 glass based industries manufacturing mainly glass bangles, glass beads, glass rods, glass tubes/shells, glass wares and glass blocks. The DG sets are of different capacities ranging between 10 KVA and 500 KVA. The capacities of DG sets used in different glass industries are 10, 15, 25, 30, 35, 40, 50, 55, 60, 62, 64, 70, 75, 100, 125, 180, 250, 347, 380, 400 and 500 KVA. Therefore, the numbers of DG sets are classified into 5 major categories as summarized in **Table 2.3.6**.

Table 2.3.6: Capacity-wise Gas based Gen Sets/DG Sets in Industries in Firozabad

Fuel Use	Number of Units in different Category					Total
	Up to 15 KVA	16-50 KVA	51-100 KVA	101-200 KVA	More than 200 KVA	
Natural Gas	55	73	85	127	30	370
HSD	-	2	1	-	4	7

All the DG sets are operated with natural gas (NG). Besides, there are 7 DG sets (standby), which are operated on HSD.

DG sets are also deployed as alternative electricity source in many Health Care Facilities (HCFs), which include all types of hospitals, nursing homes, clinics, pathological labs etc. Information available for 49 Health Care Facilities indicates that 32 DG sets are installed in the HCFs. The capacity of DG sets, in general, ranges from 5 KVA to 50 KVA, whereas one hospital (M.C. Agrawal Hospital & Research Centre) has two large DG Sets of 82 KVA and 125 KVA capacities. The distribution of different capacity DG Sets is summarized under four categories as: up to 10 KVA: 18 units, 11-25 KVA: 9 units, 26-50 KVA: 3 units and more than 50 KVA: 2 units.

DG Sets are also installed in some commercial places such as banks and hotels. Information available for such 15 establishments indicates deployment of 17 DG Sets, in the capacity range from 5 KVA to 110 KVA. The DG Sets can again be categorized as: up to 10 KVA: 5 units, 11-25 KVA: 1 unit, 26-50 KVA: 4 units and more than 50 KVA: 6 Units. Of these, one DG Set of 75 KVA, installed at GAIL India Ltd. is operated on natural gas.

All these DG sets deployed in HCF and commercial sectors are used as standby, to be used in case of power break down/ power failure. All these DG Sets are operated on diesel, commercially available in the open market.

2.3.3.3 Status of DG Sets in Mathura

In Mathura, it is estimated that nearly 1000 DG Sets are installed/are being installed in Industries and commercial/residential premises like schools, hospitals, complexes and hotels etc. Further, details relating to the capacity of DG Sets and exact number are not available at present.

Analysis of air quality data in TTZ area indicates that major air pollutants in the region are particulate matter, NO_2 and SO_2. These pollutants emanate from a large number of sources, categorized under industries, vehicular, area sources (including DG Sets). Adequacy and condition of roads also play a significant role in generation of air pollution.

Based on the analysis of available data/information/reports on air quality as well sources, air quality management plan has been delineated, as presented in following section.

2.4 Air Quality Management Plans

2.4.1 Summary of Air Quality at the Taj Mahal and in TTZ Area

Air quality data monitored by CPCB, Agra Office from 2002 to 2010 indicate that annual average concentration levels of different pollutants are in the range as, SO_2: 4-9 $\mu g/m^3$, NO_2: 18-23 $\mu g/m^3$, RSPM: 133-167 $\mu g/m^3$ and SPM: 296-376 $\mu g/m^3$. SO_2 and NO_2 levels are below the applicable annual average CPCB Standard value of 20 $\mu g/m^3$ and 30 $\mu g/m^3$ for the sensitive area category. Observations recorded by the ASI at the Taj Mahal are also in the same range.

Further, monthly average values during 2009-2011 (up to Oct 2011) for different pollutants ranged as: SO_2: 4-8 $\mu g/m^3$, NO_2: 10-36 $\mu g/m^3$, RSPM: 27-299 $\mu g/m^3$ and SPM: 64-460 $\mu g/m^3$. The lowest concentration levels are recorded during monsoon months, whereas highest levels are recorded during winter months for all the pollutants.

Analysis of air quality data with respect to routinely measured pollutants (SO_2, NO_2 & RSPM) over the years at the Taj Mahal appears to have been stabilized (within the CPCB limits) for SO_2 and NO_2, however, RSPM levels are about 2 to 3 times higher than the Standards and need more attention. Efforts are, therefore, required to bring RSPM (PM_{10}) levels below the permissible level of 60 $\mu g/m^3$ (annual average) and 100 $\mu g/m^3$ for 24 hourly average concentrations. Further, efforts are required to minimize or at least contain the existing levels of SO_2 and NO_2 at the Taj Mahal, and also in different cities/regions under TTZ.

Analysis of available ambient air quality monitored by CPCB, Agra Office, UPPCB at Agra, Mathura, Firozabad and Bharatpur indicates that concentration levels of SO_2 and NO_2, in general, are much below the applicable CPCB standards, however levels of NO_2 have increased over the years. The concentration levels of RSPM are much higher at all the sampling locations throughout the TTZ area. High levels of RSPM may be attributed to various other unaccounted sources of air pollution, than the identified sources like industries, vehicles and road dust re-suspension. Therefore, efforts are required mainly to control the pollution due to particulate matter throughout the TTZ area.

2.4.2 Measures taken in Past for Improvement in Air Quality of TTZ Area

Several actions were taken into account in the past to control/manage air pollution levels in TTZ area, mainly to protect the World Heritage, Taj Mahal. Some of the major actions were :

- Closure of coal based Thermal Power Generation Plants
- Dieselisation of Railway Yards
- Prohibition of establishment / expansion of air polluting industries
- Closure of coal/coke based industries at Agra and closure of polluting industries except those equipped with adequate Pollution Control Systems in TTZ.
- Closure of Approx. 450 Brick kilns within TTZ
- Supply of Natural Gas to Mathura Refinery and Industries of Agra and Firozabad (in phase-wise manner)
- Setting up of improved Sulfur Recovery Units at Mathura Refinery
- Supply of ultra low sulfur diesel to vehicles
- Restriction on plying of petrol, diesel driven vehicles around 500 m of Taj Mahal
- Plying of Battery operated Buses and other vehicles within 500 m of Taj Mahal, and also in Agra City
- Fixation of age for public and commercial vehicles
- No new registration of age barred vehicles
- Use of Gas/ Eco- friendly fuel by Industries of Agra
- Supply of CNG started for vehicles at Agra etc.

Though several measures have been taken in the past to control air pollution in the TTZ area, however with the growth in residential as well as floating population in the region shall continue to result in enhanced activities, thus putting pressure on the environment of the TTZ area. Continuous efforts are, therefore, required to contain the conditions/ situations which lead to generation of pollution, through improved infrastructural facilities with technological advancements.

Fulfillment of the three basic infrastructural needs, viz. safe drinking water, safe road and continuous power supply are of the utmost importance.

In general, re-suspension of dust from roads due to movement of large number of vehicles becomes a major source of dust pollution in the region. Therefore, there is urgent need to create/develop and maintain all types of roads in the region. Poorly maintained roads not only lead to higher levels of particulate emissions, but also lead to enhanced vehicular exhaust emissions and accidents.

2.4.3 Road Network and Traffic Management

In this regard, a comprehensive systematic study was conducted by Urban Mass Transit Company Limited to identify the road network and traffic management needs of Agra, the study is known as Comprehensive Mobility Plan (CMP), Agra. The report provides long term vision and goals to achieve the desirable mobility pattern for the city population in a sustainable and cost effective manner. Based on the primary data collection through traffic count, house hold survey, road network inventory, pedestrian count crossing roads/junctions, speed and delay surveys and on-street & off-street parking surveys, various key issues have been identified in the study along with their current status, which are briefly summarized in **Table 2.4.1**.

2.4.4 Vehicle Inspection and Maintenance related Aspects

Motor vehicle fitness is mandatory throughout the world. The way it is important for human beings to be deemed fit through periodic health test, it is necessary for a vehicle to be deemed fit by a periodic fitness test. The test confirms that the vehicle, at the time of test, without dismantling it, meets the minimum acceptable environmental and road safety standards required by law. Safety on road is ensured by prevention of accidents, which in turn are caused either due to driver's negligence/fault or due to mechanical defect in vehicles. The former can be improved by educating the people/drivers through proper driving training and practice, whereas mechanical faults can be prevented through periodic fitness test of vehicles.

The vehicle fitness test looks at the vehicle body structure, the fuel system, the exhaust emissions, the exhaust system, the seat belts, seats, doors, mirrors, load security (door locks and latches), brakes, tyres and wheels, registration plates, lights, bonnet, wipers and washers, windscreen, horn, steering and suspension, and vehicle identification number.

In Agra as well as the whole State of Uttar Pradesh, there exists a mandatory system for inspection and maintenance of vehicles. Every commercial vehicle has to undergo a mandatory fitness test. The renewal period for fitness certification, in general, is 2 years for new commercial vehicles and every 1 year for old vehicles. Even for private vehicles, periodic fitness check is required in case of vehicles with a seating capacity of 7+1 and above. For all other categories of private vehicles, there exists a system of re-registration of private vehicles after 15 years of initial registration. Age limit

Table 2.4.1: Identified Key Issues with their Current Status related to Road Network and Traffic Management in Agra

Sr. No.	Key Issue	Guiding Parameters with Existing Status	Salient Findings/ Identified Need
1.	Land use	City Land use pattern for various purposes	Urban sprawl has taken place in all the directions Thrust has been observed in urbanization of the West and South
2.	Regional Road Connectivity	**Inter-State Road Network** NH-2 to Delhi in north direction and to Kolkata via Kanpur towards East. NH-11 to Jaipur NH-3 to Mumbai NH-93 to Aligarh	Good network of highways radiating outwards, however, absence of ring road connectivity to link peripheral areas is observed.
3.	Road Network	**Type of Carriage Width** Up to 2 lanes – 8% 2-4 lanes – 53% 4-6 lanes – 35% 6-8 lanes – 4%	2 lane carriageway – 52% Un-divided carriageway – 77% Road makings – absent on 87% of the road network
4.	Public Transport	**Mode of Travel (including NMT)** 2W – 21% Car – 1% Public Transport – 4% Auto/Taxi- 20% Walk – 37% Cycle – 17%	Organized public transport is required in the city Dedicated routes of operation for 3-wheelers and Vikram, but not adhered to by the operators Low average occupancy in all modes of public transport Average daily utilization – 100 kms Public transport share – 4%
5.	Non-Motorized Transport (NMT)	No footpath – 8% < 1 m: 5% 1-3 m: 68% 3-5 m: 16% > 5 m: 3%	Development of footpaths and suitable street furniture is required on major roads of the city Encroachment of footpaths Absence of pedestrian crossing facilities on almost all intersections Highest pedestrian movement areas – Dayal bagh, Redfort and St. Johns
6.	Traffic Congestion	**Vehicle Ownership** No vehicle – 8% Cycles – 44% 2W – 42% Cars – 6%	Major congested roads are MG Road, By pass road and NH2 Enforcement of traffic rules is a major focus area that needs attention Overall network has average journey speed less than even 16 km/hr
7.	Parking	Survey analysis	On street parking at MG road reducing availability of carriage width High parking demand at Loha Mandi, Shahganj, Bodla, Dayalbagh, Sanjay Place resulting in heavy congestion throughout the day Unorganized parking outside major tourist attraction areas like Redfort, Dayalbagh etc.
8.	Freight System	**Average Trip Frequency of Goods Vehicles** Daily – 9.5% Alternate day – 1.45% Weekly – 48.0 Monthly – 21.9% Others – 19.1%	The city is in dire need for freight management strategy 3 Terminals – Hing ki Mandi, Belanganj and Petha Mandi located in the heart of the city
9.	Critical Intersections	**Traffic Composition (PCU)** Slow moving - 36% Light moving - 54% Heavy moving - 10%	Encroachment on footpath Low junction capacity/poor junction design, on street parking Uncontrolled traffic Un-signalized junctions Lack of Enforcement, Signages, Road markings and Non-availability of Pedestrian crossings.

(Source: Comprehensive Mobility Plan for Agra City, by Urban Mass Transit Company Ltd.)

Such mobility plans also need to be prepared for whole of the TTZ.

fixed by the Road Transport Authority (RTA)/ State Transport Authority (STA) in Agra and Taj Trapezium Zone for different types of commercial vehicles is presented in **Table 2.4.2**.

Table 2.4.2: Age Limit for different Types of Commercial Vehicles for Agra and TTZ Area (Fixed by the RTA/STA)

Jurisdiction	Type of vehicle	Type of Fuel	Age Limit
Agra City	City Bus	CNG	12 Years
	Tempo-Taxi	CNG	10 Years
	Auto-Rickshaw	CNG	10 Years
	School Bus	CNG	12 Years
	Private/Factory	CNG	12 Years
Agra Rural	Tempo-Taxi	Diesel	10 Years
	Auto-Rickshaw	Petrol/Diesel	10 Years
	School Bus	Diesel	15 Years
	Private/Factory	Diesel	15 Years
TTZ Area	Stage Carriage Bus	Diesel	10 Years
Out of TTZ Area	Stage Carriage Bus	Diesel	20 Years

To meet the requirement of CNG in the Agra region, there is one Mother Station (T.P. Nagar, Agra) with two Booster Stations (Sarai Khwaza, VIP Road and Kothi Bazaar, Agra). There is one on-line station at Sikandara. The existing facility is considered insufficient to meet the increasing demand and one more Mother Station is proposed at Taj Nagari, Agra.

Fitness Certification System in Agra

Fitness of different categories of vehicles, such as CNG buses, commercial vehicles (such as trucks, bus, auto rickshaw, school bus etc.), private vehicles such as car, van, etc. is carried out and renewed by RTO, Agra. On an average, 50 vehicles of different categories are issued fitness certificate daily, which amounts to 12000 to 15000 vehicles annually. The data provided by RTO office, Agra shows that number of on road commercial vehicles have increased gradually from 18732 in 2003-04 to 29994 in 2010-11. Further, Agra is one of the cities with highest fatalities and its risk due to road accidents. Road accident fatalities in Agra are compared with other major cities of Uttar Pradesh and also with national average, as depicted in **Table 2.4.3**.

Table 2.4.3: Fatality Risk in Agra and Other major Cities of UP (2007)

City	Population (Lakh)	Number of Fatality Cases	Fatality Risk (Cases/Lakh)
Agra	**13.2**	**510**	**38.6**
Allahabad	10.5	104	9.9
Kanpur	26.9	544	20.2
Lucknow	22.7	517	22.8
Meerut	11.7	354	30.3
Varanasi	12.1	218	18.0
UP (above cities)	97.1	2247	23.1
Uttar Pradesh (Overall)	**1885.4**	**12555**	**6.7**
India	11365.5	114590	10.1

(Source: Accidental Deaths and Suicides In India, 2007, published by the National Crime Records Bureau, Ministry of Home Affairs, GOI, New Delhi)

Thus, one center in a city is hardly adequate to cater to the huge population of transport vehicles. Looking at the trend in number of vehicles being registered in Agra annually, there is urgent need of opening another fitness centre with much higher capacity.

Further, the Transport Department in Agra, by and large, depends on visual checks and limited road tests (for checking brakes) for inspecting the vehicles for fitness certification. A modern test facility, meant for testing and certification of commercial vehicles needs to have following test equipments like Emission measurement systems, Brake Tester, Head Light Tester, Side Slip Tester, Computerized Wheel Alignment System, Sound Level Meter etc.

Various studies conducted worldwide have indicated that with the implementation of proper I/M system, there could be 30-40% reduction in pollution load from vehicles as well as significant fall in number of road accidents.

Some of the gaps identified by RTO, Agra in the existing system are outlined below, which needs to taken up on priority:

- Lack of adequate testing facility. Only one center exists in city which obviously cannot cater to the huge vehicle population requirement.

- Number of vehicle inspectors is very less. More trained inspectors need to be inducted by the Transport Department.

- Only commercial vehicles are required to go for fitness tests till now. Private vehicles with 7+1 capacity and above are also required now to go for periodic fitness test. However, there is a lack of awareness regarding this statutory provision.

- All categories of vehicles should be brought under the ambit of fitness testing. Private vehicles below 6+1 seating capacity should be made to go for fitness test at service centres.

- The existing system being inefficient and inclined more to visual checks encourage false passes and corruptions.

The menace of exhaust emissions from old vintage on-road vehicles (poorly maintained vehicles) and increasing number of road accidents call for a comprehensive and efficient vehicle fitness certification system in India. Though there exists a system of fitness certification, proper implementation and functioning of the system has been a concern for long. Concerns of road accidents due to mechanical failure of vehicles and problems of vehicle fitness can only be tackled by putting in place sufficient numbers of testing centers in each State/District, which could be established by automobiles manufacturer companies independently or in collaboration.

Considering the above problems in India, more stress for setting up better test facilities is required. Experiences of other countries may play a vital role in designing an efficient fitness testing system. Private participation may also be considered for better functioning of the test centres. Legal provision should be made for petrol pumps to provide fuel only to those vehicles which have required fitness certificate.

According to automobile experts, the setting up of fitness centres will reduce the number of vehicle breakdowns and mishaps that could have been avoided by preventive maintenance. The need is however to implement the existing rules and laws effectively. Until operators, vehicle owners as well as the authorities are not adequately educated about the perils of an ill maintained or an unfit vehicle, the importance of scientific fitness centres may not be fully realized.

Annexure 2.1

List of Air Pollution Industries in Agra

S. No.	Name and Address	Type	Remarks
1	Singhal Pesticide, Yamuna Par, Agra	-	Solar Evapo.
2	Agarwal Industries, Foundry Nagar, Agra	-	Solar Evapo.
3	Sunray Chemical Ind., Yamuna Kinara "Road, Jeoni Mandi, Agra	-	Solar Evapo.
4	Sahaj Ceramic Pvt. Ltd., 55 IInd, Nunhai, Agra	-	U.G.
5	S.K. Iron Foundry & Engg. Co. Unit-I, Rambagh, Agra	Induction Fur.	
6	S.K. Iron Foundry & Engg. Co. Unit-II, Rambagh, Agra	Cup./Rot.Fur	U.G.
7	S.G. Industries, Rambagh, Agra	Cup./Rot.Fur	U.G.
8	Golden Engg. Corpn., 44/45, Rambagh, Agra	Cup./Rot.Fur	U.G.
9	Castwel Foundry, naraich, Hathras Road, Agra	Cup./Rot.Fur	U.G.
10	Oswal Foundry, Rambagh, Agra	Cup./Rot.Fur	U.G.
11	Suraj Foundry, 11/45, Rambagh, Agra	Cup./Rot.Fur	U.G.
12	Parolia Engg. Works, 11/47-C, Rambagh, Agra	Cup./Rot.Fur	U.G.
13	Reliable Industries, Rambagh, Agra	Cup./Rot.Fur	U.G.
14	Shree Ram Iron Foundry & Engg. Works, Rambagh, Agra	Cup./Rot.Fur	U.G.
15	Jagdish Industries Corp., Naraich, Hathras Road,	Cup./Rot.Fur	U.G.
16	R.K. Engineers & Founders, Hathras Road, Agra	Rotary Fur.	U.G.
17	R.R.Iron Foundry, Rambagh, Agra	Cup./Rot.Fur	U.G.
18	Kansal Iron Foundry, 11/48/G/C, Naraich, Hathras Road, Agra	Cup./Rot.Fur	U.G.
19	Goyal Metal Industries, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
20	Ravi Agriculture Industries, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
21	V.K. Enterprises, C-48, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
22	Manik Chand Garg & Co., C-30, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
23	Bombay Engg. & Moulding Works, Nagla Kishan Lal, Agra	Cup./Rot.Fur	U.G.
24	Bharat Industries Unit-2, B-42, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
25	Techno Industries, 2919, Naraich Hathras Road, Agra	Cup./Rot.Fur	U.G.
26	Goyal Iron & Steel Works (India), Nagla Kishan Lal, Agra	Induction Fur.	U.G.
27	K.J. Industries, B-5, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
28	Bajrang Iron Foundry, B-64, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
29	Agra Loh Uddhyog, 1167, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
30	Singhal Indusries, B-2, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
31	Raj Iron Foundry, Unit-II, B-3, Foundry Nagar, Agra	Cup./Rot.Fur	
32	Naresh Iron Foundry, D-62, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
33	A.B. And Engg. Works, C-32, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.

S. No.	Name and Address	Type	Remarks
34	Suresh Iron Foundary, C-55, Foundary Nagar, Agra	Cup./Rot.Fur	U.G.
35	Shree Ram Engg. Co., D-19, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
36	Expert Founders & Engg., C-29, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
37	Bansal Casting Co., D-17, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
38	Maharaja Agensen Iron Fondry, D-15, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
39	Ajanta Industries, D-20, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
40	Accurate Ferro Casting, B-18/B, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
41	Shinning Engg. Works, B-19, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
42	Mittal Iron Founders & Engg., Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
43	Shivam Industries, C-23, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
44	Kamal Engg. Works, Unit-II, C-25, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
45	Kamal Engg. Works, 11/48 D Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
46	Narayan Brothe;rs Factory, E-3, Foundry Nagar, Agra	Pit.Fur	U.G.
47	Gopal Iron Foundry, D-43, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
48	Bhagwati Iron Foundry, D-2, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
49	Chinar Foundry, E-1,2, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
50	Modern Industries, 11B 76A, Foundry Nagar, Agra	Cup./Rot.Fur	N.O. 6M
51	Devi Sahay Gopal Das Iron Foundry, C15, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
52	Mittal Industries, C-18, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
53	B.K.Castings, C-6, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
54	N.K.Iron Foundry, C-3, Foundry Nagar, Agra	Induction Fur.	U.G.
55	Shanti Vrat & Sons, H-7, Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
56	B.S.Agriculture Ind. 17/15, Nunhai Road, Nawalganj, Agra	Induction Fur.	U.G.
57	Vijay Iron Foundry, 1250, Tedi Baghiya, Agra	Induction Fur.	
58	Kaushal Industries, Nawalganj, Agra	Cup./Rot.Fur	U.G.
59	Bharat Iron & Steel Foundry, Katra Wazir Khan, Agra	Induction Fur.	U.G.
60	Kumar Steel Udyog, 11/24, Chini Ka Rosa, Agra	Cup./Rot.Fur	U.G.
61	G.T.Iron Industries, 11/38A-3, Hathras Road, Agra	Cup./Rot.Fur	U.G.
62	Metal Cast India, 3, Industrial Estate, Nunhai, Agra	Cup./Rot.Fur	U.G.
63	Amar Enterprises, 2, Industrial Estate, Nunhai, Agra	Cup./Rot.Fur	U.G.
64	Paras Glass, 68, Industrial Estate, Nuhai, Agra	Tank.Fur	U.G.
65	Mahavir Iron Foundry, 67, Industrial Estate, Nunhai, Agra	Cup./Rot.Fur	U.G.
66	Maharishi Dayanand Iron Foundry, 71, Indl. Estate, Nunhai,	Induction Fur.	U.G.
67	Traco International, 56, Industrial Estate, Nunhai, Agra	Induction Fur.	U.G.
68	Metafeb Engg. Associate, 19 Industrial Estate, Nunhai, Agra	Induction Fur.	U.G.
69	Vinay Iron Foundry, Artoni, Mathura Road, Agra	Induction Fur.	U.G.

