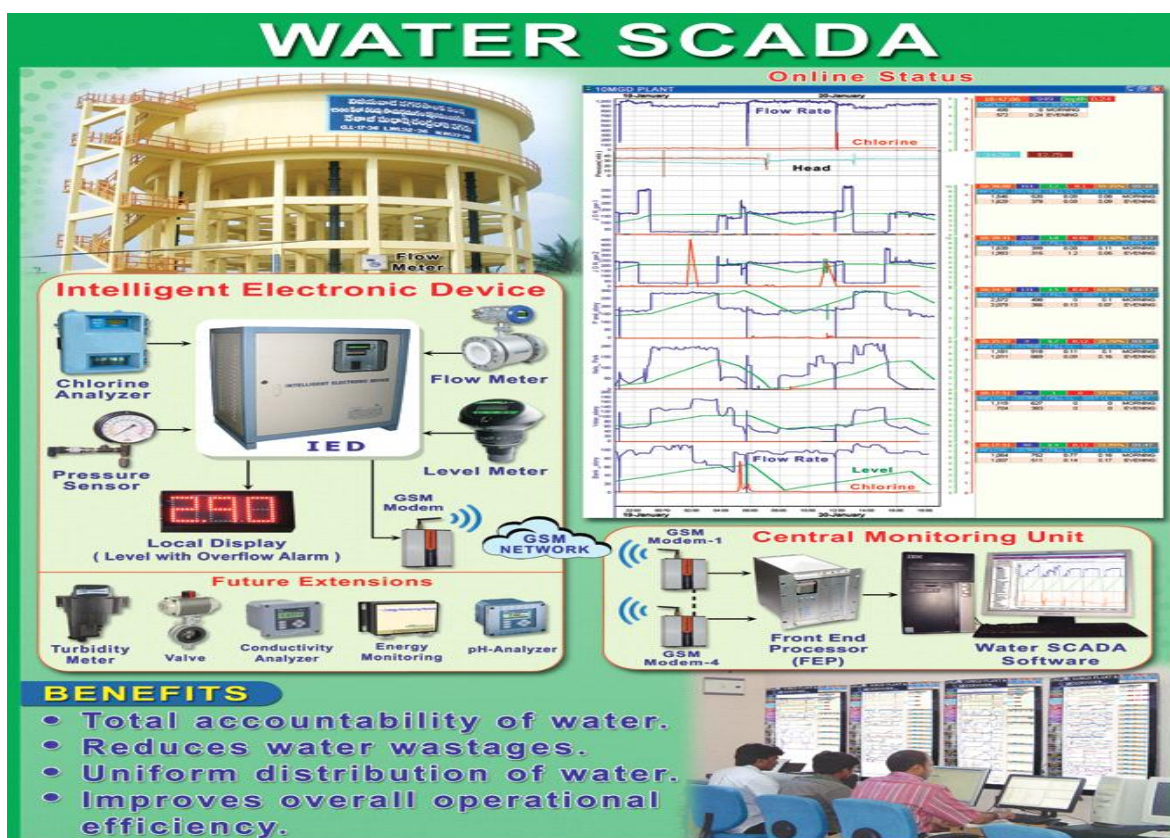


## Documentation of Best Practices-2

### WATER SCADA – AN INNOVATIVE IT SOLUTION FOR IMPROVING URBAN WATER SUPPLY MANAGEMENT

The Case of Vijayawada Municipal Corporation, Andhra Pradesh



Researcher: Prof. V. Gnaneshwar



**Regional Centre for Urban and Environmental Studies**  
Sponsored by Ministry of Urban Development, Govt. of India  
Osmania University, Hyderabad – 50000



## **FOREWORD**

Importance of safe drinking water is well recognized globally and in India. The Government of India, the State Governments and the ULBs are giving top priority for providing drinking water to the increasing urban communities. The more significant aspect of the urban water supply is quality control. The Indian Water Policies and the successive Five Year Plans accorded top priority for providing quality water by efficient monitoring and quality control. Water SCADA has emerged as an useful tool for achieving this objective.

The RCUES, Hyderabad has been focusing on core municipal services like solid waste management and urban water supply management in its research and capacity building activities. As part of this, the RCUES, Hyderabad has conducted a study to document the case of Water SCADA in Vijayawada Municipal Corporation which is one of the Mission Cities under the JnNURM scheme. This study brought-out some useful insights into the working of the Water SCADA. It is hoped, it would inspire the other Mission Cities to adopt the Water SCADA by appropriate customization as useful tool for achieving quality in the urban water supply apart from improving monitoring and surveillance systems.

The RCUES, Hyderabad acknowledges the support provided by G. Ravi Babu, IAS, Commissioner, M.V. Suryanarayana, Executive Engineer and other officials of the Vijayawada Municipal Corporation, and the Efftronics Systems Pvt. Ltd., Vijayawada during our study.

**Prof. Bhupatthi Rav  
Director.**

# **CONTENTS**

<b>Chapter</b>	<b>Page Nos.</b>
<b>I      URBAN WATER SUPPLY POLICIES IN INDIA – EMERGING FOCUS ON DATA ACQUISITION FOR QUALITY MANAGEMENT</b>	<b>1 – 3</b>
<b>II     URBAN WATER SUPPLY- MANAGEMENT ISSUES</b>	<b>4 – 5</b>
<b>III    WATER SCADA- THE CASE OF VIJAYAWADA MUNICIPAL CORPORATION</b>	<b>6 - 26</b>
<b>IV    IMPACT OF WATER SCADA REFORM</b>	<b>27 - 30</b>
<b>V     PERSPECTIVES AND WAY AHEAD</b>	<b>31 - 32</b>

## **CHAPTER-I**

### **URBAN WATER SUPPLY POLICIES IN INDIA - EMERGING FOCUS ON DATA ACQUISITION FOR QUALITY MANAGEMENT**

The importance of safe water supply is universally well recognized as a development indicator. It is not exaggeration to state that safe drinking water and sanitation are critical determinants, which directly contribute nearly 70–80% in reducing the burden of communicable diseases. Safe drinking water is a primary human need and very essential for protecting the health of the people. But, India's fragile water sources are stressed and depleted due to urbanization, industrial growth and deforestation. For instance, per capita available water resources depleted to 2,384 m<sup>3</sup> in 53 years from 6008 m<sup>3</sup> in 1947.

It is estimated that by 2025 more than 50% of the India's population will be living in cities and towns. In tune with the increasing urbanization, the demand for protected water is also growing. The demand growth scenario of urban India thus, poses critical problem to the Governments as only 91 to 93% of urban population have access to safe drinking water. At the other end, the cost of rapid urban growth has been very much visible in the urban sector with depletion of ground water, water logging, water quality decline and pollution.

The Ministry of Water Resources (MoWR) drafted a National Water Policy in 1987 to guide the planning and development of water resources throughout the country. The policy included several recommendations, which were subsequently adopted by the states. The recommendations focused on the need for introducing (i) water resource management and according domestic water supply the highest priority, (ii) design standards for groundwater structures to protect groundwater sources, (iii) water quality monitoring and mapping, and (iv) data management and valuation. A new National Water Policy adopted in 2002, accorded top priority to drinking water. The National Water Policy recognized the need for well-developed information systems at the national and state level, comprising of standardized networks of data banks and databases as a prerequisite for resource planning.

Water supply and sanitation were added to the national agenda during the first five-year planning period (1951-1956) itself, and increasing investments have been made in

subsequent plans in India. The first five Plan periods were characterized by relatively negligible investments in water supply and sanitation. Since the beginning of the Sixth Five-Year Plan (1980-85) and the launch of the International Drinking Water Supply and Sanitation Decade, India has substantially increased its commitment to the water supply and sanitation sector, and remarkable progress has been achieved on many fronts.

The national water and sanitation policy guidance was laid in the Eighth Five Year Plan. The Eighth Plan while recognizing the safe drinking water and sanitation as vital human needs for health and efficiency laid down the guiding principles, viz., management of water as a commodity, delivery of water services based on principles of effective demand and standards of services corresponding to the level that users are willing to maintain. The subsequent plans too pursued these guidelines. In fact, the Indian Five Year Plans since Eighth Plan follow the principles of the New Delhi Declaration adopted by the United Nations General Assembly in December, 1990, viz., (a) protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid waste; (b) organization of reforms, promoting and integrated approach including changes in procedures, attitudes and behavior and full participation; (c) community management of services, backed by measures to strengthen local institutions in implementing and sustaining water and sanitation programs; and (d) sound financial practices, achieved by better management of existing assets and extensive use of appropriate technologies. The goals set by the Tenth Five Year Plan clearly indicate the service standards. The Plan aims 100 per cent coverage of urban populations with safe drinking water as per stipulated standard of 40 lpcd; establishment of national wide quality monitoring and surveillance systems, evolving cost effective and socially acceptable O & M strategies like regularity of supply, avoiding excessive withdrawal leading to depletion and the need for conserving water and fixing appropriate tariffs accompanied by substantial improvements in service quality.

The JnNURM and the 11<sup>th</sup> Five Year Plan give top priority to these issues. About 40% of plan funds are likely to be towards the water and sanitation sector. Computerized MIS is a must for developing a strong data base on Urban Water Supply for decision making, planning, and mid-course corrections from time to time. The 11<sup>th</sup> FYP apart from giving priority to other vital areas of urban water supply observed that computerized MIS is a must for developing a strong data base at Local, State, and Central levels on Urban Water

Supply and Sanitation sector for decision making, planning, and mid-course corrections from time to time. In most States, elaborate computerized MIS is not in place. It is recommended that MIS cells may be created with central funding at State and Central levels for exchanging information and to develop good data base for the sector. Further, it emphasized that water quality surveillance and monitoring should be given top most priority by the State Governments/ULBs so as to ensure prevention and control of water-borne diseases

## **CHAPER-II**

### **URBAN WATER SUPPLY- MANAGEMENT ISSUES**

The main problems relating to urban water supply are: outdated and badly maintained distribution networks resulting in high operating costs, low pressures and intermittent supplies leading to back siphoning and contamination, high physical losses ranging from 25 to 50 percent; inadequate personnel training; inadequate data; lack of performance evaluation; and monitoring; and overlap of functions between ULBs and other institutions.

