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Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
AMC	Agra Municipal Corporation
DMA	District Metering Area
DRA	DRA Consultants Ltd.
OHT	Overhead Tank
ESR	Elevated Service Reservoir
ETP	Estimated Total Price
GSR	Ground Service Reservoir
LPCD	Liter per capita per day
LPS	Liter Per Second
MBR	Main Balancing Reservoir
ML	Million Liter
MLD	Million Liter Per Day
MM^3	Million Cubic Meter
NRW	Non Revenue Water
OHT	Overhead Tank
PF	Power Factor
UFW	Unaccounted for Water
ULB	Urban Local Body
WTP	Water Treatment Plant
ZPS	Zonal Pumping Station

Conversions Commonly Used in Water Audit

1 m^3	=	1000 ltrs.
1 unit	=	1000 ltrs.
1 ML	=	1000 units / 1000 m^3
1 MM^3	=	1000 ML
1 MM^3/yr.	=	2.74 MLD
1 cusec	=	2.446 MLD

1 EXECUTIVE SUMMARY

1.1 PREAMBLE

The Capacity Building for Urban Development (CBUD) Project is proposed as a Central Scheme to enhance capacity building and institutional strengthening of selected Urban Local Bodies to implement urban reforms with World Bank credit on IDA terms. The Government of India has received financing from the International Development Association (IDA) in the form of a credit toward the cost of Capacity Building for Urban Development (CBUD) Project. The Ministry of Urban Development (MOUD), Government of India, an implementing agency of the Client, intends to apply a portion of the proceeds of this credit to eligible payments under the contract The objective of the Capacity Building for Urban Development Project for India is to assist the recipient in improving the systems and skills of selected urban local government bodies with respect to urban management as well as to support the recipient's implementation of various urban policy and institutional reforms.

1.2 BRIEF OVERVIEW OF AGRA CITY

Agra formerly known as Akbar bad is a city on the banks of the river Yamuna in the Northern state of Uttar Pradesh, India, 363 km west of state capital, Luck now and 200 km south from national capital New Delhi. The modern city of Agra was founded in the 16th century by Sikandar Lodhi, who was a king of the Lodhi dynasty. In Geographical terms, the city of Agra lies between 26°44' N to 27°25'N and 77°26'E to 78°32'E. The city is located at an average altitude of 171 meters (561 feet) above the sea level. Agra features a semiarid climate that borders on a humid subtropical climate. The city features mild winters, hot and dry summers and a monsoon season. It is one of the most populous cities in Uttar Pradesh and the 19th most populous in India. Agra district population grew by 21% in the decade 2001-11 and 31% in the decade 1991-2001. On the basis of landmass, Agra is the third largest city in the state of Uttar Pradesh. Because 80 % of the city's sewage flows into Yamuna River, it is 20th most polluted city in India. Agra Airport (Kheria Airport) is about 12.5 km from city center. Agra is on the central train line between Delhi and Mumbai (Bombay) and between Delhi and Chennai. The city has a proud possession of **"Taj Mahal"** as one of the Seven Wonders of the World, now declared as World Heritage Site. The post-Mughal era of Agra saw the rule of Jats, Marathas and finally the British taking over the city. In addition to its historic importance, Agra is a main center of political, economic, commercial and cultural activities.

The Agra Nagar Nigam (ANN) is among the largest municipal bodies in the state of Uttar Pradesh providing civic services to the estimated population of 1,686,976 (as per 2010 est.) Within its jurisdiction are some of the most attractive tourist spots of the world including Taj Mahal and Sikandra. ANN came into existence under and Nagar Mahapalika Adhiniyam, 1959 of UP. Since then, the Municipal Body has always been alive in its constitution and functioning to the growing needs of citizens. Agra Nagar Nigam (ANN) is a local government committed to provide basic infrastructure facilities including entertainment facilities to the people of the city.

Figure 1:- Agra city map

1.3 PROJECT OBJECTIVE& SCOPE OF WORK

1.3.1 Scope of the project

Following are the objectives of the project:

1. To achieve the objective of the assignment, it is envisaged that the consulting firm will assess 'As is situation" e.g. collection, collation and analysis of existing data, field tests as required to assess and estimate the level of commercial losses through illegal connections, billing errors, and collection system physical losses through leaks and bursts in primary and secondary networks and house service connections and reservoir overflows and develop a strategy for

structured control and reduction of NRW in a phased manner (short term, Midterm and long term) to enable provision of continuous pressurized water supply services to the customers.

2. In a city where there is no metering, the Consulting firm will conduct detailed survey including measuring of discharge at household level for NRW assessment. The sample selection and sample size will be finalized in consultation with the SPV but in any case sample size shall not be less than the 5% of the proposed DMA or supply zone. As an outcome, the detail of DMA wise NRW losses (physical and commercial) in quantum and percent shall be submitted.
3. The Consultant will prepare a detailed 3 to 5-year NRW reduction strategy (yearly activity plan) based on reduction of losses proposed and cost associated (i.e. no cost, low cost, medium cost and high cost interventions). Provide support for seamless convergence with "AMRUT" for implementation of the strategy by facilitating its inclusion in the Service Level Improvement Plan (SLIP) for the year 2017-18 AMRUT.
4. The Consultant will assess the area wise water losses (in each DMA or supply zone), identify the reasons for water losses and suggest specific solutions for each area. The Consultant will also prepare a detailed physical and commercial loss reduction forecasts for the detailed plan.
5. The Consultant will determine which activities shall be outsourced for NRW reduction and which should be carried out by service providing agency e.g. ULB/Parastatal/State Government.
6. The Consultant will broadly undertake following key activities:
   i. Data collection on existing infrastructure assets and cost recovery
   ii. Evaluation of current production, transmission and distribution service performance
   iii. Sample surveys in consultation with the SPV for determining the customer consumption volumes
   iv. Prepare current water balance as per International Water Association (IWA) methodology
   v. To do the Energy Audit of the machinery being used for the raw water, Water treatment and supply
   vi. Establish current annual levels of NRW with breakup of commercial and physical losses and evaluate the economic loss to the utility
   vii. Develop strategy for progressive reduction of NRW with detailed action plan and costs involved
   viii. Evaluate options for implementation of NRW reduction strategy
   ix. Provide a roadmap for rationalization of user charges
   x. Provide roadmap for improvement in current system to achieve the objectives of the assignment
   xi. Prepare implementation contract documents on performance based NRW reduction framework
   xii. Assist the utility in obtaining funding for implementation.

1.4 WATER AUDIT FOR WATER SUPPLY SYSTEM OF AMC

1.4.1 WATER AUDIT FOR ALL BULK WATER SOURCES OF AMC/ Jal Nigam.

As part of water audit, all the inlet and outlet sources of Agra water supply system were measured during field flow measurement activity, carried out in presence of AMC &Jalsansthan officials. Ultrasonic Flow Meters (Portable) were used and installed at various supply points for Flow Measurement and estimation of quantum supplied. The details of field measurement activity and results of Inlet and Outlet supply are mentioned under Bulk Water Audit report hereafter. The results of bulk water audit are summarized and tabulated as below;

The following table provides the summary of Bulk Water Input/output volume based on flow measurement.

Sr.No	Bulk Water Supply System :- Audit Summary			
1	**Sikandra WTP**			
	Inlet Flow (MLD)		**Outlet Flow (MLD)**	
	Inlet-1 (From Yamuna River)	139.87	Outlet for City Supply	133.99
	Subtotal	139.87	**Subtotal**	133.99
			UFW	**4.20%**
2	**Jeoni Mandi (Water work) WTP**			
	Inlet Flow (MLD)		**Outlet Flow (MLD)**	
	New Intake well	63.28	8 VT Pump House	45.86
	Old intake well	41.49	Flow More	25.42
	New JalNigam intake well	21.13	HT Gol kamra & Synchronous	42.55
	Subtotal	125.9	**Subtotal**	**113.83**
			UFW	**8.63%**
3	**Under Ground Water**			
	Tube wells (total 18 Nos. operational)			8.78
			Subtotal	**8.78**
	Net Inlet (MLD)	*265.77*	*Net Outlet (MLD)*	*256.60*

Table 1 : water Audit summary Table

1.4.2 WATER INPUT TO CITY

The following table provides the summary of total Bulk Water input to Agra city;

*Total Input to Agra City is **256.6 MLD***

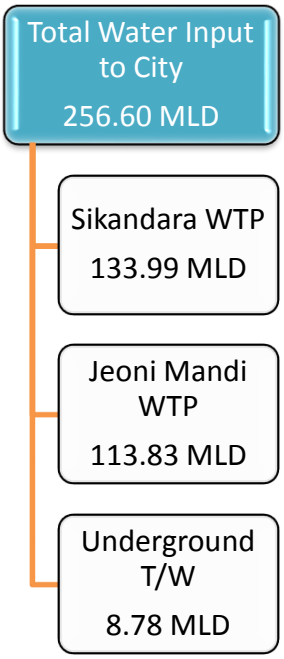


Figure 2:- Water Input to Agra city

1.4.3 WATER AUDIT FOR EXSITING WATER STORAGE RESERVOIRS & DIRECT TAPPINGS OF AMC

After measurement of all bulk water sources, WTPs were measured, Flow Measurement activity for all operational Water Storage reservoirs (ESR/ OHT's)&ZPS has been carried out to measure the quantum of water supplied to the OHT's for further water distribution. The details of measurement are tabulated below;

Water Audit Summary:- Water Storage Reservoirs					
S. No.	**Name of ESR/ZPS**	**Total Flow Measured (MLD)**	**Flow Measurement Date**	**Zone No.**	**Remark**
1	**Sanjay Place**			Zone-1	
	a) Hariparwat	5.04	21/07/2017		
	b) Maithon	6.55	22/07/2017		
	c) Sanjay Place Market	0.38	22/07/2017		
2	**Surya Nagar**	4.10	23/07/2017	Zone-1	
3	**Lawyers Colony**			Zone-1	
	a) Lawyers Colony	4.38	24/07/2017		
	b) Dayal Bag	0.73	26/07/2017		

Water Audit Summary:- Water Storage Reservoirs					
S. No.	**Name of ESR/ZPS**	**Total Flow Measured (MLD)**	**Flow Measurement Date**	**Zone No.**	**Remark**
4	**Nirbhay Nagar**	0.68	25/07/2017	Zone-1	
5	**Mathura Road**	5.33	25/07/2017	Zone-2	
6	**Shahganj phase 2 DS**			Zone-2	
	For Air force Supply	6.49	29/07/2017		
	Outlet -1	6.91	29/07/2017		
7	**Kedar Nagar**	2.72	31/07/2017	Zone-2	
8	**Kamala Nagar**	2.72	01/08/2017	Zone-1	
9	**Bodla (Keshavkunj)**	6.71	02/08/2017	Zone-2	
10	**Kalandi Vihar Block A OHT**	3.37	03/08/2017		
11	**Nagla Jamuni OHT**	2.40	03/08/2017		Through pura Govardhan ZPS
12	**Pura Govardhan ZPS**	7.30	03/08/2017		
13	**Lohamandi**			Zone-2	
	Lohamandi DS	6.53	15/08/2017		
	Lohamandi pump no 5 outlet	2.18	16/08/2017		
	Lohamandi OHT	1.08	17/08/2017		
14	**Kotwali**			Zone-2	
	Kotwali DS	1.45	06/08/2017		
	Kotwali ZPS to filling motikatra ESR	1.09	06/08/2017		
15	**kalandivihar block B ESR Filling**	1.29	07/08/2017	Zone-1	
16	**Transjamuna Phase-2**			Zone-1	
	Transyamuna Phase-2 ESR Filling premises	1.54	07/08/2017		
	Transyamuna Phase 2 DS	0.78	08/08/2017		
	Transyamuna Phase 2 Col	1.13	09/08/2017	Zone-1	
17	**Tube well No. 1**	0.74	11/08/2017	Zone -3	
18	**Tube well No. 2**	0.74	11/08/2017		
19	**Tube well No. 3**		11/08/2017		T/ W discharging air only
20	**Tube well No. 4**		11/08/2017		
21	**Tube well No. 5**		11/08/2017		
22	**Tube well No. 6**		11/08/2017		
23	**Tajganj DS**	7.06	12/08/2017		
24	**Chipi Tola ESR Filling**	1.26	14/08/2017	Zone -3	
25	**Red Fort**	0.10	14/08/2017	Zone -3	
26	**Navlakha**	18.72	16/08/2017	Zone-3	MES

Water Audit Summary:- Water Storage Reservoirs					
S. No.	**Name of ESR/ZPS**	**Total Flow Measured (MLD)**	**Flow Measurement Date**	**Zone No.**	**Remark**
27	**Rakabganj ZPS**				
	Rakabganj DS Out let-2	1.68	18/08/2017	Zone-3	
	Rakabganj DS Out let-1	3.31	20/08/2017		
	Rakabganj ESR Filling	0.20	20/08/2017		
28	**Brij Vihar**	1.93	06/09/2017	Zone-1	
29	**Shahganj Phase ZPS**			Zone-2	
	Shahganj Phase outlet-1	11.70	19/08/2017		
	Shahganj Phase outlet-2	1.69	20/08/2017		
30	**Subhash Park**	4.53	20/08/2017		
31	**Kalamahal**	0.66	04/09/2017	Zone-1	
	Kalamahal ESR	0.66	04/09/2017		
	Kalamahal DS	3.27	04/09/2017		
32	**Awas vikas tapping at Mathura road zps**	6.99	06/09/2017	Zone-1	
33	**Awas Vikas Sector 15**			Zone-1	Not In Use
34	**Awas Vikas Sector 9**			Zone-1	
35	**Awas Vikas Sector 2**			Zone-1	
36	**Awas Vikas Sector 4**			Zone-1	
Total		*141.67*	*MLD*		

Table 2 : Storage Reservoirs / ZPS flow measurement

The following table provides the summary of all Water Storage reservoir Input/output volume based on flow measurement.

As seen from above table total 40 nos. of operational OHTs/ZPS and Direct Tapping were measured under bulk water audit activity. Total Water Supply to the distribution system is 141.67 MLD.

The following table shows the overall summary of Bulk Water System of Agra Municipal Corporation.

Bulk Water Supply System -Water Balance					
Sikandara WTP to ZPS					
Outlet Water From WTP to City		MLD	Total Water Input to City	MLD	UFW
1	Sikandara WTP	133.99	ZPS & OHTs (Sikandara Source)	84.71	36.77%
2	Jeoni Mandi(Water works)	113.83	ZPS & OHTs (Jeoni Mandi Source)	48.18	57.72%
3	Ground Water (Borewell)	8.78			
Subtotal (MLD)		**256.58**	**Subtotal (MLD)**	**141.67**	
			UFW (%)	**44.78%**	

Table 3 : Water Balance for Agra City Water Supply

WTP command areawise the, the ZPS / OHT's water balance is represented as per below;

1.4.4 WATER BALANCE SUMMARY

The following line diagram shows the overall summary of Bulk Water System of Agra Municipal Corporation.

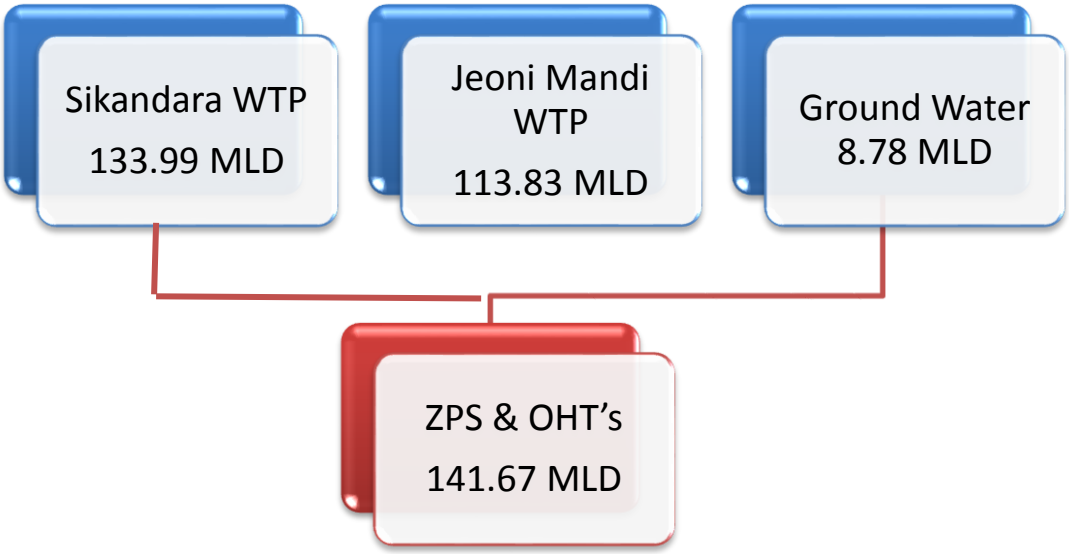


Figure 3: Water balance sheet

Total Bulk Water Input to City	**=**	**256.60**	**MLD**
Total Bulk Water Supply to OHTs	**=**	**141.67**	**MLD**
City Direct Supply* + UFW	**=**	**114.93**	**MLD**

Notes: *- i) *City direct supply points could not be measured due to physical site constraints. Direct Distribution /supply points are many as provided in table below as per actual field survey, however no such official records is available with AMC/ Jal Sansthan.*

ii) UFW stands for un-accounted for water which is inclusive of visible/invisible leaks, physical losses, illegal connections etc.

1.4.5 OBSERVATIONS & RECOMMENDATIONS

As per Water audit activity carried out for bulk water system of AMC, the following Observations were observed during field measurement.

Observations in brief are summarized as below;

- There are direct tappings on feeder mains feeding to OHT's/ ESR's and hence direct supply in the distribution by-passing the OHTs resulting into Pressure loss and un-equitable water distribution thereby resulting into water loss / revenue loss.
- Electromagnetic flow meter is installed at Jeoni Mandi WTP, Sikandra WTP, however metering at ZPS / OHT's level is not observed. Flow meters with non functional status were also observed.
- Water supply is intermittent. Supply timing is for 1-4 hrs. a day.
- Overhead Tanks are found to be very old and outlived their structural life. Structures of these tanks were damaged at many places. Jeoni Mandi WTP is old and requires rehabilitation/ revamping.
- No Record for water consumption. There is no metering at consumer end resulting into water loss. Water tariffs are being charged on fixed basis.
- Wastage of water occurs due to leakages in old pipelines and Inlet/Outlets Sluice valves
- Distribution network is not isolated. Over lapping of network from more than one Tank area is observed.
- No proper hydraulic modeling of system to know parameters for different operating condition.
- There is no monitoring and control of water supply parameters in the existing system. SCADA system is planned separately for Agra water supply system in order to transform into "Willful Operation" from the haphazard Operation. It is emphasized here again SCADA itself cannot achieve an equitable supply but only data analysis, resultant direction and its feedback can achieve an equitable supply. Nodal person/organization is required to do so.

1.4.6 Steps for NRW Reduction and achieve pressurized continuous water supply:-

1. Network Mapping& Hydraulic Modeling
2. Leakage Mapping and repairs
3. Rehabilitation /replacement of components, piping network
4. Installation of consumer water meter to measure consumption
5. Replacement of consumer House Service Connections with MDPE pipe and new fittings available.
6. Development of monitoring system, Metering for bulk water system for demand supply

management, monitoring UFW / NRW levels.

7. Development of SCADA & Billing mechanism
8. Automation of Customer complaints & redressal system
9. Capacity development & Management improvement system
10. Energy & water Audit of the system on regular basis
11. Reuse of Treated Wastewater

1.5 DMA STUDY AND NRW ASSESSMENT

Following areas were approved by AMC & Jal sansthan for DMA study and accordingly DMA study has been carried out:

Sr. No.	DMA Areas	No. of Connections
1	Awas Vikas Sector 12D	198
2	Tajganj (ABD) Area	257
3	Harjupura	250
4	Awas Vikas Sector 4R	169
5	Nawada	186
	Total	**1060**

Table 4 : Summary of DMA's As per connection

As shown above, total 1060 consumers connection were studied out of 190000 registered & un-registered consumers. The DMA's were selected based on feasible locations where area under study can be isolated or measured by fixing inflow bulk meters. DRA team has installed the Bulk flow meters and water consumer's meters to measure the actual consumption. Consumer survey was carried out to identify the registered / un-registered consumers. The results of DMA study and analyais has been discussed in detailed under Chapter10, however, brief summary is tabulated below;

Summary of DMA Study								
DMA Locataion	Connections		Population	Days Study Period		Bulk Meter Details		
	Total	Active		Start	End	Meter Location	Line Size (mm)	Avg. Flow (m3/Hr.)
Awas Vikas Sector 12D	212	198	778.00	04-10-17	13-10-17	Meter "A"	125	271.37
Tajganj (ABD Area)	287	257	1613.00	03-11-17	18-11-17	Meter "A"	250	789.20
Harjupura Tajganj (ABD Area)	297	250	1588.00	01-12-17	15-12-17	Meter "A"	200	151.45
Awas Vikas Sector 4R	175	165	806.00	08-12-17	24-12-17	Meter "A"	150	371
Nawada Tajganj (ABD Area)	208	186	1239.00	01-01-18	13-01-18	Meter "A"	200	643

Summary of DMA Study							
DMA Locataion	Population	Total input Volume (m3)	Total Measured Consumer Consumption (m3)			UFW %	NRW %
			Registered	Un-Registered	Total		
Awas Vikas Sector 12D	778.00	2713.75	1054.30	1201.95	2256.25	16.59	61.15
Tajganj (ABD Area)	1613.00	11846.81	1006.38	2963.41	3969.79	66.49	91.51
Harjupura Tajganj (ABD Area)	1588.00	2271.70	789.09	905.53	1694.62	25.40	65.26
Awas Vikas Sector 4R	806.00	5931.84	3887.76	815.76	4703.52	20.71	34.46
Nawada Tajganj (ABD Area)	1239.00	8359.00	1158.71	1533.99	2692.70	67.79	86.14

1.6 NRW REDUCTION STRATEGY & ACTION PLAN FOR IMPROVEMENT

1.6.1 Steps for NRW Reduction

12. Network Mapping& Hydraulic Modeling

13. Leakage Mapping and repairs

14. Rehabilitation /replacement of components, piping network
15. Installation of consumer water meter to measure consumption
16. Replacement of consumer House Service Connections with MDPE pipe and new fittings available.
17. Development of monitoring system, Metering for bulk water system for demand supply management, monitoring UFW / NRW levels.
18. Development of SCADA & Billing mechanism
19. Automation of Customer complaints & redressal system
20. Capacity development & Management improvement system
21. Energy & water Audit of the system on regular basis
22. Reuse of Treated Wastewater

1.6.2 Strategy to Reduce NRW towards continuous Water Supply

- **Setting up correct water supply zones for each water works:** Operational zones shall be demarcated with respect to each water works capacity, command area and serviceability.
- **Hydraulic modeling:-**The entire Transmission and Distribution Network shall be mapped by using suitable GIS Mapping tool and this shall facilitate to carry out effective and accurate Hydraulic Modeling of the entire system. It is major activity to be carried out to judge the suitability of existing network for supply of progressive demand, replacement /rehabilitation required in phases to meet the requirement. It will also help to make provision of isolation for proper controlling and demand management, restructuring of zones, looping network, introducing rider mains etc.
- **Setting up District Metering Areas (DMA):** District Metering Areas are required to be set up for each correct operational zone for the number of customers between 500 to 2000. These DMA's shall be made hydraulically discrete (isolated). Flow into the each DMA shall be metered and continuously monitored. Also, Pressure Control Valve's (PRV's) shall be installed at more than one point as per the site requirements.
- **House service connections:** House service connections which have outlived their life with existing GI pipe connections shall be replaced by using MDPE /UPVC pipe. It is a known fact that more than 50% of the leaks appear from Service Connection, old discontinued connections and leaks at ferrule points. Service connection shall be replaced with new MDPE / UPUC pipe and modern fittings available to reduce water leakage. Thus, this House Service Replacement program will amount to a huge NRW Reduction.
- **Consumer water metering:** Consumer water metering is important for any city to arrest the NRW levels and ULB shall make a policy decision to install the consumer water meters and

charge / bill accordingly.

- **Revised Tariff system :-**The current tariff shall need to be revised and telescopic tariff system shall be implemented. Corporation shall need to frame the water tariff policy based on consumption which will be useful at least discourage misuse and wastage of water.
- **Consumer Awareness Programs :**
  - Public Campaigns for the water conservation
  - Internal water audit or leak test for consumers those having history of high consumption shall be conducted. A list of such consumers shall be identified and maintained.
- **Reuse of Treated Wastewater**

  Potential for reuse of treated wastewater for non-potable uses at local or regional level, industrial reuse, housing colony/ group housing reuse option, and horticultural uses, recharge of Ground Water from treated waste water and from rain water harvesting Water harvesting, Dual Pipe System, Utilization of Treated wastewater etc. Re-use of treated waste water will reduce the demand on fresh water.

  The project cost details for House service Connection and water consumer meters and other improvement work details shall be estimated and provided in next report after approval and due consultation with Agra Municipal Corporation.

1.6.3 Improvement Work,investmet cost and Action plan

Based on the DMA study, it can be suggested that AMC shall make a policy decision to install consumer metering and replace the house service connection for existing consumers with latest fittings and material available now a days. Acordingly, the project cost estimates was derived considering the components like domestic water meters, MDPE pipe for house service connections, latest fittings and material and Road Restoration cost. Thus, the estimated project cost for water meter replacement and house service connection and road restoration cost is apprx. 129.25 crores as per details tabulated below;

Perticulars	Amount (Rs.)	Amount (Rs in Lakhs)
Ferrules	40242000.00	402.42
Meter box	43169900.00	431.70
Compression fittings	32690450.00	326.90
DI Strap Saddle	28185447.40	281.85
Domestic Water Meters	412353200.00	4123.53
ElectroFusion Tapping Ferrule	98474700.00	984.75
Excavation	21375000.00	213.75
Galvanised iron Pipe	30922500.00	309.23
Gun metal ball valve	51794000.00	517.94
MDPE Pipe	22529250.00	225.29
Moling	41467500.00	414.68
Road resotration	469297774.60	4692.98
Grand Total	**1292501722.00**	**12925.02**

1.7 ENERGY AUDIT FOR AGRA PUMPING INSTALLATIONS

The energy audit activity recently conducted for Agra Municipal Corporation is summarized as per below;

Water from Yamuna River is drawn at the following locations:

•Raw Water & Treatment Plant at Jeoni Mandi-120 MLD

•Raw Water & Treatment Plant at Sikandara-144 MLD

•There are 4 Water treatment plants which supply treated water to Agra city. There are 3 nos water treatment plant of 90 MLD, 20 MLD & 10 MLD capacities at Jeoni Mandi and 1 nos water treatment plant of 144 MLD at Sikandara.

Clear water from Water Treatment Plant is distributed through different Water Distribution Zonal Pumping Stations divided among three zones as per details below;

1.7.1 Water pumping details

S. No	Facility Name & Location	Source of water	Number of pumps	MLD Capacity	Type of Storage	Number of Reservoir/Clarifier	No. of OHT
1	Old Intake Well	River	3	225 MLD (From Jeoni Mandi Water Treatment Plant)	Intake well	0	0
2	New Intake Well	River	3		Intake well	0	0
3	New Jal Nigam Intake Well	River	3		Intake well	0	0
4	HT Plant (Golkamra)	Jeoni Mandi WTP	3		Clear Water	1	0
5	Synchronous Plant	Jeoni Mandi WTP	2		Clear Water	1	0
6	8 VT Plant	Jeoni Mandi WTP	7		Clear Water	1	0
7	Flowmore plant	Jeoni Mandi WTP	5		Clear Water	1	0
8	Sanjay Place ZPS	Sikandra WTP	10	6.9 MLD	Clear Water	1	0
9	Kotwali ZPS	Jeoni Mandi WTP	5	3.15MLD	Clear Water	1	1
10	Surya Nagar ZPS	Sikandra WTP	5	3.49 MLD	Clear Water	1	0
11	Mathura Road ZPS	Sikandra WTP	4	3.63MLD	Clear Water	2	0
12	Trans Yamuna	Jeoni Mandi WTP	2	0.8MLD	Clear Water	1	0

S. No	Facility Name & Location	Source of water	Number of pumps	MLD Capacity	Type of Storage	Number of Reservoir/Clarifier	No. of OHT
13	Lawyer's Colony ZPS	Sikandra WTP	4	1.03MLD	Clear Water	1	2
14	Nirbhay Nagar ZPS	Sikandra WTP	2	0.4MLD	Clear Water	1	0
15	Lohamandi ZPS	Sikandra WTP	5	5.73MLD	Clear Water	2	1
16	Keshavkunj ZPS (Bodla ZPS)	Sikandra WTP	5	3.8MLD	Clear Water	1	0
17	Shahganj Phase-1 ZPS	Sikandra WTP	8	8.5MLD	Clear Water	2	1
18	Shahganj Phase-2	Sikandra WTP	5	4.54MLD	Clear Water	1	0
19	Kedar Nagar	Sikandra WTP	3	0.605 MLD	Clear Water	1	1
20	Tajganj ZPS	Jeoni Mandi WTP	6	3.55MLD	Clear Water	2	0
21	Rakabganj ZPS	Jeoni Mandi WTP	5	5.05MLD	Clear Water	2	1
22	Navlakha ZPS	Jeoni Mandi WTP	4	7.95MLD	Clear Water	1	0
23	Chhipitola Booster	Jeoni Mandi WTP	2	1.5MLD	Clear Water	0	1
24	Red Fort Booster	Jeoni Mandi WTP	1	NA	Clear Water	0	0

Based on the measurement and analysis carried out during the energy audit, the pump and pump set efficiencies for both the pumping stations have been estimated. The summary of results is provided in the table below.

1.7.2 Pump range and Efficiency evaluation metrics:

Sr. no	Pump type	Pump capacity range (kW)	Weighted average pump efficiency	Weighted average pump set efficiency
8 VT Plant, Water Works, Jeoni Mandi				
1	VT	> 200 kW	39.98%	35.41%
Flowmore plant				
1	VT	150-200 kW	87.13%	83.09%
Old Intake Well, Jeoni Mandi				
1	VT	150-200 kW	37.36%	35.12%
New Intake Well, Jeoni Mandi				
1	VT	150-200 kW	45.29%	42.57%

Sr. no	Pump type	Pump capacity range (kW)	Weighted average pump efficiency	Weighted average pump set efficiency
New Jal Nigam Intake well, Jeoni Mandi				
1	VT	125-149 kW	36.90%	34.50%
Sanjay Place				
1	VT	31-45 kW	39.89%	36.30%
2	VT	61-90 kW	46.85%	42.87%
Kotwali ZPS				
1	VT	16-30 kW	66.48%	59.83%
2	VT	31-45 kW	20.01%	18.21%
Surya Nagar ZPS				
1	VT	16-30 kW	25.27%	22.74%
2	VT	31-45 kW	27.34%	24.88%
3	VT	91-125 kW	58.87%	54.75%
Mathura Road ZPS				
1	VT	31-45 kW	38.76%	35.28%
Trans Yamuna ZPS				
1	VT	16-30 kW	20.11%	18.10%
2	VT	31-45 kW	29.44%	26.79%
Lawyer's Colony ZPS				
1	VT	31-45 kW	47.39%	43.12%
Nirbhay Nagar ZPS				
1	VT	16-30 kW	78.98%	71.87%
Lohamandi ZPS				
1	VT	31-45 kW	NA	32.21%
2	VT	61-90 kW	55.40%	49.97%
Keshavkunj ZPS (Bodla ZPS)				
1	VT	31-45 kW	35.40%	41.38%
Shahganj Phase-1 ZPS				
1	VT	Up to 15 kW	37.67%	33.91%
2	VT	31-45 kW	44.51%	40.50%
3	VT	61-90 kW	18.99%	17.38%
4	VT	91-125 kW	42.43%	39.67%
Shahganj Phase-2				
1	VT	31-45 kW	43.43%	39.52%
2	VT	61-90 kW	56.77%	51.54%
Kedar Nagar				
1	VT	16-30 kW	65.89%	59.30%
Rakabganj ZPS				
1	VT	61-90 kW	40.34%	37.04%

Sr. no	Pump type	Pump capacity range (kW)	Weighted average pump efficiency	Weighted average pump set efficiency
Navlakha ZPS				
1	HSC	61-90 kW	73.38%	70.29%
2	HSC	125-149 kW	59.19%	56.70%
Chhipitola Booster				
1	HSC	16-30 kW	41.67%	37.51%

1.7.3 Energy Saving Potential

The energy saving potential has been calculated on the basis of energy audit activity conducted at the pumping stations. The estimated energy saving potential finalized for Agra City is provided in the table below:

Sl. No.	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/annum)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)
Pumping System					
1	Replacement of Pump-5 at 8 VT Plant, Water Works, Jeoni Mandi with energy efficient pump set	645,356	19.92	51.31	5
2	Replacement of Pump-6 at 8 VT Plant, Water Works, Jeoni Mandi with energy efficient pump set	193,443	19.92	15.38	16
3	Replacement of Pump-7 at 8 VT Plant, Water Works, Jeoni Mandi with energy efficient pump set	330,890	19.92	26.31	9
4	Replacement of Pump-6 at Old Intake Well, Jeoni Mandi with energy efficient pump set	541,292	28.62	43.03	8
5	Replacement of Pump-1 at New Intake Well, Jeoni Mandi with energy efficient pump set	327,674	20.97	26.05	10
6	Replacement of Pump-2 at New Intake Well, Jeoni Mandi with energy efficient pump set	115,611	35.90	9.19	47
7	Replacement of Pump-2 at New Jal Nigam Intake well, Jeoni Mandi with energy efficient pump set	175,275	20.97	13.93	18
8	Replacement of Pump-3 at New Jal Nigam Intake well, Jeoni Mandi with energy efficient pump set	220,904	20.97	17.56	14
9	Replacement of Pump-5 at Sanjay Place, Maithan Side. with energy efficient pump set	16,828	8.73	1.34	78
10	Replacement of Pump-1 at Sanjay Place, Hariparvat Side. with energy efficient pump set	19,532	10.92	1.55	84

Sl. No.	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/annum)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)
11	Replacement of Pump-4 at Sanjay Place, Hariparvat Side. with energy efficient pump set	38,445	17.15	3.06	67
12	Replacement of Pump-5(0) at Sanjay Place, Hariparvat Side. with energy efficient pump set	32,014	8.18	2.55	39
13	Replacement of Pump-1 at Kotwali ZPS with energy efficient pump set	12,405	5.75	0.99	70
14	Replacement of Pump-2 at Mathura Road ZPS with energy efficient pump set	19,447	10.86	1.55	84
15	Replacement of Pump-3 at Mathura Road ZPS with energy efficient pump set	13,637	6.39	1.08	71
16	Replacement of Pump-1 at Trans Yamuna ZPS with energy efficient pump set	16,341	8.80	1.30	81
17	Replacement of Pump-1(Lawyer's Colony) at Lawyer's Colony ZPS with energy efficient pump set	35,946	8.73	2.86	37
18	Replacement of Pump-2(Lawyer's Colony) at Lawyer's Colony ZPS with energy efficient pump set	86,044	8.20	6.84	14
19	Replacement of Pump-1 at Shahganj Phase-1 ZPS with energy efficient pump set	37,113	9.42	2.95	38
20	Replacement of Pump-5 at Shahganj Phase-2 with energy efficient pump set	109,617	12.11	8.71	17
21	Replacement of Pump-2 at Rakabganj ZPS with energy efficient pump set	31,695	14.52	2.52	69
22	Replacement of Pump-3 at Navlakha ZPS with energy efficient pump set	154,038	9.07	12.25	9
23	Replacement of Pump-2 at Chhipitola Booster with energy efficient pump set	7,119	2.50	0.57	53
	Subtotal	**3,180,667**	**328.53**	**252.86**	**16**
Auxiliary loads					
24	Installation of APFC panel at Sanjay Place		6.49	9.76	8
25	Installation of APFC panel at Kotwali ZPS		1.73	2.07	10
26	Installation of APFC panel at Surya Nagar ZPS		2.88	4.07	9
27	Installation of APFC panel at Mathura Road ZPS		1.73	3.48	6
28	Installation of APFC panel at Trans Yamuna ZPS		1.01	0.19	63

Sl. No.	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/annum)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)
29	Installation of APFC panel at Lawyer's Colony ZPS		1.95	3.42	7
30	Installation of APFC panel at Nirbhay Nagar ZPS		1.01	0.15	82
31	Installation of APFC panel at Lohamandi ZPS		3.61	6.14	7
32	Installation of APFC panel at Keshavkunj (Bodla) ZPS		5.19	1.39	45
33	Installation of APFC panel at Shahganj Phase-1 ZPS		5.77	16.44	4
34	Installation of APFC panel at Shahganj Phase-2		4.33	5.53	9
35	Installation of APFC panel at Kedar Nagar		1.01	1.19	10
36	Installation of APFC panel at Tajganj ZPS		6.13	3.08	24
37	Installation of APFC panel at Rakabganj ZPS		3.61	5.14	8
38	Installation of APFC panel at Navlakha ZPS		3.24	6.75	6
39	Installation of capacitor at Chhipitola Booster		0.18	0.25	9
40	Installation of capacitor at Red Fort Booster		0.05	0.04	17
	Subtotal		**49.91**	**69.09**	**9**
41	Replacement of existing lighting equipment at Old Intake Well with LED lamps	525.6	0.03	0.04	10
42	Replacement of existing lighting equipment at New Intake Well with LED lamps	411.72	0.02	0.03	6
43	Replacement of existing lighting equipment at New Jal Nigam Intake Well with LED lamps	2,312.64	0.10	0.18	7
44	Replacement of existing lighting equipment at Synchronous with LED lamps	192.72	0.01	0.02	7
45	Replacement of existing lighting equipment at Flowmore Plant with LED lamps	1,020.54	0.03	0.08	5
46	Replacement of existing lighting equipment at 8 VT Plant with LED lamps	617.58	0.03	0.05	6
47	Replacement of existing lighting equipment at Sanjay Place with LED lamps	1,787.04	0.32	0.14	27
48	Replacement of existing lighting equipment at Kotwali ZPS with LED lamps	1,300.86	0.18	0.10	21

Sl. No.	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/annum)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)
49	Replacement of existing lighting equipment at Surya Nagar ZPS with LED lamps	4,673.46	0.71	0.37	23
50	Replacement of existing lighting equipment at Mathura Road ZPS with LED lamps	44,67.6	0.89	0.36	30
51	Replacement of existing lighting equipment at Trans Yamuna ZPS with LED lamps	227.76	0.02	0.02	12
52	Replacement of existing lighting equipment at Lawyer's Colony ZPS with LED lamps	502.24	0.10	0.04	29
53	Replacement of existing lighting equipment at Nirbhay Nagar ZPS with LED lamps	1,419.12	0.29	0.11	31
54	Replacement of existing lighting equipment at Lohamandi ZPS with LED lamps	487.64	0.03	0.04	8
55	Replacement of existing lighting equipment at Keshavkunj ZPS with LED lamps	459.9	0.04	0.04	14
56	Replacement of existing lighting equipment at Shahganj-1 ZPS with LED lamps	1949.1	0.30	0.15	23
57	Replacement of existing lighting equipment at Shahganj Phase-2 ZPS with LED lamps	398.58	0.03	0.03	10
58	Replacement of existing lighting equipment at Kedar Nagar with LED lamps	889.14	0.08	0.07	13
59	Replacement of existing lighting equipment at Tajganj ZPS with LED lamps	779.64	0.11	0.06	20
60	Replacement of existing lighting equipment at Navlakha ZPS with LED lamps	2409	0.54	0.19	34
61	Replacement of existing lighting equipment at Chhipi Tola ZPS with LED lamps	551.88	0.02	0.04	5
62	Replacement of existing lighting equipment at Red Fort Booster with LED lamps	718.32	0.01	0.06	2
	Subtotal	**28,102**	**3.85**	**2.23**	**21**
TOTAL		**3,208,769**	**332.39**	**255.10**	**16**

1.7.4 Energy Conservation Measures:

Eenrgy conservation measures (ECMs) are divided into 3 categories, namely ECM-1 involving minor investment, ECM-2 involving medium investment and ECM-3 involving major investment. Measures and savings for each category are given below:

ECM-1: Savings through Revision of Contract Demand

Location	Existing contract demand kVA	Proposed contract demand kVA	Estimated annual savings Rs lakh
Sanjay Place	330	500	10.03
Kotwali	218	160	0.44
Surya nagar	143	240	4.45
Mathura Road	102	140	1.23
Lawyers Colony	183	150	0.44
Nirbhay Nagar	55.56	70	0.40
Lohamandi	127	320	9.54
Keshav Kunj (Bodla)	182	320	6.87
Shahganj phase-1	376	500	3.95
Shahganj phase-2	202.22	320	5.41
Tajganj	111.1	400	16.08
Rakabganj	264.4	320	1.43
Chhipitola	13	30	0.72
Total			**60.97**

Thus, estimated annual savings around Rs. 60 lakh can be achieved through revision of contract demand with minimal investment.

ECM-1: Savings through Replacement of Lighting Fixtures with LED-based lighting equipment

Location	Potential annual energy savings in kWh	Estimated annual savings Rs lakh	Investment Rs lakh	Payback period months
Old Intake Well	526	0.04	0.03	10
New Intake Well	412	0.03	0.02	6
New Jal Nigam Intake Well	2313	0.18	0.10	7
Synchronous	193	0.02	0.01	7
Flowmore Plant	1021	0.08	0.03	5
8 VT Plant	618	0.05	0.03	6
Sanjay Place	1787	0.14	0.32	27
Kotwali ZPS	1301	0.10	0.18	21
Surya Nagar ZPS	4673	0.37	0.71	23
Mathura Road ZPS	4468	0.36	0.89	30
Trans Yamuna ZPS	228	0.02	0.02	12
Lawyer's Colony ZPS	502	0.04	0.10	29
Nirbhay Nagar ZPS	1419	0.11	0.29	31

Location	Potential annual energy savings in kWh	Estimated annual savings Rs lakh	Investment Rs lakh	Payback period months
Lohamandi ZPS	488	0.04	0.03	8
Keshavkunj ZPS	460	0.04	0.04	14
Shahganj-1 ZPS	1949	0.15	0.30	23
Shahganj Phase-2 ZPS	399	0.03	0.03	10
Kedar Nagar	889	0.07	0.08	13
Tajganj ZPS	780	0.06	0.11	20
Navlakha ZPS	2409	0.19	0.54	34
Chhipi Tola ZPS	552	0.04	0.02	5
Red Fort Booster	718	0.06	0.01	2
Total	**28102**	**2.23**	**3.85**	**21**

Thus, estimated annual savings of around 28000 kWh, with monetary savings around Rs. 2.23 lakh, can be achieved through replacement of existing lighting equipment with new, energy efficient LED-based lighting equipment. The investment required for installation of new lighting equipment is estimated to be around Rs. 3.85 lakh, and the resultant simple payback period is around 21 months.

ECM-2: Savings through Improvement of Power Factor

Location	Avg recorded PF	Potential savings through PF improvement	Estimated investment	Estimated payback period months
Sanjay Place	0.780	9.76	6.49	8
Kotwali ZPS	0.676	2.07	1.73	10
Surya Nagar ZPS	0.774	4.07	2.88	9
Mathura Road ZPS	0.735	3.48	1.73	6
Trans Yamuna ZPS	0.896	0.19	1.01	63
Lawyer's Colony ZPS	0.819	3.42	1.95	7
Nirbhay Nagar ZPS	0.839	0.15	1.01	82
Lohamandi ZPS	0.768	6.14	3.61	7
Keshavkunj (Bodla) ZPS	0.903	1.39	5.19	45
Shahganj Phase-1 ZPS	0.651	16.44	5.77	4
Shahganj Phase-2	0.835	5.53	4.33	9
Kedar Nagar	0.810	1.19	1.01	10
Tajganj ZPS	0.858	3.08	6.13	24
Rakabganj ZPS	0.724	5.14	3.61	8
Navlakha ZPS	0.847	6.75	3.24	6
Chhipitola Booster	0.907	0.25	0.18	9
Red Fort Booster	0.877	0.04	0.05	17
Total		**69.09**	**49.91**	**9**

Thus, estimated annual savings around Rs. 69 lakh can be achieved through improvement of power factor. The investment required for installation of APFC panels/fixed capacitors is estimated to be around Rs. 49.91 lakh, and the resultant simple payback period is around 9 months.

ECM-3: Savings through Replacement of Pumping Machinery

Location	Potential annual energy savings in kWh	Estimated annual savings Rs lakh	Investment Rs lakh	Payback period months
8 VT Plant, Water Works, Jeoni Mandi	1169688	92.99	59.77	8
Old Intake Well, Jeoni Mandi	541292	43.03	28.62	8
New Intake Well, Jeoni Mandi	443285	35.24	56.88	19
New Jal Nigam Intake well, Jeoni Mandi	396180	31.50	41.95	16
Sanjay Place	106820	8.49	44.98	64
Kotwali ZPS	12405	0.99	5.75	70
Mathura Road ZPS	33084	2.63	17.25	79
Trans Yamuna ZPS	16341	1.30	8.80	81
Lawyer's Colony ZPS	121990	9.70	16.93	21
Shahganj Phase-1 ZPS	37113	2.95	9.42	38
Shahganj Phase-2	109617	8.71	12.11	17
Rakabganj ZPS	31695	2.52	14.52	69
Navlakha ZPS	154038	12.25	9.07	9
Chhipitola Booster	7119	0.57	2.50	53
Total	**3180667**	**252.86**	**328.53**	**16**

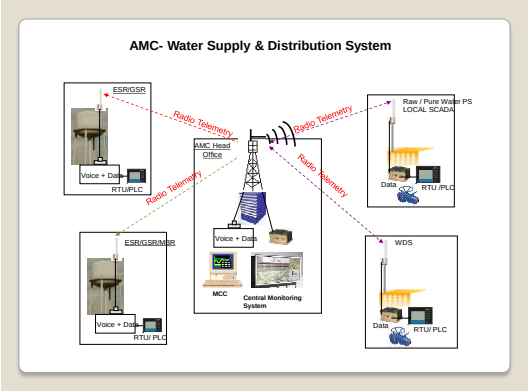
Thus, estimated annual savings of around 31 lakh kWh, with monetary savings around Rs. 250 lakh, can be achieved through replacement of existing pumping machinery with new, energy efficient pumping machinery. The investment required for installation of new pumping machinery is estimated to be around Rs. 328.53 lakh, and the resultant simple payback period is around 16 months.

Overall summary of energy efficiency measures is provided below:

	Annual savings in kWh	Annual savings in Rs lakh	Investment in Rs lakh	Payback period months
ECM-1: Contract demand revision	-	60.97	-	-
ECM-1: Installation of LED-based lighting equipment	28102	2.23	3.85	21
ECM-2: Power factor improvement	-	69.09	49.91	9
ECM-3: Replacement of pumping machinery	3180667	252.86	328.53	16
Total	**3208769**	**385.16**	**382.30**	**12**

The details of energy audit activity and saving potential areas are discussed in details under Chapter hereafter;

1.8 CENTRAL MONITORING SYSTEM FOR AMC-PROPOSED



Centralized Water distribution monitoring and Management System is proposed for AMC water supply System. The central monitoring station shall be located at Jalkal office building displaying the information of each location of water distribution components online. The Central Server of the system shall monitor, record the parameters like flow, level, pressure, residual chlorine of existing ESR, UGRs, MBRs & ZPS locations. It is also proposed to install the instrument on all water supply components and interface with RTU/ PLC's communicate with Central Station for real-time monitoring & control. GPRS / Radio Telemetry System is proposed to communicate the data and information between water supply locations to the Master Control Center (MCC).

It is also proposed to provide the centralized Supervisory Control and Data Acquisition System (SCADA) along with local SCADA for the Booster Pumping Stations. It is also proposed to connect valve location actuators to the central SCADA to operate from central locations. The SCADA system shall be connected through Remote Terminal Unit (RTU) with the Central Server via RF communication.

The estimated project cost for the proposed monitoring system is tabulated as per below;

AGRA MUNICIPAL CORPORATION: MONITORING SYSTEM - PROJECT COST SUMMARY				
Sr No	**Monitoring SYstem Instrumentation and Components**	**Qty**	**Unit**	**Cost (Rs.)**
1	Pressure Measuring Instruments	144	Nos.	9849600
2	Temperature Scanners	126	Nos.	1077300
3	Level Measurement Systems	45	Nos.	3847500
4	Residual Chlorine Measuring Instruments	42	Nos.	14723100
5	Electromagnetic Flow-meter (EMF)	49	Nos.	26841090
6	Turbidity Meter	8	Nos.	2280000
7	pH Meter	3	Nos.	971112
8	RPM Measuring Instruments	126	Nos.	2154600
9	Energy Measuring (Power Analyser) Instruments	126	Nos.	2370060
10	RTUs/PLCs	46	Nos.	10046250
11	Lightening / Surge Protection System	46	Nos.	393300
12	Instrumentation Cable	3150	Mtr	513513
13	R.C.C. Chambers for Flowmeters	18	Nos.	903600
14	Wireless Radio Telemetry	46	Nos.	13680000
15	MS Tubular Tower	46	Nos.	11328750
16	Central Monitoring System for all UGR/GSR/Pumping stations	1	Nos.	855000
17	Central Server PC	1	Nos.	427500
18	PCs, Softwares, Keyboards, Printers and Other Hardware Complete	1	Nos.	897750
19	Uninterrupted Power Supply System	46	Nos.	3249000
20	Air Conditioning Unit	1	Nos.	76950
21	Pipe Specials and Fittings for Flowmeters / Flow Control Valves	343	Nos.	3819399
			Total Capital Cost (Rs.)	**110305374**

Total O&M Cost for 5 years (Rs.)	**89450000**
Total Project Cost (Rs.)	**199755374**
Total Project Cost (Rs. Crores)	**19.98**

1.9 PROJECT COST AND FUNDING OPTION

Thus, total project cost investment programme for Agra Water supply-Priority work is tabulated as below;

Sr.No.	Description of Works	(Rs. Crores)
1	Central Monirtoring System and Instrumentation	19.98
2	Consumer water Metering and Rehab for HSC	129.25
3	Energy Efficiency Improvement for Pumping System	3.82
	Total Project cost (Rs.crores)	**153.05**

1.10 CONCLUSION

The interim report 3rd covers the existing water supply system and deals with deficiency of the system & water losses in the system and present NRW/ UFW levels for the DMA study carried out for the selected area. Water is an expensive commodity and wastage of water occurs due to leakages in old pipelines and Inlet/Outlets Sluice valves of Overhead tanks and also at Direct Tapping's for supply from feeder mains in the system. It provides details of water loss resulting into Non Revenue Water (NRW) and need for improvement and revamping of the entire water supply system in Agra City. Also, the need on energy efficiency improvement observed as per Energy Audit study carried out for entire water pumping system of Agra city. However, the report reveals the water input to the system with Unaccounted for Water (UFW) in % which is due to direct bulk water supply points i.e. direct tapping's to pipelines and suggests the need of instrumentation and SCADA / monitoring system to control and reduce the UFW / NRW in water Supply System. AMC shall initiate the improvement works while installing the monitoring system in place and integrating it various other improvement works like consumer water metering, house service connection replacement, pump replacement, water tariff policy implementation etc. Agra Municipal Corporation can make policydecision and initiate the implementation of improvement plan as per following and action plan for NRW Reduction as discussed in report either through AMRUT/ Smart City Yojana or any other funding programme ;

- Install water consumer meters and charge for volumetric consumption
- Metering & monitoring system for water supply & distribution system
- For equitable water distribution, Hydraulic Modelling of the entire system

Energy Audit study and Report suggests good potential for energy conservation for Agra Water Supply System. Many potential energy savings proposal are identified during energy audit study and discussed in the report with action plan for each pumping station Agra Municipla Corporation may initiate the following action plan for energy savings;

- Invest in Pump and Motor Replacement for energy efficiency
- Invest in Pump and Motor Retrofiitings/ modification/ upgradation
- Install and ensure Energy Efficiency Monitoring System in place.

The Energy Conservation Measures (ECMs) identified and described in this repoprt with minor and without investment can be implemented immediately. Major energy saving potential areas identified for various WTP's and Pumping Stations which requires major investment can be implemented under suitable funding programme or through ESCO mode.

2 INTRODUCTION TO WATER SUPPLY SYSTEM OF AGRA CITY

2.1 BACKGROUND OF AGRA MUNICIPAL CORPORATION

Agra formerly known as Akbarabad is a city on the banks of the river Yamuna in the Northern state of Uttar Pradesh, India, 363 km west of state capital, Lucknow and 200 km south from national capital New Delhi. The modern city of Agra was founded in the 16th century by Sikandra Lodhi, who was a king of the Lodhi dynasty. In Geographical terms, the city of Agra lies between 26°44' N to 27°25'N and 77°26'E to 78°32'E. The city is located at an average altitude of 171 meters (561 feet) above the sea level. Agra features a semiarid climate that borders on a humid subtropical.

Figure 4:- Agra city boundary map

The Features mild winters, hot and dry summers and a monsoon season. It is one of the most populous cities in Uttar Pradesh and the 19th most populous in India. Agra district population grew by 21% in the decade 2001-11 and 31% in the decade 1991-2001. On the basis of landmass, Agra is the third largest city in the state of Uttar Pradesh. Because 80 % of the city's sewage flows into Yamuna River, it is 20th most polluted city in India. Agra Airport (Kheria Airport) is about 12.5 km from city center. Agra is on the central train line between Delhi and Mumbai (Bombay) and between Delhi and Chennai. The city has a proud possession of **"Taj Mahal"** as one of the Seven Wonders of the World, now declared as World Heritage Site. The post-Mughal era of Agra saw the rule of Jats, Marathas and finally the British taking over the city. In addition to its historic importance, Agra is a main center of political, economic, commercial and cultural activities.

The Agra Nagar Nigam (ANN) is among the largest municipal bodies in the state of Uttar Pradesh providing civic services to the estimated population of 1,686,976 (as per 2010 est.) Within its

jurisdiction are some of the most attractive tourist spots of the world including Taj Mahal and Sikandra. ANN came into existence under and Nagar Mahapalika Adhiniyam, 1959 of UP. Since then, the Municipal Body has always been alive in its constitution and functioning to the growing needs of citizens. Agra Nagar Nigam (ANN) is a local government committed to provide basic infrastructure facilities including entertainment facilities to the people of the city.

2.2 OVERVIEW OF WATER SUPPLY SYSTEM

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 onslaught of visiting tourists, estimated at 1.80 million every year. In the city, Agra Jal Sansthan (AJS) is responsible for operation and maintenance (O&M), and revenue collection in supplying water to the city, while all capital works related to water supply and sanitation are undertaken by Agra Jal Nigam (AJN). According to the AJS, the total water demand of the city is 320 million liters per day, which includes the demand for bulk supply, estimated at 75 MLD.

The source of water supply in the city is mainly surface water. The river Yamuna is the only surface water source, which enters the town from northeast corner, flow towards south of the city for some distance and then turns towards left.

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.

The transmission mains carry water from the source i.e. Yamuna to the water treatment plants and subsequently towards the Master Balancing Reservoirs for further distribution to the consumers. Presently there are two water works namely Jeoni Mandi water treatment plant and Sikandra water treatment plant. Both the treatment plants are giving a final output of about 270 MLD,

Water Works–I(Jeoni Mandi): Raw Water Pumping plant having capacity of 260 MLD. This raw water is pumped through Water Mains of 1500 m to WTP having capacity of 250 MLD.

Water Works–I I(Sikandra): Raw Water Pumping plant having capacity of 158 MLD. This raw water is pumped through Water Mains of 1450 m to Water Treatment Plant (WTP) having capacity of 144 MLD.

Clear water from Water Treatment Plant is distributed through different Water Distribution Zonal Pumping Stations divided among three zones.

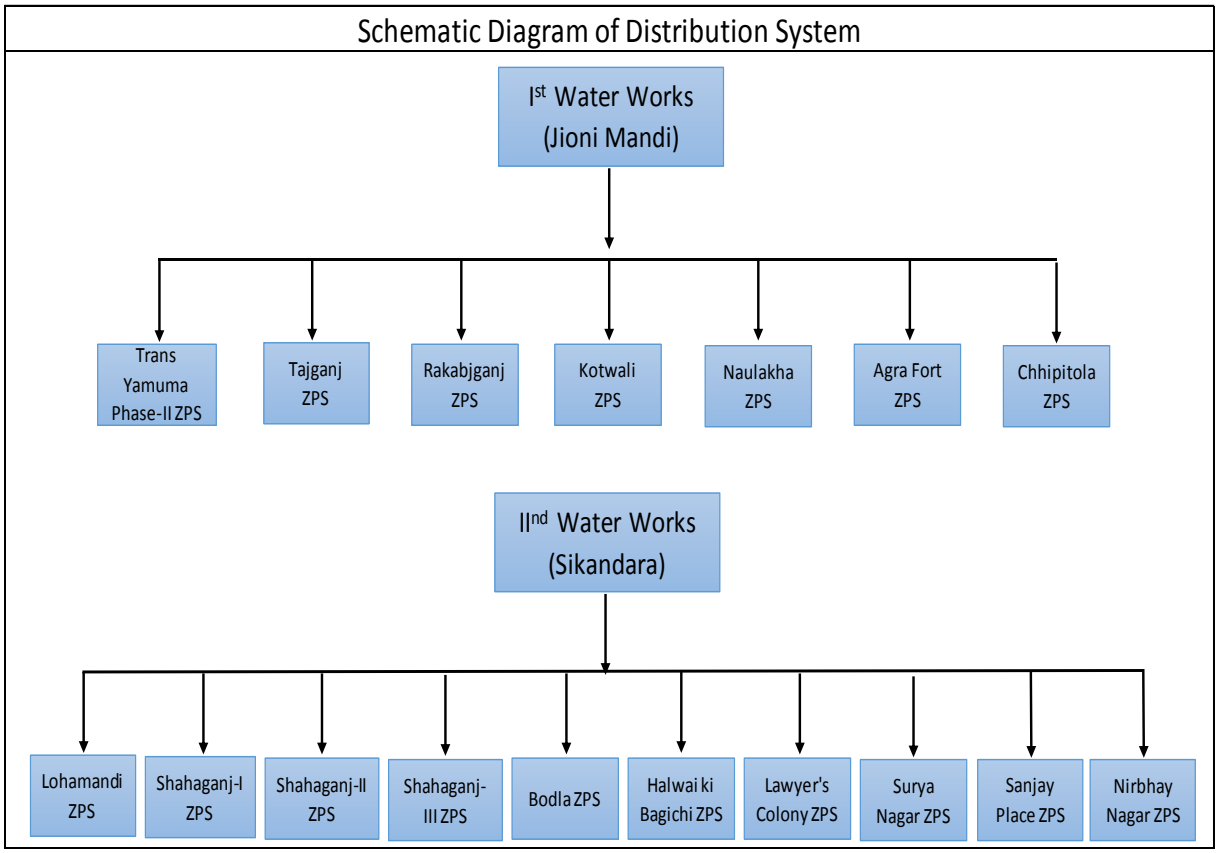


Figure 5:- Schematic Diagram of Distribution system

2.3 PRESENT WATER SUPPLY STATUS:

The water supply for Agra is the responsibility of the Jalkal Department. The sources of water supply are Yamuna River, and groundwater. The water from the rivers is treated in a plant before being supplied through a system of overhead tanks & ZPS as shown in the table below.

Water Capacity	**MLD**
Sikandra Water Treatment Plant	144
Jeoni Mandi Water Works	225
Total Capacity	**369**

The population of Agra city as per 2011 census is 1585704. Water supply to town is presently made from the following sources:

(1) River Yamuna

(2) Underground water

The total capacity of the plants constructed with above sources, is as under:-

(1) River Yamuna (At Sikandra WTP)144 MLD

(2)) River Yamuna (At Jeoni Mandi WTP)225 MLD

(3) Hand pumps & Tube-wells 8.78MLD

Total 377.78 MLD

2.4 SOURCE OF WATER

Major sources are –

Yamuna River –The source of water supply in the city is mainly surface water. The river Yamuna is the only surface water source, which enters the town from northeast corner, flow towards south of the city for some distance and then turns towards left. 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 276cusecs 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 UpperGanga 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.

Minor Sources are –.

Tube wells –there are almost 21 tube-wells located at Indirapuram & Puragovardhan area of Agra city for underground water

2.5 WATER TREATMENT PLANTS

I) Treatment plants at Sikandra: -W.T.P. gets raw water from the Yamuna River the capacity of this treatment plant was increased to 144 MLD. After treatment, the treated water pumped by the centrifugal pumps to the city through 800 mm dia pumping main. This pumping main is used to fill up various service reservoirs located at different places in Agra city.

Figure 6:- Image of Sikandra WTP

(II) Treatment plants at Jeoni Mandi: - W.T.P. gets raw water from the Yamuna River; the capacity of treatment is 225 MLD.After treatments, the treated water pumped by the centrifugal pumps to the city through different pump house. This pumping main is used to fill up various service reservoirs and OHTs located at different places in Agra city.

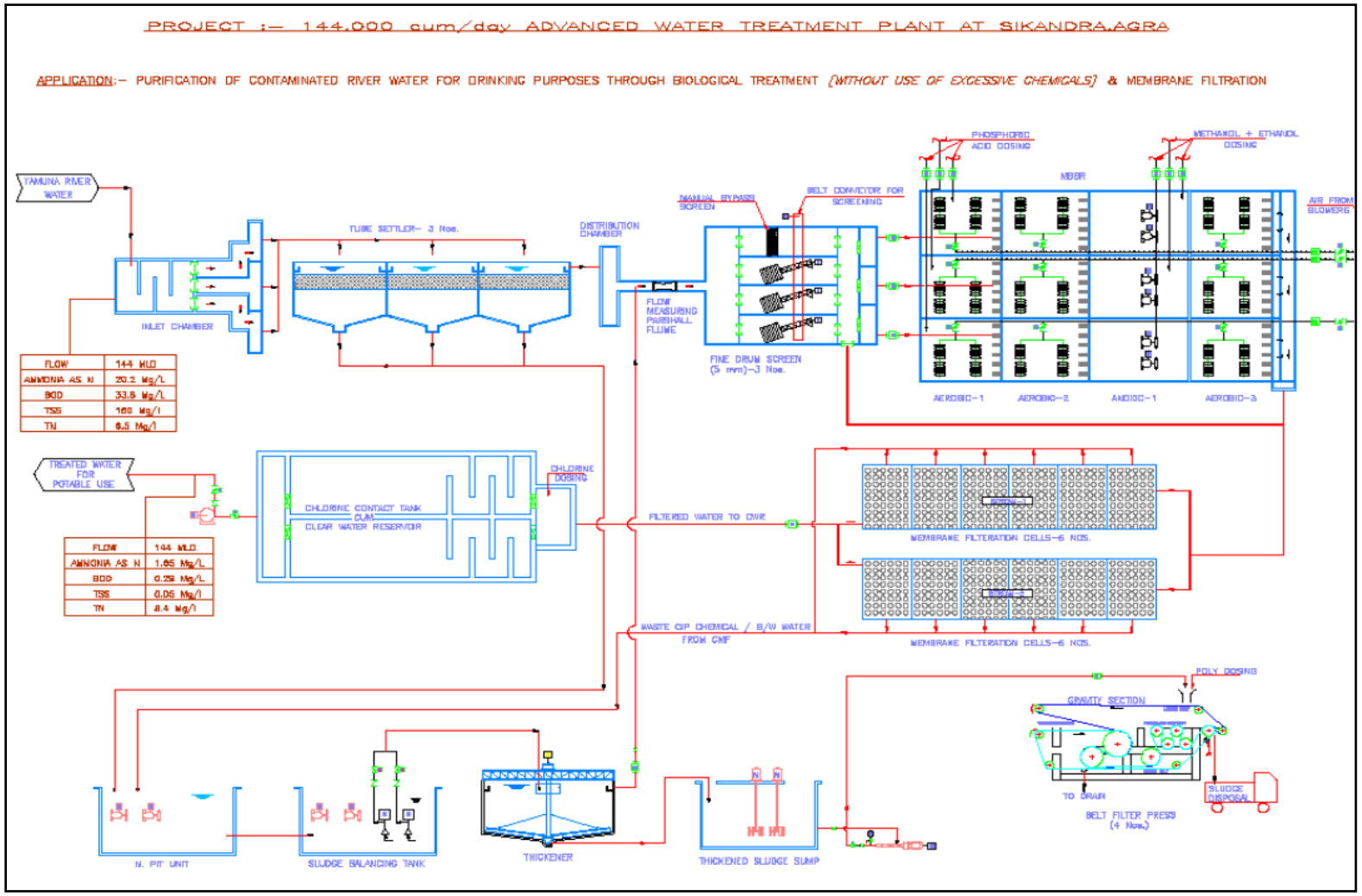


Figure 7:- Schematic Diagram of Distribution system

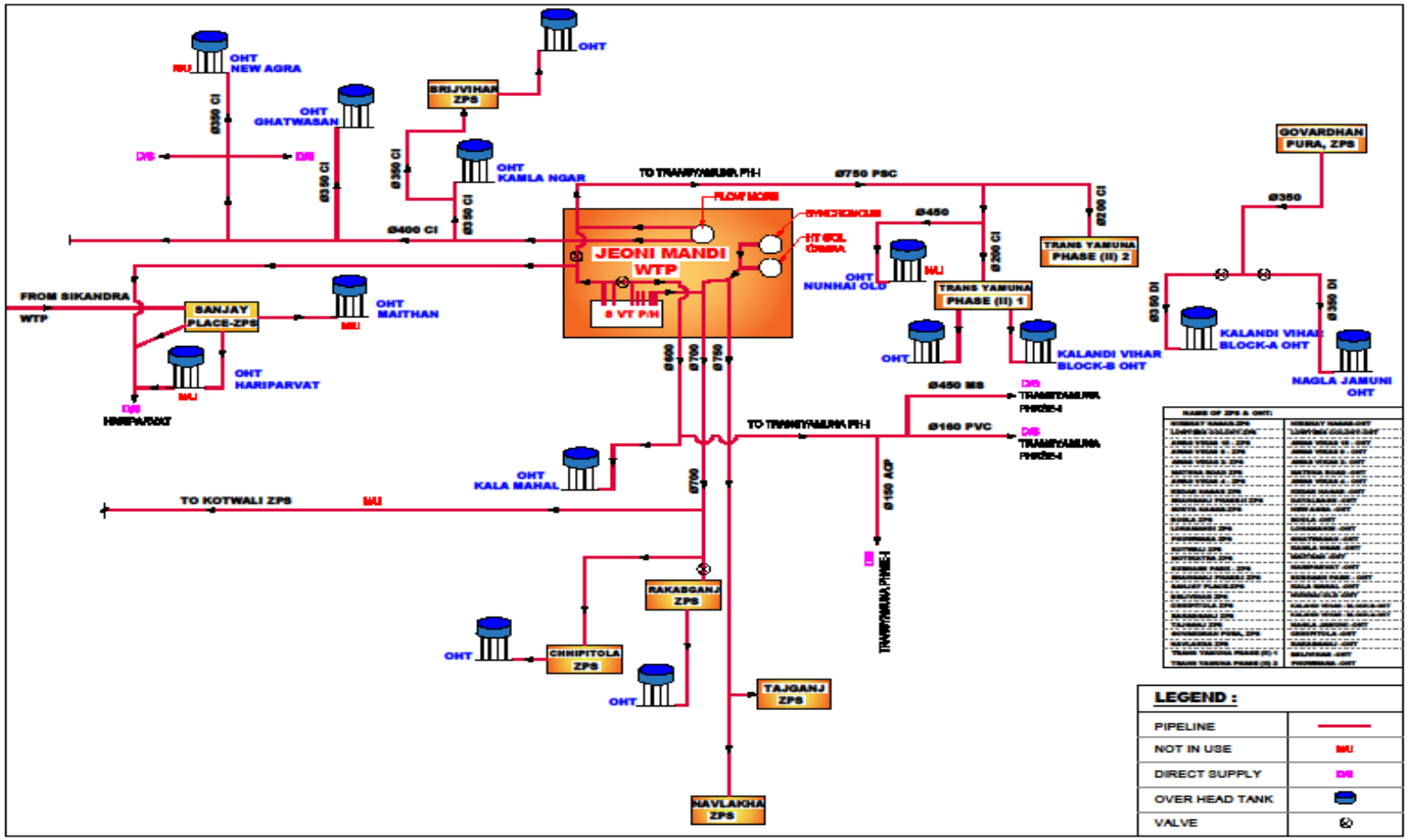


Figure 8:- Schematic Diagram of Distribution system (Jioni Mandi WTP)

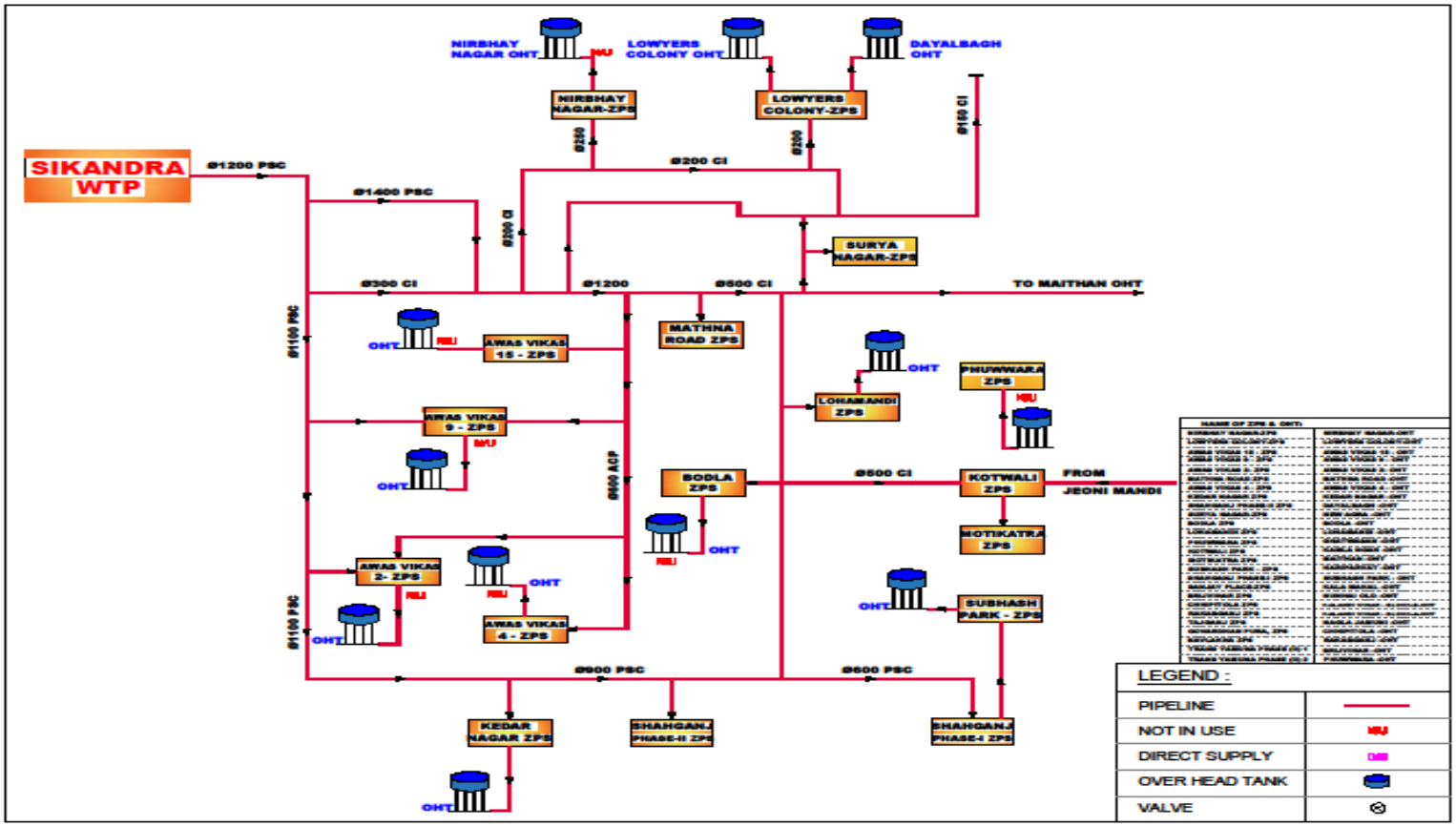


Figure 9:- Schematic Diagram of Distribution system(Sikandara WTP)

2.6 SALIENT FEATERS OF SIKANDARA WTP

1 **INLET MIXING CHAMBER**

Quantity	:	1 No
Size	:	10.2m L x 7m W x 1.2m LD x 0.5m FB
	:	

2 **TUBE SETTLER**

1. Quantity	:	3 Nos.
2. Flow Through Each Unit	:	2000 m3/hr
3. Each Tank Size	:	14 m x 14 m
4. MOC	:	RCC

3 **5mm FINE DRUM SCREEN**

1. Quantity	:	3 Nos.
2. Make	:	Screens JASH
3. Model	:	RC-3600-1200-5-M2-S1
4. Bar Spacing	:	5mm
5. Inclination	:	35deg
6. MOC	:	AISI 316
7. Drum Dia	:	1200mm
8. Drum Length	:	1200mm
9. Drum screen Speed	:	6 RPM
10. Motor Rating	:	1.5 kW
11. Voltage 3Ph.	:	415V AC +/- 10%

4 **MANUAL SCREEN**

1. Quantity	:	1 No.
2. Make Of Screens	:	Triveni Engg & Industries Ltd.
3. Bar Spacing	:	10mm
4. Bar Size	:	10mm Thick x 40 mm Wide
5. Inclination	:	60deg
6. MOC	:	SS-316
7. Width of Screen channel	:	2050mm

BELT CONVEYOR for 5mm FINE DRUM
5 **SCREEN**

1. Conveyor Horizontal Trough Belt Conveyor	:	
2. Toughing angle	:	20deg
3. Capacity	:	1 ton / hr.
4. Length of conveyor	:	7.1m
5. Width of conveyor	:	600mm
6. Type of take up screw	:	

	7. Speed of conveyor	:	30m/min
6	**MOVING BED BIO-REACTOR**		
	1. Design Flow	:	6792 m3/hr
	2. No. of Streams	:	3 Nos.
	3. Design Flow Per Stream	:	2263.89 m3/hr
	4. Approach Velocity	:	35.0 m3/m2/hr.
7	**AIR BLOWERS FOR MBBR UNIT**		
	1. Quantity	:	9 Nos.
	2. Make.	:	KAY INTERNATIONAL LTD
	3. Type Twin Lobe Type –	:	Directly coupled
	4. Model	:	1225 AC
	5. Capacity	:	6500 m3/hr
	6. Head	:	5.8 MWC
	7. Blower Speed	:	928 RPM
	8. Blower	:	BkW 123
8	**AIR DIFFUSERS FOR MBBR UNIT**		
	STAGE-1 (All Streams)	:	
	1. Total length of diffusers provided	:	1368m
	STAGE-2 (All Streams)	:	
	1. Total length of diffusers provided	:	1032m
	STAGE-4 (All Streams)	:	
	1. Total length of diffusers provided	:	504m
9	**2mm FINE DRUM SCREEN**		
	1. Quantity	:	3 Nos.
	2. Make	:	Screens JASH
	3. Model RC-4000-1600-2-M2-S1	:	RC-4000-1600-2-M2-S1
	4. Bar Spacing	:	2mm
	5. Inclination	:	35deg
	6. MOC	:	AISI 316
	7. Drum Dia	:	1600mm
	8. Drum Length	:	1600mm
	9. Drum Speed	:	6 RPM
	10. Motor Rating	:	2.2kW
	12. Voltage	:	3Ph. 415V AC +/- 10%
10	**CMF PERMEATE PUMPS**		
	1. Quantity	:	18 Nos. (12W + 6S)
	2. Type	:	Horizontal Centrifugal pump
	3. Make	:	KBL PUMPS
	4. Capacity	:	650 m3/hr
	5. Head	:	12.5 m

	6. Model	:	UP 250/35 (MS)
	7. Efficiency	:	86%
	8. Power	:	BKW 25.73 kW
11	**CMF AIR SCOUR BLOWER**		
	1. Quantity	:	4 Nos.
	2. Make Kay International Ltd.	:	
	3. Type Twin Lobe Blower –	:	Directly coupled
	4. Model	:	1030 AC
	5. Capacity	:	7780 m3/hr.
	6. Blower Pressure	:	0.26 kg/cm2
	7. Blower speed	:	1254 RPM
	8. Blower BkW	:	65
12	**CMF BACKWASH PUMP**		
	1. Quantity	:	4 Nos. (2W+2S)
	2. Type Horizontal Centrifugal Pump	:	
	3. Make	:	MATHER & PLATT LTD.
	4. Capacity	:	1460 m3/hr
	5. Head	:	11m
	6. Model	:	15/15 MFV 1
	7. Efficiency	:	88%
	8. Power BkW	:	49.7 kW
13	**CWR DISTRIBUTION PUMPS**		
	1. Quantity	:	3 Nos. (2W+1S)
	2. Type	:	Horizontal Centrifugal Pump
	3. Make	:	MATHER & PLATT LTD.
	4. Capacity	:	3125 m3/hr
	5. Head	:	30 m
	6. Model	:	500/600 BST
	7. Efficiency	:	88%
	8. Power BKW	:	290.13 kW
14	**SUBMERSIBLE MIXER AT NEUTRALISATION PIT**		
	1. Quantity	:	2 Nos.
	2. Make	:	LANDIA
	3. Type Of Mixer	:	PODR-I /ms 100R
	4. Propeller Revolutions /	:	Diameter 750 rpm / 290 mm
	5. Weight	:	58 kg
15	**SUBMERSIBLE MIXER AT SLUDGE BALANCING TANK**		
	1. Quantity	:	3 Nos.

