



AN IMPACT OF 24X7 WATER SUPPLY IN NORTHWEST (NW) SECTOR OF CENTRAL ZONE AREA OF GREATER VISAKHAPATNAM MUNICIPAL CORPORATION (GVMC) IN VISAKHAPATNAM CITY

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Abstract:

The Current project study is to prepare 'Service Improvement Plan' (SIP) for implementation of continuous (24x7) water supply in the NW sector of Central zone area of GVMC and reduction of NRW to less than 10-12%, by adopting implementable measures like replacement of transmission mains and distribution network, augmentation of storage capacity, installation of water meters and computerized monitoring mechanism through integration with SCADA software.

Keywords: 24X7 water supply, Economic Impact, Monitoring mechanism, Happiness Index

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1 Introduction

Department of Industries, Government of Andhra Pradesh (GoAP) as Project Monitoring Unit (PMU) is implementing the Visakhapatnam Chennai Industrial Corridor Project (VICIDP) with Asian Development Bank loan assistance. The Greater Visakhapatnam Municipal Corporation (GVMC) is Implementing Unit (PIU) and Mott MacDonald Pvt Ltd, India, is the Project Management & Supervising Consultant (PMSC). Under Urban Water Supply, Distribution Network improvements for Non-Revenue Water (NRW) reduction (10-12%) & 24x7 water supply in Northwest sector of central zone area of GVMC including 10 years of O&M in Visakhapatnam City is one of the

subprojects is being implemented under Tranche-1.

The Greater Visakhapatnam Municipal Corporation (GVMC) is the governing body of Vishakhapatnam city largest city in Indian state of Andhra Pradesh. The total GVMC area covers about 681.96 sq.km. The Subproject area is confined to the Northwest (NW) Sector of Central zone area covers an area of 40.389 sq.km. The project was designed for a period of 30 years to cover population 324000, 492998 & 727501 persons respectively for the year 2018, 2033 and 2048. The subproject area covers 13 municipal wards which consists of 32 Blocks comprising 149 nos of DMA (District Metered Area) s. The below drawing (Fig. 1) shows the block plan of NW Sector of GVMC.



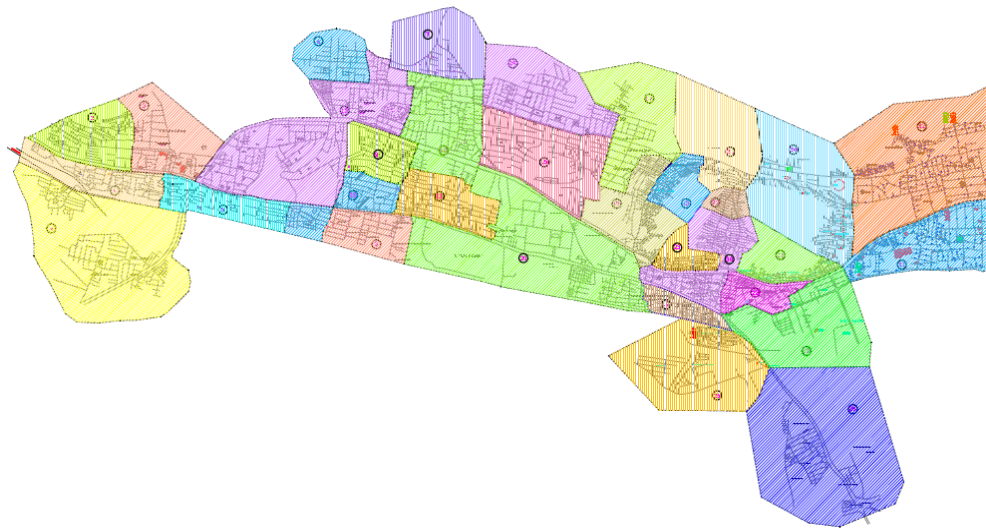


Fig.1- **Block Plan of Northwest Sector of Greater Visakhapatnam City**

1.1 Objective of the study

- 1.1.1. To ensure safe and equitable water supply to the entire population staying in the NW Sector sub-project area
- 1.1.2. To ensure the distribution of water availability during the entire day
- 1.1.3. To reduce the level of water losses and non-revenue water
- 1.1.4. To study the Happiness Index before and after 24x7 water supply on the local consumers

1.2 Scope of work

The improvements are being made by adopting measures like Construction of new pump house, laying new gravity, and pumping main to Ground Level Balancing Reservoir (3500 KL), replacement of transmission mains and distribution network, augmentation of storage capacity, installation of Ultrasonic water meters and computerized monitoring mechanism through integration with Supervisory Control and Data Acquisition(SCADA)software. The total revised cost of the project is Rs. 447.62 Cr.