On the management front, the urban water supply sector in India suffers from chronic inefficiencies in the coverage, quality and efficient delivery of the service. The focus so far has been mostly on supply side factors, such as capital investments, the creation of infrastructure, cost recovery etc. This approach though needed, is found to be inadequate to meet the demand and improve the service delivery. One of the primary lacunae has been the lack of reliable information on the performance of utilities at various stages resulting in the poor monitoring. Data inadequacies result from the lack of appropriate infrastructure; systems to measure and record data; and incentives and/or necessary regulatory systems that require such data to be generated. For instance, water production data provided by the utilities are considered Grade A, if output of the water treatment plants is measured using flow meters. This is used as an indicator in the benchmarking system for better performance evaluation of the utility. Water quality surveillance and monitoring should be given top most priority so as to ensure prevention and control of water-borne diseases.

The Supervisory Control And Data Acquisition (SCADA) System has emerged as great potential area in real time monitoring and control of the distribution systems through state-of-the art encompassing all networks including water supply. Evidence across various sectors, energy, water supply, etc. prove the efficacy of the SCADA system for plugging pilferage points, enhancing the quality of energy/water supply, facilitation of faster identification and rectification of faults, and for proper planning of networks.

It is in this backdrop, the initiative of the Vijayawada Municipal Corporation (VMC) in the form of Water SCADA becomes significant. This research paper documents the experience of the VMC while throwing useful insights into the water SCADA performance.



### **CHAPTER-III**

#### **WATER SCADA - THE CASE OF VIJAYAWADA MUNICIPAL CORPORATION**

The Municipality of Vijayawada (Bezawada) was constituted on 1st April, 1888 and was upgraded as a selection grade municipality in the year 1960. The municipality was upgraded to Vijayawada Municipal Corporation (VMC) in 1981. The total area of the corporation is 58 sq. kms with a population of over ten lacs at present . The city is divided into 59 political wards.

The VMC has introduced several e-Governance and other reforms in the municipal governance to offer good governance to the people and to realize the reform objectives of the JnNURM. On line citizen grievance redressal system, property tax reform, introduction of the accrual double entry accounting system and IT enables MIS and SCADA are some of the important initiatives in this respect. Due to its consistent endeavors, it won several awards and laurels. VMC is the first Corporation in the State to receive ISO 9001 Certification for Quality Management System. CRISIL has bestowed Best Practices Award for the "Siti e-Governance" Project. And VMC was the Finalist in Stockholm Challenge Award too. The water management reforms are more significant and has own national level laurels. For instance, the Corporation started implementing energy audit and energy savings methods to reduce the power bills and overall operation and maintenance cost. The monthly power bills were reduced to 50-60% by this method. Further, the VMC offered water-tap connections on demand and covered all households on a mission mode. In the process, the Vijayawada has become the first city in the country to have universal access to treated-water supply. Existing water connection charges were reduced, and procedures streamlined. This has earned the VMC a national award (under runner category) under Services to the Poor category of the National Urban Water Awards for the year 2009. Similarly, the SCADA initiative of the VMC is also a significant initiative for improving the water supply management.

## **1. Water Supply in Vijayawada Municipal Corporation**

In respect of protected drinking water, the Vijayawada Municipal Corporation has an installed capacity of 50 mgd for surface water from Krishna River and 5mgd water for drawing by bore wells additionally. But, the actual water being supplied is 39 MGD every day to the city residents. For treatment of the water, there are five plants with a capacity of 50 mgd. The distribution network comprise of 60 water reservoirs with another 4 under construction with a storage capacity of 620.50 lac gallons. The total number of house service connections are 80,825 (including 30,573 connections for BPL households), of which only 7,143 connections (non-residential) are metered while the remaining are not metered. It means only about 9 per cent of the connections are metered.

## **2. Situation before Implementation of the Water SCADA**

The basic problem of the water supply in the VMC similar to other ULBs in India is the lack of accurately measured data on various parameters of supply viz., flow, overflows, leakages, chlorine level, etc. In fact, huge quantities of treated water was wasted due to overflows and leakages at the service reservoirs. A pilot study was conducted at Governerpet before implementation of the SCADA. The pilot study brought-out several such problems to light. For instance, the study revealed that about 13,138 kilo liters of purified water was leaked-out from the reservoir at Governerpet during a month of observation which worked-out to a loss of Rs 3,15,000/- per reservoir per year in financial terms. The main causes identified were incomplete closing of the valves, no timely maintenance of valves, etc. Further, water overflowed at the reservoir due to no timely closing of valves in the absence of overflow indication and alert mechanism available. The over flows accounted for about 4,700 kilo liters of purified water in the pilot study. The leakages and the overflows were found to be the main problems which resulted in the Unaccounted For Water (UFW) estimated to be about 40 to 45 per cent. For instance, if the estimated 40 per cent of the water losses of UFW before implementation of the Water SCADA are deducted from the total water supply of 39 MGD, the net supply comes to about 24 MGD only. The SCADA project was implemented to overcome these problems.

## **3. Water SCADA in VMC**

The water SCADA was implemented in the VMC under the JnNURM scheme of the Ministry of Urban Development, Government of India. The SCADA project formed part

of the total JnNURM project of the VMC. The cost of the project was about 5.4/- crore including the capital cost of Rs. 4.8/- for installation. The project is of four year duration- one year for implementation and installation and three year contract for maintenance. The Efftronics Systems Pvt. Ltd., Vijayawada executed the project and the contract included one year execution and three years maintenance. The Efftronics which has long experience in the signaling system for the Indian Railways customized its hardware and software to make it suitable to the water supply systems.

### ***Objectives of the Reform***

The main purpose of the project was to acquire critical data online by accurate measurement and generate reports for taking timely corrective measures by the water supply officials on parameters like flow, level and chlorine. The specific objectives identified are:

- Ensuring quality from source to end user by an online measurement and monitoring.
- Rationalization of existing distribution to avoid imbalances created by excess supply in one area and shortfall in other area.
- Ensuring regular water supply in terms of timing and duration.
- Reducing unaccounted for water.
- Reduction/optimization in unit cost of production.
- Complete elimination of overflows up-to 0% level.
- Rationalization of fillings of ELSRs/Boosters.
- Generation and utilization of data for planning.

### ***Strategy***

The focus of the project has been on the data based management. A comprehensive online data and information base was set-up with tested software and equipment. IT enabled solution was the prime strategy adopted in the entire exercise.

### ***Activities Implemented***

The project involved several dimensions of MIS: data acquisition; installing measurement equipment on identified parameters; networking; report generation; and online monitoring.

**Data acquisition:**

Data acquisition is one of the major phases in the Water SCADA project. Various parameters concerning the measurement of the quantity, quality and controlling were logged after due validation, processing, time stamping and storing.

- Parameters logged for Quantity Measurement were Flow Rate and Level.
- Parameters logged for Quality Measurement were Free Residual Chlorine (PPM) at Water Treatment Plant and Free Residual Chlorine (PPM) at ELSR filling period and also during distribution time.
- Parameters logged for improvement of the plant / booster stations operations were Power Consumption of Pumps and Pressure Head on the pumps.
- Parameters logged for controlling were Pump ON/OFF Status, Pump Parameters: Frequency, Amps, Rpm and Valve position.

**Instrumentation:**

Following measuring equipment were installed to measure on the above parameters.

Equipment	Principle	Advantage
1. Flow Meter	Ultrasonic principle or magnetic field principle	<ul style="list-style-type: none"><li>• To measure outlet flow rate at plant, reservoir inlet and outlet flow rate</li><li>• To measure flow rate at junction points to identify UFW.</li></ul>
2. Level Meter	Ultrasonic principle	<ul style="list-style-type: none"><li>• To measure depth of water in the reservoir.</li><li>• To measure depth of water in the sump with respect to plant</li></ul>
3. Chlorine Analyzer	DPD method	<ul style="list-style-type: none"><li>• To measure free residual chlorine at the plant outlet, reservoir inlet and reservoir outlet</li></ul>

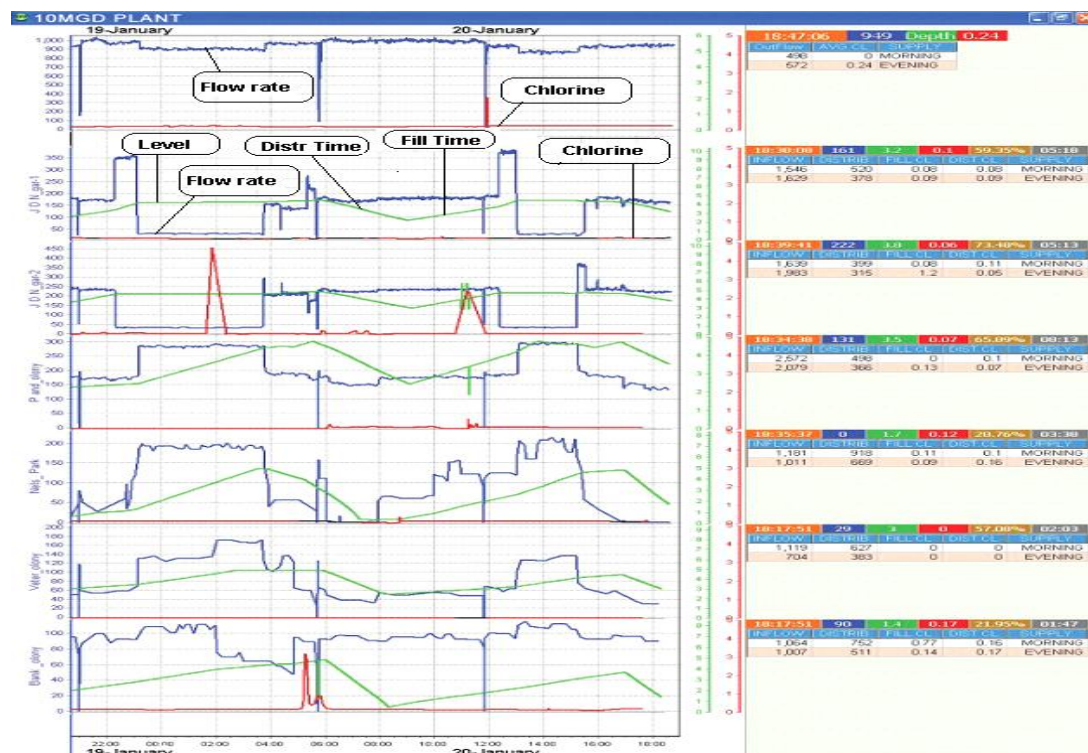
**Online Information at a Central Place and Networking:**

Data collected from the site was validated, processed for representing the reports in user required format and networked into a central place. Networking is very important and crucial for integrated management of the project. GSM communication is tested in pilot project and adopted, since the rate of change of data is not faster. Full handshaking mechanism is implemented between the IED (Intelligent Electronic Device) at reservoir and FEP at Central Monitoring Unit to avoid the data losses in any circumstances. On line

trending of various operations facilitates monitoring for taking timely corrective actions. The following aspects are monitored online.