2. Make	:	LANDIA
3. Type Of Mixer	:	POPR-I /ms 100R
4. Propeller Revolutions /	:	Diameter 150 rpm / 730 mm
5. Weight	:	126 kg

16 **SUBMERSIBLE PUMPS AT SLUDGE BALANCING TANK**

1. Quantity	:	2 Nos. (1W+1S)
2. Make.	:	Kishor Pumps Pvt. Ltd
3. Type	:	Submersible pump
4. Model	:	ASTRA SA 250-500
5. Capacity	:	1000m3/hr
6. Head	:	17m
7. Efficiency	:	77%
8. Power	:	BkW 61.36 kW

17 **THICKENER**

1. Quantity	:	1 No.
2. Make	:	Triveni Engg. & Industries Ltd.
3. Size	:	38m dia. x 3.5m SWD x 0.5m FB
Rake Arm Details	:	
1. Type Centrally Rotating	:	Clockwise
2. Rake Speed	:	0.035rpm

18 **PADDLE MIXER AT SLUDGE HOLDING TANK**

1. Quantity	:	2 Nos.
2. Make	:	Triveni Engg. & Industries Ltd.
3. Agitator type	:	Paddle mixer
4. No. of Arms	:	4 Nos
5. No. of Blades per arm	:	3 Nos
6. Blade size .	:	200mm wide X 1250mm high X 3mm thk
7. Mixer MOC	:	(blades & Shaft) SS316
8. Mixer Speed	:	4 RPM

19 **BELT FILTER PRESS**

1. Quantity	:	4 Nos. (3W+1S)
2. Make	:	Triveni Engg. & Industries Ltd.
3. Capacity	:	35m3/hr
4. Gravity Belt Thickener Model	:	2000X14 (2 M wide)
5. No. of Rollers	:	14 Nos
6. Size of Roller	:	8" Dia to 30" Dia
7. Belt Width	:	2.0m

2.7 WATER STORAGE RESERVOIRS & SUMP

The Details of Water Storage OHTs with capacity of Agra city are as below:

Sr. No.	Name of OHTs	OHTs Working Status	OHTs Capacity (ML)
1	Hari Parwat Rectangular	Not in Use	1.00
2	Mandi Sayed Khan	Not in Use	1.19
3	Nirbhay Nagar OHT	Not in Use	1.50
4	Lawyers Colony OHT	In Use	1.80
5	Dayal bag OHT	In Use	1.80
6	Moti Katra OHT	In Use	1.10
7	Sub hash Park OHT	In Use	2.30
8	Namada ki Tanki	Not in Use	-
9	Kedar Nagar/Shahganj III	In Use	2.30
10	Chippi Tola OHT	In Use	1.50
11	Keshavkunj OHT	Not in Use	1.19
12	Lohamandi OHT	In Use	1.19
13	Rakabganj OHT	In Use	1.19
14	Awas Vikas Sector 15	In Use	1.20
	Awas Vikas Sector 9	Not in Use	-
15	A		1.20
16	B		0.75
	Awas Vikas Sector 2	Not in Use	-
17	A		1.20
18	B		1.20
19	Awas Vikas Sector 4	Not in Use	0.75
20	Kamla Nagar	In Use	0.75
21	Kala Mahal	In Use	1.36
22	Brij Vihar	In Use	2.10
23	New Agra OHT	Not in Use	1.50
24	Kalandi Vihar Block A	In Use	2.00
25	Sikandra	Not in Use	2.45
26	Bindu katra	In Use	0.75
27	Ghatwasan/Kamlanagar	In Use	0.75
28	Nunai old OHT	Not in Use	_
29	Nunai New OHT/Jaganpura	Not in Use	0.90
30	Tall firoze khan OHT	In Use	2.25
31	Nagala mewati	Not in Use	_
32	Indirapuram	Not in Use	_
33	ADA Tajnagari 1	Not in Use	_
34	ADA Tajnagari 2	Not in Use	_
35	PSC	Not in Use	0.75

36	Kotwali	Not in Use	1.65
37	Kalandi Vihar Block B	In Use	2.00
38	Nagala jamuni	In Use	1.90
39	Transyamuna phase 2 col	In Use	1.50

Table 5 : Storage Capacity of OHTs

Details of ZPS Reservoirs with their capacity are as below:-

Sr. No.	Name of ZPS	CWR Capacity (ML)
1	Sanjay Place	6.9
2	Surya Nagar	3.49
3	Nibhay Nagar	0.4
4	Lawyers Colony	1.03
5	Kotwali	3.15
6	Shahganj Phase 1	8.5
7	shahganj phase 2	4.54
8	Tajganj	3.55
9	Kedar Nagar	0.605
10	Mathura Road	3.63
11	Chipi Tola	This ZPS working as booster its takes water from distribution line and feed area.
12	Red Fort	
13	Navlakha	7.95
14	Bodla (Keshavkunj)	3.8
15	Lohamandi	5.73
16	Rakabganj	5.05
17	Transyamuna Col	0.8
18	Awas Vikas Sector 15	1.2
19	Awas Vikas Sector 9	1.5
20	Awas Vikas Sector 2	1.65
21	Awas Vikas Sector 4	1.25
22	Govardhan Pura ZPS	-
23	Transyamuna Phase 2	2.8

Table 6 : Storage Capacity of ZPS

2.8 ZPS & OHT FEED BY WTP

The details of ZPS & OHTs feed by WTP with their outlet capacity

Feed by Sikandra WTP	
Name of ZPS	**ZPS**
Sanjay Place	11.97
Surya Nagar	4.10
Nirbhay Nagar	0.68
Shahganj Phase 1	17.92
shahganj phase 2	13.40
Lawyers Colony	5.11
Kedar Nagar	2.72
Mathura Road	5.33
Bodla (Keshavkunj)	6.71
Lohamandi	9.79
Awas Vikas Sector 15	6.99
Awas Vikas Sector 9	
Awas Vikas Sector 2	
Awas Vikas Sector 4	
Total Outlet in MLD	**84.71**

Table 7 : ZPS & OHT feed by Sikandra WTP

Feed by Jeoni Mandi WTP	
Kotwali	2.54
Tajganj	7.06
Chipi Tola	1.26
Red Fort	0.10
Navlakha	18.72
Rakabganj	5.20
Kala Mahal	3.93
Brij Vihar	1.93
Kamla Nagar	2.72
Transyamuna Phase 2	3.61
Transyamuna Phase 2 Col	1.13
Total Outlet in MLD	**48.18**

Table 8 : ZPS & OHT feed by Jeoni Mandi WTP

2.9 BULK SUPPLY TAPPINGS

The Unaccounted for Water is mainly due to direct supply points from the transmission main of different dia from WTP to OHTs & ZPS. Direct supply tappings is provided to various bulk consumers like MES, Railway, Contonment area, Awas vikas sectors, Kalamahal etc. on transmission mains. As per water audit study there are more than 62 nos. of direct bulk supply points on the transmission main which supplies water to many areas as listed in following table. Flow measurement activity was carried out for few bulk supply tappings points like Awas vikas sectors & Kalamahal Area, however, most of other bulk tapping points were underground and unidentified and has several physical site constraints due to old water supply system.

The details of direct tapping points is tabulated below;

Direct Tapping From Feeder Main Agra water supply						
Sr .No.	**Area**	**Feeder main size & location**	**Tapping size**	**Material**	**Feeding area**	**Remark**
1	Chatta Bazar	28" from 8VT pump house	3"	PVC	Dhobi gali	From Jeoni Mandi Wtp Kalamahal OHT
2		24" from 28"	4"	PVC	Kahoda Bazar	
3		24" from 28"	4"	PVC	Belan ganj	
6		24" from 28"	4"	PVC	Takiya maula khan	
7		24" from 28"	4"	PVC	Kachiyan galli	
8		24" from 28"	3"	PVC	Barahghar	From Jeoni Mandi WtpTo Fawara Kotwali OHT
9		24" from 28"	4"	PVC	Hajjam gali	
10		24" from 28"	4"	PVC	Katara khan	
11		24" from 28"	4"	PVC	Khan Mal bazaar	
12		24" from 28"	4"	PVC	Cham cham Gali	
13		24" from 28"	4"	PVC	Kambal katara	
14		From28"	2"	GI	Girish Bhau Kothi	
15		From 24"	3"	ACP	New market	
16			2"	GI	Pan line	
17			3"	PVC	Uthawali Gali	
18			3"	PVC	Kayath Gali	
19			3"	PVC	Nibhawah galli	From Jeoni Mandi Wtp to Rakabganj ZPS
20			3"	PVC	Patal Gali	
21			3"	CI	Fatima Gali	
22		From 18"	3"	GI	Nawab Ka Phatak	
23			3"	PVC	Paswan Gali	

24			6"	PVC	Gulab Khana ,Jimkhhana,Kaju Gali	
25			4"	PVC	Kotawali Gali	
26			3"	PVC	Pirhaji Husen Gali	
27			4"	PVC	Pipal nala	
28			3"	PVC	Judge sahab Gali	
29			3"	PVC	Hakima Gali	
30	Sanjay place	From 30" Pushapanjali Multispecialty Hospital Mathura road	4"	PVC	Madhuban plaza Pushapanjali Apartment	From Sikandra Wtp Sanjay place ZPS
31		From18" beni madhav sarkar road	3"	PVC	Evergreen residency welfare society	From Sikandra Wtp to SuryaNagar ZPS
32	Mathura road	From32" Halwai ki bagichi Zps campus	30"	CI	Sector 4R 12D 15	From Sikandra Wtp To Awas vikas sector
33	Gandhi Nagar	30" From Jeoni Mandi WTP 8VT & Flow more	3"	PVC	Gandhi Nagar Road	From 8VT & Flow more to sanjay place Zps
34			3"	PVC	Vijay Nagar	
35			3"	ACP	Sultan Ganj	
36			4"	PVC	Sulatan ganj Square	
37			4"	PVC	Vijay Nagar colony	
38			4"	PVC	Old Vijay Nagar	
39			3"	PVC	Dhamin Nagariya, Work Nagar.	
40			3"	PVC	Ratan pura ; Worknagala	
41			3"	GI	Work Nagala , post office galli	
42			3"	ACP	Langade ki chouki, Hanuman Mandir	
43			3"	GI	Nagara harmukha	
44			3"	ACP	Nagara harmukha	
45			4"	PVC	Langada chouki HIG Flats	
46			3"	PVC	Gandhi Nagar	

47			4"	PVC	Gandhi Nagar ; Nagla Beniprasad	
48			4"	PVC	Wajir pura Sanjay place	
49	chipotla	from 18"	4"	PVC	Anna gali ,Kumar pada,badakwaligali	From Jeoni Mandi wtp to Rakabganj zps
50			2"	PVC	Hanuman gali	
51			2"	PVC	lakad mandi	
52			2"	PVC	jain gali	
53			4"	PVC	sabji mandi	
54			3"	PVC	chakipath	
55			2"	PVC	chakipath mohalla	
56			4"	PVC	mahor gali back side of Shalimar hotel	
57			3"	PVC	Machali Mandi	
58			2"	PVC	Shyamji Mandir ,kajipada	
59			2"	PVC	Ballaji ghar shiwaji market	
60			4"	PVC	Kajipada,tabolipada,dhaulikar	

Table 9 : List of Bulk Water supply ponts / Direct tapping points

3 WATER AUDIT FOR AGRA WATER SUPPLY SYSTEM

Water Audit and flow measurement activity has been carried out by DRA team and water balance for entire Agra city have been discussed under Interim Report 1 & 2 as submitted and approved earlier. Flow measurement details (in tabular format) of individual water pumping stations and ESR/ ZPS is not included in this report to avoid repetation and duplicasy. For Flow measurement details, if any, please refer to Interim Report 2 as submitted earlier.

3.1 WATER AUDIT FOR SIKANDARA RAW WATER PUMP HOUSE

Raw water intake well is situated on the bank of Yamuna river which is located at village kailash gaon, Raw water is pumped by Deep well Centrifugal pumps installed in intake well by rising mains 1200 mm dia MS pipe. Pumping main to theSikandra water treatment plant 2 kmfrom intake well there are 4 nos of Centrifugal pumps installed for lifting raw water to WTP's. Out of which (2W + 2S) pumps lifting raw water for Sikandra WTP.

Flow Measurement at Intake well outlet has been carried out 26/7/2017 to27 /7/2017 for 24 Hrs in presence of AMC/Jal Nigam officials.

As seen in flow mesurment activity of raw water inlet, the average flow to Inlet for Sikandra WTP is 5788.2 m3/ hr. and hence 24 hrs.

The Results of flow measurement activity are attached in previous reports;

As seen in flow mesurment activity, total Outlet fromSikandra WTP for 24 hrs is **139.87 MLD**

3.2 WATER AUDIT FOR SIKANDARA CLEAR WATER PUMP HOUSE

The Clear water pump house receives treated water from the Sikandra WTP total 3 centrifugal pumps are installed here, (2W+1S).

The pump house operates daily. Pure water is pumped to fill up various service reservoirs, Ds & OHTs located at different places in Agra city.

Flow Measurement at Intake well outlet has been carried out26/7/2017 in presence of AMC/Jalsansthan officials.

The Results of flow measurement activity are attached in previous reports;

As seen in flow mesurment activity, total Outlet fromSikandra WTP for 24 hrs is **133.99 MLD.**

3.3 WATER AUDIT FOR JEONI MANDI WATER TREATMENT PLANT

Jeoni Mandi WTP is situated at bank of Yamuna River and water received from Yamuna. Jeoni Mandi WTP Constructed First Jalkal in 1988 & Second Jalkal in 1997 having capacity of 260& 158 MLD. After treatment, the treated water pumped by the centrifugal pumps to the city through pumping main. This pumping main is divided into 750 mm 400,600,700 and 750mm dia pumping to fill up various service reservoirs& OHTs located at different places in Agra city.

Jeoni Mandi WTP has 3 nos of raw water intake well 1) New intake well 2) New Jal Nigam intake well 3) Old raw water intake well.

Jeoni Mandi WTP has 3 nos of pump house for clearer water to city 1) 8VT pump house 2)Flow more clearer water pump house 3) HT Goal karma & synchronous.

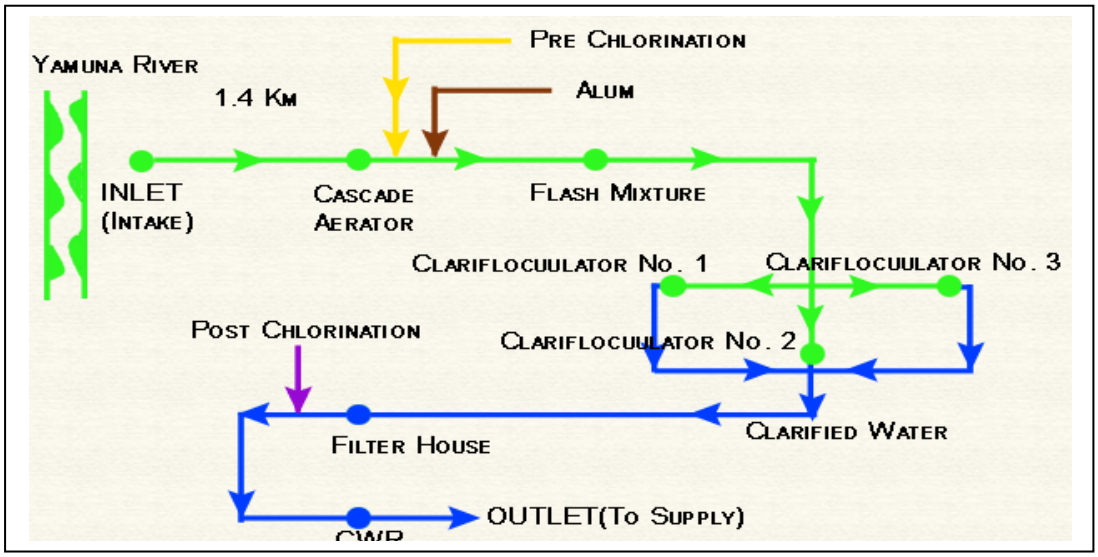


Figure 10: WTP flowchart

3.3.1.1 Flow Measurement @ Raw water New intake well

Raw water new intake well is situated on the bank of Yamuna river, the new intake well lifts from the Yamuna and feeds to Jeoni Mandi WTP. There are three VT pumps installed, operating in a 2W+1SB arrangement . Pump no 3 pressure gauge installed but not in working condition, Flow meter installed and in working condition. Any two pump running per day 1& 2 or 1& 3.

Flow Measurement at Intake well outlet has been carried out 28/7/2017 in presence of AMC/Jalsansthan officials.

As seen in flow mesurment activity(Pump No-1), the average flow to Jeoni Mandi W TP from Raw water New intake well 1012.2m3/hr and hence Inlet Supply to WTP is 20.26 MLD.

As seen in flow mesurment activity(Pump No-2), the average flow to Jeoni Mandi WTP from Raw water New intake well 2095.5 m3/hr and hence Inlet Supply to WTP is 42.36MLD.

As seen in flow mesurment activity(Pump No-3), the average flow to Jeoni Mandi WTP from Raw water New intake well 2165 m3/hr and hence Inlet Supply to WTP is 43.02 MLD.

The Results of flow measurement activity are attached in previous report

3.3.1.2 Flow Measurement @ Raw water New Jal Nigam intake well

Raw water intake well is situated on the bank of Yamuna river The New Jal Nigam I ntake well lifts raw water from the Yamuna and feeds it to the Jeoni Mandi WTP. There are three VT pumps installed, of which one was in breakdown condition and the others are operated in 1W+1SB arrangement

Flow Measurement at Intake well outlet has been carried out 29/7/2017 for 4Hrs in presence of AMC/Jalsansthan officials.

As seen in flow mesurment activity, the average flow to Jeoni Mandi WTP from Raw water New intake well 1071.2 m3/hr and hence Inlet Supply to WTP is 21.13 MLD.

The Results of flow measurement activity are attached in previous report;

Thus, The total Raw Water form New intake well to WTP is 63.28 MLD

3.3.1.3 Flow Measurement @ Raw water Old intake well

Raw Water intake well is situated on the bank of Yamuna river. The Old In take Well lifts raw water from the Yamuna and feeds it to the Jeoni Mandi WTP. There are 3 VT pumps installed here. Two pumps either pump no. 6 & 5 or 6 & 7 are running in parallel per day.

Flow Measurement at Intake well outlet has been carried out 30/7/2017 in presence of AMC/Jalsansthan officials.

As seen in flow mesurment activity, the average flow to Jeoni Mandi WTP from Raw water New intake well 1026.2 m3/hr and hence Inlet Supply to WTP is 8.94 MLD.

As seen in flow mesurment activity, the average flow to Jeoni Mandi WTP from Raw water New intake well 1976.6 m3/hr and hence Inlet Supply to WTP is 21.59MLD.

The Results of flow measurement activity are attached in previous report;

Thus, The total Raw Water form Old intake well to WTP is 41.49 MLD

3.3.1.4 Flow Measurement @ Clear water Outlet from 8VT Pump house

The 8 VT Plant receives treated water from the Jeoni Mandi WTP. 8 VT pumps are installed here, of which three were in breakdown condition and two are used in emergency.

The pump house operates daily. Pure water is pumped to fill up various service reservoirs, Ds & OHTs located at different places in Agra city.

Flow Measurement at Intake well outlet has been carried out26/7/2017 for 2Hrs in presence of AMC/Jalsansthan officials

As seen in flow mesurment activity of pump 6&7 , the average flow to various reservoirs ,DS & OHTS from Clear water Pump house 2550.4m3/hr and hence Inlet Supply to city is 12.51 MLD.

As seen in flow mesurment activity of pump 5, the average flow to various reservoirs ,DS & OHTS from Clear water Pump house 12.50.9 m3/hr and hence Inlet Supply to city is 25.53 MLD

As seen in flow mesurment activity of pump 6, the average flow to various reservoirs ,DS & OHTS from Clear water Pump house1279.3 m3/hr and hence Inlet Supply to city is 9.83 MLD.

As seen in flow mesurment activity of pump 7, the average flow to various reservoirs ,DS & OHTS from Clear water Pump house 1318 m3/hr and hence Inlet Supply to city is 9.89 MLD.

The Results of flow measurement activity are attached in previous report;
Thus, The total clear Water form 8VT Pump house to Zonal pumping stations is 45.87 MLD

3.3.1.5 Flow Measurement @ Clear water Outlet from Flow more Pump house

The Flow more plant receives treated water from the Jeoni Mandi WTP and then pumps it to zonal pumping stations. Five VT pumps are installed here, of which two were in breakdown condition. Generally Pump No.1 & Pump No. 2 used to feed to kamala Nagar OHT

The pump house operates daily. Pure water is pumped to fill up various service reservoirs, Ds & OHTs located at different places in Agra city.

Flow Measurement at Intake well outlet has been carried out26/7/2017 for 2Hrs in presence of AMC/Jalsansthan officials

As seen in flow mesurment activity, the average flow to various reservoirs ,DS & OHTS from Clear water Pump house 1463 m3/hr and hence Inlet Supply to city is 11.84 MLD.

Thus, The total clear Water form Flow more pump house to Zonal pumping station & OHTs is 25.45 MLD

3.3.1.6 Flow Measurement @ Clear water Outlet from HT Goal kamara & Shncronous Pump house

The Flow more plant receives treated water from the Jeoni Mandi WTP.The Synchronous Plant has three pump sets of which one is in breakdown condition. The remaining two, one having HT motor and one having LT motor, are operated in 1W+1SB combination. Its common header joins the common header from the Gol kamraplant. The pump house operates daily. Pure water is pumped to fill up OHT & direct supply at different places in Agra city.

Flow Measurement at Intake well outlet has been carried out26/7/2017 for 2Hrs in presence of AMC/Jalsansthan officials.

As seen in flow mesurment activity, the average flow to OHT from Clear water Pump house 2156.9 m3/hr and hence Inlet Supply to city is 26.52 MLD.

As seen in flowmesurment activity, the average flow to Direct supply from Clear water Pump 2481.0 m3/hr and henceInlet Supply to city is is 16.4 MLD

Thus, The total clear Water form HT Goal kamra &Synchronous Pump house to Direct supply & OHTs is 42.92 MLD

3.4 WATER AUDIT FOR EXISTING WATER STORAGE RESERVOIRS OF AGRA CITY

Measurement of Water Input to the Agra city was necessary to identify the demand Supply Gap. Accordingly, Consultant has carried out the field studies for identifying all the water sources to the Agra city and installed the portable clamp on type flow meters. Accordingly, as part of water audit all ESR's & ZPS Inflow/ outflow and direct supply tapping points were measured.

Flow Measurement Activity was carried out by DRA Audit team between July 2017 to Sep 2017 in presence of AMC/ Jalkal officials.

3.4.1 Sanjay place ZPS

Sanjay place ZPS having storage capacity 6.9 MLlocated at Zone no 1 of Agra city & inlet source from Sikandra WTP.Sanjay place ZPS supplies water on daily basis to different areas. The supply is normally in morning from 5.30 am to 7.30 am and evening from 5.30 pm to 7.30 pm.

There are total three outlets for Hariparwat rectangular ESR, Maithon OHT& for Sanjay place market but both OHT is currently not in use so direct supply is carried out to hariparwat and matron area.

Flow Measurement at outlet of Hariparwat has been carried out in 21st July 2017in the presence of AMC& Jalkal Engineers/officials.

Flow Measurement at outlet of Maithonhas been carried out in 22nd July 2017 in the presence of AMC&Jalkal Engineers/officials. Generally pump no. 1, 2 & 5 is running & pump no 3 & 4 is under maintenance at the time of audit carried out.

Flow Measurement at outlet of Sanjay place market side has been carried out in 22nd July 2017 in the presence of AMC& Jalkal Engineers/officials.

The details of field measurement activity and results for this pump house is attached in previous report.

Thus, thetotal outlet from this Zonal pumping station is 11.97 MLD

3.4.2 Surya Nagar ZPS

Surya nagar ZPS having storage capacity 3.49 MLislocated at Zone no 1 of Agra city & Inlet source from Sikandra WTP.Surya Nagar ZPS supplies water on daily basis to different areas. The supply is normally in morning from 6.00 am to 8.00 am and evening from 6.00 pm to 8.00 pm.

From this ZPSdirect supply is carried out to Khandari area.

Total 5 no of pumps are installed in which 3 are working & 2 standbys.Generallypump no. 2,3& 4 is running & pump no 5 is under maintenance at the time of audit carried out.

Flow Measurement at outlet of Surya Nagar ZPS has been carried out in 23nd July 2017 in the presence of AMC& Jalkal Engineers/officials.

The details of field measurement activity and results for Surya Nagar ZPS outlet are attached in previous report

3.4.3 Lawyers Colony ZPS

Lawyers Colony ZPS having storage capacity 1.03 ML is located at Zone no 1 of Agra city & inlet source from Sikandra WTP.There are two outletsfor Layers colony & Dayalbagh ESR.

Lawyers Colony ZPSsupplies water on daily basis to feeding of Dayalbagh & Lawyers colony OHT .There are 4VT Pumps of installed in which two pumps for Dayalbagh & two for Lawyers colony ESR and Supplies water daily to different areas. The supply time is not fixed but lawyer's colony pumps running 12 hours out of 24 hours and for Dayal bag pump is running 4 hr. out of 24 hours.

Flow Measurement at outlet of Lawyers colony side has been carried out in 24th July 2017 in the presence of AMC& Jalkal Engineers/officials.

The details of field measurement activity and results for Lawyers colony side outlet are attached in previous reports.

Flow Measurement at outlet of Dayalbagh side has been carried out in 24th July 2017 in the presence of AMC& Jalkal Engineers/officials.

The details of field measurement activity and results for Dayalbagh side outlet are attached in previous report.

Thus, thetotal outlet from this Zonal pumping station is 5.11 MLD

3.4.4 Nirbhay Nagar ZPS

Nirbhay nagar ZPS having storage capacity 0.4 MLislocated at Zone no 1 of Agra city &Inlet source from Sikandra WTP.Nirbhay Nagar ZPS supplies water on daily basis to different areas. The supply is normally in morning from 6:30 am to 8.00 am and evening from 5.30 pm to 6.30 pm.

ESR is available for this ZPS but currently not in use. From this ZPS direct supply is carried out to Nirbhay Nagar area.

Total 2 no of pumps are installed in which both are running.

Flow Measurement at outlet of Nirbhay Nagar ZPS has been carried out in 25thJuly 2017 in the presence of AMC& Jalkal Engineers/officials.

The details of field measurement activity and results for Nirbhay Nagar ZPS outlet are attached in previous report

3.4.5 Mathura Road ZPS

Mathura Road ZPS having capacity 3.63 MLislocated at Zone no 2 of Agra city. Mathura Road ZPS supplies water on daily basis to different areas.The supply is normally in morning from 5.30 am to 8.30 am and evening from 6.00pm to 7.30pm.& depend on water available at storage.

From this ZPS direct supply is given to different area like halwai ki bagichi, Awas Vikas etc.Total 4 no of VT pumps are installed in which 3 are running & 1 stand by. But Pump no. 4 is under maintenance at the time of audit carried out.

Flow Measurement at Outlet of Mathura Road ZPS has been carried out in 25th July2017in the presence of AMC/ Jalkal Engineers/officials.

The details of field measurement activity and results for Mathura Road ZPS Outlet are attached in previou report

3.4.6 Shahganj Phase 2 ZPS

Shahganj Phase 2 ZPS having storage capacity 4.54 MLislocated at Zone no 2of Agra city & Inlet source from Sikandra WTP. Shahganj Phase 2 ZPS supplies water on daily basis to different areas.

There are two outlets from this ZPS one is for General supply and one is for Air force colony area.

The General supply is normally in morning from 3:45 am to 5.45 am and evening from 6.00 pm to 7.00 pm.

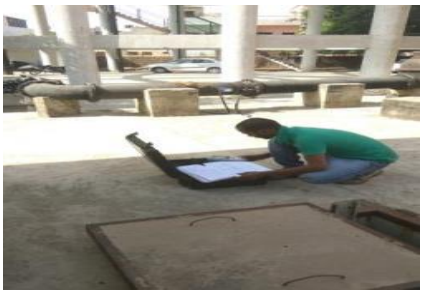
The Air force supply is normally from 9.00 pm to 3.00 am and from 8.00 am to 5.00 pm.

Total 5 no of pumps are installed in which 4 (Pump No. 1, 2, 3 & 4) are running for general supply & 1 (Pump No. 5) is running for Air force colonysupplyFlow Measurement at outlet of Shahganj phase 2 for general supply has been carried out in 29thJuly 2017 in the presence of AMC& Jalkal Engineers/officials.

The details of field measurement activity and results for Air force colony supply are attached in previous reports.

Thus, the total outlet from this Zonal pumping station is 13.40 MLD

3.4.7 Kedar Nagar ZPS



Kedar Nagar ZPS having storage capacity 0.60MLislocated at Zone no 2of Agra city & Inlet source from Sikandra WTP. Kedar Nagar ZPSsupplies water on daily basis to different areas.

Pump is used to filled Shahganj Phase 3/ Kedar Nagar OHT then given to supply for different areas.

Pumping time is not fixed but it runs 14hr per day.

Three pumps are installed, of which one was in breakdown condition. ESR filling and direct distribution are performed at different times.

Flow Measurement at outlet of Shahganj phase 2 for general supply has been carried out in 31st July 2017 in the presence of AMC& Jalkal Engineers/officials.

3.4.8 Bodla/ Keshavkunj ZPS

Bodla/Keshavkunj ZPS having capacity 3.8 MLislocated at Zone no.2of Agra city. Inlet source is from Sikandra Water Treatment Plant. Bodla ZPS supplies water on daily basis to different areas. The supply is normally in morning from 6.00 am to 7.30 am evening from 6.00 pm to 7.00 pm.&it's depend on water level.

Supply Area from ZPS is given below: -Keshavkunj, Lohamandi etc.

OHT is constructed in this ZPS but currently not in use.

Total 5 no of pumps are installed in which 4 are running for & 1 is standby.

Flow Measurement at Outlet of Bodla ZPS has been carried out 8th August 2017in the presence of AMC & Jalkal Engineers/officials.

The details of field measurement activity and results for Bodla ZPS outlet are attached in previous reports.

3.4.9 Lohamandi ZPS and OHT

Lohamandi ZPS having sump capacity 5.73 ML and OHT Capacity 1.19 ML islocated at Zone no.2of Agra city. Inlet source is from Sikandra Water Treatment Plant. Lohamandi ZPS supplies water on daily basis to different areas.

Both supply direct supply and OHT filling is carried out from this ZPS.

The Direct supply is normally in morning from 4.30 am to 6.30 am evening from5.00 pm to 6.30 pm and OHT filling time is not fixed but run only one hour per day.

Supply Area from ZPS is Lohamandi, St. Johns etc.Two outlets is given for supply in different areas.

Total 5 no of pumps are installed in which 4 are running & 1 is standby.

Flow Measurement at Outlet of Lohamandi ZPS has been carried out 15th,16th and 17th August 2017in the presence of AMC& Jalkal Engineers/officials.

As seen in field mesurment activity, the average flow rate OHT filling outlet is 656.5 m^3/ hr. and hence total outlet Supply toOHT is 1.08 MLD.

The details of field measurement activity and results for Lohamandi ZPS outlet are attached in previous reports

Thus, the total outlet from this Zonal pumping station is 6.71 MLD

3.4.10 Kamala Nagar OHT

Kamala Nagar OHT having capacity 0.75 Ml,is located Zone No.1 of Agra city. Inlet source from Jeoni Mandi Kamala Nagar OHT apart from that, ZPS is constructed but not in use. Supplies water on daily basis to Kamala Nagar Area. The supply is normally in morning from 6.00am to 9.00 am.& evening from 6.00am to 9.00am.

Flow Measurement at Outlet of Kamala Nagar OHT has been carried out 1stAug 2017in the presence of AMC& Jalkal Engineers/officials.

As seen in field activity & flowmesurment, the average flow rate to Kamala Nagar OHT outlet is 401.21 m^3/ hr. and hence total outlet Supply to Kamala Nagar area is 1.56 MLD.

The details of field measurement activity and results for Kamala Nagar outlet are attached in previous report

3.4.11 Kalandi Vihar OHT

Kalandivihar OHT having capacity 2.0 MLislocated Zone No. 1 of Agra city. Inlet source is Under ground water from Pura govardhan Zonal pumping station supplies water on daily basis to Soha Nagar, Chandan Nagar,RadhaNagar, Isalam Nagar, shyam Nagar om nagar area .The supply is normally in morning from 7.00 am to 7.40 am & evening from 7.00 pm to 7.40 pm.

Flow Measurement at Outlet of Kalandivihar OHT has been carried out 3 Aug 2017in the presence of AMC& Jal kal Engineers/officials.

As seen in field activity & flow mesurment, the average flow rate of Inlet is 281.26 m^3/ hr. and hence total Inlet to Kalandi vihar OHTis 3.37MLD.

The details of field measurement activity and results for Kalandi vihar OHT Inlet are attached in previous report

3.4.12 Nagla Jamuni OHT

Nagla Jamuni OHT having capacity 1.5 MLislocated Zone No. 1 of Agra city. Inlet source is Under ground water from Pura govardhan Zonal pumping station supplies water on daily basis to Kalandivihar area .The supply is normally in morning from 6.00am to 8.00 am.& evening from 6.00am to 9.00 am.

Flow Measurement at Outlet of Kalandivihar OHT has been carried out 3 Aug 2017in the presence of AMC& Jal kal Engineers/officials.

As seen in field activity & flow mesurment , the average flow rate of Inlet is 246.1 m^3/ hr. and hence total Inlet to Nagla Jamuni OHT is2.4 MLD.

The details of field measurement activity and results for Pura Govardhan ZPS outlet are attached in previous reports

3.4.13 Pura Govardhan ZPS

Pura Govardhan ZPS having sump capacity of 1.2 MLislocated at Pura Govardhan Villagenear Agra city. Source for this ZPS in underground water only through 16 nos. tubewells located at different places within village premises. From this ZPS water being pumped on daily basis to NaglaJamuni&Kalandi vihar Block A OHT.Average supply timing are 12 hr per day.

Total 3 nos. of pumps are installed with 2 running & 1 standby operating capacity.

Flow Measurement at Outlet of PuraGovardhan ZPS has been carried out 3rdAugust 2017in the presence of AMC& Jalkal Engineers/officials.

As seen in flow mesurment activity, the average flow rate of Outlet is 649.0 m^3/ hr. and hence total common outlet to Kalandi vihar Block A &Nagla Jamuni OHT is 7.30 MLD

The details of field measurement activity and results for Pura Govardhan ZPS outlet are attached in previous reports

3.4.14 Kotwali ZPS

Kotwali ZPS having sump capacity 5.73 MLis located at Zone no.2 of Agra city. Inlet source is from Jeoni Mandi Water Treatment Plant. Kotwali ZPS Both supply direct supply and OHT

Filling is carried out from this ZPS.The Direct supply is normally in morning from 6.00 am to 8.00 through pump no.1&2 and OHT filling carried out from Pump no.4 time is not fixed but run only 6 hr per day.

Supply Area from ZPS is given below: - Kotwali, Motikatra etc.

Five pumps are installed here, of which one was discarded and one was under maintenance at the time of audit. ESR filling and direct distribution are performed through dedicated sets of pumps and pipe lines.

Flow Measurement at Outlet of Kotwali ZPS has been carried out 6th August 2017in the presence of AMC& Jalkal Engineers/officials.

As seen in the flow mesurment activity, the average flow rate of Outlet is 637.8 m^3/ hr. and hence outlet is 1.45MLD

As per above, the average flow rate of Outlet for OHT is 185.7 m^3/ hr. and hence outlet is 1.09MLD

Thus, the total outlet from this Zonal pumping station is 2.54 MLD

The details of field measurement activity and results for Kotwali ZPS outlet are attached in previous reports.

3.4.15 Trans Yamuna Phase 2 ZPS

Trans Yamuna phase 2 ZPS having storage capacity 2.8 MLislocated at Zone no 1 of Agra city & Inlet source from Jeoni Mandi WTPTrans Yamuna phase 2 ZPS supplies water on daily basis to different areas. Direct supply & OHTs filling is carried out from this ZPS.

There are three out let from this ZPS one is for direct supply and second for Kalandi vihar block B (OHT filling) and third is OHT filling located at Trans Yamuna ZPS premises.

The General supply is normally in evening from5.30 pm to 8.0 pm for Kalandi vihar Block B OHT is 4.00 am to 8.00am (2 pumps running) & 8.00 am to 10.00 am (1- pump running)

The Premises OHT filling is normally in from 5.30am to 6.30 am and evening 4.00pm to8.00pm.

Total 9 no of VT pumps are installed in which (Pump No. 1, 2) for Kalandi vihar block B OHT filling ,(Pump no.3,4,5) for Direct supply & pump no.8,9 for Premises OHT filling apart from that (pump no 6,7) under maintenance at the time of audit carried out .

Flow Measurement at outlet of Shahganj phase 2 for general supply has been carried out in $4^{th,}7^{th}8^{th}$Aug 2017 in the presence of AMC& Jalkal Engineers/officials.

As seen in flow mesurment activity of Transjamuna phase 2, the average flow rate of Outlet is 356.14 m^3/ hr. and hence outlet is 0.78MLD

As seen in flowmesurment activity of *Kalandi Vihar Block B Zps*, the average flow rate of Outlet is 160.4 m^3/ hr. and hence outlet is 0.33 MLD

As seen in flow mesurment activity of *Kalandi Vihar Block B OHT Filling (1-pumps)*, the average flow rate of Outlet is 251.7 m^3/ hr. and hence outlet is 0.96MLD

As seen flow mesurment activity of OHT filling in premises, the average flow rate of Outlet is 193.7 m^3/ hr. and hence outlet is 1.54 MLD

The details of field measurement activity and results for this ZPS are attached in previous reports:

Thus, the total outlet from this Zonal pumping station is 3.61 MLD

3.4.16 Trans Yamuna phase 2 colony ZPS

Trans Yamuna phase 2 colony ZPS having storage capacity 0.8 MLislocated at Zone no 1 of Agra city .The Inlet source from Jeoni Mandi WTP &supplies water on daily basis to block-A to block-B areas. Of Trans Yamuna area. Direct supply is carried out from this ZPS

The supply is normally in morning from 8.00am to 9.30 am.& evening from 8.00pm to 9.00 pm

Total 2 pumps are installed, out of which one was in breakdown condition.

Flow Measurement at outlet of Shahganj phase 2 for general supply has been carried out in 9th Aug 2017 in the presence of AMC& Jalkal Engineers/officials.

As seen in flow mesurment activity, the average flow rate of Outlet is 366.5 m^3/ hr. and hence outlet is 1.13 MLD

The details of field measurement activity and results for this ZPS are attached in previous reports:

3.4.17 Tajganj ZPS

Tajganj ZPS having storage capacity 3.55 MLislocated at Zone no 3 of Agra city. The Inlet source from Jeoni Mandi WTP &supplies water on daily basis to Tajganj areas. Direct supply is carried out from this ZPS

The supply is normally in morning from 3.45am to 5.45 am.& evening from 5.00pm to 6.00 pm

Total 6 nos. ofpumps are installed, of which one was in breakdown condition since long time.

Flow Measurement at outlet of Shahganj phase 2 for general supply has been carried out in 12th Aug 2017 in the presence of AMC& Jalkal Engineers/officials.

As per above, the average flow rate of Outlet is 2957 m^3/ hr. and hence outlet is 7.06 MLD

The details of field measurement activity and results for direct supply are attached in previous reports:

3.4.18 Chipi tola buster pump House

Chipitola pump station is used for in-line boosting of treated water from Jeoni Mandi WTP from chipitola squareit is used for chipitola OHT feeding.OHT is constructed at pump house premises having storage capacity1.5MLislocated at Zone no 3 of Agra city . Pump House supplies water on daily basis toChipitolaareas. The supply is normally in morning from 8.00am to 10.00 am. & evening from 8.00pm to 10.00 pm

Total 2 Centrifugal pumps are installed in pump house.

Flow Measurement at inlet of OHT for general supply has been carried out in 14th Aug 2017 in the presence of AMC& Jalkal Engineers/officials.

As seen in field mesurment activity , the average flow rate of Outlet is 238.3m^3/ hr. and hence outlet is 1.26MLD

The details of field measurement activity and results for direct supply are attached in previous reports:

3.4.19 Red Fort buster pump House

The Red Fort booster is an in-line boosting pump house which receives water from Jeoni Mandi WTP and supplies it to Red Fort area. It is located at Zone no 3 of Agra city .The supplies water on daily basis& supply is normally in morning from 5.00 am to 7.30am& evining from 5.00 pm to 7.30 pm

Two pumps are installed here, of which one was not in use from long time. The pipeline from which the pump receives water is also used for direct distribution, during which the suction valve of the Red Fort booster pump is closed.

Pump Flow Measurement at inlet of OHT for general supply has been carried out in 14th Aug 2017 in the presence of AMC& Jalkal Engineers/officials.

As seen flow mesurment activity, the average flow rate of Outlet is 24.01m^3/ hr. and hence outlet is 0.10MLD

The details of field measurement activity and results for direct supply are attached in previous reports:

3.4.20 Navlakha (MES) ZPS

Navlakha ZPS having storage capacity 7.95MLislocated at Zone no 3 of Agra city. The Inlet source from Jeoni Mandi WTP &supplies water on daily basis toMES cantonment, Cannt & Bindu colony areas at different time. Direct supply is carried out from this ZPS.

The supply is normally in morning & evening As, MES area 4.00 am to 8.0am,12.00 pm to 3.00 pm & ,5.00 pm to 7.00 pm . Supply to Cannt area from 9.00am to 11 am and Bindu colony is 5.00am to 6.30 am

Total 4 pumps are installed, of which pump no.1 supply and billing is under MES.

Flow Measurement at outlet of Navlakha for pump no.4has been carried out in 16th Aug 2017 in the presence of AMC& Jalkal Engineers/officials. The details of field measurement activity and results for pump no.2 are given as below:

As seen in flow mesurment activity of pump no-2, the average flow rate of Outlet is 1000.7 m^3/ hr. and hence outlet is 12.69 MLD

As seen flow mesurment of pump No-4, the average flow rate of Outlet is 458.0 m^3/ hr. and hence outlet is 6.03MLD

Thus, the total outlet from this Zonal pumping station is 18.72 MLD

The details of field measurement activity and results for direct supply are attached in previous reports:

3.4.21 Rakab Ganj ZPS

Rakab Ganj having storage capacity 5.05MLislocated at Zone no 3of Agra city & Inlet source from Jeoni Mandi WTP.Both supplies are carried out i.e. direct & OHT filling from this ZPS.Rakabganj ZPS supplies water on daily basis to different areas.

OHT filling is carried out one time in a day for 20min by 2-pumps.

There are two out let from this ZPS for different area.

The General supply is normally in morning from 6.00 am to 8.00 am by pump no.2, 6&5 and evening from 6.00 pm to 6.45 pm.

Total 5 no of pumps are installed out of which 1 pump is not working at the time of audit.

Flow Measurement at outlet of Shahganj phase 2 for general supply has been carried out in 20th Aug 2017 in the presence of AMC& Jalkal Engineers/officials.

As seen in flowmesurment of direct supply (pump no-5), the average flow rate of Outlet is 691.9 m^3/ hr. and hence outlet is 1.68 MLD

As seen in flow mesurment activity of direct supply, the average flow rate of Outlet is 1035m^3/ hr. and hence outlet is 3.31MLD

As seen in flow mesurment activity of OHT filling, the average flow rate of Outlet is 289.6 m^3/ hr. and hence outlet is 0.20 MLD

The details of field measurement activity and results for direct supply are attached in previous reports:

Thus, the total outlet from this Zonal pumping station is 5.20 MLD

3.4.22 Brij vihar ZPS

Brij viharZPS feed the Brij vihar OHT having capacity 2.1 MLislocated at Zone no.1of Agra city. Inlet source is from Jeoni Mandi Water Treatment Plant. OHT filling is carried out from this ZPS and then distribute to Brij vihar area.

The supply is normally in morning from 8.00 am to 11.am.

Total 3 pumps installed hear (2W+1s) pump running time is not fixed but run 6 hour per day

Flow Measurement at Outlet of Brij vihar ZPS has been carried out 7thSept 2017in the presence of AMC& Jalkal Engineers/officials.

As seen in flow mesurment activity, the average flow rate of inlet is 383.8 m^3/ hr. and hence outlet is 1.93 ML

The details of field measurement activity and results for Brij vihar ZPS outlet are attached in previous reports:

3.4.23 Kalamahal booster &OHT

Kalamahal booster feed the OHT from feeder main.OHT capacity 1.36 MLislocated Zone No. 1 of Agra city. Inlet source is Jeoni mandi WTP supplies water on daily basis to Kalamahal area .Direct supply & OHT filling is carried out from this ZPS The supply is normally in morning from 5.00am to 9.00 am. & evening from 5.00am 9.00 am.

Flow Measurement at Outlet of Kalandivihar OHT has been carried out 4Sept 2017in the presence of AMC& Jal kal Engineers/officials.

As seen in flow mesurment activity of oht filling, the average flow rate of inlet is 127.4 m^3/ hr. and hence outlet is 0.66 MLD

As seen in flow mesurment activity direct supply, the average flow rate of outlet is 541.28 m^3/ hr. and hence outlet is 3.27 MLD

The details of field measurement activity and results for Brij vihar ZPS outlet are attached in previous reports:

Thus, the total outlet from this OHT is 3.93 MLD

3.4.24 Awas Vikas Tapping at Mahura road ZPS

Flow Measurement at AwasVikas tapping at Mathura road ZPS for direct supply has been carried out on 6thSep 2017. Supply from this direct Tapping is daily basis. Supply Areas from Direct Tapping are: - Awas Vikas Sector 15, Awas Vikas Sector 9, Awas Vikas Sector 2 and Awas Vikas Sector 4 etc. Six OHT constructed in AwasVikas area but not in use.

As seen in flow mesurment activity of direct tapping, the average flow rate of outlet is 800.0 m^3/ hr. and hence outlet is 4.79MLD

As seen in flow mesurment activity of direct tapping (Leakage flow), the average flow rate of Leakage flow is 112.9 m^3/ hr. and hence outlet is 2.20 MLD

Thus, the total outlet from this OHT is 6.99 MLD.

3.4.25 Tube well at Indirapuram Area

There are total 6 nos. of tube wells which are usedto supply water forIndirapuram area. As per audit, it was observed that presently only 2 nos. of tubewell were lifting water however, other 4 nos. tubewell were discharging only air without any water. Supply time is normally morning and evening depending on power and water level. OHTs are constructed but presently not in working condition.

Flow Measurement for direct supply has been carried out on 11thAug 2017.

Flow Measurement at tube wells No.1 & 2

As seen in flow mesurment activity of tube well -1, Average flow rate of outlet is 30.87m^3/ hr. and hence outlet is 0.74 MLD

As seen in flow mesurment activity of tube well -2, Average flow rate of outlet is 30.87m^3/ hr. and hence outlet is 0.74 MLD

Thus, total outlet from this tube well is 1.48MLD

3.5 WATER BALANCE SUMMARY

The following table shows the overall summary of Bulk Water System of Agra Municipal Corporation.

Bulk Water Supply System -Water Balance					
Sikandara WTP to ZPS					
Outlet Water From WTP to City		MLD	Total Water Input to City	MLD	UFW
1	Sikandara WTP	133.99	ZPS & OHTs (Sikandara Source)	84.71	36.77%
2	Jeoni Mandi(Water works)	113.83	ZPS & OHTs (Jeoni Mandi Source)	48.18	57.72%
Subtotal (MLD)		**247.8**	**Subtotal (MLD)**	**132.89**	
			UFW (%)	**46.38%**	

Table 10 : Water Balance for Agra City Water Supply

The details of above individual pump house wtp , Zonal pumping station @ OHTs is also measured to derive at bulk system water balance. The flow measurement details for all above Zonal pumping station, direct tappings etc. are tabulated in following headings;

3.5.1 Sikandara WTP

Bulk Water Supply System -Water Balance			
Sikandara WTP to ZPS			
Outlet Flow From WTP	MLD	Outlet flowfrom ZPS @ OHTS	MLD
Jeoni Mandi WTP (Water works)	133.99	Kotwali	2.54
		Tajganj	7.06
		Chipi Tola	1.26
		Red Fort	0.1
		Navlakha	18.72
		Rakabganj	5.2
		Kala Mahal	3.93
		Brij Vihar	1.93
		Kamla Nagar	2.72
		Transyamuna Phase 2	3.61
		Transyamuna Phase 2 Col	1.13
Subtotal (MLD)	**133.99**	**Subtotal (MLD)**	**48.20**
		UFW (%)	**36.77%**

Table 11 : Water Balance chart of Sikandara WTP

3.5.2 Jeoni mandi (Water works) WTP

Bulk Water Supply System -Water Balance			
Sikandara WTP to ZPS			
Outlet Flow From WTP	MLD	Outlet flowfrom ZPS @ OHTS	MLD
Jeoni Mandi WTP (Water works)	113.83	Kotwali	2.54
		Tajganj	7.06
		Chipi Tola	1.26
		Red Fort	0.1
		Navlakha	18.72
		Rakabganj	5.2
		Kala Mahal	3.93
		Brij Vihar	1.93
		Kamla Nagar	2.72
		Transyamuna Phase 2	3.61
		Transyamuna Phase 2 Col	1.13
Subtotal (MLD)	**113.83**	**Subtotal (MLD)**	**48.2**
		UFW (%)	**57.66%**

Table 12 : Water balance chart of Jeoni Mandi WTP

4 INTRODUCTION TO DMA

4.1 DISTRICT METER AREAS (DMA)

Division of the distribution system into small geographic areas of manageable size (known as District Meter Areas, DMAs) is generally considered to be essential for effective control of NRW. This enables will enable ULB water supply administers to gain an understanding of the performance of the network, actively target areas with high losses and manage pressures.

Generally, the DMAs are isolated from the neighbouring distribution network by boundary valves which are kept shut except for operational reasons such as a burst main or routine maintenance of the system. All inflows (and if appropriate outflows) from the zone are continuously monitored using flow meters.

DMAs can be established on an area by area basis. As far as possible, the boundaries of the DMAs will follow existing system divisions. All boundary valves will need to be checked for water tightness. The condition of boundary valves is fundamental to the success of the proposed monitoring.

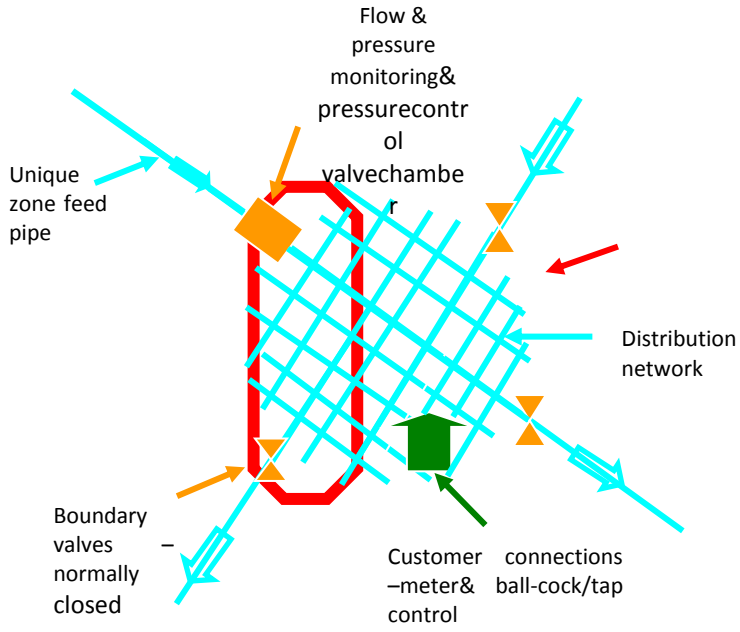


Figure 11: Schematic representation of a DMA.

4.2 PRESSURE MANAGEMENT

Leakage from distribution systems is very sensitive to pressure. At present average pressures within the distribution network may be very low even during supply periods. As a result many customers may not get water at required pressure.

A minimum residual pressure of 10m to 12m at customer's connections is considered to be a reasonable target. Without control, average night time pressures will be higher due to the reduction in demand. Therefore effective management of pressures is an important component of the proposed strategy.

The components of effective pressure management are three fold:

- division of the distribution network into hydraulically discreet zones;
- identification of pressure management areas within DMAs;
- Installation of suitable pressure control devises.

4.3 METERING CONSUMER CONNECTIONS

This is possibly the most important step, and is often got wrong. The whole purpose of DMA activity is to rigorously compare the summated consumptions of the individual consumer meters with the input flows entering the zone. Thus, the water meter measuring the zone's entry flows must be well established and correctly sized.

4.4 DMA MONITORING

To effectively manage DMAs it is necessary to monitor the flows within them. Flow reading shall be noted at specific intervals during supply hours at consumer end as well as bulk meter location within DMA.

This information shall be monitored for water loss control in a proactive manner.

4.5 DATA INTERPRETATION AND NRW REDUCTION

To effectively manage DMA's it is necessary to have an understanding of the number and type of connections within the distribution area. Figures for water usage can then be put into a system analysis to assess the levels of water loss from the distribution system. This component based approach will help to assess the level of apparent and real losses in the distribution network.

Using the same data collection methodology and analysis for the other DMAs, shall be able to compare the volumes lost in the DMAs and hence most appropriate methodology to reduce losses.

4.6 CUSTOMER CONNECTIONS

Available information suggests that customer connections (including the ferrule) are a significant source of water loss. Typically 50% to 70% of water physically lost from the pipe network (i.e. total physical losses exclusive of wastage from stand posts) is lost from customer connections.

The ferrule is considered to be the major point of physical water losses.

Traditionally galvanised iron has been used for service connections. Galvanised iron pipes are relatively thin walled and are subject to internal and external corrosion.

4.7 VOLUMETRIC CHARGING

The introduction of continuous water supplies at higher average pressure is likely to cause an increase in water consumption. Effective volumetric charging is recommended to control customer demand (in particular wastage).

5 DMA STUDY FOR ASSESSMENT OF NRW

5.1 INTRODUCTION TO SELECTED DMA AREA

Following areas were approved by AMC & Jal sansthan for DMA study and accordingly DMA study has been carried out:

Sr. No.	DMA Areas	No. of Connections
1	Awas Vikas Sector 12D	198
2	Tajganj (ABD) Area	257
3	Harjupura	250
4	Awas Vikas Sector 4R	169
5	Nawada (Tajganj ABD Area)	186
	Total	**1060**

Table 13 : Summary of DMA's connections

As shown above, total 1060 consumers connection were studied out of 190000 registered & un-registered consumers. The DMA's were selected based on feasible locations where area under study can be isolated or measured by fixing inflow bulk meters. DRA team has installed the Bulk flow meters and water consumer's meters to measure the actual consumption. Consumer survey was carried out to identify the registered / un-registered consumers within the DMA area. The results of DMA study and analyais has been discussed in detail in this report, however, brief summary is tabulated below;

Supply pattern / total water inflow

2) Billing methods

3) Water consumption

4) Water pressure at Consumer end

5) Per capita supply (LPCD)

6) UFW (Un- account for water) i.e. difference between supplied volume as measured by Bulk meters and measured consumption up to consumer meter.

7) Non- Revenue Water (NRW) is estimated losses (Technical + Commercial) based on billing database of DMA assuming there is no major change in consumption pattern.

5.1.1 Summary of DMA Study

The summary of DMA study and analysis is given in following table

Summary of DMA Study								
DMA Locataion	Connections		Population	Days Study Period		Bulk Meter Details		
	Total	Active		Start	End	Meter Location	Line Size (mm)	Avg. Flow (m3/Hr.)
Awas Vikas Sector 12D	212	198	778.00	04-10-17	13-10-17	Meter "A"	125	271.37
Tajganj (ABD Area)	287	257	1613.00	03-11-17	18-11-17	Meter "A"	250	789.20
Harjupura Tajganj (ABD Area)	297	250	1588.00	01-12-17	15-12-17	Meter "A"	200	151.45
Awas Vikas Sector 4R	175	165	806.00	08-12-17	24-12-17	Meter "A"	150	371
Nawada Tajganj (ABD Area)	208	186	1239.00	01-01-18	13-01-18	Meter "A"	200	643

Summary of DMA Study						
DMA Locataion	Total input Volume (m3)	Total Measured Consumer Consumption (m3)			UFW %	NRW %
		Registered	Un-Registered	Total		
Awas Vikas Sector 12D	2713.75	1054.30	1201.95	2263.63	16.59	61.15
Tajganj (ABD Area)	11846.81	1006.38	2963.41	3969.79	66.49	91.51
Harjupura Tajganj (ABD Area)	2271.70	789.09	905.53	1694.62	25.40	65.26
Awas Vikas Sector 4R	5931.84	3887.76	815.76	4703.52	20.71	34.46
Nawada Tajganj (ABD Area)	8359.00	1158.71	1533.99	2692.70	67.79	86.14

Table 14 : Summary of DMA's

5.1.2 DMA Area Index Map & Drawings

Agra Municiapl Corporation do not have updated drawings in hard and soft format, however, DRA team prepared the map for transmission network and distribution map for DMA areas. Index map, representating the DMA areas is shown as per below;