1.3 Salient Features of Project

- 1.3.1. Distribution Network Improvement (DNI) on District Metering Area (DMA) basis for NRW reduction.
- 1.3.2. House Service Connections with Advanced Metering Infrastructure (AMI).
- 1.3.3. Preparation & Implementation of Service Improvement Plan (SIP)
- 1.3.4. Implementation of 24x7 water supply through continuous pressurized water supply (min 12m head)
- 1.3.5. Laying of 384 km pipeline and Construction of New Elevated Level Service Reservoir (ELSR)s (3 Nos) & Ground Level Service Reservoir(GLSR)s (3 Nos)- augmentation of additional storage capacity of 13500KL; Providing 48000 connections which will benefit 72000 households in the project area.
- 1.3.6. Computerized monitoring mechanism through integration with SCADA for better monitoring of the network.
- 1.3.7. Efficiency improvement in water supply through reduction of NRW.
- 1.3.8. Consumer Friendly Grievance Redressal Mechanism during Operation & Maintenance

2 Hypothesis:

- 2.1 There is no significant difference on public health and happiness before and after 24X7 Water Supply.
- 2.2 There is no significant reduction in the time and money spent by resident to store water and additional water requirement to meet the consumer demand.

3 Current / before situation & 24x7 situation

Presently the water supply is made available for about 45min to 1 hour to the residents. The average household level coverage of direct water supply connections in NW Sector is 59.42%. and the Nonrevenue water is about 34.82%. The available storage capacity in NW Sector is 15, 355 KL which comprises of 23 reservoirs. It is observed that out of the 23 existing service reservoirs, 16

are GLSRs and 7 are ELSRs. The total capacity of the ELSRs is 3925 KL which constitutes 25.56% of the total storage capacity. Total capacity required is about 28855KL up to 2033 and shortfall for the prospective year 2033 is 13, 600 KL. It was proposed to construct of 3 Nos. ELSRs and 3 Nos. GLSRs. This will render the storage capacity to 1/3rd of prospective demand.

During the start of these works, to assess the prevailing service levels, a consumer survey has been conducted in all the blocks of NW Sector at the start of the project (April 2018). During the house-to-house survey, information pertaining to the number of households, assessments, availability of water connection, metering of supply, and the category of the connection has been recorded. The summary results of the consumer survey are given Table 1 below.

Table 1 – summary of consumer survey results

Description	Unit	Value
Total No of assessments during initial consumer survey conducted door to door*	Nos	73046
Total No of HSC's*	Nos	44031
Quantity of Water Supplied	KL	41664
Total Quantity of Water Billed	KL	27155
Losses	KL	14509
NRW	%	34.82

It was observed from the study NRW of maximum 67.01% is recorded for the Madhavadhara (225 KL) reservoir and the lowest NRW of 6.35% is recorded for the Bapuji Nagar Pump House reservoir.

observed less than 10% and water saving of about

3.1 Present status of the project

Presently 249km of pipeline completed out of 384 kms. The 3 GLSR is completed and construction of 3 ELSR is in progress. 24x7 is being implemented 20 out of 149 DMAs where the NRW is

The outcome of the implementation of 24x7 water supply in five blocks is presented in below table 2 – Section A before 24x7 and Section B after 24x7.



Table 2 – Comparison of NRW before and after implementation of 24x7

Sl No.	FY	Block 6 – 2 DMA's (342 HSC's)	Block 7 2 DMA's (235 HSC's)	Block 10 4 DMA's (792 HSC's)	Block 12 4 DMA's (1125 HSC's)	Block 13 8 DMA's (1178 HSC's)
A Before Implementation 24x7						
1	Initial NRW	18.54%	23.81%	41.19%	40.23%	67.01%
		38.16%				
Population		3008	3243	4786	4254	4170
B After Implementation of 24x7						
1	2019	6.54%	3.93%	8.45%		
2	2020	0.31%	1.06%	5.16%		
3	2021	1.75%	2.00%	5.85%		
4	2022	1.98%	3.14%	7.25%	6.50%	4.99%
Average		2.65%	2.53%	6.68%	6.50%	4.99%
Average		4.67%				

4 Data Analysis

4.1 Age Group of Respondents

Table 3: Age wise distribution of respondents

Age in year	Respondents	%Age
18-34	19	27.14
35-44	17	24.29
45-54	15	21.43
55 & above	19	27.14