The Flow, Level and Chlorine at each plant and reservoir provide information on whether all the reservoirs have been supplied with enough water or not based on which supervisory control can be executed by the water supply engineer to rationalize the water supply by altering the filling plan of reservoirs (Chart-1). This is useful in understanding the day trend for the following parameters: Flow rate at the pumping main; pressure head at the pumping main; flow rate at the reservoir inlet; quantity of water filled into the reservoir; quantity of water distributed from the reservoir to ensure sufficient distribution; water leaked during storage period; overflow quantity; chlorine during time of filling; chlorine during time of distribution from a reservoir are shown to ensure quality water.

**Chart-1: Day Trending of the Reservoirs**

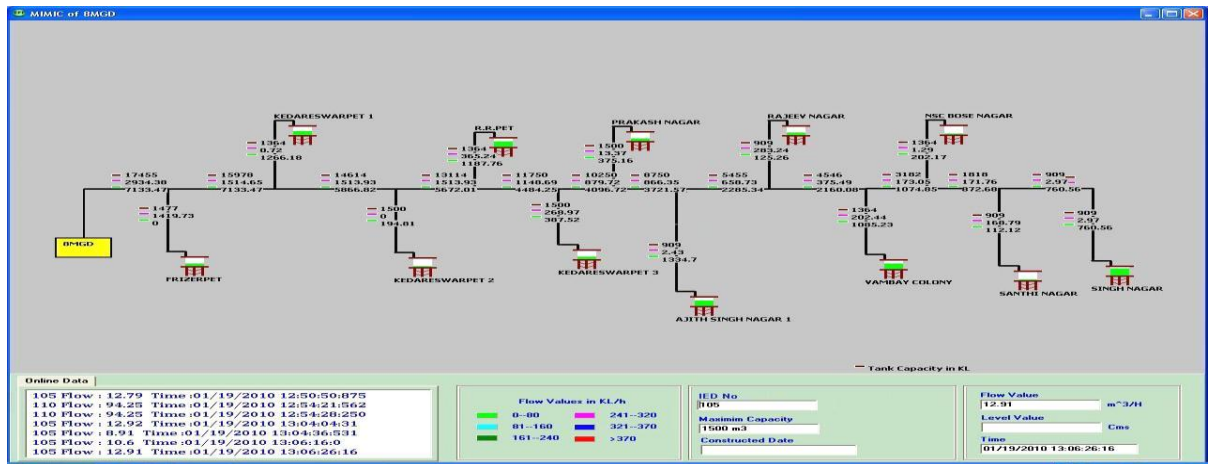


The following online benefits were observed in the process.

***Mimic display of plant and reservoirs network***

The flow rate and level at each point in the network as shown in chart-2 will identify plant outflow rate, accumulated plant outflow for the day, reservoir inflow rate, accumulated reservoir inflow quantity and designed flow rate at different points in the network.

**Chart-2: Mimic Display of Plant and Reservoir**



### Monitoring online exceptions

The abnormal behavior of reservoir operations will draw the water supply engineer attention towards immediate issues like early filling, late filling, early distribution, late distribution, low chlorine, less chlorine, overflow are triggered in online (chart-3). The water supply engineer can take appropriate action immediately.

**Chart-3: Online Exceptions Tracking**

Online Exceptions		
Exceptions   Equipments Health   Faults		
RESERVOIR NAME	FAULT MESSAGE	OCCURED TIME
Gollapalem gattu	Less Chlorine	01/19/2010 00:06:18.844
Fish Market	Less Chlorine	01/19/2010 00:13:26.484
H B Colony-2	Less Chlorine	01/19/2010 00:07:30.422
H B Colony - 1	Filling Started Late	01/19/2010 00:02:45.688
H B Colony - 1	Less Chlorine	01/19/2010 00:04:04.891
Kedareswarpet2	Filling Started Late	01/19/2010 00:01:00.609
Kedareswarpet2	Less Chlorine	01/19/2010 00:06:54.219
Machavaram 2	Filling Started Late	01/18/2010 23:59:53.234
P and T Colony	Filling Started Late	01/19/2010 00:03:16.78
ORRS	Filling Started Late	01/19/2010 00:03:03.812
Bank Colony	Filling Started Late	01/19/2010 00:12:06.859
Priyadarshini Colony	Filling Started Late	01/19/2010 00:03:30.141
Nelson Mandela Park	Filling Started Late	01/19/2010 00:06:17.516
Vambay colony	Filling Started Late	01/19/2010 00:03:00.859
Raja Rajeswari Pet	Less Chlorine	01/19/2010 00:19:26.781
Prakash Nagar	Less Chlorine	01/19/2010 00:14:39.625
Kedareswarpet3	Less Chlorine	01/19/2010 00:14:50.734
Vambay Colony	Filling Started Late	01/19/2010 00:03:13.284

Analog Beep: YES Digital Beep: YES Popup Faults Screen: NO

Clear Faults

### Monitoring chlorine chart in software

The chlorine chart as shown below chart-4 informs the user regarding amount of chlorine to be mixed in water for right quality during distribution.

**Chart-4: Chlorine Chart**

Chlorine Chart						
Chlorine[PPM] 2 VOL[L] 4500 Weight [gms] 28.0515 Weight [kg] 0.006232666666666667						
Save						
Reservoir Name	Inform Time (h:m:m:ss)	Volume of water in tank(KL/hr)	Quantity of Bleaching powder required(Kg)	Target Chlorine to be raised(ppm)	Avg Chlorine(ppm)-Distribution	Chlorine mixed
16 MGD						
Gollapalem gattu	4:17:55	0	0	0.66		0
Gulamohiddin Nagar	4:33:51	652.446	1.71	0.84	1.8	1.30
Rahman Park	5:24:59	1960.338	4.28	0.7	0.817	0
Sn Nagar Colony	5:24:15	1138.799	4.29	1.21	1.002	0.75
Gandhi Nagar2	5:30:28	1340.422	4.18	1	0.73	0
Gandhi Nagar1	5:30:29	1457.451	4.36	0.96	1.02	0
Mallikarjun pet	5:31:07	1403.101	4.15	0.95	1.012	0
Labbipet	5:20:31	1550.088	5.6	1.16	1.417	2.79
8 MGD						0
Rajeev Nagar	16:20:01	1487.925	6.86	1.53	0.592	0.55
Singh Nagar(old)	5:15:02	1239.341	3.55	0.92	2.181	4.25
Santhi Nagar	5:18:42	1451.032	7.06	1.56	1.351	4.12

### Reports Generated

The following reports were generated and used for controlling and continuous monitoring of various operations.

#### Daily Report

Daily report (tables-1 to 3) generated with an array of details regarding reservoir like the capacity of reservoirs in kilo liters, total depth of water in tank, filling start time of selected session, filling end time of selected session, duration of filling, in flow, over flow volume, fill status, distribution from and start time (HH:MM), distribution actual duration, net quantity pumped (kl), UFW Fill (kl): leakage while filling, UFW Overflow (kl)-UFW due to overflow, UFW Storage (kl)-inflow while storage, UFW Dist (kl)-inflow while distribution, UFW Total (kl)-total UFW, Filling Cl (ppm)-chlorine in water filled into the reservoir and distribution and CL (ppm)-chlorine in water distributed to public.