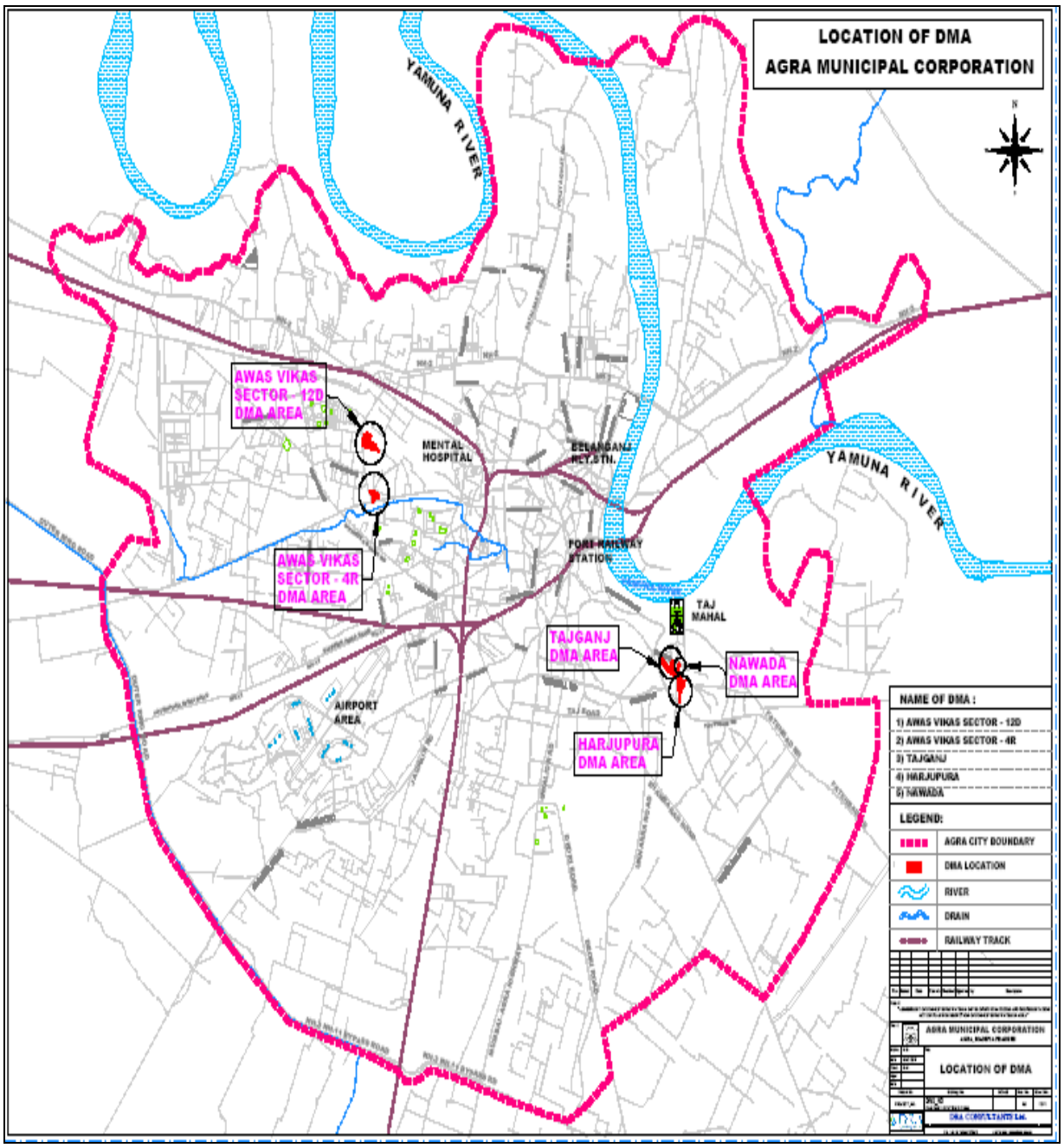


Figure 12: DMA Index Map

5.1.3 ABD area boundary Map Drawing

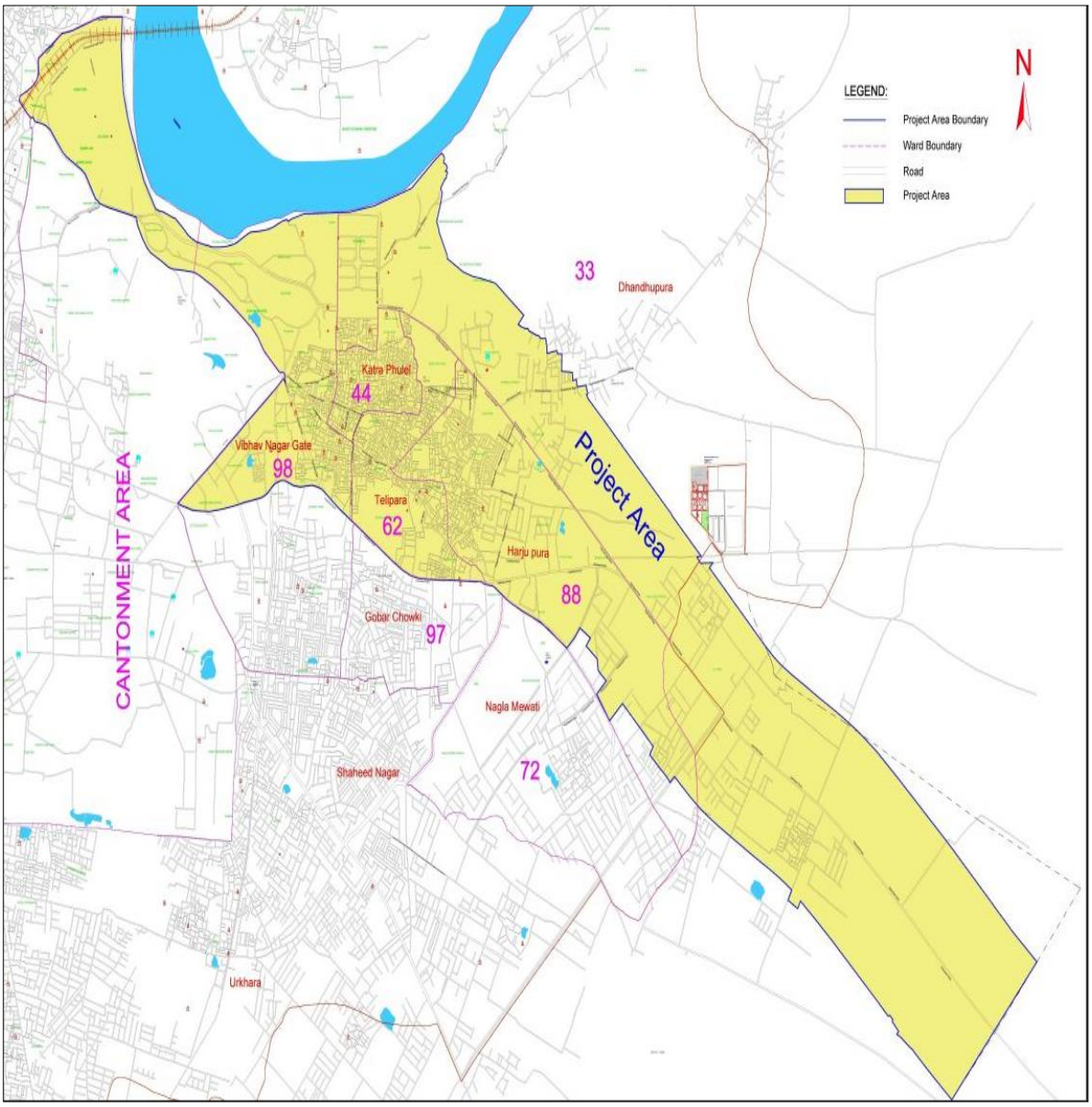


Figure 13: ABD area boundary Map

5.1.4 Awas Vikas sector 12D Area DMA Drawing

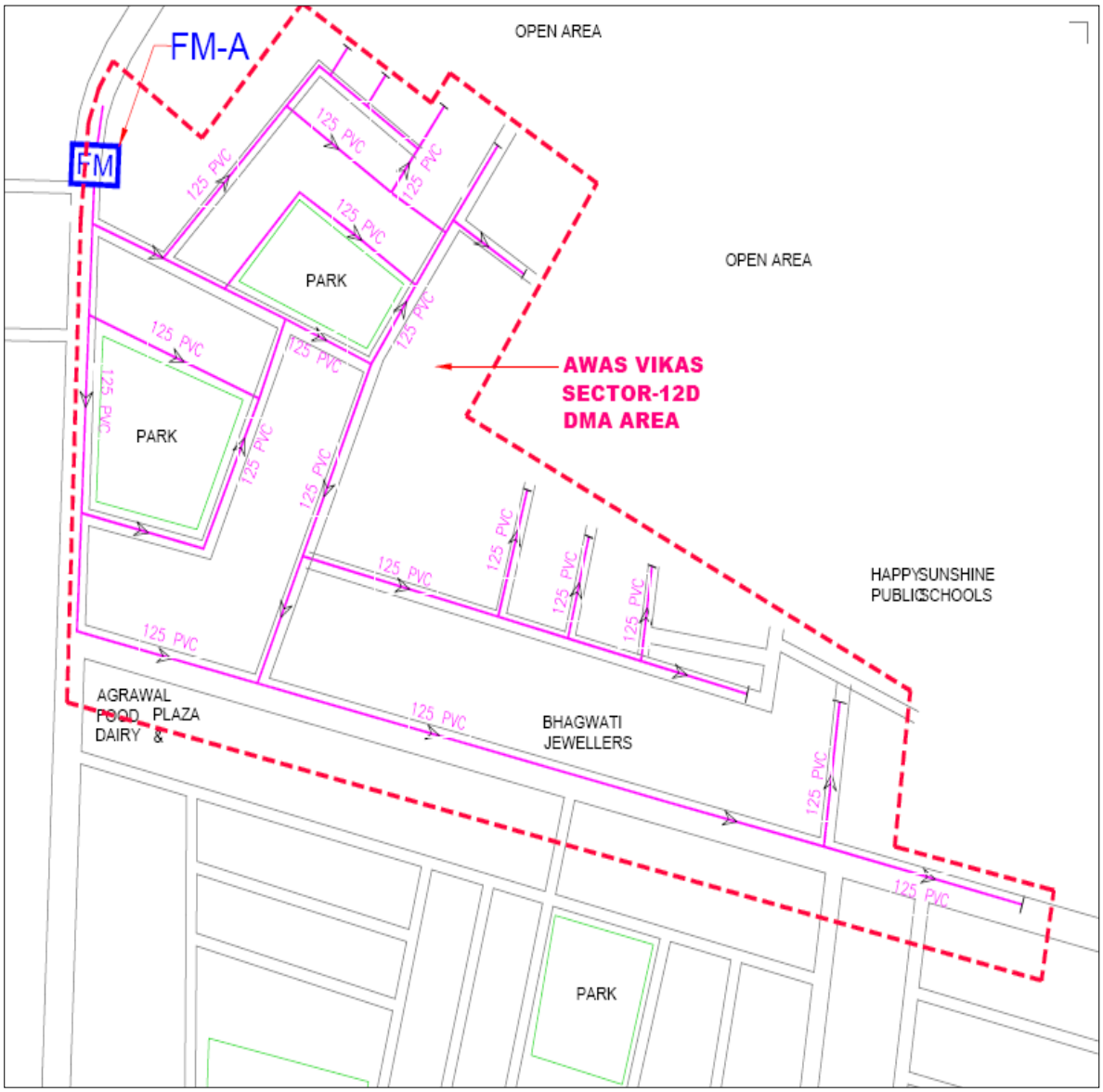


Figure14: Awas Vikas sector 12D DMA Map

5.1.5 Tajganj (ABD) Area DMA Drawing

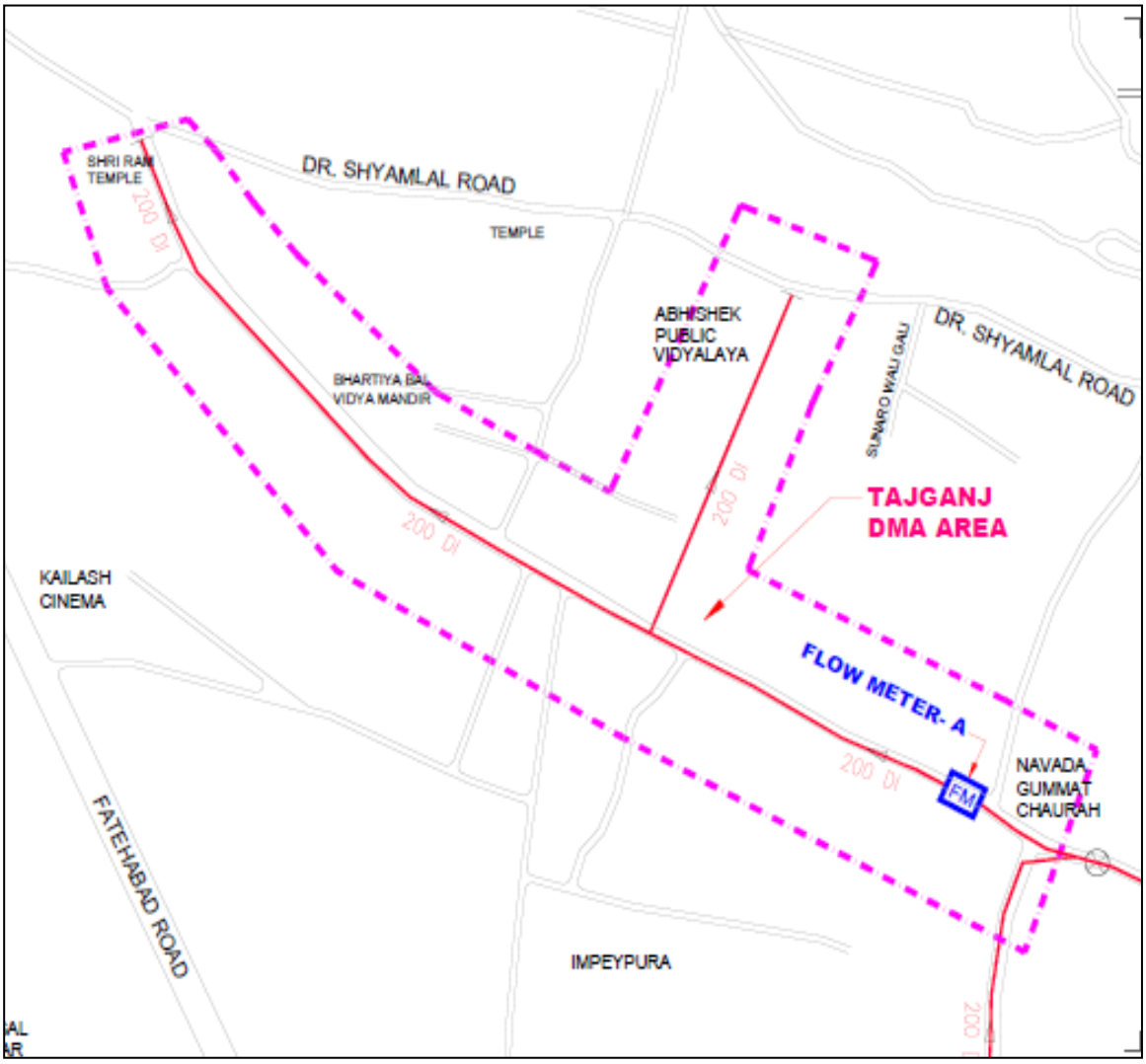


Figure15: Tajganj DMA Map

5.1.6 Harjupura (Tajganj ABD) Area DMA Drawing

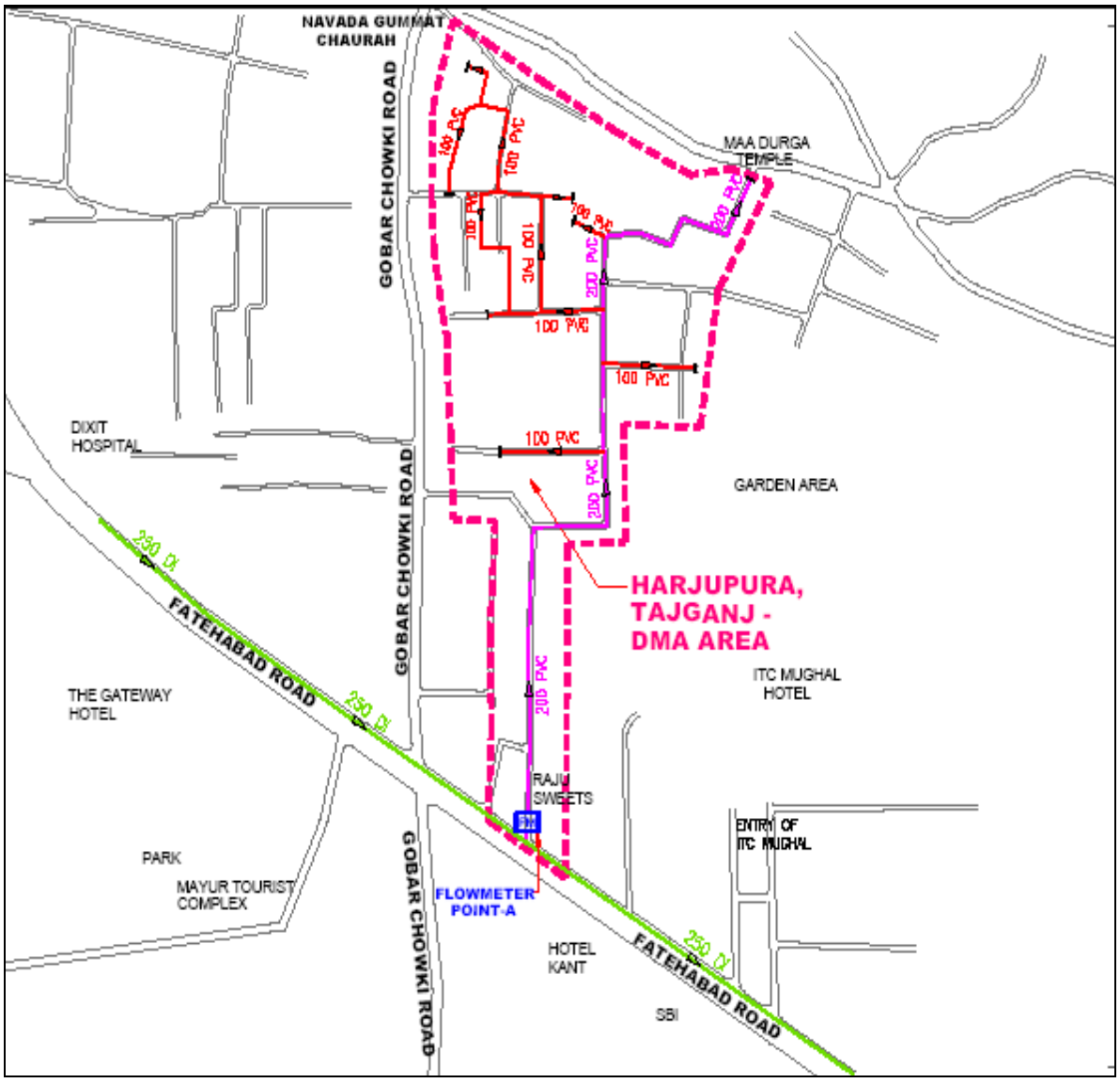


Figure16: Harjupura (Tajganj) DMA Map

5.1.7 Awas vikas sector4R Area DMA Drawing

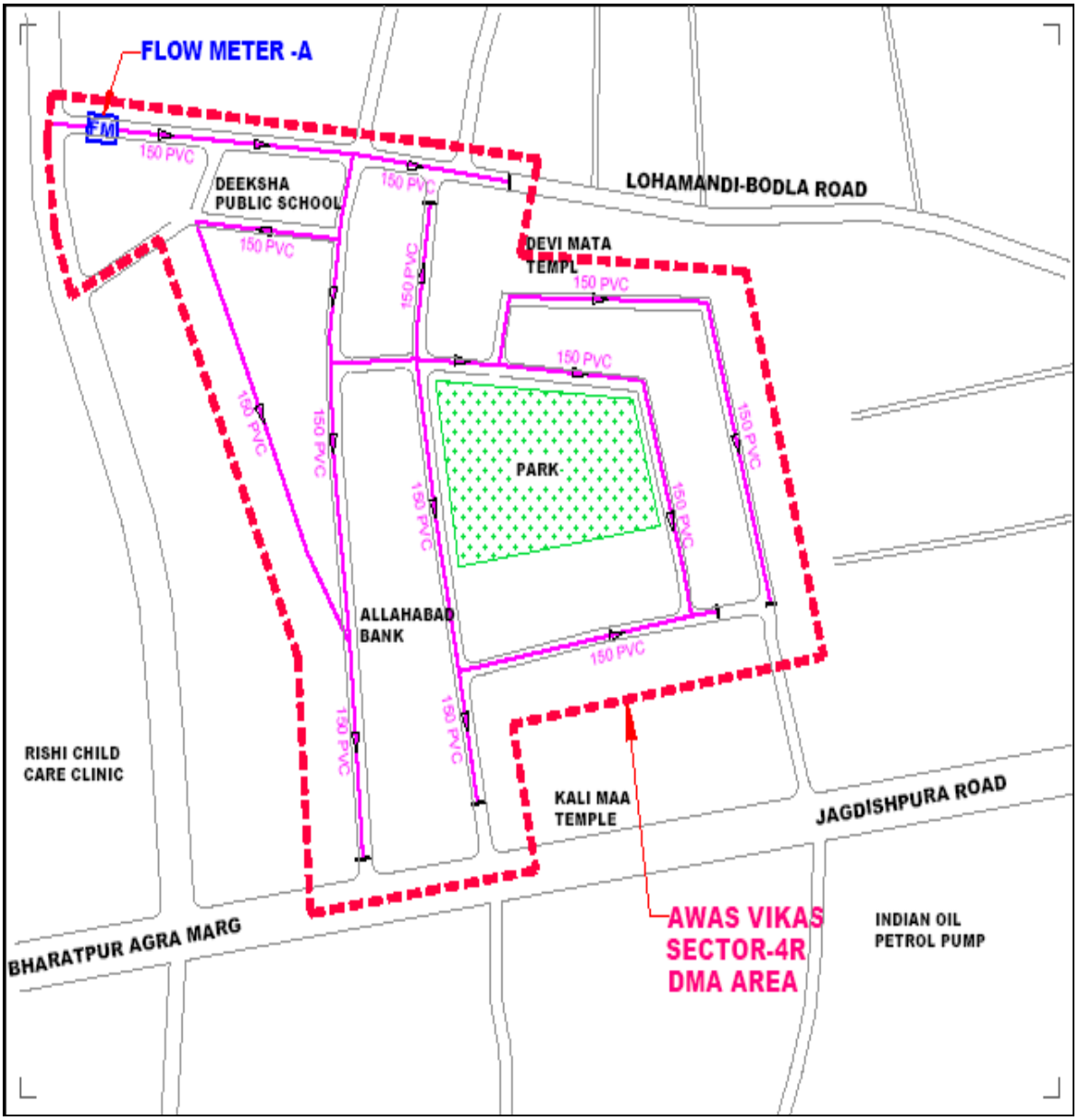


Figure17: Awas vikas sector 4R DMA Map

5.1.8 Nawada (Tajganj ABD) Area DMA Drawing

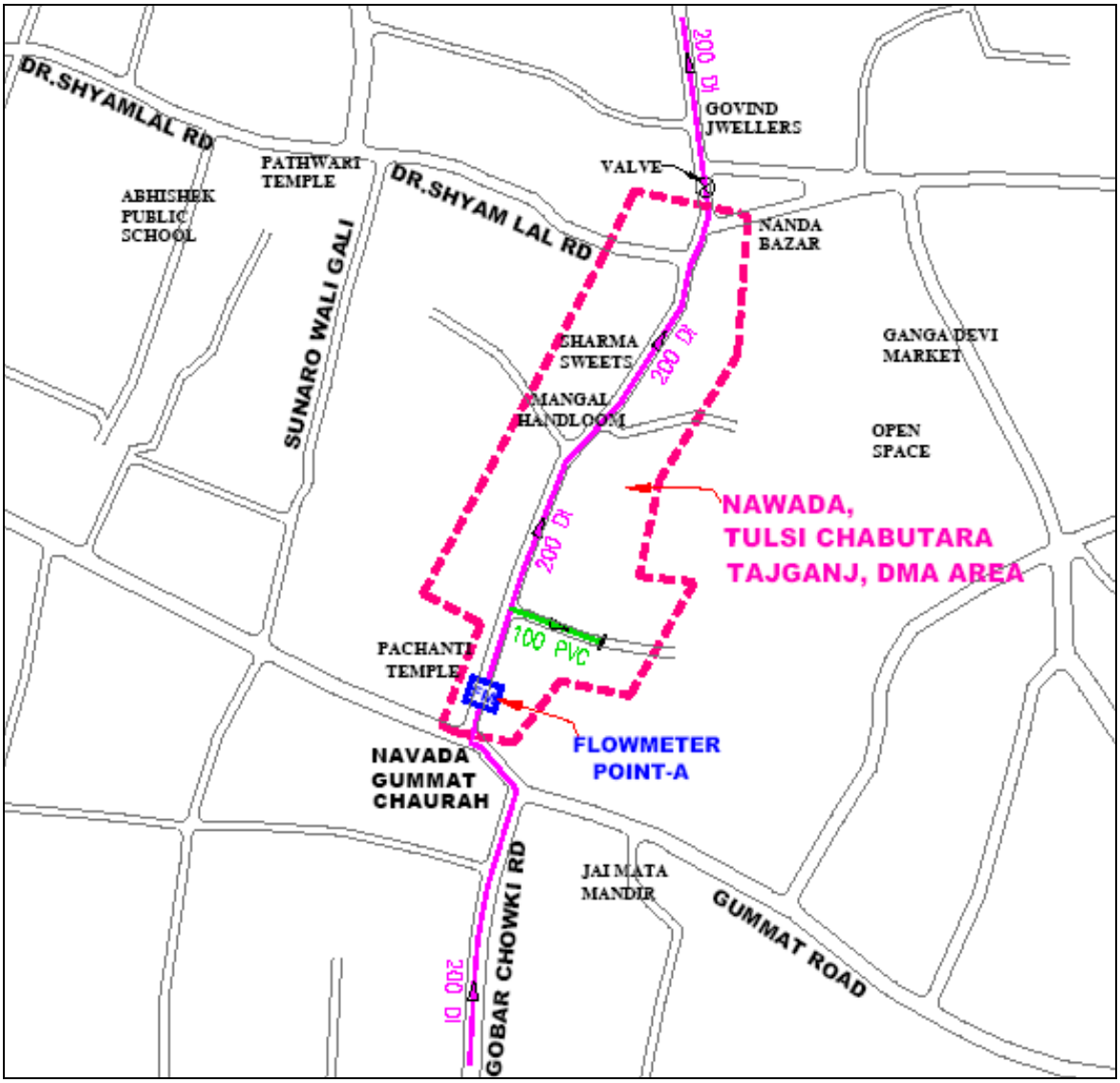


Figure18: Nawada Tajganj DMA Map

5.2 DMA STUDY FOR AWAS VIKAS SECTOR 12D

As per the instruction of the Municipal Corporation and Jalsansthan officials, following DMA areas were selected for NRW study.

Figure 19: Index Map for Awas vikas sector 12D

The distribution network details for the Awas vikas Sector 12D Network are as below;

LENGTH OF AWAS VIKAS SECTOR 12D AREA		
Sr no.	**Diameter**	**LENGTH**
1	125mm PVC	38.45
2	125mm PVC	19.81
3	125mm PVC	56.52
4	125mm PVC	13.82
5	125mm PVC	9.95
6	125mm PVC	9.07
7	125mm PVC	104.06
8	125mm PVC	57.12
9	125mm PVC	39.36
10	125mm PVC	25.94
11	125mm PVC	25.23

12	125mm PVC	27.57
13	125mm PVC	34.55
14	125mm PVC	140.79
15	125mm PVC	115.93
16	125mm PVC	64.82
17	125mm PVC	121.08
18	125mm PVC	92.95
19	125mm PVC	415.93
20	125mm PVC	10.54
Grand Total		**1423.50**

Table 15: Awas vikas sector 12D Network details

DMA Analysis reports are submitted as per following:

5.2.1 NRW Assessment for Awas vikas sector 12d

Sector 12D falls under Awas vikas area of Agra City. The area comprises of mostly domestic consumers. Door to door consumer survey activity was carried out by DRA team to identify the actual consumer's within the DMA area and collect the details such as total no. of members, registered/ un-registered consumers, consumption pattern etc. The boundary limits of the DMA area is marked in drawings and the results of consumer's survey are tabulated as per following:

Figure 20 : Awas Vikas Sector12D

Total property / Connections as per consumer survey	**224**	**Nos.**
Toatl Connections matched with Billing database	**107**	**Nos.**
Total No Connections Status	**27**	**Nos.**
Total Un-registered Consumers (not in Water Billing Database)	**90**	**Nos.**
Connections with House Lock Status (Permanent Lock)	**14**	**Nos.**
Connections with House Lock Status (Temporary Lock)	**10**	**Nos.**
Stand post (free connections)	**0**	**Nos.**
Connections with Open taps (un-authorised access)	**4**	**Nos.**
Net Active Connections during study	**197**	**Nos.**

Table 16; Consumer Survey Summary

As per consumer survey, population of the DMA area is as following:

Total population for DMA Area as per Consumer Survey	**778**	**Nos.**
Population per connection for DMA	**3.47**	**Nos.**

Table 17 : DMA Consumer Survey Summary

During DMA study, the selected area was surveyed and studied to isolate the area boundary with other area and accordingly water inlet points to the project area were identified and marked on drawings. The distribution network of the DMA area was also updated in consultation with Jalsansthan staff. Awasvikas sector 12D Area DMA has following water sources;

1. 125 mm PVC dia inlet from Mathura road ZPS.

DMA water flow meters were installed on all above water inlet points to measure the actual water input to the DMA area. Accordingly, inlet points were metered and measured and referred as in this report.

Bulk Flow Meters have been installed at following locations in the study area;

Location Details	**Line Size**	**Date of Meter installation**	**Flow Rate (m3/Hr.) Morning Supply**	**Flow Rate (m3/Hr.) Evening Supply**
Near Torrent Substation main road awas vikas.	**125 mm**	04/10/2017	124.03	100.33

Figure 21: DMAFlow Measurement Photos

The DMA study was carried out from 4/10/2017 to 13/10/2017. Water is being supplied to the consumers of the DMA area on daily basis during morning and evening hrs. Water Supply timing details for the DMA area is as following:

Figure 22: DMA pressure Measurement Photos

Supply Time	**Total avg Hrs. = 7 hrs.**
Morning Supply	**i) 5:00 a.m. to 8:30 a.m**
Evening Supply	**ii) 5:00 p.m. to 8:30 p.m.**

The Pressure Measurement activity was carried out during DMA study in the area on sample basis. The pressure mesured with consumer pumps,Total no. of pressure samples taken for 69 nos. Pressure gauges were installed at various locations of consumer connection and measured for study purpose.

The results of pressure measurement activity are as below;

Average Pressure at consumer end	**0.79**	**kg/cm2**
Max Pressure observed during study	**2.25**	**kg/cm2**

DMA study for the sector 12D DMA Area started on 4-10-2017 and ended on 13-10-2017. Thus total study period for the DMA is 10 days

Thus, Total Un-accounted for water (UFW) in Awas vikas sector 12D DMA is;

Total population for DMA Area as per registered /unregistered	**667**	**Nos.**
Population per connection for DMA	**2.97**	**Nos.**
Total DMA Study Period	**10**	**Days**
Net Flow Input to DMA area (As per Bulk Meter Readings)	**2713.75**	**M^3**
Thus, the flow input to DMA area	**271.37**	**M3/day**
Total Consumption for DMA area	**2263.6**	**M3**
Thus, Consumption for DMA Area	**226.36**	**M3/day**
Total Population of DMA connections as per Consumer Survey	**778**	**Nos**
LPCD for DMA consumers	**406**	**LPCD**
Total UFW (un-accounted for Water)	**(2713.75-2263.6)/2713.75**	
Total UFW (un-accounted for Water)	**16.59%**	

For NRW assessment, billing database diary of DMA Study area consumers are collected from ULB and studied and analysed as per following:

Total Input for the DMA area	**2713.75**	m3
Total Consumption for Registered consumers as per Water Billing Database of Agra Municipal Corporation	1054.30	m3
Total Non Revenue Water (NRW)	**(2713.75-1054.3)/2713.75**	
Total Non Revenue Water (NRW)	**61.15%**	

5.2.2 Water Balance

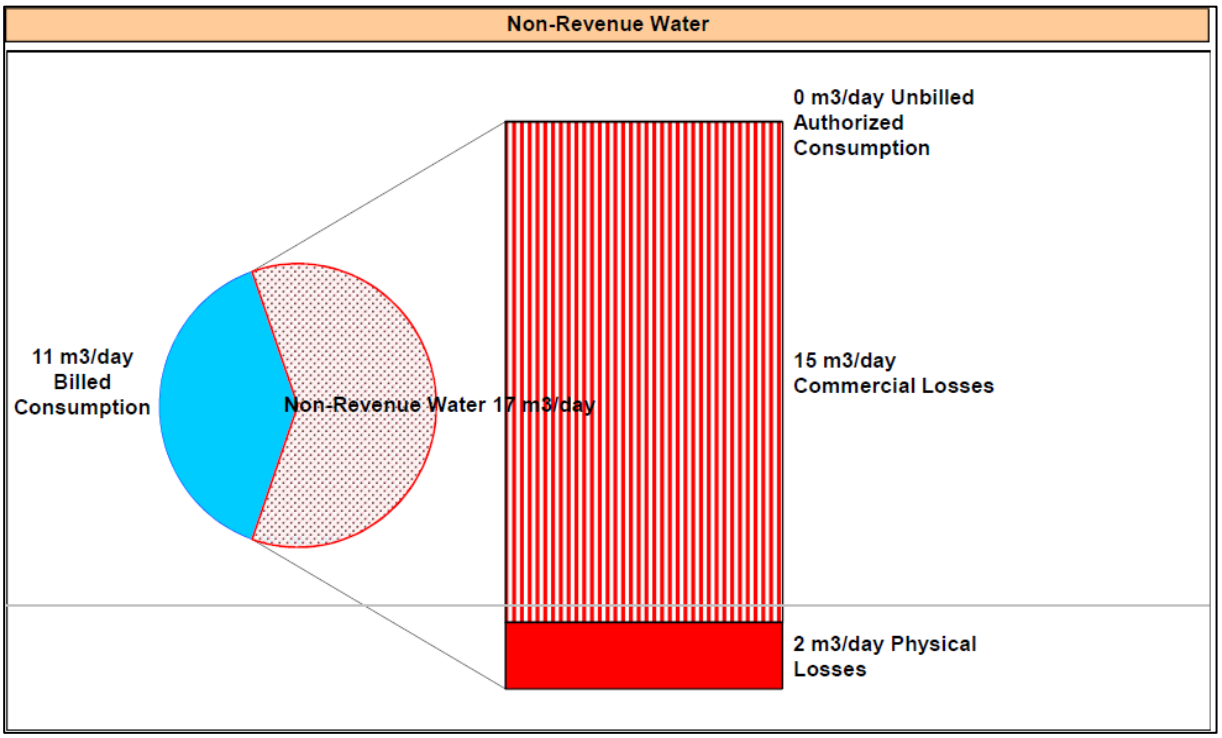


Figure 23 : Non Revenu water Chart

Home System Input Volume 27 m3/day Error Margin [+/-]: 2.0%	Authorized Consumption 11 m3/day Error Margin [+/-]: 0.0%	Billed Authorized Consumption 11 m3/day	Billed Metered Consumption 0 m3/day	Revenue Water 11 m3/day
			Billed Unmetered Consumption 11 m3/day	
		Unbilled Authorized Consumption 0 m3/day Error Margin [+/-]: 0.0%	Unbilled Metered Consumption 0 m3/day	Non-Revenue Water 17 m3/day Error Margin [+/-]: 3.3%
			Unbilled Unmetered Consumption 0 m3/day Error Margin [+/-]: 0.0%	
	Water Losses 17 m3/day Error Margin [+/-]: 3.3%	Commercial Losses 15 m3/day Error Margin [+/-]: 4.2%	Unauthorized Consumption 15 m3/day Error Margin [+/-]: 4.2%	
			Customer Meter Inaccuracies and Data Handling Errors 0 m3/day Error Margin [+/-]: 0.0%	
		Physical Losses 2 m3/day Error Margin [+/-]: 40.9%		

Table 18 : Water Balance (m3 / day)

Home System Input Volume 271 [m3] Error Margin [+/-]: 2.0%	Authorized Consumption 105 [m3] Error Margin [+/-]: 0.0%	Billed Authorized Consumption 105 [m3]	Billed Metered Consumption 0 [m3]	Revenue Water 105 [m3]
			Billed Unmetered Consumption 105 [m3]	
		Unbilled Authorized Consumption 0 [m3] Error Margin [+/-]: 0.0%	Unbilled Metered Consumption 0 [m3]	Non-Revenue Water 166 [m3] Error Margin [+/-]: 3.3%
			Unbilled Unmetered Consumption 0 [m3] Error Margin [+/-]: 0.0%	
	Water Losses 166 [m3] Error Margin [+/-]: 3.3%	Commercial Losses 146 [m3] Error Margin [+/-]: 4.2%	Unauthorized Consumption 146 [m3] Error Margin [+/-]: 4.2%	
			Customer Meter Inaccuracies and Data Handling Errors 0 [m3] Error Margin [+/-]: 0.0%	
		Physical Losses 20 [m3] Error Margin [+/-]: 40.9%		

Table 19: Water Balance (m3) for study period

5.2.3 DMA Area Consumer Survey Activity

The consumer survey activity for selected DMA area consumers / properties has been carried out by DRA team. The Billing Database list collected from the Corporation and physical site survey conducted to identify and verify the consumers of the DMA area.

Results of consumer survey are summarised below;

1. Total property / connections surveyed = 212 Nos.
2. Total Connections matched as per billing database = 107 Nos.
3. Total Consumers which are not registered = 77 Nos.

5.2.4 DMA Area Distribution Map updating

DMA area distribution network map have been prepared and updated in CAD format. The network map was verified from area incharge / line Engineer of JalSansthan. From the drawings below, it can be observed that the DMA area can be segregated from the other areas by installing bulk flow meters to inlet pipelines to the DMA area. The network details are marked on the map and updated in CAD format. The details of the network of DMA are as below;

Diameter(mm)	Diameter(inch)	Material	Length (mm)	Total length (km)
125	5"	PVC	1423.50	1.423
		Grand Total		**1.423**

Table 20: Distribution Network details

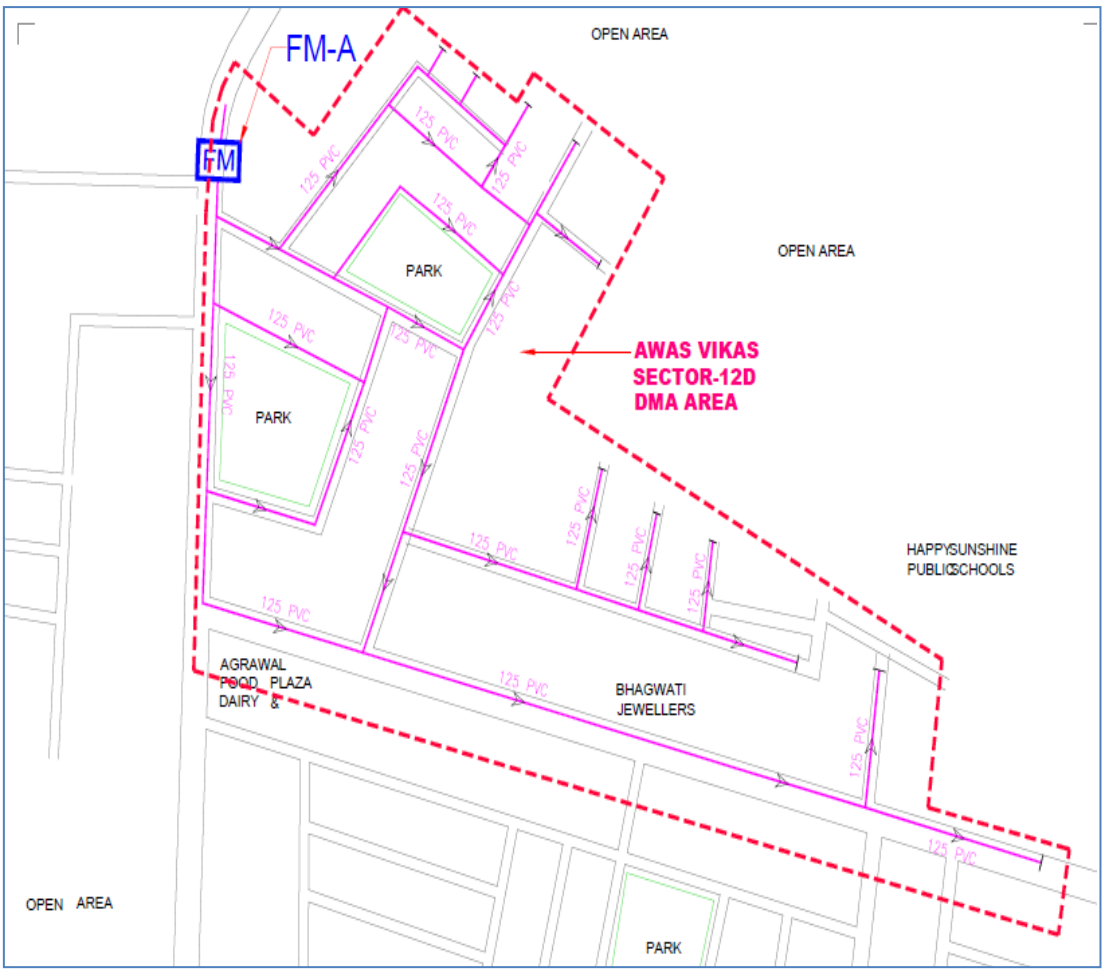


Figure 24: DMA Distribution Network Map

5.2.5 DMA Inlet Meter installations

To measure the bulk water input / supply to DMA, DRA team installed the bulk flow meters at the inlet pipeline to the Awas vikas sector 12D DMA area. The inlet pipelines where flow meters were installed to derive water input / supply to the DMA area near torent office main road awas vikas Flow and pressure data were measured for inlet points of the DMA area. ULB/Jalsansthan engineers visited the water inlet point and verified the data.

Figure 25: DMA Inlet point photos

The Water input to DMA area is tabulated below;

Bulk Flow Meter Reading for DMA- Awas vikas sector 12D					
Total Water Input to DMA (m3)					
Bulk meter installation point					
Sr.No	**Date**	**(Morning)**	**Evening**	**Total Inflow (m3)**	**Total Inflow (ML)**
1	04/10/2017	131.20	108.70	239.89	0.240
2	05/10/2017	189.37	135.76	325.13	0.325
3	06/10/2017	126.12	123.54	249.66	0.250
4	07/10/2017	94.10	127.71	221.82	0.222
5	08/10/2017	168.07	144.56	312.63	0.313
6	09/10/2017	107.90	128.56	236.46	0.236
7	10/10/2017	131.96	154.44	286.40	0.286
8	11/10/2017	128.58	131.90	260.48	0.260
9	12/10/2017	123.78	154.05	277.83	0.278
10	13/10/2017	169.08	134.36	303.44	0.303
Total Average		**137.02**	**134.36**	**271.37**	**0.271**
Total		**1370.17**	**1343.58**	**2713.75**	**2.714**

Table 21 : Water input to Awas vikas sector12D DMA Area

5.2.6 DMA Area Consumer Meter installtions

As per the consumer's survey data, it can be observed that the water meter not installed at consumers end House Service Connecion within DMA area. Consumers are being charged on flat rate basis. DRA team installed the water consumer meters for the selected consumers on sample basis for the measurement of water consumption. House service connection of the DMA area consumers were observed in poor condition due to rusted pipe and improper fittings.

Figure 26: Consumer Meter installations

5.2.7 Water Consumption / Flow Measurement

As per the supply hours, the consumers of the DMA area where the water meters were installed measured for actual water consumption. While installing the water meters, the consumers like domestic, non domestic were covered for actual water consumption. Also, the consumers which are not registered in billing database diary but consuming water from the system were measured to estimate the actual water loss & revenue loss to the Agra Jal Sansthan.

Un-authorised water connection was also measured by installing water meters and bucket filling method to derive the water consumption / water loss.

Figure 27: Bucket filling at sector 12D

5.2.8 Identification of water loss / NRW areas

Also, the water loss areas like pipe leakge from 125 mm PVC pipe was observed due pipe break resulting into water lekages and water loss.

Figure 28: Pipeline leakage at sector 12D

During study period few open taps / un-authorised access points was observed near by vinay medical store house no.392 at Awas vikas sector 12D DMA area. Open tap is being misused by nearby consumers resulting into Non Revenue water / water loss to the department.

Figure 29: Open Tap / Un-authorised acess

5.2.9 Pressure Measurement at Consumer tap

Pressure measurement activity was also carried out on the consumers of the DMA area to know average pressure available at consumer tap. The pressure mesurment taken with consumar pumps.

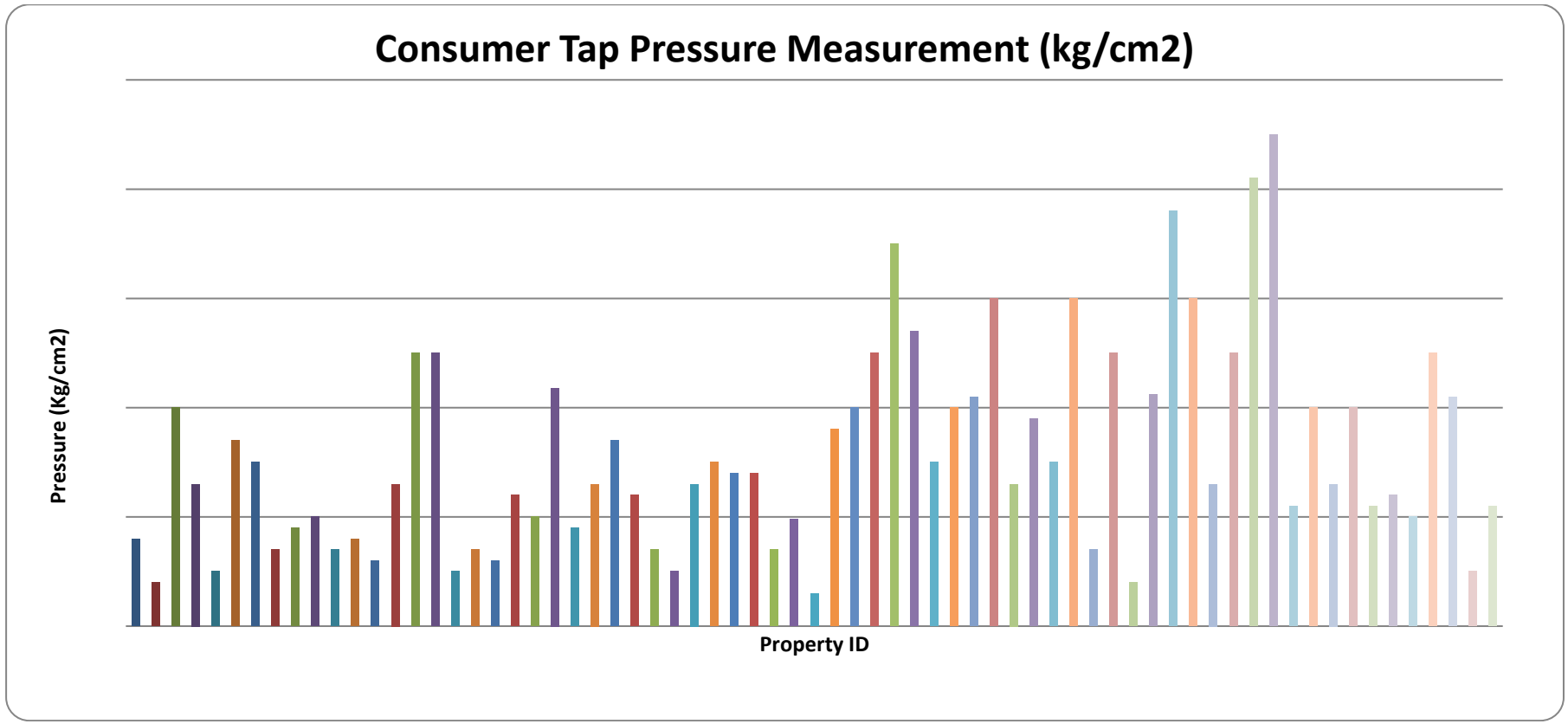
Sr.No	Property ID	Name	Address	Consumer ID	Date	Connection & Meter Status	Pressure (kg/cm2
1	314	Samta Goutam	319	AW-222/206	05-Oct-17	Registered	0.40
2	322	Gajendra Kumar sharma	222	AW-222/165/166	05-Oct-17	Registered	0.2
3	327	Devendar Singh	216	AW-222/160	05-Oct-17	Registered	1
4	328	Bal Kishan Tomat	215	AW-222/159	05-Oct-17	Registered	0.65
5	337	Sita Laskari	323	AW-222/208	05-Oct-17	Registered	0.25
6	339	Usha Devi	327	AW-222/212	05-Oct-17	Registered	0.85
7	344	R C Jain	333,334	AW-222/216/217	05-Oct-17	Registered	0.75
8	347	Ajay Sharma	262		05-Oct-17	Un-Registered	0.35
9	351	Puneet Arora	254			Un-Registered	0.45
10	361	Ashok Madan	413	AW-222/253	05-Oct-17	Registered	0.50
11	369	Dinesh Singh	404		05-Oct-17	Un-Registered	0.35
12	370	Ajay Singh	405		05-Oct-17	Un-Registered	0.40

Sr.No	Property ID	Name	Address	Consumer ID	Date	Connection & Meter Status	Pressure (kg/cm2
13	371	Anil Kumar	403		05-Oct-17	Un-Registered	0.30
14	372	CS Yadav	402	AW-222/250	05-Oct-17	Registered	0.65
15	373	Shadhna Yadav	401	AW-222/371	05-Oct-17	Registered	1.25
16	377	RK Varma/ Shiv LaL Varma	394	AW-222/347	05-Oct-17	Registered	1.25
17	378	Manoj Sharma/ Amit Sharma	395		05-Oct-17	Un-Registered	0.25
18	379	Sath Prabha Yadav	396	AW-222/247	05-Oct-17	Registered	0.35
19	381	Ravi Parkash Sharma	398	AW-222/248	05-Oct-17	Registered	0.30
20	383	AP Srivastav	399		05-Oct-17	Un-Registered	0.6
21	385	Umesh Chandra Agnihotri	399		05-Oct-17	Un-Registered	0.50
22	388	Amar Singh	338		05-Oct-17	Un-Registered	1.09
23	395	Manoj chandri	368	AW-222/230	06-Oct-17	Registered	0.45
24	396	Aftab ahemad Khan	369	AW-222/231	06-Oct-17	Registered	0.65
25	397	Vinod Kumar	370	AW-222/232	06-Oct-17	Registered	0.85
26	398	Chohan	371	AW-222/335	06-Oct-17	Registered	0.6
27	402	Praveen	375	AW-222/337	06-Oct-17	Registered	0.35
28	404	Rajendar Kumar	377	AW-222/339	06-Oct-17	Registered	0.25
29	406	Radha Devi	379	AW-222/341	06-Oct-17	Registered	0.65
30	407	Vimla Devi	380	AW-222/234	06-Oct-17	Registered	0.75
31	408	GL Gupta	381/382	AW-222/342	06-Oct-17	Registered	0.7
32	409	Santhosh Kumar	383	AW-222/235	06-Oct-17	Registered	0.7
33	501	Ravendar Singh Yadav	558		06-Oct-17	Un-Registered	0.35
34	502	Mohine Katheriya	559		96 sec	Un-Registered	0.49
35	503	Nirmala devi	556		06-Oct-17	Un-Registered	0.15
36	505	Bablu Gupta	554		06-Oct-17	Un-Registered	0.9

Sr.No	Property ID	Name	Address	Consumer ID	Date	Connection & Meter Status	Pressure (kg/cm2
37	507	Shubedar AK Das	552		06-Oct-17	Un-Registered	1
38	508	Mundra Upadhya	551		06-Oct-17	Un-Registered	1.25
39	509	Jetandar Singh	550		06-Oct-17	Un-Registered	1.75
40	510	Srabni Das	549		08-Oct-17	Un-Registered	1.35
41	511	Ravi Kapoor	548,		08-Oct-17	Un-Registered	0.75
42	512	Ajay Mohan Kasyap	547		117 sec	Un-Registered	1
43	513	Daya Sankar tilak	546		08-Oct-17	Un-Registered	1.05
44	514	Haneef Khan	545	AW-222/369	08-Oct-17	Registered	1.5
45	515	Raju	544		08-Oct-17	Un-Registered	0.65
46	516	Harsh Gupta	543		08-Oct-17	Un-Registered	0.95
47	517	Rama Sankar pachori	542	AW-222/330	08-Oct-17	Registered	0.75
48	518	Jugal Kishor/ Naval Kishor	541 & 540		08-Oct-17	Un-Registered	1.5
49	519	Jyoti Shuri	539		123 sec	Un-Registered	0.35
50	520	Sanjay Khatri	538		135 sec	Un-Registered	1.25
51	521	Manoj Gupta	537	AW-222/374	08-Oct-17	Registered	0.2
52	522	Dav Dash	536		08-Oct-17	Un-Registered	1.06
53	523	Pravesh Chandra	535		08-Oct-17	Un-Registered	1.9
54	526	Verma Ji	532/531		08-Oct-17	Un-Registered	1.50
55	533	Pushpa Sharma	524			Un-Registered	0.65
56	534	Bagwan Das	523		08-Oct-17	Un-Registered	1.25
57	539	Vivek	462		08-Oct-17	Un-Registered	2.05
58	540	Sashi Yadav	461		08-Oct-17	Un-Registered	2.25
59	542	VishvNath Parasar	459		08-Oct-17	Un-Registered	0.55
60	543	Jawahar Singh	458		80 sec	Un-Registered	1
61	546	Kamlesh kumar	453		09-Oct-17	Un-Registered	0.65
62	547	Tripta arora	452		09-Oct-17	Un-Registered	1
63	548	Shiv Singh	457		09-Oct-17	Un-Registered	0.55
64	552	Uma Devi	446		09-Oct-17	Un-Registered	0.6
65	624	Virendra	517		13-Oct-17	Un-Registered	0.50
66	626	Mr.mukesh	519	AW-222/384	13-Oct-17	Registered	1.25

Sr.No	Property ID	Name	Address	Consumer ID	Date	Connection & Meter Status	Pressure (kg/cm2
67	629	Dinesh	511		13-Oct-17	Un-Registered	1.05
68	633	Mamta Varma	505		13-Oct-17	Un-Registered	0.25
69	634	Bharadwaj Raghav	506		13-Oct-17	Un-Registered	0.55

Table 22 : Details of Pressure Measurement



Graph 1: Pressure at Consumer tap

5.3 DMA STUDY FOR TAJGANJ AREA

As per the instruction of the Municipal Corporation and Jalsansthan officials, following DMA areas were selected for NRW study.

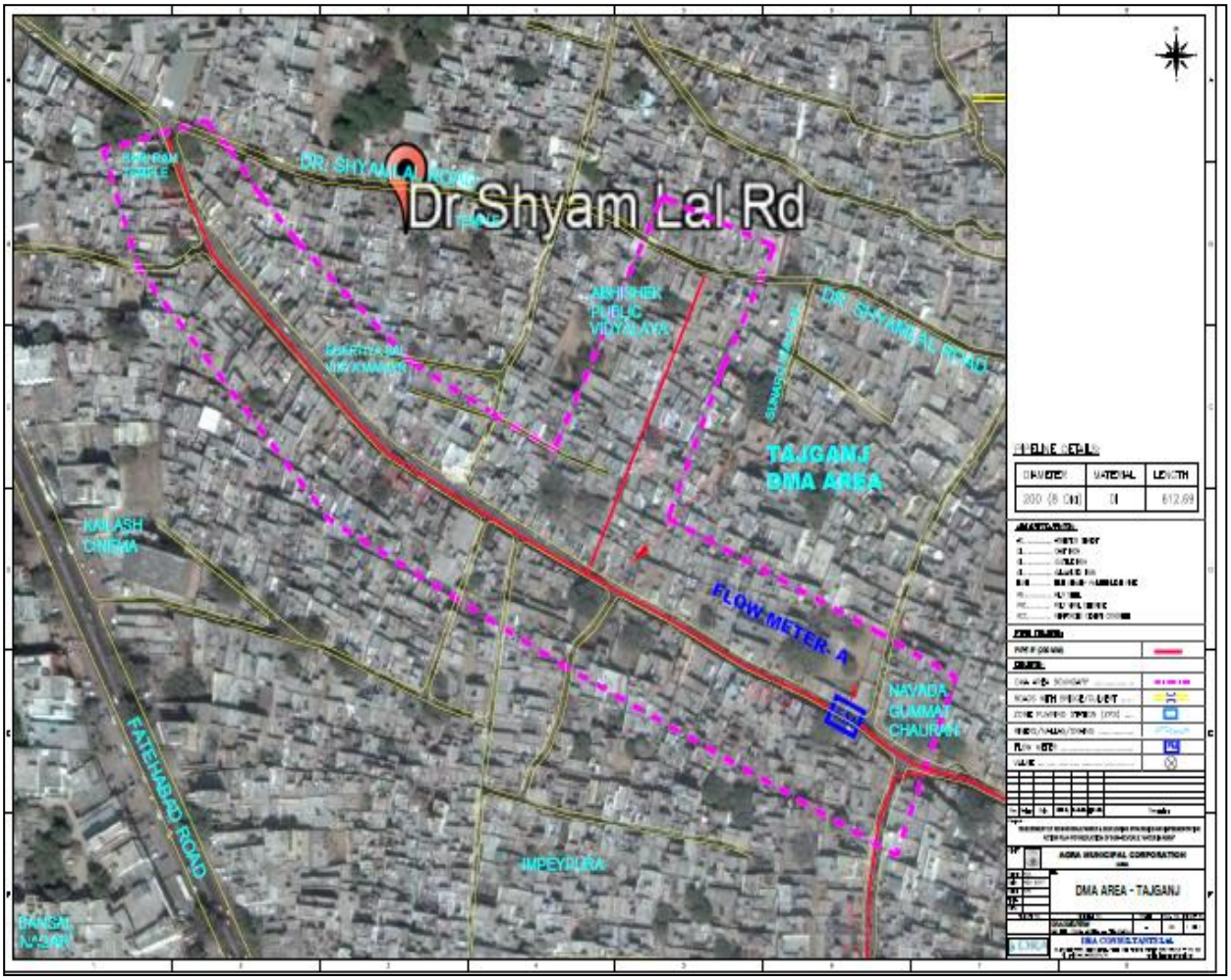


Figure 30: Schematic representation of a DMA.

The distribution network details for the Tajganj Network are as below;

LENGTH OF TAJGANJ DMA AREA		
Sr. no.	**Diameter(mm)**	**LENGTH(m)**
1	250 mm DI	612.69

Table 23: Tajganj Network details

5.3.1 NRW Assessment for Tajganj

Tajganj DMA area is located near to famous "Tajmahal" which is also selected under Smart City Project(ABD area) by Agra Municipal Corporation. The area comprises of mostly domestic consumers. Door to door consumer survey activity was carried out by DRA team to identify the actual consumer's within the selected DMA area and also to collect the information such as total no. of members, registered/ un-registered status of consumers, consumption pattern etc. The boundary limits of the DMA area is marked in drawings and the results of consumer's

Figure 31: DMA Inlet point Hajipura square

Survey is tabulated as per following;

Total property / Connections as per consumer survey	**287**	**Nos.**
Total Connections matched with Billing database	**70**	**Nos.**
Total Connection where meter installed during DMA study	**77**	**Nos**
Total consumers with "No Connections Status"	**26**	**Nos.**
Total Un-registered Consumers (not in Water Billing Database)	**198**	**Nos.**
Connections with House Lock Status (Permanent Lock)	**3**	**Nos.**
Connections with House Lock Status (Temporary Lock)	**1**	**Nos.**
Stand post (free connections)	**0**	**Nos.**
Connections with Open taps (un-authorized access)	**7**	**Nos.**
Net Active Connections during study	**258**	**Nos.**

Table 24: Consumer Survey Summary

As per consumer survey, population of the DMA area is as following:

Total population for DMA Area as per Consumer Survey	**1498**	**Nos.**
Population per connection for DMA	**5.22**	**Nos.**

Table 25 : DMA Consumer Survey Summary

During DMA study, the selected area was surveyed and studied to isolate the area boundary with other area and accordingly water inlet points to the project area were identified and marked on drawings. The distribution network of the DMA area was also updated in consultation with Jalsansthan staff. Tajganj DMA area has following water input sources;

2. 250 mm dia DI pipes inlet from Tajganj ZPS.

DMA water flow meters were installed on all above water inlet points to measure the actual water input to the DMA area. Accordingly, inlet points were metered and measured and referred as in this report.

Bulk Flow Meters have been installed at following locations in the study area;

Location Details	Line Size	Date of Meter installation	Flow Rate (m3/Hr.) Morning Supply	Flow Rate (m3/Hr.) Evening Supply
Shyamalal Marg Tajganj	**250 mm**	03/11/2017	272	175

Table 26: DMA Inlet Flow Measurement Point

Location-Hajipura Square

Figure 32: DMA inlet Flow Measurement Photos

The DMA study was carried out from 3/11/2017 to 18/11/2017. Water is being supplied to the consumers of the DMA area on daily basis during morning and evening hrs. Water Supply timing details for the DMA area is as following:

Supply Time	**Total Avg Hrs. =2.30 hrs.**
Morning Supply	i) 3:45 a.m. to 5:15 am
Evening Supply	ii) 4:15 p.m. to 5:15 p.m.

Location-House No-7/151 1K-1A

Location -House No 7/151-1A

Location -House No 15/1A

House No-16/17

House No-16/21

House No-16/43B-2R

Figure 33: DMA pressure Measurement Photos

The Pressure Measurement activity was carried out during DMA study in the area on sample basis. Total No. of pressure samples taken for 43 Nos. Pressure gauges were installed at various locations of consumer connection and measured for study purpose. The results of pressure measurement activity are as below;

Average Pressure at consumer end	**0.41**	**kg/cm2**
Max Pressure observed during study	**0.90**	**kg/cm2**

DMA study for the Tajganj DMA Area started on 3-11-2017 and ended on 18-11-2017. Thus total study period for the DMA is 15 days.

Thus, Total Un-accounted for water (UFW) in Tajganj DMA is;

Total active population for DMA Area	**1498.00**	**Nos.**
Population per connection for DMA	**5.22**	**Nos.**
Total DMA Study Period	**15**	**Days**
Net Flow Input to DMA area (As per Bulk Meter Readings)	**11846.81**	**M^3**
Thus, the flow input to DMA area	**789.79**	**M3/day**
Total Consumption for DMA area	**3969.79**	**M3**
Thus, Consumption for DMA Area	**264.65**	**M3/day**
Total Population of DMA connections as per Consumer Survey	**1613**	**Nos.**
LPCD for DMA consumers	**489.64**	**LPCD**
Total UFW (un-accounted for Water)	**(11846.81-3969.79)/11846.81**	
Total UFW (un-accounted for Water)	**66.49%**	

For NRW assessment, billing database diary of DMA Study area consumers are collected from Agra Municipal Corporation Billing department and studied and analysed as per following:

Total Input for the DMA area	**11846.81**	**M3**
Total Consumption for Registered consumers as per Water Billing Database of Agra Municipal Corporation	**1006.38**	**M3**
Total Non Revenue Water (NRW)	**(11846.81- 1006.38) / 11846.81**	
Total Non Revenue Water (NRW)	**91.51%**	

5.3.2 Water Balance

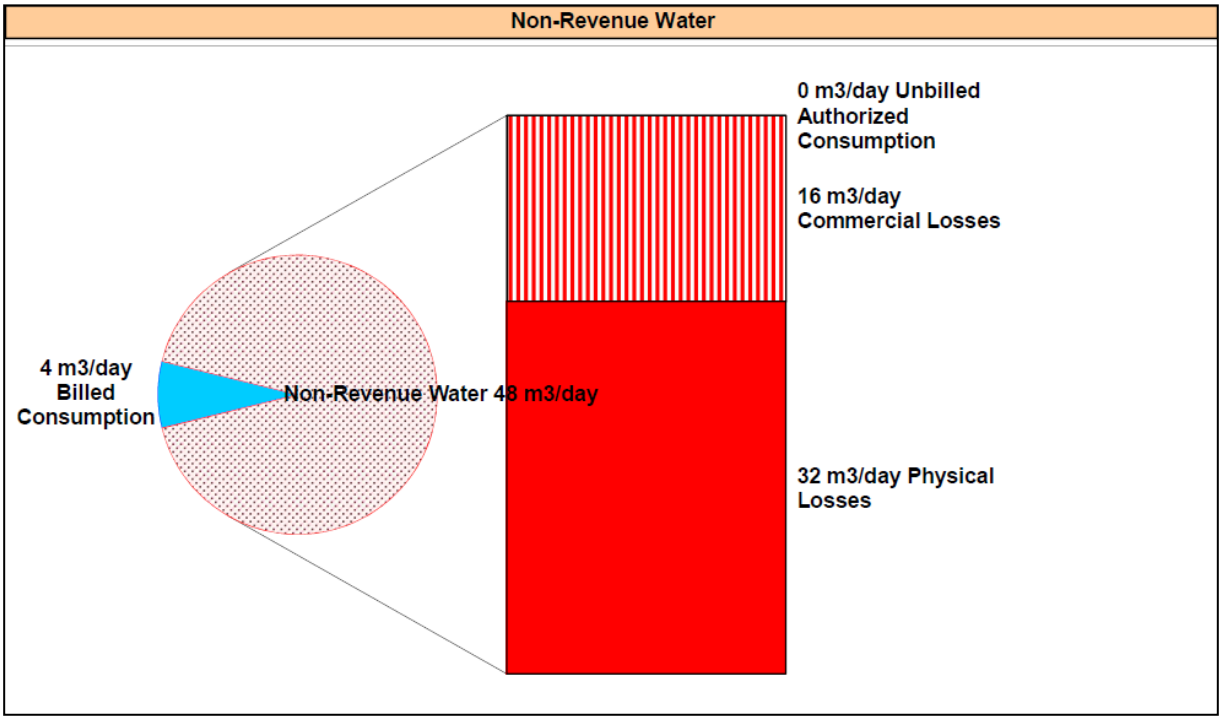


Figure 34 : Non Revenue water Chart

Water Balance in m3/day

Home System Input Volume 53 m3/day Error Margin [+/-]: 2.0%	Authorized Consumption 4 m3/day Error Margin [+/-]: 0.0%	Billed Authorized Consumption 4 m3/day	Billed Metered Consumption 0 m3/day	Revenue Water 4 m3/day
			Billed Unmetered Consumption 4 m3/day	
		Unbilled Authorized Consumption 0 m3/day Error Margin [+/-]: 0.0%	Unbilled Metered Consumption 0 m3/day	Non-Revenue Water 48 m3/day Error Margin [+/-]: 2.2%
			Unbilled Unmetered Consumption 0 m3/day Error Margin [+/-]: 0.0%	
	Water Losses 48 m3/day Error Margin [+/-]: 2.2%	Commercial Losses 16 m3/day Error Margin [+/-]: 4.2%	Unauthorized Consumption 16 m3/day Error Margin [+/-]: 4.2%	
			Customer Meter Inaccuracies and Data Handling Errors 0 m3/day Error Margin [+/-]: 0.0%	
		Physical Losses 32 m3/day Error Margin [+/-]: 3.9%		

Table 27 : Water Balance (m3 / day)

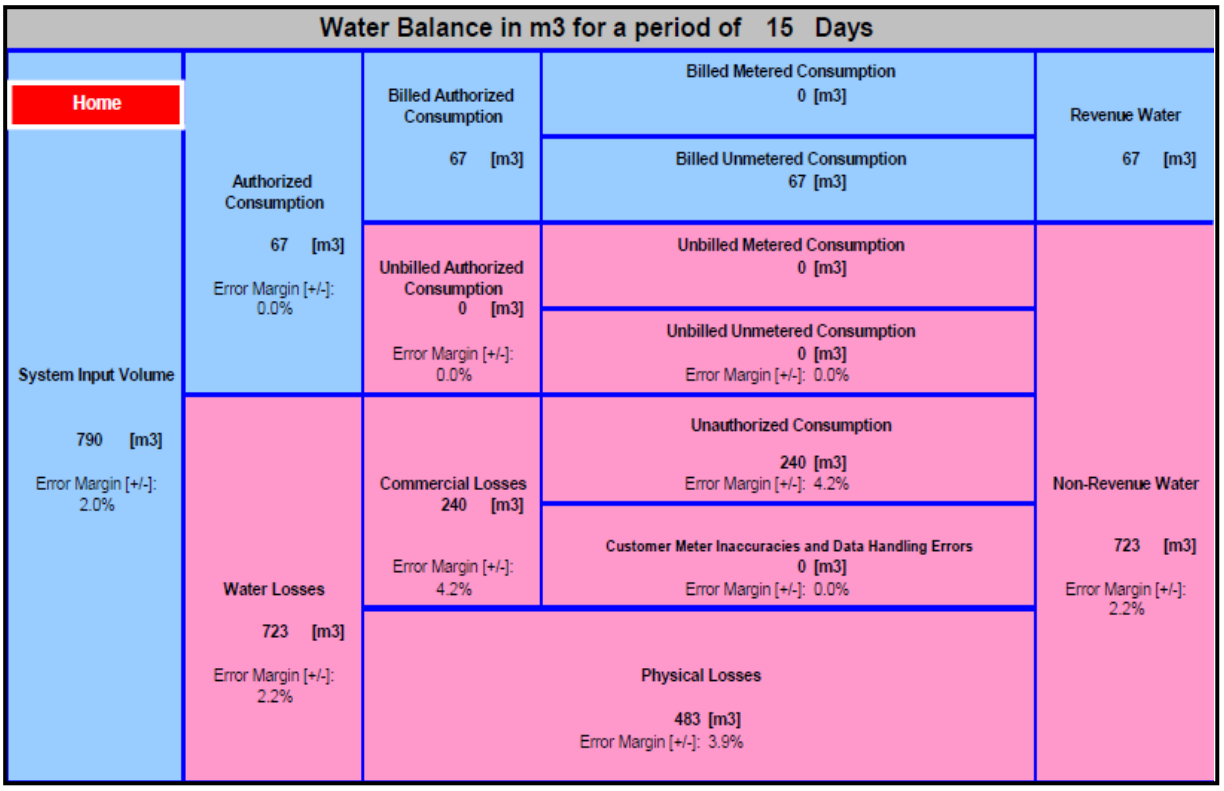


Table 28: Water Balance (m3) for study period

5.3.3 DMA Area Consumer Survey Activity

The consumer survey activity for selected DMA area consumers / properties has been carried out by DRA team. The Billing Database list collected from the Corporation and physical site survey conducted to identify and verify the consumers of the DMA area.

Location House No- 7/144 House No-16/21Gc House No- 16/66C18

Figure 35: DMA Consumer survey Photos

Results of consumer survey are summarised below;

1. Total property / connections surveyed = 287 Nos.
2. Total Connections matched as per billing database = 70 Nos.
3. Total Consumers which are not registered = 198 Nos.
4. Total Connection with "no Connection" status =26 Nos.
5. Total meter installed in DMA by DRA = 77 Nos.

5.3.4 DMA Area Distribution Map updating

DMA area distribution network map have been prepared and updated in CAD format. The network map was verified from area in charge / line Engineer of Jalsansthan. From the drawings below, it can be observed that the DMA area can be segregated from the other areas by installing bulk flow meters to inlet pipelines to the DMA area. The network details are marked on the map and updated in CAD format. The details of the network of DMA are as below;

Diameter(mm)	Diameter(inch)	Material	Length (m)	Total length (km)
250	10"	DI	612.69	0.612
		Grand Total		**0.612**

Table 29: Distribution Network details

5.3.5 DMA Inlet Meter installations

To measure the bulk water input / supply to DMA, DRA team installed the bulk flow meters at the inlet pipeline to the Tajganj DMA area. The inlet pipelines where flow meters were installed to derive water input / supply to the DMA Hajipura Square Shyamalal Marg Flow and pressure data were measured for inlet points of the DMA area. ULB/Jalsansthan engineers visited the water inlet point and verified the data.

Location- Shyamlal Marg Square

Figure 36: DMA Inlet point photos

The Water input to DMA area is tabulated below;

Bulk Flow Meter Reading for DMA- Tajganj						
Total Water Input to DMA (m3)						
Bulk meter installation point						
Sr.No	**Date**	**Morning Supply(m3)**	**Evening Supply(m3)**	**Leakage flow supply(m3)**	**Total Inflow (m3)**	**Total Inflow (M3)**
1	3/11/2017	272	175	343	447	790
2	4/11/2017	255	134	400	389	789
3	5/11/2017	265	144	380	409	789
4	6/11/2017	278	145	366	423	789
5	7/11/2017	258	164	367	422	789
Total Average		**265.6**	**152.4**	**371.2**	**418**	**789.2**
Total		**1328**	**762**	**1856**	**2090**	**3946**

Table 30 : Water input to Tajganj DMA Area

As per the consumer's survey data, it can be observed that the water meter not installed at consumers end House Service Connection within DMA area. Consumers are being charged on flat rate basis by Agra Jal Sansthan. DRA team installed the water consumer meters for the selected consumers on sample basis for the measurement of water consumption. House service connection of the DMA area consumers were observed in poor condition due to rusted pipe and improper fittings.

Location-House No 7/121

Location-HouseNo 5/229

Location-House No 7/128

Figure 37: DMA Area Consumer Meter installations

5.3.6 Water Consumption / Flow Measurement

As per the supply hours, the consumers of the DMA area where the water meters were installed measured for actual water consumption. While installing the water meters, the consumers like domestic, non domestic were covered for actual water consumption. Also, the consumers which are not registered in billing database diary but consuming water from the system were measured to estimate the actual water loss & revenue loss to the ULB. Un-authorised water connection was also measured by installing water meters and bucket filling method to derive the water consumption / water loss.

Location-House No 15/28

Location-House No 18/246

Figure 38: Bucket filling at Tajganj

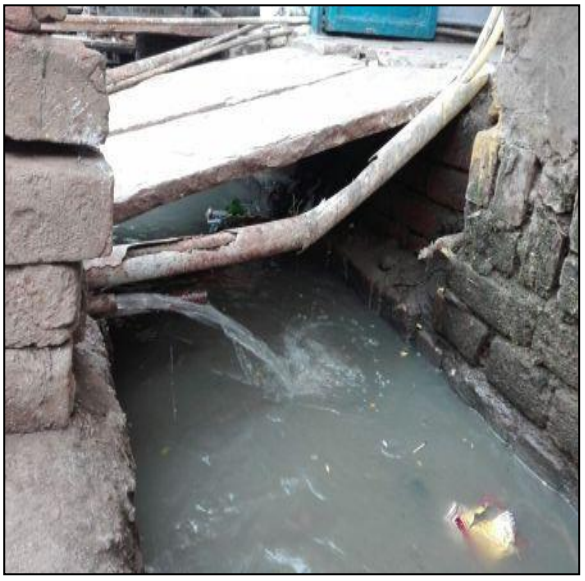
5.3.7 Identification of water loss / NRW areas

During study period many open taps / un-authorised access points was observed in Tajganj DMA area. Open tap is being misused by nearby consumers resulting into Non Revenue water / water loss to the department.

Location- House No 15/215

Location- Near Janseva Kendra

Location-Kala Devi Temple



Location-Near House No 15-51A

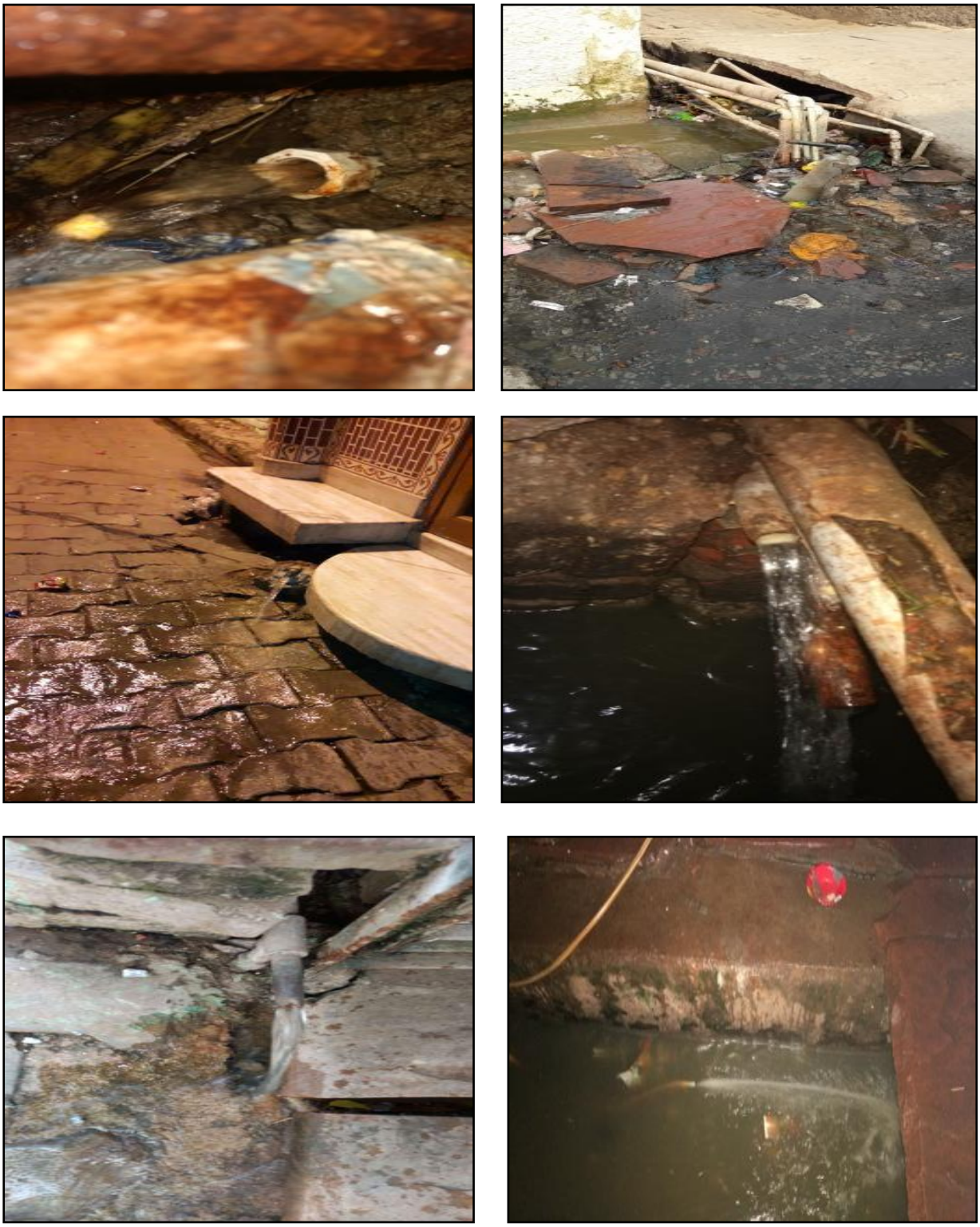
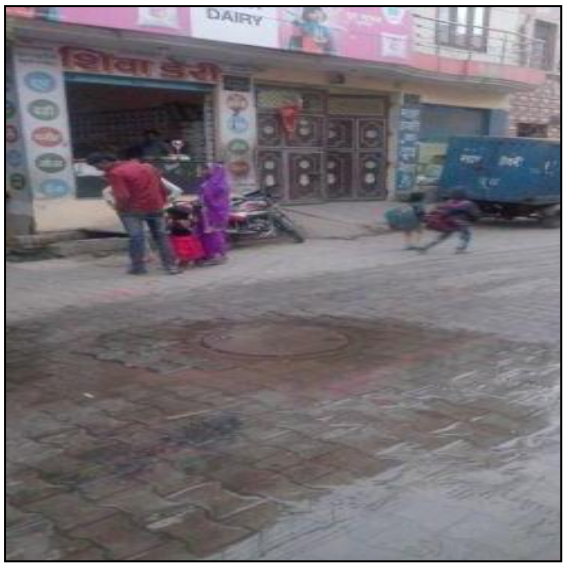


Figure 39: Open Tap / Un-authorized access

Also, the water loss areas like pipe leakage from 280 mm DI pipe was observed due pipe break resulting into water leakages and water loss.



Location -Shiv Dairy

Location – House No-15-195

Location- Near Kalidevi Temple

Location –Near House No 15/151

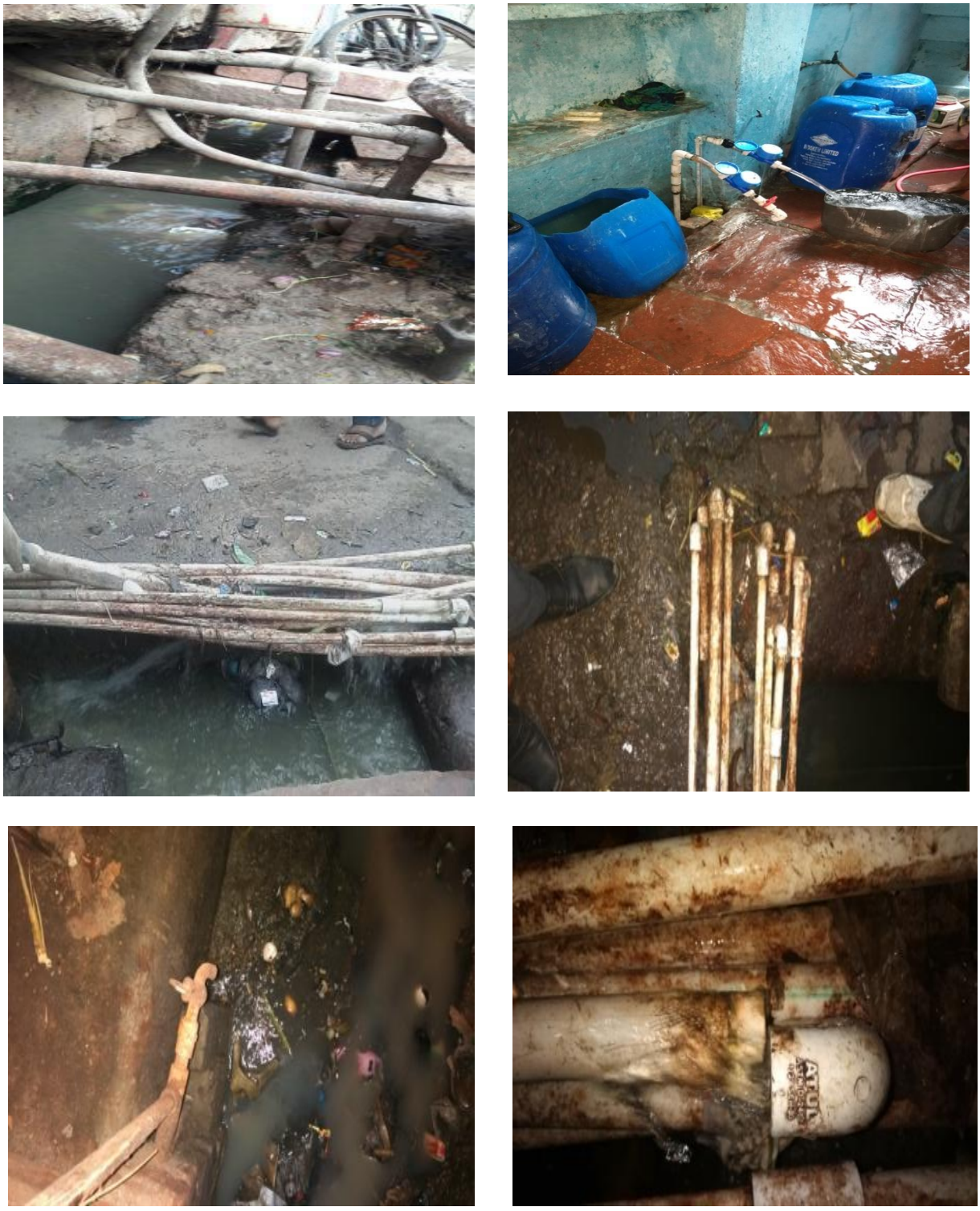


Figure 40: Pipe Leakage Tajganj DMA

5.3.8 Pressure Measurement at Consumer tap

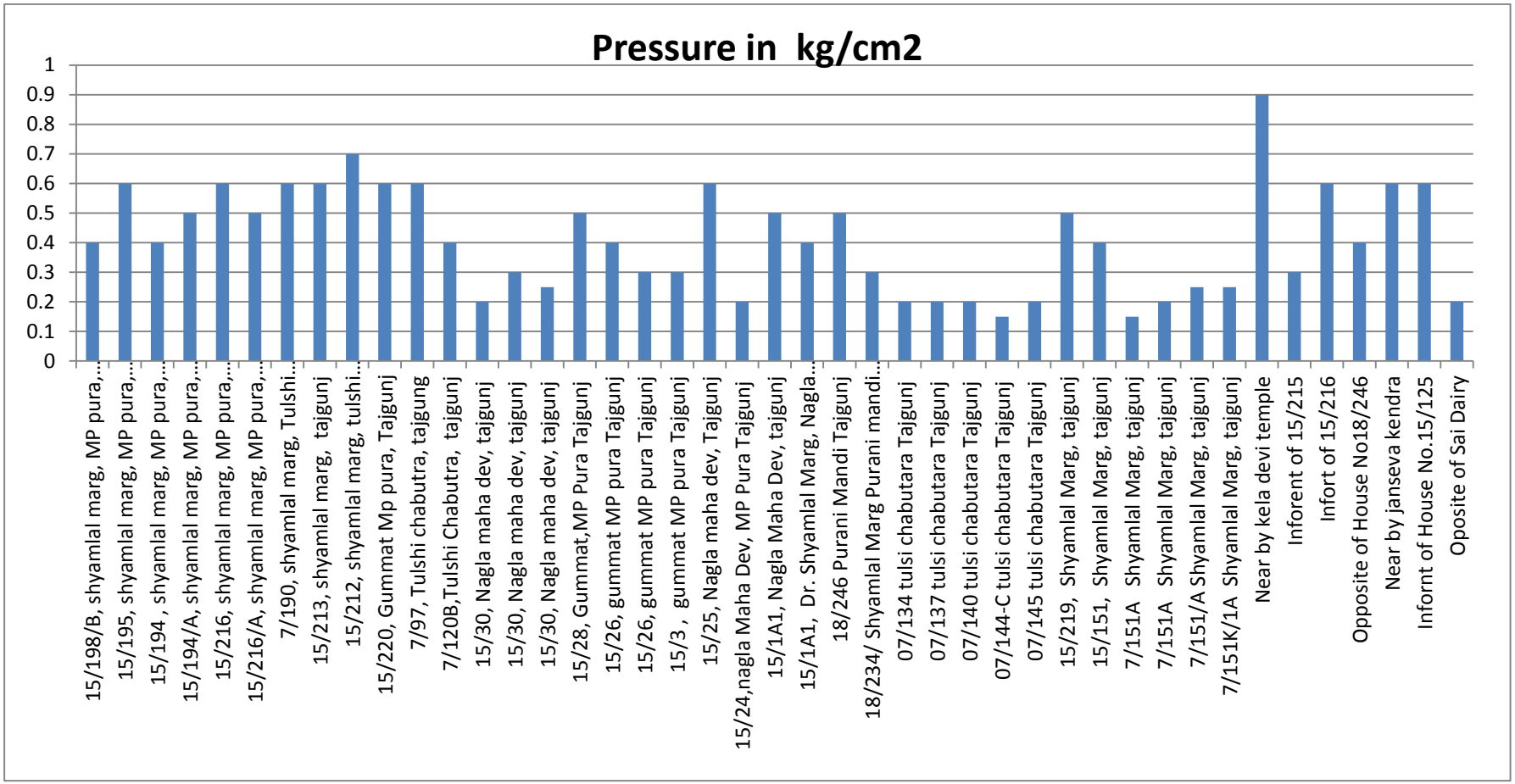
Pressure measurement activity was also carried out on the consumers of the DMA area to know average pressure available at consumer tap.