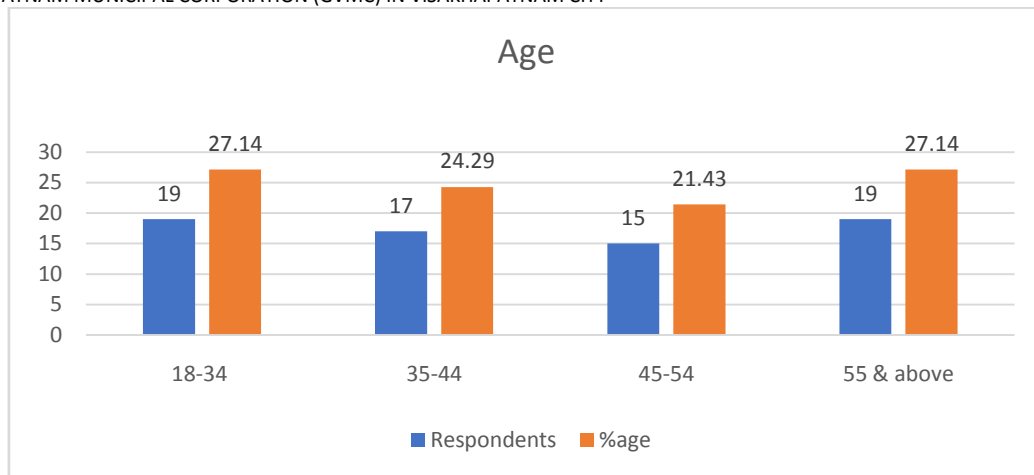


Fig 2: Graphical representation of age wise respondents and percentage:

From table, 27.14% of respondents were from 18-34 years old, 24.29% of respondents were 35-44 years old, 21.43% of respondents were 45-54 years old and 27.14% of respondents were above 55 years old.

4.2 Present occupation of the respondent

Table 4: Occupation wise distribution of respondents

Present occupation of the respondent		
	Respondents	%Age
Govt employee	7	10
Self-employed	5	7.14
Private employee	7	10
Businessman'	44	62.86
Daily wage	4	5.71
labour	3	4.29
Total	70	100

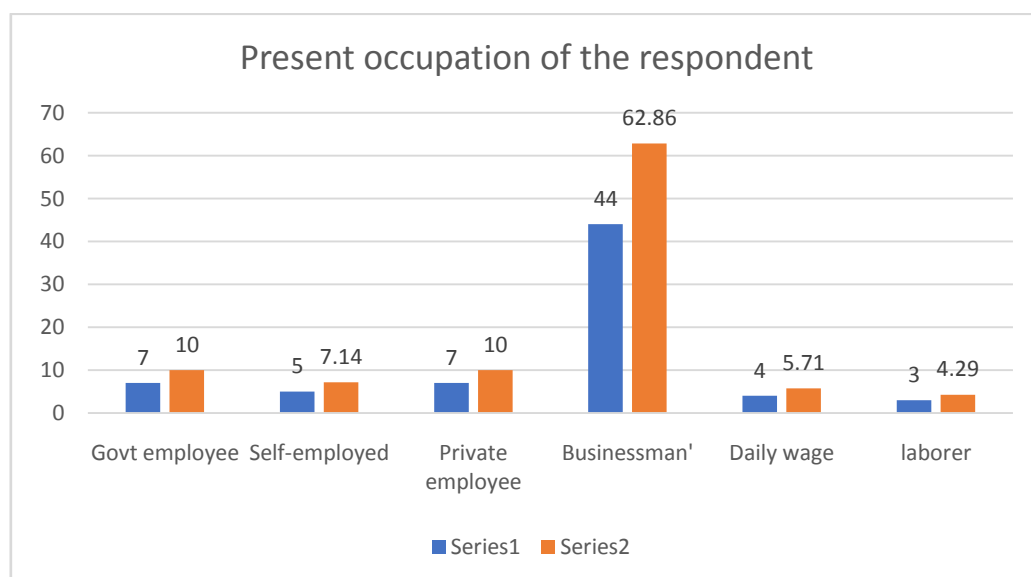


Fig 3: Graphical representation of Occupation wise respondents and percentage

4.3 Type of family

Table 5: Type of family distribution of respondents

Type of family		
	Respondents	%Age
Joint	9	12.86
Nuclear	56	80
Single Parent	5	7.14