**Table-1: Overall Reservoirs Report (19-Mar, 2010- Morning)**

RESERVOIR INFORMATION				FINDINGS (HH:MM)			INFLOW VOLUME (KL)					LEVEL						
S. No	Reservoir Name	Capacity (KL)	Height (m)	From Time (HH:MM)	To Time (HH:MM)	Actual Duration (HH:MM)	InFlow volume (KL)	Over Flow (KL)	Storage In Flow (KL)	Distr InFlow (KL)	Total InFlow (KL)	Fill Start Level (m)	Fill Start Volume (KL)	Fill End Level (m)	Fill End Volume (KL)	Net QTY Pumped (KL)	%Reservoir Filled	Fill STATUS
1	Labbipet	1,477.00	5.00	20:57	03:15	06:18	1,995.31	0.00	0.74	4.64	2,000.69	0.13	32.71	4.96	1,594.05	1,561.34	99%	FULL
2	Match Factory	1,477.00	5.00	19:47	05:25	09:38	1,958.69	0.00	11.78	89.75	2,060.22	0.20	45.95	3.99	1,189.19	1,143.24	80%	NOT FULL
3	Mallikarjun pet	1,477.00	4.35	19:58	03:33	07:35	1,558.45	0.00	1.26	287.71	1,847.42	0.26	81.09	4.14	1,291.15	1,210.06	95%	FULL
4	Lorry Stand	1,477.00	3.66	21:08	02:35	05:27	1,491.28	0.00	0.26	579.93	2,071.47	0.14	45.43	3.58	1,385.09	1,339.66	98%	FULL
5	Gandhi Nagar1	1,477.00	4.50	18:16	04:30	10:13	1,622.69	0.00	49.98	36.83	1,709.50	0.85	284.79	4.19	1,403.84	1,119.05	93%	FULL
6	Gandhi Nagar2	1,477.00	4.15	19:48	04:58	09:10	1,375.32	0.00	20.47	78.19	1,473.98	0.78	230.39	3.67	1,290.86	1,060.47	88%	NOT FULL
7	Machavaram1	517.00	3.00	17:13	04:22	11:08	1,631.00	0.00	93.19	27.95	1,752.14	0.73	125.94	3.00	517.56	391.62	100%	FULL
8	Frizerpet	1,450.00	3.00	20:01	07:00	10:58		0.00			15,055.49	1.66	0.00	1.51	0.00	0.00	50%	NOT FULL
9	Machavaram 2	517.00	3.00	17:26	04:28	11:01	618.51	0.00	12.43	111.11	742.05	0.36	62.11	2.91	502.03	439.92	97%	FULL
10	Gandhigi high School	1,023.00	3.20	19:26	01:32	06:05	997.25	0.00	1.52	36.25	1,035.02	0.19	37.43	3.15	927.46	890.03	98%	FULL
11	Kadareswarpet-1 [old]	1,363.00	3.38	18:44	22:32	03:47	1,363.69	0.00	2.72	1.21	1,367.62	0.31	126.62	3.31	1,351.96	1,225.34	98%	FULL
12	N.S.C Bose Nagar	1,477.00	5.00	21:32	03:31	05:58	1,182.22	0.00	108.57	64.56	1,355.35	0.86	243.13	4.56	1,344.02	1,100.89	91%	FULL
13	Vambay colony	1,364.00	5.13	21:20	04:07	06:46	1,564.51	0.00	6.14	2.82	1,573.47	0.25	48.36	4.98	1,415.42	1,367.06	97%	FULL
14	J D Nagar-1	1,500.00	5.00	19:58	00:30	04:31	910.86	0.00	1,126.54	551.93	2,589.33	1.85	442.93	4.21	1,236.68	793.75	84%	NOT FULL
15	J D Nagar-2	1,500.00	4.95	20:04	00:13	04:08	817.58	0.00	1,203.00	572.23	2,592.81	2.60	695.13	4.61	1,371.22	676.09	93%	FULL
16	P and T Colony	1,500.00	5.00	19:59	03:38	07:38	1,529.26	0.00	552.11	57.66	2,139.03	2.05	541.73	4.73	1,358.19	816.46	95%	FULL
17	Nelson Mandela Park	1,000.00	5.00	19:23	02:35	07:12	1,003.37	0.00	626.25	91.74	1,721.36	0.25	27.06	4.95	987.51	960.45	99%	FULL
18	Veternary Colony	1,200.00	5.00	18:38	01:47	07:09	565.14	0.00	683.53	276.56	1,525.23	3.18	738.62	4.84	1,205.08	466.46	97%	FULL
19	Bank Colony	1,000.00	5.00	18:47	00:01	05:13	956.23	0.00	1,064.53	501.72	2,522.48	0.94	128.28	4.83	995.07	866.79	97%	FULL
20	Sri Nagar Colony	1,477.00	4.20	21:26	04:21	06:55	1,285.59	0.00	0.03	6.05	1,291.67	0.56	161.66	4.09	1,330.67	1,169.01	97%	FULL
21	Kedareswarpet2	1,500.00	4.90	04:29	05:20	00:50	22.32	0.00	2.90	16.81	42.03	0.30	46.32	0.40	63.86	17.54	8%	NOT FULL
22	Kedareswarpet3	1,500.00	4.95	22:44	05:08	06:23	1,504.89	0.00	0.26	0.06	1,505.21	0.20	30.28	4.53	1,302.62	1,272.34	92%	FULL

23	Priyadarshini Colony	1,477.00	3.62	20:23	04:04	07:41	1,322.21	0.00	1.24	20.12	1,343.57	0.10	40.49	2.85	1,153.88	1,113.39	<b>79%</b>	NOT FULL
24	ORRS	1,500.00	6.11	19:29	03:59	08:30	956.23	0.00	208.58	0.00	1,164.81	0.69	89.02	5.02	647.63	558.61	<b>82%</b>	NOT FULL
25	Rahman Park	1,136.00	3.58	19:18	01:30	06:12	1,339.35	0.00	2.25	53.56	1,395.16	1.26	118.78	3.51	784.90	666.12	<b>98%</b>	FULL
26	Santhi Nagar	910.00	4.18	23:03	06:01	06:57	755.04	0.00	8.49	9.52	773.05	0.21	8.92	3.27	541.44	532.52	<b>78%</b>	NOT FULL
27	Ajith Singh Nagar-1	1,500.00	3.74	20:05	05:33	18:55	2,732.77	0.00	0.65	12.37	2,745.79	0.21	60.70	3.47	1,293.18	1,232.48	<b>93%</b>	FULL
28	Singh Nagar(old)	1,200.00	4.57	20:07	23:04	02:57	1,146.96	0.00	220.27	175.76	1,542.99	0.42	12.72	4.52	754.24	741.52	<b>99%</b>	FULL
29	Rajeev Nagar	1,000.00	4.59	23:05	04:52	05:47	1,068.53	0.00	82.73	0.87	1,152.13	0.35	6.89	4.47	733.44	726.55	<b>97%</b>	FULL
30	Four pillar center	1,500.00	4.70	21:37	05:16	07:38	1,570.34	0.00	68.50	127.37	1,766.21	0.34	114.03	4.19	1,405.20	1,291.17	<b>89%</b>	NOT FULL
31	H B Colony-2	455.00	2.98	00:48	04:40	03:52	454.99	0.00	0.00	0.53	455.52	0.29	0.00	3.02	0.00	0.00	<b>100%</b>	FULL
32	Gulamohiddin Nagar	455.00	5.25	21:19	00:06	02:47	612.45	0.00	149.52	175.17	937.14	0.33	43.15	4.84	632.83	589.68	<b>92%</b>	FULL
33	Gollapalem gattu	455.00	5.25	21:49	03:58	06:08	354.09	0.00		258.22	612.31	0.15	12.99	4.20	363.82	350.83	<b>80%</b>	NOT FULL
34	Rama Rajya Nagar	1,477.00	5.86	20:38	03:02	06:24	1,456.18	0.00	445.13	308.07	2,209.38	0.06	15.27	5.27	1,341.59	1,326.32	<b>90%</b>	FULL
35	Gandhi Bavi-1	230.00	4.00	17:03	02:12	09:09	480.34	0.00	18.27	213.42	712.03	0.18	13.34	3.33	246.75	233.41	<b>83%</b>	NOT FULL
36	Gandhi Bavi-2	395.00	4.20	18:14	23:41	05:26	372.26	0.00	38.93	0.79	411.98	0.14	12.90	3.96	364.78	351.88	<b>94%</b>	FULL
37	Raja Rajeswari Pet	1,500.00	5.00	20:41	01:24	04:42	1,689.18	0.00	67.28	269.73	2,026.19	0.13	36.49	4.95	1,495.46	1,458.97	<b>99%</b>	FULL
38	Governerpet1	1,137.00	4.48	10:53	21:19	13:32	3,061.35	0.00	301.35	472.77	3,835.47	0.06	17.68	2.97	875.34	857.66	<b>66%</b>	NOT FULL
39	Governerpet2	1,137.00	4.56	21:20	02:17	04:57	1,448.51	0.00	46.77	19.47	1,514.75	0.10	0.00	3.11	0.00	0.00	<b>68%</b>	NOT FULL
40	Krishna Lanka-1	1,477.00	3.67	19:09	06:10	11:01	1,396.47	0.00	0.15	73.67	1,470.29	0.07	30.84	2.09	920.82	889.98	<b>57%</b>	NOT FUL
41	ODA	1,477.00	4.85	20:00	22:47	02:46	341.19	0.00	561.74	328.28	1,231.21	3.86	109.18	4.61	130.40	21.22	<b>95%</b>	FUL
42	Fish Market	1,500.00	4.80	20:07	03:16	07:08	1,014.79	0.00	0.01	0.00	1,014.80	2.13	558.60	4.76	1,421.16	862.56	<b>99%</b>	FUL
43	Brahmamgari matam_2	277.00	3.30	18:45	21:26	02:41	222.57	0.00	591.19	328.54	1,142.30	0.91	55.37	3.19	194.10	138.73	<b>97%</b>	FUL
44	Brahmamgari matam-1	455.00	4.35	21:43	01:54	04:10	574.88	0.00	0.74	526.77	1,102.39	0.23	19.17	4.26	355.10	335.93	<b>98%</b>	FUL

**Table-1: Overall Reservoirs Report (19-Mar, 2010- Morning- contd.)**

DISTRIBUTION										UFW (KL)					AVERAGE CL (PPM)	
S. No	Reservoir Name	From Time (HH:MM)	To Time (HH:MM)	Duration (HH:MM)	Start Level (m)	Start Volume (KL)	End Level (m)	End Volume (KL)	Net QTY Distributed (KL)	Fill	Over flow	Storage	Dist	Total	Filling	Distribution
1	Labbipet	05:21	06:19	00:57	4.69	1,502.79	0.17	42.93	1,459.86	433.97	0.00	92.00	4.64	530.61	0.99	0.76
2	Match Factory	05:33	07:26	01:53	4.00	1,192.40	0.28	64.87	1,127.53	815.45	0.00	8.57	89.75	913.77	1.63	1.45
3	Mallikarjun pet	05:35	09:35	04:00	3.90	1,216.30	0.51	159.06	1,057.24	348.39	0.00	76.11	287.71	712.21	1.37	0.86
4	Lorry Stand	03:52	08:21	04:29	3.50	1,352.39	0.16	51.99	1,300.40	151.62	0.00	32.96	579.93	764.51	3.81	2.69
5	Gandhi Nagar1	05:35	08:11	02:35	4.24	1,420.60	0.16	53.61	1,366.99	503.64	0.00	33.22	36.83	573.69	0.82	1.39
6	Gandhi Nagar2	05:19	07:15	01:55	3.73	1,313.65	0.21	59.02	1,254.63	314.85	0.00	-2.32	78.19	390.72	1.81	1.54
7	Machavaram1	05:31	06:04	00:33	2.64	455.45	0.44	75.91	379.54	1,239.38	0.00	155.30	27.95	1,422.63	1.31	1.07
8	Frizerpet									15,055.49	0.00			15,055.49	1.90	
9	Machavaram 2	04:41	07:52	03:11	2.95	508.93	0.31	53.48	455.45	178.59	0.00	5.53	111.11	295.23	0.09	0.46
10	Gandhigi high School	05:41	07:46	02:05	3.06	894.50	0.92	203.04	691.46	107.22	0.00	34.48	36.25	177.95	1.80	2.14
11	Kadareswarpet-1 [old]	05:27	08:06	02:38	2.72	1,110.97	0.08	32.68	1,078.29	138.35	0.00	243.71	1.21	383.27	0.49	0.87
12	N.S.C Bose Nagar	06:08	07:22	01:13	4.72	1,391.63	0.43	119.09	1,272.54	81.33	0.00	60.96	64.56	206.85	0.60	0.60
13	Vambay colony	06:11	07:42	01:30	4.83	1,368.69	1.13	246.26	1,122.43	197.45	0.00	52.87	2.82	253.14	0.98	1.21
14	J D Nagar-1	05:34	08:58	03:23	4.32	1,273.68	1.19	240.91	1,032.77	117.11	0.00	1,089.54	551.93	1,758.58	0.07	0.08
15	J D Nagar-2	05:35	09:06	03:30	4.67	1,391.40	1.99	489.95	901.45	141.49	0.00	1,182.82	572.23	1,896.54	0.07	0.61
16	P and T Colony	05:58	09:34	03:36	4.44	1,269.84	0.10	21.72	1,248.12	712.80	0.00	640.46	57.66	1,410.92	0.00	
17	Nelson Mandela Park	05:44	08:23	02:39	4.50	889.70	0.32	35.49	854.21	42.92	0.00	724.06	91.74	858.72	0.10	1.65
18	Veternary Colony	05:58	08:16	02:17	4.80	1,193.84	3.49	825.73	368.11	98.68	0.00	694.77	276.56	1,070.01	0.09	0.05
19	Bank Colony	05:19	07:58	02:39	4.82	992.79	1.65	272.07	720.72	89.44	0.00	1,066.81	501.72	1,657.97	0.10	0.15
20	Sri Nagar Colony	05:33	08:05	02:32	4.08	1,327.32	0.24	67.84	1,259.48	116.58	0.00	3.38	6.05	126.01	1.21	0.91
21	Kedareswarpet2	05:31	10:27	04:56	0.42	67.50	0.22	33.04	34.46	4.78	0.00	-0.74	16.81	20.85	0.99	0.84
22	Kedareswarpet3	05:23	06:53	01:30	4.53	1,302.62	0.98	187.19	1,115.43	232.55	0.00	0.26	0.06	232.87	0.55	1.22
23	Priyadarshini Colony	04:45	08:39	03:53	2.82	1,141.74	0.12	48.58	1,093.16	208.82	0.00	13.38	20.12	242.32	3.11	2.36
24	ORRS	05:54	19:31	10:22	0.00	0.00	0.00	0.00	0.00	397.62	0.00	856.21	0.00	1,253.83	2.15	
25	Rahman Park	05:34	07:21	01:46	3.51	784.90	1.31	127.45	657.45	673.23	0.00	2.25	53.56	729.04	1.75	1.04
26	Santhi Nagar	06:06	06:59	00:52	3.28	543.59	0.24	10.53	533.06	222.52	0.00	6.34	9.52	238.38	1.19	1.54