Sr. No	Property ID	Name	Address	Consumer ID	Connection & Meter Status	Pressure in kg/cm^2
1	204	Gopichand	15/198/B, shyamlal marg, MP pura, Ghumat, Tajganj	TG-25/372	Registered	0.4
2	209	Shyam Babu	15/195, shyamlal marg, MP pura, Ghumat, tajgunj	TG-25/369	Registered	0.6
3	210	Rajkumari	15/194 , shyamlal marg, MP pura, Ghumat, tajgunj		Un-Registered	0.40
4	211	Amar Singh/ Ninu singh	15/194/A, shyamlal marg, MP pura, Ghumat, tajgunj	Bill available No id	Registered	0.50
5	214	Nathilal	15/216, shyamlal marg, MP pura, Ghumat, tajgunj	TG-25/395	Registered	0.60
6	215	Lala singh	15/216/A, shyamlal marg, MP pura, Ghumat, tajgunj		Un-Registered	0.50
7	218	Maan devi	7/190, shyamlal marg, Tulshi chabutra, tajgunj	TG-11/318	Registered	0.60
8	224-A	Dooji Ram	15/213, shyamlal marg, tajgunj	TG-25/389	Registered	0.60
9	229	Monga devi	15/212, shyamlal marg, tulshi Chabutra, tajgunj	TG-25/388	Registered	0.70
10	247	rajan Devi	15/220, Gummat Mp pura, Tajgunj		Un-Registered	0.60
11	255-A	Ram devi	7/97, Tulshi chabutra, tajgung		Un-Registered	0.60
12	255-B	Rama devi	7/120B,Tulshi Chabutra, tajgunj		Un-Registered	0.40
13	273	Gumman Singh Bhageal	15/30, Nagla maha dev, tajgunj		Un-Registered	0.20
14	274	gopi Chand bhageal	15/30, Nagla maha dev, tajgunj		Un-Registered	0.30
15	275	Abdesh bhageal	15/30, Nagla maha dev, tajgunj		Un-Registered	0.25
16	281	ramesh Chandr	15/28, Gummat,MP		Un-Registered	0.50

Sr. No	Property ID	Name	Address	Consumer ID	Connection & Meter Status	Pressure in kg/cm^2
		kerry	Pura Tajgunj			
17	283	kaila devi	15/26, gummat MP pura Tajgunj		Un-Registered	0.40
18	284	Ashok	15/26, gummat MP pura Tajgunj		Un-Registered	0.30
19	285	Nand Kishor	15/3 , gummat MP pura Tajgunj		Un-Registered	0.30
20	287	Vishnu kaire	15/25, Nagla maha dev, Tajgunj		Un-Registered	0.60
21	299	rajesh khare	15/24,nagla Maha Dev, MP Pura Tajgunj		Un-Registered	0.20
22	306	rajendar kumar	15/1A1, Nagla Maha Dev, tajgunj	Bill available No id	Registered	0.50
23	307	kunni Ram	15/1A1, Dr. Shyamlal Marg, Nagla Maha Dev, tajgunj	Bill available No id	Registered	0.40
24	349	jasvant singh	18/246 Purani Mandi Tajgunj		Un-Registered	0.50
25	357	Shitaram choukhey	18/234/ Shyamlal Marg Purani mandi Tajgunj		Un-Registered	0.30
26	364	Rajendra prasad	07/134 tulsi chabutara Tajgunj		Un-Registered	0.20
27	365	Basantlal	07/137 tulsi chabutara Tajgunj		Un-Registered	0.20
28	366	Daulat Ram	07/140 tulsi chabutara Tajgunj		Un-Registered	0.20
29	373	Ramesh chand	07/144-C tulsi chabutara Tajgunj		Un-Registered	0.15
30	374	Adal Singh	07/145 tulsi chabutara Tajgunj		Un-Registered	0.20
31	427	Patiram	15/219, Shyamlal Marg, tajgunj	TG-25/399	Registered	0.50
32	429	Maha Devi	15/151, Shyamlal Marg, tajgunj		Un-Registered	0.40
33	469	Angat Singh	7/151A Shyamlal Marg, tajgunj		Un-Registered	0.15
34	470	Angat Singh	7/151A Shyamlal Marg, tajgunj		Un-Registered	0.20
35	471	Bhogiram	7/151/A Shyamlal Marg, tajgunj	TG-10/216	Registered	0.25
36	472	Shobharam Singh	7/151K/1A Shyamlal Marg, tajgunj		Un-Registered	0.25

Sr. No	Property ID	Name	Address	Consumer ID	Connection & Meter Status	Pressure in kg/cm^2
37	473	Open Tab	Nearby kela devi temple		Un-Registered	0.90
38	473	Open Tab	In front of 15/215		Un-Registered	0.30
39	473	Open Tab	In front of 15/216		Un-Registered	0.60
40	473	Open Tab	Opposite of House No18/246		Un-Registered	0.40
41	473	Open Tab	Nearby janseva kendra		Un-Registered	0.60
42	473	Open Tab	In front of House No.15/125		Un-Registered	0.60
43	473	Open Tab	Opposite of Sai Dairy		Un-Registered	0.20

Table 31 : Details of Pressure Measurement



Graph 2: Pressure at Consumer tap

5.4 DMA STUDY FOR HARJUPURA AREA

As per the instruction of the Municipal Corporation and Jalsansthan officials, following DMA areas were selected for NRW study.

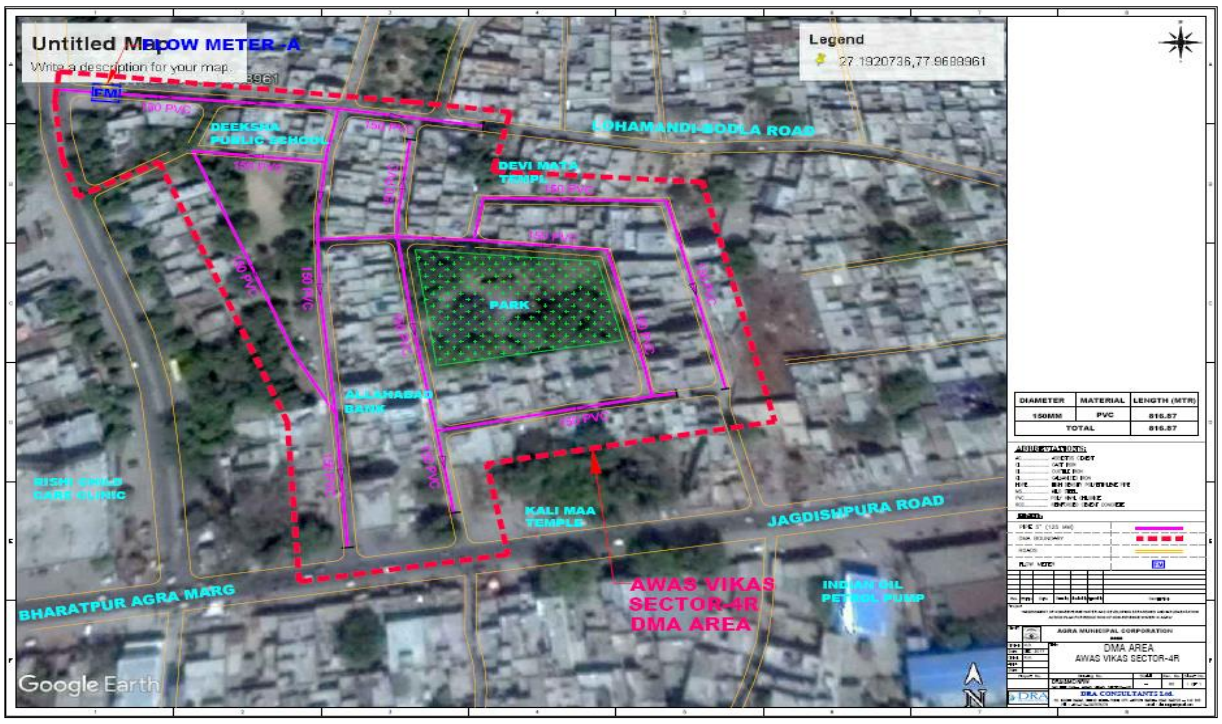


Figure 41: Schematic representation of a DMA.

The distribution network details for the Harjupura Network are as below;

LENGTH OF HARJUPURA DMA AREA		
Sr. no.	**Diameter(mm)**	**LENGTH(m)**
1	100 (4')	31.28
2	100 (4')	91.44
3	100 (4')	55.11
4	100 (4')	116.59
5	100 (4')	61.64
6	100 (4')	54.58
7	100 (4')	20.02
8	100 (4')	118.16
9	200 (8')	485.68
TOTAL LENGTH		**1034.50**

Table 32: Harjupura Network details

5.4.1 NRW Assessment for Harjupura

Harjupura DMA area is located near to famous "Tajmahal" which is also selected under Smart City Project by Agra Municipal Corporation. The area comprises of mostly domestic consumers. Door to door consumer survey activity was carried out by DRA team to identify the actual consumer's within the selected DMA area and also to collect the information such as total no. of members, registered/ un-registered status of consumers, consumption pattern etc. The boundary limits of the DMA area is marked in drawings and the results of consumer's Survey is tabulated as per following;

Figure 42: Fatehabad road DMA Inlet point

Harjupura Area Consumer Survey summary		
Total property / Connections as per consumer survey	**297**	**Nos.**
Total Connections matched with Billing database (Registered)	**110**	**Nos.**
Total Connection where meter installed during DMA study	**97**	**Nos.**
Total No Connections Status	**40**	**Nos.**
Total Un-registered Consumers (not in Water Billing Database)	**139**	**Nos.**
Connections with House Lock Status (Permanent Lock)	**7**	**Nos.**
Connections with House Lock Status (Temporary Lock)	**5**	**Nos.**
Stand post (free connections)	**0**	**Nos.**
Connections with Open taps (un-authorized access)	**3**	**Nos.**
Net Active Connections during study	**250**	**Nos.**

As per consumer survey, population of the DMA area is as following:

Total population for DMA Area as per Consumer Survey	**1329.00**	**Nos.**
Population per connection for DMA	**4.47**	**Nos.**

Table 33 : DMA Consumer Survey Summary

During DMA study, the selected area was surveyed and studied to isolate the area boundary with other area and accordingly water inlet points to the project area were identified and marked on drawings. The distribution network of the DMA area was also updated in consultation with Jalsansthan staff. Harjupura DMA area has following water input sources;

3. 250 mm dia DI pipes inlet from Tajganj ZPS.

DMA water flow meters were installed on all above water inlet points to measure the actual water input to the DMA area. Accordingly, inlet points were metered and measured and referred as in this report.

Bulk Flow Meters have been installed at following locations in the study area;

Location Details	Line Size	Date of Meter installation	Flow Rate (m3/Hr.) Morning Supply	Flow Rate (m3/Hr.) Evening Supply
Near Bansal Play wood Fatehabad road Tajganj.	**200 mm**	1/12/2017	84	59

Table 34: DMA Inlet Flow Measurement Point

Location-Fatehabad road

Figure 43: DMA Flow Measurement Photos

The DMA study was carried out from 1/12/2017 to 15/12/2017. Water is being supplied to the consumers of the DMA area on daily basis during morning and evening hrs. Water Supply timing details for the DMA area is as following:

Supply Time	**Total Average Hrs. =2.15 hrs.**
Morning Supply	i) 4:00 a.m. to 5:15 am
Evening Supply	ii) 4:00 p.m. to 5:00 p.m.

Location -House No 16-21-G6

Location -House No 16/21/B-22R

Location- House No 16/21C

Figure 44: DMA pressure Measurement Photos

The Pressure Measurement activity was carried out during DMA study in the area on sample basis. Total 25 No. of pressure samples taken during DMA study. Pressure gauges were installed at various locations of consumer connection and measured for study purpose. The results of pressure measurement activity are as below;

Average Pressure at consumer end	**0.90**	**kg/cm2**
Max Pressure observed during study	**1.50**	**kg/cm2**

DMA study for the Harjupura DMA Area started on 3-12-2017 and ended on 15-12-2017. Thus total study period for the DMA is 15 days.

Thus, Total Un-accounted for water (UFW) in Harjupura DMA is

Total active population for DMA Area	**1329.00**	**Nos.**
Population per connection for DMA	**4.47**	**Nos.**
Total DMA Study Period	**15**	**Days**
Net Flow Input to DMA area (As per Bulk Meter Readings)	**2271.70**	**M^3**
Thus, the flow input to DMA area	**151.45**	**M3/day**
Total Consumption for DMA area	**1715.98**	**M3**
Thus, Consumption for DMA Area	**114.399**	**M3/day**
Total Population of DMA as per Consumer Survey	**1588.00**	**Nos.**
LPCD for DMA consumers	**95.37**	**LPCD**
Total UFW (un-accounted for Water)	**(2271.70-1715.98)/2271.70**	
Total UFW (un-accounted for Water)	**24.46%**	

For NRW assessment, billing database diary of DMA Study area consumers are collected from Agra Municipal Corporation Billing department and studied and analysed as per following:

Total Input for the DMA area	**2271.70**	**m3**
Total Consumption for Registered consumers as per Water Billing Database of Agra Municipal Corporation	789.09	m3
Total Non Revenue Water (NRW)	**(2271.70-789.09)/2271.70**	
Total Non Revenue Water (NRW)	**65.26%**	

5.4.2 Water Balance

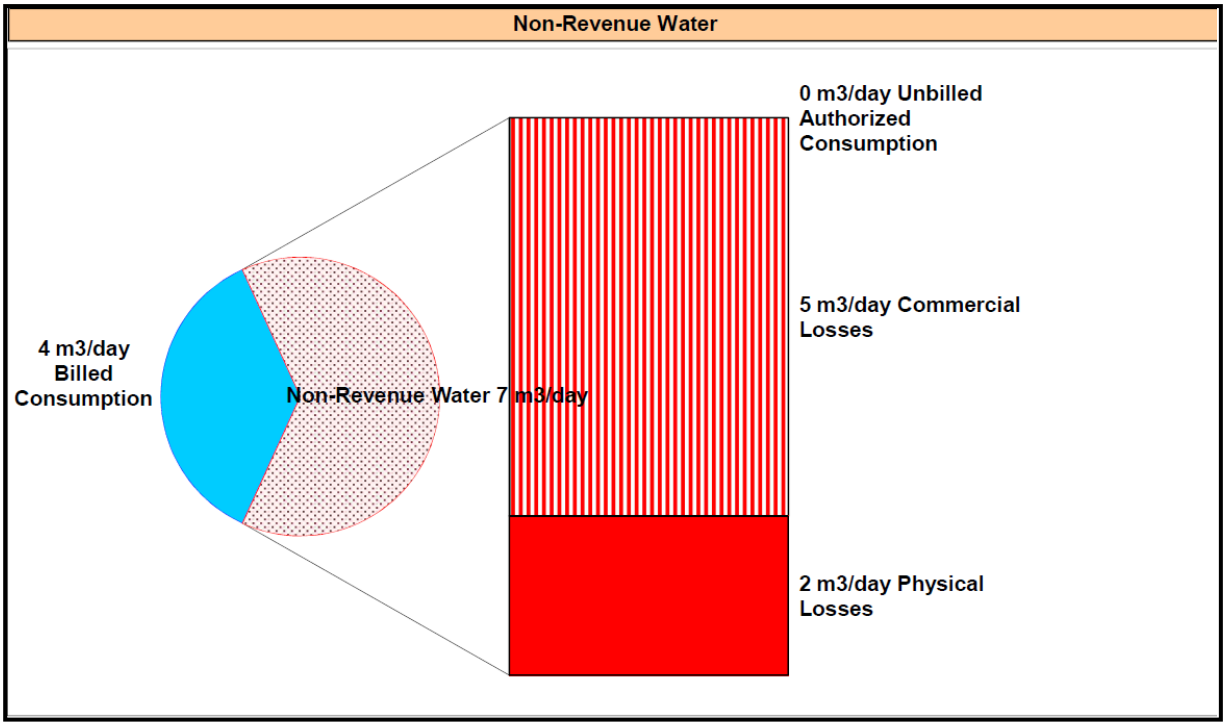


Figure 45 : Non Revenue water Chart

Water Balance in m3/day

Home System Input Volume 10 m3/day Error Margin [+/-]: 2.0%	Authorized Consumption 4 m3/day Error Margin [+/-]: 0.0%	Billed Authorized Consumption 4 m3/day	Billed Metered Consumption 0 m3/day	Revenue Water 4 m3/day
			Billed Unmetered Consumption 4 m3/day	
		Unbilled Authorized Consumption 0 m3/day Error Margin [+/-]: 0.0%	Unbilled Metered Consumption 0 m3/day	Non-Revenue Water 7 m3/day Error Margin [+/-]: 3.1%
			Unbilled Unmetered Consumption 0 m3/day Error Margin [+/-]: 0.0%	
	Water Losses 7 m3/day Error Margin [+/-]: 3.1%	Commercial Losses 5 m3/day Error Margin [+/-]: 4.1%	Unauthorized Consumption 5 m3/day Error Margin [+/-]: 4.1%	
			Customer Meter Inaccuracies and Data Handling Errors 0 m3/day Error Margin [+/-]: 0.0%	
		Physical Losses 2 m3/day Error Margin [+/-]: 14.7%		

Table 35 : Water Balance (m3 / day)

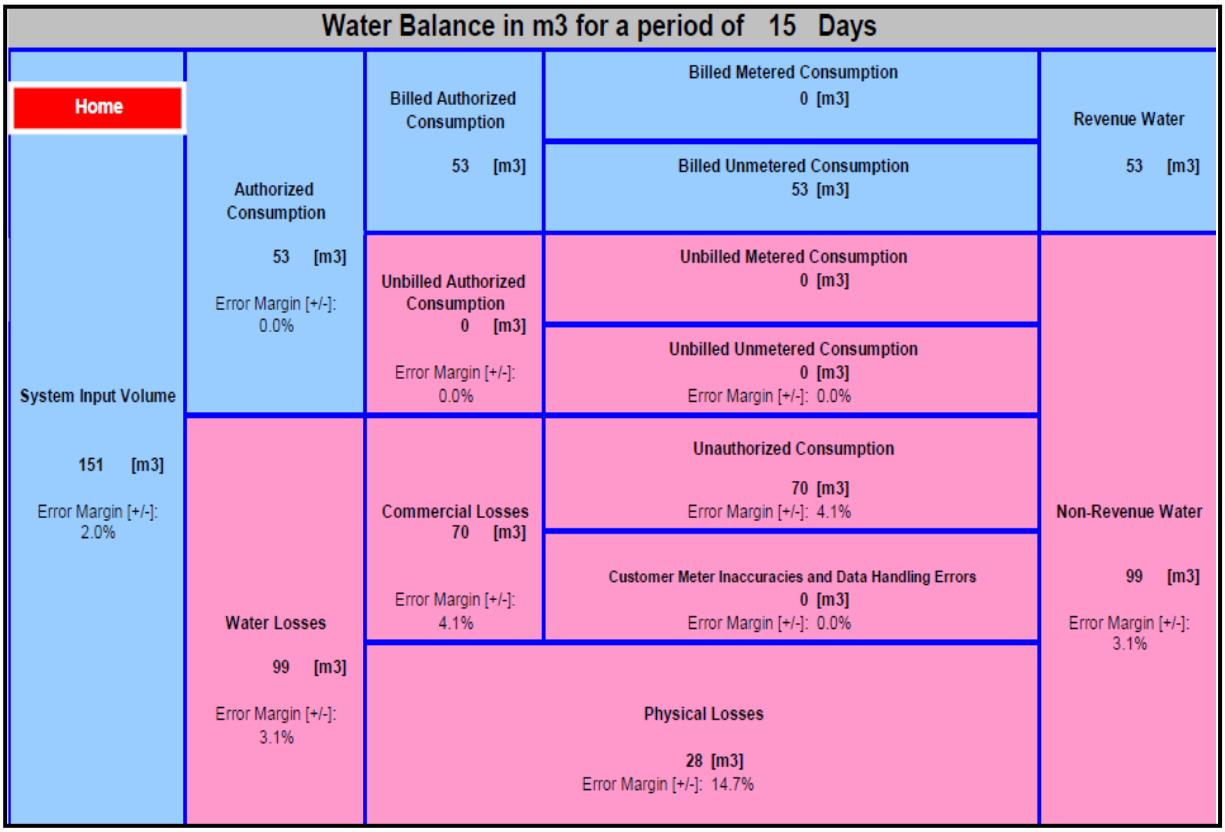


Table 36: Water Balance (m3) for study period

5.4.3 DMA Area Consumer Survey Activity

The consumer survey activity for selected DMA area consumers / properties has been carried out by DRA team. The Billing Database list collected from the Corporation and physical site survey conducted to identify and verify the consumers of the DMA area.

Figure46: DMA Consumersurvey Photos

Results of consumer survey are summarised below;

1. Total property / connections surveyed =297 Nos.
2. Total Connections matched as per billing database =110 Nos.
3. Total Consumers which are not registered = 139 Nos.
4. Total Connection with "no Connection" status =40 Nos.
5. Total meter installed in DMA by DRA = 97 Nos.

5.4.4 DMA Area Distribution Map updating

DMA area distribution network map have been prepared and updated in CAD format. The network map was verified from area in charge / line Engineer of Jalsansthan. From the drawings below, it can be observed that the DMA area can be segregated from the other areas by installing bulk flow meters to inlet pipelines to the DMA area. The network details are marked on the map and updated in CAD format. The details of the network of DMA are as below;

Diameter(mm)	Diameter(inch)	Material	Length (m)	Total length (km)
250	8"&4"	DI & PVC	1034.50	1.034
		Grand Total		**1.034**

Table 37: Distribution Network detail

5.4.5 DMA Inlet Meter installations

To measure the bulk water input / supply to DMA, DRA team installed the bulk flow meters at the inlet pipeline to the Harjupura DMA area. The inlet pipelines where flow meters were installed to derive water input / supply to the DMANear Bansal shop Fatehabad road, Flow and pressure data were measured for inlet points of the DMA area. ULB/Jalsansthan engineers visited the water inlet point and verified the data.

Location- near Bansal shop

Figure 47: DMA Inlet point photos

The Water input to DMA area is tabulated below;

Bulk Flow Meter Reading for DMA- Harjupura, Tajganj					
Total Water Input to DMA (m3)					
Bulk meter installation point					
Sr.No	**Date**	**Morning**	**Evening**	**Total Inflow (m3)**	**Total Inflow (ML)**
1	1/12/2017	84.00	59.00	143.00	0.143
2	2/12/2017	75.00	51.00	126.00	0.126
3	3/12/2017	65.00	60.00	125.00	0.125
4	4/12/2017	137.00	41.00	178.00	0.178
5	5/12/2017	59.00	54.00	113.00	0.113
6	6/12/2017	84.00	59.00	143.00	0.143
7	7/12/2017	120.00	86.00	206.00	0.206
8	8/12/2017	119.00	58.57	177.57	0.178
Total Average (Per Day)		**92.88**	**58.57**	**151.45**	**0.151**
Total (Eight Days)		**743.00**	**468.57**	**1211.57**	**1.21**

Table 38 : Water input to Harjupura DMA Area

5.4.6 DMA Area Consumer Meter installations

As per the consumer's survey data, it can be observed that the water meter not installed at consumers end House Service Connection within DMA area. Consumers are being charged on flat rate basis. DRA team installed the water consumer meters for the selected consumers on sample basis for the measurement of water consumption. House service connection of the DMA area consumers were observed in poor condition due to rusted pipe and improper fittings.

Location-House No 16/66B-9

Location- Nai Abadi

Location-House No 16/45

Figure 48: Meter Installation at Harjupura DMA

5.4.7 Water Consumption / Flow Measurement

As per the supply hours, the consumers of the DMA area where the water meters were installed measured for actual water consumption. While installing the water meters, the consumers like domestic, non domestic were covered for actual water consumption. Also, the consumers which are not registered in billing database diary but consuming water from the system were measured to estimate the actual water loss & revenue loss to the ULB.

Un-authorised water connection was also measured by installing water meters and bucket filling method to derive the water consumption / water loss.

Location- House No-16/17

Location-House No -16/21

Figure 49: Bucket filling at Harjupura

5.4.8 Identification of water loss / NRW areas

Also, the water loss areas like pipe leakage from 280 mm DI pipe was observed due pipe break resulting into water leakages and water loss.

Location-House No-16/68

Location-Near House No 16/66C-18

Location- House No 16/56

Location- Nai Abadi Harjupura

Figure 50: Open Tap / Un-authorized access

During study period few open taps / un-authorised access points was observed in Harjupura DMA area. Open tap is being misused by nearby consumers resulting into Non Revenue water / water loss to the department.

Location – In front of House No.16/45

Location – Near Dharamshala

Figure 51: Pipe Leakage Harjupura DMA

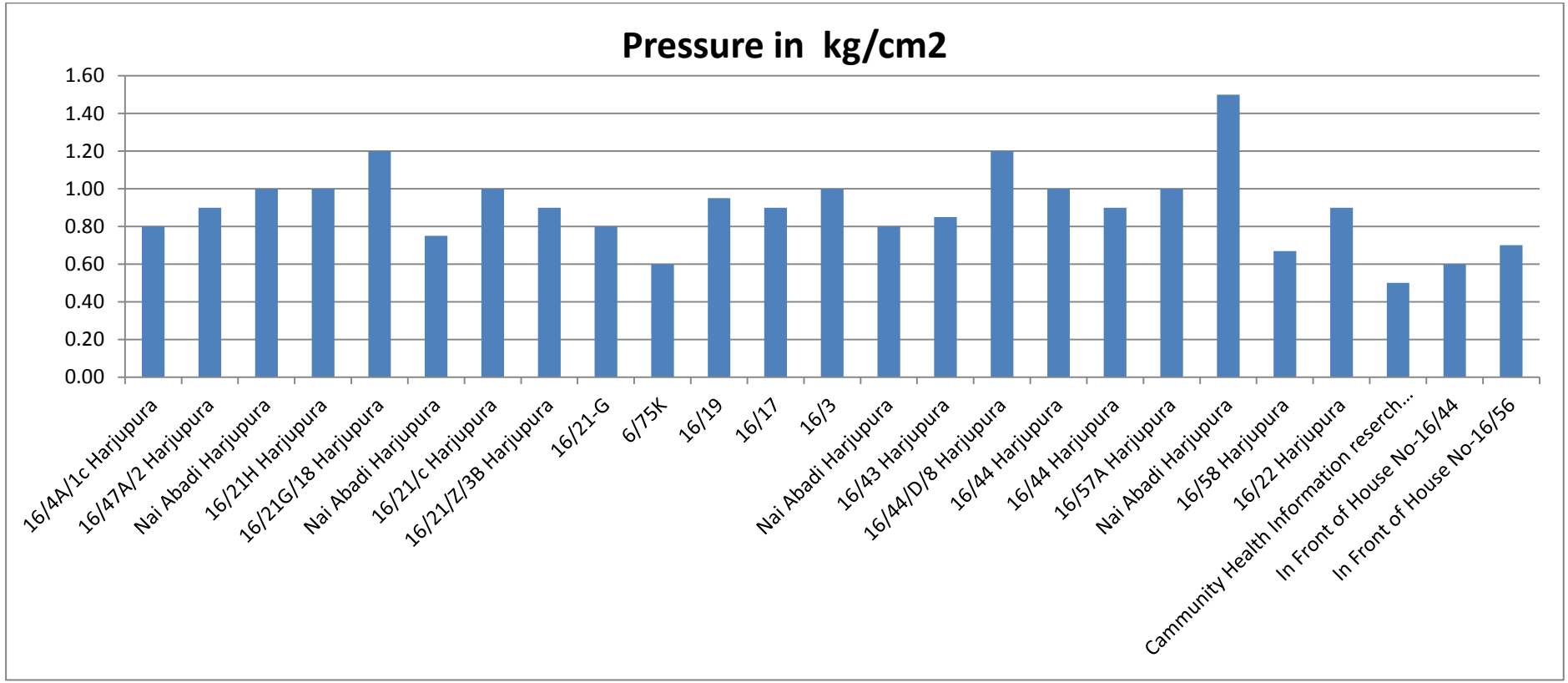
5.4.9 Pressure Measurement at Consumer tap

Pressure measurement activity was also carried out on the consumers of the DMA area to know average pressure available at consumer tap.

Sr. No	Property ID	Name	Address	Consumer ID	Connection & Meter Status	Pressure in kg/cm^2
1	302-B	Giri raj singh	16/4A/1c Harjupura		unregistered	0.80
2	308	Shree Man Bhudev Singh	16/47A/2 Harjupura	II-PC	Registered	0.90
3	325	Nihal Singh	Nai Abadi Harjupura		unregistered	1.00
4	341	savita Singh	16/21H Harjupura	TG-27/157	Registered	1.00
5	344	Ajay Kushwah	16/21G/18 Harjupura		unregistered	1.20
6	347	P.R. Sharma	Nai Abadi Harjupura		unregistered	0.75
7	360	Roshanlal verma	16/21/c Harjupura	TG-27/29	Registered	1.00
8	361	Hari chand	16/21/Z/3B Harjupura		unregistered	0.90
9	381	Dropadi Devi	16/21-G	TG-28/21-G	Registered	0.80
10	402	Chandrapal Singh	6/75K		unregist	0.60

Sr. No	Property ID	Name	Address	Consumer ID	Connection & Meter Status	Pressure in kg/cm^2
					ered	
11	407	Kishan singh	16/19		unregistered	0.95
12	411	Motilal Singh	16/17	TG-27/21	Registered	0.90
13	433	Sri laxmi narayan	16/3	TG-27/6	Registered	1.00
14	441	Mamta	Nai Abadi Harjupura		unregistered	0.80
15	446	Sonu kushwah	16/43 Harjupura		unregistered	0.85
16	479	Saroj devi	16/44/D/8 Harjupura	TG-27/51	Registered	1.20
17	482	Birma devi	16/44 Harjupura		unregistered	1.00
18	483	Meva ram	16/44 Harjupura		unregistered	0.90
19	504	Swarnalata	16/57A Harjupura		unregistered	1.00
20	532	Raju bhai	Nai Abadi Harjupura		unregistered	1.50
21	534	Santa Devi	16/58 Harjupura		unregistered	0.67
22	566	Sri Baini	16/22 Harjupura	TG-27/34	Registered	0.90
23	591	Open Tab	Community Health Information research center		unregistered	0.50
24	592	Open Tab	In Front of House No-16/44		unregistered	0.60
25	593	Open Tab	In Front of House No-16/56		unregistered	0.70

Table 39 : Details of Pressure Measurement



Graph 3: Pressure at Consumer tab

5.5 DMA STUDY FOR AWAS VIKA SECTOR 4R AREA

As per the instruction of the Municipal Corporation and Jal sansthan officials, following DMA areas were selected for NRW study.

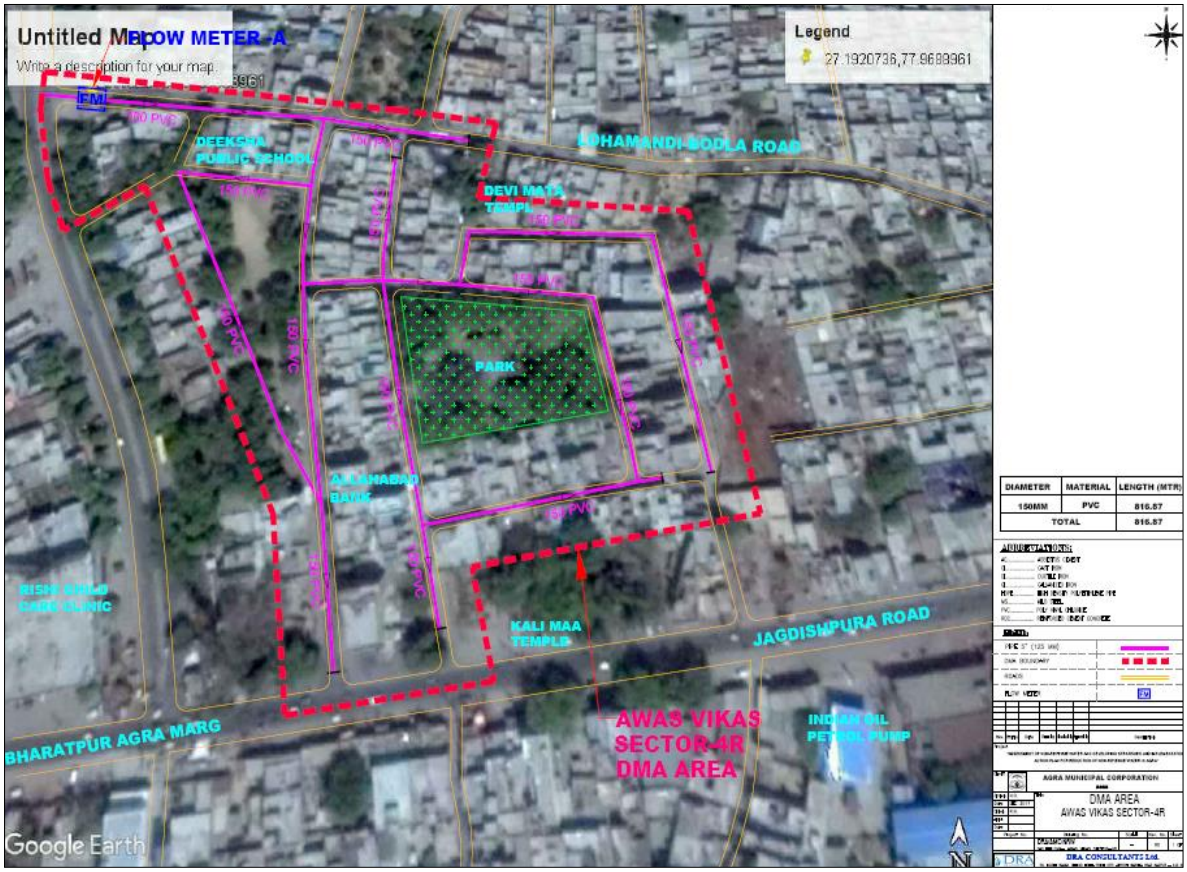


Figure 52: Schematic representation of a DMA.

The distribution network details for the Awas vikas sector 4R Network are as below;

LENGTH OF Awas Vikas sector 4R DMA AREA		
Sr. no.	Diameter(mm)	LENGTH(m)
1	150 mm pvc	816.87

Table 40: Awas Vikas Sector 4R Network details

5.5.1 NRW Assessment

Sector 4R falls under Awas vikas area of Agra City. The area comprises of mostly domestic consumers. Door to door consumer survey activity was carried out by DRA team to identify the actual consumer's within the DMA area and collect the details such as total no. of members, registered/ un-registered consumers, consumption pattern etc. The boundary limits of the DMA area is marked in drawings and the results of consumer's survey are tabulated as per following:

Figure 53: Sector 4R consumer survey

Total property / Connections as per consumer survey	**175**	**Nos.**
Total Connections matched with Billing database (Registered)	136	**Nos.**
Total Connection where meter installed during DMA study	45	**Nos.**
Total No Connections Status	7	**Nos.**
Total Un-registered Consumers (not in Water Billing Database)	32	**Nos.**
Connections with House Lock Status (Permanent Lock)	4	**Nos.**
Connections with House Lock Status (Temporary Lock)	3	**Nos.**
Stand post (free connections)	0	**Nos.**
Connections with Open taps (un-authorized access)	5	**Nos.**
Net Active Connections during study	165	**Nos.**

Table 41: Consumer Survey Summary

As per consumer survey, population of the DMA area is as following:

Total population for DMA Area as per Consumer Survey	**785.00**	**Nos.**
Population per connection for DMA	4.49	Nos.

During DMA study, the selected area was surveyed and studied to isolate the area boundary with other area and accordingly water inlet points to the project area were identified and marked on drawings. The distribution network of the DMA area was also updated in consultation with Jal sansthan staff. Awas vikas sector 4R DMA area has following water input sources;

150 mm dia PVC pipes inlet from Direct tapping at Mathura ZPS.

DMA water flow meters were installed on all above water inlet points to measure the actual water input to the DMA area. Accordingly, inlet points were metered and measured and referred as in this report.

Bulk Flow Meters have been installed at following locations in the study area;

Location Details	Line Size	Date of Meter installation	Flow Rate (m3/Hr) Morning Supply	Flow Rate (m3/Hr) Evening Supply
Awas Vikas Colony Near Sweet shop	150mm	08-12-17	104.67	58.00

Table 42: DMA Inlet Flow Measurement Point

Figure 54: DMA Flow Measurement Photos

The DMA study was carried out from 8/12/2017 to 24/12/2017. Water is being supplied to the consumers of the DMA area on daily basis during morning and evening hrs. Water Supply timing details for the DMA area is as following:

Supply Time	Total Avg Hrs. =5:30 hrs.
Morning Supply	5:00 a.m. to 8:00 a.m
Evening Supply	5:00 p.m. to 7:30 p.m.

Nearby House No 881

Location- House No 914

Location-House No-782

Figure 55: DMA pressure Measurement Photos

The Pressure Measurement activity was carried out during DMA study in the area on sample basis. Total No. of pressure samples taken for 14Nos. Pressure gauges were installed at various locations of consumer connection and measured for study purpose. The results of pressure measurement activity are as below;

Average Pressure at consumer end	**0.57**	**kg/cm2**
Max Pressure observed during study	**1.00**	**kg/cm2**

DMA study for the Awas vikas sector 4R DMA Area started on 8-12-2017 and ended on 24-12-2017. Thus total study period for the DMA is 16 days.

Thus, Total Un-accounted for water (UFW) in Awas vikas sector 4R DMA is

Total population for DMA Area as per registered /unregistered	785.00	Nos.
Population per connection for DMA	4.49	Nos.
Total DMA Study Period	16	Days
Net Flow Input to DMA area (As per Bulk Meter Readings)	5932	M^3
Thus, the flow input to DMA area	371	M3/day
Total Consumption for DMA area	4703.52	M3
Thus, Consumption for DMA Area	293.97	M3/day
Total Population of DMA connections as per Consumer Survey	806.00	Nos
LPCD for DMA consumers	460	LPCD
Total UFW (un-accounted for Water)	**(5932-4703.52)/5932**	
Total UFW (un-accounted for Water)	**20.71%**	

For NRW assessment, billing database diary of DMA Study area consumers are collected from Agra Municipal Corporation Billing department and studied and analysed as per following:

Total Input for the DMA area	5931.84	m3
Total Consumption for Registered consumers as per Water Billing Database of Agra Municipal Corporation	3887.76	m3
Total Non Revenue Water (NRW)	**(5931.84-3887.76)/5931.84**	
Total Non Revenue Water (NRW)	**34.46%**	

5.5.2 Water Balance

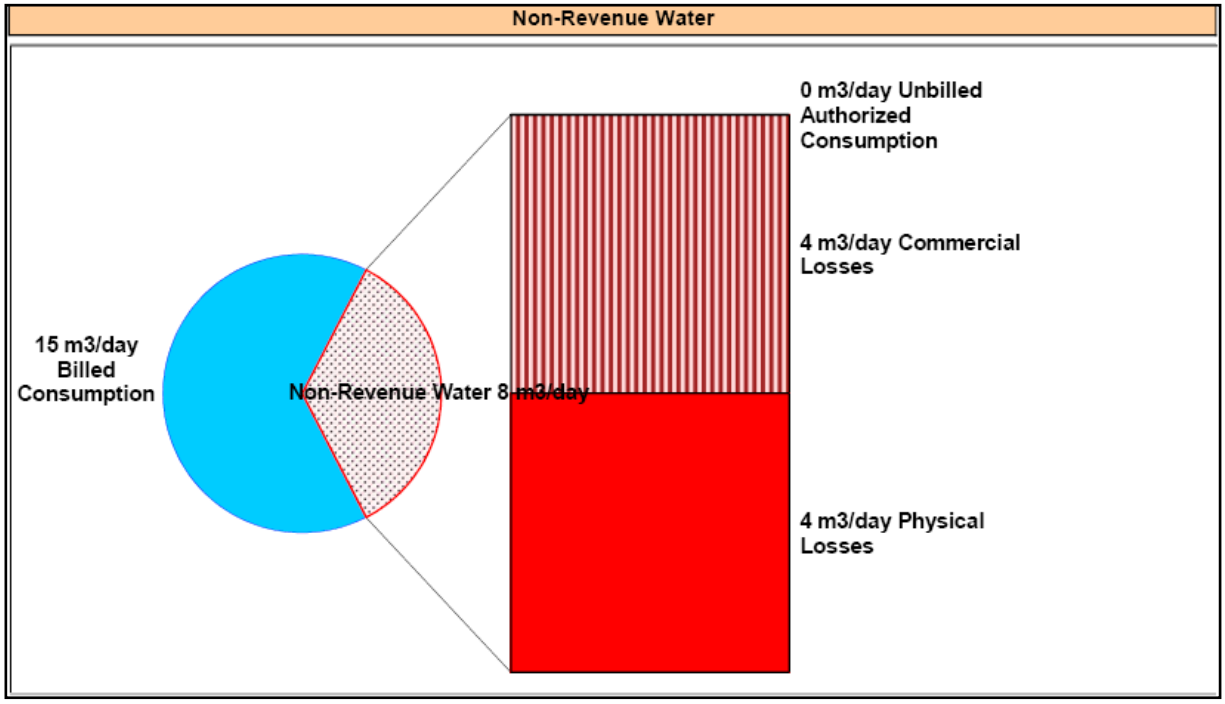


Figure 56 : Non Revenue water Chart

Home System Input Volume 23 m3/day Error Margin [+/-]: 2.0%	Authorized Consumption 15 m3/day Error Margin [+/-]: 0.0%	Billed Authorized Consumption 15 m3/day	Billed Metered Consumption 0 m3/day	Revenue Water 15 m3/day
			Billed Unmetered Consumption 15 m3/day	
		Unbilled Authorized Consumption 0 m3/day Error Margin [+/-]: 0.0%	Unbilled Metered Consumption 0 m3/day	
			Unbilled Unmetered Consumption 0 m3/day Error Margin [+/-]: 0.0%	
	Water Losses 8 m3/day Error Margin [+/-]: 5.8%	Commercial Losses 4 m3/day Error Margin [+/-]: 3.7%	Unauthorized Consumption 4 m3/day Error Margin [+/-]: 3.7%	Non-Revenue Water 8 m3/day Error Margin [+/-]: 5.8%
			Customer Meter Inaccuracies and Data Handling Errors 0 m3/day Error Margin [+/-]: 0.0%	
		Physical Losses 4 m3/day Error Margin [+/-]: 13.5%		

Table 43 : Water Balance (m3 / day)

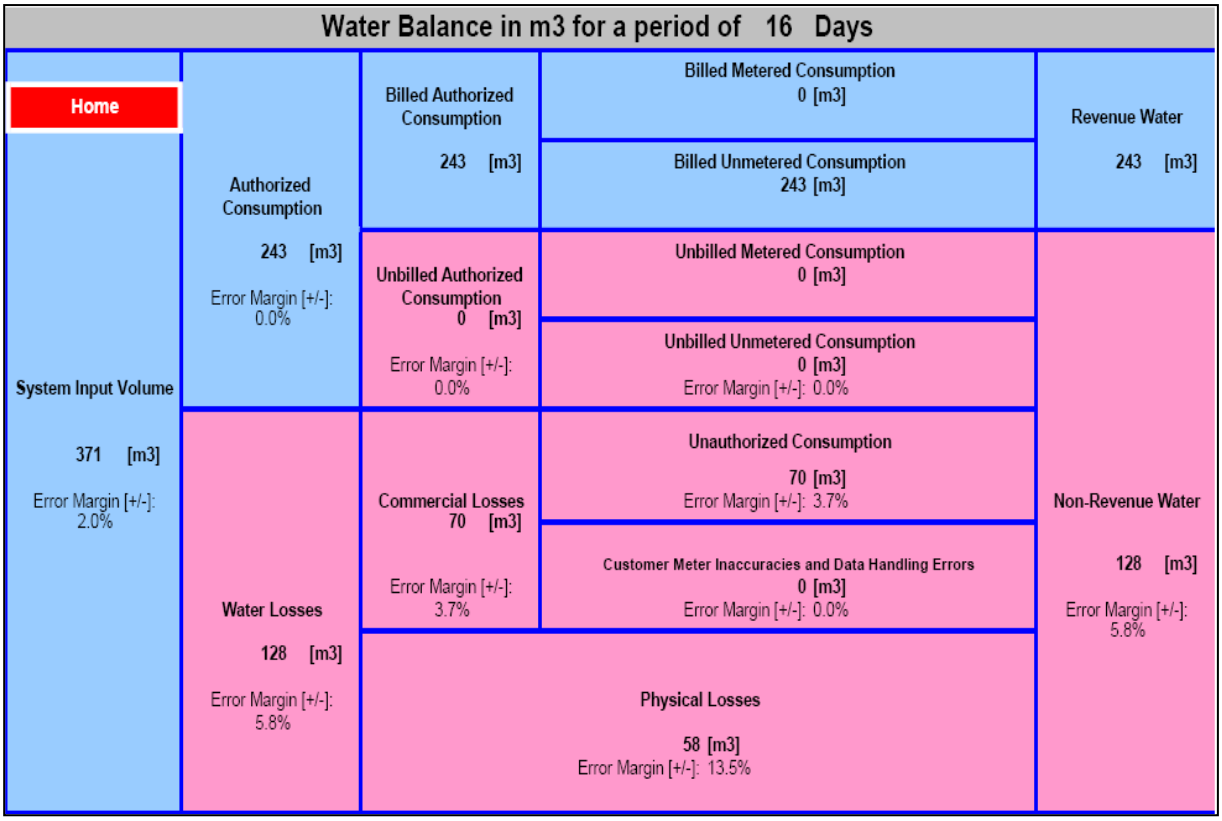


Table 44: Water Balance (m3) for study period

5.5.3 DMA Area Consumer Survey Activity

The consumer survey activity for selected DMA area consumers / properties has been carried out by DRA team.The Billing Database list collected from the Corporation and physical site survey conducted to identify and verify the consumers of the DMA area.

Location House No- 44-326

House No-Ews 837

House No-LIG791

Figure 57: DMA Consumer survey Photos

Results of consumer survey are summarised below;

1. Total property / connections surveyed =175 Nos.
2. Total Connections matched as per billing database = 136Nos.
3. Total Consumers which are not registered = 32 Nos.
4. Total Connection with "no Connection" status = 07 Nos.
5. Total meter installed in DMA by DRA = 45Nos.

5.5.4 DMA Area Distribution Map updating

DMA area distribution network map have been prepared and updated in CAD format. The network map was verified from area in charge / line Engineer of Jal sansthan. From the drawings below, it can be observed that the DMA area can be segregated from the other areas by installing bulk flow meters to inlet pipelines to the DMA area. The network details are marked on the map and updated in CAD format. The details of the network of DMA are as below;

Diameter(mm)	Diameter(inch)	Material	Length (m)	Total length (km)
150	6"	PVC	816.87	0.816
		Grand Total		**0.816**

Table 45: Distribution Network details at Awasvikas sector 4R DMA

5.5.5 DMA Inlet Meter installations

To measure the bulk water input / supply to DMA, DRA team installed the bulk flow meters at the inlet pipeline to the Sector 4R DMA area. The inlet pipelines where flow meters were installed to derive water input / supply to the DMA Awas vikas sector 4R Flow and pressure data were measured for inlet points of the DMA area. ULB/Jal sansthan engineers visited the water inlet point and verified the data.

Location- sector 4R near Sweet Shop

Figure 58: DMA Inlet point snaps

The Water input to DMA area is tabulated below;

Bulk Flow Meter Reading for DMA- Awas vikas sector 4R						
Total Water Input to DMA (m3)						
Bulk meter installation point						
Sr.No	Date	Morning Supply(m3)	Evening Supply(m3)	Leakage flow supply(m3)	Total Inflow (m3)	Total Inflow (M3)
1	08-12-17	104.67	58.00	208.00	162.67	370.67
2	09-12-17	65.00	64.50	241.00	129.50	370.50
3	12-12-17	104.67	36.00	230.00	140.67	370.67
4	13-12-17	109.00	61.00	201.00	170.00	371.00
5	14-12-17	104.67	34.00	232.00	138.67	370.67
6	15-12-17	104.67	109.00	157.00	213.67	370.67
7	16-12-17	98.78	201.57	142.00	229.00	371.00
Total Average (Per Day)		**98.78**	**80.58**	**201.57**	**169.17**	**371.00**
Total (Seven Days)		**691.46**	**564.07**	**1411.00**	**1184.18**	**2595.18**

Table 46 : Water input to Awas vikas sector 4R DMA Area

5.5.6 DMA Area Consumer Meter installations

As per the consumer's survey data, it can be observed that the water meter not installed at consumers end House Service Connection within DMA area. Consumers are being charged on flat rate basis. DRA team installed the water consumer meters for the selected consumers on sample basis for the measurement of water consumption. House service connection of the DMA area consumers were observed in poor condition due to rusted pipe and improper fittings.

Figure 59: Meter Installation

5.5.7 Water Consumption / Flow Measurement

As per the supply hours, the consumers of the DMA area where the water meters were installed measured for actual water consumption. While installing the water meters, the consumers like domestic, non domestic were covered for actual water consumption. Also, the consumers which are not registered in billing database diary but consuming water from the system were measured to estimate the actual water loss & revenue loss to the ULB. Un-authorised water connection was also measured by installing water meters and bucket filling method to derive the water consumption/water loss

Figure 60: Bucket filling at sector 4R

5.5.8 Identification of water loss / NRW

areas

During study period few open taps / un-authorised access points was observed in Awas vikas sector 4R DMA area. Open tap is being misused by nearby consumers resulting into Non Revenue water / water loss to the department.

Location House No.817

Location-Near House No 881

Location-Near House No 818

Location: Sector 4R

Figure 61: Open Tap / Un-authorized access

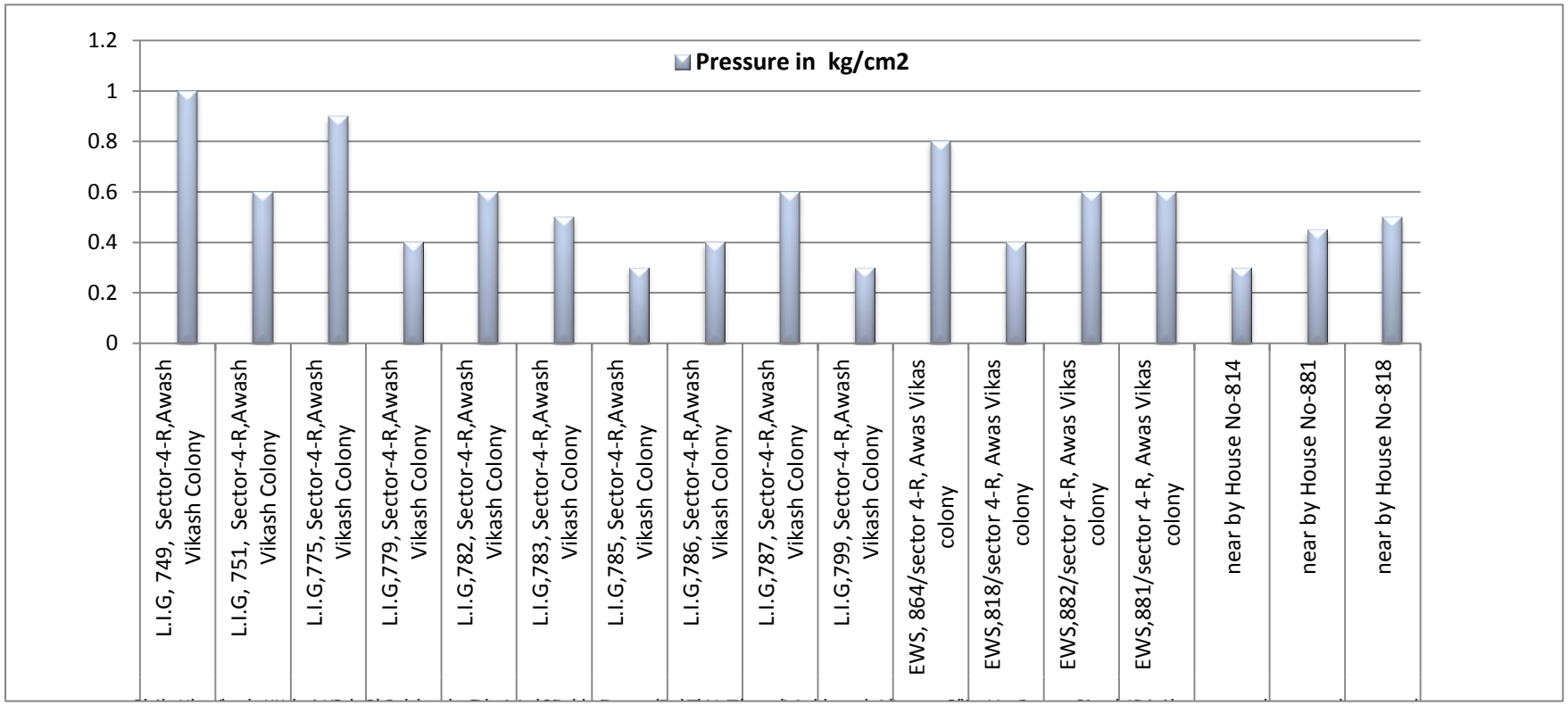
5.5.9 Pressure Measurement at Consumer tap

Pressure measurement activity was also carried out on the consumers of the DMA area to know average pressure available at consumer tap.

Sr. No	Property ID	Name	Address	Consumer ID	Category	Total members	Connection & Meter Status	Pressure in kg/cm^2
1	130	Shila devi	L.I.G, 749, Sector-4-R,Awash Vikash Colony	AW-207/381	D	4	Registered	1.00
2	132	Kamlesh Varma	L.I.G, 751, Sector-4-R,Awash Vikash Colony	AW-207/383	D	3	Registered	0.60
3	155	Veer Kishan	L.I.G,775, Sector-4-R,Awash Vikash Colony	AW-207/391	D	4	Registered	0.90
4	158	shri. Gyan Parkash Gupta	L.I.G,779, Sector-4-R,Awash Vikash Colony	AW-207/55	D	6	Registered	0.40
5	161	Shivkumar Bharat Singh	L.I.G,782, Sector-4-R,Awash Vikash Colony	AW-207/52	D	6	Registered	0.60
6	162	Maha devi	L.I.G,783, Sector-4-R,Awash Vikash Colony	AW-207/51	D	6	Registered	0.50
7	164	Ram Baroshelal	L.I.G,785, Sector-4-R,Awash Vikash Colony	AW-204/237		2	Registered	0.30
8	165	Dr.T.Nath	L.I.G,786, Sector-4-R,Awash Vikash Colony	AW-72/110	D	4	Registered	0.40
9	166	Tarachand	L.I.G,787, Sector-4-R,Awash Vikash Colony	AW-207/47	D	3	Registered	0.60
10	176	Mahmud Alam	L.I.G,799, Sector-4-R,Awash Vikash Colony	AW-207/449	D	3	Registered	0.30
11	196	Iman Ali	EWS, 864/sector 4-R, Awas Vikas colony	AW-207/414	D	4	Registered	0.80
12	232	Shaera Bano	EWS,818/sector 4-R, Awas Vikas colony	AW-207/433	D	8	Registered	0.40
13	238	Hariveer Singh Dixit	EWS,882/sector 4-R, Awas Vikas colony	AW-207/416	D	5	Registered	0.60

14	239	Kamle	EWS,881/sector 4-R, Awas Vikas colony	AW-207/436	D	9	Registered	0.60
15	290	open tab	near by House No-814					0.30
16	291	open tab	near by House No-881					0.45
17	292	open tab	near by House No-818					0.50

Table 47 : Details of Pressure Measurement



Graph 4: Pressure at Consumer tap

5.6 DMA STUDY FOR NAWADA ABD AREA

As per the instruction of the Municipal Corporation and Jal sansthan officials, following DMA areas were selected for NRW study.

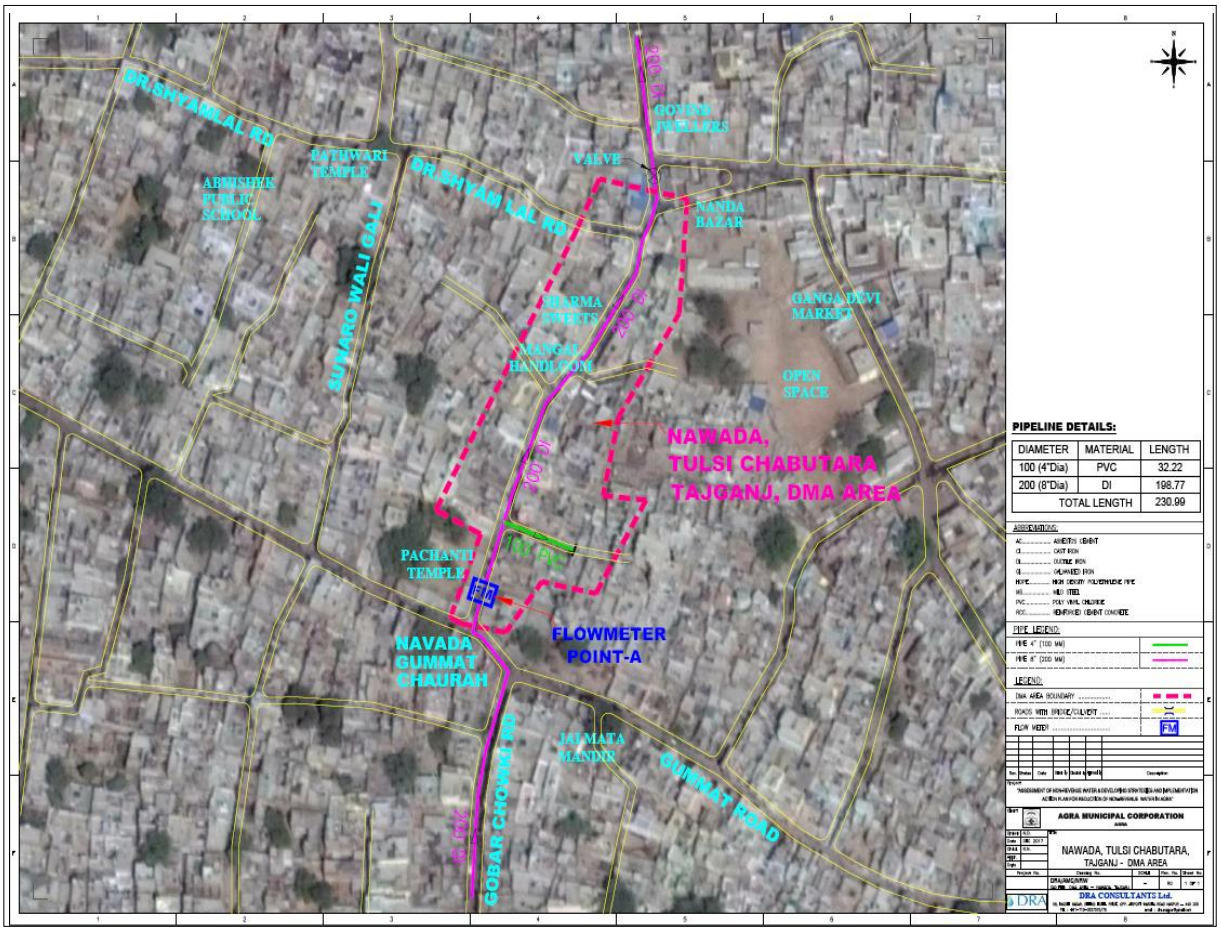


Figure 62: Schematic representation of a DMA.

The distribution network details for the Nawada Network are as below;

LENGTH OF NAWADA DMA		
Sr. no.	**Diameter(mm)**	**LENGTH(m)**
1	200 mm DI	230.99

Table 48: Nawada Network details

DMA Analysis reports are submitted for following areas as per following:

5.6.1 NRW Assessment

Nawada DMA area is located near to famous "Tajmahal" which is also selected under Smart City Project by Agra Municipal Corporation. The area comprises of mostly domestic consumers. Door to door consumer survey activity was carried out by DRA team to identify the actual consumer's within the selected DMA area and also to collect the information such as total no. of members, registered/ un-registered status of consumers, consumption pattern etc. The boundary limits of the DMA area is marked in drawings and the results of consumer's Survey is tabulated as per following;

Figure 63: Nawada square inlet point

Total property / Connections as per consumer survey	**208**	**Nos.**
Total Connections matched with Billing database (Registered)	**83**	**Nos.**
Total Connection where meter installed during DMA study	**60**	**Nos.**
Total No Connections Status	**22**	**Nos.**
Total Un-registered Consumers (not in Water Billing Database)	**103**	**Nos.**
Connections with House Lock Status (Permanent Lock)	**0**	**Nos.**
Connections with House Lock Status (Temporary Lock)	**2**	**Nos.**
Stand post (free connections)	**0**	**Nos.**
Connections with Open taps (un-authorized access)	**7**	**Nos.**
Net Active Connections during study	**186**	**Nos.**

Table 49: Consumer Survey Summary

As per consumer survey, population of the DMA area is as following:

Total population for DMA Area as per Consumer Survey	**1239.00**	**Nos.**
Population per connection for DMA	**5.96**	**Nos.**

Table 50 : DMA Consumer Survey Summary

During DMA study, the selected area was surveyed and studied to isolate the area boundary with other area and accordingly water inlet points to the project area were identified and marked on

drawings. The distribution network of the DMA area was also updated in consultation with Jal sansthan staff. Nawada DMA area has following water input sources;

4. 250 mm dia DI pipes inlet from Tajganj ZPS.

DMA water flow meters were installed on all above water inlet points to measure the actual water input to the DMA area. Accordingly, inlet points were metered and measured and referred as in this report.

Bulk Flow Meters have been installed at following locations in the study area;

Location Details	Line Size	Date of Meter installation	Flow Rate (m3/Hr.) Morning Supply	Flow Rate (m3/Hr.) Evening Supply
Nawada square	**200 mm**	01-01-18	149.23	232.57

Table 51: DMA Inlet Flow Measurement Point

Figure 64: DMA Flow Measurement Photos

The DMA study was carried out from 1/1/2018 to 13/1/2018. Water is being supplied to the consumers of the DMA area on daily basis during morning and evening hrs. Water Supply timing details for the DMA area is as following:

Supply Time	**Total Avg Hrs. =3.00 hrs.**
Morning Supply	**4:00 a.m. to 6:00 a.m**
Evening Supply	**5:00 p.m. to 6:00 p.m.**

Location-Walmikiswami tempal

Location -House No 7/176

Location -House No 7/115

Location-House No-14/74 Loc-In front of Anuradha fashion shops

Location –Govt tap Nawada

Figure 65: DMA pressure Measurement Photos

The Pressure Measurement activity was carried out during DMA study in the area on sample basis. Total No. of pressure samples taken for 32Nos. Pressure gauges were installed at various locations of consumer connection and measured for study purpose. The results of pressure measurement activity are as below;

Average Pressure at consumer end	**0.66**	**kg/cm2**
Max Pressure observed during study	**1.60**	**kg/cm2**

DMA study for the Nawada DMA Area started on 1-1-2018 and ended on 13-1-2018. Thus total study period for the DMA is 13 days.

Thus, Total Un-accounted for water (UFW) in Nawada DMA is

Total population for DMA Area as per registered /unregistered	1125.00	Nos.
Population per connection for DMA	5.41	Nos.
Total DMA Study Period	13	Days
Net Flow Input to DMA area (As per Bulk Meter Readings)	8359	M^3
Thus, the flow input to DMA area	643	M3/day
Total Consumption for DMA area	2692.70	M3
Thus, Consumption for DMA Area	207.13	M3/day
Total Population of DMA connections as per Consumer Survey	1239.00	Nos
LPCD for DMA consumers	519	LPCD
Total UFW (un-accounted for Water)	**(8359-2692.70)/8359**	
Total UFW (un-accounted for Water)	**67.79%**	

For NRW assessment, billing database diary of DMA Study area consumers are collected from Agra Municipal Corporation & Jal sansthan billing department and studied and analysed as per following:

Total Input for the DMA area	8359.00	m3
Total Consumption for Registered consumers as per Water Billing Database of Agra Municipal Corporation	1158.71	m3
Total Non Revenue Water (NRW)	**(8359-1158.71)/8359**	
Total Non Revenue Water (NRW)	**86.14%**	

5.6.2 Water Balance

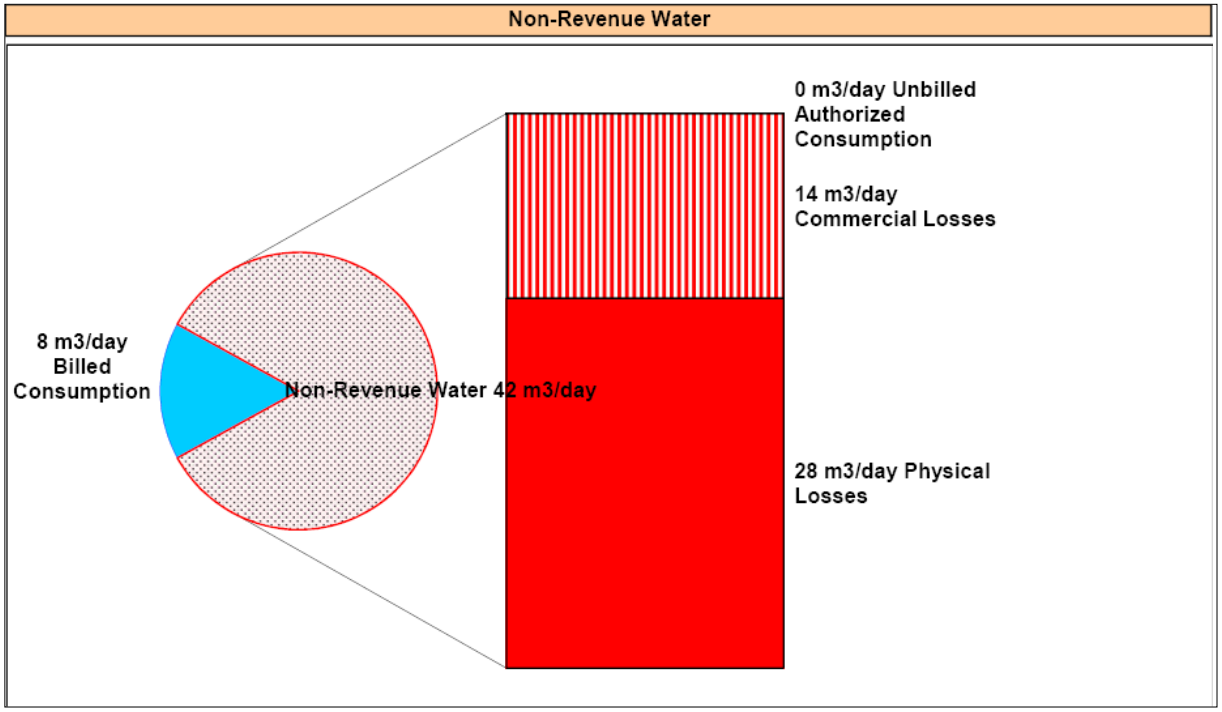


Figure 66 : Non Revenue water Chart

Water Balance in m3/day

Home System Input Volume 49 m3/day Error Margin [+/-]: 2.0%	Authorized Consumption 8 m3/day Error Margin [+/-]: 0.0%	Billed Authorized Consumption 8 m3/day	Billed Metered Consumption 0 m3/day	Revenue Water 8 m3/day
			Billed Unmetered Consumption 8 m3/day	
		Unbilled Authorized Consumption 0 m3/day Error Margin [+/-]: 0.0%	Unbilled Metered Consumption 0 m3/day	Non-Revenue Water 41 m3/day Error Margin [+/-]: 2.4%
			Unbilled Unmetered Consumption 0 m3/day Error Margin [+/-]: 0.0%	
	Water Losses 41 m3/day Error Margin [+/-]: 2.4%	Commercial Losses 14 m3/day Error Margin [+/-]: 4.3%	Unauthorized Consumption 14 m3/day Error Margin [+/-]: 4.3%	
			Customer Meter Inaccuracies and Data Handling Errors 0 m3/day Error Margin [+/-]: 0.0%	
		Physical Losses 28 m3/day Error Margin [+/-]: 4.2%		

Table 52 : Water Balance (m3 / day)

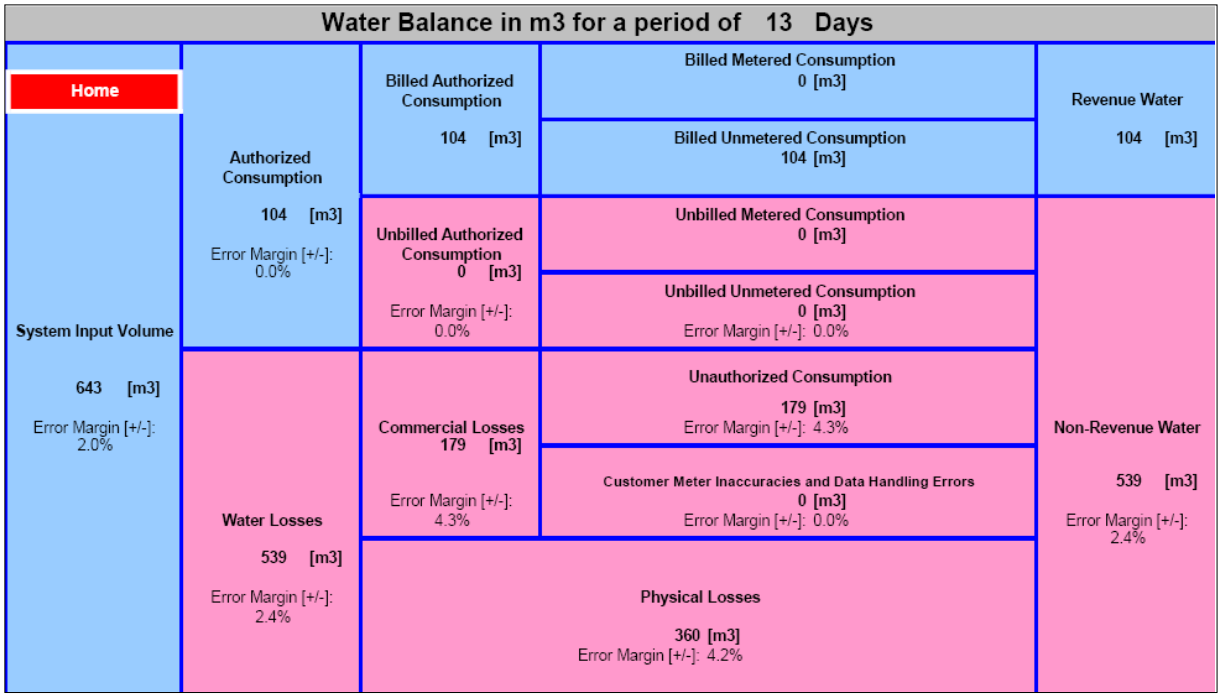


Table 53: Water Balance (m3) for study period

5.6.3 DMA Area Consumer Survey Activity

The consumer survey activity for selected DMA area consumers / properties has been carried out by DRA team. The Billing Database list collected from the Corporation and physical site survey conducted to identify and verify the consumers of the DMA area.