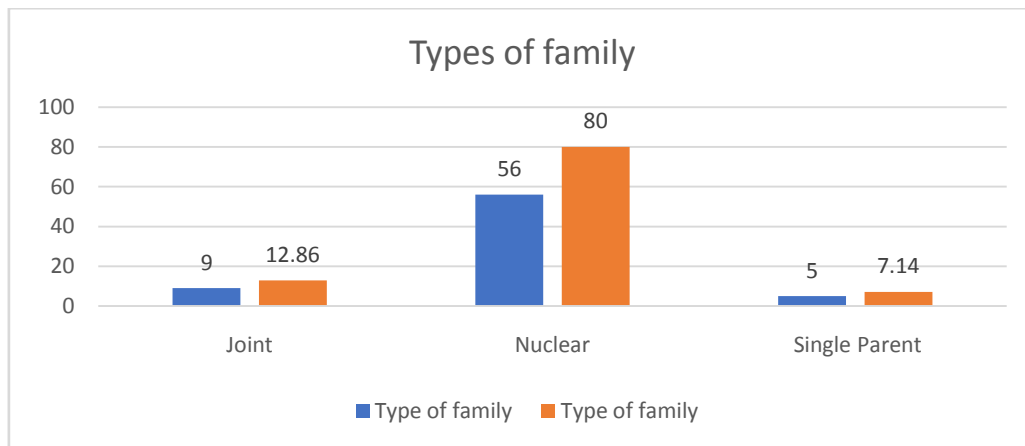


Fig 4: Graphical representation of Type of family respondents and percentage

From the, 10% of the respondent were govt employees, 7.14% of respondents were self-employed, 10% of respondents were private employee, 62.86% of respondents were businessman, 5.71% of respondents were daily wages and 4.29% of respondents were labourer.

5 Hypothesis testing

5.1 Hypothesis # 1

Null hypothesis: There is no significant difference on public health between before and after 24X7 Water Supply delivers

Alternative hypothesis: There is significant difference on public health between before and after 24X7 Water Supply delivers

Table 6: Anova – Single Factor (statistical analysis)

Anova: Single Factor				
SUMMARY				
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Source of water before 24 x 7 project water supply connection	70	278	3.971429	3.216563
Time spent on collection of water	70	205	2.928571	0.299172
Quantity of water available	70	168	2.4	0.446377
Amount spent for purchase of water per month	70	73	1.042857	0.0706
Time taken for collection of water???	70	76	1.085714	0.16646



Table 7: Anova – Source of variation (statistical analysis)

ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	437.6857	4	109.4214	130.2893	0.00	2.397828
Within Groups	289.7429	345	0.839834			
Total	727.4286	349				

In the ANOVA table, the p-value is 0.00. Because this value is less than our significance level of 0.05, we reject the null hypothesis. Our sample data provide strong enough evidence to conclude that the four-population means are not equal. So alternative hypothesis is accepted.

5.2 Hypothesis # 2

Null hypothesis: There is no significant reduces the time and money spent by residents to store water

Alternative hypothesis: There is significantly reduces the time and money spent by residents to store water

Table 8: Anova – Single Factor (statistical analysis)

Anova: Single Factor				
SUMMARY				
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Quality of water	70	159	2.271429	0.200621
Any health issues due to water	70	458	6.542857	1.41118
Time taken for collection of water???	70	76	1.085714	0.16646
Any health issues	70	484	6.914286	0.514286

Table 9: Anova – Source of variation (statistical analysis)

ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	1839.2	3	613.0702	1069.676	0.00	2.6373
Within Groups	158.19	276	0.573137			
Total	1997.4	279				

In the ANOVA table, the p-value is 0.00. Because this value is less than our significance level of 0.05, we reject the null hypothesis. So alternative hypothesis is accepted



6 Impact of the 24 X 7 water supply:

6.1 Water savings & Method adopted

The entire distribution pipeline was replaced with new High Density Polyethylene Pipes(HDPE), Ductile Iron (DI)&Galvanized Iron (GI) pipelines as the existing pipelines are largely Asbestos Cement (AC) pipes which are about 30 years old and apart from this, a small percentage of pipelines consists of GI and HDPE pipes.