27	Ajith Singh Nagar-1	05:38	07:40	03:35	3.47	1,293.18	0.41	120.79	1,172.39	1,500.29	0.00	0.65	5.92	1,513.31	1.29	1.80
28	Singh Nagar(old)	06:06	08:42	02:35	4.41	731.07	1.09	69.14	661.93	405.44	0.00	243.44	175.76	824.64	0.85	1.19
29	Rajeev Nagar	05:56	07:07	01:11	4.38	714.76	0.37	7.66	707.10	341.98	0.00	101.41	0.87	444.26	0.95	1.01
30	Four pillar center	05:38	08:49	03:10	4.24	1,421.97	0.86	288.42	1,133.55	279.17	0.00	51.73	127.37	458.27	2.43	1.16
31	H B Colony-2	05:31	07:03	01:32	2.94	0.00	0.30	0.00	0.00	454.99	0.00		0.53	455.52	2.72	2.07
32	Gulamohiddin Nagar	05:28	07:16	01:47	4.93	644.60	0.52	67.99	576.61	22.77	0.00	137.75	175.17	335.69	1.65	0.87
33	Gollapalem gattu	03:58	08:00	04:01	4.26	369.02	0.17	14.73	354.29	3.26	0.00	-5.20	258.22	256.28	1.25	1.24
34	Rama Rajya Nagar	04:46	07:40	02:53	5.17	1,316.13	1.58	402.22	913.91	129.86	0.00	470.59	308.07	908.52	3.37	2.61
35	Gandhi Bavi-1	04:51	07:52	03:00	2.88	213.41	0.25	18.53	194.88	246.93	0.00	51.61	213.42	511.96	2.22	1.74
36	Gandhi Bavi-2	04:52	07:30	02:37	3.54	326.09	0.18	16.58	309.51	20.38	0.00	77.62	0.79	98.79	1.90	
37	Raja Rajeswari Pet	05:43	08:35	02:51	3.99	1,202.99	0.20	56.32	1,146.67	230.21	0.00	359.75	269.73	859.69	1.05	1.06
38	Governerpet1	05:36	10:24	04:47	2.42	713.24	0.06	17.68	695.56	2,203.69	0.00	463.45	472.77	3,139.91	0.32	0.05
39	Governerpet2	05:33	08:02	02:28	2.95	0.00	1.37	0.00	0.00	1,448.51	0.00	46.77	19.47	1,514.75	0.14	0.05
40	Krishna Lanka-1	06:25	09:37	03:12	2.08	916.41	0.08	35.25	881.16	506.49	0.00	4.56	73.67	584.72	0.24	0.54
41	ODA	04:25	06:57	02:31	4.32	122.19	3.28	92.78	29.41	319.97	0.00	569.95	328.28	1,218.20	0.14	0.07
42	Fish Market	05:05	08:05	03:00	4.57	1,358.84	2.11	552.04	806.80	152.23	0.00	62.33	0.00	214.56	1.94	0.84
43	Brahmamgari matam_2	04:03	08:23	04:19	2.96	180.10	0.19	11.56	168.54	83.84	0.00	605.19	328.54	1,017.57	1.86	2.44
44	Brahmamgari matam_1	03:57	10:33	06:36	4.03	335.93	0.23	19.17	316.76	238.95	0.00	19.91	526.77	785.63	<b>3.31</b>	<b>2.29</b>

**Table -2: Overall Reservoirs Report (19-Mar, 2010- Evening)**

RESERVOIR INFORMATION			FILLINGS ( HH:MM )				INFLOW VOLUME (KL)					LEVEL						Fill STATUS
S.No	Reservoir Name	Capacity (KL)	Height (m)	From Time (HH:MM)	To Time (HH:MM)	Actual Duration (HH:MM)	InFlow Volume (KL)	Over Flow (KL)	Storage InFlow (KL)	Distr InFlow (KL)	Total InFlow (KL)	Fill Start Level (m)	Fill Start Volume (KL)	Fill End Level (m)	Fill End Volume (KL)	Net QTY Pumped (KL)	% Reservoir Filled	
1	Labbipet	1,477.00	5.00	06:23	15:34	09:10	2,180.35	0.00	3.50	0.00	2,183.85	0.17	42.93	4.93	1,583.91	1,540.98	99%	FULL
2	Match Factory	1,477.00	5.00	06:58	16:53	09:54	2,282.38	0.00	10.64	1.58	2,294.60	0.25	57.74	4.68	1,410.21	1,352.47	94%	FULL
3	Mallikarjun pet	1,477.00	4.35	09:34	15:50	06:15	1,280.96	0.00	1.04	6.18	1,288.18	0.52	162.17	3.60	1,122.74	960.57	83%	NOT FULL
4	Lorry Stand	1,477.00	3.66	09:12	15:21	06:09	1,456.06	0.00	2.44	702.71	2,161.21	0.11	35.62	3.58	1,385.09	1,349.47	98%	FULL
5	Gandhi Nagar1	1,477.00	4.50	09:57	16:21	06:23	1,751.90	0.00	44.33	130.14	1,926.37	0.14	46.91	4.08	1,366.99	1,320.08	91%	FULL
6	Gandhi Nagar2	1,477.00	4.15	07:15	16:47	09:31	1,487.53	0.00	16.32	3.35	1,507.20	0.18	50.46	3.43	1,199.67	1,149.21	83%	NOT FULL
7	Machavaram1	517.00	3.00	06:04	11:21	05:17	827.93	0.00	360.62	19.00	1,207.55	0.43	74.18	2.31	398.52	324.34	77%	NOT FULL
8	Frizerpet	1,450.00	3.00	08:05	19:53	11:48	9,065.18	0.00			9,065.18	0.12	0.00	1.54	0.00	0.00	51%	NOT FULL
9	Machavaram 2	517.00	3.00	07:52	14:37	06:44	334.70	0.00	41.66	23.24	399.60	0.31	53.48	1.77	305.36	251.88	59%	NOT FULL
10	Gandhigi high School	1,023.00	3.20	07:45	14:34	06:49	1,034.71	0.00	0.16	0.00	1,034.87	0.92	203.04	3.06	894.50	691.46	96%	FULL
11	Kadareswarpet-1 [old]	1,363.00	3.38	08:40	16:56	08:16	1,103.69	0.00	11.01	0.00	1,114.70	0.08	32.68	1.95	796.47	763.79	58%	NOT FULL
12	N.S.C Bose Nagar	1,477.00	5.00	16:59	17:30	00:31	169.51	0.00	17.37	0.00	186.88	0.40	110.63	0.97	275.71	165.08	19%	NOT FULL
13	Vambay colony	1,364.00	5.13	08:33	10:51	02:18	595.33	0.00	28.75	0.00	624.08	1.03	221.51	2.73	714.56	493.05	53%	NOT FULL
14	J D Nagar-1	1,500.00	5.00	08:58	16:49	07:51	1,742.20	0.00	28.96	558.36	2,329.52	1.18	238.22	4.34	1,280.40	1,042.18	87%	NOT FULL
15	J D Nagar-2	1,500.00	4.95	09:06	16:39	07:32	1,641.30	0.00	191.53	432.16	2,264.99	1.99	489.95	4.77	1,425.04	935.09	96%	FULL
16	P and T Colony	1,500.00	5.00	09:53	16:49	06:56	1,555.22	0.00	2.44	415.88	1,973.54	0.02	4.31	4.22	1,202.82	1,198.51	84%	NOT FULL
17	Nelson Mandela Park	1,000.00	5.00	08:13	14:08	05:55	971.56	0.00	527.42	86.99	1,585.97	0.32	35.49	4.88	972.30	936.81	98%	FULL
18	Veternary Colony	1,200.00	5.00	08:13	14:52	06:38	625.43	0.00	90.97	223.68	940.08	3.48	822.92	4.79	1,191.03	368.11	96%	FULL
19	Bank Colony	1,000.00	5.00	07:59	12:33	04:34	834.35	0.00	859.25	571.78	2,265.38	1.65	272.07	4.73	972.33	700.26	95%	FULL
20	Sri Nagar Colony	1,477.00	4.20	07:56	15:58	08:01	1,047.70	0.00	0.11	206.15	1,253.96	0.25	70.72	3.23	1,041.96	971.24	77%	NOT FULL
21	Priyadarshini Colony	1,477.00	3.62	08:26	16:52	08:25	1,135.08	0.00	1.57	0.93	1,137.58	0.11	44.54	2.34	947.40	902.86	65%	NOT FULL
22	ORRS	1,500.00	6.11	09:43	16:10	06:26	536.34	0.00	176.18	9.54	722.06	1.47	189.64	3.19	411.54	221.90	52%	NOT FULL
23	Rahman Park	1,136.00	3.58	07:40	14:55	07:14	1,240.22	0.00	1.98	0.04	1,242.24	1.20	108.80	3.48	773.92	665.12	97%	FULL
24	Santhi Nagar	910.00	4.18	10:09	10:45	00:36	56.91	0.00			56.91	0.20	8.40	0.26	11.66	3.26	6%	NOT FULL
25	Ajith Singh Nagar-1	1,500.00	3.74	15:44	18:31	02:47	728.63	0.00		135.63	864.26	0.51	151.69	2.22	774.09	622.40	59%	NOT FULL
26	Singh Nagar(old)	1,200.00	4.57	07:54	18:31	10:36	1,152.15	0.00	2.87	17.98	1,173.00	1.15	76.48	4.34	716.33	639.85	95%	FULL