Location House No- 7-153

Figure 67: DMA Consumer survey Photos

Results of consumer survey are summarised below;

1. Total property / connections surveyed =208 Nos.
2. Total Connections matched as per billing database = 83 Nos.
3. Total Consumers which are not registered = 103 Nos.
4. Total Connection with "no Connection" status =22 Nos.
5. Total meter installed in DMA by DRA = 60 Nos.

5.6.4 DMA Area Distribution Map updating

DMA area distribution network map have been prepared and updated in CAD format. The network map was verified from area in charge / line Engineer of Jal sansthan. From the drawings below, it can be observed that the DMA area can be segregated from the other areas by installing bulk flow meters to inlet pipelines to the DMA area. The network details are marked on the map and updated in CAD format. The details of the network of DMA are as below;

Diameter(mm)	Diameter(inch)	Material	Length (m)	Total length (km)
200	8"	DI	230.99	0.231
		Grand Total		**0.231**

Table 54: Distribution Network details

5.6.5 DMA Inlet Meter installations

To measure the bulk water input / supply to DMA, DRA team installed the bulk flow meters at the inlet pipeline to the Nawada DMA area. The inlet pipelines where flow meters were installed to derive water input / supply to the DMA in front of house no- 14/63 C, Flow and pressure data were measured for inlet points of the DMA area. ULB/Jal sansthan engineers visited the water inlet point and verified the data.

Location- In front of House no-14/63c

Figure 68: DMA Inlet point photo

The Water input to DMA area is tabulated below;

Bulk Flow Meter Reading for DMA- Nawada						
Total Water Input to DMA (m3)						
Bulk meter installation point						
Sr.No	**Date**	**Morning Supply(m3)**	**Evening Supply(m3)**	**Leakage flow supply(m3)**	**Total Inflow (m3)**	**Total Inflow (M3)**
1	01-01-18	232.57	149.23	253.12	381.80	635
2	02-01-18	210.5	140.10	248.56	395.60	644
3	03-01-18	221.54	160.70	261.85	382.24	644
4	04-01-18	200.10	150.01	283.56	365.11	649
Total Average		**266**	**150**	**262**	**381**	**643**
Total		**660.04**	**864.71**	**1047.1**	**1524.75**	**2571.84**

Table 55 : Water input to Nawada DMA Area

5.6.6 DMA Area Consumer Meter installations

As per the consumer's survey data, it can be observed that the water meter not installed at consumers end House Service Connection within DMA area. Consumers are being charged on flate rate basis. DRA team installed the water consumer meters for the selected consumers on sample basis for the measurement of water consumption. House service connection of the DMA area consumers were observed in poor condition due to rusted pipe and improper fittings.

Location-House No -7/174

Location-House No -7/174

Location-House No 14/63

House No- 14/58

House No-7/170

Figure 69: Meter Installation at Nawada Area

5.6.7 Water Consumption / Flow Measurement

As per the supply hours, the consumers of the DMA area where the water meters were installed measured for actual water consumption. While installing the water meters, the consumers like domestic, non domestic were covered for actual water consumption. Also, the consumers which are not registered in billing database diary but consuming water from the system were measured to estimate the actual water loss & revenue loss to the ULB.

Un-authorised water connection was also measured by installing water meters and bucket filling method to derive the water consumption / water loss.

Location-I

Location

Figure 70: Bucket filling at Nawada Area

5.6.8 Identification of water loss / NRW areas

Also, the water loss areas like pipe leakage from 200 mm DI pipe was observed due pipe break resulting into water leakages and water loss.

Location- for House no-176/170/177

Location- In front of Neha ladies corner

Location- In front of shiv temple

Location

Location- In front of house no-7/113

Location –

Location- In front of house no

Locat

Location- near Neha ladies corner

Loca

Figure 71: Pipe Leakage Nawada DMA

During study period few open taps / un-authorised access points was observed in Nawada DMA area. Open tap is being misused by nearby consumers resulting into Non Revenue water / water loss to the department.

Location- Nearby house no. 7/199

Location- Walmiki swami Temple

Location-Nearby House No.7/58

Locatio

Location- In front of house no 14/58

Location –In front of Shiva temple

Figure 72: Open Tap / Un-authorized access

5.6.9 Pressure Measurement at Consumer tap

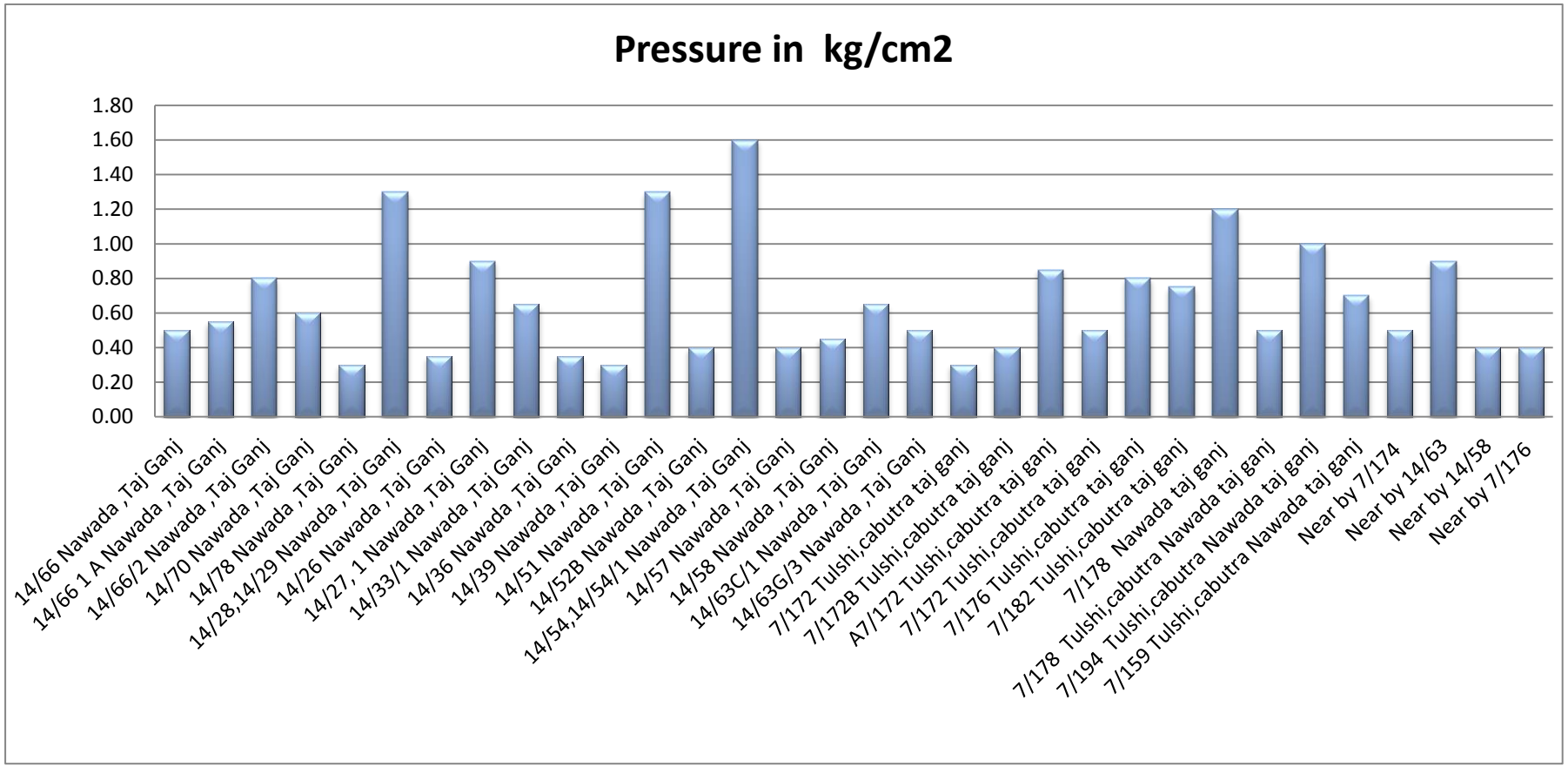
Pressure measurement activity was also carried out on the consumers of the DMA area to know average pressure available at consumer tap.

Sr. No	Property ID	Name	Address	Consumer ID	Connection & Meter Status	Pressure in kg/cm^2
1	505	Chedi Lal	14/66 Nawada ,Tajganj	TG-22/101	Registered	0.50
2	506	Chedi Lal	14/66 1 A Nawada ,Tajganj		Un-registered	0.55
3	508	Choke Lal S/O Nathi Lal	14/66/2 Nawada ,Tajganj	TG-22/102	Registered	0.80
4	512	Rajeshavari Devi	14/70 Nawada ,Tajganj	TG-22/106	Registered	0.60
5	516	Naragi Devi	14/78 Nawada ,Tajganj	TG-22/115	Registered	0.30
6	522	Kali charan	14/28,14/29 Nawada ,Tajganj	TG-22/110	Registered	1.30
7	526	vinod kumar,Ram kishan	14/26 Nawada ,Tajganj	TG-22/29 II	Registered	0.35
8	528	Bisan sawaroop (Rakesh)	14/27, 1 Nawada ,Tajganj	TG-22/30	Registered	0.90
9	533	Pradeep thakur	14/33/1 Nawada	TG-	Registere	0.65

Sr. No	Property ID	Name	Address	Consumer ID	Connection & Meter Status	Pressure in kg/cm^2
			,Tajganj	22/36	d	
10	538	Bhishan swaroop	14/36 Nawada ,Tajganj		Un-registered	0.35
11	545	Mahaveer singh	14/39 Nawada ,Tajganj		Un-registered	0.30
12	553	Mina devi	14/51 Nawada ,Tajganj		Un-registered	1.30
13	557	Chen shukh rathore	14/52B Nawada ,Tajganj	TG-22/128	Registered	0.40
14	559	Omprakash s/o Chote lal	14/54,14/54/1 Nawada ,Tajganj	TG-22/61	Registered	1.60
15	561	Banshi lal	14/57 Nawada ,Tajganj	TG-22/67	Registered	0.40
16	567	Shanti devi	14/58 Nawada ,Tajganj		Un-registered	0.45
17	580	Lohare s/o Ninua	14/63C/1 Nawada ,Tajganj		Un-registered	0.65
18	592	Ram bati	14/63G/3 Nawada ,Tajganj		Un-registered	0.50
19	610	Rakesh kumar rathore (Kundan	7/172 Tulshi,cabutra Tajganj	TG-11/300	Registered	0.30
20	617	shankar singh	7/172B Tulshi,cabutra Tajganj		Un-registered	0.40
21	633	Suniri lal dagoar	A7/172 Tulshi,cabutra Tajganj		Un-registered	0.85
22	646	Vipin singh	7/172 Tulshi,cabutra Tajganj		Un-registered	0.50
23	648	Vinay singh	7/176 Tulshi,cabutra Tajganj		Un-registered	0.80
24	656	Ram prashad (Karan Singh)	7/182 Tulshi,cabutra Tajganj	TG-11/308	Registered	0.75
25	660	Saroj devi	7/178 Nawada Tajganj		Un-registered	1.20
26	663	Khanna ji	7/178 Tulshi,cabutra Nawada Tajganj		Un-registered	0.50
27	666	Chinna singh	7/194 Tulshi,cabutra Nawada Tajganj	TG-11/323	Registered	1.00
28	679	Puran s/o Legraj	7/159 Tulshi,cabutra Nawada Tajganj	TG-11/279	Registered	0.70
29	709	Open tab	Nearby 7/174			0.50
30	712	Open tab	Nearby 14/63			0.90

Sr. No	Property ID	Name	Address	Consumer ID	Connection & Meter Status	Pressure in kg/cm^2
31	713	Open tab	Nearby 14/58			0.40
32	715	Open tab	Nearby 7/176			0.40

Table 56 : Details of Pressure Measurement



Graph 5: Pressure at Consumer tap

6 ABD AREA CONSUMER SURVEY ACTIVITY

The consumer survey activity for selected ABD area including Tajganj,Harjupura,Basai, etc. consumers / properties has been carried out by DRA team. The Billing Database list collected from the Corporation and physical site survey conducted to identify and verify the consumers of the ABD area.

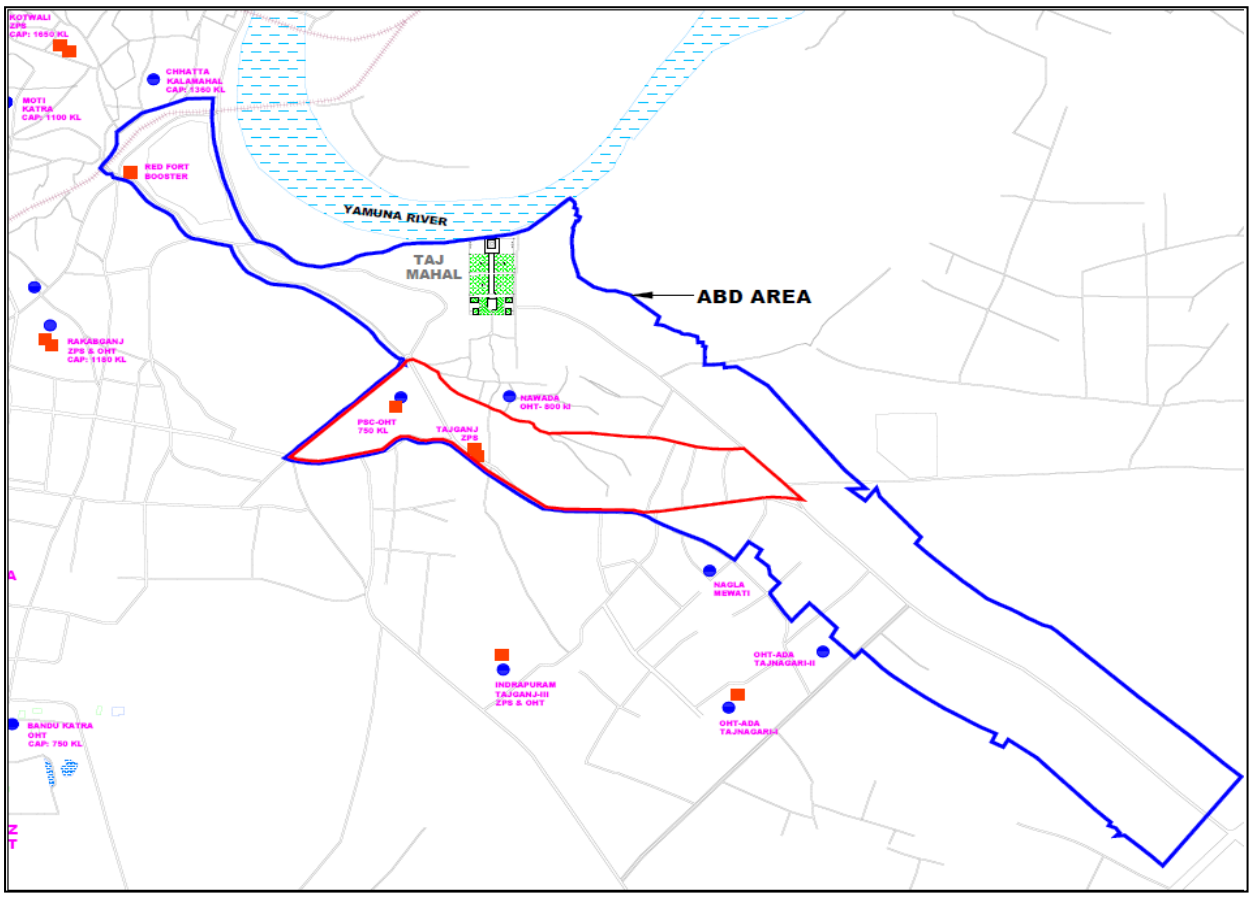
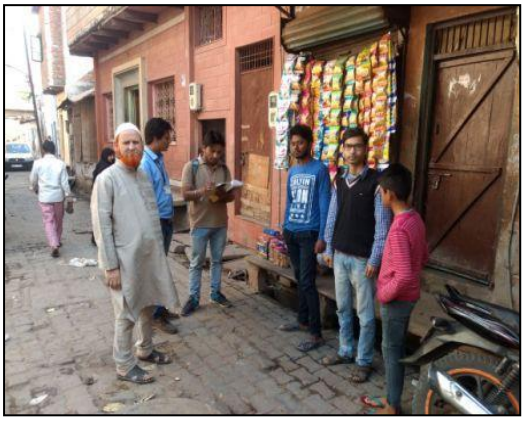


Figure 73: ABD area consumer survey

Summary of consumer survey is tabulated below and results of Consumer survey activity is enclosed separately under Volume-2 of this report as Annexture – Consumer Survey ABD area.

Discription	Nos
Registered Connection	823
Un-Registered Connection	971
No-Connection	1550
Lock Property	60
Permanent Lock	4
Temporay Lock	3
Total Property As per Consumer survey	3406

The field photographs for consumer survey activity is represented as per below;



House No- 16/16 Tajganj

House No-6/57 Harjupura

House No-19/63 Gadhiya tajganj

House No-19/39 tajganj

House No-18/244C Purani mandi tajganj

House No-18/256 tajganj

Figure 74: ABD area consumer survey Photos

7 ROAD MAP & OPTIONS FOR WATER LOSS REDUCTION

7.1 DEFICIENCIES OF THE EXISTING SYSTEM

Following are the critical issues prevailing with existing water supply system of AMC and hence resulting into reasons for water loss and gap between water management and citizen services.

1. Direct Supply

In current scenario, the bulk water supplied into the system has too many direct tappings for distribution of water resulting into pressure drop and non filling of ESR / Zonal pumping stations and leading to un-equitable distribution / un-accounted for water.

2. Metering

The city does not have metered water connections due to lack of metering policy at consumer end. Consumer are being charged on flat rate system on annual basis. Hence, the quantity of water consumption and the physical losses in the city is difficult to be estimated.

3. Improper Operation Zones:

Serving area/ zone served by each elevated service reservoir (ESR) / puming zone is not designed as per their capacity. Despite disarrayed service area, existing pipelines have been found laid in haphazard manner. Thus the residents get water with less pressure. The operational zones are created with multiple tanks. There is common inlet and outlet for tanks. No integrated approach was observed of demand-supply management.

4. Water leakages / loss

There is substantial loss of water due to old and worn out pipelines / valves/ worn out assets leading to leakage. Leaking house service connection is main reason for water loss.

There is substantial wastage in the public stand post during supply hours due to free flow of water. In addition there is significant leakage in the pipelines of which there is no systematic management for detection and repair.

There is significant wastage in the house connections also due to intermittent supply where the beneficiaries throw away stored water and store again the fresh daily supply.

In addition there are too many unauthorised / illegal connections in the distribution system.

5. Poor Water quality

Quality of water being supplied to the city, is the core issue in Agra City. There are major concerns among citizens regarding quality of water due to contamination issues mostly due to old & dilipiated distribution system. This is resulting into un-willingness to pay water bills/ charges and ultimately non revenue water to ULB.

6. Improper database

The database with regards to several aspects like, water network, water connection details, asset details, history of installation etc is not of available. Pipe network details are available only in piece meal manner and no such integrated base map for the network is available.

7. Monitoring System

There is no proper instrumentation to monitor flow- pressure in transmission, bulk supply tappings & distribution network. In absence of proper instrumentation system there is no accountability for water supplied from WTP level and distributed at ESR /ZPS/ Pump house level . This is leading to un-efficient operation of the system.

8. Water Quality monitoring

Integrated approach for water quality monitoring and quality surveillance is needed for the system.

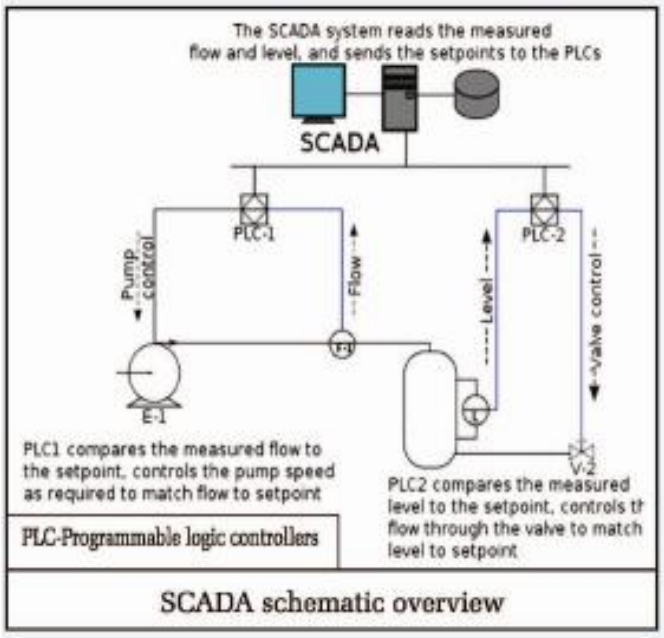
9. Water Tariff

There is no water tariff policy yet for Agra City. In absence proper water tariff policy, there is increase in customer dissatisfaction and poor customer services.

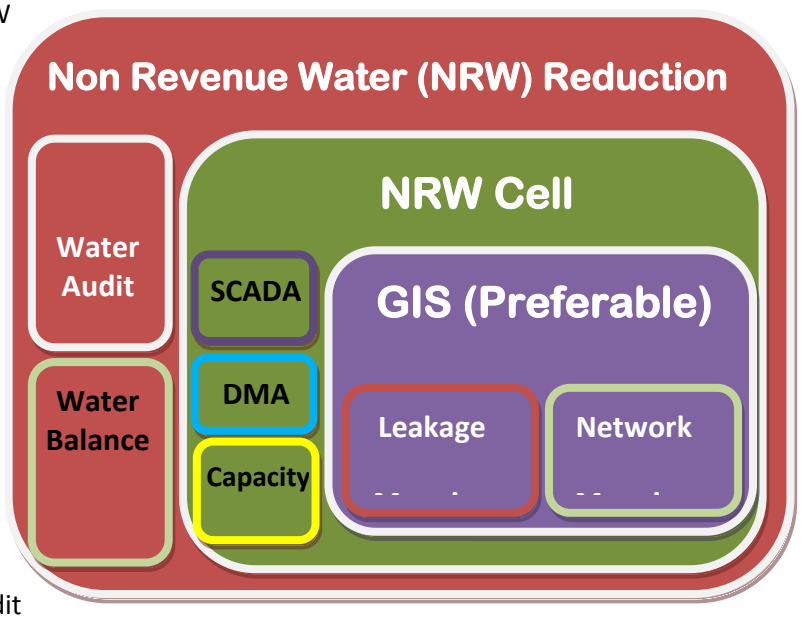
7.2 IMPROVEMENT OPTIONS / PLAN

It is recommended that any NRW Reduction strategy include the following main components:

1. Establishment of NRW Cell:- Capacity building and institutional strengthening - including leak detection teams and NRW monitoring and management cell or appointment of service provider
2. Installation of metering for effective water accounting
    i. Water Production
    ii. Distribution
    iii. Consumer
3. Leakge Mapping through detailed investigation and NRW category
4. Action plan to implement NRW reduction plan



7.3 NRW CELL / TEAM



Establish separate NRW monitoring & training cell at AMC level for imparting training to all water supply system staff and for monitoring reduction of NRW in each zone / plant / unit / facility etc. The main objective of this cell is to enhance the efficiency of the transmission and distribution network, ensure equitable distribution of water and conduct water audit every 3 years. AMC shall work out an annual NRW reduction plan which will document the actual steps that will be taken to reduce NRW apart for leak repair and management. In absence of staff or team , AMC may appoint service provider for the services.

7.4 SUPERVISORY CONTROL AND MONITORING SYSTEM:

Supervisory Control and Data Acquisition (SCADA) is a monitoring system that allows to monitor and control water supply and distribution system that are distributed among various remote locations. It enables better data collection related to the water flow in the system which in turn enables better assessment of NRW from the Central Location. Such operational NRW can then be reduced by implementing measures such as installation of more flow meters, better operations and preventive maintenance. There are quite a few examples of installation of SCADA in the country. The SCADA system consists of servers having SCADA software and the three following elements:

a) **The master terminal unit (MTU);** The master terminal unit which is responsible for communication gathers data, stores information, sends information to other systems, and interfaces with operators.
b) **The remote terminal unit (RTU);** The function of remote terminal units is to gather information from remote sites from various input devices like valves, pumps. alarms. meters, etc.
c) **The communications equipment;** Communication equipment is required for two way communications between an RTU and the MTU.

7.5 NETWORK / LEAKAGE MAPPING:

Adoption of network mapping by preparing "as built" drawings and carrying out hydraulic modeling from time to time can facilitate NRW reduction. There must also be a Unique Id/ common Id that links all utilities in the vicinity. For example pipes, valves, valve chambers should have specific Id& GIS linked. This will come in handy during regular O&M operations and during emergency breakdowns. Net work drawings also enable the maintenance staff to get accurate information about the location of valves, joints, flow meters and alignment of the water lines even after a long time, which will in turn save time and money in repairs etc. It involves a combination of finding out old drawings, getting information from valve operators and mapping pielines marked with the help of fitters of respective zone / areaetc. The GIS map should also be linked to other data base such as property map data by linking the house service connection numbers to the property numbers. By achieving this data connectivity billing, consumption analysis, payment potential could be easily ascertained. This will also yield valuable information when it comes to tariff revision

Once the network process completed, leakage mapping can be easily attempted based on the actual number of complaints received on day to day basis. Locations of leakages can be identified and maps are prepared showing such locations. Accordingly, replacement of such leaking pipelines can be carried out which can significantly result into reduction of NRW / Water loss.

7.6 IMPLEMENTATION STEPS FOR NRW REDUCTION

Action for NRW Reduction for AMC water supply includes following chronology of activities; The activities as per below is executed properly either through service provider or performance based management contract, water loss can be reduce considerably and NRW level can be brought down upto acceptable norms for the city. This needs the holistic approach and 5 to 7 years strategy for implementation of improvement plan to achieve the objectives. The Implemantation activities as discussed below can be implemented under AMRUT or Smart City Yojana.

I. Preparatory Surveys

i. Setting up a core NRW Team
ii. Preparation of Base Maps
iii. Customer door-to-door survey
iv. Topographical Ground Survey
v. Network mapping
vi. Setting up a GIS

II. DMA Establishment

vii. Hydraulic modelling
viii. DMA establishment

III. Flow and Consumption Metering

ix. Production metering
x. Installation of zonal meters
xi. Customer metering
xii. Extend metered connections in unserved areas

IV. Initial Water Balance

xiii. Striking an initial water balance
xiv. Continuous water supply

V. Reducing Commercial Losses

xv. Regularize illegal connections
xvi. Improved billing and revenue collection

VI. Reducing Physical Losses

xvii. Segregation of old network
xviii. Leak detection and repair within the DMAs
xix. Pipe and connection replacements
xx. Pressure management
xxi. SCADA system

VII. NRW Monitoring

xxii. Network monitoring and management
xxiii. NRW control

Following NRW reduction staretgy / target shall be implemented as per 5 to 7 year plan (considering 65 to 70 % as base indicator). The Strategy output will be as per below, if implemented succefully;

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
2018	2019	2020	2021	2022	2023	2024
-	60%	55%	50%	40%	35%	20%

7.7 ACTION PLAN FOR NRW REDUCTION PROGRAMME

1. **Setting up correct zones:** Operational zones shall be demarcated with respect to Zone wise water works /ESR wise / pumping stations capacity andserviceability.
2. **Survey & Investigations:-** Under this activity entire Transmission and Distribution Network shall be mapped by using suitable GIS Mapping tool and this shall facilitate to carry out effective and accurate Hydraullic Modelling of the entire system. This will help to identify and locate the pipelines with more leakage history and distribution pipe network which can be replaced/ repaired with new pipeline. Thus, after replacement, NRW can be brought down considerably as the pipes will be new with good joint system.
3. **Hydraulic modeling:-**This activity will judge the suitability of existing network for supply of progressive demand, replacement /rehabilitation required in phases to meet the requirement.

   This will also enhance with provision of isolation for proper controlling and demand management, restructuring of zones, looping network, introducing rider mains etc.
4. **Setting up District Metering Areas (DMA)**: under this activity District Metering Areas shall be set up for each correct operational zone for the number of customersbetween 500 to 2000. These DMA's shall be made hydraulically discrete (isolated) by carrying out zero pressure tests. Flow into the each DMA shall be metered and continuously monitored. Also, Pressure Control Valve's (PRV's) shall be installed at more than one point as per the site requirements.
5. **House service connections**: All house service connections shall be replaced by using MDPE pipe. It is a known fact that more than 50% of the leaks appear from Service Connection, old discontinued connections and leaks at ferrule points. Also, the service connections are made of Galvanized Iron (GI) pipes which have effective life of less than 15 years depending upon the soil condition in which it is laid. Thus, this House Service Replacement program will amount to a huge NRW Reduction.

6. **Consumer water metering:** The city has very few metered water connections and many of them are old and defective resulting into average reading. Smart water meters shall be installed and also the consumers shall be tagged on GIS for real time monitoring of consumption and arresting water loss / NRW.
7. **Leak identification**: under this activity water leakage areas shall be identified by conducting step tests and gathering data from the data loggers. Exact location of leak spots shall be then fixed using leakage identification instruments such as injection of helium gas, sounding rods, noise-corelator etc. Firstly, efforts should be made on apparent loss detection and surface (visible) leakage repair. In the mean time, underground leakage should be detected intensively.
8. **Revised Tariff system :-** The current tariff can be reviewed and modified. AMC is presently collecting water tariff through bimonthly billing. AMC shall frame the water tariff policy based on consumption which will be useful at least discourage misuse and wastage of water. The new progressive tariff should be implemented.
9. **Central Monitoring System:-** Centralised Water distribution monitoring and Management System shall be installed for the entire city project area. The central monitoring station shall be located at Municipal Corporation main office building displaying the information of each location of water sources and distribution components online on realtime basis through GPRS/ RF. The Central Server of the system shall monitor, record the parameters like flow, level, pressure, residual chlorine of each existing water works locations locations.

10. **Consumer Awareness Programs :**
    a) Public Campaigns for the project & water conservation while conversing DMA's in to continuous (24x7) Water Supply shall beundertaken.
    b) Internal water audit or leak test for consumers those having history of high consumption shall be conducted. A list of such consumers shall be identified andmaintained.
    c) Checklist of probable leak points to consumers of DMA's shall be provided as a part of awareness programme.

11. **Reuse of Treated Wastewater**

There are a lot of opportunities for reuse of treated waste water as follows:

Potential for reuse of treated wastewater for non-potable uses at local or regional level, industrial reuse, housing colony/ group housing reuse option, irrigation and horticultural uses, recharge of Ground Water from treated waste water and from rain water harvesting Water harvesting, Dual Pipe System, Utilization of Treated wastewater etc. Re-use of treated waste water will reduce the demand on fresh water. However, consumer needs to be educated and encouraged on this aspects.

8 NRW REDUCTION STRATEGIES AND ACTION PLAN

8.1 CONSUMER METERING & HOUSE SERVICE CONNECTION

It is recommended that AMC should adopt policy decision for instllation of consumer metering and House Service Connection and shall replace existing service connection pro-actively with good quality water meter. House Service Connection will be given to each consumer by providing EEC / MID/ OIML approved AMR Multi-jet Domestic / bulk water meter with MDPE service pipeline with specials. The typical house connection service connection shall be as per below;

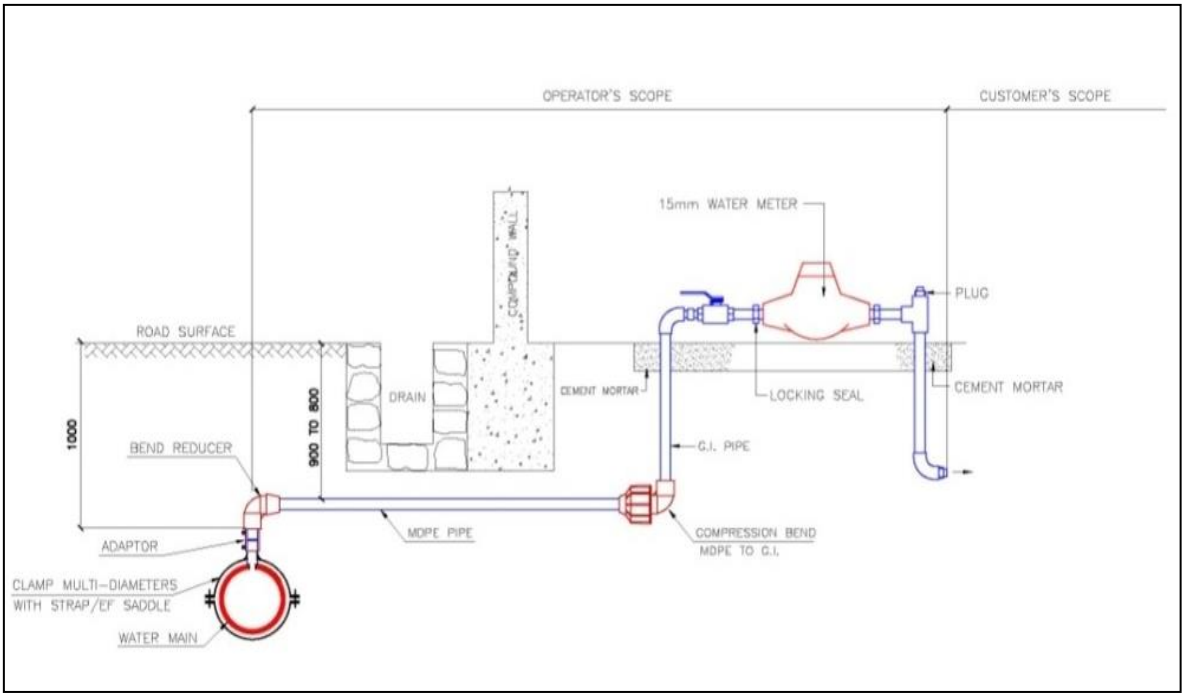


Figure 75: Typical House Service Connection

8.2 NRW / WATER LOSS REDUCTION STRATEGY FOR AMC

8.2.1 HSC Rehabilitation Plan

Main reason for system losses are house service connections and the strategy to be applied first for House Service connections is discussed as below;

Strategy

The strategy used to prepare the rehabilitation plan for the House Service Connections are as follows:

a. 100% of the connections should be equipped with the accurate calibrated flow meter.
b. The number of connections to be equipped with a meter is based on the results of the customer survey.
c. 100% of the active House Service Connections shall be replaced with MDPE pipes.
d. The new meter should be installed near the property boundary. In these conditions, the average length of MDPE pipes from the service pipe to the meter should be kept around 10 m.
e. The connection of the service main shall be made with the use of Saddle with strap on existing metallic pipes and new DI pipes Electro-fusion saddle on MDPE pipes
f. Ball valve from shall be installed upstream the meter of all consumers of15 & 20 mm size connections.
g. It is proposed to install the meter near the boundary of the plot. However, it will be proposed to the customer to lay the internal pipe downstream the meter up to the sump or suitable internal pipe of the customer.
h. It has been proposed to install meter boxes where they are required for security and protection purpose.
i. HSC will be connected to the main pipe through a saddle and various diameter compression fittings.

Saddle V/s Ferrule:

In order to reduce drastically the risk of leakage and make the house service connections more sustainable, it is proposed to use an innovative product on metallic pipes – the saddle with strap – to replace the use of the ferrule in the metallic pipes.

Figure 76: Proposed Saddle

The several advantages of this product proven throughout the world (Casablanca– Morroco, Bucarest – Romania, France…) and full city area of 24x7 in Nagpur where the replacement of HSC has resulted in to the improvement in pressure.

One can mention in particular:

a. Easiness of installation
b. A single product whatever the outer diameter and nature of the pipe (PE, CI, DI…).
c. Good quality of materials which guarantees a life time equal to those of the pipes.
d. Reduced risk of leakage
e. Easier store management due to reduced number of different strap diameters (upto 175mm or 350mm dia.).
f. In addition, we are of the opinion that under 24x7 and pressurized supply, ferrule connections must be avoided since there is a strong risk of leakage at the ferrule point due to the difficulties to install them properly on the pipe.
g. On PE pipes, it is proposed to use electro-fusion saddles which are 100% leak proof and less expensive than saddle with strap.

8.2.2 Map updating & Rehabilitation of Network :-

Strategy

AMC shall make a policy decision to update the entire distribution network of water supply system and replace / rehabilitate the worn out / leaking pipelines. The strategy used to prepare the rehabilitation plan for the network are as follows:

1. Abandon of all conservancy lines and ACP / PVC lines age more than 25-30 years as per AMC policy (Phase wise manner) and replacement by HDPE upto 315 mm dia. Pipes and above by DI pipes. These pipes are old and impossible to reach for maintenance.
2. Minimum diameter for new pipes: 110mm and 160 mm
3. It is proposed to put HDPE pipes upto 315 mm dia. to optimize the overall cost of the investment plan. It must be however noted that DI pipes is used above 315 mm dia.
4. Valves:
   - Air valves: 1 per 500m of new pipes
   - Distribution valves: As per the DMA zoning of the system
5. Flow Control Valves (FCV)- to manage and control the distribution demand based on DMA
6. Pressure dataloggers – to retrieve the filed pipe pressure and monitor the distribution system pressure.
7. PL C/ RTU- for monitoring and control for equitable distribution
8. Road restoration:
   - WBM / Cement & Tar Road: as per actual condition

Rehabilitation of network mainly consist of following area

1. Replacement of GI, PVC/ACP pipes.
2. Replacement of pipe with frequent complaint of polluted water.
3. Replacement of pipe with frequent complaint of leaks.
4. Rehabilitation or replacement for lead joint.
5. Interconnections for removal of discarded pipes from the network.

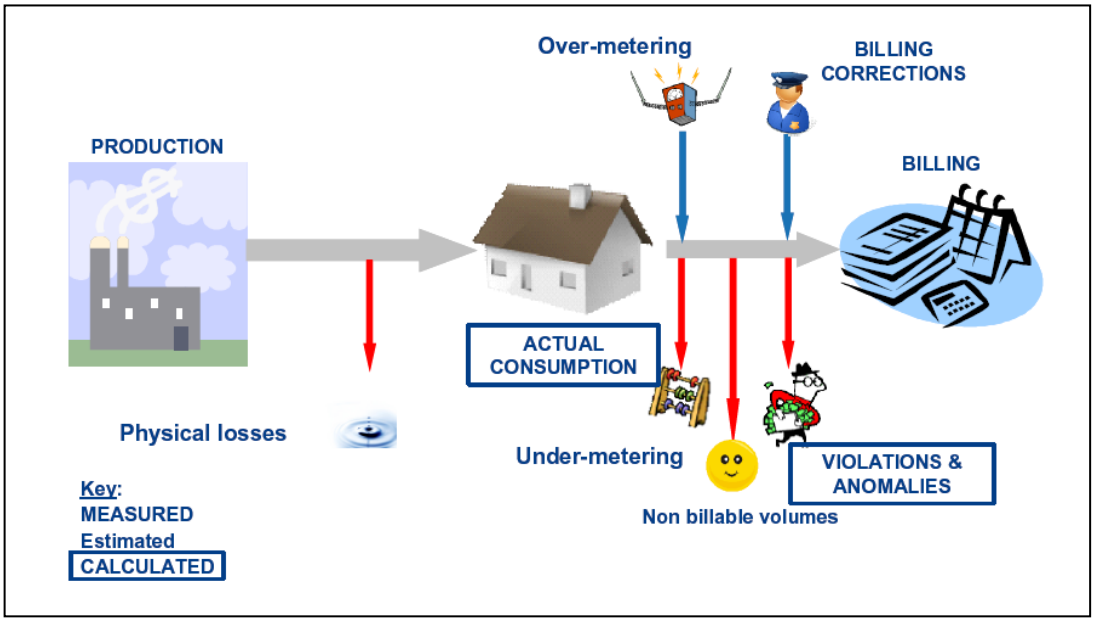
8.2.3 Reducing Non revenue water (NRW)

NRW is the difference between net production (the vol. of water delivered into the network) and consumption of water (vol. of water accounted). It includes Technical Losses or Real losses due to leakages and Commercial losses or Apparent Losses because of faulty meters, illegal connections etc.

Thus NRW = Produced Water – Revenue Water

= UFW Leakage + UFW Meter + UFW Violations

The figure below illustrates the various elements of NRW(Non-Revenue Water).



8.2.4 Measurement, Estimation and Calculation of Water Loss

Accurate measurement of water volumes is an essential strategy to meet the targets for reducing NRW. It is proposed to install appropriate measurement infrastructure wherever required. However some sub-elements of the water balance will require estimation either

because sufficient measurement infrastructure is not yet available or measurement is impractical.

The system losses are divided into Real / Technical and commercial losses as discussed below;

Technical / Real Losses:-

The quantity of real losses in a given water systems is a good indicator of how efficient a water supplier is in managing its assets (the distribution network) and the product it delivers to its customers. Volumes of real losses that are significantly higher than what is economically justifiable indicate that action needs to be taken if the water supplier is to be viewed as water-efficient, customer-responsive, and a responsible steward of water resources.

Real losses are made up of three components.

i) Reported breaks and leaks: They typically have high flow rates, are visibly evident and disruptive, and have a short run time before they are reported to the AMC by customers or AMC personnel since they cause nuisance to the customer (pressure drop or supply interruption).

ii) Unreported breaks and leaks: They are typically hidden from above-ground view, have moderate flow rates, and a long run time since AMC must seek out these leaks to become aware of them. They are difficult to locate through active leak detection.

iii) Background Leakage: These are the weps and seeps in pipe joints and connections. They run continuously until they gradually worsen to the point they affect the quality and quantity of water supply to consumers. The complaint of polluted water or absence of residual chlorine is one of the indicators that background seeps are increased and it converts in to points of ingress during non supply hours in intermittent water supply.

Reported breaks and Leaks:-

Analysis of reported leaks, customer complaints and maintenance record of AMC is an effective tool for identify the most appropriate causes for water losses.

AMC should have the strategy for repairs and maintenance which provide the insight in to the cause for leaks on area, size, material etc and it will be useful to prepare focused approach for global intervention to reduce water losses.

Commercial Losses:-

Commercial losses as defined are measurement error, illegal use and errors in reading and billing.

8.2.5 Monitoring of Water Supply System

Central Monitoring / SCADA System

Water distribution monitoring is possible using the subsystem referred as water distribution management system WDMS shall be installed for the water Supply System. Central monitoring station with SCADA is proposed for AMC and it can be located at Jalkal office or any other location suggested by AMC.

Objectives:-

1. To provide continuous real time data monitoring & storing from Central station office for to monitor water flows at each ESR & water inventory at Reservoirs.
2. Water flow / discharge from Reservoirs to various ESRs.
3. To create mathematical model for each UGR & use the same along with past data to derive demand curve for each ESR.
4. To ensure the balance between incoming & outgoing flow at each ESR location.
5. To provide levels data each reservoirs continuously 24 Hrs.
6. Residual chlorine content in water at in each ESRs / Reservoirs
7. Daily flow for all ESR / Direct Tappings with flow meter location by graphics display.
8. Graphical trending diagrams of water balance (Pie Chart) for all ESRs / Reservoirs.
9. Water Audit charts
10. LPCD for each zone- Bar chart

8.2.6 Improvement of Billing and Collection Efficiency

This can be improved through implementing consumer water metering, implementing telescopic tariff, charge for volumetric consumption and further to that with proper customer management system (CMS). Hence following GIS based software's with customised applications are proposed for AMC.

Web GIS customized Applications with water Billing Solutions

A Latest Geographical Information System is proposed for AMC water supply distribution network with integrated server to deal with all geographical data/database. The systems should enhance corporate GIS, effectively dealing with the capturing, structuring, maintenance and management of network data and assets.

The proposed Web GIS systems shall address the entire spectrum of network data management and perform following functions:

- network data acquisition,
- network data analysis,
- network data management,
- mapping, network data modeling,
- customer complaint identification
- and should support asset management functions

Proposed Web GIS customized application shall interface with billing and customer information systems to achieve following;

- work order and maintenance management,
- interfacing with demand management and
- Network analysis applications enabling functions such as consumption analysis, demand-forecasting, design standards evaluation and non-revenue water (UFW) analysis and operational audits.

The Water Billing Solutions systems shall be a comprehensive commercial management system equipped with functionality to cover all operational areas of revenue management and customer information as well as to manage commercial data quality.

The proposed system shall perform following functions:-

- Billing, revenue collection, statement delivery, debt management, customer services, enquiries, new accounts, pricing & consumer analysis, meter reading & control, meter & connection maintenance and reporting.
- Dealing with customer complaints and enquiries, and efficiently administer and process applications for new services.
- System shall be online, semi-offline with batch updating of a central server, and stand alone (offline).
- The systems shall be integrated with geographical information systems (GIS) to enable optimized walk route management and property/connection reconciliation and should be able to interface with existing system.

9 ROADMAP FOR RATIONALIZATION OF USER TARIFF / CHARGES

9.1 BACKGROUND

With the acceleration in the rate of India's urbanization and growth in consumption levels, there is increasing demand for urban water supply and sanitation services. As per 2011 Census, out of total 1210.2 million population of India, the urban population is 377.1 million, living in 7935 towns, which is 31.16% of the total population. The rate of urban growth in the country is very high as compared to developed countries, and the large cities are becoming larger mostly due to continuous migration of population to these cities. It is also projected that by year 2050 the urban population will reach 50% of the country's population and 695 million will live in urban areas.

On the other hand, the urban water supply service delivery systems continue to be characterized by chronic inefficiencies, and poor service quality. According to the Census of 2011, about 70.6% of urban households have a tap water connection out of which 62 % are from treated source. 20.8% of households depend upon hand pumps/tube wells, 6.2% use Well water and 2.5% use other sources. This suggests that a significant portion of the urban population has access to infrastructure, but water supply services in urban area are characterized by poor quality, low reliability of supply, poor water quality, high Non Revenue Water (NRW) levels, and low cost recovery. Poor revenue generation further worsens the matter. The per capita availability of water across most urban centres also has high degree of variability. Typically, water is supplied for just one to three hours per day, regardless of the quantity available. The existing infrastructure suffer from a high degree of operational in efficiencies, for instance, approximately 30- 60 percent of the water pumped into the system is not available for consumption since it is lost in transmission, through theft, and so on and the most important one is loss within premises of consumers. Consumer level metering is still not the norm in most cities and, where adopted, the maintenance and functionality of meters tend to be poor. Low tariffs, operational inefficiencies, and poor tariff collection practices by the utilities have resulted in low cost recovery rates at 40-50 percent of O&M cost. These shortcomings are compounded by the low levels of technical, financial and managerial capacity of local governments, which are inadequate to meet the service needs of their citizens.

The problem of inadequate water availability, as described above, has tended to be addressed primarily through creation of new assets to augment water supply. These have usually resulted in increased costs, without necessarily improving services substantially. Little or no effort was made to improve service delivery through better management of existing assets. The neglect of asset maintenance has resulted in declining asset quality, and consequent deterioration in service levels and operational efficiencies. Efforts to restore or refurbish assets are further constrained by poorly maintained asset registers and records.

In recent years, policies focusing on improved urban services and reform- linked schemes such as Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT), AMRUT have created a new sector vocabulary that has helped mainstream the elements of cost recovery, service accountability, and private participation. However, despite the investments and allocations

made in the sector over the years, adequate water supply service is still lacking. As per the census, there have been improvements; nevertheless, wide service gaps and serious institutional challenges continue to dominate the sector.

The Ministry has notified the desired service Level Benchmark for cost recovery in water supply services as 100%. This was aiming at meeting up of all operating expenses such as electricity, chemicals, staff, outsourced operations, bulk water purchase cost and other O&M expenses but excluding interest payment, principal repayment and other capital expenses through water supply related revenues in a Year. The revenue includes taxes/cess/surcharges, user charges, connection charges, sale of bulk water, tankers etc. excluding capital income as grant, loans etc.

Urban services such as water supply, sewerage, and garbage collection require not only major investments in urban infrastructure assets but also regular maintenance for efficient operation and effective delivery. User charges for these services ensure that the assets are maintained in tip top condition and delivery of services sustained. Tariff for water should ideally cover not only the cost of Operation & Maintenance of the system but also the capital replacement cost. However, in most of the Indian cities and towns even the O&M cost is also not recovered. Water is considered to be essential good and provided at very low rates and even free of cost. The rates fixed are also not revised frequently to reflect the prevailing cost, widening the gap between cost of production and tariff charged.

The High Power Empowered Committee (HP'EC) report of Ministry mentioned that more evidence of user charges being put to good use in improving services will break the vicious circle of low user charges and poor service delivery.

Following has been recommended in the Committee report:

1. Where services can be measured and beneficiaries identified, user charges must apply rather than taxes. Where beneficiaries are not easily identifiable or benefits not easily measured, the cost of services should be recouped through a surrogate tax on an appropriate base. Therefore, water charges should be levied separately rather than built into the property tax. Similarly, sewerage charges should be collected separately and not built into the property tax;
2. User charges should be so structured as to meet O&M cost, debt servicing, and depreciation towards the cost of the project. In addition, they must also generate some surplus to enable building the equity base of ULBs, supported, where appropriate, with Viability Gap funding (VGF);
3. Since ULBs have to get the approval of State Governments for levying user charges, this limits their autonomy and has an adverse impact on their ability to deliver urban services. The Committee recommends that the Municipal Service Regulator be assigned the responsibility of revising user charges regularly. Even when different segments of the population are charged differently, the cross-subsidization should be such that the overall O&M cost is recovered and a minimal surplus generated. Automatic indexation will ensure smooth increase over time without the challenge of having to defend cumulative adjustment every few years;

In above background, efforts have been made in subsequent headings to evolve model tariff structure for water supply of Agra Municipal Corporation, with emphasis on metered connections, so as to collect enough user charges to operate and maintain the utilities in tip top condition and ensure desirable service delivery standards. The effort may go a long way in checking wastage of precious treated water, which at present ranges 60 to 70 percent of water supplied, and 60 percent of all losses occurred in water distribution network occurs primarily within the house premises only because of unmetered connections of faulty ones.

9.2 COMPONENTS WATER TARIFF

Water tariff philosophy should be based on economic principles of pricing namely revenue sufficiency, economic efficiency, equity and fairness. The key elements of tariff philosophy that need to be considered are given in Table below;

Cost components of water tariff

Major Cost	Minor Cost
Fixed Cost	• Water meter monthly rent (all meters are ULB/AMC property)' • Bill reading, bill generation and revenue collection
O & M Cost	• Bulk water rates • Treatment cost including chemical cost • Energy cost • Manpower cost • Repair and maintenance cost • Repair and replacement cost of water meters
Capital recovery cost	• Interest costs • Depreciation and reasonable return • Return on interest

Rationloisation in water tariff is required for ;

- *Cost recovery for economic and financial sustainability*
- *Volumetric basis for efficiency and reduction in NRW level*
- *Life line supply with lowest tariffs to address social justice aspect and to make it affordable to urban poor especially those living in slums. Where individual metered system is not feasible other alternative arrangements like metered community stand post to be made ensuring bare minimum NRW level.*

The cost components which should be included while determining user charges are as under.;
Tariff for water should ideally cover not only the cost of operation and maintenance of the system but also the capital replacement cost. However, in most Indian cities and towns even the operation and maintenance cost is not recovered. Water is considered to be an essential good, and therefore, expected to be either provided at very low rates or even free of cost. The rates fixed are also not revised frequently to reflect the prevailing costs, widening the gap between the cost of production and tariff charged. This ultimately results in poor service to consumers. Further, in many states/cities, there is prevailing practice to charge the cost of water meters (or some time rent for meters) from consumers additionally viz. in addition to the cost of house service connections. This sometime discourages consumers to opt for water meter based connections and they continue with

flat rate based connections, which ultimately results in wastage of precious treated water inside house premises due to flat rate basis charging. This practice need to be discouraged and efforts should be made to convert all house service connections based on metered water supply only to conserve water in long run. The installation of meters can also be helpful in water auditing and plugging leakages and theft etc. This approach would also be helpful in preventing contamination of water from external impurities which often results in the form of water borne diseases.

9.3 IMPLEMENTATION OF WATER TARIFF

Water supply charged for in three ways:

- Through consumption based tariff model
- Through flat rates
- Through water taxes

Tariff for water supply varies considerably between cities and between States. Water tariff should be different for domestic and non-domestic uses. The tariff should generally be much higher for industrial and commercial uses than for domestic use to introduce cross subsidization against domestic use. Also, minimum lifeline supply of 20 lpcd as per WHO life line supply is@ 20 lpcd only) may be charged with marginal charge of cost of billing and collection only. This will inculcate the habit of payment for water supply and will also help to encourage conservation of water and to bring in due awareness in consumers.

9.4 PREVAILING WATER TARIFFS

1. Water connections (domestic and nondomestic) can be of two types - metered and unmetered.
2. Water tariff for metered connections is consumption based, i.e. based on the quantity of water consumed.
3. Water tariff for unmetered connections is on flat rate (fixed amount), which is not related to the quantity of water consumed.

9.4.1 Domestic Water tariff

Domestic water connection can further classified into;

9.4.1.1 Metered Rates

Consumption based water rates for metered connections are of two types:

(i) A uniform volumetric rate per kilo liter (KL i.e.1000 liters) for the entire quantity of water consumed in a month; and

(ii) An Increasing Block Tariff (IBT) / telescopic tariff or slab based rate with higher rate per KL for higher quantities of water consumed per month per house connection, with a minimum monthly fixed charge in some cities.

Uniform volumetric rate is a single rate per KL of water for the entire quantity of water consumed per month through a single connection, applied uniformly to large as well as small consumers. Therefore, the monthly bill, where this rate is used, is directly proportional to the quantity of water consumed. On the other hand, IBT differentiates between the low end users and the high end users and often cross-subsidies low end users by high end users. In IBT, it is assumed that the poorest family would have a monthly consumption, which will generally not exceed the first block, and so they will pay the lowest rates. The lowest block, generally varies up to 10 KL /20KL. Most of the domestic consumers in the case of SI. No (ii) would fall in the first block itself, while in case of others they may go up to the second or the third blocks.

9.4.1.2 Unmetered Rates

Flat rate for unmetered connections can be grouped into five categories. These categories are:

(I) Based on ferrule size of connection;

Ferrule based rates depend on the ferrule size (i.e .the diameter of pipe) of the connection. Most domestic connections are only of half-inch (1/21') diameter; larger ferrule size connections are generally taken by large consumers such as apartment blocks.

Tap based rates depend upon the number of taps in a house. Generally, the rate for the first tap Is higher than the rate for additional taps. These rates are much less commonly used in the sampled urban centers than the ferrule based rates.

The fixed flat rate, charged either annually or at lesser intervals, is the most common method of charging for water (for unmetered connections). The basis of this flat rate is not explicitly stated but could be based on ferrule size, or the duration of supply or some other basis known to local authorities.

(II) A VARIABLE MONTHLY FLAT RATE BASED ON THE ANNUAL RATEABLE VALUE(ARV) OF PROPERTY.

Water tax, charged in a few urban centers is a certain percentage of the Property-tax. This ARV based charge for unmetered connections is not very common in the urban centers. However, in some urban centres a flat rate is charged but it is called water tax.

(III) Based on plot area.

In some cities/towns, Flat Water Tariff based on Plot Area per Household (without meter connection) is also in force as approximately given below in Table below;

Plot area based tariff

1	Plot are <100 sq yd (900 sq.ft) or Built-up are <500 sq.ft.	Rs.60 per month / connection.
2	Plot area>100 sq. yd. &<200 sq.yd. or Built-up area<1000 sq.ft.	Rs.150 per month/connection.
3	Plot area>200 sq. yd or Built-up area<1500 sq.ft.	Rs.250 per month/connection.
4.	Plot area>300 sq. yd or Built-up area>1500 sq.ft.	Rs.400 per month/connection.

9.4.2 Tariff for non-domestic use

Tariff for non-domestic uses, in some cities, differentiate between different types of nondomestic uses in a fairly detailed manner and charge different water rates for different uses. The schedule of tariff for large cities often follows an elaborate categorization by uses and the scale of activity.

There is also a provision of cross-subsidy within the water sector whereby domestic consumers are subsidized by industrial and commercial consumers. The extent of cross subsidy varies, though on an average industrial consumers pay anything between 2 to 10 times higher tariff than domestic consumers.

If Tariff for Institutional, Industrial and commercial use in different DPRs of various cities is compared, it is noticed that out of 13 cities/towns, 8 towns charges about 1.5 to 2 times of domestic tariff or Industrial/commercial use. In the other 5 cities, the charges for Industrial & Commercial use vary between 3 to 5times of domestic tariff.

9.5 PROPOSED MODEL TARIFF

9.5.1 Metered connection rates

Based on analysis of proposed water tariff in 19 cities, under recently completed JNNURM programme, a model tariff structure has been evolved on 'Volumetric Basis'. The proposed model rates are indicative only and may vary from city to city depending on factors like surface source based water supply, ground water based water supply, high head pumping based water supply and distance of source, cost of treatment and electricity charges etc. However, in each city efforts should be made to fully recover operation & maintenance charges soon after completion and commissioning of project and capital cost for replacement of assets on expiry of its useful life. Based on above analysis the model tariff for domestic and non-domestic uses with Increasing Block tariff (IBT) are given below-

Domestic Use

A minimum charge for meter reading, billing and collection need to be recovered at rate of Rs.30.00 per month from each house having water supply connection. Water Tariff based on volumetric consumption per household (meter connection) per month may be charged as in given table below;

Volumetric tariff (Increasing block tariff) domestic connection

Volume (KL)/month #	Water supply rate (LPCD)	Tariff (Rs./KL)**	Range (in Rs.) (cost of water + Rs.30 (fixed))
$0-\leq 3$	20	Nil^	30.0*
$>3-\leq 15$	100	7.00	50.0 – 135.0*
$>15-\leq 30$	200	8.50	135.0 – 285.0
>30	>200	9.50	>315.0

The above charges may be subsidized for BPL family up to 50% or so for water use up to a maximum of 15 KI/month usage. In no case water supply should be made completely free of

cost to any house hold to check wastages of water. Efforts may also be made to meter the stand post supply also where individual house connections are not feasible due to any reason and the same may also be charged suitably on above lines.
Rates are indicative only and may vary from city to city to fully recover at least O&M charges to begin with.

The minimum lifeline supply of 0-6 KL/ month per household has been mentioned in the Advisory note for improving Urban Water Supply & sanitation Services published by MoUD. For water consumption crossing from one slab to the next higher one, the entire consumption shall be charged at rate of higher slab only to conserve water.

However, as per TERI report submitted on review of current practices in determining user charges and incorporation of economic principles of pricing in 2010, 3 slabs have been proposed with 5-10KL/HH/month as lifeline consumption with marginal price. 2nd Slab for consumption up to 25 KI/month to ensure recovery of O&M costs and 3'd Slab for consumption of more than 25 KL/month to be charged at O&M cost +% to recover interest on debt or capital investment.

Non-domestic Use

The suggested tariff for Industrial /commercial use may be kept around twice of domestic tariff. However, the same may vary suitably from city to city to incorporate cross subsidy as well as to discourage those industries which are not situated in designated locality and other similar factors like that. For nondomestic uses tariff may be charged at a rate in the multiples of highest rate of domestic use. This will help in collecting cross subsidy for life line consumption and subsidy for BPL families. The proposed tariff for Industrial /commercial use may be kept as per Table below;

Volume (KL)/month	Tariff (Rs./KL)
$0-\leq 30$	**15.00***
> 30	**25.00***

***** *To promote recycle & reuse of water, after treatment to specific standards, the same may be supplied at 50% rates as proposed above for non potable uses.*

In case of Institutional demand, tariff may be fixed as per domestic rates only considering the nature of consumption being similar to domestic uses.

9.5.2 Unmetered Connection Rates

Flat rate for unmetered connections can be grouped into five categories. These categories are:

(i) Based on ferrule size of connection; (15 mm -Rs 50/ month, 20mm - Rs.75/ month) @

(ii) Based on the number of taps in a house; (1-3 tap Rs. 80/month,4-7 tap Rs. 130/ month, 8-12 tap Rs. 225/month) @

(iii) A fixed monthly flat rate; (Rs. 60-100 per month) @

(iv) A variable monthly flat rate based on the annual rental value (ARV) of property (12.5% of ARV).@

(v) Plot area basis@ as proposed below in Table 2.5

Rates are indicative and may vary from city to city to fully recover at least O&M charges to begin with. @ In case of non-metered connections, till metering system is put in place, the existing mode of revenue collection may be continued with suitable revision in tariff so as to generate enough revenue for at least O&M of scheme.

1	Plot area <100 sq yd (900 sq.ft) or Built-up are <500 sq.ft.	Rs.60 per month / connection.
2	Plot area>100 sq. yd. &<200 sq.yd. or Built-up area<1000 sq.ft.	Rs.150 per month/connection.
3	Plot area>200 sq. yd or Built-up area<1500 sq.ft.	Rs.250 per month/connection.
4.	Plot area>300 sq. yd or Built-up area>1500 sq.ft.	Rs.400 per month/connection.

In case of non-metered connections, connections may be checked from time to time as maximum losses in water distribution network occurs at house connection levels. Necessary remedial measures may be taken to reduce Nonrevenue water (NRW) including replacing existing house service connections with suitable pipes as has been successfully done in case of Nagpur 24x7 water supply and also In case of World Bank assisted Hubli & Dharwad towns in Karnataka.

Tariff revision should be taken up at regular intervals in transparent manner. While changes due to inflation, etc. should be passed through in tariff on annual basis.

10 CENTRAL MONITORING SYSTEM FOR AMC

10.1 WATER SUPPLY SYSTEM MONITORING & MANAGEMENT SYSTEM

10.1.1 INTRODUCTION:

The proposed SCADA, Instrumentation and Control (I&C) System for Management, Monitoring and control of Water Treatment & Distribution System (WDMS) for Agra Municipal Corporation (AMC)/Jalsansthan Area will comprise of Master Control Center (MCC) at Jal sansthan office / Agra Municipal Corporation Building and various remote monitoring and control centers within the water supply network.

It is proposed to establish real-time system for monitoring hydraulic data and parameters like flow, pressure, levels, pump status, valve positions, electrical parameters and water quality parameters at various locations and stages of the Water treatment and distribution system in AMC area. The proposed system will have wireless data communication network using VHF Radio Telemetry or GPRS.

10.1.2 OBJECTIVES

The objectives of the proposed system shall include -

a. Real time monitoring of flow, pressure, levels, valve positions, pump status, electrical parameters and water quality parameters like residual chlorine, pH, Turbidity at various selected locations using sensors, local storage and display of the data and transmission of data to the Master station and Central Monitoring station.

b. Establishing Supervisory control & Data Acquisition (SCADA) system for local WDS and remote operation of the Pumping stations and treatment plant(s) within the water supply distribution network.

c. Designing and establishing comprehensive Application software at MCC of generating Water audit Reports, Energy Audit reports, Water Balance and zone wise per Capita daily water usage reports, Billing and Revenue module, generation of various daily, monthly and yearly reports, event logging, alarms, warnings and trends for various parameters.

d. Designing and implementing Web-application for publishing the real time data for public and concern authorities over Web based application/ internet. Secured data for authorities will have password protection. The application will automatically fire the alarm SMS massage to the concern officer/Engineer / Authorities of AMC in case of emergencies

10.1.3 SYSTEM ARCHITECTURE:

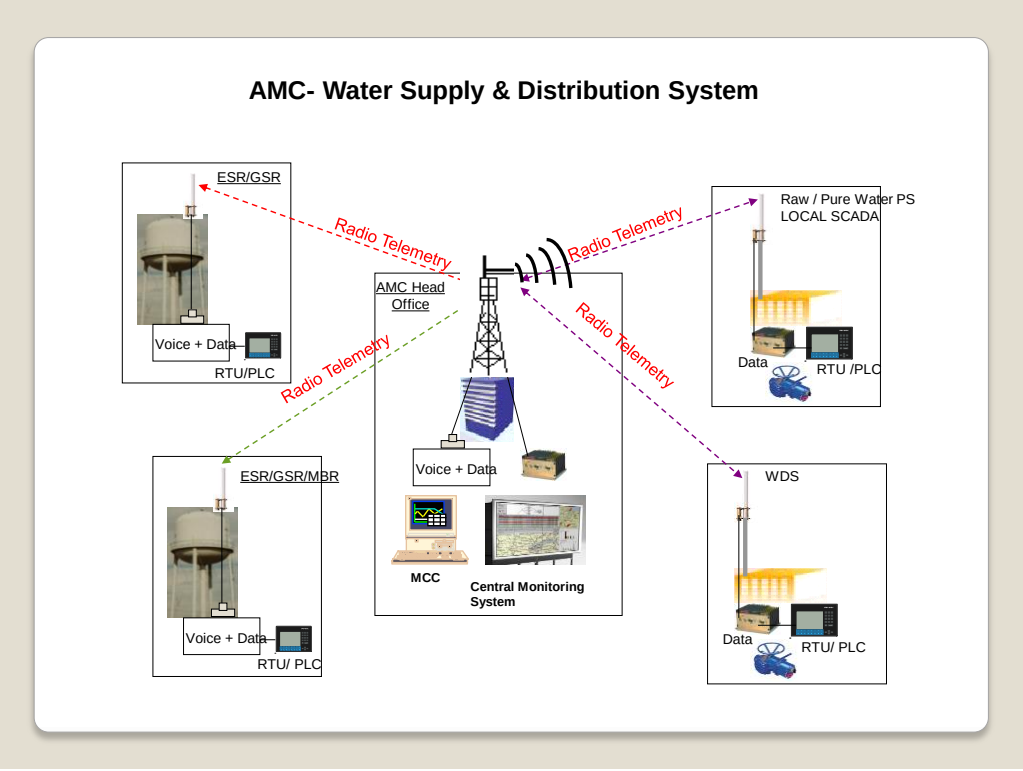
The proposed system shall have multi-level approach.

LEVEL -1: Physical measurement of the various parameters using real-time on-line type precision sensors interfaced with the local Data Collection Platform at various WDS, UGRs, ESRs distribution nodes and direct tapings. This Data collection platform will have capabilities to acquire the data from the local sensors, display the received validated real-time data, store historical data and transmit the same to the MCC using Radio Telemetry based data communication network.

LEVEL -2: PLC based SCADA system for operation and control (Local/Remote) of the Pumping Stations and Water Treatment Plants with the interfacing of pump starters, electrical systems and regulation valves. The PLC system will be capable of acquiring the data from the local sensors, storing and displaying received validated data, transmitting the data to MCC using wireless Radio telemetry, receiving commands from MCC and local operator console for operation of the pumps and distribution Valves . Local report generation, trends, alarms and event log with the password security for the operation will be provided in the local SCADA.

LEVEL-3: The received data from the remote station over wireless Radio telemetry system will be processed at MCC to display in graphical and digital formats, storage of the historical database for future use and transmitting the data to Central Monitoring Station for public displays will be done at MCC.

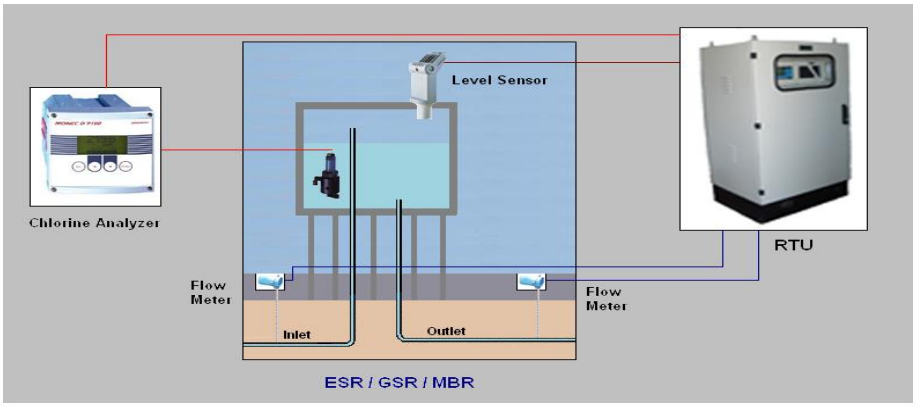
The proposed system Architecture is shown in the illustration.



1. LEVEL -1: ZPS /OHT Locations:

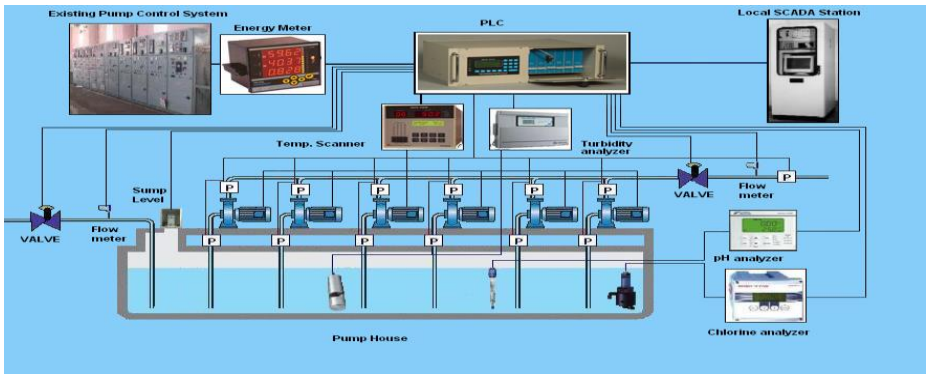
The instrumentation and equipment's at Water Pumping stations / Elevated Storage Reservoirs (ESR) / Underground Reservoirs (Sumps) at various locations / zones of AMC water supply system includes measurement sensors like, flow meters (at inlet & outlet), residual chlorine sensors, water level sensors, pressure sensors interfaced with the Data Collection Platform (DCP). The Data Collection Platform will comprise of suitable interfaces for all the sensors and capability to transmit the data to MCC over

selected radio telemetry option. Typical schematic illustration showing installations at Level-1 stations is shown in the following figure.



2. LEVEL -2: All Pumping Stations & WTP Locations:

All Pumping stations: All pumping stations including water booster station shall be provided with the local Supervisory control and data Acquisition (SCADA) System with modular PLC interfaced with monitoring and control instrumentation. All pumping station operations like starting and stopping of the pump, selection of the operation mode and pumps, etc., will be done from the local HMI. Remote operation of the pumps from the MCC should be possible if the control is passed to MCC by selecting remote mode. Typical schematic illustration showing installations at pumping stations is shown in the following figure.



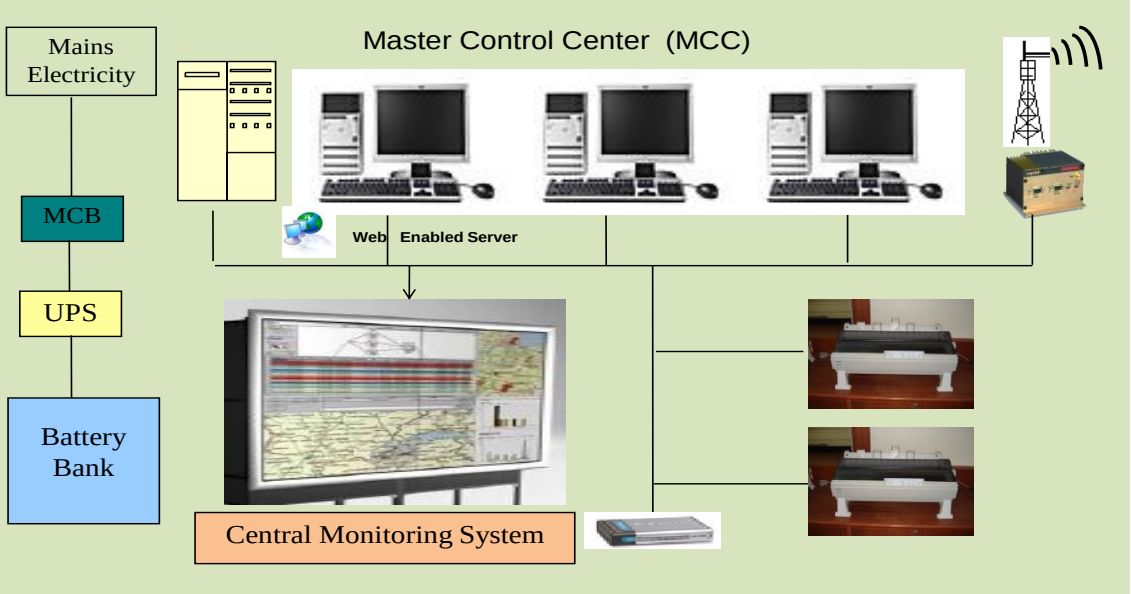
Water Treatment Plant: Similar to the pumping station, water treatment plants will also be provided with the PLC based SCADA system for operation and monitoring of the treatment plant. This includes automatic backwashing of the filter beds, dosing control for alum and chlorine, sludge disposal system and Clarifier system in the treatment plant. Treatment plant system will have interfacing with the online water quality instruments for chlorine, turbidity, pH, and conductivity etc., the operation of the treatment plant can be controlled locally from the local HMI and remotely when control is passed to the MCC.