6.2 Social Impact

On implementation of the 24x7 water supply, the following social benefits were provided to the residents

- 6.2.1 24X7 Water Supply delivers better quality water for public health of the residents.
- 6.2.2 24x7 Water Supply reduces the time and money spent by residents to store water.
- 6.2.3 Continuous pressurized water supply (min 12m head) is the most efficient and cost-effective way of supplying water.
- 6.2.4 Around 72000 Households will be benefited on completion of the project.
- 6.2.5 Computerized monitoring mechanism through integration with SCADA for better monitoring of the network.
- 6.2.6 Efficiency improvement in water supply through reduction of NRW and revenue generation for Effective water supply management.
- 6.2.7 Consumer Friendly Grievance Redressal Mechanism during Operation & Maintenance

6.3 Storage of water

When the water is supplied intermittently, the customer intends to fill fresh water every day and the water stored on earlier day will be simply thrown away without utilising the same. This unnecessarily leads to wastage of water and causing additional load to the sewage system. As the water is made available for 24x7 to the residents at their houses, this has reduced the wastage of water as no additional storage is required and by not throwing away any unused water, thus reducing the load on sewage generation.

6.4 Gender Home maker Woman/Girls& Happiness Index

Usually, woman and girls in the house spent a lot of time for collection of water and being intermittent they have to wait for the water to come and need to adjust their work schedule accordingly. After implementation of the 24x7, there is no need to wait for water as it is available throughout the day. Hence the housewife & home makers can concentrate more on other activities and children can do/continue their studies without any disturbance. Out of 70 respondents 15.71% mentioned that there is no disturbance for education of kid, 51.43% mentioned that they could go to work or other activity and 28.57% mentioned that they find Time for recreational activity.

6.5 Less use of Plastic

Previously, the residents used to store water in plastic overhead tanks, buckets for full day use. However, due to availability of 24X7 water supply, any additional storage is no more required and thus reduce the usage of plastics

6.6 Economic Impact

- 6.6.1 Savings in Power – No – Pumps for GVMC



Presently most of the water supply is being done through intermediate pumping and booster pumps. The implementation of new scheme i.e., through gravity water supply through transmission lines will eliminate these intermediate pumping stations and booster pumps. This will lead to good amount of savings in energy cost.

6.6.2 Revenue collection

Currently, GVMC is collecting flat rate Rs. 60/KL (bulk water cost) from its consumers. In new scheme, 100% metering is proposed for all households. This will lead to elimination of unauthorised connections and will improve revenue of GVMC through regular monthly billing & collections. Billing through the actual consumption of water instead of fixed rate will increase the revenue. Initially the NRW was 34.82% which has reduced to 4.67.

The saving in non-revenue water reduction is as good as saving the water production. This will lead to the resources more sustainable.

6.7 Impact on Sewerage system

After implementation of 24x7, there is reduction in waste of unused water throwing into the sewerage system. Thus reducing the load on sewage system ultimately reduction in operating cost of Sewage Treatment Plant and sewage pumping stations.

6.8 Less wastage of water

Reduction in NRW and wastage of water, will improve the sustainability of the source and reduce over exploitation of water source. As water is available for 24x7 will reduce the use of existing borewells thereby improves the level of ground water table considerably.

6.9 Electronic meter reduces the loss of revenue

The ultrasonic water meters are provided through which exact water consumption can be measured. As 100% metering will do and the consumer has to pay only for their actual consumption as per the tariff fixed by GVMC will reduce the loss of revenue to GVMC.

7 Findings: Metering System

7.1 ADVANCED METERING INFRASTRUCTURE (AMI)

- 7.1.1 Providing Advanced Metering Infrastructure (AMI) with Self powered Ultra Sonic flow meter with LoRa (Long Range) communication to individual HSC consumers.
- 7.1.2 Providing gateways for Remote Data Transmitting to AMR smart meter management system (WARLUS Concentrator) with Solar Power Supply on High raised buildings to collect the meter data through LoRa (Long Range) & Sending Via GPRS Communication to web server.
- 7.1.3 Data Computation, Report generation, Raising Demand & Collection.
- 7.1.4 Each meter was geotagged, and all the consumer data will be fed into the data base.



7.1.5 Assess the NRW between DMA inlet and total number of consumers served in DMA.

7.2 Solar Power system

In order to have the sustainable power supply for Gateway concentrator and Remote Transmission units' solar panels were provided battery backup can last for 10-15days at the worst climatic condition (monsoon)

7.3 ScadaMonitoring system

In 24x7 it is implemented for monitoring of the distribution network. The following activities will be monitored through SCADA

7.3.1 The valves in the distribution system will be operated through piezoelectric accelerometers connected to SCADA.

7.3.2 The real time data from bulk flow meters will also be logged into the SCADA system.

7.3.3 Data from the AMR meters will be processed by the SCADA system and usage data will be communicated to the consumers from time to time.