27	Rajeev Nagar	1,000.00	4.59	17:00	17:30	00:29	68.99	0.00	1.24	1.26	71.49	0.28	4.51	0.84	38.16	33.65	<b>18%</b>	NOT FULL
28	Four pillar center	1,500.00	4.70	09:27	15:54	06:26	1,268.74	0.00	0.06	0.00	1,268.80	0.82	275.00	3.47	1,163.74	888.74	<b>74%</b>	NOT FULL
29	H B Colony-2	455.00	2.98	11:40	15:38	03:57	460.27	0.00	0.13	0.32	460.72	0.26	0.00	3.01	0.00	0.00	<b>100%</b>	FULL
30	Gulamohiddin Nagar	455.00	5.25	11:46	14:45	02:59	656.62	0.00	39.37	281.54	977.53	0.53	69.30	5.20	679.90	610.60	<b>99%</b>	FULL
31	Gollapalem gattu	455.00	5.25	08:00	14:19	06:19	394.34	0.00	0.00	196.32	590.66	0.17	14.73	3.64	315.32	300.59	<b>69%</b>	NOT FULL
32	Rama Rajya Nagar	1,477.00	5.86	06:58	17:03	10:05	1,967.62	0.00	38.71	91.47	2,097.80	1.59	404.77	3.95	1,005.56	600.79	<b>67%</b>	NOT FULL
33	Gandhi Bavi-1	230.00	4.00	07:59	19:51	11:52	566.19	0.00			566.19	0.27	20.01	0.52	38.53	18.52	<b>13%</b>	NOT FULL
34	Raja Rajeswari Pet	1,500.00	5.00	09:28	18:32	09:04	692.92	0.00	14.41	169.61	876.94	0.13	36.49	1.98	590.64	554.15	<b>40%</b>	NOT FULL
35	Governerpet2	1,137.00	4.56	08:02	10:31	02:28	871.29	0.00	48.63	5.08	925.00	1.37	0.00	3.17	0.00	0.00	<b>70%</b>	NOT FULL
36	Krishna Lanka-1	1,477.00	3.67	13:28	16:26	02:58	850.95	0.00	0.21	0.29	851.45	0.04	17.62	1.48	652.06	634.44	<b>40%</b>	NOT FULL
37	Moghalrajapuram	455.00	4.31	09:44	15:03	05:18	439.11	0.00	6.01	3.17	448.29	1.13	127.85	3.87	437.86	310.01	<b>90%</b>	FULL
38	ODA	1,477.00	4.85	08:03	19:55	11:51	1,438.47	0.00			1,438.47	4.42	125.02	2.91	82.31	-42.71	<b>60%</b>	NOT FULL
39	Fish Market	1,500.00	4.80	08:05	14:38	06:32	873.70	0.00	0.18	8.22	882.10	2.10	548.77	4.64	1,381.80	833.03	<b>97%</b>	FULL
40	Brahmamgari matam_2	277.00	3.30	08:23	11:41	03:18	298.03	0.00	519.31	223.18	1,040.52	0.18	10.95	3.14	191.06	180.11	<b>95%</b>	FULL
41	Brahmamgari matam_1	455.00	4.35	12:36	15:58	03:21	470.87	0.00	22.05	294.18	787.10	0.21	17.50	3.77	314.25	296.75	<b>87%</b>	NOT FULL

**Table-2: Overall Reservoirs Report (19-Mar, 2010- Evening-contd.)**

DISTRIBUTION										UFW (KL)					AVERAGE CL (PPM)	
S.No	Reservoir Name	From Time (HH:MM)	To Time (HH:MM)	Duration (HH:MM)	Start Level(m)	Start Volume (KL)	End Level (m)	End Volume (KL)	Net QTY Distributed (KL)	Fill	Overflow	Storage	Dist	Total	Filling	Distribution
1	Labbipet	16:45	17:30	00:45	4.81	1,543.35	0.15	37.81	1,505.54	639.37	0.00	44.06	0.00	683.43	1.03	0.61
2	Match Factory	16:58	18:20	01:22	4.69	1,413.41	0.21	48.30	1,365.11	929.91	0.00	7.44	1.58	938.93	1.43	1.33
3	Mallikarjun pet	16:49	19:33	02:43	3.49	1,088.43	0.10	31.19	1,057.24	320.39	0.00	35.35	6.18	361.92	1.20	0.77
4	Lorry Stand	16:01	20:16	04:15	3.50	1,352.39	0.16	51.99	1,300.40	106.59	0.00	35.14	702.71	844.44	2.54	2.63
5	Gandhi Nagar1	16:57	18:20	01:22	4.10	1,373.69	1.12	375.25	998.44	431.82	0.00	37.63	130.14	599.59	1.04	0.92
6	Gandhi Nagar2	16:56	18:08	01:12	3.49	1,222.47	0.87	258.99	963.48	338.32	0.00	-6.48	3.35	335.19	1.58	1.48
7	Machavaram1	16:50	17:09	00:18	1.33	229.45	0.76	131.12	98.33	503.59	0.00	529.69	19.00	1,052.28	1.24	0.25
8	Frizerpet									9,065.18	0.00			9,065.18	1.19	
9	Machavaram 2	16:38	17:18	00:39	1.72	296.73	0.43	74.18	222.55	82.82	0.00	50.29	23.24	156.35	0.01	0.03
10	Gandhigi high School	16:17	18:46	02:29	3.03	883.51	0.24	47.66	835.85	343.25	0.00	11.15	0.00	354.40	1.51	1.34
11	Kadareswarpet-1 [old]	17:37	18:36	00:59	1.92	784.22	0.10	40.84	743.38	339.90	0.00	23.26	0.00	363.16	0.37	0.22
12	N.S.C Bose Nagar	18:40	19:09	00:28	1.00	284.64	0.28	77.01	207.63	4.43	0.00	8.44	0.00	12.87	0.10	0.13
13	Vambay colony	18:13	19:14	01:01	2.80	736.36	0.23	44.36	692.00	102.28	0.00	6.95	0.00	109.23	0.61	0.40
14	J D Nagar-1	16:56	20:06	03:10	4.37	1,290.50	1.66	380.65	909.85	700.02	0.00	18.86	558.36	1,277.24	0.14	0.07
15	J D Nagar-2	17:28	20:14	02:46	4.78	1,428.41	2.76	748.95	679.46	706.21	0.00	188.16	432.16	1,326.53	0.08	0.10
16	P and T Colony	16:50	20:04	03:13	4.20	1,196.73	1.62	411.44	785.29	356.71	0.00	8.53	415.88	781.12	0.63	0.10
17	Nelson Mandela Park	16:44	19:02	02:18	4.18	820.14	0.27	29.43	790.71	34.75	0.00	679.58	86.99	801.32	0.98	0.11
18	Veternary Colony	15:58	18:27	02:28	4.83	1,202.27	3.27	763.91	438.36	257.32	0.00	79.73	223.68	560.73	0.24	0.07
19	Bank Colony	16:48	19:59	03:11	4.63	949.59	0.31	34.53	915.06	134.09	0.00	881.99	571.78	1,587.86	0.09	0.40
20	Sri Nagar Colony	16:01	18:16	02:14	3.24	1,045.32	0.26	73.59	971.73	76.46	0.00	-3.25	206.15	279.36	0.97	1.04
21	Priyadarshini Colony	17:19	19:26	02:06	2.29	927.15	0.14	56.68	870.47	232.22	0.00	21.82	0.93	254.97	2.29	2.53
22	ORRS	17:21	18:39	01:17	3.12	402.51	1.08	139.33	263.18	314.44	0.00	185.21	9.54	509.19	2.29	1.45
23	Rahman Park	16:58	18:44	01:46	3.51	784.90	1.21	110.43	674.47	575.10	0.00	-9.00	0.04	566.14	1.60	0.89
24	Santhi Nagar									53.65	0.00	11.66		65.31	0.56	
25	Ajith Singh Nagar-1	18:31	19:40	01:09	2.22	774.09	0.20	57.76	716.33	106.23	0.00		135.63	241.86	0.87	1.19