S. No.	Name and Address	Type	Remarks
70	Samta Trading Corp. 136, Industrial Estate, Nunhai, Agra	Cup./Rot.Fur	U.G.
71	ESBE Steels & Casting, 139, Nunihai, Agra	Cup./Rot.Fur	U.G.
72	Dewan Chand Suraj Prakash Jain, 11/43, Rambagh, Agra	Induction Fur.	U.G.
73	Devi Enterprises, Hathras Road, Agra	Pit Fur.	U.G.
74	Shri Bankey Bihari Udhyog, 10/9, Katra Wazir Khan, Agra	Induction Fur.	U.G.
75	A.V.Engg. Works, 160, Industrial Estate, Nunhai, Agra	Cup./Rot.Fur	U.G.
76	Paliwal Iron Foundry & Metal Works, Rambagh, Agra	Induction Fur.	U.G..
77	Ratan Industries P.Ltd., 10/12, Katra Wazir Khan, Agra	Induction Fur.	U.G.
78	Meghdoot Pistons P.Ltd. 7, Industrial Estate, Nunhai, Agra	Induction Fur.	U.G.
79	Pahuja Engg. , Foundry Nagar, Agra	Induction Fur.	U.G.
80	S.J Steels sahdara, Agra	Induction Fur.	U.G.
81	India Casting Co., D-42 , Foundry Nagar Agra	Cup./Rot.Fur	U.G.
82	Anil Metal Industries (Foundry Div.) Bichouri Road, Agra	Cup./Rot.Fur	U.G.
83	Arbariya Steels, Mathura Road, Agra	Induction Fur.	U.G.
84	Luthra Engineering, 15, K.M.Stone, Mathura Road, Agra	Induction Fur.	U.G.
85	S.B.Iron Foundry, 11/18-B, Rambagh, Agra	Cup./Rot.Fur	U.G.
86	Goyal Iron & Steel Works, Naraich, Hathras Road, Agra	Cup./Rot.Fur	U.G.
87	Shaktiman Industries, E-25, Foundry Nagar, Agra	Pit Fur.	U.G.
88	Metal Product, C-33, Foundry Nagar, Agra	Pit Fur.	U.G.
89	Alfa Engg. Works, 20, Industrial Estate, Nunhai, Agra	Cup./Rot.Fur	U.G.
90	Jagdis Metal works, 24, Industrial Estate, Nunhai, Agra	Pit Fur.	U.G.
91	Sandeep Auto Industries, 87, Industrial Estate, Nunhai, Agra	Pit Fur.	U.G.
92	Suchlam Engg. Work.,165A, Industrial Estate, Nunhai, Agra	Pit Fur.	U.G.
93	Sterling Auto Industries, Foundry Nagar, Agra	Induction/Cup. Fur.	U.G.
94	Atul Engg. Udhyog, Industrial Estate, Nunhai, Agra	Induction Fur.	U.G.
95	Accurate Engineers, 11/39B, Sitanagar, Rambagh, Agra	Cup./Rot.Fur	U.G.
96	Ashok Metal Work, 8 KM Stone, Shahdra, Agra	Cup./Rot.Fur	U.G.
97	Associated Industrial Corpn. 12/146B, Nunhai, Agra	Tank.Fur	U.G.
98	A.K.Enterprises, B-20/1 Foundry Nagar, Agra	Cup./Rot.Fur	U.G.
99	Agra Ispat Udyog, Artoni, Agra	Cup./Rot.Fur	U.G.
100	Agra Steel Corporation, Sahadra, Agra	Cup./Rot.Fur	U.G.
101	Amar Enterprises Unit -II, 66, Ind Area., Agra	Cup./Rot.Fur	U.G.
102	Atul Generators P. Ltd., Nunhai, Agra.	Cup./Rot.Fur	U.G.
103	Automotive Products, 73, I.E., Nunhai, Agra	Cup./Rot.Fur	U.G.

S. No.	Name and Address	Type	Remarks
104	Balkeshwarnath Industries, Shayam Nagar, Hathras Road, Agra	Cup./Rot.Fur	U.G.
105	Brij Iron Foundry, 13/23C, Nunhai, Agra	Induction Fur.	U.G.
106	Goyal Engineering Co., Hathras Road, Rambagh, Agra	Cup./Rot.Fur	U.G.
107	India Casting Co.,Navalganj, Nunhai, Agra	Cup./Rot.Fur	U.G.
108	India Steel Industries, B-14/2,Foundry Nagar, Agra	Cup./Rot.Fur	
109	Indu Engg. & Textiles Ltd., 12/16A, Nawalganj, Agra	Cup./Rot.Fur	U.G.
110	Khandelwal Industries Enterprises, 72-80 Ind.Estate Agra	Induction Fur.	U.G.
111	Krishna Engg. Works. 35 Ind. Estate, Agra	Cup./Rot.Fur	U.G.
112	Kajiko Industries Hathras Road, Agra	Cup./Rot.Fur	U.G.
113	Prakesh Iron Foundry, Hathras Road, Agra	Cup./Rot.Fur	U.G.
114	R. K. Iron Industry, Nunhai, Agra	Cup./Rot.Fur	U.G.
115	Novalty Metal & Rubber Indust. 155. Industrial Estate Agra	Cup./Rot.Fur	U.G.
116	Modern Slaughter House, Kuberpur, Agra - Slaughter House		
117	Ajanta Raj Proteins Ltd., Unit-II, Manikpur, Bah, Agra - Milk Processing	Boiler	
118	ACME Asbestos Pipes Pvt.Ltd., Nunhai, Agra - Asbestos Pipes		
119	HMA Frozen Food, Ltd. Kuberpur, Agra - Meat Packag.		
120	Agra Chains Pvt. Ltd. 14 Ind. Area, Nunhai Agra - Silver Jewelry	Electroplating	
121	Agra Machine tools Pvt. Ltd., Industrial Area, Nunhai Agra - Imitation Jewelry	Electroplating	
122	Benara Udyog Pvt. Ltd., Bodla Road, Agra - Bearing/Bushes	Electroplating	
123	M/s Khandelwal Industries Enterprises, 72-80, Industrial Estate, Nunhai, Agra - Metal Casting	Electroplating	
124	Atul Deepwell Hand Pumps, Atul Compund, Nunhai, Agra - Hand Pump	Electroplating	
125	M/s Bandejjia traders, Laxmi Comples, Bansal Nagar, Fatehabad Road, Agra - Textile	Dyeing	N.O. 6M
126	M/s Britania Engineering, C-31. Foundry Nagar, Agra – Casting – APCS: NA	Induction/Pit Fur.	R.L.A.
127	M/s HubbLal Molding Works, 13/19D, Purani Chungi Nunhai, Agra - Casting– APCS: NA	Rot. Fur	R.L.A.

I.A. : Installed & Adequate, U.G. - Using Gas, R.M.R. - Repair & Maintenance Required
N.O. 6M : Not in operation for last 6 months
R.L.A. : Recommended for Legal Action

CHAPTER 3.0

WATER SUPPLY, SEWERAGE & DRAINAGE

3.1 SITUATIONAL ANALYSIS

The TTZ area comprises the following six cities: Agra, Mathura-Vrindavan, Fatehpur Sikri, Firozabad, Hathras in UP and Bharatpur in Rajasthan. The major city of importance is Agra. Therefore, the water supply projects have been prepared by UPJN for Agra city water supply improvement.

Agra city, like most Indian cities, is a growing metropolis. The municipality, encompassing an area of 121.57 sq km had a population of about 1.26 million as per 2001 census. By 2005, this had grown to 1.43 million, with 2011 projected population estimated to touch 1.7 million. However, Agra, designated as a world heritage site, faces a number of challenges in terms of water, sewerage and financing municipal works. There is a bursting strain on the infrastructure and services, both from its own population and from the regular visiting tourists, estimated at 1.80 million every year.

Projected Population for Agra city

Year	Arithmetic	Geometrical	Incremental	Average	Final Population
2006	1447458.50	1535303.17	1498192.25	1493651.31	14.93
2011	1563578.00	1688357.75	1698868.00	1650267.92	17.53
2016	1679697.50	1901307.60	1933366.25	1838123.78	19.88
2021	1795817.00	2141116.49	2201687.00	2046206.83	22.69

Ref: MDP Consultants (P) Ltd. in association with Allianz Securities Limited August 2006

In the city, Agra Jal Sansthan (AJS) is in charge of operation and maintenance, and revenue collection in supplying water, while all capital works related to water supply and sanitation are undertaken by Agra Jal Nigam (AJN).

3.1.1 Major Issues

The major Sectoral (Water Supply, Sewerage and Drainage) issues evolved from the city assessment, as reported in the CDP, are as follows:

- The area covered by piped water network is only 85 per cent.
- Hand pumps and tankers meet the water requirement in Sikandra-II, Bodla-II, Shahganj-III, Tajganj-II & III, Trans Yamuna-II & Ghatwasan-II areas.
- The percentage of water loss due to leaks from pipes and pipes appurtenances ranges between 9-37 per cent while UFW ranges between 40-45 per cent of the total supply, which is very high.
- Poor raw water quality.
- Excessive water loss due to leaks in water pipes and pipe appurtenances.

- Damaged water mains and distribution mains.
- Very low pressure at tail end.
- Catchment area of the Zonal Pumping stations is not clearly segregated.
- The length of the pipe network is about 1350km, 95 per cent of the leakages due to service lines.
- Depletion in ground water table.

- Only 17 per cent of the total area of the city is covered by the sewerage system.
- The sewer lines have been laid in the year 1976 in certain parts of old city area and out of it about 50 per cent of the sewerage system is not in working condition.
- Mostly the sewage goes into the open drains. The system is badly silted, choked and damaged at number of places and overloaded due to the growth of population the city.
- The STPs are made to perform beyond capacity, but still treat only 10% of the sewage they receive. Mean while, the Dhandupura STP (78 mld) remains under utilized.
- Improper means of disposal of wastewater has also resulted in environmental pollution and creates unhygienic conditions.
- Treatment capacities being inadequate, results in discharge of untreated sewage into water bodies, particularly river Yamuna and other nallahs.
- The STPs at Dhandupura treats city sewer and discharge of 17 nallahs whereas STPs at Pila Khar and Magla Budi treats only discharge coming from nallah water.

- The drainage systems of Agra were laid about 55 years back and are in bad condition. The city is facing big problem of Storm Water Drainage due to its malfunctioning.
- Buildings have come up just over the drains resulting in water-logging / flooding of nearby areas.
- Due to new development the areas have been paved resulting in increased run off. There are about 26 major water-logging areas in the city.
- Lack of Integrated Drainage Plan
- Malfunctioning of drainage system

3.1.2 Projects under Execution

In the first phase during the Ninth Five Year Plan, 10 projects were approved and are being implemented. Four of these pertain to water and sewerage sector. These are:

- **Water supply (Agra)**
- **Water Supply (Mathura-Vrindavan)**
- **Gokul Barrage**
- **Storm Water Drainage System (Agra)**
- *Improvement in Electric Supply at Agra*
- *Improvement in Electric Supply in and around the rural areas of Agra and Fatehpur Sikri*
- *Solid Waste Management*

- *Construction of one part of Agra bye-pass*
- *Widening of Agra Bye-pass*
- *Improvement of Master Plan of Roads of Agra City*

Particular water supply related works being implemented in Agra city are given in the Table below.

Present Status of TTZ Programme

S. No.	Item	Status before T.T.Z.	Works proposed in T.T.Z.	Works completed in T.T.Z.	Present status
1	Zonal pumping station	11 Nos.	10 Nos.	2 Nos.	13 Nos.
2	Rising main	32 Km	32 Km	22 Km	54 Km
3	Distribution net work	418 Km	818 Km	419 Km	837 Km
4	Clear water storage OHT/CWR	51974 KL	36325 KL	2882 KL	80799 KL

Source: U.P. Jal Nigam, June 2006

3.2 WATER AVAILABILITY IN TTZ

The sources available for supply of water to Agra city are surface water (Yamuna river, Gokul Barrage, Kitham Lake) and groundwater. The groundwater quality is fit for drinking purpose as indicated by the water quality reports (*Annexure-I*) from UPJN. Moreover, the groundwater table is receding at high rate. The dependability on groundwater for water supply is thus jeopardised and alternate sources have to be found.

There is extreme shortage of raw water in the river Yamuna during summers, the lowest discharge has been observed as 101.7 mld. Out of this discharge the average summer drawl of raw water is of the order of 99 mld. Due to high pollution level in Yamuna water the demand of drinking water of Agra, which is presently 142 cusecs and projected to be 276 cusecs in the year 2036 could not be met from this source. Foreseeing the shortfall in River Yamuna, the Central Govt. has earmarked 140 cusecs raw water for Agra and 10 cusecs from Tehri reservoir. This 150 cusecs raw water will be conveyed up to Palra fall of Upper Ganga canal through its system and then it has to be brought to Agra. This will meet the raw water requirement up to 2011 by which raw water quality in Yamuna river is expected to improve considerably and further requirement will be met again from the river.

UPJN has prepared a scheme for conveying water from Ganga river, which has been approved by the state government. The water supply situation is expected to improve significantly with the implementation of this scheme.

The project for construction of Agra Barrage about 8km upstream of Tajmahal has also been proposed by UPJN which has not been started yet. This has been guided by the Hon'ble Supreme Court order. The barrage has been proposed to help the authorities in controlling the water level in river Yamuna downstream, which is said to be desirable for safety of the Tajmahal.

3.2.1 Ground Water level

The western parts of Uttar Pradesh are characterized by deeper water levels ranging from more than 30m bgl, as noticed in most part including Agra. The water levels have shown a declining trend over the last two decades due to over exploitation of the ground water resource. The water level declining trends in these blocks are about 30 to 55 cm/year in either pre- or post-monsoon period or both. Based on the draft report by the Central Ground water Board, U.P. Northern region, the available ground water resource in Agra was 109,269.50 ha.m. There are some places identified by the department for rain water harvesting in the city.

The water table, in general is deep, varying from 17m to 23m; a declining trend in the water table has been recorded in Agra cantonment and Kheria Air Field area where dozens of tube wells are operating.

3.2.2 Water Supply and Demand

According to the AJS, the total water demand of the city is 320 million litres per day (mld), which includes the demand for bulk supply, estimated at 75 mld. The water demand as estimated for the 1.42 million-population in 2005 was 245 mld, which was calculated on a 170 litres per capita daily (lpcd) standard. For this, the city has two water treatment plants with a capacity to treat 410 mld in entirety.

The minimum per capita water supply recommended by CPHEEO for cities with population of one lac and above is 150-200 lpcd for domestic and non-domestic needs. After consultation with officials it has been decided that the per capita water supply for Agra should be kept 150 lpcd, out of which 135 lpcd goes to meet domestic demands 15 lpcd of water over and above 135 lpcd will take care of institutional demands, floating population and other demands. As per standard of 150 lpcd the water requirement for the projected population of 22.7 lakhs for the year would be of 340 mld and if 30% wastage during distribution is also considered then the water requirement would be 442 mld. As per estimate of U.P. Jal Sansthan 70% of the area is covered by piped water supply however in some of the areas the supply is uneven.

Projected Water Demand

Year	Population	Water Demand (mld) @(150+15%)=172.50 lpcd (CPHEEO's Norms)	Bulk Water Demand (mld)	Total Water Demand (mld)	Raw Water Demand (10% wastage)	
					mld	cusec
2001	1,259,979	217	67	284	312	126
2006	**1,419,980**	**245**	**75**	**320**	**352**	**142**
2011	1,600,299	276	83	359	395	160
2016	1,803,517	311	91	402	442	179
2021	**2,032,540**	**350**	**98**	**448**	**493**	**199**
2026	2,290,647	395	105	500	550	222
2031	2,581,529	445	112	557	613	248
2036	**2,909,350**	**502**	**120**	**622**	**684**	**276**

Source: U.P. Jal Nigam; June 2006

3.3 PROPOSALS IN CDP

The CDP proposes water supply projects at a cost of Rs. 900.04 crores over a period of five years (2007-2012). The components included are:

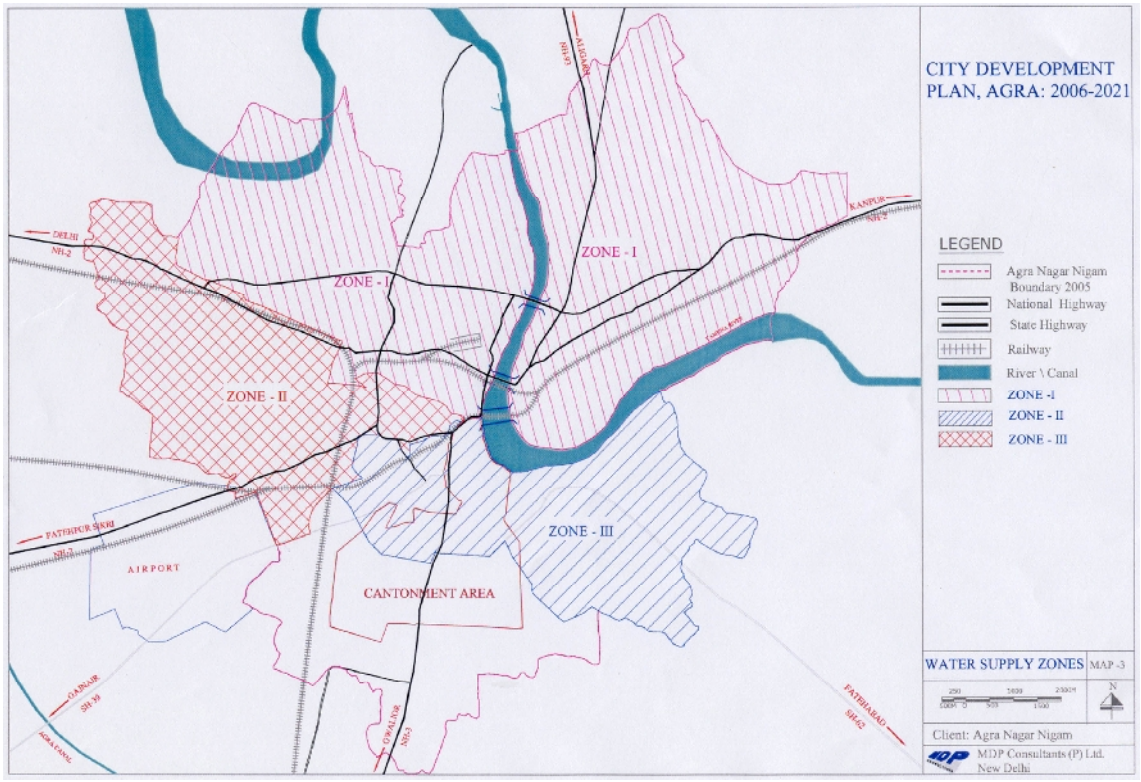
- Re organization of existing water works
- Distribution network
- Storage Improvement/ enhancement
- Reduction of UFW
- Construction / enhancing of pumping station, treatment plant
- Water Works storage Capacity enhancement
- Ganga Jal Project
- Test Laboratory

The sectoral strategies are given as under:

3.3.1 Water Supply

For full coverage of piped water supply and enhancing the duration of water supply the following strategies need to be adopted:

- Augment the existing water supply in the city
- Extend water supply network to all parts of the city
- Adopt GIS mapping for utility planning and management by preparing distribution network plan with full inventory of the water distribution system on GIS platform
- Arrest and reduce unaccounted for water to permissible limit of 15% by - undertaking leak detection study of transmission and distribution mains and house service connections; increase the net of metered connections ; identify illegal connections and subsequently phase-out the stand posts
- Water quality studies and monitoring both at the source and users end
- Adopt preventive maintenance rather than break-down maintenance
- Judicious utilization of treated water by conducting awareness programme for agra's citizen



Analysis - WATER SUPPLY

Present Shortfall / Problems 2006	Problems / Requirement 2021		Projects Proposed
	Future	Total	
• 62.54 MLD • 30 % (4.4 lacs) of population not covered by piped water lines • Water leaks in pipes & appurtenances • Inadequate flow & pressure • Poor raw water quality • Supply duration (hrs.) – 5 hours/day • Misuse of community hand pumps	• 489.4 MLD • Piped water supply required for additional population • Further decline in water pressure • Deterioration of water quality • Service duration may decrease	• 551.94 MLD piped water needed • Strengthening / renewal of water works needed	• Water Supply / Renewal Works • Water Supply Distribution Network • Construction of Pumping Stations and Water Works

Source: CDP Agra city

3.3.2 Sewerage

3.3.2.1 Waste generation

According to CPCB's *Status of sewage treatment in India* report of February 2006, the city generated 211 mld sewage in 2001. This is based on a sewage generation factor of 168 lpcd (or a 210 lpcd water supply). UPJN estimates show that the water demand has shot up from 284 mld to 320 mld leading to an increased wastewater discharge. But how much is actually used is unknown. UPJN while reviewing YAP has estimated the wastewater discharge in 2003 to be 152.15 mld. This assumes the water supply to be 107 lpcd. This is far lower that the water supply estimates provided by AJS. This difference in data will definitely affect the waste planning for the city. The most recent estimates, however, have been collated by CPCB in its 2005-06 annual report stating the flow in all drains to be 254 mld. This points to a 100 mld rise in wastewater generated over since UPJN's last estimate 3 years back.

Zone wise wastewater generation

S. No.	Zone	Projected population				Water requirement	Waste Water (MLD)	Other Waste Water	Total W/W (MLD)
		2001	2009	2024	2034				
1	Northern	138012	167104	239190	303796	52.40	41.92	11.60	53.52
2	Eastern	122378	148175	212095	269382	46.47	37.18	10.48	47.66
3	Western	358536	434113	621384	789219	136.14	108.91	29.80	138.71
4	Southern	70124	84906	121533	154359	26.63	21.30	14.40	35.7
5	Southern-II	24116	29199	41796	53085	9.14	7.33	25.08	32.41
6	Central	221756	268501	384328	488136	84.20	67.36	6.6	73.96
7	Tajganj	290332	351532	501378	639087	110.25	88.20	-	88.20
8	Cantonment	34725	42045	60182	76438	13.19	10.55	-	10.55

	Total	**1259979**	**1525575**	**2183687**	**2773501**	**478.44**	**382.75**	**97.96**	**480.71**

Water requirement @ 150 lpcd (MLD)+15% =172.50 as per CPHEO

Source: U.P. Jal Nigam; June 2006

State of Sewerage System

Wastewater generated daily (mld)	153
Present operating capacity/ Capacity of Treatment Plants (mld)	90.25
Area covered under the sewerage system	17%

Source: Agra, Jal Sansthan ; May 2006

3.3.2.2 Policy Decisions

The important policy decisions as evident in Urban Master Plan 2021 are:

- A barrage be constructed downstream of Taj so that Yamuna river retains water and the river is used for the recreational purposes.
- River Yamuna should be made pollution free by establishing treatment plants
- In order to reduce the water losses during distribution, the network needs to be improved and worn out/rusted pipes needs to be replaced
- Proper water harvesting techniques be adopted for ground water conservation and recharge
- Sewer lines be laid in a planned manner so that the sewage is properly collected and disposed
- The sewer flowing in drains be treated at suitable locations and the treated sewage discharged downstream.
- Sufficient number of sewage treatment plants be constructed
- As far as possible on both the sides of open drains a three metre wide strip be reserved for tree plantation

To ensure full coverage of sewerage network and effective disposal in environmentally friendly manner, the city need to adopt the following strategies.