3. LEVEL -3: Master Control Center (MCC):

The remote operations of the pumps and treatment plant, collection of the data from all remote stations, validation of the received data, storage of the data in the historical database, management and

maintenance of the database, displaying the data received and calculated in graphical and digital formats, generating various alarms, trends, event logs, and reports as may be required and uploading the real-time data on web portal generating and firing the SMS massages to the concern authorities in case of emergency, generation of the bulk water audit report, water audit reports, energy efficiency reports etc., are the basic functions at MCC. The schematic illustration showing installations at master Control Center are shown in the following figure.

The Central monitoring system will receive the data from the MCC and display it in graphical and digital formats on the public displays and local HMI application. All Monitoring functions, report and trending functions will be available at Central Monitoring System. This station will act as slave station with monitoring capabilities.



10.2 COMMUNICATION MEDIA AND CHANNELS

Telemetry data and signal are travel through communication media such as wireless channels such as radio waves based on VHF technology or GPRS.

Wireless low cost radio telemetry system / GPRS shall be installed for communication for the proposed system.

Radio telemetry systems offer an alternative to fiber lines, wire lines, or telephone lines for the purpose of communication with remote sites.

Specific requirement of communication system are:

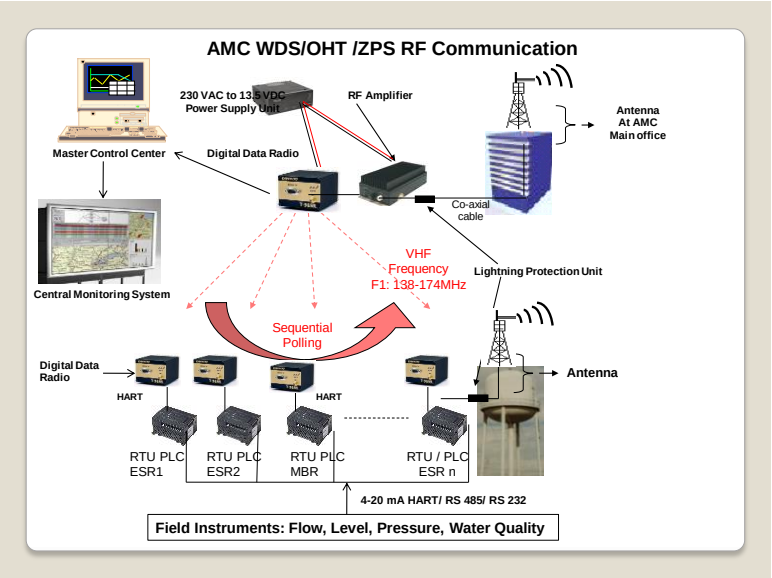
- System should work under severe weather conditions, including hot and dusty environment, torrential rains and floods
- Withstand wide voltage fluctuations and power failure
- Be accurate and fast

- Be simple to operate and repair
- Be able to expand

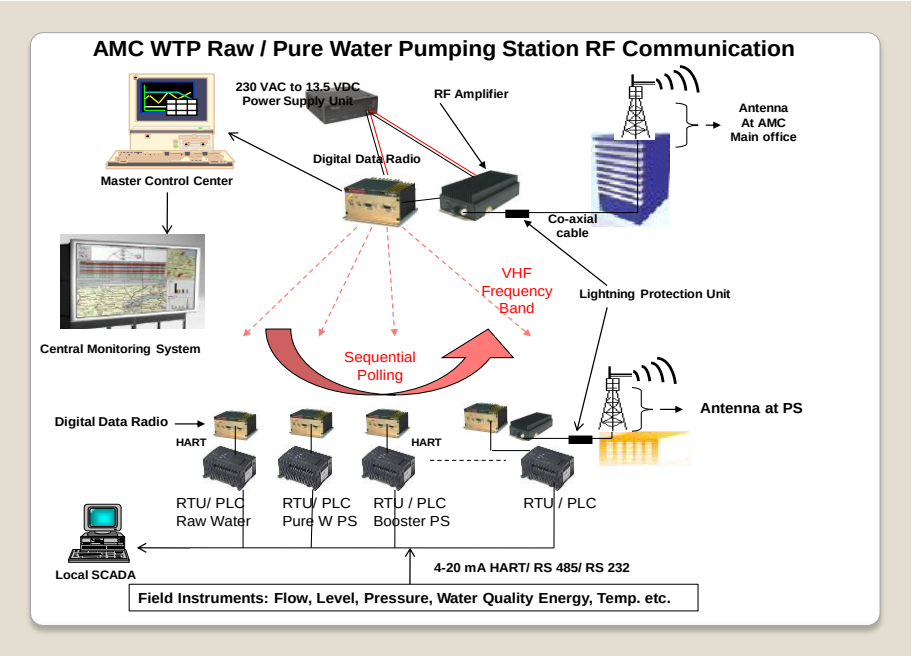
For smooth operations of proposed Central Monitoring System, following criteria shall be considered while implementing radio telemetry system.

1) Distance to the remote location
2) Terrain between the central and remote locations
3) Higher Frequency for better communication
4) Output power of transmitter
5) Sensitivity of the receiver
6) Height of antenna
7) Type of antenna
8) Repeaters should be used in case where distance or terrain do not allow the central monitoring system proper communication with the remote site.

Communication Functional Diagram at WDS /OHT/ ZPS Level



Communication Functional Diagram at Raw / Pure Water Pumping Station (WTP) level



10.2.1 CENTRAL MONITORING SYSTEM & GIS BASED WATER MANAGEMENT SYSTEM

Billing and Customer Information Systems

- The systems should be a comprehensive commercial management system equipped with functionality to cover all operational areas of revenue management and customer information as well as to manage commercial data quality.
- The systems shall include but not be limited to the following functions:
- Billing, revenue collection, statement delivery, debt management, customer services, enquiries, new accounts, pricing & consumer analysis, meter reading & control, meter & connection maintenance and reporting.
- The systems should deal effectively with customer complaints and enquiries, even if it cuts across departmental boundaries, and efficiently administer and process applications for new services.
- The systems should be configurable in order to run in different modes: online, semi-offline with batch updating of a central server, and stand alone (offline).
- The systems should be fully integrated with geographical information systems (GIS) to enable optimized walk route management and property/connection reconciliation and should be able to interface with existing system.
- It is preferable that the systems supplied can be expanded to integrate with work order and maintenance management applications, and should be able to interface .systems that enable functions such as consumption analysis, demand-forecasting, design standards evaluation and non-revenue water analysis and audits.

GIS and Network Asset Management

- A suitable Geographical Information System should form the basic geographical database and should be chosen so that all systems dealing with geographical data are integrated to the system.

- The systems should enhance corporate GIS, effectively dealing with the capturing, structuring, maintenance and management of network data.
- The systems shall address the entire spectrum of network data management that include but are not limited to the following functions: network data acquisition, network data analysis, network data management, mapping, network data modeling, and should support asset management functions such as asset valuations and risk/life cycle assessments.
- It would be preferable if the systems support enhanced engineering features such as automated and dynamic zoning.
- The systems should support seamless integration with corporate GIS systems to allow an unrestricted access to spatial data for all management and operational functions.
- It is preferable that the systems supplied can interface with billing and customer information systems and be expanded to include work order and maintenance management, and should interface with demand management and network analysis applications enabling functions such as consumption analysis, demand-forecasting, design standards evaluation and non-revenue water (UFW) analysis and operational audits.

Project Cost Summary for monitoring system is estimated as below;

AGRA MUNICIPAL CORPORATION: MONITORING SYSTEM - PROJECT COST SUMMARY				
Sr No	**Monitoring SYstem Instrumentation and Components**	**Qty**	**Unit**	**Cost (Rs.)**
1	Pressure Measuring Instruments	144	Nos.	9849600
2	Temperature Scanners	126	Nos.	1077300
3	Level Measurement Systems	45	Nos.	3847500
4	Residual Chlorine Measuring Instruments	42	Nos.	14723100
5	Electromagnetic Flow-meter (EMF)	49	Nos.	26841090
6	Turbidity Meter	8	Nos.	2280000
7	pH Meter	3	Nos.	971112
8	RPM Measuring Instruments	126	Nos.	2154600
9	Energy Measuring (Power Analyser) Instruments	126	Nos.	2370060
10	RTUs/PLCs	46	Nos.	10046250
11	Lightening / Surge Protection System	46	Nos.	393300
12	Instrumentation Cable	3150	Mtr	513513
13	R.C.C. Chambers for Flowmeters	18	Nos.	903600
14	Wireless Radio Telemetry	46	Nos.	13680000
15	MS Tubular Tower	46	Nos.	11328750
16	Central Monitoring System for all UGR/GSR/Pumping stations	1	Nos.	855000
17	Central Server PC	1	Nos.	427500
18	PCs, Softwares, Keyboards, Printers and Other Hardware Complete	1	Nos.	897750
19	Uninterrupted Power Supply System	46	Nos.	3249000
20	Air Conditioning Unit	1	Nos.	76950
21	Pipe Specials and Fittings for Flowmeters / Flow Control Valves	343	Nos.	3819399
			Total Capital Cost (Rs.)	**110305374**
			Total O&M Cost for 5 years (Rs.)	**89450000**
			Total Project Cost (Rs.)	**199755374**
			Total Project Cost (Rs. Crores)	**19.98**

11 ENERGY AUDIT FOR AGRA WATER SUPPLY SYSTEM

Agra gets drinking water supply from Yamuna River.Water is lifted at raw water pump stations and supplied toJeoni Mandi and Sikandra WTPs. Treated water is then further supplied to pumping stations divided into three different zones, from where it is pumped directly into distribution or into overhead tanks. Details of pumping stations, layout and results of performance assessment are provided in earlier submitted Interim Report 2nd and hence to avoid duplicasy and repetation, contents are not provided in this report. However, basic details of the pumping station which covered under Energy Audit Activity are mentioned alongwith summaries of Energy Efficiency and Energy Conservation Measures and Action Plan for Agra Water Supply and Pumping System.

11.1 CONNECTED LOAD AT PUMPING STATIONS

Details of connected load of pumping stationsareas given below:

Table 57: Connected load details for pumping stations

Sr. no.	Location	Connected load - pump motors (kW)	Connected load – Auxiliaries (kW)	Total connected load (kW)
1	Old Intake Well	428	0.52	428.52
2	New Intake Well	515	0.38	515.38
3	New Jal Nigam Intake Well	396	0.74	396.74
4	Golkamra HT plant	980		980
5	Synchronous Plant	335	0.04	335.04
6	Flowmore Plant	768	0.695	768.695
7	8 VT Plant	1476	0.845	1476.845
8	Sanjay Place	590	2.046	592.046
9	Kotwali ZPS	102.5	0.905	103.405
10	Surya Nagar ZPS	227	4.333	231.333
11	Mathura Road ZPS	186	1.7	187.7
12	Trans Yamuna ZPS	54		54
13	Lawyer's Colony ZPS	148	0.36	148.36
14	Nirbhay Nagar ZPS	52	0.558	52.558
15	Lohamandi ZPS	337	0.5	337.5
16	Keshavkunj ZPS (Bodla ZPS)	221	0.395	221.395
17	Shahganj Phase-1 ZPS	409	0.917	409.917
18	Shahganj Phase-2	299	0.255	299.255
19	Kedar Nagar	90	1.165	91.165
20	Tajganj ZPS	312	0.3	312.3

Sr. no.	Location	Connected load - pump motors (kW)	Connected load – Auxiliaries (kW)	Total connected load (kW)
21	Rakabganj ZPS	337	0.228	337.228
22	Navlakha ZPS	395	1.038	396.038
23	Chhipitola Booster	35	0.14	35.14
24	Red Fort Booster	7.5	0.1	7.6
Total		**5278**	**15.785**	**5293.785**

11.2 SUMMARY OF ENERGY EFFICIENCY MEASURES

A summary of the proposed energy efficiency measures at Pumping Stations in Agra is provided in the table below.

Table 58: Overall summary of energy conservation measures

Sr. No.	Energy Efficiency Measures (EEM)	Present annual energy consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)	Percentage of energy saving (%)
Pumping System							
1	Replacement of Pump-5 at 8 VT Plant, Water Works, Jeoni Mandi with energy efficient pump set	1,254,300	645,356	19.92	51.31	5	51%
2	Replacement of Pump-6 at 8 VT Plant, Water Works, Jeoni Mandi with energy efficient pump set	441,212	193,443	19.92	15.38	16	44%
3	Replacement of Pump-7 at 8 VT Plant, Water Works, Jeoni Mandi with energy efficient pump set	599,114	330,890	19.92	26.31	9	55%
4	Replacement of Pump-6 at Old Intake Well, Jeoni Mandi with energy efficient pump set	1,096,579	541,292	28.62	43.03	8	49%

Sr. No.	Energy Efficiency Measures (EEM)	Present annual energy consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)	Percentage of energy saving (%)
5	Replacement of Pump-1 at New Intake Well, Jeoni Mandi with energy efficient pump set	661,671	327,674	20.97	26.05	10	50%
6	Replacement of Pump-2 at New Intake Well, Jeoni Mandi with energy efficient pump set	892,321	115,611	35.90	9.19	47	13%
7	Replacement of Pump-2 at New Jal Nigam Intake well, Jeoni Mandi with energy efficient pump set	391,767	175,275	20.97	13.93	18	45%
8	Replacement of Pump-3 at New Jal Nigam Intake well, Jeoni Mandi with energy efficient pump set	410,544	220,904	20.97	17.56	14	54%
9	Replacement of Pump-5 at Sanjay Place, Mauthan Side. with energy efficient pump set	50,853	16,828	8.73	1.34	78	33%
10	Replacement of Pump-1 at Sanjay Place, Hariparvat Side. with energy efficient pump set	45,823	19,532	10.92	1.55	84	43%
11	Replacement of Pump-4 at Sanjay Place, Hariparvat Side. with energy efficient pump set	81,414	38,445	17.15	3.06	67	47%
12	Replacement of Pump-5(0) at Sanjay Place, Hariparvat Side. with energy efficient pump set	58,471	32,014	8.18	2.55	39	55%
13	Replacement of Pump-1 at Kotwali ZPS with energy efficient pump set	19,565	12,405	5.75	0.99	70	63%

Sr. No.	Energy Efficiency Measures (EEM)	Present annual energy consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)	Percentage of energy saving (%)
14	Replacement of Pump-2 at Mathura Road ZPS with energy efficient pump set	44,532	19,447	10.86	1.55	84	44%
15	Replacement of Pump-3 at Mathura Road ZPS with energy efficient pump set	20,033	13,637	6.39	1.08	71	68%
16	Replacement of Pump-1 at Trans Yamuna ZPS with energy efficient pump set	32,096	16,341	8.80	1.30	81	51%
17	Replacement of Pump-1 (Lawyer's Colony) at Lawyer's Colony ZPS with energy efficient pump set	136,019	35,946	8.73	2.86	37	26%
18	Replacement of Pump-2 (Lawyer's Colony) at Lawyer's Colony ZPS with energy efficient pump set	137,864	86,044	8.20	6.84	14	62%
19	Replacement of Pump-1 at Shahganj Phase-1 ZPS with energy efficient pump set	52,489	37,113	9.42	2.95	38	71%
20	Replacement of Pump-5 at Shahganj Phase-2 with energy efficient pump set	242,519	109,617	12.11	8.71	17	45%
21	Replacement of Pump-2 at Rakabganj ZPS with energy efficient pump set	53,741	31,695	14.52	2.52	69	59%
22	Replacement of Pump-3 at Navlakha ZPS with energy efficient pump set	443,586	154,038	9.07	12.25	9	35%

Sr. No.	Energy Efficiency Measures (EEM)	Present annual energy consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)	Percentage of energy saving (%)
23	Replacement of Pump-2 at Chhipitola Booster with energy efficient pump set	17,830	7,119	2.50	0.57	53	40%
	Subtotal	**7,184,344**	**3,180,667**	**328.53**	**252.86**	**16**	**44.27%**
Auxiliary loads							
24	Installation of APFC panel at Sanjay Place			6.49	9.76	8	
25	Installation of APFC panel at Kotwali ZPS			1.73	2.07	10	
26	Installation of APFC panel at Surya Nagar ZPS			2.88	4.07	9	
27	Installation of APFC panel at Mathura Road ZPS			1.73	3.48	6	
28	Installation of APFC panel at Trans Yamuna ZPS			1.01	0.19	63	
29	Installation of APFC panel at Lawyer's Colony ZPS			1.95	3.42	7	
30	Installation of APFC panel at Nirbhay Nagar ZPS			1.01	0.15	82	
31	Installation of APFC panel at Lohamandi ZPS			3.61	6.14	7	
32	Installation of APFC panel at Keshavkunj (Bodla) ZPS			5.19	1.39	45	
33	Installation of APFC panel at Shahganj Phase-1 ZPS			5.77	16.44	4	

Sr. No.	Energy Efficiency Measures (EEM)	Present annual energy consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)	Percentage of energy saving (%)
34	Installation of APFC panel at Shahganj Phase-2			4.33	5.53	9	
35	Installation of APFC panel at Kedar Nagar			1.01	1.19	10	
36	Installation of APFC panel at Tajganj ZPS			6.13	3.08	24	
37	Installation of APFC panel at Rakabganj ZPS			3.61	5.14	8	
38	Installation of APFC panel at Navlakha ZPS			3.24	6.75	6	
39	Installation of capacitor at Chhipitola Booster			0.18	0.25	9	
40	Installation of capacitor at Red Fort Booster			0.05	0.04	17	
	Subtotal			**49.91**	**69.09**	**9**	
41	Replacement of existing lighting equipment at Old Intake Well with LED lamps	919.8	525.6	0.03	0.04	10	57%
42	Replacement of existing lighting equipment at New Intake Well with LED lamps	854.1	411.72	0.02	0.03	6	48%
43	Replacement of existing lighting equipment at New Jal Nigam Intake Well with LED lamps	4204.8	2312.64	0.10	0.18	7	55%

Sr. No.	Energy Efficiency Measures (EEM)	Present annual energy consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)	Percentage of energy saving (%)
44	Replacement of existing lighting equipment at Synchronous with LED lamps	350.4	192.72	0.01	0.02	7	55%
45	Replacement of existing lighting equipment at Flowmore Plant with LED lamps	1335.9	1020.54	0.03	0.08	5	76%
46	Replacement of existing lighting equipment at 8 VT Plant with LED lamps	854.1	617.58	0.03	0.05	6	72%
47	Replacement of existing lighting equipment at Sanjay Place with LED lamps	3048.48	1787.04	0.32	0.14	27	59%
48	Replacement of existing lighting equipment at Kotwali ZPS with LED lamps	2211.9	1300.86	0.18	0.10	21	59%
49	Replacement of existing lighting equipment at Surya Nagar ZPS with LED lamps	7765.74	4673.46	0.71	0.37	23	60%
50	Replacement of existing lighting equipment at Mathura Road ZPS with LED lamps	7446	4467.6	0.89	0.36	30	60%
51	Replacement of existing lighting equipment at Trans Yamuna ZPS with LED lamps	306.6	227.76	0.02	0.02	12	74%
52	Replacement of existing lighting equipment at Lawyer's Colony ZPS with LED lamps	846.8	502.24	0.10	0.04	29	59%

Sr. No.	Energy Efficiency Measures (EEM)	Present annual energy consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)	Percentage of energy saving (%)
53	Replacement of existing lighting equipment at Nirbhay Nagar ZPS with LED lamps	2444.04	1419.12	0.29	0.11	31	58%
54	Replacement of existing lighting equipment at Lohamandi ZPS with LED lamps	671.6	487.64	0.03	0.04	8	73%
55	Replacement of existing lighting equipment at Keshavkunj ZPS with LED lamps	854.1	459.9	0.04	0.04	14	54%
56	Replacement of existing lighting equipment at Shahganj-1 ZPS with LED lamps	3578.46	1949.1	0.30	0.15	23	54%
57	Replacement of existing lighting equipment at Shahganj Phase-2 ZPS with LED lamps	635.1	398.58	0.03	0.03	10	63%
58	Replacement of existing lighting equipment at Kedar Nagar with LED lamps	1598.7	889.14	0.08	0.07	13	56%
59	Replacement of existing lighting equipment at Tajganj ZPS with LED lamps	1357.8	779.64	0.11	0.06	20	57%
60	Replacement of existing lighting equipment at Navlakha ZPS with LED lamps	4064.64	2409	0.54	0.19	34	59%
61	Replacement of existing lighting equipment at Chhipi Tola ZPS with LED lamps	788.4	551.88	0.02	0.04	5	70%

Sr. No.	Energy Efficiency Measures (EEM)	Present annual energy consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakh)	Monetary Cost Saving (Rs. Lakh)	Payback Period (Months)	Percentage of energy saving (%)
62	Replacement of existing lighting equipment at Red Fort Booster with LED lamps	876	718.32	0.01	0.06	2	82%
	Subtotal	**47013.46**	**28102.08**	**3.85**	**2.23**	**21**	60%
	TOTAL	**7,231,358**	**3,208,769**	**332.39**	**255.10**	**16**	44%

11.3 ENERGY CONSERVATION MEASURES

Energy conservation measures (ECMs) as per study carried out for Agra city are divided into 3 categories, namely ECM-1 involving minor investment, ECM-2 involving medium investment and ECM-3 involving major investment. Measures and savings for each category are given below:

ECM-1: Savings through Revision of Contract Demand

Location	Existing contract demand kVA	Proposed contract demand kVA	Estimated annual savings Rs lakh
Sanjay Place	330	500	10.03
Kotwali	218	160	0.44
Surya nagar	143	240	4.45
Mathura Road	102	140	1.23
Lawyers Colony	183	150	0.44
Nirbhay Nagar	55.56	70	0.40
Lohamandi	127	320	9.54
Keshav Kunj (Bodla)	182	320	6.87
Shahganj phase-1	376	500	3.95
Shahganj phase-2	202.22	320	5.41
Tajganj	111.1	400	16.08
Rakabganj	264.4	320	1.43
Chhipitola	13	30	0.72
Total			**60.97**

Thus, estimated annual savings around Rs. 60 lakh can be achieved through revision of contract demand with minimal investment.

ECM-1: Savings through Replacement of Lighting Fixtures with LED-based lighting equipment

Location	Potential annual energy savings in kWh	Estimated annual savings Rs lakh	Investment Rs lakh	Payback period months
Old Intake Well	526	0.04	0.03	10
New Intake Well	412	0.03	0.02	6
New Jal Nigam Intake Well	2313	0.18	0.10	7
Synchronous	193	0.02	0.01	7
Flowmore Plant	1021	0.08	0.03	5
8 VT Plant	618	0.05	0.03	6
Sanjay Place	1787	0.14	0.32	27
Kotwali ZPS	1301	0.10	0.18	21
Surya Nagar ZPS	4673	0.37	0.71	23
Mathura Road ZPS	4468	0.36	0.89	30

Location	Potential annual energy savings in kWh	Estimated annual savings Rs lakh	Investment Rs lakh	Payback period months
Trans Yamuna ZPS	228	0.02	0.02	12
Lawyer's Colony ZPS	502	0.04	0.10	29
Nirbhay Nagar ZPS	1419	0.11	0.29	31
Lohamandi ZPS	488	0.04	0.03	8
Keshavkunj ZPS	460	0.04	0.04	14
Shahganj-1 ZPS	1949	0.15	0.30	23
Shahganj Phase-2 ZPS	399	0.03	0.03	10
Kedar Nagar	889	0.07	0.08	13
Tajganj ZPS	780	0.06	0.11	20
Navlakha ZPS	2409	0.19	0.54	34
Chhipi Tola ZPS	552	0.04	0.02	5
Red Fort Booster	718	0.06	0.01	2
Total	**28102**	**2.23**	**3.85**	**21**

Thus, estimated annual savings of around 28000 kWh, with monetary savings around Rs. 2.23 lakh, can be achieved through replacement of existing lighting equipment with new, energy efficient LED-based lighting equipment. The investment required for installation of new lighting equipment is estimated to be around Rs. 3.85 lakh, and the resultant simple payback period is around 21 months.

ECM-2: Savings through Improvement of Power Factor

Location	Avg recorded PF	Potential savings through PF improvement	Estimated investment	Estimated payback period months
Sanjay Place	0.780	9.76	6.49	8
Kotwali ZPS	0.676	2.07	1.73	10
Surya Nagar ZPS	0.774	4.07	2.88	9
Mathura Road ZPS	0.735	3.48	1.73	6
Trans Yamuna ZPS	0.896	0.19	1.01	63
Lawyer's Colony ZPS	0.819	3.42	1.95	7
Nirbhay Nagar ZPS	0.839	0.15	1.01	82
Lohamandi ZPS	0.768	6.14	3.61	7
Keshavkunj (Bodla) ZPS	0.903	1.39	5.19	45
Shahganj Phase-1 ZPS	0.651	16.44	5.77	4
Shahganj Phase-2	0.835	5.53	4.33	9
Kedar Nagar	0.810	1.19	1.01	10
Tajganj ZPS	0.858	3.08	6.13	24
Rakabganj ZPS	0.724	5.14	3.61	8
Navlakha ZPS	0.847	6.75	3.24	6
Chhipitola Booster	0.907	0.25	0.18	9
Red Fort Booster	0.877	0.04	0.05	17

Location	Avg recorded PF	Potential savings through PF improvement	Estimated investment	Estimated payback period months
Total		**69.09**	**49.91**	**9**

Thus, estimated annual savings around Rs. 69 lakh can be achieved through improvement of power factor. The investment required for installation of APFC panels/fixed capacitors is estimated to be around Rs. 49.91 lakh, and the resultant simple payback period is around 9 months.

ECM-3: Savings through Replacement of Pumping Machinery

Location	Potential annual energy savings in kWh	Estimated annual savings Rs lakh	Investment Rs lakh	Payback period months
8 VT Plant, Water Works, Jeoni Mandi	1169688	92.99	59.77	8
Old Intake Well, Jeoni Mandi	541292	43.03	28.62	8
New Intake Well, Jeoni Mandi	443285	35.24	56.88	19
New Jal Nigam Intake well, Jeoni Mandi	396180	31.50	41.95	16
Sanjay Place	106820	8.49	44.98	64
Kotwali ZPS	12405	0.99	5.75	70
Mathura Road ZPS	33084	2.63	17.25	79
Trans Yamuna ZPS	16341	1.30	8.80	81
Lawyer's Colony ZPS	121990	9.70	16.93	21
Shahganj Phase-1 ZPS	37113	2.95	9.42	38
Shahganj Phase-2	109617	8.71	12.11	17
Rakabganj ZPS	31695	2.52	14.52	69
Navlakha ZPS	154038	12.25	9.07	9
Chhipitola Booster	7119	0.57	2.50	53
Total	**3180667**	**252.86**	**328.53**	**16**

Thus, estimated annual savings of around 31 lakh kWh, with monetary savings around Rs. 250 lakh, can be achieved through replacement of existing pumping machinery with new, energy efficient pumping machinery. The investment required for installation of new pumping machinery is estimated to be around Rs. 328.53 lakh, and the resultant simple payback period is around 16 months.

ECM description	Annual savings in kWh	Annual savings in Rs lakh	Investment in Rs lakh	Payback period months
ECM-1: Contract demand revision	-	60.97	-	-
ECM-1: Installation of LED-based lighting equipment	28102	2.23	3.85	21
ECM-2: Power factor improvement	-	69.09	49.91	9
ECM-3: Replacement of pumping machinery	3180667	252.86	328.53	16

Total	**3208769**	**385.16**	**382.30**	**12**

11.4 DETAILED ENERGY EFFICIENCY MEASURES

11.4.1 Revision of Contract Demand

Existing operating conditions: The contract demand at most pump stations was observed to be insufficient for the number of pumps being operated. The recorded demand was found to exceed the contract demand for most connections by very large margins, and excess demand charges were being paid by most locations.

Recommendations: Most pump house connections were found to incur a very significant expenditure on excess demand charges due to insufficient contract demand. It is recommended to revise the contract demand as per the actual requirement of the pumping stations.

Cost benefit analysis: Expected savings from revision of contract demand are around Rs. 60 lakh per annum. The expenditure involved is minimal, and the payback almost immediate. Detailed cost benefit analysis for each connection is given in the tables below:

Table 59: Contract demand revision at Sanjay Place ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Aug-16	330	500.4	500.4	123399	84041	500	500.4	500.4	123611	83828
Sep-16	330	495.3	495.3	131753	87941	500	495.3	495.3	131753	87941
Oct-16	330	489.9	489.9	130316	85069	500	489.9	489.9	130316	85069
Nov-16	330	486	486	125108	80317	500	486	486	125108	80317
Dec-16	330	490.2	490.2	130396	85228	500	490.2	490.2	130396	85228
Feb-17	330	494.4	494.4	118786	78998	500	494.4	494.4	118786	78998
Total				**759758**	**501594**				**759970**	**501382**
Estimated annual				**1519515**	**1003189**				**1519941**	**1002763**

Table 60: Contract demand revision at Kotwali ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	218	144.96	163.5	33845	160	144.96	144.96	30007	3838
May-16	218	139.36	163.5	33845	160	139.36	139.36	28848	4997
Jun-16	218	144.32	163.5	33845	160	144.32	144.32	29874	3970
Jul-16	218	145.92	163.5	33845	160	145.92	145.92	30205	3639
Aug-16	218	148.64	163.5	40319	160	148.64	148.64	36655	3664
Sep-16	218	150.56	163.5	43492	160	150.56	150.56	40050	3442
Oct-16	218	152.32	163.5	43492	160	152.32	152.32	40518	2974
Nov-16	218	150.4	163.5	42089	160	150.4	150.4	38717	3372
Dec-16	218	153.92	163.5	43492	160	153.92	153.92	40944	2548
Jan-17	218	151.2	163.5	43492	160	151.2	151.2	40220	3272
Feb-17	218	143.04	163.5	39283	160	143.04	143.04	34367	4916
Total				**431037**				**390404**	**40633**
Estimated annual				**470222**				**425895**	**44327**

Table 61: Contract demand revision at Surya Nagar ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	143	217	217	44919	30636	240	217	217	44919	30636
May-16	143	217.2	217.2	44960	30719	240	217.2	217.2	44960	30719
Jun-16	143	215.8	215.8	44671	30139	240	215.8	215.8	44671	30139
Jul-16	143	224	224	46368	33534	240	224	224	46368	33534
Aug-16	143	218.4	218.4	53857	37187	240	218.4	218.4	53857	37187
Sep-16	143	219.4	219.4	58362	40646	240	219.4	219.4	58362	40646
Oct-16	143	218.6	218.6	58149	40220	240	218.6	218.6	58149	40220
Nov-16	143	222.2	222.2	57200	40776	240	222.2	222.2	57200	40776
Dec-16	143	222.2	222.2	59106	42135	240	222.2	222.2	59106	42135
Jan-17	143	224.8	224.8	59798	43519	240	224.8	224.8	59798	43519
Feb-17	143	223.6	223.6	53723	38730	240	223.6	223.6	53723	38730

Total				**581112**	**408241**				**581112**	**408241**
Estimated annual				**633941**	**445354**				**633941**	**445354**

Table 62: Contract demand revision at Mathura Road ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	102	141.6	141.6	29311	16394	140	141.6	141.6	30162	15543
May-16	102	140.8	140.8	29146	16063	140	140.8	140.8	29571	15638
Jun-16	102	139.6	139.6	28897	15566	140	139.6	139.6	28897	15566
Jul-16	102	140.68	140.68	29121	16014	140	140.68	140.68	29483	15652
Aug-16	102	135.2	135.2	33340	16374	140	135.2	135.2	33340	16374
Sep-16	102	105.4	105.4	28037	1809	140	105.4	105.4	28037	1809
Oct-16	102	107.6	107.6	28622	2979	140	107.6	107.6	28622	2979
Nov-16	102	110.2	110.2	28368	4222	140	110.2	110.2	28368	4222
Dec-16	102	111.6	111.6	29686	5107	140	111.6	111.6	29686	5107
Jan-17	102	110.4	110.4	29367	4469	140	110.4	110.4	29367	4469
Feb-17	102	134	134	32195	15377	140	134	134	32195	15377
Total				**326091**	**114375**				**327729**	**112736**
Estimated annual				**355736**	**124772**				**357523**	**122985**

Table 63: Contract demand revision at Lawyers Colony ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	183	116.8	137.25	28411	150	116.8	116.8	24178	4233
May-16	183	147.4	147.4	30512	150	147.4	147.4	30512	0
Jun-16	183	148.4	148.4	30719	150	148.4	148.4	30719	0
Jul-16	183	125	137.25	28411	150	125	125	25875	2536
Aug-16	183	131	137.25	33846	150	131	131	32305	1541
Sep-16	183	112	137.25	36509	150	112	112.5	29926	6584
Oct-16	183	104.8	137.25	36509	150	104.8	112.5	29926	6584

Nov-16	183	84.4	137.25	35332	150	84.4	112.5	28960	6371
Dec-16	183	111.8	137.25	36509	150	111.8	112.5	29926	6584
Jan-17	183	146.4	146.4	38943	150	146.4	146.4	38943	0
Feb-17	183	113	137.25	32976	150	113	113	27150	5826
Total				**368677**				**328418**	**40259**
Estimated annual				**402193**				**358274**	**43919**

Table 64: Contract demand revision at Nirbhaynagar ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	55.56	64.28	64.28	13306	3610	70	64.28	64.28	13306	3610
May-16	55.56	63.96	63.96	13240	3478	70	63.96	63.96	13240	3478
Jun-16	55.56	61.8	61.8	12793	2583	70	61.8	61.8	12793	2583
Jul-16	55.56	67.72	67.72	14018	5034	70	67.72	67.72	14018	5034
Aug-16	55.56	63.72	63.72	16271	4167	70	63.72	63.72	16271	4167
Sep-16	55.56	61.04	61.04	15713	2821	70	61.04	61.04	15713	2821
Oct-16	55.56	61.44	61.44	17398	3330	70	61.44	61.44	17398	3330
Nov-16	55.56	60.72	60.72	16152	2745	70	60.72	60.72	16152	2745
Dec-16	55.56	61	61	15703	2801	70	61	61	15703	2801
Jan-17	55.56	60.16	60.16	15487	2368	70	60.16	60.16	15487	2368
Feb-17										
Total				**150080**	**32938**				**150080**	**32938**
Estimated annual				**180096**	**39526**				**180096**	**39526**

Table 65: Contract demand revision at Lohamandi ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	127	305.8	305.8	63301	74023	320	305.8	305.8	63301	74023

May-16	127	293	293	60651	68724	320	293	293	60651	68724
Jun-16	127	289.2	289.2	59864	67151	320	289.2	289.2	59864	67151
Jul-16	127	301.8	301.8	62473	72367	320	301.8	301.8	62473	72367
Aug-16	127	306.2	306.2	75509	88381	320	306.2	306.2	75509	88381
Sep-16	127	290.6	290.6	77301	87037	320	290.6	290.6	77301	87037
Oct-16	127	289.6	289.6	77035	86505	320	289.6	289.6	77035	86505
Nov-16	127	285.6	285.6	73520	81655	320	285.6	285.6	73520	81655
Dec-16	127	296.6	296.6	78897	90229	320	296.6	296.6	78897	90229
Jan-17	127	286.8	286.8	76290	85015	320	286.8	286.8	76290	85015
Feb-17	127	279.2	279.2	67081	73136	320	279.2	279.2	67081	73136
Total				**771923**	**874224**				**771923**	**874224**
Estimated annual				**842098**	**953699**				**842098**	**953699**

Table 66: Contract demand revision at Keshavkunj ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	182	251.2	251.2	51998	28649	320	251.2	251.2	51998	28649
May-16	182	301.2	301.2	62348	49349	320	301.2	301.2	62348	49349
Jun-16	182	303.6	303.6	62845	50342	320	303.6	303.6	62845	50342
Jul-16	182	310.2	310.2	64211	53075	320	310.2	310.2	64211	53075
Aug-16	182	305.2	305.2	75262	60762	320	305.2	305.2	75262	60762
Sep-16	182	300	300	79802	62777	320	300	300	79802	62777
Oct-16	182	305	305	81132	65437	320	305	305	81132	65437
Nov-16	182	309	309	79544	65386	320	309	309	79544	65386
Dec-16	182	310.6	310.6	82621	68417	320	310.6	310.6	82621	68417
Jan-17	182	309.2	309.2	82249	67672	320	309.2	309.2	82249	67672
Feb-17	182	302.6	302.6	72704	57951	320	302.6	302.6	72704	57951
Total				**794717**	**629817**				**794717**	**629817**
Estimated annual				**866964**	**687074**				**866964**	**687074**

Table 67: Contract demand revision at Shahganj Phase-1 ZPS

Month	Contract demand kVA	Recorded demand kVA	Bill demand kVA	Demand chgs	Excess demand chgs	Proposed contract demand kVA	Max recorded kVA	Esimated billing demand kVA	Estimated demand chgs	Estimated savings
Apr-16	376	422	422	87354	19044	500	422	422	87354	19044
May-16	376	426.8	426.8	88348	21031	500	426.8	426.8	88348	21031
Jun-16	376	419.6	419.6	86857	18050	500	419.6	419.6	86857	18050
Jul-16	376	477.6	477.6	98863	42062	500	477.6	477.6	98863	42062
Aug-16	376	438.4	438.4	108109	30776	500	438.4	438.4	108109	30776
Sep-16	376	448.8	448.8	119383	38730	500	448.8	448.8	119383	38730
Oct-16	376	436.8	436.8	116191	32346	500	436.8	436.8	116191	32346
Nov-16	376	442.4	442.4	113885	34186	500	442.4	442.4	113885	34186
Dec-16	376	456.8	456.8	121511	42986	500	456.8	456.8	121511	42986
Jan-17	376	449.6	449.6	119596	39156	500	449.6	449.6	119596	39156
Feb-17	376	466.4	466.4	112059	43440	500	466.4	466.4	112059	43440
Total				**1172156**	**361808**				**1172156**	**361808**
Estimated annual				**1278716**	**394700**				**1278716**	**394700**

Table 68: Contract demand revision at Shahganj Phase-2 ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	202.22	274.8	274.8	56884	30048	320	274.8	274.8	56884	30048
May-16	202.22	280.8	280.8	58126	32532	320	280.8	280.8	58126	32532
Jun-16	202.22	287.7	287.7	59554	35389	320	287.7	287.7	59554	35389
Jul-16	202.22	295.22	295.22	61106	38494	320	295.22	295.22	61106	38494
Aug-16	202.22	291	291	71761	43786	320	291	291	71761	43786
Sep-16	202.22	290.7	290.7	77328	47072	320	290.7	290.7	77328	47072
Oct-16	202.22	293.4	293.4	78046	48509	320	293.4	293.4	78046	48509
Nov-16	202.22	308.4	308.4	79390	54667	320	308.4	308.4	79390	54667
Dec-16	202.22	313.5	313.5	83393	59202	320	313.5	313.5	83393	59202
Jan-17	202.22	309.6	309.6	82355	57127	320	309.6	309.6	82355	57127
Feb-17	202.22	304.2	304.2	73088	49004	320	304.2	304.2	73088	49004
Total				**781030**	**495831**				**781030**	**495831**
Estimated annual				**852032**	**540906**				**852032**	**540906**

Table 69: Contract demand revision at Tajganj ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	111.1	385.2	385.2	79736	113477	400	385.2	385.2	79736	113477
May-16	111.1	386.4	386.4	79985	113974	400	386.4	386.4	79985	113974
Jun-16	111.1	398.8	398.8	82552	119108	400	398.8	398.8	82552	119108
Jul-16	111.1	404.8	404.8	83794	121592	400	404.8	404.8	85781	119605
Aug-16	111.1	406	406	100120	145445	400	406	406	103079	142485
Sep-16	111.1	403.2	403.2	107253	155400	400	403.2	403.2	108956	153698
Oct-16	111.1	410	410	109062	159018	400	410	410	114382	153698
Nov-16	111.1	409.2	409.2	105338	153477	400	409.2	409.2	110075	148740
Dec-16	111.1	407.6	407.6	108424	157741	400	407.6	407.6	112467	153698
Jan-17	111.1	364.8	364.8	97039	134971	400	364.8	364.8	97039	134971
Feb-17	111.1	361.2	361.2	86783	120180	400	361.2	361.2	86783	120180
Total				**1040085**	**1494383**				**1060834**	**1473634**
Estimated annual				**1134639**	**1630236**				**1157274**	**1607601**

Table 70: Contract demand revision at Rakabganj ZPS

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	264.4	334.4	334.4	69221	28980	320	334.4	334.4	75182	23018
May-16	264.4	337	337	69759	30056	320	337	337	76797	23018
Jun-16	264.4	338	338	69966	30470	320	338	338	77418	23018
Jul-16	264.4	267.6	267.6	55393	1325	320	267.6	267.6	55393	1325
Aug-16	264.4	249.2	249.2	61453	0	320	249.2	249.2	61453	0
Sep-16	264.4	238.8	238.8	63522	0	320	238.8	240	63841	-319
Oct-16	264.4	325.2	325.2	86505	32346	320	325.2	325.2	89271	29580
Nov-16	264.4	274	274	70534	4943	320	274	274	70534	4943
Dec-16	264.4	276.4	276.4	73524	6384	320	276.4	276.4	73524	6384
Jan-17	264.4	280.4	280.4	74588	8512	320	280.4	280.4	74588	8512
Feb-17	264.4	287.8	287.8	69148	11244	320	287.8	287.8	69148	11244
Total				**763613**	**154261**				**787150**	**130724**
Estimated annual				**833032**	**168285**				**858709**	**142608**

Table 71: Contract demand revision at Chhipitola booster

Month	Contract Demand KVA	Recorded Demand KVA	Bill Demand KVA	Demand charges	Excess demand charges	Proposed contract demand	Recorded Demand KVA	Estimated billing demand	Estimated demand chgs	Estimated savings
Apr-16	13	23.72	23.72	4910	4438	30	23.72	23.72	4910	4438
May-16	13	24.7	24.7	5113	4844	30	24.7	24.7	5113	4844
Jun-16	13	24.84	24.84	5142	4902	30	24.84	24.84	5142	4902
Jul-16	13	24.76	24.76	5125	4869	30	24.76	24.76	5125	4869
Aug-16	13	25.16	25.16	6596	6376	30	25.16	25.16	6596	6376
Sep-16	13	24.92	24.92	6629	6342	30	24.92	24.92	6629	6342
Oct-16	13	24.92	24.92	6629	6342	30	24.92	24.92	6629	6342
Nov-16	13	25.62	25.62	6815	6714	30	25.62	25.62	6815	6714
Dec-16	13	27.02	27.02	6956	7218	30	27.02	27.02	6956	7218
Jan-17	13	28.24	28.24	7270	7846	30	28.24	28.24	7270	7846
										0
Total				**61184**	**59890**				**61184**	**59890**
Estimated annual				**73421**	**71868**				**73421**	**71868**

11.4.2 Lighting Optimization

Sr. No.	Location	Existing lighting load			Proposed lighting load			Savings					Investment Required	Simple Payback Period in months
		Type	Rated W	Nos	Type	Rated W	Nos	Reduction in W	Operating hours per day	kWh per day	kWh per annum	Rs per annum		
1	Synchronous	Tubelight	40	1	LED Tubelight	18	1	22	24	0.528	192.72	1532.12	850	6.66
2	Flowmore Plant	Tubelight	40	2	LED Tubelight	18	2	44	12	0.528	192.72	1532.12	1700	13.31
		CFL	75	3	LED Tubelight	18	2	189	12	2.268	827.82	6581.17	700	3.10
3	8 VT Plant	CFL	65	3	LED Tubelight	18	3	141	12	1.692	617.58	4909.76	2550	6.23
4	Old Intake Well	CFL	65	2	LED Tubelight	18	3	76	12	0.912	332.88	2646.4	2550	11.56
		Tubelight	40	1	LED Tubelight	18	1	22	24	0.528	192.72	1532.12	850	6.66
5	New Intake Well	CFL	65	2	LED Tubelight	18	2	94	12	1.128	411.72	3273.17	1700	6.23
6	New Jal Nigam Intake Well	Tubelight	80	6	LED Tubelight	36	6	264	24	6.336	2312.64	18385.49	10200	6.66
7	Sanjay Place	Tubelight	36	6	LED Tubelight	18	6	108	12	1.296	473.04	3760.67	5100	16.27
		HPSV	160	3	LED	60	3	300	12	3.6	1314	10446.3	26400	30.33

Sr. No.	Location	Existing lighting load			Proposed lighting load			Savings					Investment Required	Simple Payback Period in months
		Type	Rated W	Nos	Type	Rated W	Nos	Reduction in W	Operating hours per day	kWh per day	kWh per annum	Rs per annum		
8	Kotwali ZPS	CFL	85	3	LED Tubelight	18	6	147	12	1.764	643.86	5118.69	5100	11.96
		Metal Halide	250	1	LED	100	1	150	12	1.8	657	5223.15	12600	28.95
9	Surya Nagar ZPS	Tubelight	40	6	LED Tubelight	18	6	132	12	1.584	578.16	4596.37	5100	13.31
		Tubelight	36	3	LED Tubelight	18	3	54	12	0.648	236.52	1880.33	2550	16.27
		CFL	85	5	LED Tubelight	18	8	281	12	3.372	1230.78	9784.70	6800	8.34
		Sodium Vapour Lamp	150	5	LED	60	5	450	12	5.4	1971	15669.45	44000	33.70
		Metal Halide	250	1	LED	100	1	150	12	1.8	657	5223.15	12600	28.95
10	Mathura Road ZPS	HPSV	250	4	LED	100	4	600	12	7.2	2628	20892.6	50400	28.95
		Metal Halide	250	1	LED	100	1	150	12	1.8	657	5223.15	12600	28.95
		Metal Halide	150	3	LED	60	3	270	12	3.24	1182.6	9401.67	26400	33.70
11	Trans Yamuna ZPS	Tubelight	40	1	LED Tubelight	18	1	22	6d	0.132	48.18	366.17	850	27.86
		Bulb	100	1	LED Tubelight	18	1	82	6	0.492	179.58	1364.81	850	7.47

Sr. No.	Location	Existing lighting load			Proposed lighting load			Savings					Investment Required	Simple Payback Period in months
		Type	Rated W	Nos	Type	Rated W	Nos	Reduction in W	Operating hours per day	kWh per day	kWh per annum	Rs per annum		
12	Lawyer's Colony ZPS	Tubelight	40	1	LED Tubelight	18	1	22	8	0.176	64.24	510.71	850	19.97
		Metal Halide	250	1	LED	100	1	150	8	1.2	438	3482.1	8800	30.33
13	Nirbhay Nagar ZPS	Tubelight	36	3	LED Tubelight	18	3	54	12	0.648	236.52	1880.33	2550	16.27
		Metal Halide	150	3	LED	60	3	270	12	3.24	1182.6	9401.67	26400	33.70
14	Kedar Nagar	Tubelight	40	7	LED Tubelight	18	7	154	12	1.848	674.52	5362.43	5950	13.31
		CFL	85	1	LED Tubelight	18	2	49	12	0.588	214.62	1706.23	1700	11.96
15	Lohamandi ZPS	Bulb	100	1	LED Tubelight	18	1	82	12	0.984	359.16	2855.32	850	3.57
		Tubelight	40	2	LED Tubelight	18	2	44	8	0.352	128.48	1021.42	1700	19.97
16	Tajganj ZPS	Tubelight	40	2	LED Tubelight	18	2	44	24	1.056	385.44	3064.25	1700	6.66
		Sodium Vapour	150	1	LED	60	1	90	12	1.08	394.2	3133.89	8800	33.70
17	Keshavkunj ZPS	CFL	65	3	LED Tubelight	18	5	105	12	1.26	459.9	3656.21	4250	13.95

Sr. No.	Location	Existing lighting load			Proposed lighting load			Savings					Investment Required	Simple Payback Period in months
		Type	Rated W	Nos	Type	Rated W	Nos	Reduction in W	Operating hours per day	kWh per day	kWh per annum	Rs per annum		
18	Shahganj-1 ZPS	CFL	85	1	LED Tubelight	18	2	49	12	0.588	214.62	1706.23	1700	11.96
		Metal Halide	150	2	LED	60	2	180	12	2.16	788.4	6267.78	17600	33.70
		Tubelight	36	12	LED Tubelight	18	12	216	12	2.592	946.08	7521.34	10200	16.27
19	Navlakha ZPS	CFL	28	1	LED Tubelight	18	1	10	12	0.12	43.8	348.21	850	29.29
		Sodium Vapour	150	3	LED	60	3	270	12	3.24	1182.6	9401.67	26400	33.70
		Sodium Vapour (Pole)	150	3	LED	60	3	270	12	3.24	1182.6	9401.67	26400	33.70
20	Shahganj Phase-2 ZPS	CFL	85	1	LED Tubelight	18	2	49	12	0.588	214.62	1706.23	1700	11.96
		Bulb	60	1	LED Tubelight	18	1	42	12	0.504	183.96	1462.48	850	6.97
21	Chhipi Tola ZPS	Tubelight	40	1	LED Tubelight	18	1	22	24	0.528	192.72	1532.12	850	6.66
		Bulb	100	1	LED Tubelight	18	1	82	12	0.984	359.16	2855.32	850	3.57
22	Red Fort Booster	Bulb	100	1	LED Tubelight	18	1	82	24	1.968	718.32	5710.64	850	1.79

Sr. No.	Location	Existing lighting load			Proposed lighting load			Savings					Investment Required	Simple Payback Period in months
		Type	Rated W	Nos	Type	Rated W	Nos	Reduction in W	Operating hours per day	kWh per day	kWh per annum	Rs per annum		
Total annual											**28102**	**223331.82**	**385250**	**20.70**

11.4.3 Power factor improvement through installation of APFC panels

Table 72: Cost benefit analysis of APFC installation at Sanjay Place ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.83
Average power factor from recent EB bill		0.780
Average real power	kW	320.81
Average apparent power	kVA	383.1
Annual grid electricity consumption	kWh	498408
	kVAh	639906
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	271
Annual grid electricity consumption	kWh	498408
	kVAh	639906
Annual grid electricity savings	kVAh	136464
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	9.76
Investment towards APFC panel	Rs. Lakhs	6.49
Payback period	Months	7.98

Table 73: Cost benefit analysis of APFC installation at Kotwali ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.94
Average power factor from recent EB bill		0.676
Average real power	kW	79.38

Parameters	Unit	Parameters
Average apparent power	kVA	83.17
Annual grid electricity consumption	kWh	65267
	kVAh	94848
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	73
Annual grid electricity consumption	kWh	65267
	kVAh	94848
Annual grid electricity savings	kVAh	28922
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	2.07
Investment towards APFC panel	Rs. Lakhs	1.730
Payback period	Months	10.03

Table 74: Cost benefit analysis of APFC installation at Suryanagar ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.81
Average power factor from recent EB bill		0.774
Average real power	kW	161.01
Average apparent power	kVA	198.49
Annual grid electricity consumption	kWh	184041
	kVAh	242740
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	119
Annual grid electricity consumption	kWh	184041

Parameters	Unit	Parameters
	kVAh	242740
Annual grid electricity savings	kVAh	56841
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	4.07
Investment towards APFC panel	Rs. Lakhs	2.884
Payback period	Months	8.51

Table 75: Cost benefit analysis of APFC installation at Mathura Road ZPS

Parameters	*Unit*	*Parameters*
Present System		
Average power factor measured on main incomer		0.76
Average power factor from recent EB bill		0.735
Average real power	kW	92.27
Average apparent power	kVA	120.67
Annual grid electricity consumption	kWh	139480
	kVAh	189537
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	72
Annual grid electricity consumption	kWh	139480
	kVAh	189537
Annual grid electricity savings	kVAh	48647
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	3.48
Investment towards APFC panel	Rs. Lakhs	1.73
Payback period	Months	5.97

Table 76: Cost benefit analysis of APFC installation at Trans Yamuna ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.88
Average power factor from recent EB bill		0.896
Average real power	kW	34.4
Average apparent power	kVA	38.82
Annual grid electricity consumption	kWh	25698
	kVAh	28666
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	38
Annual grid electricity consumption	kWh	25698
	kVAh	28666
Annual grid electricity savings	kVAh	2708
Electricity tariff	Rs./kVAh	6.84
Annual monetary saving	Rs. Lakhs	0.19
Investment towards APFC panel	Rs. Lakhs	1.01
Payback period	Months	65.40

Table 77: Cost benefit analysis of APFC installation at Lawyers Colony ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.84
Average power factor from recent EB bill		0.819
Average real power	kW	68.12
Average apparent power	kVA	80.97

Parameters	Unit	Parameters
Annual grid electricity consumption	kWh	228386
	kVAh	278437
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	81
Annual grid electricity consumption	kWh	228386
	kVAh	278437
Annual grid electricity savings	kVAh	47744
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	3.42
Investment towards APFC panel	Rs. Lakhs	1.947
Payback period	Months	6.84

Table 78: Cost benefit analysis of APFC installation at Nirbhay Nagar ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.82
Average power factor from recent EB bill		0.839
Average real power	kW	46.58
Average apparent power	kVA	56.29
Annual grid electricity consumption	kWh	11241
	kVAh	13425
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	37
Annual grid electricity consumption	kWh	11241
	kVAh	13425
Annual grid electricity savings	kVAh	2070

Parameters	Unit	Parameters
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	0.15
Investment towards APFC panel	Rs. Lakhs	1.01
Payback period	Months	81.77

Table 79: Cost benefit analysis of APFC installation at Lohamandi ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.87
Average power factor from recent EB bill		0.768
Average real power	kW	221.11
Average apparent power	kVA	252.83
Annual grid electricity consumption	kWh	294912
	kVAh	383655
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	168
Annual grid electricity consumption	kWh	294912
	kVAh	383655
Annual grid electricity savings	kVAh	85764
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	6.14
Investment towards APFC panel	Rs. Lakhs	3.605
Payback period	Months	7.05

Table 80: Cost benefit analysis of APFC installation at Keshav Kunj (Bodla) ZPS

Parameters	Unit	Parameters

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.89
Average power factor from recent EB bill		0.903
Average real power	kW	239
Average apparent power	kVA	266.89
Annual grid electricity consumption	kWh	199257
	kVAh	220752
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	188
Annual grid electricity consumption	kWh	199257
	kVAh	220752
Annual grid electricity savings	kVAh	19483
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	1.39
Investment towards APFC panel	Rs. Lakhs	5.19
Payback period	Months	44.69

Table 81: Cost benefit analysis of APFC installation at Shahganj-1 ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.88
Average power factor from recent EB bill		0.651
Average real power	kW	278.05
Average apparent power	kVA	317.38
Annual grid electricity consumption	kWh	407053

Parameters	Unit	Parameters
	kVAh	640891
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	221
Annual grid electricity consumption	kWh	407053
	kVAh	640891
Annual grid electricity savings	kVAh	229726
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	16.44
Investment towards APFC panel	Rs. Lakhs	5.77
Payback period	Months	4.21

Table 82: Cost benefit analysis of APFC installation at Shahganj-2 ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.85
Average power factor from recent EB bill		0.835
Average real power	kW	238
Average apparent power	kVA	281.31
Annual grid electricity consumption	kWh	411608
	kVAh	493099
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	170
Annual grid electricity consumption	kWh	411608
	kVAh	493099
Annual grid electricity savings	kVAh	77333
Electricity tariff	Rs./kVAh	7.155

Parameters	Unit	Parameters
Annual monetary saving	Rs. Lakhs	5.53
Investment towards APFC panel	Rs. Lakhs	4.33
Payback period	Months	9.38

Table 83: Cost benefit analysis of APFC installation at Kedar Nagar ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.817
Average power factor from recent EB bill		0.810
Average real power	kW	26.38
Average apparent power	kVA	32.35
Annual grid electricity consumption	kWh	77546
	kVAh	95006
Proposed System		
Proposed power factor at Incomer	Cos ø	0.99
Required capacitor bank	kVAr	41
Annual grid electricity consumption	kWh	77546
	kVAh	95006
Annual grid electricity savings	kVAh	16677
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	1.19
Investment towards APFC panel	Rs. Lakhs	1.01
Payback period	Months	10.15

Table 84: Cost benefit analysis of APFC installation at Tajganj ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.87

Parameters	Unit	Parameters
Average power factor from recent EB bill		0.858
Average real power	kW	301.28
Average apparent power	kVA	346.44
Annual grid electricity consumption	kWh	286791
	kVAh	332719
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	232
Annual grid electricity consumption	kWh	286791
	kVAh	332719
Annual grid electricity savings	kVAh	43030
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	3.08
Investment towards APFC panel	Rs. Lakhs	6.129
Payback period	Months	23.89

Table 85: Cost benefit analysis of APFC installation at Rakabganj ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.83
Average power factor from recent EB bill		0.724
Average real power	kW	177.68
Average apparent power	kVA	208.41
Annual grid electricity consumption	kWh	199119
	kVAh	272928
Proposed System		
Proposed power factor at Incomer		0.99

Parameters	Unit	Parameters
Required capacitor bank	kVAr	165
Annual grid electricity consumption	kWh	199119
	kVAh	272928
Annual grid electricity savings	kVAh	71797
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	5.14
Investment towards APFC panel	Rs. Lakhs	3.61
Payback period	Months	8.42

Table 86: Cost benefit analysis of APFC installation at Navlakha ZPS

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.83
Average power factor from recent EB bill		0.847
Average real power	kW	175.52
Average apparent power	kVA	210.93
Annual grid electricity consumption	kWh	561593
	kVAh	661572
Proposed System		
Proposed power factor at Incomer		0.99
Required capacitor bank	kVAr	145
Annual grid electricity consumption	kWh	561593
	kVAh	661572
Annual grid electricity savings	kVAh	94306
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	6.75
Investment towards APFC panel	Rs. Lakhs	3.245
Payback period	Months	5.77

Table 87: Cost benefit analysis of capacitor installation at Chhipitola booster

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.864
Average power factor from recent EB bill		0.907
Average real power	kW	10.58
Average apparent power	kVA	12.24
Annual grid electricity consumption	kWh	38074
	kVAh	41977
Proposed System		
Proposed power factor at Incomer		0.99
Required Fixed Type capacitor	kVAr	17
Annual grid electricity consumption	kWh	38074
	kVAh	41977
Annual grid electricity savings	kVAh	3519
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	0.25
Investment towards ixed Type capacitor	Rs. Lakhs	0.180
Payback period	Months	8.59

Table 88: Cost benefit analysis of capacitor installation at Red Fort booster

Parameters	Unit	Parameters
Present System		
Average power factor measured on main incomer		0.882
Average power factor from recent EB bill		0.877
Average real power	kW	5.18
Average apparent power	kVA	5.87
Annual grid electricity consumption	kWh	4185
	kVAh	4773

Parameters	Unit	Parameters
Proposed System		
Proposed power factor at Incomer		0.99
Required Fixed Type capacitor	kVAr	5
Annual grid electricity consumption	kWh	4185
	kVAh	4773
Annual grid electricity savings	kVAh	546
Electricity tariff	Rs./kVAh	7.155
Annual monetary saving	Rs. Lakhs	0.04
Investment towards Fixed Type Capacitor	Rs. Lakhs	0.0541
Payback period	Months	16.62

11.4.4 Replacement of old pump sets with new, efficient pump sets

Existing operating conditions: The existing pump sets in most pumpstations are quite old and were observed to be operating away from their best efficiency point. A number of pump sets were in breakdown condition.

Recommendations: The present operating pump efficiency of many pump sets across pump houses is less than 55%. Therefore, it is suggested to replace existing pumps with energy efficient pump to reduce the energy consumption. A total of 23 nos. of pump sets have been identified for replacement.

Cost benefit analysis: Expected savings from the replacement of pump sets is about 3,180,667 kWh per year, which would result in a cost benefit of about Rs. 252.86 Lakh per year. Estimated investment for implementation of this measure is about Rs 328.53 Lakh, which includes cost of pump set, installation cost, cost of NRV, gate valve and cost of Web based dashboard. Simple payback period of this intervention is estimated to be about 16months. Detailed cost benefit analysis for each pump house is given in the tables below:

Table 89: Cost benefit analysis of pump replacement at 8VT Plant

Description Rated Parameters	Units	8 VT Plant Pump -5	8 VT Plant Pump -6	8 VT Plant Pump -7
Flow delivered	m^3/hr.	1226	1212	1212
Head developed	M	53	47	47
Motor power consumption	kW	260	220	220
Measured Parameters				
Flow delivered	m^3/hr.	1255	1281	1287
Head developed	M	22	18	20

Description Rated Parameters	Units	8 VT Plant Pump -5	8 VT Plant Pump -6	8 VT Plant Pump -7
Motor power consumption	kW	200	173	217
Calculated efficiency of pumpset	%	37.18 %	36.91 %	32.13 %
Proposed Parameters				
Flow of the pump	m^3/hr.	1250	1250	1250
Head of the pump	M	22	22	22
Power of the motor on existing duty point	kW	97.16	97.16	97.16
Proposed efficiency of pump set on existing duty point	%	77%	77%	77%
Operating hours of the pump	Hours	6267	2550	2761
Electricitytariff	Rs./kWh	7.95	7.95	7.95
Annual energy saving	kWh	645356	193443	330890
Annual cost saving	Rs. Lakhs	51.31	15.38	26.31
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	17.61	17.61	17.61
Investment towards NRV replacement including GST	Rs. Lakh	1.06	1.06	1.06
Investment towards gate valve replacement including GST	Rs. Lakh	1.18	1.18	1.18
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08	0.08	0.08
Payback period	Months	5	16	9

Table 90: Cost benefit analysis of pump replacement at Old and New Intake Wells

` Rated Parameters	Units	Old Intake Well Pump -6	New Intake Well Pump -1	New Intake Well Pump -2
Flow delivered	m^3/hr.	3180	2460	3180
Head developed	M	15	16	16
Motor power consumption	kW	185	150	180
Measured Parameters				
Flow delivered	m^3/hr.	2249	1015	2079
Head developed	M	13	11	12
Motor power consumption	kW	230	105	134
Calculated efficiency of pumpset	%	35.12 %	29.14 %	51.07 %
Proposed Parameters				

Flow of the pump	m^3/hr.	2200	1000	2200
Head of the pump	M	15	15	15
Power of the motor on existing duty point	kW	116.29	52.92	116.29
Proposed efficiency of pump set on existing duty point	%	77%	77%	77%
Operating hours of the pump	Hours	4775	6311	6679
Electricitytariff	Rs./kWh	7.95	7.95	7.95
Annual energy saving	kWh	541292	327674	115611
Annual cost saving	Rs. Lakhs	43.03	26.05	9.19
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	28.54	16.04	28.54
Investment towards NRV replacement including GST	Rs. Lakh	0.00	2.29	3.52
Investment towards gate valve replacement including GST	Rs. Lakh	0.00	2.56	3.76
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08	0.08	0.08
Payback period	Months	8	10	47

Table 91: Cost benefit analysis of pump replacement at New Jal Nigam Intake Well

Description **Rated Parameters**	**Units**	**New Jal Nigam Intake well Pump -2**	**New Jal Nigam Intake well Pump -3**
Flow delivered	m^3/hr.	1950	1950
Head developed	M	16	16
Motor power consumption	kW	132	132
Measured Parameters			
Flow delivered	m^3/hr.	1113	1080
Head developed	M	12	12
Motor power consumption	kW	96	115
Calculated efficiency of pumpset	%	38.17 %	30.83 %
Proposed Parameters			
Flow of the pump	m^3/hr.	1000	1000
Head of the pump	M	15	15
Power of the motor on existing duty point	kW	52.92	52.92

Proposed efficiency of pump set on existing duty point	%	77%	77%
Operating hours of the pump	Hours	4091	3583
Electricitytariff	Rs./kWh	7.95	7.95
Annual energy saving	kWh	175275	220904
Annual cost saving	Rs. Lakhs	13.93	17.56
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	16.04	16.04
Investment towards NRV replacement including GST	Rs. Lakh	2.29	2.29
Investment towards gate valve replacement including GST	Rs. Lakh	2.56	2.56
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08	0.08
Payback period	Months	18	14

Table 92: Cost benefit analysis of pump replacement at Sanjay Place ZPS

Description Rated Parameters	Units	Sanjay Place, Maithan Side. pump-5	Sanjay Place, Hariparvat Side. Pump-1	Sanjay Place, Hariparvat Side. Pump-4	Sanjay Place, Hariparvat Side. Pump-5(0)
Flow delivered	m^3/hr.	324	300	648	*NA
Head developed	M	30	35	30	*NA
Motor power consumption	kW	37	37	75	67
Measured Parameters					
Flow delivered	m^3/hr.	292	359	574	99
Head developed	M	21	10	13	52
Motor power consumption	kW	38	34	61	44
Calculated efficiency of pumpset	%	43.29%	28.72 %	34.14 %	32.16 %
Proposed Parameters					
Flow of the pump	m^3/hr.	250	350	600	100
Head of the pump	M	28	15	15	50
Power of the motor on existing duty point	kW	25.58	19.64	32.10	19.73
Proposed efficiency of pump set on existing duty point	%	75%	73%	76%	69%
Operating hours of the pump	Hours	1330	1339	1339	1341

Electricitytariff	Rs./kWh	7.95	7.95	7.95	7.95
Annual energy saving	kWh	16828	19532	38445	32014
Annual cost saving	Rs. Lakhs	1.34	1.55	3.06	2.55
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	7.41	9.59	15.82	6.86
Investment towards NRV replacement including GST	Rs. Lakh	0.59	0.59	0.59	0.59
Investment towards gate valve replacement including GST	Rs. Lakh	0.66	0.66	0.66	0.66
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08	0.08	0.08	0.08
Payback period	Months	78	84	67	39

Table 93: Cost benefit analysis of pump replacement at Kotwali ZPS

` Rated Parameters	Units	Kotwali ZPS Pump-1
Flow delivered	m^3/hr.	324
Head developed	M	30
Motor power consumption	kW	37
Measured Parameters		
Flow delivered	m^3/hr.	232
Head developed	M	6
Motor power consumption	kW	28
Calculated efficiency of pumpset	%	13.14%
Proposed Parameters		
Flow of the pump	m^3/hr.	225
Head of the pump	M	12
Power of the motor on existing duty point	kW	10.20
Proposed efficiency of pump set on existing duty point	%	72%
Operating hours of the pump	Hours	702
Electricitytariff	Rs./kWh	7.95
Annual energy saving	kWh	12,405
Annual cost saving	Rs. Lakhs	0.99
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	5.05
Investment towards NRV replacement including GST	Rs. Lakh	0.27
Investment towards gate valve replacement including GST	Rs. Lakh	0.35

Rated Parameters	Units	Kotwali ZPS Pump-1
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08
Payback period	Months	70

Table 94: Cost benefit analysis of pump replacement at Mathura Road ZPS

Description	Units	Mathura Road ZPS	Mathura Road ZPS
Rated Parameters		Pump-2	Pump-3
Flow delivered	m^3/hr.	300	300
Head developed	M	35	35
Motor power consumption	kW	37	37
Measured Parameters			
Flow delivered	m^3/hr.	408	150
Head developed	M	16	15
Motor power consumption	kW	41	28
Calculated efficiency of pumpset	%	43.87 %	22.45 %
Proposed Parameters			
Flow of the pump	m^3/hr.	350	120
Head of the pump	M	18	18
Power of the motor on existing duty point	kW	23.31	8.81
Proposed efficiency of pump set on existing duty point	%	74%	67%
Operating hours of the pump	Hours	1076	726
Electricitytariff	Rs./kWh	7.95	7.95
Annual energy saving	kWh	19447	13637
Annual cost saving	Rs. Lakhs	1.55	1.08
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	9.53	5.07
Investment towards NRV replacement including GST	Rs. Lakh	0.59	0.59
Investment towards gate valve replacement including GST	Rs. Lakh	0.66	0.66
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08	0.08
Payback period	Months	84	71

Table 95: Cost benefit analysis of pump replacement at Trans Yamuna ZPS

Description Rated Parameters	Units	Trans Yamuna ZPS Pump-1
Flow delivered	m^3/hr.	300
Head developed	M	32
Motor power consumption	kW	37
Measured Parameters		
Flow delivered	m^3/hr.	367
Head developed	M	9
Motor power consumption	kW	35
Calculated efficiency of pumpset	%	26.79%
Proposed Parameters		
Flow of the pump	m^3/hr.	300
Head of the pump	M	15
Power of the motor on existing duty point	kW	17.27
Proposed efficiency of pump set on existing duty point	%	71%
Operating hours of the pump	Hours	913
Electricitytariff	Rs./kWh	7.95
Annual energy saving	kWh	16341
Annual cost saving	Rs. Lakhs	1.30
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	8.72
Investment towards NRV replacement including GST	Rs. Lakh	0.00
Investment towards gate valve replacement including GST	Rs. Lakh	0.00
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08
Payback period	Months	81

Table 96: Cost benefit analysis of pump replacement at Lawyers' Colony ZPS

Description Rated Parameters	Units	Lawyer's Colony ZPS Pump-1(Lawyer's Colony)	Lawyer's Colony ZPS Pump-2(Lawyer's Colony)
Flow delivered	m^3/hr.	270	270
Head developed	M	34	34
Motor power consumption	kW	37	37
Measured Parameters			
Flow delivered	m^3/hr.	232	119

Description Rated Parameters	Units	Lawyer's Colony ZPS Pump-1(Lawyer's Colony)	Lawyer's Colony ZPS Pump-2(Lawyer's Colony)
Head developed	M	28	28
Motor power consumption	kW	35	35
Calculated efficiency of pumpset	%	51.75%	25.71%
Proposed Parameters			
Flow of the pump	m^3/hr.	250	125
Head of the pump	M	28	28
Power of the motor on existing duty point	kW	25.58	13.24
Proposed efficiency of pump set on existing duty point	%	75%	72%
Operating hours of the pump	Hours	3912	3914
Electricitytariff	Rs./kWh	7.95	7.95
Annual energy saving	kWh	35946	86044
Annual cost saving	Rs. Lakhs	2.86	6.84
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	7.41	6.87
Investment towards NRV replacement including GST	Rs. Lakh	0.59	0.59
Investment towards gate valve replacement including GST	Rs. Lakh	0.66	0.66
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08	0.08
Payback period	Months	37	14

Table 97: Cost benefit analysis of pump replacement at Shahganj Phase-1 ZPS

Description Rated Parameters	Units	Shahganj Phase-1 ZPS Pump-1
Flow delivered	m^3/hr.	600
Head developed	M	32
Motor power consumption	kW	75
Measured Parameters		
Flow delivered	m^3/hr.	352
Head developed	M	12
Motor power consumption	kW	65
Calculated efficiency of pumpset	%	17.38%

Proposed Parameters		
Flow of the pump	m^3/hr.	350
Head of the pump	M	14
Power of the motor on existing duty point	kW	19.04
Proposed efficiency of pump set on existing duty point	%	70%
Operating hours of the pump	Hours	807
Electricitytariff	Rs./kWh	7.95
Annual energy saving	kWh	37113
Annual cost saving	Rs. Lakhs	2.95
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	8.72
Investment towards NRV replacement including GST	Rs. Lakh	0.27
Investment towards gate valve replacement including GST	Rs. Lakh	0.35
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08
Payback period	Months	38

Table 98: Cost benefit analysis of pump replacement at Shahganj Phase-2 ZPS

Description Rated Parameters	Units	Shahganj Phase-2 Pump-5
Flow delivered	m^3/hr.	600
Head developed	M	31
Motor power consumption	kW	75
Measured Parameters		
Flow delivered	m^3/hr.	439
Head developed	M	22
Motor power consumption	kW	66
Calculated efficiency of pumpset	%	40.80%
Proposed Parameters		
Flow of the pump	m^3/hr.	400
Head of the pump	M	25
Power of the motor on existing duty point	kW	38.95
Proposed efficiency of pump set on existing duty point	%	70%
Operating hours of the pump	Hours	3682
Electricitytariff	Rs./kWh	7.95
Annual energy saving	kWh	99125
Annual cost saving	Rs. Lakhs	7.88

Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	15.09
Investment towards NRV replacement including GST	Rs. Lakh	0.59
Investment towards gate valve replacement including GST	Rs. Lakh	0.66
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08
Payback period	Months	25

Table 99: Cost benefit analysis of pump replacement at Rakabganj ZPS

Description **Rated Parameters**	**Units**	**Rakabganj ZPS** **Pump-2**
Flow delivered	m^3/hr.	648
Head developed	M	30
Motor power consumption	kW	75
Measured Parameters		
Flow delivered	m^3/hr.	792
Head developed	M	5
Motor power consumption	kW	77
Calculated efficiency of pumpset	%	14.26%
Proposed Parameters		
Flow of the pump	m^3/hr.	700
Head of the pump	M	12
Power of the motor on existing duty point	kW	31.47
Proposed efficiency of pump set on existing duty point	%	73%
Operating hours of the pump	Hours	700
Electricitytariff	Rs./kWh	7.95
Annual energy saving	kWh	31695
Annual cost saving	Rs. Lakhs	2.52
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	13.19
Investment towards NRV replacement including GST	Rs. Lakh	0.59
Investment towards gate valve replacement including GST	Rs. Lakh	0.66
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08
Payback period	Months	69

Table 100: Cost benefit analysis of pump replacement at Navlakha ZPS

Description	**Units**	**Navlakha ZPS**

Rated Parameters		Pump-3
Flow delivered	m^3/hr.	1200
Head developed	M	35
Motor power consumption	kW	160
Measured Parameters		
Flow delivered	m^3/hr.	784
Head developed	M	36
Motor power consumption	kW	148
Calculated efficiency of pumpset	%	51.31%
Proposed Parameters		
Flow of the pump	m^3/hr.	800
Head of the pump	M	35
Power of the motor on existing duty point	kW	96.57
Proposed efficiency of pump set on existing duty point	%	79%
Operating hours of the pump	Hours	2998
Electricitytariff	Rs./kWh	7.95
Annual energy saving	kWh	154038
Annual cost saving	Rs. Lakhs	12.25
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	7.75
Investment towards NRV replacement including GST	Rs. Lakh	0.59
Investment towards gate valve replacement including GST	Rs. Lakh	0.66
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08
Payback period	Months	9