26	Singh Nagar(old)	18:34	19:26	00:52	4.35	718.43	0.43	13.23	705.20	512.30	0.00	0.77	17.98	531.05	0.72	1.52
27	Rajeev Nagar	17:39	18:44	01:04	0.78	32.91	0.33	6.16	26.75	35.34	0.00	6.49	1.26	43.09	0.15	0.25
28	Four pillar center	16:50	19:12	02:21	2.95	989.34	0.38	127.44	861.90	380.00	0.00	174.46	0.00	554.46	1.82	0.52
29	H B Colony-2	16:56	18:16	01:20	2.90	0.00	0.27	0.00	0.00	460.27	0.00	0.13	0.32	460.72	2.18	0.70
30	Gulamohiddin Nagar	16:59	19:08	02:09	4.91	641.99	0.36	47.07	594.92	46.02	0.00	77.28	281.54	404.84	1.31	1.45
31	Gollapalem gattu	14:24	18:14	03:49	3.75	324.84	0.14	12.13	312.71	93.75	0.00	-9.52	196.32	280.55	1.09	0.92
32	Rama Rajya Nagar	17:49	19:45	01:55	3.96	1,008.10	0.13	33.09	975.01	1,366.83	0.00	36.17	91.47	1,494.47	2.53	2.36
33	Gandhi Bavi-1									547.67	0.00	38.53		586.20	1.98	
34	Raja Rajeswari Pet	18:36	19:22	00:46	1.94	578.46	0.19	53.48	524.98	138.77	0.00	26.59	169.61	334.97	0.54	0.52
35	Governerpet2	17:02	18:37	01:34	2.75	0.00	0.12	0.00	0.00	871.29	0.00	48.63	5.08	925.00	0.04	0.05
36	Krishna Lanka-1	16:40	18:34	01:53	1.47	647.66	0.09	39.65	608.01	216.51	0.00	4.61	0.29	221.41	0.61	0.09
37	Moghalrajapuram	15:27	17:58	02:31	3.84	434.47	2.82	319.06	115.41	129.10	0.00	9.40	3.17	141.67	0.03	0.05
38	ODA									1,481.18	0.00	82.31		1,563.49	0.16	
39	Fish Market	17:06	20:15	03:09	4.53	1,345.72	1.99	513.25	832.47	40.67	0.00	36.26	8.22	85.15	1.76	0.59
40	Brahmamgari matam_2	16:54	18:43	01:48	2.98	181.32	0.47	28.60	152.72	117.92	0.00	529.05	223.18	870.15	1.78	2.82
41	Brahmamgari matam_1	16:37	19:26	02:49	3.78	315.09	0.26	21.67	293.42	174.12	0.00	21.21	294.18	489.51	2.73	2.81



**Table -3: Reservoirs-Hourly Depth Status**

S.NO	RESERVOIR NAME	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	Mar17	AVGCL (PPM)	Total Volume (KL)	Capacity ( KL )	Level status( m )	Remarks
		08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00					
0	GallapalemGattu-1 5m																					
1	Fish Market 4.8m	2.0	2.0	2.0	2.4	2.9	3.1	3.2	3.5	3.9	4.4	3.6	2.7	2.1	2.5	2.8	3.2	1.0	1,545.16	1,500.00	FULL	FullSupply
2	Labbipet-1 4.37m	0.5	0.5	0.6	0.8	0.9	1.0	1.0	0.9	1.0	2.0	0.2	0.2	0.2	0.2	0.2	0.2	0.8	787.11	1,000.00	3.5	PartialSupply
3	Moghalrajapuram 4.31m	1.6	1.4	0.9	1.5	2.1	2.6	3.1	3.4	3.6	3.1	2.8	3.0	2.8	2.8	2.4	2.9	0.0	1,180.11	455.00	3.6	FullSupply
4	Krishna Lanka-1 3.67m	1.0	0.1	0.1	0.1	0.0	0.0	0.3	0.7	1.1	1.3	0.4	0.1	0.3	0.6	0.7	0.7	0.3	2,222.42	1,477.00	2.5	FullSupply
5	Governerpet2 4.56m	1.3	1.9	2.5	3.2	3.1	3.0	3.0	2.9	2.8	2.7	1.0	0.1	0.1	0.2	0.6	1.1	0.3	1,516.83	1,137.00	3.2	FullSupply
6	Governerpet1 4.48m	0.1	0.1	0.1	0.1	0.7	1.4	1.6	1.6	1.5	1.4	1.5	1.7	2.3	3.0	2.9	2.8	0.3	2,977.80	1,137.00	3.0	FullSupply
7	Gollapalem gattu 5.25m	---	0.2	0.9	1.6	2.3	2.9	3.5	3.1	---	---	0.2	0.1	0.1	0.2	0.5	1.2		1,329.55	455.00	FULL	FullSupply
8	Gulamohiddin Nagar 5.25m	0.6	0.6	0.6	0.6	1.0	2.5	3.9	5.1	5.1	4.9	2.4	0.4	0.3	0.3	1.3	2.8	1.1	1,707.27	455.00	FULL	FullSupply
9	Karmika nagar 5m																		1,122.47	910.00		FullSupply
10	Rahman Park 3.58m	1.3	1.6	2.0	2.4	2.7	2.8	3.1	3.3	3.6	3.5	2.4	1.3	1.2	1.8	2.2	2.5	1.4	2,614.51	1,136.00	FULL	FullSupply
11	Sri Nagar Colony 4.2m	0.2	0.8	1.3	1.8	2.3	2.8	3.2	3.7	4.0	4.0	0.7	0.2	0.2	0.2	0.5	1.0	0.8	2,066.92	1,477.00	FULL	FullSupply
12	Machavaram 2 3m	0.7	1.0	1.2	1.5	1.7	1.8	1.9	1.9	2.0	1.5	0.8	1.0	1.3	1.5	1.7	1.9	0.2	1,070.12	517.00	FULL	FullSupply
13	Machavaram1 3m	0.4	0.9	1.4	1.6	1.6	1.5	1.5	1.3	1.2	0.9	0.8	1.1	1.2	1.4	1.5	1.5	1.1	2,660.95	517.00	FULL	FullSupply
14	Gandhi Nagar2 4.15m	0.2	1.2	2.0	2.5	2.9	3.3	3.6	3.8	3.8	3.5	1.2	0.8	0.8	1.1	1.4	1.6	1.3	2,636.83	1,477.00	FULL	FullSupply
15	Gandhi Nagar1 4.5m	0.7	0.9	1.1	1.5	1.9	2.4	2.8	3.2	3.6	3.9	2.1	1.4	1.8	2.3	2.7	3.1	0.7	3,816.11	1,477.00	FULL	FullSupply
16	Mallikarjun pet 4.35m	1.8	0.8	0.5	1.0	1.5	2.0	2.5	3.0	3.4	3.3	1.6	0.5	0.1	0.5	1.1	1.6	1.0	2,852.06	1,477.00	FULL	FullSupply
17	Match Factory 5m	0.2	0.5	0.7	0.9	1.1	1.2	1.2	1.3	1.6	1.4	0.2	0.2	0.3	0.8	1.1	1.4	1.3	2,813.01	1,477.00	3.8	FullSupply
18	Labbipet 5m	0.3	0.9	1.4	1.8	2.1	2.5	3.0	3.7	4.5	3.4	0.1	0.1	0.1	0.2	1.2	2.0	0.8	4,675.35	1,477.00	FULL	FullSupply

### ***Historical Trend of the Reservoir***

The historical data of reservoir can be analyzed for future enhancements. The report shows the historical trend of the reservoir filling and distribution cycles. The graphical display shows the flow rate into the reservoir, level of water and free residual chlorine. Various parameters like filling start time, filling end time, distribution start time, distribution end time, filling duration and distribution duration are derived from the graph.

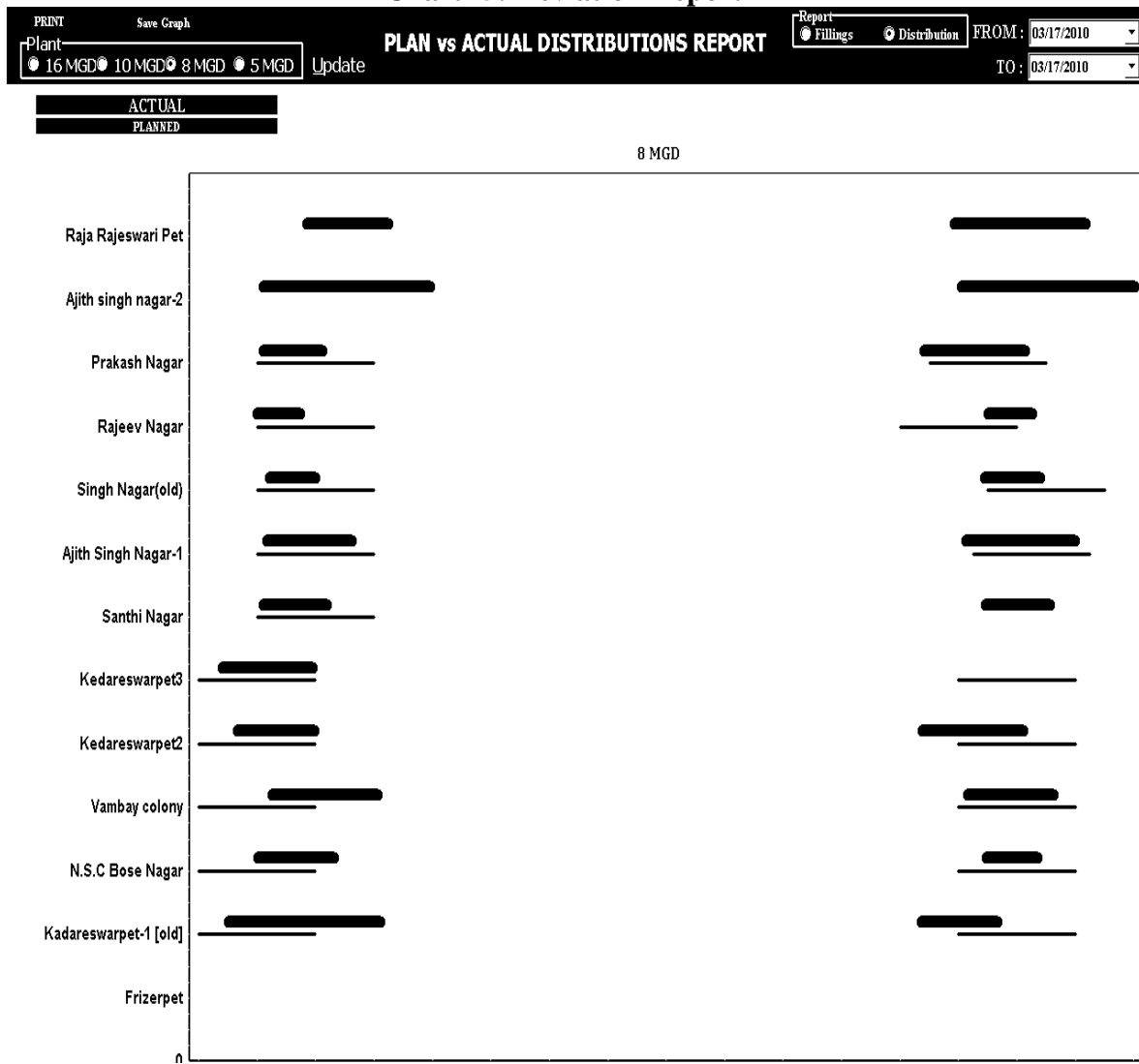
### ***Reservoir Monthly Summary Report***

This report shows the list of problems occurred in a month. Problems viz., low chlorine, overflows, leakages, excess supply and less supply can be identified.