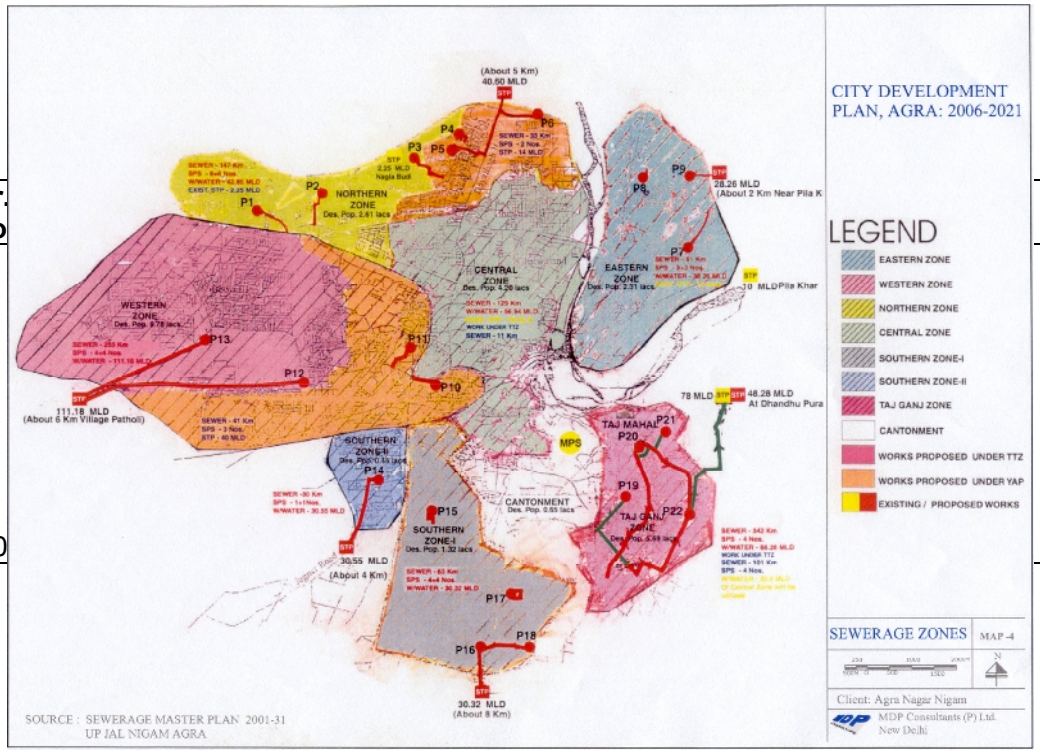
- Extending sewerage network to un-serviced areas
- Rehabilitating existing sewers
- Provide the missing links in the sewerage system so that the sewage treatment plants (STP) – 2 STPs overburdened & 1 STP under-utilized can start working efficiently
- Substantial improvement in efficiency of the 2 STPS (at Burhi ka Nagla & Peela Khari) required
- Full utilization of the under-utilized STP at Dhandhupra
- Sanitation facilities in the slum areas
- Provision of Public Toilets in the city
- Adopt GIS mapping for sewerage planning and management

Analysis - SEWERAGE

Present Shortfall / Problems 2006	Problems / Requirement 2021		Projects Proposed
	Future	Total	
• STP Capacity 90.25mld • Area uncovered by sewerage system – 17% • Badly silted, choked, damaged at number of places & overloaded • Discharge of untreated sewage into river • 10% of sewerage received by STPs is treated • Absence of public toilets & urinals	• Sewage to be treated would be 313.12MLD • Provision of adequate number of STPs • Maintenance of existing sewerage system & STPs • Provision of community toilets in public areas	• 428.90 MLD to be treated • Additional STPs • Additional Network • Public toilets	• Argumentation of Sewerage System • Const. of STPs • Public Toilets & Urinals • Purchase of Modern Equipment for Desilting

Source: CDP Agra city

Sr. No	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	



Sewerage Zones in Agra for Planning Sewerage System

Source: CDP Agra city

3.3.3 Storm Water Drainage

3.3.3.1 Major Existing Drains

In Agra there are 20 major drains (at least 1 meter width); most with outfalls into the

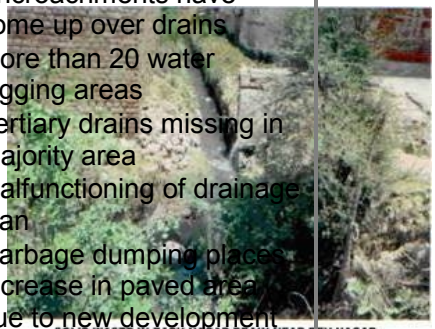
River Yamuna. A few of these drains, like the Mantola Drain, convey significant volumes of storm water. The town has further a large number of smaller and street drains also. The major drains of the town are listed in below.

The problems associated with these drains, as depicted in the photographs below, are primarily dilapidated condition, heavy silting, absence of cleaning, accumulation of solid waste and plastic bags, unscrupulous dumping of solid waste by public, the drain being easy accessible, blocked flow resulting in overflow and waster logging posing health hazards, encroached by buildings and houses posing blocking / cleaning problems, etc.

BROKEN & LEATHER CUTTINGS IN MANTOLA DRAIN AT MAHAVIR CINEMA

ENCROACHMENTS OVER RAJWAH DRAIN

	ms / Requirement 2021		Projects Proposed
	ure	Total	
• Ab dr • 25 in K. Yamuna • Encroachments have come up over drains • More than 20 water logging areas • Tertiary drains missing in majority area • Malfunctioning of drainage plan • Garbage dumping places Increase in paved area due to new development has increased the run off	onal ement ins	• Requirement of internal drains • Maintenance	• Storm Water Drainage Network • Purchase of ii



SOLID WASTE IN BAPU NAGAR DRAIN NEAR DEV NAGAR

WATER LOGGED AREA NEAR KARMAYOGI R-BLOCK PARK

Analysis -STORM WATER DRAINAGE

3.3.4 Industrial Wastewater Treatment

3.3.4.1Electroplating Industry

Major water polluting industry in Agra and around is electroplating small scale units. According to UPPCB report, the total number of electroplating industrial units in Agra is 71 out of which 39 have provided ETP while the rest do have any treatment facility.

Out of the 32 units that do not have ETP, 20 are reported closed while 12 are operating without ETP.

3.4 WATER QUALITY ISSUES IN RIVER YAMUNA

The water flow characteristics of Yamuna River changes significantly from monsoon to non-monsoon seasons. This change in water flow along with the construction of various barrages hampers the continuous flow of the river. Thus, in dry season (almost nine months), the river becomes segmented in four distinguished independent segments.

Segment I: This segments (length 157 km) is identified from Yamunotri and terminate at Hathnikund / Tajewala barrage

Segment II: This segment (about 224 km) lies between Hathnikund / Tajewala barrage and Wazirabad barrage.

Segment III: This 22 km segment of Yamuna River is located in between Wazirabad barrage and Okhla barrage.

Segment IV: This Segment of Yamuna River is about 973 km long initiate immediately downstream to Okhla barrage and extends upto confluence to Ganga River at Allahabad. The source of water in this segment are ground water accrual, its tributaries like Hindon, Chambal, Sindh, Ken, Betwa etc. and waste water carrying drains of Delhi, Mathura-Vrindavan, Agra and Etawah. The water of this segment is used for drinking and industrial uses at Mathura & Agra.

At Mathura, recently Gokul barrage has been constructed to trap the Yamuna river water for drinking purposes. Due to low drinking water demand only part of water is pumped out and rest flows downstream. As the water demand will increase in future. It is likely that no water will be allowed to flow downstream like Wazirabad and Okhla barrage. This may create further segmentation of segment IV into two segments of 154 & 804 km. With the construction of another barrage near Sikandara at Agra the river would be further segmented.

CPCB is monitoring the water quality of river Yamuna regularly at several locations out of which the following four pertain the TTZ area near Agra.

- Mathura Upstream: At Vrindavan near Chirharan Ghat about 188 km downstream from Wazirabad barrage. The sampling location shifts to Pantoon Bridge in case river flow changes to other side of the ghat. This location of river is being monitored to assess the water quality of Yamuna before it enters Vrindavan – Mathura.

- Mathura Downstream: About 204 km from Wazirabad barrage at Gokul Barrage. The site depicts the impact of wastewater discharges from Mathura-Vrindavan city.
- Agra upstream: At Poia Ghat, about 272 Km downstream from Wazirabad barrage towards Dayalbagh near Central Water Commission's gauge station. The site presents the water quality of river Yamuna before it enters Agra city.
- Agra downstream: Near temple at West Burzi of Tajmahal monument (Behind the monument) about 310 km downstream from Wazirabad Barrage. The location depicts the impact of wastewater discharges from Agra city.

The water quality in river Yamuna is deteriorating and is not within the stipulated standards as per CPCB as is evident from the Table 4.3.1 and Table 4.3.2. The DO-BOD profiles of the river Yamuna at three monitoring stations is given in Figure 4.3.1.and Figure 4.3.2.

3.5 POST EVALUATION REPORT

The Post evaluation Report by NEERI stated the following regarding Gokul Barrage project undertaken by the authorities.

Gokul barrage was constructed at Gokul in Mathura under the TTZ by Uttar Pradesh Irrigation Department, Mathura. The barrage has been constructed on the river Yamuna with a view to augment the water availability for Agra, Mathura and Vrindavan and to improve the groundwater table in the area and reducing the salinity level. The construction of the barrage at Gokul was initiated in the year 1990 and completed in 2001.

It maintained high flood levels within 162.9 - 164.05 meters. The downstream discharge was maintained between 421 and 3925 cumecs depending on the storage levels after monsoon. The quantity of water stored in the barrage was lowest during the year 2004. The major reasons attributed include low rainfall during the period and maintaining downstream minimum flow conditions. Presently, around 30 cusec (73.5 MLD) and 115 cusec (282 MLD) of water are supplied at Mathura and Agra. Based on the data provided by the UP Jal Nigam, the ground water levels have fallen over the years between 2003 and 2009.

Construction of the barrage on Yamuna River has bought mixed results to the public and environment at large. Some salient features of the project include.

- The flow in the river downstream has been impacted as a result of the impoundment, and the characteristics of the river Yamuna has changed due to reduced flow conditions downstream. The quality of impounded water of the barrage with respect to dissolved oxygen meets the CPCB classification D for propagation of wild life and fisheries in Inland surface water Standards, however, fail to meet the BOD parameter. Large-scale growth of water hyacinth was also found in the river at the Gokul barrage in Mathura.
- The TDS concentration in the ground water samples from the nearby areas indicated concentrations in the range of 777-1664 mg/l. However, the TDS concentration of the ground water collected from hand pumps was considerably higher in downstream vis-à-vis upstream quality. Some hand pumps water quality does not meet the CPCB classification E (Irrigation, Industrial cooling and controlled disposal) of water quality for conductivity.

- The surrounding area near the barrage has increased vegetative cover due to availability of water.
- Construction of a four lane road on the barrage with foot path on both sides has resulted in partial reduction of traffic in Mathura due to diversion of vehicles through the barrage, reducing waiting times since the project was implemented

Following suggestions are made in the Environmental Management plan (EMP):

- Resource operation plan and environment management system should be prepared and implemented
- Forcing factors or system states should be monitored
- Sufficient upstream measure should be taken to prevent breach
- Water level, flow rate, ground water level, water quality, biological indicators, bed level change, condition of structure, sluices, power supply, effluent loading (if any) etc should regularly be monitored
- Accidents/incident/near misses should be recorded
- Contingency plan should be prepared and implemented
- Silt/sediment/accretion should be periodically removed
- The EMP should be revised in the event of change in effluent loading (if any), change in upstream/downstream water quality, engineering works, abstraction

3.6 RECOMMENDATIONS FOR EMP

3.6.1 Water Supply, Sewerage and Drainage

3.6.1.1 Water Supply

The following strategies need to be adopted:

- Augmentation of existing water supply system for entire city area
- Institute the water safety plans for supply of safe drinking water which inter alia includes organized preventive maintenance rather than break-down maintenance, sanitary inspections and assessment of risk.
- Periodic water quality studies and monitoring both at the source and users end as confirmation
- Management of unaccounted for water through regular leak detection studies as part of the O&M activity
- Complete water metering and dissuading illegal connections through heavy penalty

- Judicious utilization of treated water by conducting awareness programme for Agra's citizen
- Evaluation of Point of Use treatment decentralised local system where water supply coverage is difficult
- Evaluation of 24x7 water supply system and implementation on pilot scale in the city.
- GIS mapping of entire water supply system including the display system

3.6.1.2 Sewerage System

To ensure full coverage of sewerage network and effective disposal in environmentally friendly manner, the city need to adopt the following strategies.

- Coverage of entire city area with sewerage network and ensuring proper collection of sewerage and conveyance to treatment plants. Decentralised local systems may also be evaluated through appropriate studies to identify the areas for implementation.
- Augmentation and Rehabilitation existing sewerage system
- Evaluation and remodelling of the waste treatment facilities to identify the augmentation needs and ensuring full capacity utilization. Evaluation for effluent recycle / reuse potential, but not for groundwater recharge, may also be undertaken.
- Evaluation of modern sewage treatment technologies including in-situ treatment in bigger drains and in IDT schemes.
- Proper water supply and sanitation facilities for the urban poor
- Being a heritage city and in view of the large floating population adequate sanitary facility / public toilets, with local treatment, at strategic locations in the city is essential
- GIS mapping for entire sewerage and sanitary facilities for proper O&M

3.6.1.3 Drainage System

The storm water drainage master plan needs to be implemented in order to strengthen the existing drainage system. The broad strategies to be adopted are:

- Evaluation of adequacy of existing drains (these are storm water drains that are carrying sewage also)
- Regulation on dumping the solid waste in these drains (it has been observed at a number of locations)
- Regular cleaning and desilting of the drains in an organized manner as part of O&M.
- Regulation on encroachments and construction of permanent structures on these drains at a number of places has been noticed.
- Development of proper drainage plan and O&M to avoid blockages, siltation, retardation in flow, etc.
- In-situ wastewater treatment employing bio- / phyto-remediation in large drains like Mantola drain and develop the area as entertainment parks, needs to evaluated through pilot scale studies

3.5.2 Environmental Improvement Action

3.5.2.1 Prevention of Pollution in the river Yamuna

The activities along the river should be restricted. The polluting activities like disposal of sewage, dumping of garbage along the riverbank should be prevented in the river. The strict norms should be enforced.

The proper solid waste disposal sites should be allocated so that garbage is not dumped. The minimum flow of the river should be maintained for reducing the pollution levels. This requires proper study and analysis related to the depth, velocity of flow, etc.

Public awareness needs to be done for action against activities related to the pollution of the river. Regular cleaning and maintenance of the river.

In order to improve the water quality, R&D studies on estimation of environmental flow in river Yamuna is necessary and the water releases accordingly regulated. Necessary corrective measures need to be identified based on R&D studies for delineation of assimilative capacity of different stretches of river in different seasons and the discharge of treated effluents regulated accordingly. A complete waste load allocation strategy and maintenance of environmental flows in river is expected to maintain the quality to CPCB Class-C/B category at the least.

3.5.2.2 Preservation and conservation of water bodies and development of new parks

The maintenance and revitalization factors should be suggested for preservation and conservation of water bodies in the city. The pollution levels, water quality check should be done in the city. The water bodies can also be developed as tourist spots.

Out of the total of 41 water bodies (covering 0.45 km^2 area), 13 water bodies, like Guru ka Talao, Tota ka Talao, etc. To name a few, have been completely dried and land reclaimed for developmental activity. The Palwal Park and Sardar Patel parks also have water bodies located inside, which should be preserved and developed.

3.5.2.3 Conserve ground water resource by adopting rainwater-harvesting techniques

The rainwater harvesting techniques should be introduced in the city. Existing large government / institutional buildings should set an example by adopting these techniques.

3.5.2.4 Proposed Schemes for Environmental Improvement in Agra

The environment projects at a cost of Rs. 254.78 crores include river front development, improvement and development of parks and protection of forest areas as given in Table below.

S. No.	Projects Proposed	Cost (Rs. Crore)	Department

S. No.	Projects Proposed	Cost (Rs. Crore)	Department
1	River Front Development Landscaping, Theme park, bio-diversity park, garden of five senses, musical fountain, activities for passive recreation, tree plantation along the banks of R. Yamuna in conformity with Land use plan 2021	45.65	ADA
2	Improvement and beautification of existing parks	54.83	ANN
3	Development of new parks	18.69	ADA
4	Protection of forest area / afforestation	16.95	Forest
5	Rain water harvesting in state government & ANN properties and select locations as identified by U.P. Jal Nigam	12.29	ADA/ ANN
6	Restoration and beautification of water bodies	33.26	ANN
7	Construction of weir across Yamuna downstream of Taj	73.10	Irrigation

Table 3.3.1 :Water Quality (DO-BOD) of Yamuna River at Water Works (U/S, D/S)

S. NO.	MONTH	U/S Kailash Ghat			U/S WATER WORKS			D/S NEAR TAJ MAHAL		
		pH	D.O	B.O.D	pH	D.O	B.O.D	pH	D.O	B.O.D
			mg/l	mg/l		mg/l	mg/l		mg/l	mg/l
1	Jan-04	7.7	6.9	10.5	7.7	6.4	11.4	7.7	6.25	13
2	Feb-04	7.5	7.1	11.7	7.5	6.5	13.6	7.5	5.3	17
3	Mar-04	7.8	7	12.3	7.8	6.4	12.8	7.7	5.6	16.7
4	Apr-04	8.2	8.9	10.7	8.4	8.5	11.7	8.36	7	16.4
5	May-04	8.7	9.4	12.4	8.5	8.5	13	-	-	-
6	Jun-04	8.4	9	-	8.3	8.5	-	-	-	-
7	Jul-04	8.4	8.7	-	8.9	7.4	-	-	-	-
8	Aug-04	7.8	6.3	-	7.8	5.8	-	-	-	-
9	Sep-04	7.6	6.7	10.67	7.7	6.3	12.3	7.8	5.2	16.1
10	Oct-04	7.5	7.6	10.35	7.6	7.4	12.2	7.6	5.7	18.5
11	Nov-04	8	7.4	17	7.9	7.3	23	8	6	29
12	Dec-04	8.3	8.8	14.9	8.1	8.1	17.1	8.17	5.75	29
13	Jan-05	8.3	8.3	13.4	8.2	7.5	15.7	8.15	5.1	27
14	Feb-05	7.8	7.6	16.4	7.8	7.1	19.5	7.9	6	29
15	Mar-05	7.5	7.8	14.8	7.6	7.2	16.5	7.3	4.3	25
16	Apr-05	7.8	7.8	14.6	7.7	6.2	17.5	8	3.9	22.5
17	May-05	8.4	9.6	13.3	8.3	9.1	16	8.3	4.6	20.5
18	Jun-05	8.7	8.3	13.3	8.7	7	15.5	8.8	4.9	21
19	Jul-05	8	5.8	13.4	8.2	5.3	16.1	8.4	5.6	17.5
20	Aug-05	7.5	6	12.3	7.5	5.8	14.5	7.5	4.8	20
21	Sep-05	8.1	7.4	12.5	8.1	7	14.5	7.2	5.1	22
22	Oct-05	7.5	6.6	13	7.6	6.4	15	7.8	5.2	22
23	Nov-05	7.5	8.3	10.5	7.5	7.2	13.5	7.7	5.4	18.7
24	Dec-05	7.5	8.3	9.3	7.5	6.8	11.6	7.5	6.5	13.2
25	Jan-06	7.9	7.4	11.4	8	7.1	13.4	7.9	6.3	14.6
26	Feb-06	7.6	6.8	12.2	7.8	6.7	14.2	7.8	5.5	15.4
27	Mar-06	7.9	7	11.2	7.7	6.5	15	7.9	5.7	17.1
28	Apr-06	7.7	7.3	11.8	7.7	7	15.5	7.8	6.3	17.7
29	May-06	8	6.6	11.2	7.8	6.2	15.6	7.8	5	17.2
30	Jun-06	7.6	7.8	11.3	7.5	7.3	16.5	7.7	5.9	17.9
31	Jul-06	7.7	7.9	11.6	7.7	7.2	16.9	7.5	5.2	18.4
32	Aug-06	7.7	7.7	11.2	7.4	6.8	16.1	7.3	5.4	17.7
33	Sep-06	7.5	7.5	10.9	7.5	7.4	15.6	7.5	5.7	17.3
34	Oct-06	7.7	7.5	12	7.8	6.5	17.1	7.7	4.9	18.6
35	Nov-06	7.6	7.7	9.8	7.5	7.4	14	7.5	4.8	17.5
36	Dec-06	7.5	7.5	12.5	7.5	7.2	15.2	7.6	5.1	18.9
37	Jan-07	7.5	7.5	12.3	7.5	6.6	15	7.9	5.9	18.4
38	Feb-07	7.7	6.7	12.6	8.2	6.4	15.8	7.7	5	19

Table 3.3.1 :Water Quality (DO-BOD) of Yamuna River at Water Works (U/S, D/S)

S. NO.	MONTH	U/S Kailash Ghat			U/S WATER WORKS			D/S NEAR TAJ MAHAL		
		pH	D.O	B.O.D	pH	D.O	B.O.D	pH	D.O	B.O.D
			mg/l	mg/l		mg/l	mg/l		mg/l	mg/l
39	Mar-07	7.5	6.5	8.9	7.5	5.9	10.9	7.7	4.8	11.9
40	Apr-07	7.5	7.1	9.7	7.5	6.7	10.7	7.5	5.6	11.9
41	May-07	7.7	7.8	10.3	7.9	7.5	11.1	7.9	5.5	12.7
42	Jun-07	7.5	8	8.4	7.5	7.6	11.3	7.5	5.1	14
43	Jul-07	7.5	7.1	9.1	7.5	6.7	11.4	7.5	5	14.4
44	Aug-07	7.5	6	11.5	7.5	5.6	13	7.5	4.7	14.9
45	Sep-07	7.7	7.1	10.3	7.7	6.6	13.3	7.7	5.7	14.3
46	Oct-07	7.8	7.9	10.4	7.5	7.2	12.7	7.5	5.2	14.3
47	Nov-07	7.5	5.7	17.3	7.5	6.9	18.4	7.5	4.2	26.1
48	Dec-07	7.5	6.1	14.5	7.5	5.7	15.4	7.5	4.4	23.3
49	Jan-08	8	6.4	12.4	7.7	5.5	16.2	7.7	4.9	22.8
50	Feb-08	7.8	5.8	12.6	7.8	5.2	16.7	7.8	5	23.5
51	Mar-08	8	6	12.5	8	4.8	16.3	7.7	4	22.7
52	Apr-08	7.8	6.7	11.5	7.8	6.2	16.6	7.8	4.4	22.1
53	May-08	7.5	7.1	11.2	7.5	6.7	15.5	7.5	4.9	21.5
54	Jun-08	7.5	6.9	10.8	7.5	6.3	16.7	7.5	4.9	21.6
55	Jul-08	7.5	5.3	8.6	7.5	5.1	9.4	7.5	5	9.6
56	Aug-08	7.5	6	10	7.5	5	10.5	7.5	5	12
57	Sep-08	7.8	6.1	10	7.8	5.7	11	7.8	5.1	13
58	Oct-08	7.5	6	9.5	7.5	5.5	11	7.5	4.8	12.5
59	Nov-08	7.5	7	9.5	7.5	6.6	11	7.8	6	12
60	Dec-08	7.5	6.2	12	7.5	6.4	11	7.5	6.9	9.5
61	Jan-09	7.5	6.6	11.5	7.5	6.3	13	7.5	5.6	16.5
62	Feb-09	7.6	6.6	10.5	7.5	6.4	12.5	7.5	5.5	15
63	Mar-09	7.6	7.2	11.5	7.5	6.8	13	7.5	5.9	16.5
64	Apr-09	7.9	7.3	12.5	7.7	6.6	15	7.5	5.6	17
65	May-09	7.5	7.2	13.5	7.5	6.8	15	7.7	5.8	19
66	Jun-09	8.3	8.6	14	8.5	8.4	16.5	8.5	6.4	21
67	Jul-09	8.4	7.8	12.5	8.3	7.1	13.8	8	6.2	19.8
68	Aug-09	7.8	7.9	13	8.2	7.5	14	7.8	6	20.5
69	Sep-09	7.7	6.4	13	7.8	6	15	7.8	5.8	18
70	Oct-09	7.8	8.1	13	7.5	7.6	-	7.5	6.2	19
71	Nov-09	7.6	6.7	12	7.5	5.9	15.6	7.5	4.9	22
72	Dec-09	7.8	5.9	9.2	7.8	5.5	15.2	7.5	4.9	24.5
73	Jan-10	7.6	6.7	12	7.6	6.3	12.5	7.5	4.5	23
74	Feb-10	7.5	7.8	14	7.5	5.4	18	7.4	4.5	26
75	Mar-10	7.5	6.6	13	7.5	5.7	15	7.5	4.2	23
76	Apr-10	7.5	6.6	12.8	7.5	5.8	15	7.5	4.5	27
77	May-10	7.7	6.7	13.5	7.6	6.2	15	7.5	4.5	25
78	Jun-10	8.85	7.2	9.3	7.93	6.4	10.5	7.79	5.4	21