7.3.4 Monthly bill generation and payment records will be integrated with the system.

7.3.5 Real time data from the pressure transducers will be logged in the SCADA system.

	
<p>AMI water meters installed in houses through House Service connection</p>	<p>AMI Gateway Concentrators for collection and transmitting the meter reading data to the central Server from each DMA</p>
	
<p>Data Collection & Transmitting RTU with Solar Power Supply at DMA inlet</p>	<p>RTU Panel in DMA Inlet – SCADA Based DMA Management System</p>



7.4 Master balancing reservoir (MBR) management

- 7.4.1 Measurement of instant & cumulative flow of inlet & outlet of the MBR to conduct NRW Audit and synchronization with pumping station to vary the discharge according to demand in distribution.
- 7.4.2 Quality analyzers for PH & Chlorine at MBR to monitor continuously for assured water quality.
- 7.4.3 Level Management of MBR to monitor and synchronize with VFD supported Pumps at pumping station to control and avoid the overflow.
- 7.4.4 RTU control panel with solar based power to connect all instruments, auto & manual operation, data compiling and synchronize with central server for remote operation on real time.

7.5 OFF take management (feeder mains to storage reservoirs)

- 7.5.1 Hydro Dynamic & electric operated Pressure control valves to manage the required outlet pressure according to demand and ensure the pressure in main line to meet other areas demand
- 7.5.2 Flow measurement for Precise allocation of water into the tapping points which supply water to 29 ELSRs & GLBRs (Existing & New).
- 7.5.3 RTU control panel with solar based power to connect all instruments, auto & manual operation, data compiling and synchronize with central server for remote operation on real time.

7.6 DMA Management

- 7.6.1 Hydro Dynamic & electric operated Pressure control valves on inlet of the Individual DMA for ON/OFF operation to ensure constant downstream pressure.
- 7.6.2 Self-powered Ultrasonic flow meter at inlet of the individual DMA to measure the flow & Volume to asses & conduct NRW Audit.
- 7.6.3 RTU control panel with solar based power to connect all instruments, auto & manual operation, data compiling and synchronize with central server for remote operation on real time.

8 SERVICE LEVEL BENCHMARK (SLBM) INDICATORS

After implementation of 24x7 water supply in 20 DMAs the service level of were improved and the same is table 10 below:

Table 10: Service Level Benchmark Indicators

Sl. No.	Indicators	Required	Before 24x7 (Block 6, 7, 10, 12 & 13)	Present (after 24x7)(Block 6, 7, 10, 12 & 13)
1	Household level coverage of direct water supply connections	100%	59.42%	100%
2	Per capita supply based on current consumption.	135 lpcd	128.59 lpcd	130 lpcd



Sl. No.	Indicators	Required	Before 24x7 (Block 6, 7, 10, 12 & 13)	Present (after 24x7)(Block 6, 7, 10, 12 & 13)
3	Extent of metering of water connections	100%	10.32%	100%
4	Extent of NRW loss in this project	10-12%	38.16%	4.67%
5	Continuity of water supply	24 hrs	45-60 min	24hrs
6	Quality of water supplied (CPHEEO Std)	100%	100%	100%

9 Conclusion

- 9.1. Preparation & systematic implementation of SIP with Smart meters, AMI, Off-take Point Management, pressure management, distribution reservoir management, SCADA etc. have assisted to identify and reduce the sources of NRW.
- 9.2. Generation of DMA wise data is very helpful in analyzing the problems to address it immediately and assess the water consumption pattern of the particular and which can be used for taking up schedule maintenance work of the block or DMA.
- 9.3. The utilisation of solar power have reduced the conventional power thus reducing the energy cost as well as having significant effect on CO2 emissions.
- 9.4. With 100% metering of households will improve the revenue collection. After 24x7 commissioned in block 6, 7, 10, 12 & 13 there is a water saving of 646KL/day which saves around Rs.1.415 Cr /annum (646*365*60=1.415) to GVMC

10 Recommendation

- 10.1. The implementation of 24x7 has increased the public happiness index as they are having time for other activities. Hence it is recommended to extend to other part of the city.

10.2. The best practices adopted shall be implemented in other state in India.

11 Bibliography

The handbook of 'Service Level Benchmarking (SLBM)' published by Ministry of Housing and Urban Affairs (MoHUA), (erstwhile Ministry of Urban Development), specifies performance indicators to assess quality of service, effectiveness of the systems to manage the water supply networks with technical and financial sustainability.