Table 101: Cost benefit analysis of pump replacement at Chhipitola booster

Description Rated Parameters	Units	Chhipitola Booster Pump-2
Flow delivered	m^3/hr.	140
Head developed	M	30
Motor power consumption	kW	20
Measured Parameters		
Flow delivered	m^3/hr.	90
Head developed	M	18
Motor power consumption	kW	11
Calculated efficiency of pumpset	%	40.85%

Proposed Parameters		
Flow of the pump	m^3/hr.	100
Head of the pump	M	18
Power of the motor on existing duty point	kW	6.60
Proposed efficiency of pump set on existing duty point	%	74%
Operating hours of the pump	Hours	1623
Electricity tariff	Rs./kWh	7.95
Annual energy saving	kWh	7119
Annual cost saving	Rs. Lakhs	0.57
Investment towards new pumpset including installation and commissioning, including GST	Rs. Lakh	2.07
Investment towards NRV replacement including GST	Rs. Lakh	0.00
Investment towards gate valve replacement including GST	Rs. Lakh	0.35
Investment towardsWeb based dashboard including GST	Rs. Lakh	0.08
Payback period	Months	53

12 PROJECT COST ESTIMATES

The cost estimates for the project are extremely important as Project's viability and implementation depends on the project cost. Therefore, cost estimates and rate analysis of the items have been carried Out with due care while considering the priority of improvement works. The project cost estimateshave been prepared considering various items of works based on UP PWD CSR-15-16. The rates for the items of work not included in PWD have been assessed from PHE (UP)/ MJP SOR/ INDST /PWD CSR 17-18 for HDD and Trenchless technology or current market rates and also the consultants experience on similar works in the vicinity of the project.The details are provided in tables below;

12.1 ASSUMPTIONS FOR PROJECT COST

1. It is basically a Capital investment required for priority works for revamping of existing water supply systems of Agra City.
2. As per existing situation, it can be observed that AMC requires proper monitoring system for water supply and distribution system and for that various instrumentation and equipments desired for central monitoring and control system are considered and cost estimated. Apart from monitoring system based on the finding of DMA study and analysis, UFW/NRW levels within AMC water supply system was observed. It can be seen that as per currnet demand water is sufficient but the proper management and equitable distribution is priority to reduce present UFW/NRW to desired levels. In this regard AMC need to take policy decision to install consumer metering and charge on volumetric basis to the consumers. Also more prone area for NRW is house service connection at consumer end. There is need for AMC, to rehabilitate the existing house service connection replace them with latest fitting and materials to arrest water loss and increase revenue. Hence capital cost includes cost of central monitoring syste, rehabilitation of house service connection and energy effieicncy potential in water pumping system

- Installation of realtime central monitoring system for water supply system along with minimum instrumentation
- House Service connection
- Consumer water metering
- Replacement of old pump and motor with new energy efficienct pump and motors
- Installation of APFC control panels

12.2 PROJECT COST

As per discussed in earlier chapters, the water supply improvement program for priority works for Agra city requires various works including instrumentation, flow meters for water pumping stations, monitoring system, realtime water balance system, consumer meter (smart metering), providing house service connections, laying of tertiary network, Replacement old dilapidated network, road restoration etc.. However, as per the priority works discussed with AMC, following works have been considered for implementation as a improvement programme for NRW reduction. The investment programme for priority works for AMC water supply system is tabulated hereafter;

1. **Cost estimates for Central monitoring system**
2. **Project cost for consumer water meter and HSC**
3. **Cost estimates for Pump & motor replacement**

1. Cost estimetes for Central monitoring system

AGRA MUNICIPAL CORPORATION: MONITORING SYSTEM - PROJECT COST SUMMARY				
Sr No	**Monitoring SYstem Instrumentation and Components**	**Qty**	**Unit**	**Cost (Rs.)**
1	Pressure Measuring Instruments	144	Nos.	9849600
2	Temperature Scanners	126	Nos.	1077300
3	Level Measurement Systems	45	Nos.	3847500
4	Residual Chlorine Measuring Instruments	42	Nos.	14723100
5	Electromagnetic Flow-meter (EMF)	49	Nos.	26841090
6	Turbidity Meter	8	Nos.	2280000
7	pH Meter	3	Nos.	971112
8	RPM Measuring Instruments	126	Nos.	2154600
9	Energy Measuring (Power Analyser) Instruments	126	Nos.	2370060
10	RTUs/PLCs	46	Nos.	10046250
11	Lightening / Surge Protection System	46	Nos.	393300
12	Instrumentation Cable	3150	Mtr	513513
13	R.C.C. Chambers for Flowmeters	18	Nos.	903600
14	Wireless Radio Telemetry	46	Nos.	13680000
15	MS Tubular Tower	46	Nos.	11328750
16	Central Monitoring System for all UGR/GSR/Pumping stations	1	Nos.	855000
17	Central Server PC	1	Nos.	427500
18	PCs, Softwares, Keyboards, Printers and Other Hardware Complete	1	Nos.	897750
19	Uninterrupted Power Supply System	46	Nos.	3249000
20	Air Conditioning Unit	1	Nos.	76950
21	Pipe Specials and Fittings for Flowmeters / Flow Control Valves	343	Nos.	3819399
			Total Capital Cost (Rs.)	**110305374**

Total O&M Cost for 5 years (Rs.)	**89450000**
Total Project Cost (Rs.)	**199755374**
Total Project Cost (Rs. Crores)	**19.98**

2. Project cost for consumer water meter and HSC

Perticulars	Amount (Rs.)	Amount (Rs in Lakhs)
Ferrules	40242000.00	402.42
Meter box	43169900.00	431.70
Compression fittings	32690450.00	326.90
DI Strap Saddle	28185447.40	281.85
Domestic Water Meters	412353200.00	4123.53
ElectroFusion Tapping Ferrule	98474700.00	984.75
Excavation	21375000.00	213.75
Galvanised iron Pipe	30922500.00	309.23
Gun metal ball valve	51794000.00	517.94
MDPE Pipe	22529250.00	225.29
Moling	41467500.00	414.68
Road resotration	469297774.60	4692.98
Grand Total	**1292501722.00**	**12925.02**

3. Project Cost for Energy Efficiency Improvement programme

Overall summary of energy efficiency measures is provided below:

Location	Description of ECM	Estimated investment (Rs. Lakh)	Estimated annual savings kWh	Estimated annual savings (Rs. Lakh)	Esimated payback (years)
Jeoni Mandi	ECM-1: Contract demand revision	-	-	-	-
	ECM-1: Installation of LED-based lighting equipment	0.22	5081	0.40	0.55
	ECM-2: Power factor improvement	-	-	-	-

	ECM-3: Replacement of pumping machinery	187.21	2550445	202.76	0.92
	Total	**187.43**	**2555526**	**203.16**	**0.92**
Sanjay Place	ECM-1: Contract demand revision	-		10.03	-
	ECM-1: Installation of LED-based lighting equipment	0.32	1787	0.14	2.22
	ECM-2: Power factor improvement	6.49		9.76	0.66
	ECM-3: Replacement of pumping machinery	44.98	106820	8.49	5.30
	Total	**51.78**	**108607**	**28.43**	**1.82**
Kotwali	ECM-1: Contract demand revision	-		0.44	-
	ECM-1: Installation of LED-based lighting equipment	0.18	1301	0.10	1.71
	ECM-2: Power factor improvement	1.73		2.07	0.84
	ECM-3: Replacement of pumping machinery	5.75	12405	0.99	5.83
	Total	**7.66**	**13705**	**3.60**	**2.13**
Surya Nagar	ECM-1: Contract demand revision	-		4.45	-
	ECM-1: Installation of LED-based lighting equipment	0.71	4673	0.37	1.91
	ECM-2: Power factor improvement	2.88		4.07	0.71
	ECM-3: Replacement of pumping machinery	-	-	-	-
	Total	**3.59**	**4673**	**8.89**	**0.40**
Mathura Road	ECM-1: Contract demand revision	-		1.23	-
	ECM-1: Installation of LED-based lighting equipment	0.89	4468	0.36	2.52
	ECM-2: Power factor improvement	1.73		3.48	0.50
	ECM-3: Replacement of pumping machinery	17.25	33084	2.63	6.56
	Total	**19.87**	**37552**	**7.70**	**2.58**
Trans Yamuna	ECM-1: Contract demand revision	-		0.00	-
	ECM-1: Installation of LED-based lighting	0.02	228	0.02	0.98

	equipment				
	ECM-2: Power factor improvement	1.01		0.19	5.21
	ECM-3: Replacement of pumping machinery	8.80	16341	1.30	6.77
	Total	**9.83**	**16569**	**1.51**	**6.51**
Lawyers Colony	ECM-1: Contract demand revision	-		0.44	-
	ECM-1: Installation of LED-based lighting equipment	0.10	502	0.04	2.42
	ECM-2: Power factor improvement	1.95		3.42	0.57
	ECM-3: Replacement of pumping machinery	16.93	121990	9.70	1.75
	Total	**18.97**	**122493**	**13.59**	**1.40**
Nirbhay Nagar	ECM-1: Contract demand revision	-		0.40	-
	ECM-1: Installation of LED-based lighting equipment	0.29	1419	0.11	2.57
	ECM-2: Power factor improvement	1.01		0.15	6.81
	ECM-3: Replacement of pumping machinery	-	-	-	-
	Total	**1.30**	**1419**	**0.66**	**1.98**
Lohamandi	ECM-1: Contract demand revision	-		9.54	-
	ECM-1: Installation of LED-based lighting equipment	0.03	488	0.04	0.66
	ECM-2: Power factor improvement	3.61		6.14	0.59
	ECM-3: Replacement of pumping machinery	-	-	-	-
	Total	**3.63**	**488**	**15.71**	**0.23**
Keshavkunj	ECM-1: Contract demand revision	-		6.87	-
	ECM-1: Installation of LED-based lighting equipment	0.04	460	0.04	1.16
	ECM-2: Power factor improvement	5.19		1.39	3.72
	ECM-3: Replacement of pumping machinery	-	-	-	-
	Total	**5.23**	**460**	**8.30**	**0.63**

Shahganj Phase 1	ECM-1: Contract demand revision	-		3.95	-
	ECM-1: Installation of LED-based lighting equipment	0.30	1949	0.15	1.90
	ECM-2: Power factor improvement	5.77		16.44	0.35
	ECM-3: Replacement of pumping machinery	9.42	37113	2.95	3.19
	Total	**15.49**	**39062**	**23.49**	**0.66**
Shahganj Phase 2	ECM-1: Contract demand revision	-		5.41	-
	ECM-1: Installation of LED-based lighting equipment	0.03	399	0.03	0.80
	ECM-2: Power factor improvement	4.33		5.53	0.78
	ECM-3: Replacement of pumping machinery	12.11	109617	8.71	1.39
	Total	**16.46**	**110016**	**19.69**	**0.84**
Kedar Nagar	ECM-1: Contract demand revision	-		0.00	-
	ECM-1: Installation of LED-based lighting equipment	0.08	889	0.07	1.08
	ECM-2: Power factor improvement	1.01		1.19	0.85
	ECM-3: Replacement of pumping machinery	-	-	-	-
	Total	**1.09**	**889**	**1.26**	**0.86**
Tajganj	ECM-1: Contract demand revision	-		16.08	-
	ECM-1: Installation of LED-based lighting equipment	0.11	780	0.06	1.69
	ECM-2: Power factor improvement	6.13		3.08	1.99
	ECM-3: Replacement of pumping machinery	-	-	-	-
	Total	**6.23**	**780**	**19.22**	**0.32**
Rakabganj	ECM-1: Contract demand revision	-		1.43	-
	ECM-1: Installation of LED-based lighting equipment	-	-	-	-
	ECM-2: Power factor improvement	3.61		5.14	0.70

	ECM-3: Replacement of pumping machinery	14.52	31695	2.52	5.76
	Total	**18.12**	**31695**	**9.08**	**2.00**
Navlakha	ECM-1: Contract demand revision	-		0.00	-
	ECM-1: Installation of LED-based lighting equipment	0.54	2409	0.19	2.80
	ECM-2: Power factor improvement	3.24		6.75	0.48
	ECM-3: Replacement of pumping machinery	9.07	154038	12.25	0.74
	Total	**12.85**	**156447**	**19.19**	**0.67**
Chhipitola booster	ECM-1: Contract demand revision	-		0.72	-
	ECM-1: Installation of LED-based lighting equipment	0.02	552	0.04	0.39
	ECM-2: Power factor improvement	0.18		0.25	0.72
	ECM-3: Replacement of pumping machinery	2.50	7119	0.57	4.42
	Total	**2.70**	**7671**	**1.58**	**1.71**
Red Fort booster	ECM-1: Contract demand revision	-		-	-
	ECM-1: Installation of LED-based lighting equipment	0.01	718	0.06	0.15
	ECM-2: Power factor improvement	0.05		0.04	1.38
	ECM-3: Replacement of pumping machinery	-	-	-	-
	Total	**0.06**	**718**	**0.10**	**0.65**
TOTAL		**382.30**	**3208769**	**385.16**	**0.99**

Thus, total project improvement & investment programme for Agra is as per below;

Sr.No.	Description of Works	(Rs. Crores)
1	Central Monirtoring System and Instrumentation	19.98
2	Consumer water Metering and Rehab for HSC	129.25
3	Energy Efficiency Improvement for Pumping System	3.82
Total		**153.05**

12.3 PROJECT IMPLEMENTATION FORCAST

Project for improvement in water supply system and NRW reduction objective can be implemented considering the following phase of work programme and estimated duration of 7 to 10 years of implementation.

S.No	Phase	Period
1.	Study Phase	12 months from the date of commencement of contract and up to approval of Service Improvement Plan
2.	DMA Establishment Phase	12 months from the date of approval of Service Improvement Plan and up to the date of completion of DMA Establishment Works
3.	Rehabilitation Phase	36 months from the date of approval of Service Improvement Plan
4.	NRW Reduction Phase	108 months from the date of approval of Service improvement Plan and up to the date of completion of contract

Energy audit and efficiency project can be implemented through ESCO mode or pumping stationwise EPC contract.

12.4 FUNDING OPTIONS

Project Implementation strategy is developed and the project can be implemented through either performance based management contracts (PBMC) or EPC / DBO with or without private sector participation. The project funding can be through AMRUT / Smart City programe or World Bank (MoUD) programme. The project funding composition of water supply project cost is as below;

Particulars	**AMRUT (Phase-I) Amount in Rs. Crores**	
Govt. of India	30%	45.92
Govt. of Uttar Pradsh	50%	76.53
ULB (AMC) Share	20%	30.61
Total	**100%**	**153.05**

13 PROJECT COST AND BILL QUANTITES

13.1 Bill of Quantites of Instrumentation

BILLS OF QUANTITIES					
Item No.	**Description of items**	**Qty.**	**Unit**	**Rate**	**Total Cost**
INSTRUMENTATION FOR AGRA MUNICIPAL CORPORATION - WATER SUPPLY					
	A. 1st Level of System Architecture				**(Rs)**
1	Supply, delivery, installation, testing, training and commissioning of **Pressure measuring instruments** consisting of pressure transducers, pressure transmitters with cabinet for pressure transmitter, digital pressure indicator, sensors, converters, cables, structure required for mounting viz: platforms, railings, etc and all required installation hardware complete and as directed by Engineer-in - charge				
	a) At Pump House : delivery of each pump	126	each set	68400	8618400
	b) At ESR, Inlet and outlet	18	each set	68400	1231200
	SUBTOTAL	**144**			**9849600**
2	Supply, delivery, installation, testing, training and commissioning of **Temperature Scanner** to measure temperature of motors at pump house				
	At Pump House : each motor	126	each set	8550	1077300
3	Supply, delivery, installation, testing, training and commissioning of **level measurement systems** to measure UGR / GSR level and water / sump level at pump house consisting of level transducers, level transmitters, sensors, converters, cables, digital level indicators with proper cabinets, structure required for mounting the level transducer viz: platforms, railings etc and all required installation hardware complete and as directed by Engineer-in-charge				
	b) At Pump Houses	27	each set	85500	2308500
	c) At ESR	18	each set	85500	1539000

	SUBTOTAL	**45**	**each set**		**3847500**
4	Supply, delivery, installation, testing, training and commissioning of **Residual Chlorine measuring instruments** consisting of transducers, transmitters, sensors, converters, cables, proper cabinets, structure required for mounting viz: platforms, railings etc and all required installation hardware complete and as directed by Engineer-in-charge				
	a) At WTP	24	each set	350550	8413200
	b) At ESR	18	each set	350550	6309900
	SUBTOTAL	**42**	**each set**		**14723100**
5	Supply, delivery, installation, testing, training and commissioning of **Electromagnetic flow meter** (EMF) for raw/ pure water with accuracy 0.5% of measured value and protection as per given specifications for size 50mm - 1600mm. Including sensor, transmitter, surge arrestor, 25meter sensor/ transmitter cable, GI duct of suitable size for 25 mtr/ each flow meter including pipe cutting, levelling and installation of flow meter in pipe lines with necessary tool tackles cranes etc. as may be required at site and based on technical specification etc. as per attached with 10 years battery back-up. With data logger				
	Dia (mm)				
	50	0	each set	20610	0
	100	2	each set	69273	138545
	150	1	each set	171750	171750
	200	5	each set	228428	1142138
	300	5	each set	285907	1429533
	350	0	each set	343500	0
	400	6	each set	400750	2404500
	450	0	each set	601125	0
	500	27	each set	687000	18549000
	600	1	each set	801500	801500
	700	1	each set	938900	938900
	800	0	each set	1048820	0
	900	1	each set	1265225	1265225
	1000	0	each set	2354761	0
	1200	0	each set	1688875	0
	1500	0	each set	2771221	0

				0	
	SUBTOTAL	**49**			**26841090**
6	Supply, delivery, installation, testing, training and commissioning of **Turbidity meter** consisting of transducers, transmitters, sensors, converters, cables, structure required for mounting the transducer viz: chambers, platforms, railings etc and all required installation hardware complete and as directed by Engineer-in -charge				
	At 4 WTPs	**8**	**each set**	285000	**2280000**
7	Supply, delivery, installation, testing, training and commissioning of **pH measuring instruments** consisting of transducers, transmitters, sensors, converters, cables, structure required for mounting the transducer viz: chambers, platforms, railings etc and all required installation hardware complete and as directed by Engineer-in -charge				
	At 4 WTPs	**3**	**each set**	323704	**971112**
8	Supply, delivery, installation, testing, training and commissioning of **RPM measuring instruments** consisting of transducers, transmitters, sensors, converters, cables, structure required for mounting the transducer viz: chambers, platforms, railings etc and all required installation hardware complete and as directed by Engineer-in -charge				
	At Pump Houses	**126**	**each set**	**17100**	**2154600**
9	Supply, delivery, installation, testing, training and commissioning of **Energy measuring** (Power analyser) instruments. Communicating type energy monitoring system capable of monitoring all energy parameters consisting of transducers, transmitters, sensors, converters, cables, cabinets, structure required for mounting the transducer viz: platforms, railings etc and all required installation hardware / software complete etc. and as directed by Engineer-in -charge				

	At Pump Houses	126	each set	18810	2370060
10	Supply, delivery, erection, installation, testing and commissioning of all required *communication interface*, telemetry interfaces,**RTUs/PLCs**hardwares, controls, cables and all required accessories to communicate with all field instruments to receive, store, transfer data /information. Consisting of PLC / RTUs system with all peripherals, converters & cabinets, power points and structure required for mounting viz: platforms, railings etc and all required hardware / softwares complete and as directed by Engineer-in -charge				
	a) At Pump Houses	27	each set	213750	5771250
	b) At ESR	18	each set	213750	3847500
	c) At Control Room	1	each set	427500	427500
	SUBTOTAL	**46**	**each set**		**10046250**
11	Supply, delivery, erection, installation, testing and commissioning of **Lightning / Surge protection system** with all required accessories for all field instruments, controls, towers, antennas etc. consisting of all protection/lightning devices with all peripherals, cabinets and structure required for mounting viz: chambers, platforms, railings etc. with all required hardware complete and as directed by Engineer-in -charge				
	a) At Pump House	27	each set	8550	230850
	b) At ESR	18	each set	8550	153900
	c) At Control Room	1	each set	8550	8550
	SUBTOTAL	**46**	**each set**		**393300**
12	Supply, delivery, erection, installation, testing and commissioning of **Instrumentation Cable** with all required accessories for all field instruments & controls i.e. for telemetry consisting of all peripherals and structure required for mounting viz: furnitures, platforms, railings etc. with all required hardware complete and as directed by Engineer-in -charge				
	At all Pump Houses & ESR locations & Central Location.	3150	meter	163	513513

13	Providing and constructing **R.C.C. chambers** 2mX2mX2.5m for field instruments of required size and depth in M-20 grade concrete including necessary, excavation, backfilling, P.C.C. 150 mm thick below foundation, R.C.C. wall 150 mm thick, R.C.C. precast roof cover in M.S. angle frame in strip of 30 cm width with proper hooks for lifting, necessary number of M.S. steps embedded in wall etc. complete				
	a) At ESR Inlet and outlet (37 Nos)	18	nos.	50200	903600
	SUBTOTAL	**18**			**903600**
14	Supply, delivery, erection, installation, testing, training and **commissioning of *Wireless Radio Telemetry*** as a communication media including GPS site survey of all locations for determining communication parameters & towers for Central Monitoring system with proper Towers/ Antennas /subscriber module / reflector disk at each location and central location and all necessary accessories inclusive of all liscence fees at all locations of pumping stations and ESR consisting of all required equipments, Towers, Antennas, subscriber module, disk, pedestal for tower base, lightning arrestors, cables, structure required for mounting viz: poles, platforms, railings, furnitures etc and all required installation hardwares complete and as directed by Engineer-in -charge				
	a) At Pump House	18	nos.	427500	7695000
	b) At ESR	27	nos.	213750	5771250
	c) At Control Room	1	nos.	213750	213750
	SUBTOTAL	**46**			**13680000**
15	ii) Providing Fabricated self supported triangular shape **MS Tubular Tower** of suitable height from ground , providing matched pedestal for tower base, providing Aluminium earthing wire upto nearest earth terminal, providing GI lightening arrestor at WTP / pump House locations and At Central Location				
	a) Tower Height upto 5 meter (For ESR)	18	nos.	178125	3206250
	b) Tower Height 10 to 15 meter (For Pump Houses)	27	nos.	285000	7695000
	c) Tower Height 25 to 30 meter (At Control Room)	1	nos.	427500	427500

	SUBTOTAL	**46**			**11328750**
16	a) Supply, delivery, erection, installation, testing, training and commissioning of ***Central Monitoring System* for all UGR/GSR / Pumping stations**including a) project Plan b) System hardware c) System Software and all necessary accessories as per the General Specifications & Technical Specifications for telemetry consisting of all monitoring equipments, LED or TFT screens not less than7 m x 3.5 m, cables, all hardwares/softwares to communicate with telemetry system, power supplies, structure required for mounting viz: furnitures, cabinets, platforms, railings etc. and all required installation hardwares and as directed by Engineer-in -charge				
	At central location Control Room	**1**	system	855000	**855000**
17	Supply, delivery, erection, installation, testing, and commissioning of ***Central Server PC***for storing data including all necessary accessories consisting of reputed make Server PC with Min configuration: P4 (Dual Core), 3 GHz or above, 3MB L2 cache,4 GB RAM, 880 GB HDD, 10/100 Ethernet, Keyboard, Mouse, 1.44MB FDD, CD / DVD ROM, CD writer, Windows latest software inclusive of liscence with commercial grade monitor(LCD) not less than42" along with networking components and internet connection for web enabled data facility, printers and all mounting structures viz, furnitures, cabinets, platforms, railings etc. and all required installation softwares and hardwares cables and as directed by Engineer-in -charge				
	At central location i.e. Control Room	**1**	System	427500	**427500**

18	Supply, delivery, erection, installation, testing, training and commissioning of ***PCs, Softwares***, Keyboards, Printers etc. including all associated softwares like Operating system, database software, application software, resource planning, WDM software etc.& its all accessories Minimum configuration for 5 nos. PCs are :- Reputed make PC with P4 (Dual Core), 3 GHz or above, 1MB L2 cache, 4GB RAM, 880 GB HDD, 10/100 Ethernet, Keyboard, Mouse, 1.44MB FDD, CDROM, Windows latest software inclusive of liscence with not less than 42" commercial grade monitor (LCD) along with all networking components to connect with server and other PCs.Softwares Consisting of Windows based MMI Software inclusive of liscence to provide dynamic graphics, process mimics, real time & historical trending, group displays, faceplate displays, alarm management and reports and all mounting structures viz, furnitures, chambers, platforms, railings, cables etc. as directed by Engineer-in -charge.	Lump sum (Min 3 user)			
	At central location i.e. Control Room	1		897750	897750
19	Supply, delivery, erection, testing and commissioning of ***Uninterrupted Power Supply*** **system**for 240 V AC 50 Hz. consisting of inverters and Lead Acid Batteries of high capacity and all electrical power supplies & point arrangement, mounting structures viz, furnitures, chambers, platforms, railings, cables etc. and as directed by the Engineer-in -charge				
	a) AT Pump House locations	27	nos.	68400	1846800
	b) At ESR	18	nos.	68400	1231200
	c) At Central Location Control Room.	1	nos.	171000	171000
	SUBTOTAL	**46**	**nos.**		**3249000**

20	Supply, delivery, erection, installation, testing and commissioning of ***Air conditioning***unit for Central control Room with all accessories consisting of 2 ton capacity, sized to maintain a temperature of 24 + 1 degree Celsius, 50 % relative humidity inside at all time, energy efficient. It shall be constructed with the strength and rigidity adequate for normal conditions of handling, transport and usage. All power point and mounting structures viz, furnitures, cabinets platforms, railings, cables etc. complete shall be provided and as directed by Engineer-in - charge				
	At Central Location Control Room.	1	nos.	76950	76950
	SUBTOTAL	**1**			**76950**
21	**Providing and laying in position all specials**				
	Providing and laying in position following cast iron flanged spigot (tail piece)				
	Dia (mm)				
	50	0	Each	575	0
	80	0	Each	897	0
	100	2	Each	1049	2098
	125	0	Each	1372	0
	150	1	Each	1695	1695
	200	5	Each	2823	14116
	250	0	Each	3792	0
	300	5	Each	4840	24202
	350	0	Each	6576	0
	400	6	Each	7960	47762
	450	0	Each	9431	0
	500	27	Each	11248	303700
	600	1	Each	17391	17391
	700	2	Each	22583	45165
	750	0	Each	25612	0
	SUBTOTAL	**49**			**456129**
	Providing and laying in position following cast iron double flanged tapers (all size in mm) body X Branch				
	75 X 50	0	Each	460	0
	80 X 50	0	Each	575	0

	100 X 80	0	Each	919	0
	125 X 80	0	Each	1503	0
	125 X 100	0	Each	1671	0
	150 X 80	0	Each	1754	0
	150 X 100	0	Each	1921	0
	150 X 125	0	Each	2088	0
	200 X 100	0	Each	2422	0
	200 X 125	0	Each	2589	0
	200 X 150	2	Each	2840	5680
	250 X 150	0	Each	3174	0
	250 X 150	0	Each	3341	0
	250 X 200	2	Each	3842	7684
	300 X 150	0	Each	3926	0
	300 X 200	8	Each	4427	35415
	300 X 250	0	Each	5012	0
	350 X 200	0	Each	6599	0
	350 X 250	0	Each	7267	0
	350 X 300	6	Each	8019	48112
	400 X 250	0	Each	8186	0
	400 X 300	4	Each	10056	40224
	400 X 350	0	Each	9940	0
	450 X 300	0	Each	9773	0
	450 X 350	0	Each	10942	0
	450 X 400	0	Each	11944	0
	500 X 350	0	Each	12028	0
	500 X 400	10	Each	13114	131137
	500 X 450	0	Each	14033	0
	600 X 400	2	Each	15870	31740
	600 X 450	0	Each	16705	0
	600 X 500	54	Each	18042	974259
	700 X 500	0	Each	21216	0
	700 X 600	0	Each	23972	0
	750 X 600	0	Each	25559	0
	750 X 700	0	Each	27898	0
	800 X 600	2	Each	28733	57467
	800 X 700	0	Each	31072	0
	800 X 750	0	Each	32408	0
	900 X 700	2	Each	34664	69327
	900 X 750	0	Each	36167	0
	900 X 800	2	Each	38506	77012

	1000 X 800	2	Each	43267	86534
	1200 X 900	2	Each	46775	93550
	SUBTOTAL	**98**			**1658142**
	Providing and Laying in Position Cast Iron Blank Flanges [Conform to IS 1538]				
	mm dia				
	80	0	Each	351	0
	100	0	Each	421	0
	125	0	Each	561	0
	150	4	Each	772	3088
	200	2	Each	1122	2244
	250	2	Each	1614	3228
	300	8	Each	2245	17960
	350	8	Each	3235	25880
	400	2	Each	4138	8276
	450	0	Each	5041	0
	500	10	Each	6395	63950
	600	56	Each	9480	530880
	700	0	Each	13317	0
	750	0	Each	15575	0
	800	2	Each	18434	36868
	900	2	Each	23550	47100
	1000	2	Each	30547	61094
	SUBTOTAL	**98**			**800568**
	Labour for laying in position following cast iron blank flanges (all sizes in mm)				
	80 mm dia	0	Each	404	0
	100 mm dia	0	Each	484	0
	125 mm dia	0	Each	645	0
	150mm dia	4	Each	888	3551
	200 mm dia	2	Each	1290	2581
	250 mm dia	2	Each	1856	3712
	300 mm dia	8	Each	2582	20654
	350 mm dia	8	Each	3720	29762
	400 mm dia	2	Each	4759	9517
	450 mm dia	0	Each	5797	0
	500 mm dia	10	Each	7354	73543
	600 mm dia	56	Each	10902	610512
	700 mm dia	0	Each	15315	0

	750 mm dia	0	Each	17911	0
	800 mm dia	2	Each	21199	42398
	900 mm dia	4	Each	27083	108330
	SUBTOTAL	**98**			**904560**
22	**Operation & Maintenance contract for 5 years**	**5**	per Year	**17890000**	**89450000**
	Capital Cost (Rs.)				**110305374**
	Total O&M Cost (Rs.)				**89450000**
	Total Project Cost				**199755374**
	Total Project Cost (Rs. Crores)				**19.98**

13.2 Bill Of Quantites Of Hsc & Road Restoration

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
1	UP PWD DSR 2015-16 item No. 1 Pg. No. 16	Excacation in foundation in ordinary soil (Loam, Clay or Sand) including lift upto 1.50 and lead upto 30 m and including filling watering and ramming of excavated earth into the trenches or into the space between the building and the sides of foundation trenches or into the plinth and removal and disposal of surplus earth as directed by the Engineer -in-charge upto a distance of 30m from the foundation trenches. (Rate including Royalty of earth also).									
		in soft soil	item no-3								
		15 mm dia.	931000	50%	465500	0.5	0.75	174562.5	Cum		
		20 mm dia.	4750	50%	2375	0.5	0.75	890.625	Cum		
		25 mm dia.	4750	50%	2375	0.5	0.75	890.625	Cum		
		40 mm dia.	9500	50%	4750	0.5	0.75	1781.25	Cum		
							Total	**178125**	**Cum**	120	**21375000**

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
2	E&M CSR 2016-17 Item No.WM-1 (a) Pg. No.83 (For Rate Plz. Refer pg. No. 19)	Supply & Installation of Domestic Water Meters of inferential type, multijet, magnetically coupled, having dry dial, straight reading Class B conforming to is : 779/1994, ISO and EECapproved, including transportation to site, storage, safety, installation, testing, commissioning, making connections with existing pipeline, including excavation at site, dewatering andreinstating the same after completion of installation as per specifications including all			Prop OHT-33						
2.1		15 mm dia.			190000	98.0%	186200	186200	Nos.	2096.00	390275200
2.2		20 mm dia.			190000	0.50%	950	950	Nos.	2560.00	2432000
2.3		25 mm dia.			190000	0.50%	950	950	Nos.	4362.00	4143900
2.4		40 mm dia.			190000	1.00%	1900	1900	Nos.	8159.00	15502100
						100.00%	190000	190000			
3	MJP CSR 2016-17 Item No.1 Pg. No. 121 (For Rate	Providing and supplying Blue MDPE pipes conforming to ISO 4427:1996 manufactured from virgin resin PE 80 Food grade compounded Raw Material having Blue Colour only with quality assurance certificate from			5mtr MDPE pipe consider for Each House service connection						

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
	Plz. Refer pg. No. 21)	quality agencies like WRC/CIPET (India)/DVGM/KIWA/SPGN etc. for usage in Drinking Water System. The cost shall include testing of all materials, all taxes Central, State, Municipal, Inspection charges, transportation upto site, transit insurance, loading, unloading, stacking etc. complete PN 1.6 (SDR 9)									
						5mtr					
3.1		20 mm dia Medium class			186200	5		931000	Mtr.	23	21413000
3.2		25 mm dia Medium class			950	5		4750	Mtr.	31	147250
3.3		32 mm dia. Medium class			950	5		4750	Mtr.	52	247000
3.4		40 mm dia. Medium class			1900	5		9500	Mtr.	76	722000
4	MJP CSR 2016-17 Item No.2 (H) Pg. No. 126-127 (For Rate Plz. Refer pg. No. 22-24)	Providing and supply of ElectroFusion Tapping Ferrule (Branch Tapping Saddle) female BSP Threaded with SS 304 insert fittings in accordance with BS EN 12201 : Part-3 suitable for drinking water with in black/blue colour manufactured from compounded PE80/PE 100 virgin polymer and compatible with PE80/PE100 pipes, in pressure rating SDR 11 with min PN 12.5 rated for			Proposed & existing Pipe length in project area						

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
		water application and shall be inclusive of all cost such as testing, all taxes related to central, state,& municipal, inspection charges, transportation up to site, transitinsurance, loading, unloading, stacking etc. complete									
		Total pipe length HDPE	110		16432	41					
		Total pipe length HDPE	160		9133	23					
		Total pipe length HDPE	200		2743	7					
		Total pipe length C.I /D.I	100		8895	22					
		Total pipe length C.I /D.I	150		1003	3					
		Total pipe length C.I /D.I	200		1894	5					
					40100	101					
					Total connection	%					
4.1		110x 20 mm			190000	39		74088	Nos	643	47638584
4.2		160x 20 mm			190000	19		36100	Nos	643	23212300
4.3		200x 20 mm			190000	16		30400	Nos	908	27603200
4.4		160x25 mm				6		6	Nos	643	3858
4.5		200x 25 mm				6		6	Nos	908	5448
4.6		160x32 mm				3		3	Nos	643	1929
4.7		200x 32 mm				3		3	Nos	908	2724
4.8		160x40 mm				3		3	Nos	910	2730
4.9		200x 40 mm				3		3	Nos	1309	3927
								140612			

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
5	Quotation (For Rate Plz. Refer pg. No. 26)	Providing and supply of Clamp saddle (DI Strap Saddle) for house Service connections from metal pipe water distribution mains shall be of fastened strap type with threaded outlet for service connection. Clamp saddle shall be suitable for nominal size of distribution mains pipeline									
					Total connection	%					
5.1		100 mm			190000	18		34188	Nos	436.05	14907677.4
5.2		150 mm			190000	3		5700	Nos	780.3	4447710
5.3		200 mm			190000	5		9500	Nos	929.48	8830060
						100	**Total**	**49388**	**Nos**		
								190000			
6	UP PWD DSR 2015-16 item No. 16 Pg. No. 53	Providing and fixing ball valve (brass) of approved quality, High or low pressure, with plastic floats complete.									
6.1		15 mm dia.	1		186200			186200	Nos.	270	50274000
6.2		20 mm dia.	1		1900			1900	Nos.	370	703000
6.3		25 mm dia.	1		1900			1900	Nos.	430	817000
7	qotation	Providing and Fixing HDPE meter box as per the detailed specification									
			1		190000			190000	Nos.	227.21	43169900

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
8	MJP CSR 2016-17 Item No.3 (A) Pg. No. 127-128 (For Rate Plz. Refer pg. No. 24-25)	Providing & 8upply of Compression fittings, PN16 rated in conformation to 180 :14236-2000 and shall be tested as per 180 :3459, 180 :3501 & 18 0 :3503, suitable for drinking water & approved by WRA8, UKI KIWA etc , in food grad e ' polypropy lene and shall be inclusive of all cost such as testing, all taxes related to centra l, state & unlcipal, inspection charges, transportation up to site, transit insurance, loading, unloading, stacking etc. complete.			Plz refer item no -3						
	A)	compersion 90 deg. elbow									
8.1		20 mm	1		186200			186200	Nos.	111	20668200
8.2		25 mm	1		950			950	Nos.	132	125400
8.3		32 mm	1		950			950	Nos.	162	153900
8.4		40 mm	1		1900			1900	Nos.	265	503500
8.5	B)	metal inserted compression male threaded Adopter with SS304 material (MDPE to G.I/ MDPE)									
8.6		20 mm	1		186200			186200	Nos.	58	10799600
8.7		25 mm	1		950			950	Nos.	66	62700
8.8		32 mm	1		950			950	Nos.	85	80750

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
		40 mm	1		1900			1900	Nos.	156	296400
9	UP PWD DSR 2015-16 item No. 17 Pg. No. 54	Providing and fixing bass ferrule with C.I. mouth cover including boring and tapping the main.									
9.1		15 mm dia.	1		186200			186200	Nos.	210	39102000
9.2		20 mm dia.	1		1900			1900	Nos.	260	494000
9.3		25 mm dia.	1		1900			1900	Nos.	340	646000
10	UP PWD DSR 2015-16 item No. 10 Pg. No. 52	Providing and fixing G.I. Pipes complete with G.I. Fittings and clamps, including cutting and making good the walls etc.									
10.1		15 mm dia. medium duty (As stand pipe)	1		186200			186200	Rm	160	29792000
10.2		20 mm dia. medium duty (As stand pipe)	1		950			950	Rm	180	171000
10.3		32 mm dia. medium duty (As stand pipe)	1		950			950	Rm	290	275500
		40 mm dia. medium duty (As stand pipe)	1		1900			1900	Rm	360	684000
11	Indian	Installation of MDPE duct by Moling									

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
	Society for Trenchless Technology-2016 of Item No. 17) (For Rate Plz refer Pg. No.31)	method including making of entry and exist pits , all related civil works like excavation, shoring/strtting, maintaining the pits, backfilling the pits after pipe installation etc. and restoration of site after completion but excluding the cost of the MDPE pipe									
		in soft soil upto 50 MM	475000	30%	142500			142500	Rm	291	41467500
		Road restoration									
12	UP PWD DSR 2015-16 item No. 4 Pg. No. 40	Dismantling reinforcement cement concrete or reinforced brick work including stacking of dismantled materials as directed by Engineer-in-charge within a distance of 60 meters (200 feet)	475000	50%	237500	0.75	0.1	17812.5	cum	900	16031250
13	PWD CSR 2017-18 Item No. 2.27 MORTH 305 Pg. No. 16	Providing earth work in embankment with approved materials obtained from departmental land or other sources upto lead of 50m. including all lifts, laying in layers of 20cm. to 30cm. thickness breaking clods, dressing to the required lines, curves, grades and section, watering and	237500	60%	142500	0.75	0.3	32062.5	cum	113	3623062.5

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
		compaction with Power roller to achieve not less than 97 % of standard proctor density etc. complete									
14	PWD CSR 2017-18 Item No. 3.01, 3.02, 3.03 MORTH 401 Pg. No. 18	Constructing of granular sub base by providing coarse graded material, spreading in uniform layers with on prepared surface, mixing by mix in place method at OMC , and compacting with vibratory roller to achieve the desired density, complete in all respect and as per relevant clause of section 400									
					142500						
		i) for grading - I Material			33915	0.75	0.15	3815	cum	1416	5402040
		ii) for grading - II Material			8122.5	0.75	0.1	609	cum	1429	870261
		iii) for grading - III Material			12212.25	0.75	0.075	686.9	cum	1429	981580.1
					0.1						
15	PWD CSR 2017-18 Item No. 3.29 MORTH 502 Pg. No. 17	Prime coat - Providing and applying primer coat with bitumen emulsion on prepared surface of granular Base including cleaning of road surface and spraying, primer at the rate of 0.60 kg/sqm using mechanical means.	142500	10%	14250	0.75		10688	sqm	17	181696
16	PWD CSR 2017-18	Providing and applying tack coat with bitumen emulsion (RS1) using	142500	10%	14250	0.75		10688	sqm	6	64128

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
	Item No. 3.34 MORTH 503 Pg. No. 17	emulsion pressure distributer at the rate of 0.20 kg per Sq.M. on the prepared bituminous cleaned with mechanical broom									
17	PWD CSR 2017-18 Item No. 3.51 MORTH 507 Pg. No. 21	BITUMINOUS CONCRETE:--Providing and laying bituminous concrete using crushed aggregate of grading 2, premixed with bituminous binder @5.4% by weight of total mix and filler, transported at site with VTS, laid over a previously prepared surface, finished to the required grade ,level, alignment, and rolling to achieve the desired density for 30/40 mm compacted thickness with drum mix plant with SCADA, Sensor paver and Vibratory roller excluding prime/Tack coat etc. complete --Bitumen VG-30 grade with stone dust filler			14250	0.75	0.04	428	cum	5940	2542320
18	PWD CSR 2017-18 Item No. 4.01 MORTH 511 Pg. No. 21	Providing bituminous Type A liquid seal coat on bituminous surface including supplying all materials and bitumen of VG-30 grade preparing existing road surface, heating and applying bitumen @ 0.98 KgSqm. by			14250	0.75	0.02	214	cum	33	7062

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
		mechanical means, spreading chips and rolling, by static roller having weight 8 to 10 MT. etc. complete.									
19	PWD CSR 2017-18 Item No. 5.13 MORTH 601 Pg. No. 27	Construction of dry lean cement concrete Sub- base over a prepared sub-grade with coarse and fine aggregate conforming to IS: 383, the size of coarse aggregate not exceeding 25 mm, , cement content not to be less than 150 kg/ cum, optimum moisture content to be determined during trial length construction, concrete strength not to be less than 10 Mpa at 7 days, mixed in a batching plant/ Weigh batch mixer, transported to site with all leads and lifts, laid with a paver with electronic sensor /by suitable means as approved by Engineer-incharge , compacting with vibratory roller, finishing, curing and including preparation of sub-grade surface if required etc. complete.	142500	90%	128250	0.75	0.100	9619	cum	2470	23758930
20	PWD CSR 2017-18 Item No.	Providing and laying in situ cement concrete M -30 with tremix treatment for 200 mm thickness for	142500	90%	128250	0.7	0.200	17955	cum	5870	105395850

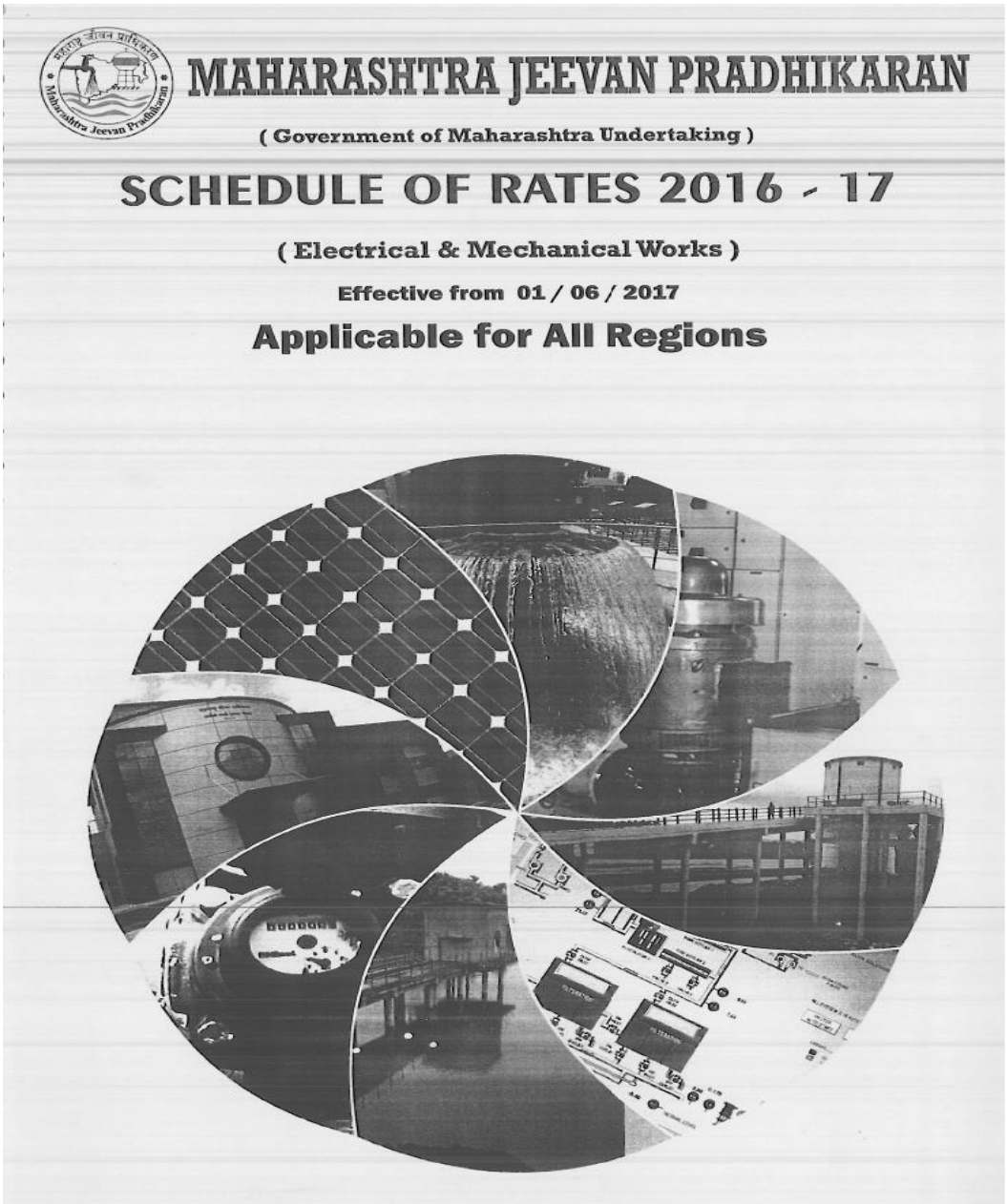
Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
	5.22 MORTH 602 Pg. No. 29	Concrete Road is including laying plastic sheet for 125 micron thickness with groove cutting of 4 mm wide and 20 mm deep with necessary refilling with bitumen (excluding reinforcement) with Natural sand etc. complete									
21	PWD CSR 2017-18 Item No. 5.03 MORTH 602 Pg. No. 24	Providing and laying in-situ M40 Grade unreinforced plain cement concrete pavement over a prepared sub base with 43 grade cement , coarse and fine aggregate conforming to IS 383, using fine and coarse aggregates combined gradation as per Table 600-3 of MORTH Specification 2013, mixed in a batching and mixing plant/ non tilting mixer and Weigh batcher as per approved mix design, admixtures, transporting to site, spreading, laying with approved make paver,compacted and finished in a continuous operation, finishing to lines and grades as directed by Engineer-in-charge and curing by curing compound /by providing	142500	90%	128250	0.7	0.300	26933	cum	4885	131567705

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
		cement vata in cement Mortar 1:8 @0.6m X 0.6m centre to centre, admeasuring 80 mm at bottom and 40 mm at top with depth of 75mm and maintaining the same throughout curing period by anyother method approved by Engineer-incharge.									
22		Providing and laying mechanically mix cement with crushed stone aggregate excluding centering and shuttering (with 40 mm nominal size graded stone) M10	142500	90%	128250	0.7	0.400	35910	Cum	3529	126726390
23	PWD CSR 2017-18 Item No. 11.24 CD.14 Page.No. 167 Pg. No. 77	Providing selected hard murum filling including laying in layers of 15 to 20cmwith watering and compacting etc. complete.	237500	40%	95000	0.75	0.2	14250	Cum	276	3933000
24	PWD CSR 2017-18 Item No. 5.20 IRC-SP-63 Pg. No. 28	Providing and fixing factory made Hydraulically pressed Mechanically vibrated and compacted precast inter locking cement concrete paving blocks 80MM thick in M-40 grade of approved size and shape for City	237500	40%	95000	0.7		66500	Sqm	725	48212500

Sr. No.	SOR Reference	Item	Nos.	%	Length	Breadth	Height	Quantity	Unit	Rate (Rs.)	Amount (Rs.)
		streets, small /medium market roads,low volume roads, utility cuts on arterial roads etc. as specified and as per IS 15658:2006 including cost of all materials, manufacturing, curing, transportation of blocks to work site including loading, unloading and stacking as directed, laying paving blocks in position over prepared bed of natural sand / crushed sand of 50 mm thickness including necessary excavation in all stratas, spreading blindge of fine sand over the prepared bed, compacting blocks by plate vibrator etc. complete.									
25	PWD CSR 2017-18 Statement C-1	Carriage of material as by mechanical transport including loading and stacking etc. earth distance									
		For a lead upto 1 km	0	20%				0	Cum	69.24	0
		For a lead upto 2 km	0	20%				0	Cum	87.23	0
										Total	**1292501722**

14 RATE ANALYSIS

14.1 ELECTRICAL & MECHANICAL CSR



Code No	Description	Unit	2016-2017 Supply Rate Rs.	2016-2017 Erection Rate Rs.	2016-2017 Total Amount Rs.
	SECTION 19 - WM **[WATER METERS]**				
WM 1	**Mechanical Type Meters.**				
A)	**Domestic Meters**				
a)	**I S I mark as per IS 779/1994** Providing, installing and giving satisfactory field testing of Domestic water meter, horizontal inferential multijet type with magnetic drive and dry dial suitable for ambient 50° C Temperature duly sealed against tampering complete with couplings at both ends and conforming to class B as per IS 779/1994 (VI Revision) with ISI mark along with manufacturer's test certificate and guarantee certificate, including cost of all materials and labour.				
1	15 mm dia	No	865	156	1021
2	20 mm dia	No	1966	156	2122
3	25 mm dia	No	2787	156	2943
4	40 mm dia	No	6104	156	6260
b)	**Multijet meters** Providing, installing and giving satisfactory field testing of Domestic water meter, horizontal inferential multijet type with magnetic drive and dry dial suitable for ambient 50° C Temperature duly sealed against tampering complete with couplings at both ends and conforming to class B as per ISO 4064 along with manufacturer's test certificate and guarantee certificate, including cost of all materials and labour etc with OIML , MID certification for Abroad and FCRI for India including 36 months guarantee etc complete				
1	15 mm dia	No	1940	156	2096
2	20 mm dia	No	2404	156	2560
3	25 mm dia	No	4206	156	4362
4	40 mm dia	No	8003	156	8159
c)	**AMR Meters** Providing, installing and giving satisfactory field testing of domestic multijet mechanical AMR water meters horizontal inferencial with magnetic drive and dry dial suitable for ambient 50°C temperature duly sealed against tampering complete with coupling at both ends and conforming to ISO 4064 with GSM / radio frequency (RF) for communication to server via transreceiver alongwith Hand held Device and PC software etc complete with EEC / OIML MID certification for Abroad meter and FCRI for India including 36 months guarantee etc complete.				
1	15 mm dia	No	7751	593	8344
2	20 mm dia	No	8871	678	9549

14.2 MJP CSR 2016-17

Section - I (X) M.D.P.E. Pipes				
Item	Description of works	Unit	2016-17	2017-18
1	Providing and Supplying Blue MDPE pipes conforming to ISO 4427:1996 manufactured from virgin resin PE 80 Food grade compounded Raw Material having Blue Colour only with quality assurance certificate from quality agencies like WRC / CIPET (India) / DVGM / KIWA / SPGN etc. for usage in Drinking Water system The cost shall include testing of all materials,including all statutary duties and taxes such as GST levied by GOI and GOM in all respect,, Inspection charges, transportation up to site, transit insurance, loading, as specified and directed.unloading, stacking etc. complete as specified and directed			With GST
A)	**PN16 (SDR 9)**			
	20mm	Rmt	23.00	
	25mm	Rmt	31.00	
	32mm	Rmt	52.00	
	40mm	Rmt	76.00	
	50mm	Rmt	115.00	
	63mm	Rmt	170.00	
	75mm	Rmt	229.00	
	90mm	Rmt	331.00	
	110mm	Rmt	491.00	
	125mm	Rmt	634.00	
	140mm	Rmt	797.00	
	160mm	Rmt	1056.00	
	180mm	Rmt	1337.00	
	200mm	Rmt	1653.00	
	225mm	Rmt	2093.00	
	250mm	Rmt	2575.00	
	280mm	Rmt	3236.00	
	315mm	Rmt	4162.00	
B)	**PN 12.5 (SDR 11)**			
	25mm	Rmt	29.00	
	32mm	Rmt	49.00	
	40mm	Rmt	72.00	
	50mm	Rmt	102.00	
	63mm	Rmt	137.00	
	75mm	Rmt	191.00	
	90mm	Rmt	277.00	
	110mm	Rmt	408.00	

Item	Description of works	Unit	DSR 16-17	DSR 17-18
E)	**PN6(SDR 21)**			
	50mm	Rmt		
	63mm	Rmt	72.00	
	75mm	Rmt	106.00	
	90mm	Rmt	148.00	
	110mm	Rmt	225.00	
	125mm	Rmt	284.00	
	140mm	Rmt	359.00	
	160mm	Rmt	468.00	
	180mm	Rmt	585.00	
	200mm	Rmt	729.00	
	225mm	Rmt	922.00	
	250mm	Rmt	1128.00	
	280mm	Rmt	1426.00	
	315mm	Rmt	1793.00	
2	Providing & Supply of Electro Fusion Fittings in accordance with BS EN12201;Part-3 suitable for drinking water with in black/ blue colour manufactured from compounded PE80/ PE100 virgin polymer and compatible with PE80/PE100 pipes, in pressure rating SDR11 with min PN12.5 rated for water application and shall be inclusive of all cost such as testing,of all material including all statutary duties and taxes such as GST levied by GOI and GOM in all respect, inspection charges, transportation up to site, transit insurance loading, unloading, stacking etc. complete. as specified and directed			
A)	**Coupelers**			
i)	Couplers 20	No.	85.00	
ii)	Couplers 25	No.	85.00	
iii)	Couplers 32	No.	85.00	
iv)	Couplers 40	No.	147.00	
v)	Couplers 50	No.	184.00	
vi)	Couplers 63	No.	218.00	
vii)	Couplers 75	No.	370.00	
viii)	Couplers 90	No.	405.00	
ix)	Couplers 110	No.	564.00	
x)	Couplers 125	No.	574.00	
xi)	Couplers 140	No.	1229.00	
xii)	Couplers 160	No.	1334.00	

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Item	Description of works	Unit	2016-17	2017-18
G)	**End Cap**			
i)	End Cap 20	No.	34.00	
ii)	End Cap 25	No.	34.00	
iii)	End Cap 32	No.	47.00	
iv)	End Cap 40	No.	51.00	
v)	End Cap 50	No.	54.00	
vi)	End Cap 63	No.	71.00	
vii)	End Cap 75	No.	262.00	
viii)	End Cap 90	No.	298.00	
ix)	End Cap 110	No.	419.00	
x)	End Cap 125	No.	530.00	
xi)	End Cap 140	No.	868.00	
xii)	End Cap 160	No.	940.00	
xiii)	End Cap 180	No.	1030.00	
xiv)	End Cap 200	No.	1747.00	
xv)	End Cap 225	No.	3001.00	
xvi)	End Cap 250	No.	3868.00	
xvi)	End Cap 315	No.	6398.00	
H)	**Ferrule tapping tee**			
i)	Ferrule tapping tee 63 x 1/2"	No.	643.00	
ii)	Ferrule tapping tee 63 x 3/4"	No.	643.00	
iii)	Ferrule tapping tee 63 x 1"	No.	643.00	
iv)	Ferrule tapping tee 75 x 1/2"	No.	643.00	
v)	Ferrule tapping tee 75 x 3/4"	No.	643.00	
vi)	Ferrule tapping tee 75 x 1"	No.	643.00	
vii)	Ferrule tapping tee 90 x 1/2"	No.	643.00	
viii)	Ferrule tapping tee 90 x 3/4"	No.	634.00	
ix)	Ferrule tapping tee 90 x 1"	No.	634.00	
x)	Ferrule tapping tee 90 x 11/4"	No.	835.00	
xi)	Ferrule tapping tee 90 x 11/2"	No.	835.00	
xii)	Ferrule tapping tee 90 x 2"	No.	835.00	
xiii)	Ferrule tapping tee 110 x 1/2"	No.	643.00	
xiv)	Ferrule tapping tee 110 x 3/4"	No.	643.00	
xv)	Ferrule tapping tee 110 x 1"	No.	643.00	
xvi)	Ferrule tapping tee 110 x 11/4"	No.	835.00	
xvi)	Ferrule tapping tee 100 x 11/2"	No.	835.00	
xvii)	Ferrule tapping tee 110 x 2"	No.	835.00	

Item	Description of works	Unit	2016-17	2017-18
xviii)	Ferrule tapping tee 160 x 1/2"	No.	643.00	
xix)	Ferrule tapping tee 160 x 3/4"	No.	643.00	
xxi)	Ferrule tapping tee 160 x 1"	No.	643.00	
xxii)	Ferrule tapping tee 160 x 11/4"	No.	910.00	
xxiii)	Ferrule tapping tee 160 x 11/2"	No.	910.00	
xxiv)	Ferrule tapping tee 160 x 2"	No.	910.00	
xxv)	Ferrule tapping tee 200 x 1/2"	No.	908.00	
xxvi)	Ferrule tapping tee 200 x 3/4"	No.	908.00	
xxvii)	Ferrule tapping tee 200 x 1"	No.	908.00	
xxviii)	Ferrule tapping tee 200 x 11/4"	No.	1309.00	
xxix)	Ferrule tapping tee 200 x 11/2"	No.	1309.00	
xxx)	Ferrule tapping tee 200 x 2"	No.	1309.00	
xxxi)	Ferrule tapping tee 250 x 1/2"	No.	908.00	
xxxii)	Ferrule tapping tee 250 x 3/4"	No.	908.00	
xxxiii)	Ferrule tapping tee 250 x 1"	No.	908.00	
xxxiv)	Ferrule tapping tee 250 x 11/4"	No.	1309.00	
xxxv)	Ferrule tapping tee 250 x 11/2"	No.	1309.00	
xxxvi)	Ferrule tapping tee 250 x 2"	No.	1309.00	
xxxvii)	Ferrule tapping tee 315 x 1/2"	No.	1080.00	
xxxviii)	Ferrule tapping tee 315 x 3/4"	No.	1080.00	
xxxix)	Ferrule tapping tee 315 x 1"	No.	1080.00	
xxxx)	Ferrule tapping tee 315 x 11/4"	No.	1467.00	
xxxxi)	Ferrule tapping tee 315 x 11/2"	No.	1467.00	
xxxxii)	Ferrule tapping tee 315 x 2"	No.	1467.00	
	Providing & Supply of Compression fittings, PN16 rated in conformation to ISO:14236-2000 and shall be tested as per ISO:3459, ISO:3501 & ISO:3503, suitable for drinking water & approved by WRAS, UK/ KIWA etc, in food grade polypropylene and shall be inclusive of all cost such as testing, all taxes related to central, state & unicipal, inspection charges, transportation up to site, transit insurance, loading, unloading, stacking etc. complete.			
A	**Male Adaptor**			
i)	Male Adaptor 20x1/2"	No.	58.00	
ii)	Male Adaptor 25x3/4"	No.	66.00	
iii)	Male Adaptor 32x1"	No.	85.00	
iv)	Male Adaptor 40x1 1/4"	No.	156.00	
v)	Male Adaptor 50x1 1/2"	No.	205.00	
vi)	Male Adaptor 63x2"	No.	292.00	

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Item	Description of works	Unit	2016-17	2017-18
B	**Female Adaptor**			
i)	Female Adaptor 20x1/2"	No.	62.00	
ii)	Female Adaptor 25x3/4"	No.	73.00	
iii)	Female Adaptor 32x1"	No.	92.00	
iv)	Female Adaptor 40x1 1/4"	No.	172.00	
v)	Female Adaptor 50x1 1/2"	No.	220.00	
vi)	Female Adaptor 63x2"	No.	310.00	
C	**Coupling**			
i)	Coupling 20x20	No.	60.00	
ii)	Coupling 25x25	No.	65.00	
iii)	Coupling 32x32	No.	83.00	
iv)	Coupling 40x40	No.	159.00	
v)	Coupling 50x50	No.	204.00	
vi)	Coupling 63x63	No.	295.00	
D	**Reducing Coupling**			
i)	Reducing Coupling 25x20	No.	109.00	
ii)	Reducing Coupling 32x20	No.	144.00	
iii)	Reducing Coupling 32x25	No.	144.00	
iv)	Reducing Coupling 40x25	No.	246.00	
v)	Reducing Coupling 40x32	No.	246.00	
vi)	Reducing Coupling 50x32	No.	318.00	
vii)	Reducing Coupling 50x40	No.	318.00	
viii)	Reducing Coupling 63x50	No.	451.00	
E)	**90 Deg. Elbow**			
i)	90 Deg. Elbow 20	No.	111.00	
ii)	90 Deg. Elbow 25	No.	132.00	
iii)	90 Deg. Elbow 32	No.	162.00	
iv)	90 Deg. Elbow 40	No.	265.00	
v)	90 Deg. Elbow 50	No.	377.00	
vi)	90 Deg. Elbow 63	No.	510.00	
F)	**90 Deg. Elbow threaded male off take**			
i)	90 Deg. Elbow threaded male off take 20x1/2"	No.	66.00	
ii)	90 Deg. Elbow threaded male off take 25x3/4"	No.	81.00	
iii)	90 Deg. Elbow threaded male off take 32x1"	No.	105.00	
iv)	90 Deg. Elbow threaded male off take 40x11/4"	No.	167.00	
v)	90 Deg. Elbow threaded male off take 50x11/2"	No.	229.00	
vi)	90 Deg. Elbow threaded male off take 63x2"	No.	318.00	

Section - I (X) - M.D.P.E. Pipes 128

14.3 QUOTATION ANALYSIS FOR METER BOX AND DI STRAP SADDLE

Sr. No.	Description	Manufacturer Name		Lowest Rate Adopted
		M/s AIVA ENGINEERING PVT. LTD.	M/s Al-Aziz Plastics Pvt . Ltd.	
1	Providing, lowering, laying and fixing D.I saddle strap of following bore size and pipe diameter including all taxes(central, state and municipal), insurance, freight, loading, unloading, stacking, etc complete as directed by Engineer in Charge			
	a)	100 mm dia. pipe	546	436.05
	b)	150 mm dia. pipe	546	780.3
	c)	200 mm dia. pipe	616	929.48
2	Providing and fixing water meter box ,of HDPE material, including necessary excavation, cost of locking arrangement etc complete of suitable size for 15 to 40 mm dia..	259	227.21	227.21

aiva engineering pvt. ltd.
All Innovations for Versatile Applications

Office: 39/10, "Bahar"
Adarsh Nagar,
Market Yard Road,
Pune - 411037
Maharashtra, INDIA.

Telefax: +91-020-24267303
Mobile: +91 9561348868
+91 9422030302
Email: enquiry@aivaengineering.com
Website: www.aivaengineering.com

Budgetary Offer

Ref – Aiva/3/2015
Date : 4- October-15
Offer to : DRA Consultants Pvt. Ltd.,
Kind Attention : Mr Ritesh Rangari (AGM).

AIVA Engineering Pvt. Ltd. is one of the leading manufacturers of all the components related to House Service Connection. Our product range covers following products –

- Strap Saddles – In ductile Iron and in PP body – total having 5 variants
- Entire range of compression fittings in PP suitable for PP/ HDP/ UPV Pipes (15,20,25,32 & 40 mm)
- Ferrule in PP with SS (304) insert.
- "Y" Strainers in PP with SS (304) inserts (15,20,25,32 & 40 mm)
- Water Meter Enclosure/ Box in PP- heavy duty – duly certified for load testing.
- Surface Chamber in Cast-Iron
- Entire range of Electro-Fusion fittings.
- High Quality PP/ HDP Pipes.

We are glad to furnish the budgetary offer as per your requirement (Mail dated 1-october-2015)

Prices

DI Strap Saddle

Sr No	Description	Pipe Diameter	Qty	Rate /Piece in Rs	Total Rate in Rs
1	DI STRAP SADDLE FOR CI /DI PIPE, DIA 15mm(1/2")	100mm	35780	546	19535880
2	DI STRAP SADDLE FOR CI /DI PIPE, DIA 15mm(1/2")	150mm	100	546	54600
3	DI STRAP SADDLE FOR CI /DI PIPE, DIA 15mm(1/2")	200mm	100	616	61600
				Total	**19652080**

Water Meter Protection Box

Sr No	Description	Qty	Rate/Piece in Rs	Total Rate in Rs
1	Water Meter Protection Box - PP with positive Locking arrangement. **Dimension-278MM(L) X 232MM (W) X175 MM(H)**	35780	259	9267020

Terms & Conditions

1) Make / Brand – AIVA ENGINNERING PVT .LTD
2) Taxies & Duties – Inclusive in the price.
3) Payment Term – Agent's BG /LC with confirm P.O
4) Deliver – Within 6 to 8 week after the confirm P.O and BG/LC.
5) Packing & Forwarding – Included in the price.
6) LBT – extra as applicable ,
7) Fright /Transportation – Inclusive in price.
8) Quotation Validity – 30 /10/2015

You are kindly requested to review the quotation and revert back to us in case you need any clarification/ additional information and rest assured that AIVA team will respond back to it on top most priority.

Thanks and Regards
Sandeep Gharate/Vivek Shewale
7722075941 / 8380039256.

aiva engineering pvt. ltd.
All Innovations for Versatile Applications

e-mail | sales@aivaengineering.com

2 OF 2

Al-Aziz Group
envisioning energy affluent world

Al-Aziz Plastics Pvt. Ltd.
(An ISO 9001:2008 Company)
2-Nateline Industrial Estate, Andheri-Kurla Road,
Sakinaka, Andheri(E), Mumbai - 72
email : ashfak@alaziz.com, Phone : 022-28512590, 28510273

Date : 28.10.2015

AAPPL/PO/1516/129

To
DRA Consultants Pvt. Ltd.
Nagpur

Sub.: Price Offer for the Supply of Presto HSC Fittings for Pimpari-Chinchwad Water Supply System.

Kind Attn.: Mr. Hemant V Deo

Dear Sir
This is further to your mail, we are pleased to offer our most competitive Prices for the Supply of Presto HSC Fittings for Pimpari-Chinchwas Water Project.

Price Offer -DRA Consultants Pvt. Ltd. - Presto HSC Fittings - 28.10.2015						
Enquiry Reference : Your email dated 27.10.2015						
Product	**Size**	**Qty**	**Unit Price**	**Excise @ 12.50%**	**CST @2%**	**Price after Tax**
Strapon Saddle with SS Strip and PE for DI/CI Pipes	100x1/2"	35780	380.00	47.50	8.55	436.05
Strapon Saddle with SS Strip and PE for DI/CI Pipes	100x3/4"		420.00	52.50	9.45	481.95
Strapon Saddle with SS Strip and PE for DI/CI Pipes	150x1/2"	100	680.00	85.00	15.30	780.30
Strapon Saddle with SS Strip and PE for DI/CI Pipes	150x3/4"		710.00	88.75	15.98	814.73
Strapon Saddle with SS Strip and PE for DI/CI Pipes	200x1/2"	100	810.00	101.25	18.23	929.48
Strapon Saddle with SS Strip and PE for DI/CI Pipes	200x3/4"		840.00	105.00	18.90	963.90
Electro Fusion Coupler	110 mm	25	255.00	31.88	5.74	292.61
Electro Fusion End Cap	110 mm	42	340.00	42.50	7.65	390.15
Water Meter Enclosure	15-25	54	198.00	24.75	4.46	227.21
Water Meter Enclosure	32-40		430.00	53.75	9.68	493.43

Terms & Conditions
01. Above Prices are inclusive of Excise @ 12.50% & CST@2% against Form-C.
02. Excise Exemption is available against notification no. 108/95.
03. Transportation shall be on Buyer's Account.
04. Any other Govt. Tax, Entry Tax, Octroi if any, shall be on Buyer's Account.
05. Third Party Inspection Charges if any, shall be on buyer's Account.
06. Payment - 30 days from the invoice date. Delay in the payment shall attract interest as per bank rate from 31st Day.

Look Forward to receive your valuable order at your earliest.

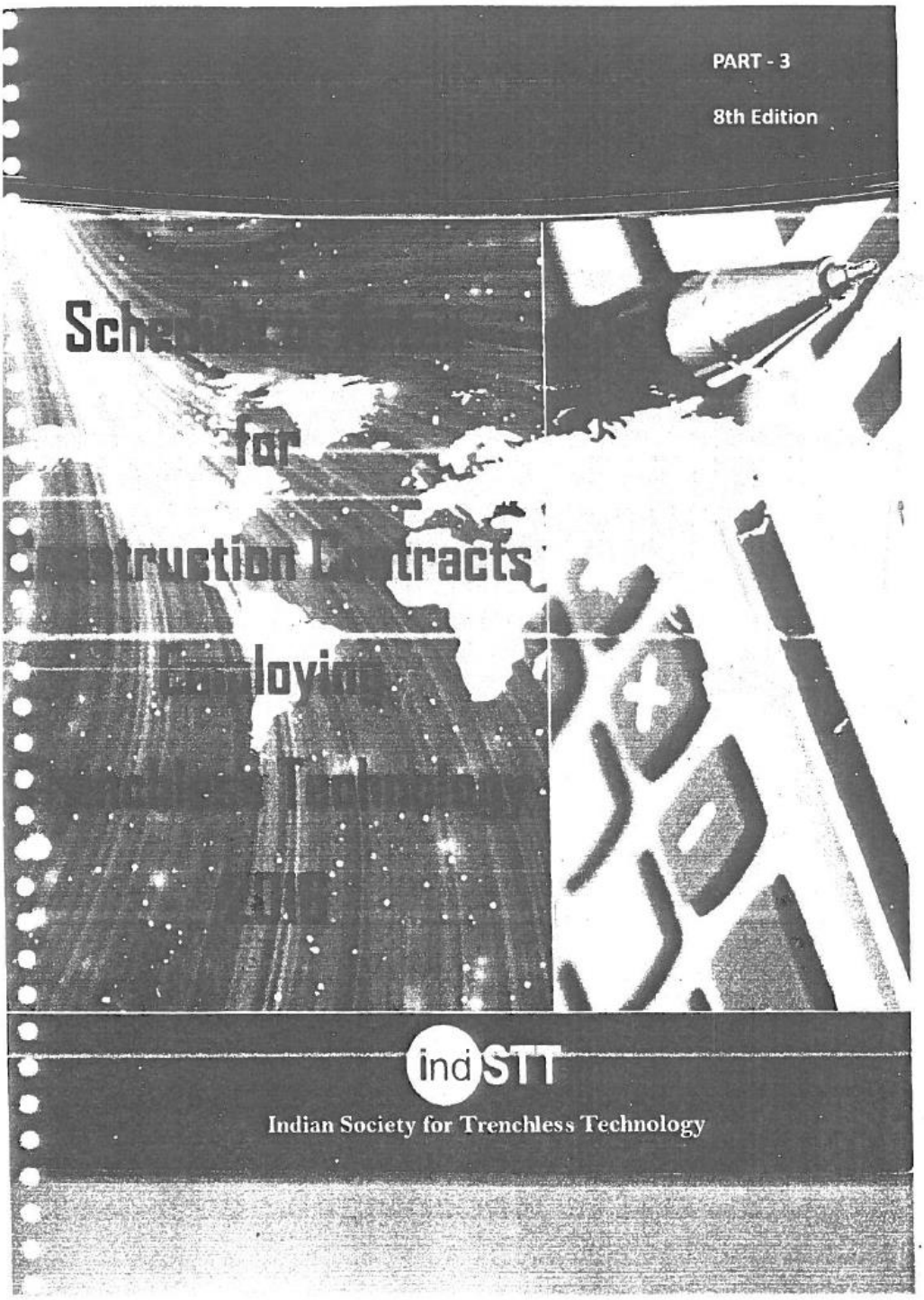
Thank You Sir.

Warm Regards,

Ashfak Sayed
Works Manager
Al-Aziz Plastics Pvt. Ltd.
9925944666

This is a computer generated document hence signature is not Required.