Table 3.3.1 :Water Quality (DO-BOD) of Yamuna River at Water Works (U/S, D/S)

S. NO.	MONTH	U/S Kailash Ghat			U/S WATER WORKS			D/S NEAR TAJ MAHAL		
		pH	D.O	B.O.D	pH	D.O	B.O.D	pH	D.O	B.O.D
			mg/l	mg/l		mg/l	mg/l		mg/l	mg/l
79	Jul-10	7.89	6.7	7.5	7.98	6.2	9	7.9	5.25	17
80	Aug-10	7.23	6	6.1	7.69	5.8	7	7.55	5.4	8.5
81	Sep-10	7.54	6.8	5	7.69	6.1	6	7.64	5.8	8.4
82	Oct-10	7.77	6.7	6.7	7.67	7.7	7.3	7.7	5.7	8.5
83	Nov-10	7.5	7.2	7.8	7.6	6.9	8.1	7.7	6.3	8.3
84	Dec-10	7.67	7.9	8.3	7.58	7.4	8.7	7.56	6.8	8.9
85	Jan-11	7.8	4.6	12.5	7.78	3.8	15	7.8	4.6	22
87	Feb-11	7.61	5.5	12.5	7.75	5.75	10.3	7.1	4.9	22.5
88	Mar-11	7.59	6.2	13.5	7.6	5.8	15.5	7.57	4.85	22.5
89	Apr-11	7.75	6.5	13.5	7.83	5.7	15.5	7.77	5	23
90	May-11	8.35	6.35	8.1	8.25	5.7	11	8.03	4.8	20.5
91	Jun-11	8.11	9.1	7	8.34	8.5	10	8.41	6.3	20
92	Jul-11	7.72	6.4	9	7.7	6.2	12	7.76	6.1	17
93	Aug-11	7.61	6.2	9.3	7.51	5.8	10.3	7.54	5.1	15
94	Sep-11	7.49	5.9	8.7	7.54	5.9	10	7.49	5.5	16

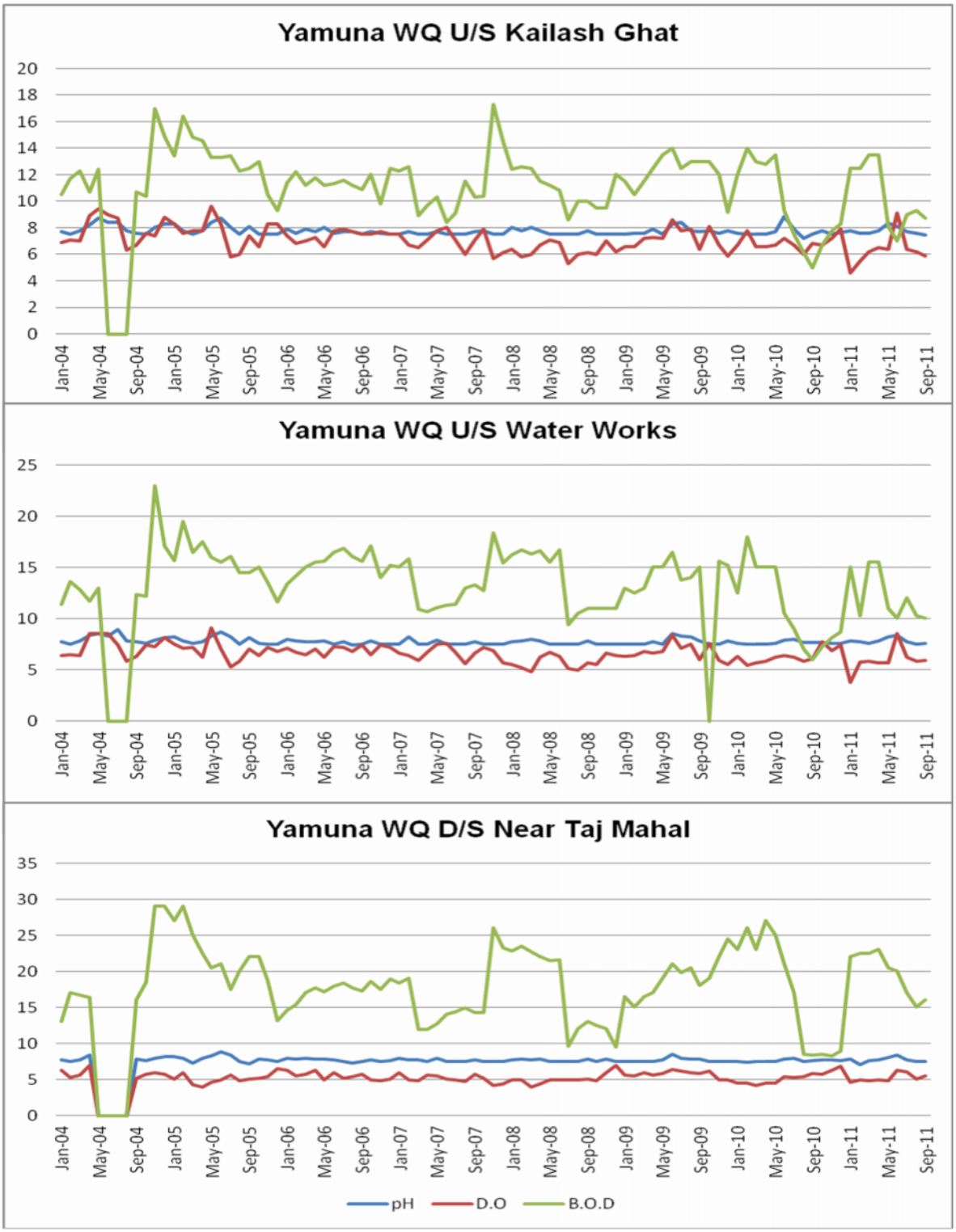


Figure 3.3.1 : WQ Profile of Yamuna River at Water Works (U/S, D/S)

DO

Table 3.3.2 : Water Quality (DO-BOD) Profile of Yamuna River during 1997 - 2003

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean	SD	Max	Min
Kailash Ghat	1997	3.2	7	7.1	5.6	5.3	8.2	7.8	7.8	7.8	11.6	9.8	10.4	7.6	2.30	11.6	3.2
	1998	9.2	6.4	7.3	6.9	7	7	5.8	7.6	8	7.3	7	9	7.4	0.98	9.2	5.8
	1999	10.6	8.6	9.3	8.8	7.8	8.2	7	6.8	8.2	9.6	8.4	9	8.5	1.06	10.6	6.8
	2000	7.9	8.2	9	9.6	10.2	9.2	7.8	7.5	6.6	8	7.4	8.1	8.3	1.02	10.2	6.6
	2001	9	6	8.3	8	8.6	8.1	7.9	8.2	8.1	7.2	6.4	9.6	8.0	1.01	9.6	6
	2002	9	8.2	8.2	8	9	12	8.2	7.5	8-0	7.2	7.8	10.2	8.7	1.38	12	7.2
	2003	7.9	7.8	5.8	7.6	4.5	9.8	7.1	5.9	-	-	-	-	7.1	1.63	9.8	4.5
D/S Near Taj Mahal	1997	5	2.8	3	2.1	2	1.2	3.6	6.7	7.1	--	8.9	8	4.6	2.69	8.9	1.2
	1998	7.5	5	4.1	3	2.8	3.5	5	7.5	6.8	6.2	6.5	6.3	5.4	1.69	7.5	2.8
	1999	7.5	5.3	5.6	6.2	4.2	4.3	4.1	5.8	6.4	7.4	6.7	6.2	5.8	1.16	7.5	4.1
	2000	5.6	4.5	5	4.5	3.6	5.3	6.4	6.2	6	5.9	4.2	4.1	5.1	0.93	6.4	3.6
	2001	4.4	4.3	4.2	4.1	4.2	4.8	6.2	6.8	5.4	5.8	4.1	6.3	5.1	1.00	6.8	4.1
	2002	5.6	5.9	4.8	9	5	3.2	5.7	2.2	5.2	6	6.2	6.3	5.4	1.67	9	2.2
	2003	5.9	6.2	4.7	4.1	4.4	6.2	5.1	4	-	-	-	-	5.1	0.92	6.2	4
U/S Water Works	1997	8	6.5	7.9	4.8	4.7	5	6	7.5	7.4	11	8.6	9.4	7.2	1.94	11	4.7
	1998	9	5.2	6	5.8	5.5	6.4	6	7.5	7.3	7	6.7	8.6	6.8	1.19	9	5.2
	1999	9.3	7.8	7	6.9	6.9	5.1	6.4	6.2	7.2	8.6	8	8.3	7.3	1.16	9.3	5.1
	2000	6.8	7.3	8.1	7.6	8	8.9	7	7.2	6.4	7.1	6.3	7	7.3	0.74	8.9	6.3
	2001	7.9	5.9	7.1	7.2	7.1	7.3	7.3	7.9	7.8	7	5.9	9	7.3	0.85	9	5.9
	2002	7.2	7.8	6.4	7.4	6.5	7	8	8	7.1	7.1	7.5	10	7.5	0.94	10	6.4
	2003	7.8	7	5	6.2	4	9.4	7	5.2	-	-	-	-	6.5	1.73	9.4	4

Table 3.3.2 : Water Quality (DO-BOD) Profile of Yamuna River during 1997 - 2003

BOD (mg/L)

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean	SD	Max	Min
Kailash Ghat	**1997**	7.2	5.8	5.1	11.8	12.2	7.6	8.2	3.4	3.4	9	7.6	4.8	7.2	2.89	12.2	3.4
	1998	2	6.8	8.3	8	5.8	5.8	4.3	3.8	4	4.2	4.8	8.9	5.6	2.10	8.9	2
	1999	17	14	11.4	16.2	13.2	13.2	11	4.7	7	15	12	11	12.1	3.55	17	4.7
	2000	11.6	14	12.2	9	7.8	7.8	4.2	3.9	4.6	8.2	8.8	8.4	8.4	3.16	14	3.9
	2001	7.3	9.4	9.8	8.6	8.4	8.4	6.3	8.5	8.8	8.3	8.6	7.9	8.4	0.91	9.8	6.3
	2002	7.4	8.1	9	10.4	12	16.8	9.8	7.4	5-0	5.9	7	7.9	9.2	3.04	16.8	5.9
	2003	11.2	12	12.6	12	13.4	12.8	12.6	9	-	-	-	-	12.0	1.36	13.4	9
Near Taj Mahal	**1997**	22	32	42	92	110	120	58	4.1	8.2	70	18.2	15.2	49.3	40.42	120	4.1
	1998	36	30	48	54	74	60	44	4.3	5.2	6.3	7.1	32	33.4	23.73	74	4.3
	1999	34	41	54	64	70	59	59	5.8	18	36	40	56	44.7	19.28	70	5.8
	2000	60	66	80	76	66	42	5.9	4.8	11.4	32	44	64	46.0	27.13	80	4.8
	2001	55	84	80	72	82	70	18	16	24	30	48	56	52.9	25.55	84	16
	2002	74	66	88	9.8	110	118	130	62	8.2	9.6	10.2	12.4	58.2	46.94	130	8.2
	2003	56	19.6	22	30	36	42	18	12	-	-	-	-	29.5	14.61	56	12
U/S Water Works	**1997**	7.8	7.4	6.4	17.6	18.4	15.4	13.4	4.1	4.3	11.2	9.8	7.8	10.3	4.92	18.4	4.1
	1998	11.4	9.2	9	12	10	9	5	4	4.4	5	6	11.2	8.0	2.96	12	4
	1999	21.2	17	14	16.4	20.4	19	16.4	5	11.8	21	17	16.4	16.3	4.52	21.2	5
	2000	15.8	19.2	18	14.4	13	13	4.5	4.3	5.9	10.6	9.6	10.6	11.6	4.96	19.2	4.3
	2001	11.2	12.2	11.4	10.8	9.8	9.8	7	7.2	9.6	9.5	9.4	9.2	9.8	1.55	12.2	7
	2002	8.8	9.2	11.6	13.6	13.6	18	11.4	8.8	5.6	6.8	7.8	8.4	10.3	3.49	18	5.6
	2003	13	14.4	14.8	14.8	15	14	14	10.6	-	-	-	-	13.8	1.45	15	10.6

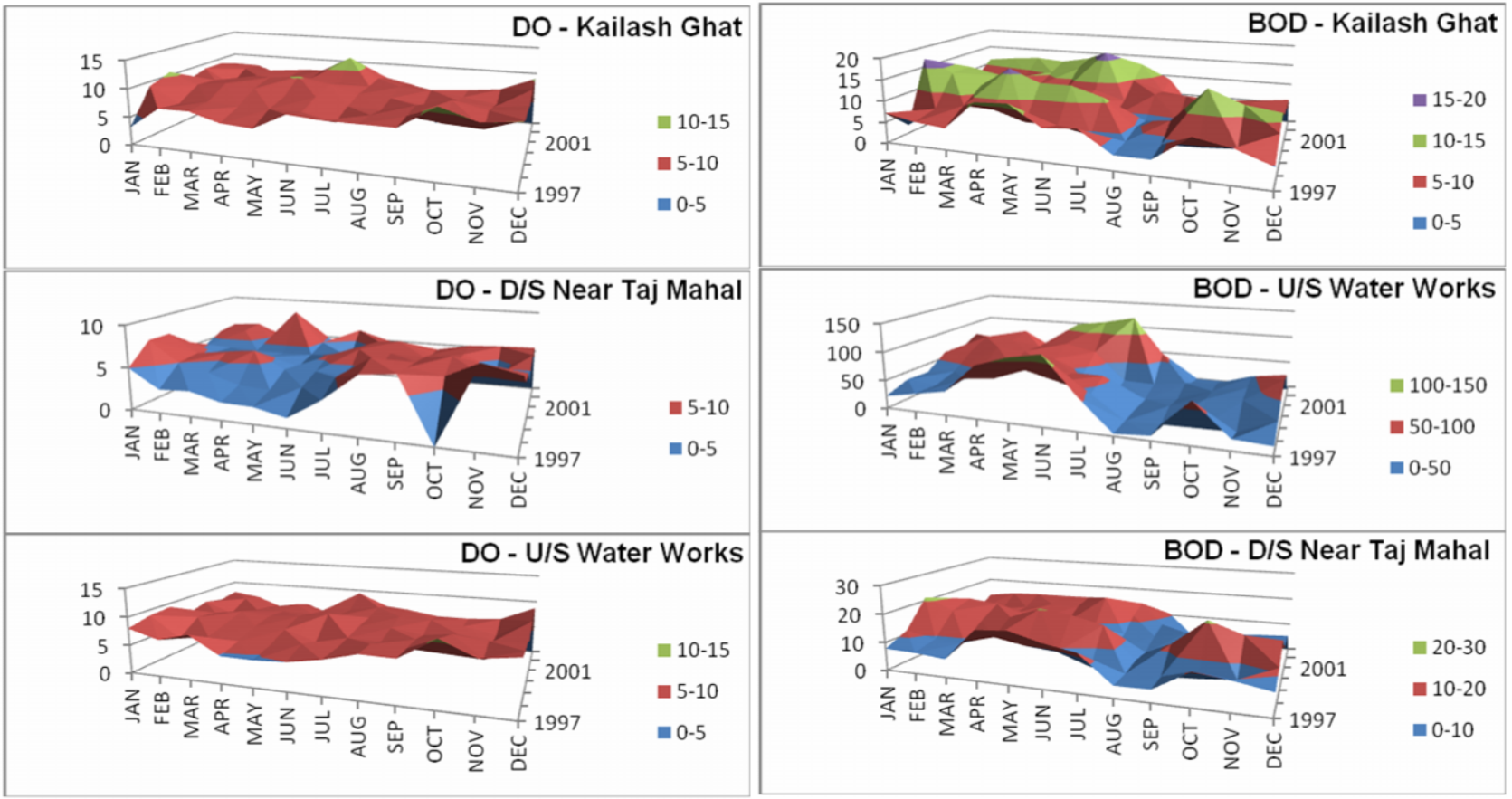
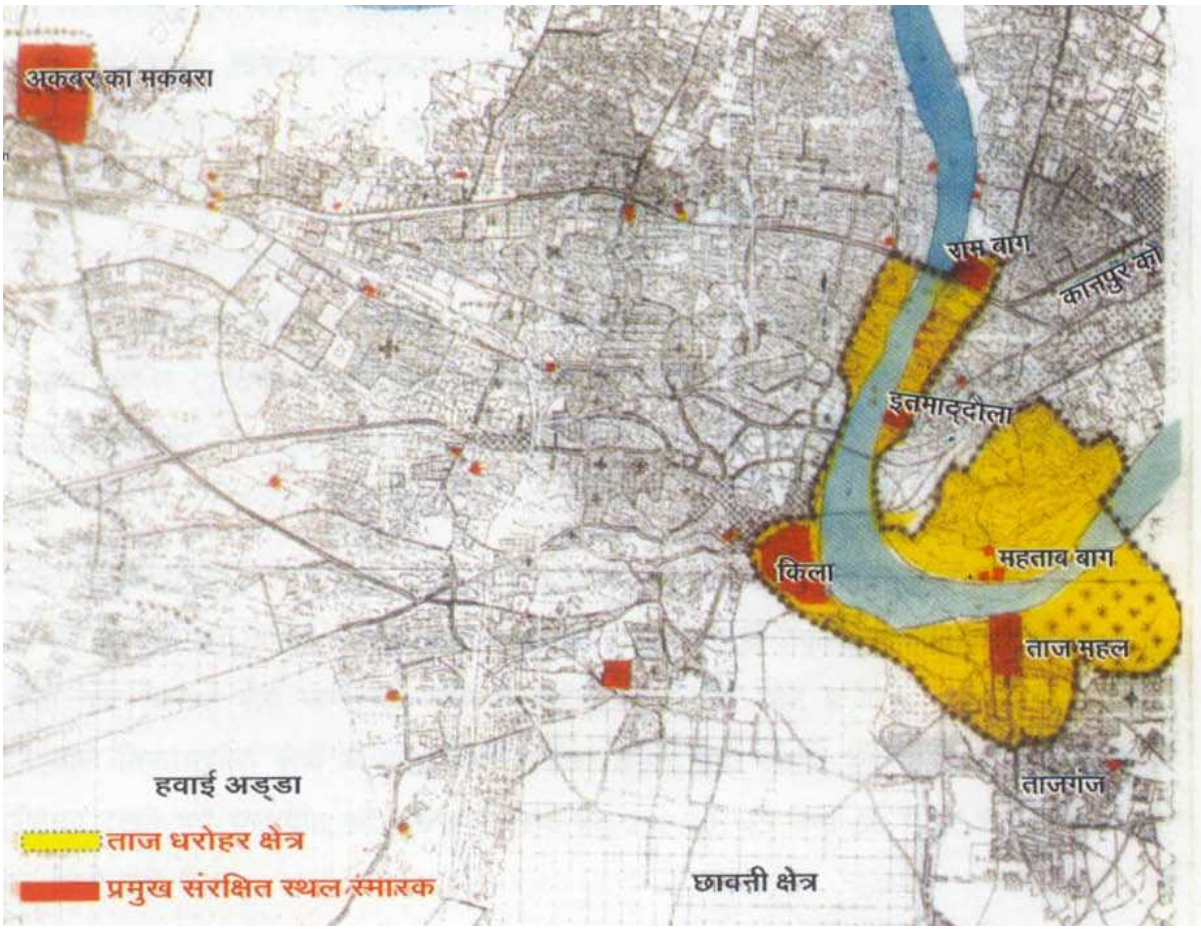


Figure 3.3.2 : DO-BOD Profile of Yamuna River at Water Works during 1997 - 2003



Taj Trapezium Zone

4.0 Wastewater Management in TTZ Area

Comprehensive wastewater management plan formulation is necessary for environmental improvement in the TTZ and it should include initiating activities on storm water management, domestic and industrial wastewater management through construction of drainage/sewer network systems, sewage and effluent treatment plants. The following section provides the status on sewerage, storm water and industrial effluent discharges in the TTZ area.

4.1 Status of Sewerage and Sewage Management in the TTZ

The existing status of wastewater management in the TTZ comprising Agra, Mathura, Vrindavan and Firozabad is discussed in this section. The percentage of population covered by sewerage system in the TTZ is very low and varies from nil to 25%. Large number of activities have to be undertaken to improve the overall situation in the TTZ with respect to the water environment. Several areas in the TTZ are not covered by the sewerage network for collection of domestic, commercial and industrial effluents **(Table 4.1.1)**. The latest census data (2011) was not available in the public domain for assessment. Hence Information based on the available data was used. The status of TTZ wrt wastewater would improve significantly if it meets the current or 2010 waste water generation of 260, 50, 8, 67 MLD in TTZ. The information on all aspects of wastewaters have increased in the last few years due to improved reporting and recent information which was available in public domain.

Many low lying areas are severely affected during monsoon due to overflow of sewage on the roads and open plots adjoining the building blocks due to the presence of solid waste choking the sewer lines. In the absence of sewerage system, majority of the houses have septic tanks and those that do not have, discharge into nearest drains posing a threat to the public health and causing bad odor. The untreated effluents reach Yamuna River through the various storm water drains. The Yamuna River also receives industrial and domestic discharges from Faridabad, Paliwal, Kosi, Vrindavan and Mathura before reaching Agra. The flow in the river is mainly sewage except during monsoon. All the above towns discharge domestic wastewaters into Yamuna river of varying quantities. Yamuna, in its course of 10 km in Agra, receives wastewater of 105 MLD at 28 points where 57.5 MLD is from domestic sources, 5.3 MLD from industrial areas and 42.4 MLD from mixed sources (CPCB-2002). The total pollutant load in terms of BOD and SS discharged through these drains is 32 t/d and 40 t/d respectively as per the CPCB report[10]**.** The major drains in Agra discharging into Yamuna is Mantola (BOD - 27 t/d) Bhairon (BOD - 1.4 t/d) and Etamudulla (BOD- 1t/d), respectively.

Table 4.1.1: Status of Sewerage Network in the TTZ [1, 3, 9]

Area	Population (2001), Lakhs	Wastewater Generation+ 2010, MLD	Sewer Coverage, %	Sewer Districts	No. of STPs (Quantity, MLD)					
					Total	O	NOP	UC	NRCP	TF
Agra	12.42	260*	17	8	5(144) 3 under YAP I 2 under YAP II	3 (90.25)	-	1(40)	1(14)	UASB, OP
Mathura	2.99	50	25	7	2(28) 2 under YAP I	2(28)				WSP
Vrindavan	1.00	8	NA	NA	2(9.5) 2 under NRCP	2(4.5)	1 (0.5)	-	2(4.5)	OP
Firozabad	3.97	67 (2001)	NA	NA	NIL	NIL				NIL
Fathepur Sikri	0.288	3.2	NA	NA	NIL	NIL				NIL
Bharatpur	2.05	23	NA	NA	NIL	NIL				NIL

Assumed @140 litres per capita day as water consumption and 80% as waste water generation.
+ Wastewater generation in 2010.
*Estimated value is 240 MLD calculated at above assumption. However recent data indicates 260 MLD based on CPCB report, 2013
O – Operational; NOP- Non operational; UC- Under construction; NRCP- Sanctioned under NRCP for GAP and YAPs; TR – Treatment route.
UASB- Upflow Anaerobic Sludge Blanket; OP – Oxidation Pond; WSP – Waste Stabilization Pond.

The STPs design and operated in the TTZ are based on anaerobic and natural oxidation treatment route. The treated effluent quality from all the STP at Agra, Vrindavan and Mathura does not meet the inland surface water discharge standards. The pollutant concentration discharged from STPs are presented in **Table 4.1.2**. Additional treatment sequence is required to reduce the organic pollutants before discharging into river. The treated effluents from the STPs are partially used for farm irrigation near the river bed in Agra. The quantum of E-Coli discharged through treated effluent from STPs into the Yamuna River ranged between 2 x 10^3 to 6.54 x 10^6 MPN /100 ml. The treated effluent quality status of STPs in TTZ is mentioned in **Table 4.1.2**. About 300 out of 800 hectares is used for irrigation[10]. The details of greenbelt development in Mathura, Vrindavan, Firozabad, Fathepur Sikri and Bharatpur using treated effluent are not available for comment.

4.2 Storm water Management in the TTZ

The storm water network designed in the TTZ is inadequate and most of the drains are natural drains which usually collect domestic and industrial effluents and run off during precipitation. However, during the last 2 decades, increase in population had resulted in increased discharge into these drains. The number of natural drains in the respective urban agglomeration is presented in **Table 4.2.1**.

All the storm water drains in the TTZ finally discharge into Yamuna river. Large parts of the urban agglomeration comprising residential and commercial areas are bereft of sewer network, particularly in Agra, Mathura and Vrindavan leading to discharge into the storm water drains. Discharge of solid waste into the storm water drains results in choking of the storm water drains leading to water logging, stench and groundwater pollution. The situation also aggravates growth of aquatic weeds and disease causing vectors (mosquito).

The storm water drainage system in TTZ area is in a very bad condition. The system comprises of natural and man-made drains that the ultimately discharge surface run off and waste water generated in the TTZ. The quality of water flowing in the drains located in Mathura is presented in **Table 4.2.2**. The water quality status of Agra, Vrindavan, Firozabad, Fathepur sikri and Bharatpur are not available.

Table 4.1.2: Status of Sewage Management Systems and Treated Effluent Quality in TTZ

Sr. No.	Area	STPs Name	Capacity, MLD	Treatment Type	Existing flow, MLD	pH	BOD	COD
							mg/L	
1	Agra	Burhi Ka Nagla	2.25	OP	2.25	6.4-7.4	37-149	214-514
2		Peela Khar	10.00	OP	8.0	7.1-7.7	42-98	210-411
3		Dhandupura	78.00	UASB,FP	50.0	7.3-7.7	38-120	173-424
240 (Total) – 90.25 (Treated) = 150.75 MLD(Untreated)								
4	Mathura	Masani	13.59	OP	13.5	5.3-8.4	64-145	400-720
5		Bangal Ghat	14.50	WSP	13.5	6.3-8.8	58-175	384-768
50 (Total) – 28.09 (Treated) = 21. 98 MLD(Untreated)								
6	Vrindavan	Kali Deh	0.50	OP	NOP	6.3-7.2	60-180	432-752
7		Pagal Baba Mandir	4.00	OP	8.00	6.3-7.2	52-175	352-752
8 (Total) – 4.5 (Treated) = 3.5 MLD (Untreated)								

Source: UPPCB; CPCB Report 2013
Effluent Management System
ANP –Anaerobic ponds; FP – Facultative ponds; UASB – Upflow Anaerobic Sludge Blanket; PP - Polishing ponds;
NOP- Non Operational

Table 4.2.1: Status of Storm Water Network in the TTZ [3, 4, 5]

Area	No. of Natural Drains	Storm Water Coverage in the UA, hectares
Agra	20	17730.68
Mathura	19	2707.12
Vrindavan	18	NA
Firozabad	2	NA
Data forFathepur Sikri and Bharatpur not available		

Source: SWDP, Agra City, UPJN, 2011; CDP of Mathura-Vrindavan, JNNURM-NPP, 2006

Table 4.2.2: Water Quality Status of Drains in Mathura in TTZ

Drains in Mathura	Pollutant Parameters, mg/l					
	pH	DO	BOD	COD	TDS	Cl
Goochi Drain	6.3-8.1	4.6-6.8	12-36	40-288	-	-
Goverdhan Drain	6.3-7.3	-	24-40	96-492	-	-
Mansi Ganga Goverdhan	6.2-9.1	1.7-7.8	6-16	12-80	-	148-240
Refinary Drains	6.1-7.5	7.4	18-42	72-288	1840	-

Source: UPPCB

4.3 Status of Industries and Effluent Discharges in the TTZ

The industries in the TTZ are basically of small and medium scale category with most of them operating in the Firozabad area. Brick kilns, peta, tanneries, iron foundries, glass and other chemical industries are found in large number in TTZ. At Mathura, only petroleum refinery is the major industry in the area. Most of the industries are of dry type and as such water demand in these industries is less or insignificant. The existing status of the industries in the TTZ is presented in **Table 4.3.1**.

The major water pollution-causing industrial units are (i) tannery, peta, dairy, slaughter house, and (ii) electroplating units. Inorganic pollutants and heavy metals are generated by the later (ii); effluent having organic pollutants are discharged by the former (i). All of these industrial units do not have a proper effluent management system and currently they discharge their raw/partially treated effluents into nearby nallahs which finally join any one of the natural drains of Agra. Based on the available data, the quantum of effluent generated has been included in

the report. However, the details pertinent to individual industrial sectors were not available for assessment. The quantum of pollutants discharged from TTZ is presented in **Table 4.3.2**.

Table 4.3.1: Status of Industries in the TTZ [1, 3, 9]

Sr. no.	City/Town	Number of Industries	Industry Type (Nos. in Brackets)
1	Agra	127	Pesticides (3); Ceramics (1); Foundry (111); Slaughter houses (1); Milk processing (1); Asbestos pipes (1); Meat packing (1) ; Electroplating (5); Textile (1); Casting (2)
2	Mathura-Vrindavan	229	Oil refinery[+] (1); Textile industries (NA) ; Sari printing industries (NA); Electroplating industries (NA); Pakai bhatti (NA)
3	Firozabad	622	Gas based industries (185); Industries which are not obtained gas (238); Waste paper recycling unit[*] (2); Pakai bhatti (21); Brick kilins (29); Health care units (49); Cold storage (42); Other mix. Industries (56)
4	Bharatpur	109	Oil industries (NA); Ceramic industry (NA)
5	Fathepur Sikri	NA	NA

- Mathura Oil Refinery discharges about 5016 KLD of effluent from ETP after treatment through physico-chemical route, biological and filtration and adsorption and stored in holding ponds before discharge into river Yamuna. Part of the treated effluent is used as firewater and for greenbelt development.
- The waste paper recycling unit has ETP treating 550 KLD is discharged into industrial drain. Wastewater generation details are not available for other areas

In Mathura, a CETP of 6.5 MLD is operating for the treatment of sari printing effluents. Based on the information received from UPPCB, the CETP receives only half of the designed flow. However, the effluent quality and discharge details not available. Oil refinery owned by Indian Oil Corporation at Mathura is the only large scale industry particularly relevant to the water environment. However, the refinery has an effluent treatment plant which treats the effluent.

4.4 Efficacy of Preventive and Control Measures in TTZ

The Nagar Palika Parishad (NPP) has undertaken various projects since the last decade to reduce negative impacts of growth. The degree of preventive control measures and actions taken with respect to wastewater management in TTZ is presented in **Table 4.4.1**.

Table 4.3.2: Quantum of Industrial (Water) Pollution in the TTZ[(11)]

City/ Town	Industry	Area	No.of Units	Wastewater generation, m^3/d	Effluent management	Treatment type	Effluent discharged	Pollution Load[#], kg/d		
								BOD	COD	SS
Agra	Peta	Noori Darwaza	1000	5103	Nil	-	ND	4618	9430	2860
	Dairy	Not confined	1160	454	Nil	-	ND	1055	2037	-
	Slaughter house[+]	Kuber	NA	NA	Nil	-	ND	NA	NA	NA
	Tannery	Khatik Pada	70	65	Nil	-	ND	560	1233	272
	Shoe making[+]	Chakki Pat	2300	NA	Nil	-	ND	NA	NA	NA
	Electroplating *	Vijay Nagar	70	300	Nil	CC	ND	-	-	323
Mathura-Vrindavan	Refinery	-	-	5016	ETP	CC,ASP	ND	-	-	-
	Sari printing	NA	NA	6500	CETP	CC,ASP	MD	NA	NA	NA
Firozabad	Wastepaper recycling	NA	2	550	-	-		NA	NA	NA
Total pollution load received from the industrial units in TTZ				17988				6233	12700	3455

Pollution load assessed may be higher than these values if additional data was available
+ Dry process and wastewater discharge is insignificant.
- contains heavy metals such as zinc, copper, chromium and cyanide which are used during plating of iron and brass metals.
ND- natural drain, MD- municipal drain

Table 4.4.1: Efficacy of Preventive and Control Measures in TTZ

Area	Problem/Preventive Measures	Control Measures
Agra	- Three STPs having total installed capacity of about 90.25 MLD are in operation and the total wastewater generated is about 260 MLD. Additionally 2 STPs will be commissioned from 2012 to increase the capacity to 156 MLD. - The drainage system in city is very old. 20 major drains are present in the city and carry sewage all the time. - In Agra 73 industries and 2 industrial clusters including tanneries, electroplating, textile, ceramics and foundries generate 5.3 MLD of effluent.	– Complete replacement of septic tank, soak pits and storm water with sewerage system. Old STPS commissioned should be upgraded to meet the inland surface water discharge standards. Proposal for resource recovery from STPs through biogas and water recovery may be initiated for future activities. – Additional STPs to be commissioned to meet 300 MLD Demand for the year 2020 or old ones capacity may be augmented provided space is available to meet the deficiency of 84 MLD – Periodic cleaning of natural drains should be undertaken – Segregate the solid waste before dumping into drains – Zero liquid discharge should be implemented through the common effluent treatment plants for the red category industries in TTZ area. Tanneries, slaughter houses, electroplating, dairy and peta units to delveop CETPs schemes in their area. Effluents of homogeneous nature eg., organic effluents (slaughter house, dairy, peta units and tannery) to treat in a CETP with energy and water recovery module. – Units located in far-off areas may be aided for transportation of effluent to the new CETPs.
Mathura	- The sewerage network in Mathura is old. Two STPs are operated. Due to various reasons, the system became	– Provision of new sewer networks. – Additional STPs to be commissioned to meet demand for the year 2020 or old ones capacity may be augmented provided space is available to meet the deficiency of 22 MLD. The

	almost defunct and effluents of domestic and industrial origin find their way into roadside open storm water drains which ultimately discharge into the Yamuna river. - In Mathura, most of the drains are open and water logging is the main problem. - Industries (101 Nos,) include water intensive operations, such as, refinery, oil industries, printing industries which discharge toxic effluents.	treated effluent may be used by Mathura Refinery to meet the quality and quanity requirement for which payment could be made by the refinery. If there is excess quantity it may be combined with the CETP influents and the water treated to reuse quality for textile printing process. – Construction of new drains. – Separation of solids at source. – Upgrade the existing CETP for meeting the discharge standards and increase in the inflow into CETP. – Creating of waste minimization and recovery circle. – Periodic assessment of pollutant reduction by industries and CETPs with financial benefits for the efforts.
Vrindavan	- Vrindavan has no sewerage network and due to this water bodies and ground water pollution occurs. - Flooding and water logging occurs during monsoon period due to inadequate drainage system.	– Establishment of new sewer networks with connection STPs. – Provision of STP for the treatment of sewage and other wastewaters – Upgrading the existing STPs to meet the standards. – Provision of storm water drainage network.
Firozabad	- There is no sewage treatment facility in Firozabad. About 67 MLD of domestic wastewater is generated. There is no proper drainage system. No proper effluent treatment for 420	– Septic tank, soak pits and open system should be replaced with sewerage system – Provision of sewer network and STPs to treat the wastewater from area. – Provision of new CETP.

	industries in Firozabad including glass and bangle industries.	
Fathepur	- There is no proper sewerage and drainage system.	– Assessment of water consumption and wastewater generation for delineation of sewage treatment plans. – Provision of sewer network and STP to treat the wastewater from area. – Septic tank, soak pits and open system should be replaced with sewerage system
Bharatpur	- There is no proper sewerage and drainage system.	– Assessment of water consumption and wastewater generation for delineation of sewage treatment plans. – Provision of sewer network and STPs to treat the wastewater from area. – Septic tank, soak pits and open system should be replaced with sewerage system – Storm water drain may be connected to the existing water bodies.

Source: CPCB manual, 2002; CDP Agra; CDP Mathura; CDP Firozabad; BMP

4.5 Prioritized List of Actions required for Effective EMP Implementation in the TTZ [1, 3, 9, 10]

Area	Problem	Area/Ward	Action Required	Environmental Benefits
Agra	– Inadequate sewer network, No storm water drainage due to which natural drains carry untreated sewage to river Yamuna. – Inadequate sewage treatment plant capacity – STP not meeting discharge standards.	Impeypura, Telipara, Nagla Kaachpura, Paktola, Nai basti, Baghichi, Lachipura, Telipara, Paktola, Nagla din, Payerlal ka Nagla, Garhi chandini, Garhi, Hussaninpura, Nagla devjit, Tajgani, Papal Mandi, Kashmiri Bazaar, Naulakha Bazaar, Phawara Bazaar, Nawalgang, Nagla Baluchand, Motibagh, Pratapur, Mohanpura, Khanderu, Jawahar Bazaar, Kala Mahal Bazaar, Ukhara, Charaungi, Kachipura, Ramjo ka nagla, Chatta Bazaar, Daseri, Freeganj, Sadar, Bazaar, Sev ka Bazaar, Subhash Bazaar, Hariparwat, Krishna colony, Belanganj, Nehru nagat, Kamala Nagar, Bhairon, Ghatwasan I, Ghatwasan II,Lohamandi, Bodla I, Khandari II, Trans Yamuna II	– Improvement and laying of trunk sewers on the drains – Expansion of water supply network in the area. – Provision for arresting entry of solid waste into the storm water network. – Construction of the branch sewers connecting the drains. – Development of the greenbelt along the open drains. – Construction of trunk sewer to collect sewage from trunk sewers lines laid along major drains. – Provision of new STPs to meet the deficiency in treatment. – Upgradation of existing STPS to meet discharge standards.	– Improving and increasing the sewer network helps efficient collection of all the sewage generated and the treatment through STPs. This can reduce water logging and decrease pollution of Yamuna River. – Separation of storm water and sewage resulting in less discharge of pollutants into the drains and finally to the river – Reduce the wastewater discharge into Yamuna River. – It would prevent air pollution due to enhanced treatment capacity of domestic waste water –

Mathura	– Inadequate and storm water network – Inadequate sewage treatment plant capacity	Krishna Nagar, Ambedkar Nagar, pockets of Mohali road, New Bus Stand Bhuteshwar and areas under bridges etc.	– Laying of trunk sewers on the major drains. – Construction of the branch sewers connecting the major trunk sewers. – Complete tapping of sewage generated and treatment in STPs, thereby reducing the pollution in Yamuna. – Provision for arresting solid waste entry into the storm water network. – Periodical removal of solid waste from this area. – Construction of drainage lines in un-serviced areas and streets. – Provision for pumping of storm water. – Upgradation of existing STPS to meet discharge normal standards.	– The pollution load from Mathura is anticipated to be reduced. – In addition, the Gokul barrage in Mathura would also be free from pollution.
Vrindavan	– Sewage and drainage – -Inadequate sewage treatment plant capacity	Kalidegu, Masa	– Construction of new STP and renovation of existing ones – Interceptors at outfalls to the Yamuna as per networks plans – Construction of new drains and repairs to existing drains – Upgradation of existing STPs to meet discharge normal	– Collection of all the sewage generated and diverting it to the STP. – The pollutant load from Vrindavan is anticipated to be reduced.

Firozabad	– Clogging of natural drains. – No sewer network exists.	NA	– Dumping of solid waste into the storm water drains should be banned to prevent clogging of the natural drain and reduce the pollution of Yamuna river.	– Separation of storm water and sewage resulting in low discharge of pollutants into the drains and finally into the river.
Fathep ur-sikri	– No sewer network and drains	NA	– Construction of new sewerage system on the basis of network plan	– Tapping of sewage from natural drains and treatment through STP.
Bharatpur	– Sewerage	Gopal Nagla village, wetland areas	– Construction of new sewers on the basis of networks plan, inclusive of pumping –	– Construction of new sewage treatment plant at Bharatpur and pumping of the sewage to Mathura for treatment – Feasibility of reuse of treated effluent should be explored.
Generalized comment - Sewerage Training of The staff of STPs, UPJN, ANN, ADA officials for certificate level course on management of sewer networks, wastewater treatment sludge management and resonance recovery. The staff should technical operators, engineers and managers.				

4.6 Proposed Projects on Sewerage System

4.6.1 Agra

A project is proposed for replacement of existing outdated inner city sewer network and construction of new sewer, pumping stations and construction of new STP's (1,2,3). The extent of area of coverage of the project is 1400 hectares costing Rs. 1240.82 crores. The project is scheduled to be completed during the year 2015.

4.6.2 Mathura and Vrindavan

A project was submitted by UPJN under the JNNURM Programme for the construction of sewerage system and an STP of 16 MLD capacity for sewage treatment in Mathura costing Rs. 6035.77 lakhs (4). Another project was submitted by UPJN under the same programme for construction of sewerage system and an STP of capacity 8 MLD at Vrindavan costing Rs.9181.16 lakhs (4) by the end of year 2012.

4.6.3 Firozabad

NPP, Firozabad proposes to lay sewer system with STP under the JNNURM programme at a cost of Rs. 8692.00 lakhs.

4.6.4 Bharatpur

Proposals for laying of sewer lines and construction of STP in Gopal Nagla Village were submitted and District Office has issued "No Objection Certificate" for the STP construction last year. There are no protected areas, wetlands, mangroves or estuaries at the project sites.

4.6.5 Fatehpur Sikri

There are no proposals for laying the sewerage system in Fatehpur Sikri.

4.7 Proposed projects for the Stormwater Drainage in the TTZ

4.7.1 Agra

A project was submitted by UPJN for construction of bar screens to arrest solid waste entering the river from Mantola Drain at Agra (5). Mantola drain is the largest drain in the Agra City into which other drains discharge. The total length of the drain is 14 km. The drain carries

domestic sewage from the city. A pumping station located at Khairati Tola pumps the wastewater to DhandPura STP (78 MLD) for treatment. The total cost of the project is Rs. 483.13 lakhs. The project is expected to be completed in 2012.

UPJN has proposed construction of storm water drainage (SWD) works for the Agra city (8). The cost of providing SWD at Agra covering a catchment of 24852 acres (based on 2011 cost) is about Rs. 1815 crores. The proposed project covers about 47 major drains, with construction of new closed drains in unserviced areas and desilting and repairs of old drains (5).

4.7.2 Mathura

A new storm water drainage system is proposed for Mathura with an objective of providing storm water collection system in the city covering about 71.94 kms and costing Rs.8720 lakhs. The project is planned to be completed by the year 2012.

4.7.3 Vrindavan

A storm water system covering about 25.77 kms and costing Rs. 2195.16 lakhs is proposed for Vrindavan. The project is planned to be completed by the end of year 2012.

4.7.4 Stormwater System in Bharatpur and Fatehpur Sikri

There are no proposals for construction of the storm water drainage system in Bharatpur and Fatehpur Sikri.

4.8 Industrial Effluent Discharges

Based on the information collected regarding the pollution from industrial effluents in the TTZ, it is understood that majority of the industries are dry in nature or discharge less effluents. Also, the effluent management systems have to be commissioned for dairy, peta, slaughter houses and tanneries. Since these units have higher organic concentration, efforts should be directed for energy recovery through methane generation and subsequent utilization for power generation. Plans are afoot to change effluent management in electroplating industries in Agra from conventional treatment to ion-exchange based technologies.

Advanced treatment for water recovery through membrane filtration systems may be adopted to reduce freshwater consumption and reuse treated water in electroplating units.

The major industry in the TTZ is Indian Oil Corporation's Mathura Refinery. The effluents are treated in ETP and part of the treated wastewater is recycled into the industry for power generation. The refinery may reduce wastewater generation through reuse of treated domestic sewage from Mathura & Vrindavan thus reducing freshwater consumption from Yamuna River.

4.9 Evaluation of the Proposed Projects on Sewerage Management

4.9.1 Agra

The per capita water supply for cities with population of one lakh and above is 150 lpcd for domestic and non-domestic needs (1 & 2). Based on this estimate, about 442 MLD of wastewater is expected to be generated in the year 2034 for 27.7 lakhs population. Assuming 85% of the freshwater returning as wastewater, the quantum of sewage generated is about 380 MLD. However, as per the master plan, construction of sewerage system for the year 2040 prepared and approved by the state government could meet a capacity of only 300 MLD. The project costs about Rs. 1244.82 crores and falls short by 80 MLD [(8)]. Currently about 260 MLD of sewage is generated in the Agra city and 3 STPs are made operational to treat the effluents with a combined capacity of 90.25 MLD. These STPs were built under YAP Phase I at Dhandpura (78 MLD), Burhi ka Nagla (2.25 MLD) and Peela Khar (10 MLD). Additionally, 5 new STPs having capacities of 40 mld (1no.), 36 mld (1no.) 24 mld (1no.), 14 MLD (1 no.), 12 MLD (1 no.) capacity are under various stages of construction and commissioning and anticipated to provide treatment in STP for about 216 MLD of wastewater by the year 2012 out of which the 40 & 14 MLD STPs have been created under NRCD plans with total capacity for treatment at 144 MLD.

Considering the existing volume of wastewater discharge at 260 MLD, a shortfall of 46 MLD is anticipated during the period 2012-14 which can be partially met by diverting some of the load into existing STPs. Based on the information obtained, the existing STPs are not receiving their designed flows (CPCB report, 2007). The pumping station capacity at Lal Kothi may be increased since only 50 MLD is reaching Dhandhupura STP which is capable of treating 78 MLD. Mantola drain discharges about 35% of wastewater generated in the city. Other major drains in descending order of discharge are Bhairon nallah, Narairchа nallah, discharging very near to Taj Mahal and these need to be tapped and treated urgently. The discharged effluent qualities of 3 STPs are already discussed in the earlier section. About 32 t/d of BOD and 39 t/d of SS is discharged into Yamuna river from Agra city (CPCB, 2002).

The city has underground sewerage system, which is operated and maintained by the Agra Jal Sansthan. Planning, construction and commissioning of the sewer projects is done by UPJN. Sewer lines have not been laid except in the old city area laid during the year 1976. The existing system is spread over an area of 1400 hectares. New works have been proposed for all sewerage districts which are presented in Table **4.9.1**.

A sewerage scheme is under execution in the TTZ Zone. The Phase – I of the master plan proposed sewerage system in the Taj Ganj district and for renovation and extension of some sewer lines was approved by M.M.B in July 2000. The estimated and sanctioned cost of phase –I was Rs. 43.57 crores with expected completion by June 2003, of which only projects worth Rs. 23.00 crores have been completed. Under this scheme 89.127 km of sewer lines have been laid and construction of 4 sewage-pumping stations is in progress. **Table 4.9.1** provides the status of sewerage projects in the TTZ.

Table 4.9.1: Details of Sewer Work being carried out at Agra [(2)]

Sewarage Zone	Brief Description of Works
Central	Providing 129 Km new sewer lines 3 Nos. major & 5 Nos. small pumping stations.
Northern	147 Km. sewer lines 2 Nos. major and 10 nos. small pumping station and 38.00 MLD S.T.P.
Eastern	61.40 Km. sewer line 3 major and 3 small SPS and 26.00 MLD STP
Western	255 Km. sewer line 4 major and 4 small SPS and 105.00 MLD STP
Southern Zone-I	63.40 km. sewer line, 2 major and 6 small SPS and 29.00 MLD STP.
Southern Zone-II	30.20 km. sewer line, 1 major and 1 small SPS and 29.00 MLD STP.
Tajganj	342 Km. sewer line, 4 major & 7 small pumping stations and 37.00 MLD STP

Source: CSP - Agra

4.9.2 Evaluation of the Proposed Projects on Sewerage Management in Mathura & Vrindavan

Mathura town is an important pilgrim center located on the banks of river Yamuna. A separate project incorporating sewage treatment was implemented under Yamuna Action Plan (YAP) Phase I. The city does not have an effective sewerage system and is dependent on septic tanks and open drains. Pumping stations and sewage treatment plants are provided as part of the old sewage network. The entire wastewater of the town flows through various open drains into the river. Three decades ago, an intercepting sewer and some trunk sewers were

laid along the river bank which intercepted the flow from 13 nos. of drains, which was then transmitted to a sewage farm on the other (eastern) side of the river with the help of two lifting stations. The total wastewater flow reaching Yamuna River from Mathura is about 50 MLD. Two STPs at Mathura are in operation with capacities of 13.59 and 14.60 MLD. The STPs at Mathura operate trough an anaerobic and facultative ponds. The treated effluent is used for sewage farming for which 124 hectares is available near Sadabad road and is being maintained by NPP, Mathura. Under Yamuna action plan, about 28.19 MLD capacities is available to treat the wastewaters generated in the city (as on 2011). Additionally, about 16 MLD plant is under construction with a total capacity of 44.09 MLD resulting in a deficit of 6 MLD for the year 2012 [3, 6]. Considering the population growth in Mathura from the existing 3.0 lakhs population, additional capacities in the sewage treatment are necessary and need to be augmented by the authorities. The status of the sewer projects are presented in **Table 4.9.2**.