14.4 INDIAN SOCIETY OF TRENCHLESS TECHNOLOGY 2016



SECTION 2

New Installation Techniques

Sl. No.	Description	Unit	Rate
2	**New Installation Techniques**		
2.1	**Moling**		
2.1.1	**OFC Cable Moling**		
	Installation of OFC cable by Moling method including making of entry and exit pits, all related civil works like excavation, shoring/ strutting, maintaining the pits, backfilling the pits after pipe installation etc. and restoration of site after completion but excluding the cost of the OFC cable.		
2.1.1.1	For cables Upto 54 mm in Soft Soil	lm	242
2.1.1.2	For cables Upto 54 mm in Hard Soil	lm	258
2.1.1.3	For cables Upto 54 mm in Sandy Soil	lm	291
2.1.1.4	For cables Upto 54 mm in Stoney Soil	lm	307
2.1.1.5	For cables Upto 54 mm in Soft Rock	lm	323
2.1.1.6	For cables Upto 54 mm in Mixed Soil**	lm	387
2.1.2	**LDPE/MDPE Ducts** Installation of LDPE/MDPE duct by Moling method including making of entry and exit pits, all related civil works like excavation, shoring/strutting, maintaining the pits, backfilling the pits after pipe installation etc. and restoration of site after completion but excluding the cost of the Duct.		
2.1.2.1	For ducts Upto 54 mm in Soft Soil	lm	387
2.1.2.2	For ducts Upto 54 mm in Hard Soil	lm	460

14.5 QUOTATION ANALYSIS FOR CENTRAL MONITORING SYSTEM

RATE ANALYSIS						
INSTRUMENTATION FOR MONITORING SYSTEM		Basic Rate (Rs.)	GST @ 12%	Packaging and Forwarding @ 2%	Landed Cost	Total Unit Price
Item No.	Description of items					
1	Supply, delivery, installation, testing, training and commissioning of Pressure measuring instruments.	60000	7200	1200	68400	68400
2	Supply, delivery, installation, testing, training and commissioning of Temperature measuring system	7500	900	150	8550	8550
3	Supply, delivery, installation, testing, training and commissioning of level measurement systems.	75000	9000	1500	85500	85500
4	Supply, delivery, installation, testing, training and commissioning of Residual Chlorine measuring instruments.	307500	36900	6150	350550	350550
5	Supply, delivery, installation, testing, training and commissioning of Electromagnetic flow meter (EMF).					
	Dia 50 mm	18000	2160	450	20610	20610
	Dia 100 mm	60500	7260	1513	69273	69273
	Dia 150 mm	150000	18000	3750	171750	171750
	Dia 200 mm	199500	23940	4988	228428	228428
	Dia 300 mm	249700	29964	6243	285907	285907
	Dia 400 mm	300000	36000	7500	343500	343500
	Dia 450 mm	350000	42000	8750	400750	400750
	Dia 500 mm	525000	63000	13125	601125	601125
	Dia 600 mm	600000	72000	15000	687000	687000
	Dia 700 mm	700000	84000	17500	801500	801500

	Dia 900 mm	820000	98400	20500	938900	938900
	Dia 1000 mm	916000	109920	22900	1048820	1048820
	Dia 1200 mm	1105000	132600	27625	1265225	1265225
	Dia 1400 mm	2056560	246787	51414	2354761	2354761
	Dia 1500 mm	1475000	177000	36875	1688875	1688875
	Dia 1600 mm	2420280	290434	60507	2771221	2771221
6	Supply, delivery, installation, testing, training and commissioning of Turbidity meter.	250000	30000	5000	285000	285000
7	Supply, delivery, installation, testing, training and commissioning of pH measuring instruments.	283951	34074	5679	323704	323704
8	Supply, delivery, installation, testing, training and commissioning of RPM measuring instruments.					
	At Pump House	15000	1800	300	17100	17100
9	Supply, delivery, installation, testing, training and commissioning of Energy measuring (Power analyser) instruments.					
	a) At Pump House	16500	1980	330	18810	18810
10	Supply, delivery, erection, installation, testing and commissioning of all required communication interface, telemetry interfaces - RTUs/PLCs.					
	a)At Pump House/ ESR Locations	187500	22500	3750	213750	213750
	b)At Control Room	375000	45000	7500	427500	427500
11	Supply, delivery, erection, installation, testing and commissioning of Lightning / Surge protection system.	7500	900	150	8550	8550

12	Supply, delivery, erection, installation, testing and commissioning of Instrumentation Cable.					
	At all UGR/ GSR Locations, locations of Pump House & Central Location	143	17	3	163	163
13	Providing and constructing R.C.C. chambers 2mX2mX2.5m for field instruments of required size and depth in M-20 grade concrete.					
	At Pumping Station /UGR / GSR locations	50200			50200	50200
14	Supply, delivery, erection, installation, testing, training and commissioning of Wireless Radio Telemetry.					
	i) Wireless communication system based on RF technology including all liscence fees					
	A) At Central Location	375000	45000	7500	427500	427500
	B) At all other locations	187500	22500	3750	213750	213750
15	Providing Fabricated self supported triangular shape MS Tubular Tower.					
	a) Tower Height upto 5 meter (For Remote Location tappings)	156250	18750	3125	178125	178125
	b) Tower Height 10 to 15 meter (For Pump Houses)'	250000	30000	5000	285000	285000
	c) Tower Height 25 to 30 meter (At Control Room)	375000	45000	7500	427500	427500
16	a) Supply, delivery, erection, installation, testing, training and commissioning of Central Monitoring System.					
	At central location i.e. Control Room	750000	90000	15000	855000	855000
17	Supply, delivery, erection, installation, testing, and					

	commissioning of Central Server PC.					
	At central location i.e. Control Room	375000	45000	7500	427500	427500
18	Supply, delivery, erection, installation, testing, training and commissioning of PCs, Softwares, Keyboards, Printers etc.					
	At central location i.e. Control Room	787500	94500	15750	897750	897750
19	Supply, delivery, erection, testing and commissioning of Uninterrupted Power Supply system for 240 V AC 50 Hz.					
	a) AT Pump House locations	60000	7200	1200	68400	68400
	b) At ESR	60000	7200	1200	68400	68400
	c) At Central Location Control Room.	150000	18000	3000	171000	171000
20	Supply, delivery, erection, installation, testing and commissioning of Air conditioning unit for Central control Room with all accessories.					
	a) AT Pump locations	67500	8100	1350	76950	76950
	b) At Central Location Control Room .	67500	8100	1350	76950	76950
21	**Providing and laying in position all specials**					
21a	**Providing and laying in position following cast iron flanged spigot (tail piece)**		Add 15% on SOR Rate			
	mm dia					
	50 mm dia	500	75		575	575
	80 mm dia	779.64	117		897	897
	100 mm dia	912	137		1049	1049
	125 mm dia	1193	179		1372	1372
	150 mm dia	1474	221		1695	1695
	200 mm dia	2455	368		2823	2823
	250 mm dia	3297	495		3792	3792

	300 mm dia	4209	631		4840	4840
	350 mm dia	5718	858		6576	6576
	400 mm dia	6922	1038		7960	7960
	450 mm dia	8201	1230		9431	9431
	500 mm dia	9781	1467		11248	11248
	600 mm dia	15123	2268		17391	17391
	700 mm dia	19637	2946		22583	22583
	750 mm dia	22271	3341		25612	25612
21b	**Providing and laying in position following cast iron double flanged tapers (all size in mm) body X Branch**					
	75 X 50	400	60		460	460
	80 X 50	500	75		575	575
	100 X 80	798.95	120		919	919
	125 X 80	1307.38	196		1503	1503
	125 X 100	1452.64	218		1671	1671
	150 X 80	1525.28	229		1754	1754
	150 X 100	1670.54	251		1921	1921
	150 X 125	1815.8	272		2088	2088
	200 X 100	2106.33	316		2422	2422
	200 X 125	2251.6	338		2589	2589
	200 X 150	2469.49	370		2840	2840
	250 X 150	2760.02	414		3174	3174
	250 X 150	2905.29	436		3341	3341
	250 X 200	3341.08	501		3842	3842
	300 X 150	3413.71	512		3926	3926
	300 X 200	3849.51	577		4427	4427
	300 X 250	4357.93	654		5012	5012
	350 X 200	5737.94	861		6599	6599
	350 X 250	6319	948		7267	7267
	350 X 300	6972.69	1046		8019	8019
	400 X 250	7117.95	1068		8186	8186
	400 X 300	8744.27	1312		10056	10056
	400 X 350	8643.23	1296		9940	9940
	450 X 300	8497.96	1275		9773	9773
	450 X 350	9514.81	1427		10942	10942
	450 X 400	10386.4	1558		11944	11944
	500 X 350	10459.03	1569		12028	12028

	500 X 400	11403.25	1710		13114	13114
	500 X 450	12202.21	1830		14033	14033
	600 X 400	13800.11	2070		15870	15870
	600 X 450	14526.44	2179		16705	16705
	600 X 500	15688.55	2353		18042	18042
	700 X 500	18448.57	2767		21216	21216
	700 X 600	20845.43	3127		23972	23972
	750 X 600	22225.45	3334		25559	25559
	750 X 700	24259.15	3639		27898	27898
	800 X 600	24985.47	3748		28733	28733
	800 X 700	27019.17	4053		31072	31072
	800 X 750	28181.28	4227		32408	32408
	900 X 700	30142.35	4521		34664	34664
	900 X 750	31449.73	4717		36167	36167
	900 X 800	33483.43	5023		38506	38506
	1000 X 800	37623.47	5644		43267	43267
	1000 X 900	40674.02	6101		46775	46775
21c	**Providing and Laying in Position Cast Iron Blank Flanges [Conform to IS 1538]**					
	150	671.30	101		772	772
	200	975.65	146		1122	1122
	250	1403.48	211		1614	1614
	300	1952.17	293		2245	2245
	350	2813.04	422		3235	3235
	400	3598.26	540		4138	4138
	500	5560.87	834		6395	6395
	600	8243.48	1237		9480	9480
	800	16029.57	2404		18434	18434
	900	20478.26	3072		23550	23550
	1000	26562.61	3984		30547	30547
21d	**Labour for laying in position following cast iron blank flanges (all sizes in mm)**					
	80 mm dia	351	53		404	404
	100 mm dia	421	63		484	484

	125 mm dia	561	84		645	645
	150mm dia	772	116		888	888
	200 mm dia	1122	168		1290	1290
	250 mm dia	1614	242		1856	1856
	300 mm dia	2245	337		2582	2582
	350 mm dia	3235	485		3720	3720
	400 mm dia	4138	621		4759	4759
	450 mm dia	5041	756		5797	5797
	500 mm dia	6395	959		7354	7354
	600 mm dia	9480	1422		10902	10902
	700 mm dia	13317	1998		15315	15315
	750 mm dia	15575	2336		17911	17911
	800 mm dia	18434	2765		21199	21199
	900 mm dia	23550	3533		27083	27083
	OPERATION AND MAINTENANCE FOR CMS	Basic Rate (Rs.)	GST @ 12%		Landed Cost	Total Unit Price
35	Operation & Maintenance contract for 5 years (Inclusive of Manpower cost and Equipment maintenance cost)					
	Per Year O&M Cost (CMS)	7000000	840000		7840000	7840000
	Per Year Manpower Cost					10050000

RATE COMPARISON SHEET					
INSTRUMENTATION FOR AGRA MUNICIPAL CORPORATION					**Lowest Rate**
Item No.	Description of items	Unit	**Rate Quoted by Sharp Control**	**Rate Quoted by Sai Technologies**	
			Rate (Rs)	**Rate (Rs)**	**Rate (Rs)**
1	Supply, delivery, installation, testing, training and commissioning of **Pressure measuring instruments**	Each Set	60000	67500	60000
2	Supply, delivery, installation, testing, training and commissioning of **Temperature measurement systems**.	Each Set	-	7500	7500

3	Supply, delivery, installation, testing, training and commissioning of **level measurement systems**.	Each Set	75000	157500	75000
4	Supply, delivery, installation, testing, training and commissioning of **Residual Chlorine measuring instruments**.	Each Set	400000	307500	307500
5	Supply, delivery, installation, testing, training and commissioning of Electromagnetic flow meter (EMF).				
	Electromagnetic flow meter		**Rate Quoted by Sharp Control**	**Rate Quoted by Sai Technologies**	**Rate Quoted by Krohne Marshall**
	Dia 50 mm	Each Set	18000	-	120000
	Dia 100 mm	Each Set	60500	-	160000
	Dia 150 mm	Each Set	200000	150000	171860
	Dia 200 mm	Each Set	225000	217500	199500
	Dia 300 mm	Each Set	250000	270000	249700
	Dia 400 mm	Each Set	300000	390000	399600
	Dia 450 mm	Each Set	350000	444000	471700
	Dia 500 mm	Each Set	525000	525000	565700
	Dia 600 mm	Each Set	600000	630000	689000
	Dia 700 mm	Each Set	700000	765000	744120
	Dia 900 mm	Each Set	-	820000	1096620
	Dia 1000 mm	Each Set	-	916000	1191180
	Dia 1200 mm	Each Set	-	1105000	1293660
	Dia 1400 mm	Each Set	-	-	2056560
	Dia 1500 mm	Each Set	-	1475000	2225000
	Dia 1600 mm	Each Set	-	-	2420280
6	Supply, delivery, installation, testing, training and commissioning of **Turbidity**	Each Set		250000	250000

	meter.				
					Endress Hauser
7	Supply, delivery, installation, testing, training and commissioning of **pH measuring instruments.**	Each Set			283951
8	Supply, delivery, installation, testing, training and commissioning of **RPM measuring instruments.**	Each Set	15000	52500	15000
9	Supply, delivery, installation, testing, training and commissioning of **Energy measuring (Power analyser) instruments.**	Each Set	25000	16500	16500
10	Supply, delivery, erection, installation, testing and commissioning of all required *communication interface*, SCADA interfaces, telemetry interfaces - **RTUs / PLC**				
	a) At Pump House/ UGR Locations	Each Set	187500	N/A	187500
	b) At Control Room	Each Set	375000	N/A	375000
11	Supply, delivery, erection, installation, testing and commissioning of **Lighting / Surge protection.**	Each Set	7500	10500	7500
12	Supply, delivery, erection, installation, testing and commissioning of **Instrumentation Cable.**	meter	157	143	143
13	Providing and constructing **R.C.C. chambers.**	Per M^3	50200.00	N/A	50200
14	Supply, delivery, erection,				

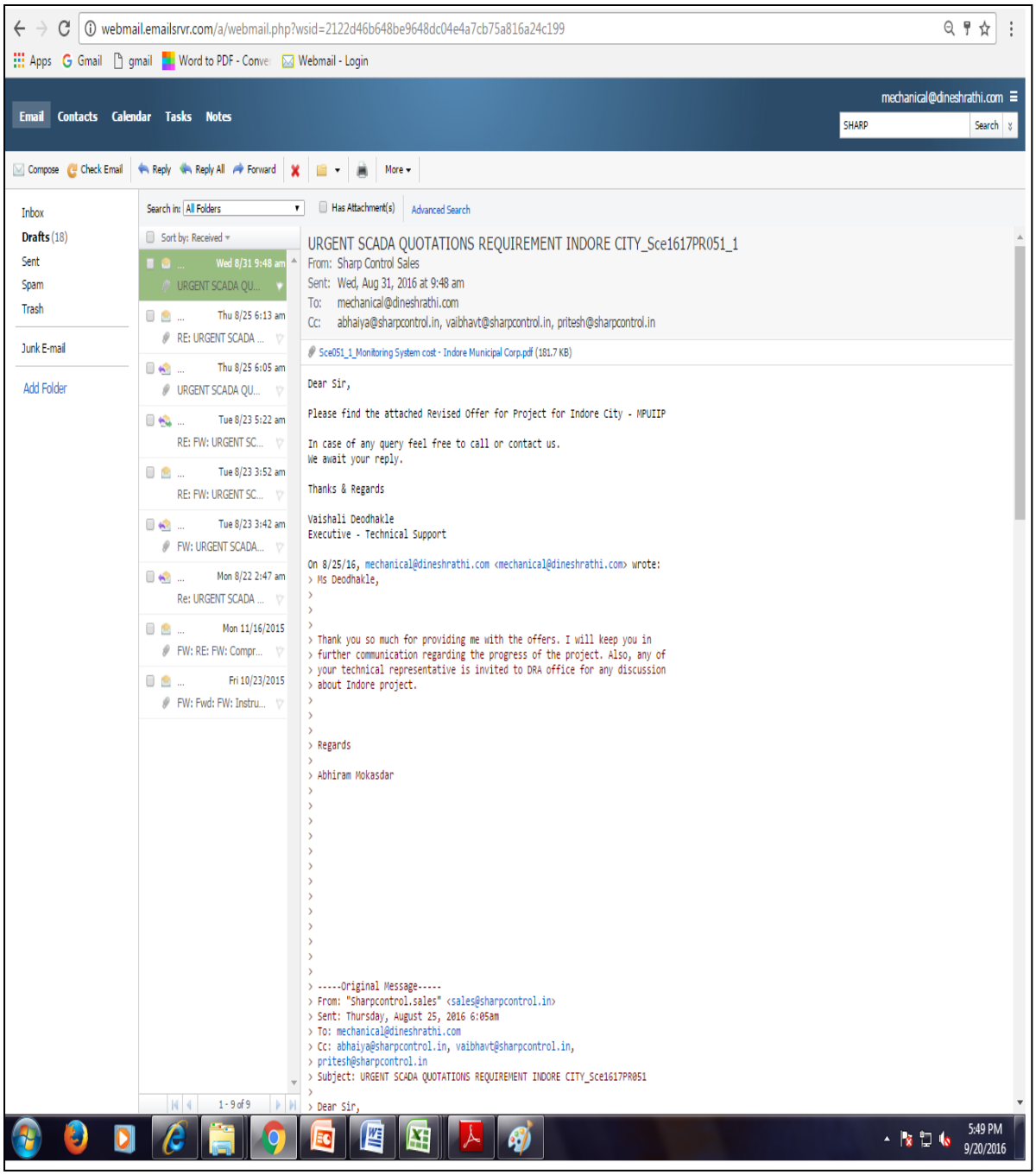
	installation, testing, training and **commissioning of *Wireless Radio Telemetry* or GPRS.**				
	i) Wireless communication system based on RF technology including all liscence fees				
	A) At Central Location	nos.	375000	N/A	375000
	B) At ESR, GSR and UGR /Direct Tapping	nos.	187500	N/A	187500
15	ii) Providing Fabricated self supported triangular shape **MS tubular Tower**.				
	a) Tower Height upto 5 meter (For Remote Location tappings)	nos.	156250	N/A	156250
	b) Tower Height 10 to 15 meter (For Pump Houses)'	nos.	250000	N/A	250000
	c) Tower Height 25 to 30 meter (At Control Room)	nos.	375000	N/A	375000
16	Supply, delivery, erection, installation, testing, training and commissioning of **Central Monitoring System.**	system	750000	1387500	750000
17	Supply, delivery, erection, installation, testing, and commissioning of **Central Server PC.**	System	500000	375000	375000
18	Supply, delivery, erection, installation, testing, training and commissioning of **PCs, Softwares, Keyboards, Printers etc**	Each Set	1250000	787500	787500
19	Supply, delivery, erection, testing and commissioning of ***Uninterrupted Power Supply system***.				
	a) At UGR/ GSR locations	nos.	60000	110000	60000
	b) At Central Location Control Room .	nos.	200000	150000	150000

20	Supply, delivery, erection, installation, testing and commissioning of **Air conditioning**.	Each Set	75000	67500	67500
	Size (mm)		**Rate (Rs)**	**Rate (Rs)**	**Rate (Rs)**
21a	**Providing and laying in position following cast iron flanged spigot (tail piece)**	**Unit**	**Rate (Rs)**		
	50 mm dia	Each	500.00		500
	80 mm dia	Each	842.00		842
	100 mm dia	Each	912.00		912
	125 mm dia	Each	1193.00		1193
	150 mm dia	Each	1474.00		1474
	200 mm dia	Each	2455.00		2455
	250 mm dia	Each	3297.00		3297
	300 mm dia	Each	4209.00		4209
	350 mm dia	Each	5718.00		5718
	400 mm dia	Each	6922.00		6922
	450 mm dia	Each	8201.00		8201
	500 mm dia	Each	9781.00		9781
	600 mm dia	Each	15123.00		15123
	700 mm dia	Each	19637.00		19637
	750 mm dia	Each	22271.00		22271
21b	**Providing and laying in position following cast iron double flanged tapers (all size in mm) body X Branch**	**Unit**	**Rate (Rs)**		
	75 x 50	Each	400.00		400
	80 x 50	Each	500.00		500
	100 x 80	Each	798.95		798.95
	125 x 80	Each	1307.38		1307.38
	x 100	Each	1452.64		1452.64
	150 x 80	Each	1525.28		1525.28
	x 100	Each	1670.54		1670.54
	x 125	Each	1815.80		1815.8
	200 x 100	Each	2106.33		2106.33
	x 125	Each	2251.60		2251.6
	x 150	Each	2469.49		2469.49
	250 x 150	Each	2760.02		2760.02

	x 150	Each	2905.29		2905.29
	x 200	Each	3341.08		3341.08
	300 x 150	Each	3413.71		3413.71
	x 200	Each	3849.51		3849.51
	x 250	Each	4357.93		4357.93
	350 x 200	Each	5737.94		5737.94
	x 250	Each	6319.00		6319
	x 300	Each	6972.69		6972.69
	400 x 250	Each	7117.95		7117.95
	x 300	Each	8744.27		8744.27
	x 350	Each	8643.23		8643.23
	450 x 300	Each	8497.96		8497.96
	x 350	Each	9514.81		9514.81
	x 400	Each	10386.40		10386.4
	500 x 350	Each	10459.03		10459.03
	x 400	Each	11403.25		11403.25
	x 450	Each	12202.21		12202.21
	600 x 400	Each	13800.11		13800.11
	x 450	Each	14526.44		14526.44
	x 500	Each	15688.55		15688.55
	700 x 500	Each	18448.57		18448.57
	x 600	Each	20845.43		20845.43
	750 x 600	Each	22225.45		22225.45
	x 700	Each	24259.15		24259.15
	800 x 600	Each	24985.47		24985.47
	x 700	Each	27019.17		27019.17
	x 750	Each	28181.28		28181.28
	900 x 700	Each	30142.35		30142.35
	x 750	Each	31449.73		31449.73
	x 800	Each	33483.43		33483.43
	1000 x 800	Each	37623.47		37623.47
	x 900	Each	40674.02		40674.02
21c	**Providing and Laying in Position Cast Iron Blank Flanges [Conform to IS 1538]**				UADD SOR pg 39
		Unit	**Rate (Rs)**		
	80	Each	351		351
	100	Each	421		421
	125	Each	561		561

	150	Each	772		772
	200	Each	1122		1122
	250	Each	1614		1614
	300	Each	2245		2245
	350	Each	3235		3235
	400	Each	4138		4138
	450	Each	5041		5041
	500	Each	6395		6395
	600	Each	9480		9480
	700	Each	13317		13317
	750	Each	15575		15575
	800	Each	18434		18434
	900	Each	23550		23550
	1000	Each	30547		30547
OPERATION AND MAINTENANCE FOR CMS					
E			**Rate Quoted by Sharp Control**	**Rate Quoted by Sai Technologies**	**Lowest Rate**
		Unit	**Rate (Rs)**	**Rate (Rs)**	**Rate (Rs)**
35	Services like Operation & Maintenance contract period of 5 years for CMS. It also includes A) Access to comprehensive portfolio of software's at any time B) The O&M component should contain software's for The software must have the SCADA connectivity & speeds technology readily available	per Year	7000000	8915000	7000000

14.5.1 Quotations From Sharp Control Pvt Ltd



Sharp Control Equipments Pvt. Ltd.
101 & 103 Bothra Complex, 1st Floor, Model Mill Square,
Ganeshpeth, Nagpur - 440 018 (MS)
Tel.: 0712 - 6563155 Telefax : 0712 - 2729727
E-mail : info@sharpcontrol.in / sharp_ngp@bsnl.in
Website : www.sharpcontrol.in
CIN No : U30000MH1998PTC115495

Project for Indore City -
Through : DRA Consultants , Nagpur
SCE1617PR051_1

Terms and Condition Sale/ Contract

(Form-A)

1. Price: - Ex – Wadi, Nagpur.
2. Packing and Forwarding charges: - 2% extra.
3. Transit Insurance: - To Buyer's account.
4. Excise Duty/ Cenvat and Educational cess: Extra as applicable at the time of dispatch
5. Freight charges: Extra at actual.
6. Sale tax: 12.5% VAT or 2 % against C form or extra as applicable. C Forms to be released immediately along with payments
7. Local Levy: - Octroi / Local Tax if any will be to buyer's account.
8. Payment terms: - 30% advance with the PO and Balance against Proforma Invoice on pro-rata basis.
9. In case of delayed payment after mutually agreed terms, interest will be charged at the rate of 15% on the balance due payment.
10. Delivery: - Material to get ready for dispatch within 12-16 weeks against receipt of techno-commercially clear order along-with advance. We reserve right to execute the orders partially/fully in one or more consignment.
11. Force Majeure: - Every effort will be made to dispatch the goods within the scheduled delivery period but we do not take responsibility for any delay occasioned by causes beyond our control known as "Force Majeure". In this case delayed delivery will not be a reason for canceling the contract or claiming Damages. No claim for refund of Deposits/advance will be entertained.
12. Warranty: - 12 months from the date of dispatch on the workman ship and Manufacturing defects. Warranty does not cover for cables, connector, Consumables, Sensors, Glassware; breakable parts/material etc. warranty does not cover on Mishandling of the Instruments and faulty operational procedures, unstable power supply for instrument operation.
13. Validity: - The quotation is valid for acceptance for 30 days.
14. Jurisdiction: -- All the disputes relating to above contract are subject to Nagpur Jurisdiction
15. **Supervision of installation and commissioning: - Rs 9,00,000 /- for onsite stay of skilled manpower for 90 days.** Any additional stay will be charged @ Rs 9500/- extra per day per person (Services Tax and Cess extra as applicable) inclusive of days of traveling. DAY boarding and local conveyance to be arranged by you.
16. All kind of Civil works and mechanical works including mounting structures/ frames/ Fabrication/pipe cutting/provision of chamber for flow meters/ for instruments and Electrical supply lines to be arranged by purchaser. Manual labor to be made available by Purchaser for basic activities at site.

For Sharp Control Equipments Pvt. Ltd

Authorized Signatory

Sharp Control Equipments Pvt. Ltd.
101 & 103 Bothra Complex, 1st Floor, Model Mill Square,
Ganeshpeth, Nagpur - 440 018 (MS)
Tel.: 0712 - 6563155 **Telefax :** 0712 - 2729727
E-mail : info@sharpcontrol.in / sharp_ngp@bsnl.in
Website : www.sharpcontrol.in
CIN NO. : U30000MH1998PTC115496

Ref No:- Sce1617PR051 **Date:- 25/08/2016**

Indore Municipal Corporation					
SCADA (Central monitoring system)					
Item No.	**Description of items**	**Qty.**	**Unit**	**Rate/ each in Rupees**	**Total (Rs.)**
	A. 1st Level of System Architecture				
1	**Supply, delivery, installation, testing, training and commissioning of *Pressure measuring instruments* as per the General Specifications described Technical Specifications for Instrumentation of this document.** Consisting of pressure transducers, pressure transmitters with cabinet for pressure transmitter, digital pressure indicator, sensors, converters, cables, structure required for mounting viz:platforms, railings, etc and all required installation hardware complete and as directed by Engineer-in -charge				

• Process Control Instruments • Analytical / Scientific / Material Science Instruments
• Environmental / Pollution Monitoring Instrument

	SITRANS P DS III, HART,4-20 MA transmitter for pressure **Technical Specifications:** **Make: SIEMENS** **Model: Sitrans P DS III Series / Type: Smart** **Measuring cell filing/cleaning** : silicone oil, normal cleaning **Wetted parts material** :Diaphragm stainless steel **Process connection** : female thread 1/2-14 npt **Material of housing** : Die-cast aluminium housing **Design** : Standard design **Explosion protection** : None explosion protection **Electric connection/cable inlet** :cable gland 1/2-14 npt **Indicator** : Housing cover with window **Mounting bracket** :With steel mounting bracket				
	Parameterization though local push buttons				
	Accuracy - 0.075% of span				
	Note: Prices are towards supply & installation of pressure transmitters only. supervision of commissioning charges are extra as per T&C				
	a) At MBR / UGR	2	each set	60000	120000
	b) At BPS (including meter at inlet & outlet of transmission main and suction & delivary of each pump	180	each set	60000	10800000

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	c) At ESR, GSR and UGR Inlet	73	each set	60000	4380000
	D) In Each DMA (19 DMA, 5 points in each)	95	each set	60000	5700000
2	**Supply, delivery, installation, testing, training and commissioning of *level measurement* systems to measure UGR / GSR level and water / sump level at pump house / BPS as per the General Specifications Technical Specifications for Instrumentation of this document.** Consisting of level transducers, level transmitters, sensors, converters, cables, digital level indicators with proper cabinets, structure required for mounting the level transducer viz: platforms, railings etc and all required installation hardware complete and as directed by Engineer-in-charge				

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	Ultrasonic Level Transmitter Model : SITRANS Probe LU ,Make: Siemens **Power :** Nominal 24 V dc with max. 550 ohm Maximum 30v dc 4 to 20 mA **Output** : 4 to 20 mA **Accuracy** : +/- 0.002 mA **Span** : proportional or inversely proportional **Accuracy** : +/- the greater of 0.15% range or 6 mm **Repeatability** : < 3mm **Frequency** : 54 KHz **Update time** : < 5 seconds **Interface** : Display: Built in alphanumeric display – visible through transparent lid; **Communication** : HART **Mechanical Enclosure** : PBT (Polybutylene Terepthalate) **Cable inlet** : 2 x ½" NPT **Ingress Protection** : Type 4X/NEMA4X **Threaded Connection** : 2" NPT Threaded TAPER (ANSI/ASME B1.20.1) **Sensor** : PVDF **Process Conditions** : Ambient Temp: -40 to 80 deg. C **Approval** : General purpose, FM, CSA, CE, C-TICK, KCC **Note: Prices are towards supply & installation only.** **2. supervision of commissioning charges are extra as per T&C**				
	a) At MBR / UGR	2	each set	75000	150000
	b) At New BPS/pumping station	16	each set	75000	1200000
	c) At ESR, GSR and UGR	73	each set	75000	5475000

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3	**Residual Chlorine Analyzer : make-reputed imported** **Range: 0 to 10 ppm (mg/L) as Cl2.** **Wetted parts: Noryl, Viton, silicone, platinum, and polyethersulfone** **pH range : 6.0 to 9.5. For samples having pH between 9.5 and 10.0,** **Sample conductivity : >50 µS/cm** **Response time : 22 sec to 95% of final reading at 25 °C (77 °F)** **Pressure 0 to 65 psig (0 to 549 kPa abs)** **Temperature 0 °C to 50 °C (32 °F to 122 °F)**				
	a) At MBR / UGR	2	each set	400000	800000
	b) At WTP	4	each set	400000	1600000
	c) At ESR, GSR and UGR	73	each set	400000	29200000
4	**Supply, delivery, installation, testing, training and commissioning of of Electromagnetic flow meter (EMF) for row/ pure water with** accuracy 0.5% of measured value and protection as per given specifications for size 100mm - 1000mm. Including sensor, transmitter, surge arrestor, 25mtere sensor/ transmitter cable, GI duct of suaitable size for 25 mtrs/ each flow meter including pipe cutting, levelling and installation of flow meter in pipe lines with necessary tool tackles cranes etc. as may be required at site and based on technical specification etc. as per attached with 10 years battery back-up.with data loger				

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	ELECTROMAGNETIC FLOW METER Sensor -10 ... +70 °C (-4 ... +158 °F) Enclosure Rating • Standard IP67 to EN 60529/NEMA 4X/6 • Housing and flanges Carbon steel ASTM A 105 • Measuring pipe Stainless steel AISI 304/1.4301 • Flange ANSI B16.5, Class 150 • Electrode Hastelloy C • Grounding electrode Hastelloy C • Min Conductivity of medium 5 micro Siemens/cm• Pressure Upto 19.7Bar • Lining Material Ebonite (Suitable for Water, Waste Water, Raw Water) Power Supply 115-230 V Output 4 ... 20 mA • Load < 800 Accuracy 0.4% ±1 mm/s Make: Siemens				
0	Dia 150 mm	3	each set	200000	600000
3	Dia 200 mm	32	each set	225000	7200000
0	Dia 300 mm	15	each set	250000	3750000
3	Dia 400 mm	43	each set	300000	12900000
0	Dia 450 mm	14	each set	350000	4900000
1	Dia 500 mm	16	each set	525000	8400000
1	Dia 600 mm	60	each set	600000	36000000
10	Dia 700 mm	10	each set	700000	7000000
5	**Supply, delivery, installation, testing, training and commissioning of *RPM measuring* instruments as per the General Specifications & Technical Specifications for Instrumentation of this document.** Consisting of transducers, transmitters, sensors, converters, cables, structure required for mounting the transducer viz:chambers, platforms, railings etc and all required installation hardware complete and as directed by Engineer-in -charge				
	a) At BPS/ Pump House	90	pump set	15000	1350000

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6	**Supply, delivery, installation, testing, training and commissioning of *Energy measuring* (Power analyser) instruments as per the General Specifications described Technical Specifications for Instrumentation of this document.** Communicating type energy monitoring system capable of monitoring all energy parameters consisting of transducers, transmitters, sensors, converters, cables, cabinets, structure required for mounting the transducer viz: platforms, railings etc and all required installation hardware / software complete etc. and as directed by Engineer-in -charge				
	a) At 20 BPS/ Pump House	63	each set	25000	1575000
7	**Supply, delivery, installation, testing, training and commissioning of PLC based *Control Panels* as per the General Specifications described Technical Specifications for Instrumentation of this document.** Consisting of of all required relays, selector switches, push buttons, power supplies,power points, transducers, transmitters, cables, structure and furniture required for mounting viz; railings, plateforms etc. complete and all required installation hardware, wiring complete and as directed by Engineer-in -charge				
	a) At BPS/ Pump House	16	each set	600000	9600000
	c) At ESR, GSR and UGR	73	each set	250000	18250000
	d) AT DMA	19	each set		

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8	**Supply, delivery, installation, testing, training and commissioning of all required sensors & instruments required to communicate / interface with Flow meters supplied by IMC as per the General Specifications described iTechnical Specifications for Instrumentation of this document. Consisting of transducers, transmitters, converters, cables, structure required for mounting the transducer viz: chambers, platforms, railings etc and all required Installation hardware complete and as directed by Engineer-in -charge**				
	a) At Flow meters point of PS /UGR	16	each set	150000	2400000
	c) At ESR, GSR and UGR	73	each set	150000	10950000
	d) In Each DMA (19 DMA, 2 points in each)	38	each set	150000	5700000
9	**Supply, delivery, installation, testing for interfacing of *valve actuators* required for automatic control of existing Sluice Valves as per the General Specifications described in Section 3: Technical Specifications for Instrumentation of this document.** Consisting of required transmitters, cables, hand wheel for emergency manual operation , wired on terminal blocks, and including repairs and reconditioning the existing Sluice Vaves etc., complete and all required installation hardware complete and as directed by Engineer-in -charge				
	a) At BPS/ Pump House	2	each set	75000	150000
	b) Locations in distribution system	1	each set	75000	75000
	c) At ESR, GSR and UGR	73	each set	75000	5475000
	ABOVE NOT IN OUR SCOPE				

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	B. 2nd Level of System Architecture				
9	**Supply, delivery, erection, installation, testing and commissioning of all required** *communication interface*, **SCADA interfaces, telemetry interfaces, RTUs / PLC hardwares, controls, cables and all required accessories to communicate with all field instruments to receive, store, transfer data /information.** Consisting of PLC / RTUs system with all peripherals, converters & cabinets, power points and structure required for mounting viz: platforms, railings etc and all required hardware / softwares complete and as directed by Engineer-in -charge	179	each set	187500	33562500

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	b) At IMC Hq	1	each set	375000	375000
10	**Supply, delivery, erection, installation, testing and commissioning of** Lighting / *Surge protection* **system with all required accessories for all field instruments, controls, towers, antennas etc. as per the General Specifications & Technical Specifications for Instrumentation of this document.** Consisting of all protection/lightning devices with all peripherals, cabinets and structure required for mounting viz: chambers, platforms, railings etc. with all required hardware complete and as directed by Engineer-in -charge				
	a) At UGR / GSR locations	73	each set	7500	547500
	b) At BPS / NEW Pump House	17	each set	7500	127500
11	**Supply, delivery, erection, installation, testing and commissioning of** *Instrumentation Cable* **with all required accessories for all field instruments & controls i.e. for telemetry & SCADA system as per the General Specifications described in Section 3: Technical Specifications for Instrumentation of this document.** Consisting of all peripherals and structure required for mounting viz: furnitires, platforms, railings etc. with all required hardware complte and as directed by Engineer-in -charge				

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	1 mm2 , with GI Pipe,				
	a) At all UGR/ GSR Locations, locations of BPS/ Pump House & IMCHq.	7000	meter	157	1099000
12	**Providing and constructing R.C.C. chambers for field instruments of required size and depth in M-200** including necessary, excavation, backfilling, P.C.C. 150 mm thick below foundation, R.C.C. wall 150 mm thick, R.C.C. precast roof cover in M.S. angle frame in strip of 30 cm width with proper hooks for lifting, necessary number of M.S. steps embedde in wall etc. complete				
	a) At Pumping Station /UGR / GSR locations	2000	Per M^3	10000	20000000
	ABOVE NOT IN OUR SCOPE				
	C. 3rd Level of System Architecture				

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13	**Supply, delivery, erection, installation, testing, training and commissioning of GPRS as a communication media including GPS site survey of all locations for detrmining communication parameters & towers for Central Monitoring system with proper Towers/ Antennas /subscriber module / reflector disk at each location and central location and all necessary accessories inclusive of all liscence fees at all locations of UGR/GSR/ BPS/ Pumping stations as per the General Specifications & Technical Specifications for telemetry / SCADA of this document.** Consisting of all required equipments, Towers, Antennas, subscriber module, disk, pedestal for tower base, lightning arrestors, cables, structure required for mounting viz: poles, platforms, railings, furnitures etc and all required installation hardwares complete and as directed by Engineer-in -charge				
	i) Wireless communication system based on RF technology including all liscence fees				
	a) At UGR/ GSR locations / BPS	17	nos.	187500	3187500
	c) At Central Location (IMCHq.	1	nos.	375000	375000
	c) At ESR, GSR and UGR	73	nos.	187500	13687500
	D) In Each DMA (19 DMA, 5 points in each)	95	nos.	187500	17812500
	ii) Providing Fabricated self supported triangular shape MS tubular Tower of suitable height from ground , providing matched pedestal for tower base, providing aluminium earthing wire upto nearest earth terminal, providing GI lightening arrestor at WTP / pump House locations and At Central Location (IMC Head office)				
	a) Tower Height upto 5 meter	74	nos.	156250	11562500
	b) Tower Height 10 to 15 meter	18	nos.	250000	4500000

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	c) Tower Height 25 to 30 meter	1	nos.	375000	375000
14	**Providing supplying, fixing and commissioning GSM Data logger with internal battery having (3 years battery life) dual channel for flow and pressure logging with internal pressure transducer, PC software, PC connection cable, Infra-red reading head, pressure hose, instruction manual etc. complete as directed by the Engineer-in-charge.**				
	D) In Each DMA (19 DMA, 5 points in each)	95	nos.	125000	11875000
15	**1)Supply, delivery, erection, installation, testing, training and commissioning of *local SCADA system* at each pumping station. including all necessary instruments & controls with all accessories as per the General Specifications & Technical Specifications for telemetry / SCADA of this document.** Consisting of all supervising controls and equipments, cables, Monitoring equipments, hardwares to communicate with telemetey system, structure required for mounting viz: platforms, railings, furnitures, cabinets etc. complete complete and all required installation hardwares and as directed by Engineer-in -charge				
	a) AT BPS/ pump House locations	16	pumping station	250000	4000000

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	2) Supply, delivery, erection, installation, testing, training and commissioning of *local SCADA PC* consol for running SCADA softwares etc.& its all accessories as per the General Specifications &Technical Specifications for telemetry / SCADA of this document. Consisting of reputed make with P4(DC), 3 GHz or above, 3 MB L@ cache, 4GB RAM, 860 GB HDD, 10/100 Ethernet, Keyboard, optical Mouse, 1.44 MB FDD, CD/DVD ROM, CD writer, Windows latest operating software inclusive of liscence with commercial grade monitor(LCD) not less than 42" etc. and all required accessories, printers and all mounting structues viz, furnitures, cabinets, platforms, railings, cables etc.complete and as directed by Engineer-in -charge				
	a) AT BPS/ pump House locations	16	pumping station	187500	3000000
	3) Supply, delivery, erection, installation, testing, training and commissioning of local *SCADA Softwares & Monitoring* including all asscocited softwares like Operating system, database software, SCADA software, application software, pump house resource planning software etc.& its all accessories as per the General Specifications & Technical Specifications for telemetry / SCADA of this document. Softwares Consisting of Windows based MMI Software inclusive of all liscence to provide dynamic graphics, process mimics, real time & historical trending, group displays, faceplate displays, alarm management and reports and all mounting structues viz, furnitures, cabinets, platforms, railings, cables etc. as directed by Engineer-in -				

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	charge				
	a) AT BPS/ pump House locations	16	pumping station	250000	4000000
	D. 4th Level of System Architecture				
16	**a) Supply, delivery, erection, installation, testing, training and commissioning of *Central Monitoring System* for all UGR/GSR / Pumping stations including a) project Plan b) System hardware c) System Software and all necessary accessories as per the General Specifications & Technical Specifications for telemetry / SCADA of this document.** Consisting of all monitoring equipments, LED or TFT screens not less than7 m x 3.5 m, cables, all hardwares/softwares to communicate with telemetey system, power supplies, structure required for mounting viz: furnitures, cabinets, platforms, railings etc. and all required installation hardwares and as directed by Engineer-in -charge				
	a) At central location i.e.IMC Head Office	1	system	750000	750000

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17	**Supply, delivery, erection, installation, testing, and commissioning of *Central Server PC* for storing data including all necessary accessories as per the General Specifications described in Section 4: Technical Specifications for telemetry / SCADA of this document.** Consisting of reputed make Server PC with Min configuration: P4 (Dual Core), 3 GHz or above, 3MB L2 cache,4 GB RAM, 880 GB HDD, 10/100 Ethernet, Keyboard, Mouse, 1.44MB FDD, CD / DVD ROM, CD writer, Windows latest software inclusive of liscence with commercial grade monitor(LCD) not less than42" along with networking components and inrenet connection for web enabled data facility, printers and all mounting structues viz, furnitures, cabinets, platforms, railings etc. and all required installation softwares and hardwares cables and as directed by Engineer-in -charge				
	a) At central location i.e. IMC office	1	System	500000	500000

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18	**Supply, delivery, erection, installation, testing, training and commissioning of** *PCs, Softwares,* **Keyboards, Printers etc.** including all asscocited softwares like Operating system, database software, application software, resource planning, WDM software etc.& its all accessories as per the General Specifications described in Section 4: Technical Specifications for telemetry / SCADA of this document. Minimum configuration for 5 nos. PCs are :- Reputed make PC with P4 (Dual Core), 3 GHz or above, 1MB L2 cache, 4GB RAM, 880 GB HDD, 10/100 Ethernet, Keyboard, Mouse, 1.44MB FDD, CDROM, Windows latest software inclusive of liscence with not less than 42" commercial grade monitor (LCD) along with all networking components to connect with server and other PCs.Softwares Consisting of Windows based MMI Software inclusive of liscence to provide dynamic graphics, process mimics, real time & historical trending, group displays, faceplate displays, alarm management and reports and all mounting structues viz, furnitures, chambers, platforms, railings, cables etc. as directed by Engineer-in -charge.	Lumpsum (Min 3 user)			
	a) At central location i.e. IMC office	1		1250000	1250000
19	**Supply, delivery, erection, testing and commissioning of** *Uninterrupted Power Supply* **system as per the General Specifications & Technical Specifications for telemetry / SCADA of this document:** for 240 V AC 50 Hz. consisting of inverters and Lead Acid Batteries of high capacity and all electrical power supplies & point arragment, mounting structues viz, furnitures, chambers, platforms,				

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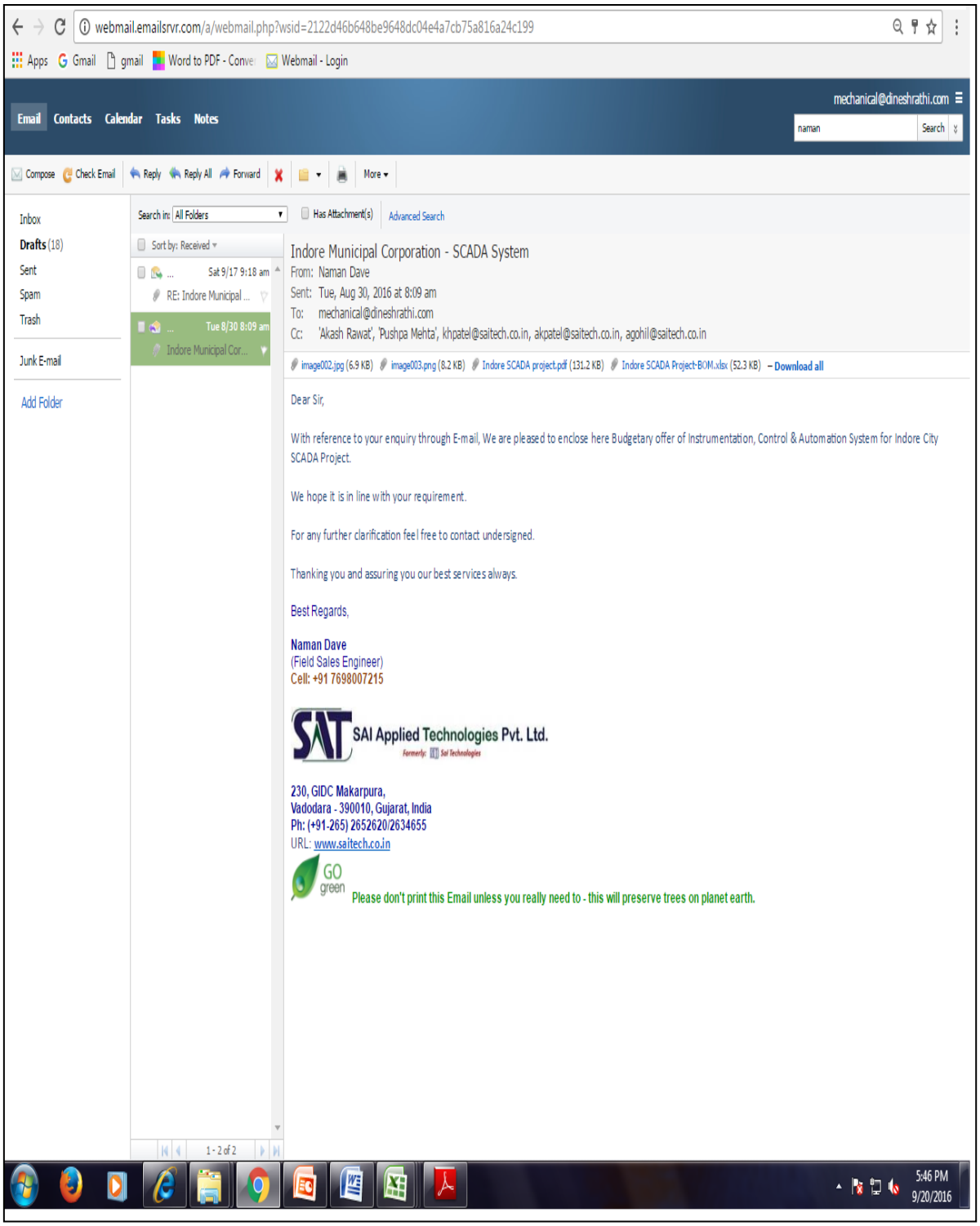
E	5th Level of System Architecture				
20	Services like Operation & Maintenance contract period as per the General Specifications & Technical Specifications for telemetry / SCADA of this document. It also includes A) Access to comprehensive portfolio of software's at any time B) The O&M component should contain software's for The software must have the SCADA connectivity & speeds technology readily available i	5Year	per Year		
		5	per Year	7000000	35000000

	railings, cables etc. and as directed by the Engineer-in -charge				
	a) Pumping Stations	16	nos.	312500	5000000
	c) At Central Location IMC Hq.	2	nos.	750000	1500000
	d) At UGR / GSR locations	73	nos.	1875000	136875000
20	**Supply, delivery, erection, installation, testing and commissioning of *Air conditioning* unit for Central control Room with all accessories as per the General Specifications & Technical Specifications for telemetry / SCADA of this document.** Consisting of 2 tonn capacity, sized to maintain a temperature of 24 + 1 degree Celsius, 50 % relative humidity inside at all time, energy efficient. Itshall be constructed with the strength and rigidity adequate for normal conditions of handling, transport and usage. All power point and mounting structues viz, furnitures, cabinets platforms, railings, cables etc. complete shall be provided and as directed by Engineer-in -charge				
	a) AT BPS / Pump locations	17	nos.	75000	1275000
	b) At Central Monitoring Control room + IMC office	2	nos.	75000	150000
E	**5th Level of System Architecture**				

14.5.2 Quotations From Sai Applied Technologies Pvt Ltd



webmail.emailsrvr.com/a/webmail.php?wsid=2122d46b648be9648dc04e4a7cb75a816a24c199

Apps Gmail gmail Word to PDF - Conve Webmail - Login

Email Contacts Calendar Tasks Notes — mechanical@dineshrathi.com — naman — Search

Compose Check Email Reply Reply All Forward More

Inbox
Drafts (18)
Sent
Spam
Trash
Junk E-mail
Add Folder

Search in: All Folders — Has Attachment(s) — Advanced Search

Sort by: Received

Sat 9/17 9:18 am — RE: Indore Municipal ...

Tue 8/30 8:09 am — Indore Municipal Cor...

Indore Municipal Corporation - SCADA System

From: Naman Dave
Sent: Tue, Aug 30, 2016 at 8:09 am
To: mechanical@dineshrathi.com
Cc: 'Akash Rawat', 'Pushpa Mehta', khpatel@saitech.co.in, akpatel@saitech.co.in, agohil@saitech.co.in

image002.jpg (6.9 KB) image003.png (8.2 KB) Indore SCADA project.pdf (131.2 KB) Indore SCADA Project-BOM.xlsx (52.3 KB) – Download all

Dear Sir,

With reference to your enquiry through E-mail, We are pleased to enclose here Budgetary offer of Instrumentation, Control & Automation System for Indore City SCADA Project.

We hope it is in line with your requirement.

For any further clarification feel free to contact undersigned.

Thanking you and assuring you our best services always.

Best Regards,

Naman Dave
(Field Sales Engineer)
Cell: +91 7698007215

SAI Applied Technologies Pvt. Ltd.
Formerly: Sai Technologies

230, GIDC Makarpura,
Vadodara - 390010, Gujarat, India
Ph: (+91-265) 2652620/2634655
URL: www.saitech.co.in

GO green Please don't print this Email unless you really need to - this will preserve trees on planet earth.

1 - 2 of 2

5:46 PM 9/20/2016

SAI Applied Technologies Pvt. Ltd.
Formerly: Sai Technologies

SATPL/2016-17/DRA/IC&A/ND/52 **DATE: 30/08/2016**

To,
DRA Consultants Pvt Ltd

KIND ATTENTION: Mr. Abhiram Mokasdar

SUBJECT: Budgetary offer for Design, Supply, Installation, Testing and Commissioning of Instrumentation Control & Automation system for Indore city SCADA project.

Reference: Your Enquiry through e-mail dated 22.08.2016

Dear Sir,

We thank you for the valued enquiry through email. In response we are pleased to enclose herewith our budgetary offer for your kind perusal.

Please do contact under signed for any further information.

We have enclosed herewith the following Annexure:

- Annexure – A: Bill of Material
- Annexure – B: Price Schedule
- Annexure – C: Terms & Condition

Thanking you once again and eagerly waiting for your valued response

Regards!

Thanking you,

For, Sai Applied Technologies Pvt. Ltd.

Naman Dave
(Field Sales Engineer)

Electrical-Instrumentation-Automation
230-GIDC, Makarpura, Vadodara – 390010, Gujarat, India
Ph: +91 265 2652620/ 2634655, Fax: +91 265 2646971
CIN No: U72200GJ2014PTC079526

SAI Applied Technologies Pvt. Ltd.
Formerly: Sai Technologies

Annexure – A: Bill of Materials

Attached in Email

- **Note:**

✓ Our Scope of Supply will be limited to above Bill of Materials Only.
✓ Any changes in above BOM will warrant to price implication.

Electrical-Instrumentation-Automation
230-GIDC, Makarpura, Vadodara – 390010, Gujarat, India
Ph: +91 265 2652620/ 2634655, Fax: +91 265 2646971
CIN No: U72200GJ2014PTC079526

SAI Applied Technologies Pvt. Ltd.
Formerly: Sai Technologies

Annexure – B: Price Schedule

Description	Qty.	Total Price INR
Budgetary Offer for Design, Supply, Installation, Testing and Commissioning of Instrumentation, Control & Automation System for **Indore City SCADA Project**	1 lot	**26,74,50,000/-**

- **Major Exclusions**

We have not considered the following:

- ✓ Providing first electrical supply at all locations.
- ✓ Providing free power supply for our site activity.
- ✓ Providing free Lockable stores as part of your main stores at each location.
- ✓ Providing free watch and ward / security arrangement.
- ✓ Insurance coverage during transit and storage as well subsequent usage at site.
- ✓ Any civil structure required for mounting of field instruments shall be provided by you.

Electrical-Instrumentation-Automation
230-GIDC, Makarpura, Vadodara – 390010, Gujarat, India
Ph: +91 265 2652620/ 2634655, Fax: +91 265 2646971
CIN No: U72200GJ2014PTC079526

SAI Applied Technologies Pvt. Ltd.

Annexure – C: Terms and Conditions

1.	PRICE	:	Ex-works Vadodara Packing: Inclusive Forwarding: Inclusive Insurance: to be arranged by client
2.	PAYMENT	:	10%against proforma Invoice/LOI. 80% against Supply of Material at site through LC of 30 days usance. 10% against site installation activities on pro-rata basis.
3.	EXCISE DUTY	:	Extra as applicable at the time of dispatch.
4.	SALES TAX / VAT	:	Extra as applicable at the time of dispatch.
5.	SERVICE TAX	:	Extra at actual. As applicable at the time of Invoice.
6.	OCTROI	:	Shall be borne by you (If Applicable).
7.	VALIDITY	:	30 days from date of our offer.
8.	BANK CHARGE	:	Your Bank charges to your account. Our bank charges to our account.
9.	COMPLETION TIME	:	10-12 Weeks after receipt of approval of drawings.
10.	STATUTORY VARIATION	:	It is to be noted that "Statutory Variation in taxes & duties" shall Be payable extra if applicable.
11.	WARRANTY	:	All proposed items are warranted for a period of 12 months From the date of dispatch.
12.	JURISDICTION	:	All transactions are subject to Vadodara Jurisdiction only.
13.	DISPATCH	:	Purchase orders should carry clear dispatch instructions, giving destination/mode of transport, etc. If P.O. do not carry any dispatch instructions it will be presumed that address as given in the purchase Order shall be the destination and the excise invoice will be prepared reflecting the same.
14.	THIRD PARTY INSPECTION FEES	:	As our supplied products are of established quality and we guarantee fault free performance, inspection before dispatch by you / your consultants are not envisaged to be necessary. If you still feel inspection is a must and to be carried out at our premises or manufacturer place for pre-identified items like cables, UPS, panel enclose etc., goods can be offered for inspection. Inspection Will be carried out within 15 days of our intimation alternatively we will assume inspection has been waived and we will have the liberty to dispatch the goods without inspection. However applicable charges for the same shall be borne by you.

Electrical-Instrumentation-Automation
230-GIDC, Makarpura, Vadodara – 390010. Gujarat. India
Ph: +91 265 2652620/ 2634655, Fax: +91 265 2646971
CIN No: U72200GJ2014PTC079526

SAI Applied Technologies Pvt. Ltd.

15.	CANCELLATION	:	Order once placed shall not be subject to cancellation.
16.	SSI Registration No.	:	Registration No. EM2 24-019-11-100688 Dt. 13-06-2014 under "Micro & Status Enterprises" Category.
17.	Our VAT Registration No.	:	24190300362 dated. 01.07.2002
18.	Our C.S.T. Registration No.	:	24690300362 dated. 07.09.1995
19.	Our ECC No.	:	AAUCS5879EEM001 dated. 1.07.2014
20.	Our PAN No.	:	AAUCS5879E
21.	Site Security	:	Your General Security shall cover the security of material sent to you by us. We shall not be responsible for any loss, theft or damage of material supplied to you thereafter.
22.	Provident fund, ESI	:	We have registered ourselves under PF and ESI and we will Provide Required letter etc. with xerox of challans thus indemnifying you from Liabilities of our workers on account of PF. Any other Government obligation if Levy likes GST, Octroi, Work Contract Tax, LBT, etc., shall be to your account.

For, Sai Applied Technologies Pvt. Ltd.

Naman Dave
(Field Sales Engineer)

Electrical-Instrumentation-Automation
230-GIDC, Makarpura, Vadodara – 390010. Gujarat, India
Ph: +91 265 2652620/ 2634655, Fax: +91 265 2646971
CIN No: U72200GJ2014PTC079526

SAI APPLIED TECHNOLOGIES				
Bills of Quantities for Online Monitoring System				
Item No.	**Description of items**	**Qty.**	**UNIT RATE**	**QUOTED RATE**
1	**Supply, delivery, installation, testing, training and commissioning of *Pressure measuring instruments***			
	a) At MBR / UGR	2	67,500	135,000
	b) At ESR, GSR and UGR Inlet	73	67,500	4,927,500
2	**Supply, delivery, installation, testing, training and commissioning of *level measurement* systems**			
	a) At MBR / UGR	2	157,500	315,000
	b) At New pumping station	16	157,500	2,520,000
	c) At ESR, GSR and UGR	73	157,500	11,497,500
3	**Supply, delivery, installation, testing, training and commissioning of Residual Chlorine measuring instruments**			
	a) At MBR / UGR	2	307,500	615,000
	b) At WTP	4	307,500	1,230,000
	c) At ESR, GSR and UGR	73	307,500	22,447,500
4	**Supply, delivery, installation, testing, training and commissioning of Electromagnetic flow meter (EMF)**			
	Dia 150 mm	3	150,000	450,000
	Dia 200 mm	32	217,500	6,960,000
	Dia 300 mm	15	270,000	4,050,000
	Dia 400 mm	43	390,000	16,770,000
	Dia 450 mm	14	444,000	6,216,000
	Dia 500 mm	16	525,000	8,400,000
	Dia 600 mm	60	630,000	37,800,000
	Dia 700 mm	10	765,000	7,650,000
5	**Supply, delivery, installation, testing, training and**			

	commissioning of *RPM measuring* instruments			
	a) At Pump House	90	52,500	4,725,000
6	**Supply, delivery, installation, testing, training and commissioning of Turbidity Measuring instruments**	4	250000	400000
7	**Supply, delivery, installation, testing, training and commissioning of *Energy measuring* (Power analyser)**			
	a) At Pump House	63	16,500	1,039,500
8	**Supply, delivery, erection, installation, testing and commissioning of all required *communication interface*, SCADA interfaces, telemetry interfaces, RTUs / PLC**			
	a) At Pump House/ UGR Locations	179	N/A	-
	b) At Control Room	1	N/A	-
9	**Supply, delivery, erection, installation, testing and commissioning of Lighting / *Surge protection* system**			
	a) At UGR / GSR locations	73	10,500	766,500
	b) At Pump House	17	10,500	178,500
10	**Supply, delivery, erection, installation, testing and commissioning of *Instrumentation Cable***			
	a) At all UGR/ GSR Locations, locations of Pump House	7000		1,000,000
11	**Providing and constructing R.C.C. chambers for field instruments of required size and depth in M-200** including necessary, excavation, backfilling, P.C.C. 150 mm thick below foundation, R.C.C. wall 150 mm thick, R.C.C. precast roof cover in M.S. angle frame in strip of 30 cm width with proper hooks for lifting, necessary number of M.S. steps embedded in wall etc. complete			
	a) At Pumping Station /UGR / GSR locations	2000	N/A	-
12	**Supply, delivery, erection, installation, testing, training and commissioning of GPRS as a communication media**			

	I) Wireless communication system based on RF technology including all license fees			
	a) At UGR/ GSR locations	17	N/A	-
	c) At Central Location	1	N/A	-
	c) At ESR, GSR and UGR	73	N/A	-
13	ii) Providing Fabricated self-supported triangular shape MS tubular Tower			
	a) Tower Height upto 5 meter	74	N/A	-
	b) Tower Height 10 to 15 meter	18	N/A	-
	c) Tower Height 25 to 30 meter	1	N/A	-
14	**a) Supply, delivery, erection, installation, testing, training and commissioning of *Central Monitoring System*.**		SCADA Softwares for Central Server PC and Client PCs	
	a) At central location	1	1,387,500	1,387,500
15	**Supply, delivery, erection, installation, testing, and commissioning of *Central Server PC*.**		1 No. Non-Redundant Server PC, 1 No. 42" LCD Display	
	a) At central location	1	375,000	375,000
16	**Supply, delivery, erection, installation, testing, training and commissioning of *PCs, Softwares,* Keyboards, Printers etc.**	Lump sum (Min 3 user)	5 Nos. PCs with 42" LCD display	
	a) At central location	1	787,500	787,500
17	**Supply, delivery, erection, testing and commissioning of *Uninterrupted Power Supply* system**			
	a) Pumping Stations	16	150,000	2,400,000
	c) At Central Location.	2	110,000	220,000

	d) At UGR / GSR locations	73	110,000	8,030,000
18	**Supply, delivery, erection, installation, testing and commissioning of *Air conditioning***			
	a) AT Pump locations	17	67,500	1,147,500
	b) At Control Room	2	67,500	135,000
19	**Services like Operation & Maintenance**	5Year		
		5		44,575,000

SAI Applied Technologies Pvt. Ltd.

Formerly: SAI Technologies

Annexure – A: Bill of Materials

Sr. No.	Description	Quantity	Unit Price INR
1.	SITC of Temperature Gauge	1	7500/-
2.	SITC of Valve actuators for different line sizes		
a)	100mm	1	88,800/-
b)	200mm	1	98,000/-
c)	250mm	1	1,16,200/-
d)	300mm	1	1,58,500/-
e)	350mm	1	1,58,500/-
f)	450mm	1	1,58,500/-
g)	500mm	1	1,59,800/-
h)	600mm	1	1,59,800/-
i)	700mm	1	1,71,900/-
j)	750mm	1	1,71,900/-
3.	SITC of pressure Gauge	1	3300/-

- **Note:**

✓ Our Scope of Supply will be limited to above Bill of Materials Only.
✓ Any changes in above BOM will warrant to price implication.

SAI Applied Technologies Pvt. Ltd.
Formerly: Sai Technologies

Annexure – A: Bill of Materials

Sr. No.	Description	Quantity	Unit Price INR
1	SITC of turbidity measuring instrument for measuring turbidity at WTP upto 200 NTU	1 No.	2,50,000
2	SITC of electromagnetic flowmeters for different line sizes		
a	900mm	1 No.	8,20,000
b	1000mm	1 No.	9,16,000
c	1200mm	1 No.	11,05,000
d	1500mm	1 No.	14,75,000

14.5.3 Quotations From Krohne-Marshall

KROHNE

Ref No: PB/NGP/16-17/DRA /K0047
Date: 11.11.2016

TO,
TO, DRA CONSULTANTS PVT. LTD.,
58, INGOLE NAGAR, OPP. AIRPORT,
B/H HOTEL PRIDE, WARDHA ROAD,
NAGPUR -440005 (INDIA)

KIND ATTENTION : MR. RAJESH NAGPURE.

SUBJECT : OFFER FOR THE SUPPLY OF KROHNE MAKE ELECTROMAGNETIC FLOWMETERS.

Dear Sir,

With reference to your enquiry, we are pleased to submit our offer for Electro Magnetic Flow meter.

We trust our offer is in line with your requirement & in case of any clarifications, please feel free to contact us.

Thanking you,

Sincerely Yours,

FOR KROHNE MARSHALL PVT. LTD.

PRATHAMESH BHARNE
SNR ENGINEER- MARKETING

KROHNE Marshall Pvt Ltd, A34/35, MIDC Estate, H Block, Pimpri, Pune 411 018. INDIA. Tel. : +91 (20) 27442020 Fax : +91 (20) 27442040
www.forbesmarshall.com, www.krohne.com
A Forbes Marshall and KROHNE company

KROHNE

TECHNICAL SPECS FOR MAINS POWERED FULL BORE ELECTROMAGNETIC FLOW METER

Process Parameters	
Service	: Water
Op Temp	: up to 50 deg cel max
Op Pressure	: up to 6 Bar g
Velocity range	: Between 0.3 m/s to 4 m/s
Flow Sensor	**: Optiflux 2000**
Type	: Pulse DC excitation
End Connection	: CS Flanges
Flange Rating	: PN 16 up to 150 mm meter size and above that PN 10
Electrode	: SS 316
Electrode type	: Round Head Electrodes
Meter Tube	: SS 304
Liner	: **Hard Rubber (100% Suitable for Potable Water).**
Coil Housing	: SS 304 with fully welded construction
Protection category	: IP 68
Connection / Junction Box	: SS 304
Earthing	: Grounding Rings
Accuracy	: ±0.5 % of MV
Flow Transmitter / Converter	**: IFC 100W**
Mounting	: Separate with 25 meters cable.
Type	: Microprocessor Based
Output	: 4-20mA, HART + Pulse/Frequency + Status
Accuracy	: ± 0.3% of measured value
Max load	: 500 Ohms
Display	: Large back lit LCD Display
Parameters	: Actual flow rate, totalized flow (8 digit), flow direction, flow velocity, conductivity, mass flow rate (at constant density)
Diagnostics	: Empty pipe detection, Coil temperature, Coil resistance, Conductivity etc
Local indication	: Programmable
Power supply	: 85-250VAC, 48-63Hz / 24VDC
Housing	: Die cast Aluminum with PU finish
Cable entry	: M20 x 1.5
Area classification	: Non-Hazardous
Protection class	: IP 66 / 67
Calibration Facility	**: In-house Calibration facility for Mag flow meter**
Accreditation	**: NABL Accredited**
Calibration Standard	**: ISO 17025**

KROHNE Marshall Pvt Ltd, A34/35, MIDC Estate, H Block, Pimpri, Pune 411 018. INDIA. Tel. : +91 (20) 27442020 Fax : +91 (20) 27442040
www.forbesmarshall.com, www.krohne.com
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KROHNE

TERMS AND CONDITIONS

Prices	: Ex Work Pune.
Packing & Forwarding	: Extra @2.5%.
Freight	: Extra at actuals to your account
Transit Insurance	: To purchaser's Account
Taxes and Duties	: Extra as applicable at the time of dispatch. The present rates are VAT @ 12.5%. and CED@ 12.5% extra.

Terms of Payment

For Supply	: 30% Advance and balance with full taxes and duties against PI.
Delivery Period	: 12-14 weeks from the date of receipt of clear order.
Offer Validity	: 60 days from date of Offer.
Warrantee	: 40 Months from the date of supply or 36 Months from the date of installation whichever is earlier.
Ordering Information	: Kindly place your order in favour of **KROHNE MARSHALL PVT. LTD.** **A 34/35, MIDC Industrial Estate** **"H" Block, Pimpri** **Pune - 411018**

HOWEVER PLEASE MAIL YOUR ORDER TO OUR NAGPUR OFFICE FOR PROCESSING THE SAME.

OUR NAGPUR OFFICE ADDRESS **Krohne Marshall Pvt Ltd**
17, FCI Housing Society, Narendra Nagar Extension,
Manish Nagar Railway Crossing Road,Nagpur-440015
Phone No : 0712 3025020, Fax No. : 0712 3025030

FOR KROHNE MARSHALL PVT. LTD.

PRATHAMESH BHARNE
SNR ENGINEER- MARKETING

KROHNE

PRICED OFFER:

Item	Description	Qty	Unit	Unit price in Rs.	Total Price in Rs.
A	Mains Powered Electromagnetic Flow meter				
1.0	50 mm dia	1.00	Nos.	120000/-	120000/-
	100 mm dia	1.00	Nos.	160000/-	160000/-
	150 mm dia	1.00	Nos.	171680/-	171680/-
	200 mm dia	1.00	Nos.	199500/-	199500/-
	300 mm dia	1.00	Nos.	249700/-	249700/-
	400 mm dia	1.00	Nos.	399600/-	399600/-
	450 mm dia	1.00	Nos.	471700/-	471700/-
	500 mm dia	1.00	Nos.	565700/-	565700/-
	600 mm dia	1.00	Nos.	689000/-	689000/-
	700 mm dia	1.00	Nos.	744120/-	744120/-
1.0	900 mm dia	1.00	Nos.	1096620/-	1096620/-
2.0	1000 mm dia	1.00	Nos.	1191180/-	1191180/-
3.0	1200 mm dia	1.00	Nos.	1293660/-	1293660/-
4.0	1400 mm dia	1.00	Nos.	2056560/-	2056560/-
5.0	1500 mm dia	1.00	Nos.	2225000/-	2225000/-
5.0	1600 mm dia	1.00	Nos.	2420280/-	2420280/-

FOR KROHNE MARSHALL PVT. LTD.

PRATHAMESH BHARNE
SNR ENGINEER- MARKETING

KROHNE Marshall Pvt Ltd, A34/35, MIDC Estate, H Block, Pimpri, Pune 411 018. INDIA. Tel. : +91 (20) 27442020 Fax : +91 (20) 27442040
www.forbesmarshall.com, www.krohne.com
A Forbes Marshall and KROHNE company

KROHNE

PRICE ANNEXURE

REFURBISHMENT OF KROHNE MAKE ELECTROMAGNETI FLOWMETERS.

Sr. No	Sensor Model	Converter Model	Type	Size(NB)	Qty	Unit Price	Total Price
Scope of Work: Repair/ Replacement of old Converters with new converters IFC 100 & primary head repairs along with cable and dry calibration at site.							
1				DN 500	1	325000.00	325000.00
2				DN 600	1	410000.00	410000.00
3				DN 900	1	565000.00	565000.00
4				DN 1000	1	695000.00	695000.00

Bill Board Display : R.2,50,000/- Ex works Pune.
1 Line Display with 6" Character Size

For KROHNE MARSHALL Pvt. Ltd

PRATHAMESH BHARNE
SNR ENGINEER MARKETING

14.5.4 Quotations From Endress & Hauser

Bill of Material

Enquiry Reference:	Email
Project Details:	Budgetory prices for Instruments
E+H Offer No. :	Reference quote for Budgetory Purpose

SL No.	Rev No.	Tag No.	Service	Item	Ordercode	Technical Annexure No.	Qty	UOM	Unit Rate -INR (Excl. of Cenvat)	Total Value - INR (Excl of Cenvat)
1	0	TBA	WATER	Pressure Transmitter (0 - 20 Kg)	PMP21-AA1B1RBVXJ+F3Z1	10	1	No	26,233	26,233
2	0	TBA	WATER	Temperature Transmitter	TMT82-AAA2HB3A1A1A2	20	1	No	19,655	19,655
3	0	TBA	WATER	Radar Type Level Transmitter	FMR20-AAABNVCERPF3+Z1	30	1	No	74,895	74,895
4	0	TBA	WATER	pH Sensor	CCS142D-GAS80	40	1	No	1,11,805	1,11,805
5	0	TBA	WATER	Cable for pH Sensor	CCA250-A0	50	1	No	34,507	34,507
6	0	TBA	WATER	Cable for pH Sensor	CYK10-A101	60	1	No	14,400	14,400
	0	TBA	WATER	Mounting Assembly	Local Broughtout	00	1	No	18,352	18,352
7	0	TBA	WATER	pH Transmitter	CM442-AAM2A2F011A+AA	70	1	No	1,04,887	1,04,887
8	0	TBA	WATER	Electromagnetic Flowmeter (Line Size : 50mm)	10W50-ULGA1AN4B4AA	80	1	No	1,15,388	1,15,388
9	0	TBA	WATER	Electromagnetic Flowmeter (Line Size : 100mm)	10W1H-ULGA1AN4B4AA	90	1	No	1,24,899	1,24,899
10	0	TBA	WATER	Electromagnetic Flowmeter (Line Size : 150mm)	10W1F-ULGA1AN4B4AA	100	1	No	1,40,968	1,40,968
11	0	TBA	WATER	Electromagnetic Flowmeter (Line Size : 200mm)	10W2H-ULGA1AN4B4AA	110	1	No	1,57,913	1,57,913

14.5.5 Estimates For Rcc Chambers

	Estimate for RCC Chamber (As per UADD (Building Works 2012)				
	Construction of Valve Chamber in cast in situ C. C. in M-20 Grade mix design as per IS-456,using quartzite trap metal of size 6 mm to 20 mm for RCC work, including reinforcement scaffolding centering, formwork, Excavation, Refilling & Plastering etc. Completed as directed by engineer in charge				
Sr. No.	**Item Description**	**Qty**	**Unit**	**Rate**	**Amount**
(2m x2m x 2.5m depth)					
1	Excavation with refilling				
	0.0 to 1.5 m	13.14	cum	129.00	1695.06
	1.5 to 3.0 m	11.39	cum	170.28	1939.49
2	PCC (1:3:6)	1.88	cum	3595.00	6740.63
3	RCC (1:1.5:3)	4.54	cum	3752.00	17048.71
5	TMT Fe 415	0.36	MT	60079.00	21429.95
6	Cement Plaster 12 mm thick	13.80	sqm	95.00	1311.00
					50164.83
				Total	**50200.00**

15 DRAWINGS

Layout Drawing for Transmission Mains / Feeder mains of Agra Water Supply System