Sewage treatment plants in Vrindavan are located at Kalidegu and Masa are of capacities 0.50 and 4.50 MLD. The treated effluents from the STPs located at Mathura and Vrindhavan are used for irrigation purpose and excess quantity is discharged into Yamuna River. Considering the population growth in Vrindavan from the existing 1.0 lakhs population, additional capacity sewage treatment plants are necessary. The status of the proposed projects in Vrindavan is presented in **Table 4.9.2**.

4.9.3 Evaluation of the Proposed Projects on Wastewater Management in Firozabad

About 67 MLD of domestic sewage is generated in Firozabad. The waste water generated from industries and municipal limits are carried through two nallahs which ultimately discharge into Yamuna river. Firozabad NPP proposed construction of a STP for treatment and disposal of sewage. Under the Jawahar lal Nehru National Urban Renewal Mission (JNNURM) programme, Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT), an amount of Rs. 8692.00 lakhs is provided by the Central Government (80% of the project cost) and the State Government and Urban Local Body contributing (10% each) [9]. About Rs. 8397.00 lakhs had been received so far and the status of the various projects under this scheme is provided. However, the project covers only sewage pipe line works in the city and not tapping the nullahs which carry the domestic sewage and industrial wastewater. Projects may be initiated to protect both nullahs from the polluting sources through diversions and providing pumping stations to the proposed STPs.

Table 4.9.2 : Status of the Sewerage Projects in the TTZ [4]

Sr. No.	Projects Details	Agra		Mathura		Virindavan		Firozabad	
		QTY	WP	QTY	WP	QTY	WP	QTY	WP
1.	Sewer lines, km	281.50	NA	66.84	35.00	112.70	101.10	160.63	118.90
2.	Raising mains, km	NA	NA	0.05	0.00	200-800 mm		200-800 mm	
						8.08	7.30	2.33	1.30
3.	Sewage pumping stations	19	95	1	50% Completed	3	60% Completed	3	80% completed
4.	Renovation of pumping stations		NA	2	0.00	-	-	-	-
5.	STP (UASB)	2	64	1	50%	1	50% completed	1	0.00
		180*		For 16 MLD		For 8 MLD		For 67 MLD	
6.	Other works	-	NA	1	80%	-	-	-	-

*** At the end of Year 2012**

4.9.4 Evaluation of Proposed Projects for Wastewater Management in Bharatpur

The **STP project** is needed due to lack of integrated sewerage and sanitary system in Bharatpur resulting in unsanitary conditions in the town. There is no settlement within 1 kilometer (km) of the STP site. However, it is located at about 4.5 km from the boundaries of the Bharatpur in TTZ. Further details related to waste water management in Bharatpur is not available for assessment. However; a STP of 25 MLD capacity should be proposed to meet the requirement of 2015.

4.9.5 Evaluation of Proposed Projects for Wastewater Management in Fatehpur Sikri

No details on wastewater management, domestic and industrial effluent management plan for the Fatehpur Sikri are available. Assessment of wastewater generation from this area is not available and this may be assessed by the regional Pollution Control Board, Agra.

4.10 Evaluation of the Proposed Stormwater Management Projects in the TTZ

4.10.1 Agra

The total length of drains in Agra is about 1080.53 km which was laid 55 years ago. The existing storm water drains are divided into 11 major catchments or zones with 20 major drains conveying significant volume of storm water in Agra city. At present, only 17 % of the city is covered by the sewerage system from which only 50 % is in working condition. Most of the sewage is discharged into the storm water drains. The storm water drains in most locations are badly silted, choked and damaged at a number of places and overloaded due to indiscriminate disposal of solid waste.

Due to the inadequate drainage, roads are damaged and create water logging during the monsoon. About 15% of road length has adequate storm water drainage system and about 30 km of roadside drain is required for the city to be upgraded. The storm water management under the master drainage plan (for the year 2021) suggested that 88 km of existing drains be remodeled and 160 km of new drains to be constructed. Considering the development in new areas, it was further divided into 47 catchment areas and 278 sub-catchment areas. For improvement in the carrying capacity of some of the existing drains, deepening, widening, rising of height and change in gradient has to be done. New drains are required to be completed in phases to draw the storm water from the new developing areas. Additional pumping stations are required along with provision of regular power supply. The status of the proposed storm water projects in Agra is presented in **Table 4.10.1**.

4.10.2 Mathura and Vrindavan

There is no provision for storm water drainage system in Mathura and Vrindavan. Most of the drainage is unlined and often is choked due to the accumulation of solidwastes viz., polythene bags, waste material, and silt. There are more than 10 locations in the city where the storm water drainage is acute during monsoon. Water logging upto 2 meters high have been reported in some areas. The problem is severe in the southern part of the town due to elevation. Some areas where the drainage problem is acutely faced are Krishna Nagar, Ambedkar Nagar, pockets of Mohali Road, New Bus Stand Bhuteshwar and areas under bridges.

Table 4.10.1: Status of the Stormwater Projects under JNNURM for the TTZ [4]

Sr. No.	Project Details	Agra		Mathura		Vrindavan		Firozabad	
		QTY	WP	QTY	WP	QTY	WP	QTY	WP
1.	Construction of new RCC drains, km	87.031	NA	23.178	15.38	13.95	10.62	Information not available	Information not available
2.	Brick masonry Nullahs, km	-	-	36.895	14.75	-	-		
3.	Renovation/ remodeling of old Nullahs, km	159.84	NA	11.865	0.05	7.41	5.07		
4.	Repairing of old Nullahs, km	47.31	NA	-	-	4.41	1.68		
5.	Storm water pumping station	-	-	3	1.50	-	-		
6.	Rising mains	-	-	0.66	0.21	-	-		
	Total length, km	294.199	NA	71.94	31.89	25.77	17.37		
WP – Work in progress; NA – Not available									

Source: JNNURM

Only about 10% of the road length has adequate storm water drainage system. More than 600 km drainage length is required to be upgraded in Mathura. Due to the inadequate drainage lines, the roads often get damaged.The entire city consisting of Trans Yamuna area and Trans Highway area (regulated area as Proposed in Master Plan 2021 by MVDA) has been divided into six drainage zones covering about 2473.84 hectares area. The status of various projects under execution in Mathura and Virindavan is presented in **Table 4.9.2**. The projects are targeted to be completed by 2012. It may be mentioned that there is no drainage tax or charges being collected by the Mathura NPP. Based on the information received from the respective authorities, certain activities such as remodeling of old nullahs and construction of new drains and brick masonry nullahs need to be paced up to be completed by 2012.

4.11 Conclusions

Based on the secondary data and visits to the sites during the studies, it was observed that many of the projects on wasterwater and storm water management have been under different stages of preparation and implementation and some of them in pipeline for some time.

However, not many projects have not been completed on the ground due to various reasons. In order to improve the overall development of the TTZ belt, some suggestions are put forth for implementation.

- Effective monitoring of the existing projects with timeline to the sponsoring bodies.
- Time based project activities which should include exigencies due to natural calamities and inflation.
- Since a number of departments are connected to the TTZ zone, integrated work activities with feedback from the local engineers and public may be taken into consideration. Solution from the engineers of the concerned should be considered whether it is on storm water, wastewater or industrial effluent management.
- **Sewage** - In respect to wastewater management, it is not necessary to treat the entire area sewage/effluents in single STP/CETPs. Decentralized wastewater management systems based on the concept of onsite treatment through effective financial packages for sustainability. The concept of wastewater treatment through private consultants/agencies could be thought for recovery and sale of products of wastewater treatment.
- **Industries** - Waste minimization circles should disseminate to industries of small and medium scale units (Peta, Dairy, Tannery, Electroplating etc.,) the benefits and costs consideration of waste management. Mechanisms may be evolved to treat the industrial effluents based on organic / inorganic nature for resource recoveries such as biogas, treated water, manure and electricity.

Reports & References

- City Development Plan, ANN, August 2006; Government of Uttar Pradesh Urban Development Department.
- Agra City Sanitation Plan, Administrative Staff College of India, 2010.
- City Development Plan of Mathura, JNNURM, NPP 2006.
- Note on sewerage and drainage works in Mathura, Vrindavan, Firozabad, JNNURM, 2011.
- Estimate for Construction of Storm Water Drainage Plans of Agra city, UPJN, 2011.
- Report on Environmental Status in Mathura City, UPPCB, 2011.
- Estimate for Environmental Management Programme for Mantola Drain, Agra, UPJN, 20110.
- Note on Agra Sewerage works, Yamuna Pollution Control Unit, UPJN, Agra, 2011.
- Environmental Management plan for TTZ in Firozabad, UPPCB, 2011.
- CPCB, Proposal on Priority Projects under Taj Protection Mission, 2002.

- Feasibility Report on Development of New Industrial Estate for Shifting of Polluting/Non-Conforming Industries at Agra.

Abbreviations

ADA – Agra Development Authority

ANN – Agra Nagar Nigam

CDP – City Development Plant

CEMP – Comprehensive Environmental Management Plan

CSP – City Sanitation Plan

JNNURM - Jawaharlal Nehru National Urban Renewal Mission

NA – Not Available

NPP – Nagar Palika Parisad

QTY – Quantity

SPS – Sewage Pumping Station

STP – Sewage Treatment Plant

TTZ - Taj Trapezium Zone

UPJN – Uttar Pradesh Jal Nigam

UPPCB- Uttar Pradesh Pollution Control Board

WP – Work Progress

YAP – Yamuna Action Plan

BMP – Bharatpur Master Plan

CPCB – Central Pollution Control Board

5.0 Solid Waste Management in TTZ Area

Solid waste generated in TTZ zone can be broadly classified into three categories :

- Municipal solid waste
- Industrial solid waste
- Biomedical waste
- Miscellaneous wastes like slaughter house waste and construction and demolition waste

Solid waste management involves various components like collection, storage, transportation, treatment and disposal. Uncontrolled dumping of solid waste results in deterioration of environmental and aesthetic quality. Earlier reports indicate that this zone of historical importance has been facing acute problems in solid waste management. Large number of tourists visit Agra every day for seeing Taj Mahal and this aggravates the problem.

5.1 Existing Status of Solid Waste Management in TTZ Area

5.1.1 Existing Status of Municipal Solid Waste Management in TTZ Area

Agra has an area of 141 sq.m. which falls under the jurisdiction of Agra Nagar Nigam. At present, as reported about 708 tpd of MSW is generated in Agra. Agra Nagar Nigam (ANN) is the nodal agency which looks after overall MSW management. Municipal Commissioner is the highest executive head of the Agra Nagar Nigam. The Health and Engineering departments are the two executive departments responsible for implementation of the SWM plan and civil infrastructure respectively in the town. The Health department is involved in planning and management of the SWM activities and in providing sanitation facilities to the residents of Agra. The Engineering department works in coordination with the Health department and undertakes civil and infrastructure development activities for the city. The Chief Health Officer and the Executive Engineer are the senior officers of the Health and Engineering departments respectively, who report to the Municipal Commissioner. The Nagar Nigam comprises of 90 election wards. For solid waste management purpose, the city is divided into 19 Sanitary wards. Each ward is headed by a sanitary inspector. The sanitary inspector is responsible for

managing the fleet routes, collection procedure, allocating diesel to vehicles, street sweeping and allotting duties to the supervisors and safaikaramcharis. Organisation structure of solid waste management along with staff strength is depicted in **Figure 5.1.1**.

Quantity and characteristics of MSW as per earlier reports are presented in **Table 5.1.1**. Road and drain cleaning is done by ANN safai karmachari. Mainly community bin collection system is used in Agra. In addition, there are road side dumps all over the city. Recently house to house collection system has been initiated. It has been reported that about 2215 ANN safai karmacharis along with 650 contract sweepers are engaged in street sweepings and collection of waste. They are provided with brooms, wheel barrows and handcarts. Waste is temporarily stored in community bin or open collection points. Various types of bins used are dumper placer bins of different capacities and masonry bins. In addition, there are many open storage areas. The type and number of community bins are presented in **Table 5.1.2.**

Various types of vehicles used for transportation of waste include tipper, dumper placer, tractor & trailer and three wheelers. The type and number of vehicles used by ANN are presented in **Table 5.1.3**. ANN has one workshop at Transport Nagar. The workshop includes one puncture repairing department, one mechanical department and vehicle service station. Major faults are repaired in private workshop.

At present, a sanitary landfill has been developed at Kuberpur which is yet to be operated. The waste is temporarily dumped at a specified area. The previous dumpsite at Shahdara is no longer in use. Other activities like house to house collection, treatment and disposal have been outsourced and entrusted to private party named as Ultra Urban Infratech.

Some of the drawbacks of solid waste management in Agra indicated in earlier reports are as given below :

Collection and Storage System

- Inadequate house to house collection
- Inadequate source segregation
- Inadequate collection implements

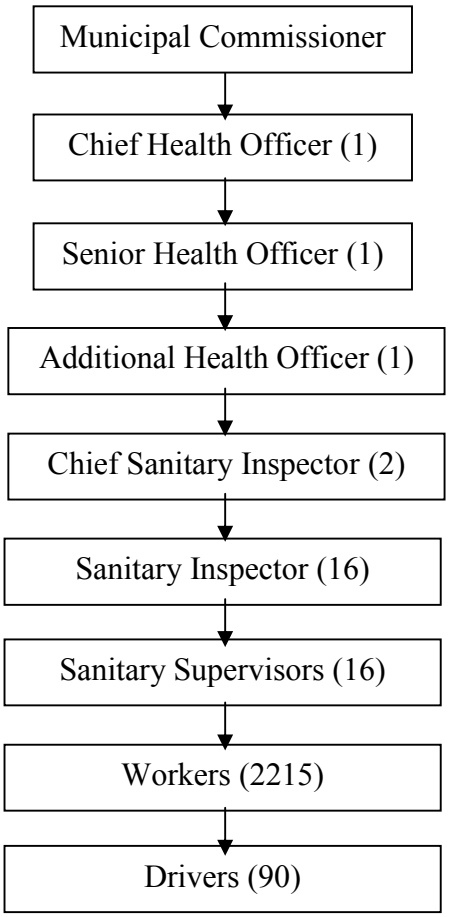


Figure 5.1.1: Organizational Structure of the Agra Nagar Nigam for Solid Waste Management

Table 5.1.1: Quantity and Characteristics of MSW in Agra

Waste Characteristics	Quantity Generated (tpd)	Percent of Total Waste
Recyclables	150	21
Organic matter including Petha waste	311	44
Construction debris	114	16
Mixed waste drain slit and street sweepings	133	19
Total	**708**	**100**

- *** Adapted from DPR (Revised) prepared by Regional Centre for Urban Development, Government of India, University of Lucknow, Lucknow**

Table 5.1.2 : Temporary Storage for Collection of Solid Waste

Type of Storage	Numbers
Open waste storage depot	225
Masonry storage depots	86
Dumper placer container (8 cum)	150
Dumper placer container (4.5 cum)	100

- **Source: City Development Plan for Agra city MDP consultant, Allianz Security Ltd.**

Table 5.1.3 : Vehicles Fleet of Nagar Nigam

Type of Vehicles	Numbers
Tipper (large)	17
Tipper (small)	14
Dumper Placer (8 cum)	16
Dumper Placer (4.5 cum)	17
Tractor and Trailer	3
Three wheeler	6

Source: City Development Plan for Agra city MDP consultant, Allianz Security Ltd.

- Absence of transfer stations
- Road side dumping creating environmental and health hazard
- Improper allocation of community bins
- Misuse and mishandling of community bins
- Presence of biomedical waste in MSW dust bins
- Open burning of waste

Transportation System

- Non availability of covered/closed body vehicles for transportation of MSW

- Use of old vehicles in transportation of waste
- Keeping vehicles at uncovered place
- Open burning of MSW leading to air pollution
- No provision of protective garments for the MSW workers
- Inadequate number of vehicles
- No proper maintenance of vehicles

Treatment and Disposal System

- Discharge of MSW in the nallah, drain obstructing the flow
- Uncontrolled waste disposal at the dumping site
- Absence of sanitary landfill and appropriate treatment facilities

Public Participation

- Lack of public participation and awareness

As evident from recent reports, initiatives have been taken to improve the situation. A sanitary landfill site along with composting facility has been developed at Kuberpur. The site is located at approximately 16 km from Nagar Nigam Office. The land adjoins slaughter house in the north. The operation of compost facility has already been started. Operation of sanitary landfill is yet to start. The task of improvement of solid waste management has been initiated under “JNNURM” scheme. Even though initiatives were taken for improvement of solid waste management in the vicinity of the Taj Mahal, solid waste management in other parts of Agra and other municipalities of TTZ still needs more attention.

Miscellaneous Wastes

Slaughter House Waste

Slaughter house waste and construction waste are also generated in significant quantities in TTZ area. Slaughtering of animals generates wastes like glands, intestines, animal tissue, organics, stomach, dung, bones etc. There is only one authorized slaughter house in Agra. It is located at Chaleswar, Kuberpur in Jamunapur sanitary ward. It has been reported that 1200 animals are slaughtered everyday. In addition to

the above, there are unauthorized slaughter houses in Kajipara, Mantola, Sayedpara, Rawatpara, Mundapara, and Khatikpara. Skins, horns and bones are sold while remaing parts are disposed off in nearby areas. There are unauthorized slaughter houses in other towns of TTZ also.

Construction and Demolition Waste

Construction and demolition waste is generated whenever any construction/demolition activity takes place such as construction of buildings, bridges, flyovers etc. It mainly consists of inerts and non-biodegradables like concrete, plastics, metals, wood etc. Construction and demolition wastes are generated depending upon the type of respective activity. A major fraction of the waste is used for reconstruction, filling up low-lying areas or kachha road.

MSW Management in TTZ Area (Excluding Agra)

TTZ area also includes municipal towns like Mathura-Vrindaban, Firozabad, Bharatpur and Fatehpur-Sikri. Considerable amount of MSW is generated in these towns also.

MSW Management at Mathura

Urban population of Mathura (as per 2011 census) is 349336. Assuming a per capita waste generation of 0.4 kg/day (average value estimated for Indian cities), the estimated quantity of MSW is 140 tpd. At present, at Mathura disposal of MSW is practised in Laxminagar area of Nimgaon in a non-scientific manner. The practice is not in compliance with the guidelines of MSW Rules. At Mathura, improvement of solid waste management under JNNURM scheme is in initial stage. As reported, Mathura Nagar Waste Processing Co. (P) Ltd. has been entrusted with the task of establishing and operating treatment and disposal facility for MSW. Total area of land proposed is 27 acres. The capacity of proposed facility is 177 tons of MSW per day. The salient features of proposed SLF project are presented in **Table 5.1.4**.

Table 5.1.4: Details of Proposed SWM Projects at Mathura under JNNURM Scheme

Sr. No.	SWM activities
1.	Boundary wall (1100 m)
2.	Internal Road (750 m)
3.	Compost plant including windrow (4800 m)
4.	Sanitary landfill (10500 sq.m.)
5.	Primary and secondary collection system
6.	Administrative building and weighbridge
7.	Presorting, shed & RDF plant
8.	Door to door collection

Source: U.P. Jal Nigam, Mathura

MSW Management at Firozabad

At Firozabad, as reported, about 130 tons of municipal solid waste is generated per day. MSW is dumped at specified low-lying areas. The disposal of waste is practised in non-scientific manner. The practice is not in compliance with the guidelines of MSW Rules. The construction of sanitary landfill and compost facility has been proposed under JNNURM and UIDSSMT programme in Kutubpur-Chanera area to be developed by U.P. Jal Nigam.

MSW Management at Bharatpur

The population of Bharatpur as per 2011 census is 252109. Assuming a per capita MSW generation of 0.4 kg/day (average value estimated for Indian cities), the waste quantity estimated is 100 tpd. Disposal of MSW is practised in non-scientific manner. The practice is not in compliance with the guidelines of MSW Rules. It has been proposed to construct a sanitary landfill and compost facility in a plot of land of area 11.92 ha on the West of Nohagaon near Achnera road.

5.1.2 Existing Status of Industrial Waste Management

It has been mentioned in the earlier report that 1000 Petha industries are operating in Agra. Petha is a popular sweet of Agra made from ash pumpkin. A huge amount of solid waste in the form of skins, seeds and spoiled pumpkins is generated in Agra during production of Petha. The solid waste is often dumped on land or is thrown in drain and subsequently the flow of water is obstructed.

Many foundries and electroplating units are existing. The products produced include various types of hardware fittings, bathroom fittings, handles, door stoppers, etc. Most of the units are having their own effluent treatment facility. Effluent treatment involves treatment with lime, alum, caustic and activated carbon. ETP sludge is generated and the same needs appropriate disposal. Various types of electroplating operations done are as follows :

- Nickel plating
- Silver plating
- Brass plating
- Gold dying
- Chrome plating
- Bright copper plating

During degreasing, saw dust and kerosene are used. Contaminated saw dust is generated as waste. Other type of solid waste generated includes metals. The waste disposal practice adopted is not environment-friendly.

Another category of industry is leather industry. Small cuttings are generated from the shoe making industries. Solid waste is also generated from existing tanneries. Dairy's are also available which generate cow dung as waste. It has been reported that about 4800 industries are existing in Agra. Location of the industries and quantity of solid waste generated is presented in **Table 5.1.5 & 5.1.6**.

Table 5.1.5 : Cluster of Industries Located at Agra

Sr. No.	Type of Industry	Location
1.	Petha Industries	Noori Darwaza, Agra *
2.	Electroplating Industries	Vijay Nagar *, Agra
3.	Tanning Industries	Khatic Pada, Agra
4.	Shoe making	Chakkipat, Agra *
5.	Dairy Farms	All over Agra

*** Cluster as well as distribution over Agra**

Source: Feasibility report on development of new industrial enface for shifting of polluting non conforming industries at Agra, Ramkey Enviro Engineers Ltd.

Table 5.1.6: Quantity of Solid Waste Generated from Different Categories of Industry

Sr. No.	Category of Industry	No of Industry	Types of Solid Waste	Average Quantity (kg/day)
1.	Tannery	70	Skin cutting, babul bark, etc.	6300
2.	Electroplating	70	Metal parts, etc.	117
3.	Shoe making	2500	Small cuttings etc.	25000
4.	Petha making	1000	Peelings of ash pumpkin	500000
5.	Dairy	1160	Dung	232000
	Total	**4800**	**Total**	**763417**

*** Adapted from Feasibility report on development of new industrial enface for shifting of polluting non conforming industries at Agra, Ramkey Enviro Engineers Ltd.**

Source: Detailed Project Report (Revised) for solid waste management in Agra, U.P.

About 15 number of small and a few large sari printing industries are existing in and around Agra city. The process involves washing, bleaching, drying, calendaring, printing etc. Agro-waste briquette is used as fuel. Ash and ETP sludge are generated as solid wastes from the industries.

At Firozabad, there are glass industries distributed all over the city. There are 412 glass industries out of which 173 industries are gas based. Somewhere, clusters of industries are available. There are many pakai bhatti which are coal based. The products of glass industries are glassware, glass bottles, vehicle headlight, bangles, etc. The raw materials used are broken glass, soda ash, silica sand, barium nitrate and sodium sulphate. The unfinished products are recycled in the process. Ash and soil are the solid wastes generated from the process. The waste is dumped in low-lying areas.

5.1.3 Existing Status of Biomedical Waste Management

Biomedical waste is generated from the hospitals, nursing home, clinics, etc. in Agra and other towns of TTZ. In Agra, at present, there are about 101 government hospitals and 127 private hospitals with 8000 beds, as reported. In addition, there are 13 dispensaries, 1 maternity hospital, 5 child health care centers, 123 nursing homes and several private clinics. Besides the above, there are hospitals for armed forces in the cantonment area, for police personnel in police lines and for railway staff in railway lines. Biomedical waste generation scenario in government and private hospitals is presented in **Table 5.1.7**. It has been reported that per capita biomedical waste generation is about 1.49 kg/bed/day. Biomedical waste is collected, segregated and stored by individual hospitals and nursing homes. However, common authorized treatment and disposal facility is not availed by some hospitals/nursing homes. Instead it is thrown into dust bins or in open area. The common facility for treatment and disposal is availed by about 635 hospitals of Agra, Mathura and Ferozabad of TTZ on payment basis. One company “Dutta Enterprise” is operating the common treatment and disposal facility on charge basis. The facility is equipped with incinerator of 200 kg/hr capacity, autoclave of 100 kg/hr, hydroclave of 100 kg/hr and shredder of 100 kg/hr capacity. About 2700 to 3000 kg of waste of TTZ is processed per day. The facility is equipped with effluent treatment plant. The flue gas from incinerator is treated in ventury scrubber. In the process, waste water is generated which is treated in effluent treatment plant. The ETP sludge generated needs appropriate disposal.

Table 5.1.7: Biomedical Waste Generation Scenario at Hospitals of Agra

Sr. No.	Features	Quantity
1.	No. of Government Hospitals	101
2.	No. of Private Hospitals	127
3.	No. of Beds	8000
4.	Waste Quantity (kg/bed/day)	1.49

6.0 Comprehensive Environmental Management and Action Plan for TTZ

6.1 Air Environment

Based on the in-depth analysis of air quality status and different sources of air pollution in TTZ area and also measures already implemented in the past in different sectors, additional management plans for improvement in air quality are suggested in the following areas:

- Industrial Pollution Control
- Vehicular Pollution Control
- Road Network and Traffic Management
- DG Sets
- Other sources/activities
- Other requirements

The suggested management plans /action plans are summarized in **Table 6.1.1**.

6.1.1 Implementation of EMP and Proposed Projects

In view of the need for protection and preservation of TajMahal and also other important monuments/National Park/Sanctuary etc. existing in the TTZ region and the developmental needs of Agra and also of other cities under TTZ, different agencies have proposed certain projects for implementation. The details of the proposed developmental projects for Agra/TTZ Area are listed in **Table 6.1.2**.

Table 6.1.1: Status and Suggested Action Plans for Different Sectors/Activities Leading to Minimization/Reduction of Air Pollution in TTZ Region

S. No.	Air Pollution Sector	Status and Suggested Action Plan	Implementing Agency/ Responsibility
1.	Industrial Sector	Major air polluting industries in Agra (Foundries) and Firozabad (glass industries) are operating on CNG. However, many other industries using different kinds of fuels and also involving non-combustion processes, also contribute to air pollution. Most of such industries are not accounted in any estimation Therefore, all the industries need to register with concerned departments and should have legal license for their operation. All such units should be identified with the help of local bodies/teams on ward-wise basis	District Administration/ UPPCB/ UPSIDC With the help of local ward teams

		Secondly, any activity/industry (including small/cottage/household units such as petha, tannery, shoe making, electroplating, bangles, chemicals or any other unit etc.) ***using daily more than 10 kgs of any kind of fuel*** (like coal, coke, diesel, kerosene, wood, agro-waste etc.)***individually or in combination*** need to control air pollution at the source, by deploying appropriate air pollution control system/ by adopting appropriate mechanism to contain air pollution	
2.	Vehicles/ Transport Sector	There are nearly 6.7 lakhs vehicles registered in Agra, of which as much as 95.25% vehicles are private vehicles, 2-Wheelers (80.43%, 5.39 lakhs) and 4-Wheelers (14.85%, about 1 lakh). Commercial vehicles are only 4.75% (31,639 nos.) Besides the movement of these vehicles in the region, a large number of tourist vehicles and other commercial vehicles come/ pass through the Agra and TTZ area. In addition to the measures taken in the past, the following aspects need to be paid attention **Fuel Quality:** Ensure proper quality of transport fuels (petrol/ diesel/ CNG) **Fuel Adulteration:** Adulteration of fuels, particularly by the commercial vehicles is evident in many studies, which leads to higher emissions. Therefore, strict mechanism should be devised to eliminate/minimize fuel adulteration **Adequate Facility for Supply of Clean Fuel:** As the CNG is used in many commercial as well as in private vehicles as clean fuel, adequate facility for uninterrupted supply of CNG should be ensured, so that such vehicles do not tend to go back to the conventional fuels **Vehicle Age:**Once the new vehicle comes on road, the level of emission depends on number of factors such as fuel quality, driving behavior, road conditions etc. However, older vehicles are expected to contribute more emissions. Therefore, from the emissions as well as operational safety point of view, maximum age for each category of public and commercial vehicles can be fixed. Accordingly, the age barred vehicles should not be used. However, it is the condition of the vehicle, which is more important than the age of the vehicle **I & M Practice** **Vehicle Owners:** All vehicle owners to follow the vehicle operation, RTO and Transport safety guidelines/norms with focus on regular inspection and maintenance of their vehicles from authorized service stations. Also, they should care for the fuel economy of the vehicle **Manufacturer Authorized Service Stations (MASS):** Manufacture Company Authorized Service Station	GAIL/Oil Companies / Transport Dept./ADA/ ANN/Other Nagar Nigams

		should ensure the proper inspection and maintenance of the vehicles with assurance on recommended fuel economy and emission levels (including PUCs) for the serviced vehicles	
3.	Road Network& Traffic Management	Well maintained roads are the lifeline of any city. In-sufficient roads, narrow roads and roads in bad conditions help in generating high level of pollution due to enhanced vehicle exhaust emissions and secondly due to lifting (re-suspension) of dust caused by movement of vehicles As there are more than 6.7 Lakhs vehicles registered in Agra and also a large number of tourist and commercial vehicles come to Agra, Mathura-Vrindavan, Bharatpur region throughout the year, therefore, utmost attention is required to provide adequate road network infrastructure to cater to the needs of traffic in the whole TTZ area. Further, public transport system should be encouraged, by providing efficient and convenient transport facility Timely repair of all types of roads (national/state high ways, feeder roads etc.) and proper maintenance of same should be ensured with proper pavements and drainage system Further, to ensure smooth and safe traffic movement, efforts are needed to provide properly maintained synchronized traffic signals, adequate parking facilities, regular training facility/ programmes for the drivers (especially for commercial vehicles), holding awareness programmes regularly for the public etc. De-congestion in highly congested areas like commercial/tourist places needs to be made by construction of flyovers, foot-over bridges, multi-level parking facility etc. Certain roads with high traffic loads, particularly in city market places, Transport Nagar etc. may be constructed as cement roads, having high load bearing capacity Special attention and continuous efforts are required on the maintenance of all the created facilities for their smooth functioning ***In this regard, Comprehensive Mobility Plan prepared by Urban Mass Transit Company Ltd. for Agra City may be followed to the extent possible. Further, such mobility plan should be prepared for whole of the TTZ covering urban as well as rural areas.***	ADA/PWD/Respective Nagar Nigams
4.	DG Sets	To meet the electricity requirement, a large number of DG Sets are installed in industries, commercial establishments and even in societies and individual houses. Large DG Sets, particularly in Firozabad glass industries are using Natural Gas as fuel, whereas others	UPPCB/ U.P. Power Corporation Ltd.

		are using locally availableHSD/Diesel Since DG Sets are installed as an alternate source of electricity, the efforts should be made to ensure continuous power supply to the whole TTZ area Household DG sets may be LPG based rather than diesel/ kerosene and the people should be encouraged to use invertors rather than DG Set Proper quantification of DG Sets in each city and their emission generation status along with their Inspection and Maintenance (I&M) practices need to assessed for delineation of any air emission mitigation strategy	
5.	Other un-accounted Sources	Besides, organized sectors like industries, vehicles, DG Sets etc., there are a large number of other sources/activities which also contribute significantly towards air pollution. Such sources/activities include agriculture & related activities, handling & transport of goods, commercial activities, domestic cooking & heating,hotels & restaurants, bakeries, crematoria, construction activitiesetc.The individual activity may not appear to contribute significantly, but due to their large number, they become significant contributor to air pollution, which routinely is defined by certain criteria pollutants like SO_2, NO_2 and RSPM/PM_{10} Any combustion process involving burning of different kinds of fuels/combustible materials in organized/un-organized manner will lead to formation of different kinds of pollutants in varying quantities, thus ultimately getting reflected in the air quality of that region. Quantification and control of such sources becomes extremely difficult, therefore, people in general are required to be educated an appropriate lifestyleskeeping in mind the adverse impacts of their activities on the environment	ADA/ ANN/ Concerned Deptt.
6.	Strengthening of Air Quality Monitoring and Continuous Assessment	Air quality data is the back bone of all the efforts being made towards the improvement in air quality that the people breathe in any region. Therefore, it is very important to ensure the quality of the data being generated by various monitoring agencies (CPCB, UPPCB, ASI etc.) for its meaningful utilization in policy/ decision making Ambient air quality in TTZ area is being monitored by CPCB Agra Office, UPPCB – Regional Offices at Agra, Mathura and Firozabad and also by ASI at the TajMahal. In order to ensure quality of data generated by different agencies, there is a need for proper coordination in data generation and its analysis. QA/QC plan should be developed to ensure quality of data generated and also evaluate the effectiveness of various strategies adopted for mitigation/ control/ management of air pollution. CPCB Agra Office or any other third party may be entrusted with this responsibility	CPCB/UPPCB/ ASI

		Secondly, the major focus of TTZ area remains the TajMahal. Therefore, a continuous air quality monitoring system along with meteorological parameters needs to be installed in the TajMahal premises Further, it is essential to conduct an in-depth study involving analysis of various other air quality parameters beyond the routinely monitored parameters. The additional parameters may include CO, HC, NH_3, H_2S, VOCs etc. and also chemical speciation of particulate matter with anions, cations and heavy metals. This will help in identifying the actual/most probable cause of air pollution having possible impact on the TajMahal, and more refined//focused approach towards air quality improvement An in-depth study focusing on assessment of impacts of air pollutants on Taj Mahal (marble structure) needs to be carried out on priority	
7.	Awareness through display of Data	To create awareness among the people, air quality data should be displayed in the area where the air quality data is being monitored. Further, the data may be displayed at certain important locations in each city, where large number of people are expected to take advantage of it. Also, in the public interest, the information can be published through daily newspapers or communicated through local channels	CPCB/ UPPCB/ ANN
8.	Green belt development/ Massive Plantation	Trees/plantation provides the most essential element required for human survival, oxygen, by converting it from CO_2generated through various human activities/processes. Further, trees act as sinks for air pollutants. Therefore, green belt/plantation including well maintained lawns and gardens should be created wherever feasible and space is available in the whole TTZ area The available local expertise can be utilized to suggest the type of plantation and develop mechanism for effective management/utilization of any useful products generated through this activity leading to economic benefits for the region Sustainable eco-tourism should also be kept in mind while developing the green belt/plantation in the region There is need to develop mechanism for proper utilization/ disposal of falling tree leaves/twigs/branches etc., to prevent any possibility of fire taking place	Forest Deptt./ ADA/ ANN/ Other Nagar Nigams
9.	Evaluation of Effectiveness of Management Plans	A huge investment (financial, manpower, time etc.) is involved in implementing any mitigation/control strategy towards air quality improvement, therefore, it becomes imperative to integrate all the efforts and also evaluate the effectiveness of the efforts made to achieve the targeted goals	Project Implementing Agency/ ADA/ ANA/CPCB/ UPPCB/ Other Nagar Nigams

10.	Public Participation (Area / Ward / City Development Teams)	Public participation is must for the overall and sustainable development of any city. Various basic facilities like electricity, water supply, sanitation, roads etc. needs to be maintained all the time for the public. Despite the best efforts, local administrative authorities, alone may not be able to come up the expectations of the public. A huge gap always remains between the expectations and the facilities available. Therefore, public participation at ward/area level may help in minimizing this gap for the overall development of the region Teams comprising of local people having the concern for the sustainable development of their region should be formed. The team consisting of people with different backgrounds like doctors, engineers, teachers, advocates, social workers, senior citizens etc. needs to be formed. Such teams may be referred to as Area/Ward/City Development Team. Some very constructive suggestions/solutions can come from such teams for the overall development of their region as well as for the city and TTZ, which ultimately will help in the protection and preservation of India's pride, the world famous monument, The TajMahal along with other important monuments existing in the region	ADA/ Respective Nagar Nigams Ward-wise Resident's Area Development Teams (ADT)

For micro-level planning, the report prepared by CPCB in 2002 on Priority Projects under Taj Protection Mission may also be considered.

Table6.1.2: List of Proposed Developmental Projects for the Agra City/TTZ Area

S. No.	Project Title	Project Cost	Project Proposed By	Evaluation Remarks
A.	**Road related Projects**			
01	Widening and Strengthening of MG Road in Agra City and Construction of Central Verge, 2011	59.20 Cr.	P.W.D.	The individual projects may be considered in view of overall mobility plan for the Agra city in Phase I. Further, there is a need for preparation of comprehensive mobility plan for the whole
02	Upgradation/Infrastructure creation Project with following components (a) Upgradation of Inter-State Bus Station in Transport Nagar, Agra (b) Workshop for long route buses in Guru KaTaal (c) Creation of Satellite Bus Terminals at Agra-Fatehpur Sikri Road, Agra-Gwalior Road, Agra-Kanpur Road (d) Upgradation of CNG bus station,	60.68 Cr.	U.P. State Road Transportation Corporation, Agra	

	and procurement of CNG buses (e) Upgradation of Transport Nagar area, 2010			TTZ area covering various cities/town as well as rural areas. For micro-level planning, the report prepared by CPCB in 2002 may also be considered.
03	Widening and Strengthening of Major Roads of Agra City	66.98 Cr.	Agra Nagar Nigam	
04	Development of Transport Nagar (Parking facility for Heavy Duty Vehicles – Trucks) at Agra	97.06 Cr.	Agra Nagar Nigam	
05	Construction of Flyover/Bridge over Railway line at **Idgaah-Bayana Rail Section** (connecting NH2 & NH3 on Runakta-Rohata Road – Southern bypass), 2011	51.35 Cr.	U.P. State Bridge Corporation Limited	
06	Construction of Flyover/Bridge over Railway line at **Agra Fort-Achhnera Rail Section** (connecting NH2 & NH3 on Runakta-Rohata Road – Southern bypass), 2011	50.07 Cr.	U.P. State Bridge Corporation Limited	
B.	**Vehicle Inspection & Maintenance related Projects**			
07	Centre for Fitness and Maintenance of Motor Vehicles	9.94 Cr.	RTO, Agra	Useful projects, needs proper planning for effective implementation
08	Establishment of Motor Driving Training School	2.457 Cr.	RTO, Agra	
09	Mobile Testing Pollution Units	6.975 Cr.	RTO, Agra	
C.	**Green Belt related Projects**			
10	Environment Management Plan for Area under TTZ Scheme	186.71 Cr.	Social Forestry Division, Agra	Very useful projects, however, needs revision in view of the proposed EMP
11	Improvement and Beautification of Existing Parks in Agra, 2011	87.75 Cr.	Agra Nagar Nigam	
12	Biodiversity Conservation Project, 2010	16.93 Cr.	Kevalaadev National Park, Bharatpur	
D.	**Power related Project**			
	System Improvement Plan for Agra Urban Area under TTZ scheme, 2010	81.51 Cr.	Torrant Power Ltd., Agra	Very useful project
E.	**Others**			
13	Construction of Electrical Crematorium at PoiyaGhat and Balkeshwar in Agra, 2011	6.55 Cr.	Agra Nagar Nigam	Useful project, needs social viability study

In general, all the proposed projects are very useful and shall help in minimizing the adverse environmental impacts, though of different magnitudes. These projects, however, need to be re-looked/revised in view of the proposed EMP with a compressive approach for the whole TTZ, and delineating the quantified expected sustained environmental benefits.

6.2 Water Supply, Sewerage and Drainage

6.2.1 Proposed Strategies

6.2.1.1 Water Supply

The following strategies are suggested :

- Augmentation of existing water supply system for entire city area
- Implementation of the water safety plans for supply of safe drinking water which inter alia includes organized preventive maintenance rather than break-down maintenance, sanitary inspections and assessment of risk
- Periodic water quality studies and monitoring both at the source and users end for confirmation
- Management of unaccounted for water (UFW) through regular leak detection studies as part of the O&M activity. Reported UFW is about 40-45% (*Source: City Sanitation Plan of Agra*)
- 1Complete water metering and discouraging illegal connections through heavy penalty
- Judicious utilization of treated water by conducting awareness programmes for Agra's citizens
- Evaluation of Point of Use treatment/decentralised local system where water supply coverage is difficult
- Evaluation of 24x7 water supply system and implementation on pilot scale in the city
- GIS mapping of entire water supply system including the display system

6.2.1.2 Sewerage

To ensure full coverage of sewerage network and effective disposal in environmentally friendly manner, the city needs to adopt the following :

- Coverage of entire city area (100%) with sewerage network and ensuring proper collection of sewerage and conveyance to treatment plants
- Decentralised local systems may also be evaluated through appropriate studies to identify the areas for implementation

- Augmentation and Rehabilitation of existing sewerage system

- Evaluation and remodelling of the waste treatment facilities to identify the augmentation needs and ensuring full capacity utilization. Evaluation for effluent recycle / reuse potential, but not for groundwater recharge, may also be undertaken

- Evaluation of modern sewage treatment technologies including in-situ treatment in bigger drains and in IDT schemes

- In-situ wastewater treatment employing bio-/phyto-remediation in large drains like Mantola drain and development of the area as entertainment parks, needs to be evaluated through pilot scale studies

- Proper water supply and sanitation facilities for the urban poor must be provided. Low cost sanitation units may need to be provided in slums and public places

- Being a heritage city and in view of the large floating population, adequate sanitary facilities / public toilets, with local treatment, at strategic locations in the city is essential

- GIS mapping for entire sewerage and sanitary facilities for proper O&M

6.2.1.3 Drainage System

When the entire city area is covered with sewerage, the storm water drains will not carry sewage as happening at present. However, till such time that the sewerage coverage is raised to 100%, these drains will carry sewage. The storm water drainage master plan needs to be implemented in order to strengthen the existing drainage system. The broad strategies to be adopted are:

- Evaluation of adequacy of existing drains (these are storm water drains that are carrying sewage also at present, a situation that is likely to continue for some more time till 100% sewerage coverage is provided)

- Ensuring the drainage of entire city area and identification and making provision of proper drains for Zone-VI to Zone –IX (*Ref: Table indicating 11 Zones in Section 3.3.3.1*)

- The Drainage Master Plan proposes covering all the 47 catchments of which 39 catchments have been identified for taking up immediate works from the base year 2012 and the remaining 8 catchments have been identified for the future works to be taken up at a later date according to the progress of urban development.

- Regulationsto prohibit dumping of the solid waste into these drains (it has been observed at a number of locations)

- Regular cleaning and desilting of the drains in an organized manner as part of O&M

- Regulations on encroachments and construction of permanent structures on these drains (which have been noticed) a number of places

- Encroachment of the drains is one of the major problems in the town, which is obstructing the flow of the drains causing flooding. It also causes inconvenience in operation and maintenance like cleaning, repairing and desilting etc.

- Implementation of the Drainage Master Plan and O&M to avoid blockages, siltation, retardation in flow, etc.

6.2.2 Environmental Improvement Action

6.2.2.1 Prevention of Pollution in River Yamuna

The activities along the river should be stopped and the polluting activities like disposal of sewage, dumping of garbage along the riverbank should be prohibited.Strict norms should be enforced.

Proper solid waste disposal sites should be identified so that garbage is not dumped. Minimum flow of the river should be maintained for reducing the pollution levels. This requires proper study and analysis related to the depth, velocity of flow, etc.

Public awareness needs to be enhanced for action against activities related to the pollution of the river. Regular cleaning and maintenance of the river is also desirable. Reuse /recycle of treated wastewater needs to be considered and holistic plan developed. No untreated sewage be discharged into the river.

In order to improve the water quality, R&D studies on estimation of environmental flow in river Yamuna is necessary and the water releases accordingly regulated. Necessary corrective measures need to be identified based on R&D studies for delineation of assimilative capacity of different stretches of river in different seasons and the discharge of treated effluents regulated accordingly. A complete waste load allocation strategy and maintenance of environmental flows in river is expected to maintain the quality to CPCB Class-C/B category at the least.

6.2.2.2 Preservation and Conservation of Water Bodies and Development of New Parks

The maintenance and revitalization factors should be suggested for preservation and conservation of water bodies in the city. The pollution levels and water quality should be checked in the city. The water bodies can also be developed as tourist spots.

Out of the total of 41 water bodies (covering 0.45 km^2 area), 13 water bodies, like Guru kaTalao, TotakaTalao, etc. have been completely dried and land reclaimed for developmental activity. The Palwal Park and Sardar Patel parks also have water bodies located inside, which should be preserved and developed.

6.2.2.3 Conserve Ground Water Resources by adopting Rainwater-Harvesting Techniques

Rainwater harvesting techniques should be introduced in the city. Existing large government / institutional buildings should set an example by adopting these techniques. The proposals already proposed in Master Drainage plan should be implemented in a timely manner.

The Forest Department of UP has undertaken works on development of wetlands by constructing earthen / pucca check dams in the forest area with a view to providing treatment to drain water, harvesting the rain water for recharge, and creation of artificial water bodies. Summary of the works undertaken is given in **Annexure 3.1**. Such works may be substantiated and duplicated.

6.2.2.4 Proposed Schemes for Environmental Improvement in Agra

The environmental projects proposed to be undertaken at a cost of Rs. 254.78 crores include river front development, improvement and development of parks and protection of forest areas as given in **Table** below :

S. No.	Projects Proposed	Cost (Rs.Crore)	Department
1	River Front Development Landscaping, Theme park, bio-diversity park, garden of five senses, musical fountain, activities for passive recreation, tree plantation along the banks of R. Yamuna in conformity with Land use plan 2021	45.65	ADA
2	Improvement and beautification of existing parks	54.83	ANN

S. No.	Projects Proposed	Cost (Rs.Crore)	Department
3	Development of new parks	18.69	ADA
4	Protection of forest area/ afforestation	16.95	Forest
5	Rain water harvesting in state government & ANN properties and select locations as identified by U.P. Jal Nigam	12.29	ADA/ ANN
6	Restoration and beautification of water bodies	33.26	ANN
7	Construction of weir across Yamuna downstream of Taj	73.10	Irrigation

6.2.3 Recommendations in other Documents

The Master Plan-2021, Master Drainage plan, and Comprehensive Action Plan 2011 etc. have identified / proposed developmental actions in each sector which should be taken up for implementation.

The Master Plan 2021 of Agra also proposes the following, which should be implemented in a timely manner :

- A barrage should be constructed downstream of Taj so that Yamuna river retains water and the river is used for the recreational purposes
- River Yamuna should be made pollution free by establishing treatment plants
- In order to reduce the water losses during distribution, the network needs to be improved and worn out/rusted pipes needs to be replaced
- Proper water harvesting techniques should be adopted for ground water conservation and recharge
- Sewer lines should be laid in a planned manner so that the sewage is properly collected and disposed
- The sewage flowing in drains should be treated at suitable locations and the treated sewage discharged downstream
- Sufficient number of sewage treatment plants be constructed
- As far as possible, on both the sides of open drains a three metre wide strip be reserved for tree plantation

The recommendations proposed in the 'Comprehensive Action Plan for Critically Polluted Industrial Clusters of Agra' prepared by U.P. Pollution Control Board, September, 2011 should be fully implemented for environmental improvement.

The CPCB had prepared the 'Proposal on Priority Projects under Taj Protection Mission' in February 2002 (given in **Annexure 3.2**) as per the directives of Hon'ble Supreme Court of India. The EMP measures suggested therein and the status of their implementation should be checked and the priority projects proposed therein must be implemented also.

6.2.4 Provisions in Other TTZ Cities

6.2.4.1 Mathura-Vrindavan

The twin city has historic importance and is a pilgrimage town with large floating population. Situated on the bank of river Yamuna, about 67 mldof sewage is generated in the town as per the information from UPPCB, UPJN sources. Population of Mathura is 3,00,000 souls. Water requirement is about 46.5 mld while sewage generation would be about 37.2 mld (return rate 80% of water supply rate).

In Mathura, 19 drains convey about 30 mld of sewage into river Yamuna while about 0.5 mld sewage is carried to river Yamuna through 18 drains in Vrindavan. The Gokul barrage has been constructed for providing water supply to Agra and Mathura and for supplying water to Vrindavan / Mathura Ghats. However, due to limited and less water available in the barrage reservoir, full capacity utilization is not possible.

The following STPs have been established and are functioning in Mathura-Vrindavan:

The following STPs have been established and are functioning in Mathura-Vrindavan:

STP	Location	Capacity
STP Kalidah	Vrindavan	0.5 mld
STP Vrindavan	Vrindavan	4.5 mld
STP Masani	Mathura	13.59 mld
STP Trans Yamuna	Mathura	14.5 mld

The STPs are not functioning properly owing to several reasons, major being lack of O&M efforts and funds, inadequacy of STP capacity, availability of electric supply, etc. Although the STP is based on low cost pond system operation of which

does not depend much on electric supply, it is non-functional due to other avoidable reasons. This can be attributed to lack of O&M efforts.

It is, therefore, utmost important that a comprehensive plan including STP construction, operation, and maintenance regularly, is developed and implemented. Technology options may also need to be re-examined to evaluate modern technologies.

6.2.4.2 Firozabad

District Firozabad is approximately at a distance of 45 Km from Agra and is an important centre of glass and its allied industries in Uttar Pradesh. Most units are engaged in manufacturing of Glass bangles (the only place in India where glass bangles are commercially produced) followed by Glassware, Glass beads, Thermos flask and other glass products manufacturing units. As far as glass bangle manufacturing units are concerned, most industrial units manufacture only raw bangles after shaping and forming of molten glass and subsequently they are taken for finishing/decoration to various households where sometimes the entire family is engaged in this job. So a major chunk of Firozabad's population is dependent on these units for livelihood through various inter-connected bangle manufacturing and allied activities and disturbance in one activity affects all the others.

In such units, water is used for domestic and cooling purposes. The cooling water is recycled and domestic effluent discharged into drain through Septic Tank. The population of Nagar PalikaParisad, Firozabad is 3.97 lakhs as per census 2001. As per the information furnished by the UP Jal Nigam, the sewage effluent generated is approximately 67 MLD. The sewage effluent generated from industries and municipal limits is carried through two Nalahs which ultimately from river Yamuna. The Sewage Treatment Plant for the disposal of sewage of Nagar PalikaParisad, Firozabad is proposed under UIDSSMT programmes. The STP is being developed by UP Jal Nigam. As per the information given by the UP Jal Nigam, the sewage pipe line work and land acquisition for STP is under progress.

6.3 Wastewater Management

6.3.1 Sewerage system

Based on the information received, the measures undertaken with respect to sewer and storm water system is insufficient especially in Agra as it has the largest

turnout of visitors. The coverage area for sewer network and storm water systems has not increased considerably since last decade. Sewerage system is not yet provided in Bharatpur, Firozabad and Fatehpursikri. The existing STPs provided in Agra, Mathura and Vrindavan do not have capacities to handle the flows anticipated in the next few years. Although considerable number of project activities areinitiated to augment treatment capacities, the degree of treatment provided to the effluents in the existing STPs received is low considering the sensitivity of the area. All the STPs discharge finally into Yamuna River which is also used as water source downstream. Hence, the sewage may be treated upto tertiarylevel followed by disinfection prior to discharge or reuse for irrigation.

6.3.2 Storm water Management

Since 2001, there is no adequate provision of underground storm water drainage system in the TTZ. Most of the drainage lines provided are open, which often get choked due to the accumulation of polythene bags, waste material, and silt. The uncovered drains pose a health hazard to the public. Due to the inadequate drainage lines, the roads often get damaged. Around 10% of the road length has adequate storm water drainage system. The major problem observed in the TTZ is that the majority of the drains carry domestic and industrial effluents in the storm water drains. Also, the speed of completion of the projects specifically storm water drainage and sewer network is required to be increased considerably to facilitate overall improvement of the zone. Provision to arrest and remove solid waste entering the storm water drains and sewer network has to be made in the interest of the public and environment.

6.3.3 Industrial Effluent Management

Based on the evaluation of the industries present in the TTZ, it was found that majority of the industries are of dry type with respect to generation with the exception of a few and is relevant with respect to parameters like organic content and heavy metals. The possibility of reuse of the treated effluent from STPs by the large and medium scale industries in Agra, Mathura and Firozabad may be looked into reduce the pollution levels in Yamuna river.

6.3.4 Conclusions

Based on the analysis of secondary data and information received on the projects proposed inTTZ, following conclusions may be drawn:

- Large scale implementation of projects with respect to domestic, commercial and industrial wastewater management is required. The performance of STPs and CETPs in the TTZ should be assessed to understand the quantum of domestic, commercial and industrial effluents generated from the TTZ and its management, treatment and safe disposal

- The shortage in terms of efficiency of treatment at STP has also to be addressed aggressively and comprehensive new proposals should be prepared to meet the demand including retro-fitment of existing STP

- Studies should be initiated to assess the pollution load received from the catchment areas falling within the TTZ area.

- Considering the future demand from sectors viz., power, agriculture and domestic, projects relating to water reuse/recycle should be taken up within this decade

- On the basis of evaluation of secondary data made available to NEERI, and discussions held with officials from Agra Development Authority, Agra Nagar Nigam, UP Jal Nigam, Central Pollution Control Board, UP Pollution Control Board, NEERI, time bound comprehensive wastewater management plans need to be detailed and executed by the agencies.

- The following **Tables (Table 6.3.1 & Table 6.3.2)** presents the issues that have to be addressed immediately for effective environmental management in the TTZ. Adoption of the measures stated in the table is expected to improve the quality of water flowing in river Yamuna. Additionally, the proposed projects have to be completed within a time bound framework to achieve the desired objectives of the TTZ.

Table 6.3.1: Wastewater Management Plan for the TTZ
Protection
❖ Segregation of storm water & sewage in TTZ area. ❖ Complete tapping of sewage generated in the catchment areas and treatment in STPs. ❖ Provision for pumping of storm water and creation of water bodies. ❖ Present practice of dumping of solid wasteinto storm water and natural drains should be stopped immediately.
❖ **Mitigation**
○ ❖ Renovation and repair of existing STPs/ETPs to meet the inland surface water discharge standards ❖ Renovation of drains/nullahs by impervious lining. ❖ Improve effluent management systems in small and medium scale commercial and industrial units through a common effluent treatment plant (CETP) approach e.g, peta and dairy units. Comprehensive feasibility studies should be conducted prior to setting up ETPs for SME's. ❖ It has been observed that large number of dairy and peta units operate within a range of 5 km from TajMahal area. It has been found that these industries do not have proper effluent management systems. It should be ensured that these industries set up workable treatment facilities or relocate to an area identified for the purpose. ❖ Efforts to achieve zero effluent liquid discharge in the refinery should be aggressively pursued.
❖ **Enhancement**
○ ❖ Improving and increasing the sewer network coverage. ❖ Development of the green belt along the open drains. ❖ Construction of new storm water drains and STPs. ❖ Expansion of storm water network in TTZ. ❖ Provision for effective collection of solid waste so as to prevent the mixing with domestic sewage flowing in natural drains. This will also prevent drains overflowing frequently. ❖ Recycle/reuse of treated sewage should be explored for large industries in the area.

Table 6.3.2: Status and Suggested Action Plans for Different Sectors/Activities Leading to Minimization/Reduction of water Pollution in TTZ Region

Sr. N.	Area	Problem	Ward	Status and Suggested Action Plan	Implementing Agency/ Responsibility
1	Agra	- Inadequate sewer network coverage - Inadequatestorm water drainage coverage - Naturaldrains carryun-treated sewage to STPs&river Yamuna - Discharge of untreated peta effluents	Impeypura, Telipara, NaglaKaachpura, Paktola, Naibasti, Baghichi, Lachipura, Telipara, Paktola, Nagla din, PayerlalkaNagla, Garhichandini, Garhi, Hussaninpura, Nagladevjit, Tajgani, Papal Mandi, Kashmiri Bazaar, Naulakha Bazaar, Phawara Bazaar, Nawalgang, NaglaBaluchand, Motibagh, Pratapur, Mohanpura, Khanderu, Jawahar Bazaar, Kala Mahal Bazaar, Ukhara, Charaungi, Kachipura, Ramjokanagla, Chatta Bazaar, Daseri, Freeganj, Sadar, Bazaar, Sevka Bazaar, Subhash Bazaar, Hariparwat, Krishna colony, Belanganj, Nehru nagat, Kamala Nagar, Bhairon, Ghatwasan I, GhatwasanII,Lohamandi, Bodla I, Khandari II, Trans Yamuna II	– Construction of the branch sewers connecting to the trunk sewers. – Improvement and layingof trunk sewers. - Expansion of water supply network. – Arrestingentry of solid waste into the storm water drainage network – Construction of trunk sewer to collect sewage from sewer line laid along major drains to avoid direct discharge of sewage into Yamuna river. – Construction of ETPs for clustures of industries like peta and tanneries. – Development of greenbelt along the open drains/natural drains	ANN/ADA/ PSDC/ UPJN UPPCB/ CPCB/MEF/ UPPCB
2	Mathura	- No sewage and storm water network	Krishna Nagar, Ambedkar Nagar, pockets of Mohali road, New Bus Stand Bhuteshwar and areas under bridges etc.	– Laying of trunk sewers for collection of sewage. – Construction of the branch sewers connecting trunk sewers. – Complete tapping of sewage generated and treatment in STPs, thereby reducing the pollution in Yamuna. – Arresting solid waste entry into the storm water network – Periodical removal of solid waste from this area. – Construction of drainage lines in un-serviced areas and streets. – Provision for pumping of storm	NN/CPCB/ UPPCB/MEF

				water.	
Sr. N.	**Area**	**Problem**	**Ward**	**Status and Suggested Action Plan**	**Implementing Agency/ Responsibility**
3	Vrinda-van	- Inadequate sewage and drainage network.	Kalidegu, Masa	– Construction of new STP and renovation of existing ones for meeting the standards. – Interceptors at outfalls to the Yamuna as per networks plans. – Construction of new drains and repairs to existing drains.	UPPPCB/ Nagar Nigam
4	Firoza-bad	- Clogging of natural drains. - Inadequate sewage and drainage network.	NA	– Dumping of solid waste into the storm water drains should be banned to prevent clogging of the natural drain and reduce the pollution of Yamuna river. – A new STP should be proposed/constructed for treatment of sewage generated in the city.	Nagar Nigam/ UPJN
5	Fateh-purSikri	- No sewer network and drains	NA	– Construction of new sewerage system on the basis of network plan. – A new STP should be proposed/constructed for treatment of sewage generated in the city.	Nagar Nigam/ UPJN
6	Bharat-pur	- No sewer network and drains	GopalNagla village, Wetland areas	– Construction of new sewers on the basis of networks plan, inclusive of pumping station. – A new STP should be proposed/constructed for treatment of sewage generated in the city.	Nagar Nigam/ UPJN

6.4 Solid Waste Management

6.4.1 MSW Management Plan for TTZ

Based on the analysis of environmental issues, various mitigation measures have been proposed in solid waste management plan. After analysis of data and information as received from the secondary sources, it is felt that there is scope for improvement of solid waste management in Agra city, specially the areas other thenTajMahal locality. Moreover, appropriate solid waste management systems as per the guidelines of MSW Rules in other towns under TTZ like Mathura-Vrindaban, Bharatpur, Fatepur-Sikri and Firozabad are still to be developed.

6.4.1.1 MSW Management Plan for Agra

Collection and Storage System

- At present, in Agra, only house to house collection is adopted in 30 wards. The service should be extended to all the wards.

- Dry and wet waste should be collected and treated separately. At present source segregation is practised in 30 wards of Agra only which should be extended to other wards also.

- Though house to house collection system has been initiated, community bins are used for collection and storing the road sweepings. Community bins should be properly maintained.

- Community bins should be installed at proper locations. This will reduce inconvenience to citizens and workers.

- Overflow of community bins and disposal of wastes around the bins should be strictly monitored. Cooperation of resident and MSW workers is necessary for this purpose.

- Closed metallic containers, namely dumper placer bins, can be installed at locations where bins are necessary. These bins are lifted by dumper placer and

carried to the disposal site for final disposal. This will avoid double handling of waste.

- Slum area lacks proper solid waste management facility. Solid waste is thrown in open space. It is necessary to develop proper solid waste management system for slum area, keeping in mind the constraints like inaccessibility due to narrow width of road and improper drainage system.

- No protective garments are supplied to the workers. They are directly exposed to dust. Gloves, goggles, gumboots and masks should be provided to the workers.

Transportation System

- Different types of vehicles are used which include tipper truck, dumper placer, tractor trailer and three wheelers for solid waste management purposes. The old vehicles which have outlived normal life, should be replaced by new ones to increase the efficiency of transportation system.

- Sometimes disposal site is located far away from the collection point. In these cases, transfer station can be established.

- Many times, waste is not covered during transportation. The waste should be covered or closed body vehicles should be used during transportation.

- Many times, vehicle routes followed are not economic. This leads to unnecessary consumption of fuel. So vehicle routes should be properly planned.

- Vehicles are often parked in open space during off period. Life of the vehicles is reduced by this process due to corrosion. Proper covered garrage/parking space should be provided.

- Preventive and routine maintenance of vehicles should be carried out in addition to the break down maintenance. This will increase the life of the vehicles.

Treatment and Disposal System

- It is observed that occasionally solid waste is discharged in nallah and drains. This obstructs the flow of sewage/drain water. Moreover, subsequent surface run

off and leachate generated also pollute the environment. Public awareness and proper construction of sewerage system will improve the situation.

- At many places, open burning of MSW is practiced by rag pickers and residents leading to air pollution. This practice should be discontinued.

- Full fledged operation of sanitary landfill and waste treatment plant should be facilitated in Agra. The waste from entire Agra should reach the facility regularly. The activities of SLF and compost plant at Kuberpur should be monitored specially with respect to environmental aspects.

- All the old dumping sites used for ultimate disposal of MSW should be closed following appropriate methods after examining environmental issues. All the small dumps created due to indiscriminate handling of MSW should also be removed.

- Sanitary landfill should be operated following the guidelines of existing MSW management rules. During disposal of waste in the landfill, compaction of waste should be carried out by bulldozer or roller. Soil cover should be applied to minimize leaching, ensure better aesthetics, minimize infiltration of leachate, reduce odour problem and prevent flies and mosquitoes breeding. Guidelines of recent MSW rules should be followed during construction, operation and closure of the landfill site. Ground water quality should be monitored from time to time.

- Compost plant should be operated in an environment friendly manner. Good quality of the compost produced should be ensured. Various parameters to be taken into consideration are pH, C/N ratio, maturity of the compost and heavy metals. The product should conform to the standards.

- Green belt should be developed around the landfill site and windrow area of composting.

Miscellaneous Waste

- A considerable amount of slaughter house and construction waste is generated in Agra. There should be a separate collection system for slaughter house and construction waste.

Public Participation

- For developing a successful SWM system, public participation is essential. Public awareness programmes should be conducted.

6.4.1.2 MSW Plan for other Towns under TTZ

Uncontrolled land disposal of MSW in other towns under TTZ creates health and environmental hazards and spoil the aesthetics. Proper solid waste management system should be introduced in Firozabad, Mathura-Vrindaban, Bharatpur and Fatepur-Sikri. In these towns, development of sanitary landfill and composting facility are either in proposal stage or in process.

There is urgent need for development of appropriate SWM system in these towns. Guidelines suggested for Agra mentioned above and MSW rules can be followed. Necessary formalities should be fulfilled during selection of site.

6.4.2 Industrial Waste Management Plan for TTZ

Industries in Agra are located in scattered areas. In some locations, clusters of industries are available. The industries are generating a considerable amount of solid waste. Uncontrolled disposal of waste poses problems like drain blockage, flies and mosquitoes breeding, bad vision and odour problem. Following measures are proposed for controlling the present situation.

- There should be a common site exclusively for Petha industries. All the dairies should also be located at one or two sites, exclusively selected for dairies. Tanneries, electroplating and shoe making industries should be accommodated at another common site.

- It is desirable that the site should be located away from the centre of the city, residential locality and water bodies. Various guidelines prepared by regulatory bodies can be followed in selection of site. Necessary requirement of regulatory bodies should be fulfilled during site selection. All the necessary formalities including EIA should be done. Proper waste management and wastewater management facilities should be provided as per the guidelines of regulatory bodies

- Possibility of recycling of other industrial wastes, leather, shoe making and electroplating industries can be explored in consultation with regulatory bodies. This will reduce the load on disposal facility for the industrial wastes. However, recycling and reuse should be done in an organized manner through authorized agencies and as per the instructions of regulatory bodies.

- Possibility of composting Petha and dairy waste can be explored. The product can be utilized by applying in local gardens or used for agriculture purpose. However, the product quality should conform to the regulatory standards and requirements.

- There is a need for green belt development around the disposal facility of the proposed industrial estate. This is necessary to provide pleasant vision, better aesthetics, to reduce odour problem and to decrease the pollution load due to the disposal activities in the proposed industrial estate.

- Hazardous waste management rules should be strictly followed during storage, transportation, treatment and disposal of hazardous waste generated from the industries. The authorized TSDF nearby should be availed by all the industries.
- All the glass industries of Firozabad should be located at one common site exclusively identified for glass industries. The waste generated from glass industries at Firozabad should be collected properly. The waste can be recycled or disposed off following the relevant regulations. The present practice of throwing the waste in nearby areas in the city should be discontinued.

6.4.3 Biomedical Waste Management Plan for TTZ

Biomedical waste management is an area which needs special attention in Agra and other towns under TTZ. The following measures are proposed for improvement of the situation.

Biomedical Waste Management for Agra

- Many hospitals, nursing homes have not developed proper biomedical management facilities. The tasks of collection, segregation and storing of waste, which are the duties and responsibilities of the hospitals, are not executed properly. It is necessary to develop appropriate facilities in all the hospitals and operate properly as per the guidelines of Biomedical Waste Management Rules.

- The common treatment and disposal facility is not availed by some hospitals. Biomedical waste is often thrown in community bins meant for MSW and in nearby area. All the hospitals should avail the common treatment and disposal facility. If required, more authorized common facilities can be developed to cater to the needs of all hospitals.

- Incinerators, autoclaves, hydroclaves and other machineries/equipments of the common treatment and disposal facility should be operated following the guidelines of BMW rules. The operating conditions of the machineries/equipments, emission and discharge should comply with the standards.

- It is necessary to operate effluent treatment plant efficiently. ETP sludge generated should be finally disposed of at authorized common TSDF.

- Activities of the biomedical waste treatment and disposal facility should be strictly monitored by the regulatory body and the experts. Flue gas analysis and wastewater analysis should be carried out regularly. The process conditions of incinerators should also be strictly monitored.

Biomedical Waste Management Plan for other Towns under TTZ

At Bharatpur, Mathura and Firozabad, quality of biomedical waste management services is yet to be improved. The common treatment facility of Agra is not availed by some hospitals. The management status of the some individual hospitals is also far from satisfactory. It is required to develop proper management systems in all the hospitals. Moreover, all hospitals should avail the common biomedical waste management facility. More authorized treatment and disposal facilities can be established to cater to the needs of all hospitals, if required.

6.4.4 Developmental Plans of Different Organizations

Different areas have been identified by various organizations for development. These are based on problems faced by the stakeholders and public due to day to day activities. Such proposals, related to solid waste management as one of the key issues, are as follows :

- Shifting of industries in Agra – Dairies, petha
- Shifting of industries in Agra – Tannery, electroplating and leather
- Establishment of new industrial estate at Firozabad

Based on the analysis of secondary data, it is felt that solid waste management problem is one of the major issues emerging out due to the activities of industries. Uncontrolled disposal of waste is likely to affect health, environment and aesthetics. Other towns under TTZ are lagging behind in developing appropriate MSW management system. Though the task of improvement has been initiated through various proposals under different schemes (JNNURM etc.), the development is in preliminary stage in these towns. Quality of SWM service is low in some parts of Agra also. Biomedical waste management is another aspect which needs more improvement in Agra, Firozabad, Fatepur-Sikri, Mathura and Bharatpur.

6.5 Suggested Administrative Mechanism for Effective and Efficient Functioning of TTZ Authority

For effective functioning, execution and monitoring of various schemes for the conservation of Taj Mahal, a secretariat for the TTZ Authority is suggested as per the details given below :

(i) **Structure of TTZ Authority** : There shall be a secretariat, chaired by the Commissioner, Agra Division, Agra, assisted by a Member Secretary not below the rank of officer of any cadre (IAS/IFS) with supporting staff and an independent office. Necessary annual budgetary provision shall be made available for the functioning of the officers and the staff of this secretariat.

(ii) **Function of the Secretariat** : Member Secretary of the Authority shall coordinate all the official meetings/inspection/monitoring after approval from the Chairman of the TTZ Authority/Commissioner, Agra.

(iii) **Objective of the Authority** : Implementation of the orders of the Hon'ble Supreme Court of India passed from time to time in various writ petitions and monitoring on regular basis and submission of report before the Supreme Court through Amicus Curiae, as and when required.

(iv) **Funding of the Authority** : Annual budgetary provisions for the official functioning of the TTZ will be carried out by the State of Uttar Pradesh. The funding can also be generated/realized as penalty from the agencies violating the order of the Supreme Court of India with respect to TTZ Authority. The

interest accrued from the penalties imposed by the Court can be utilized for smooth functioning of the TTZ Authority. This may reduce the budgetary burden of the State.

(v) Since Agra is the most important tourist destination of the country, it needs urgent attention of the executives of the State as well as Central Government. There needs to be two tier Committees – one at Government of India level and second at the level of State of Uttar Pradesh. It is important because all the development activities are not only of serious concern but also are being closely monitored by the Apex Court of the country.

- Central Government should constitute a Monitoring Committee under the Chairmanship of the Cabinet Secretary, Government of India, with Secretary of Forests and Environment, Planning Commission, Water Resources, Tourism, Expenditure/Finance, Central Water Commission, Surface Transport, Chairman, CPCB and Chief Secretary, Government of Uttrar Pradesh as members. This Committee shall annually decide on the recommendations of the Standing Committee for providing all support – technical, financial and administrative, as desired by the Standing Committee. An Annual Report may be placed by the TTZ Authority on the progress made by both Committees.

- Similarly, Government of Uttar Pradesh should constitute another Committee called the Standing Committee under Chairmanship of the Chief Secretary of the State, assisted by Planning, PWD, Irrigation, DG, Tourism and Commissioner, Agra (as Member Secretary) TTZ Authority, after detailed consultation with local people and their needs while preserving the glory of TAJ, shall formulate the Five Year Plan under the ambit of EMP for future course of action and submit before the Standing Committee of the State. After detailed deliberations on the proposed action plan, this Committee shall suggest appropriate financial provision and facilitate administrative support for execution in true spirit. Recommendations of this Committee should be sent to the Central Monitoring Committee and placed before Supreme Court through the Amicus Curiae

vi. All developmental planning in TTZ areas should be in coherence with the Master Plan of the concerned area and EMP (Environmental Management Plan)