### ***Schedule Deviation Report***

This report (chart-5) provides information whether distribution schedule is followed at reservoirs or not. It identifies any erratic timing followed at the reservoir during distribution. It also gives the information on the deviations occurred at each of the reservoir against the plan. Like a Gantt chart this represents the planned against the actual data. Using this, deviations in the plan at reservoir level can be understood, effect of deviation of plan on other reservoirs can be understood, and corrective action at the fault reservoir can be initiated.

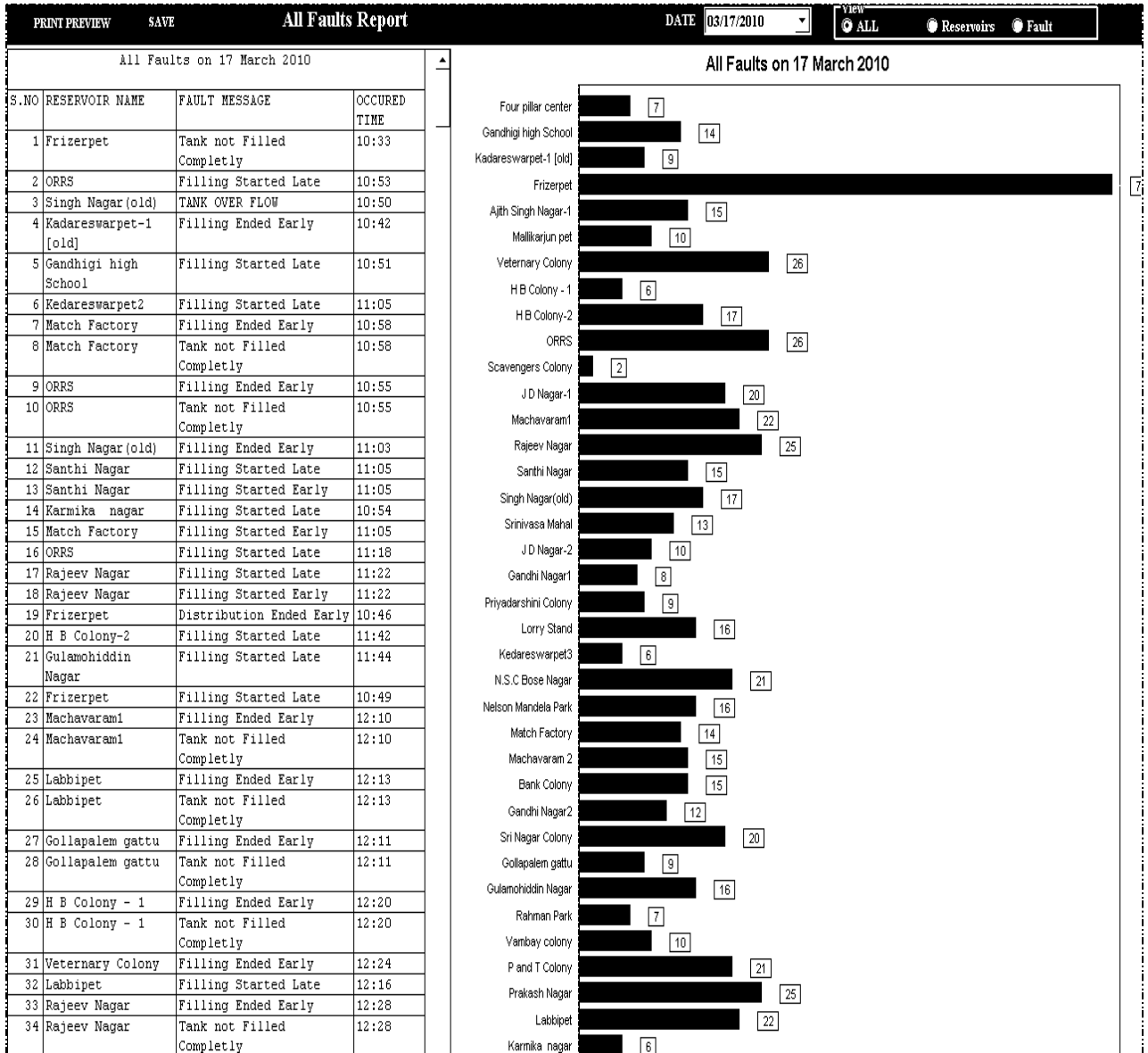
**Chart- 5: Deviation Report**



### ***Faults Report***

Faults reports show the list of failures that have occurred reservoir wise. Reservoir wise group and fault wise grouping can be done here. List of the faults could be overflow at reservoir, low chlorine, high chlorine, late distribution, early distribution, late filling start, early filling start, measuring equipment failures, etc. This report (chart-6) is used for analyzing the performance of the reservoir and identify the common operational failures across the reservoirs. The common failures are eliminated by providing training to the local operators and specific failures are eliminated by training particular local operator.

### Chart-6: System Faults Report



### Chlorination Report

The report contains the comparison of actual vs plan regarding maintenance of quality of water and quantity of chlorination during distribution time. Reports shows the graphical information for each session regarding quality of water during filling, quality of water during distribution, planned chlorination and actual chlorination

### ***Online Information in Remote LAN***

The information of plants and reservoirs processed at a central place is displayed at client's location by connecting the two remote LANs i.e. at VMC and Head Water Works, through 2MBPS dedicated leased line.

The implementation part of the water SCADA project of the VMC which commenced in January, 2009 is executed to the extent of 90 per cent covering 58 reservoirs and the treatment plants. It is observed that the remaining reservoirs will be covered in a couple of months. The online information system is established and the daily and monthly reports are being generated for supervisory control. The problems and deviations are being informed to the ground staff through SMS communication at present. A separate BSNL line is being mooted to provide the centralized information accessible online to the VMC officials at the headquarters for monitoring purposes. Once it is installed, all the officials concerned at the head office can access the water supply status online and could effectively take corrective actions by monitoring.

## **CHAPTER-IV**

### **IMPACT OF WATER SCADA REFORM**

The executing agency, Efftronics, faced certain problems in the initial stages. The customization of the equipment took some time as the engineers had to understand the water supply system and its operations totally. The executing personnel expressed that now they have understood the system properly and are able to guide the municipal officials more appropriately. Lack of proper maps indicating the distribution network is found to be a big problem. In the absence of proper maps, the executing personnel had to contact different persons connected with the system to get the required details.

The water supply officials did not have the knowledge of the electronic domain with which the system was installed. In fact, they did not have interest in the project suspecting its utility. The executing agency trained the ground staff on the basics of the operation part of the system and developed confidence among the staff..

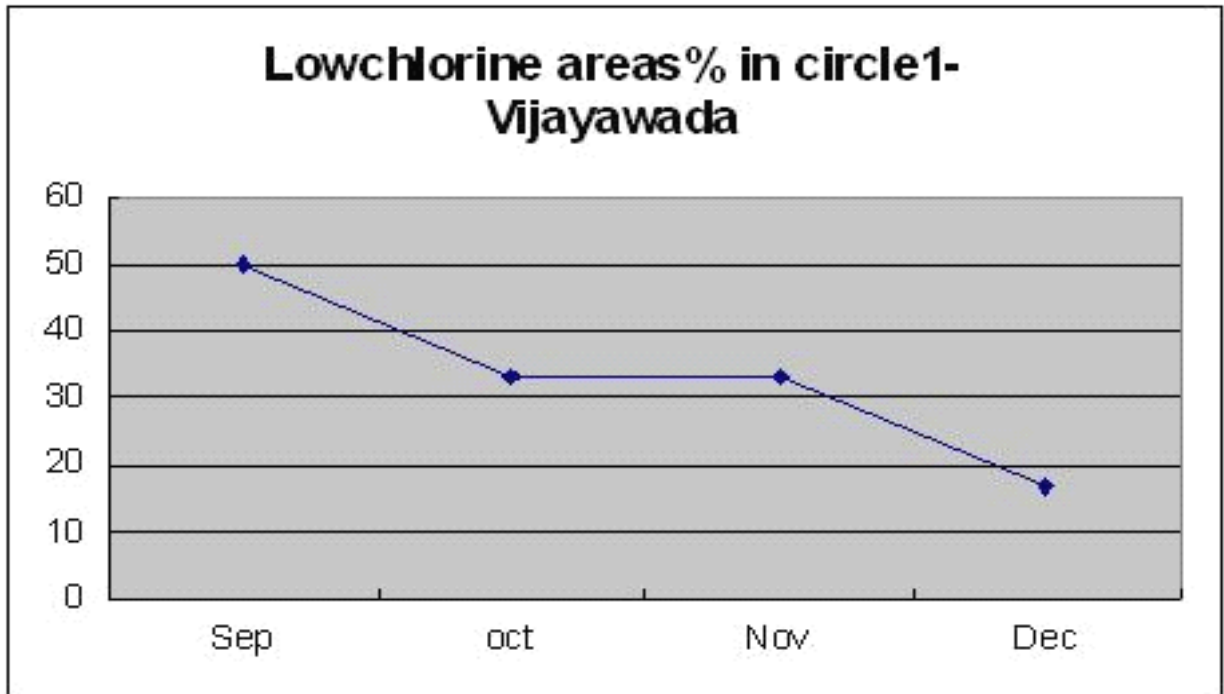
#### **Outcome of the Water SCADA Reform**

The Water Supply Management project through SCADA has streamlined the water supply information system up-to reservoir level. The local level distribution and consumer level monitoring are yet to be covered. Even with this partial coverage of the SCADA, there has been very good improvement in the water supply system in an over all perspective especially, in monitoring the reservoirs levels and flows, distribution and quality of water distributed to the people. The following concrete results were achieved:

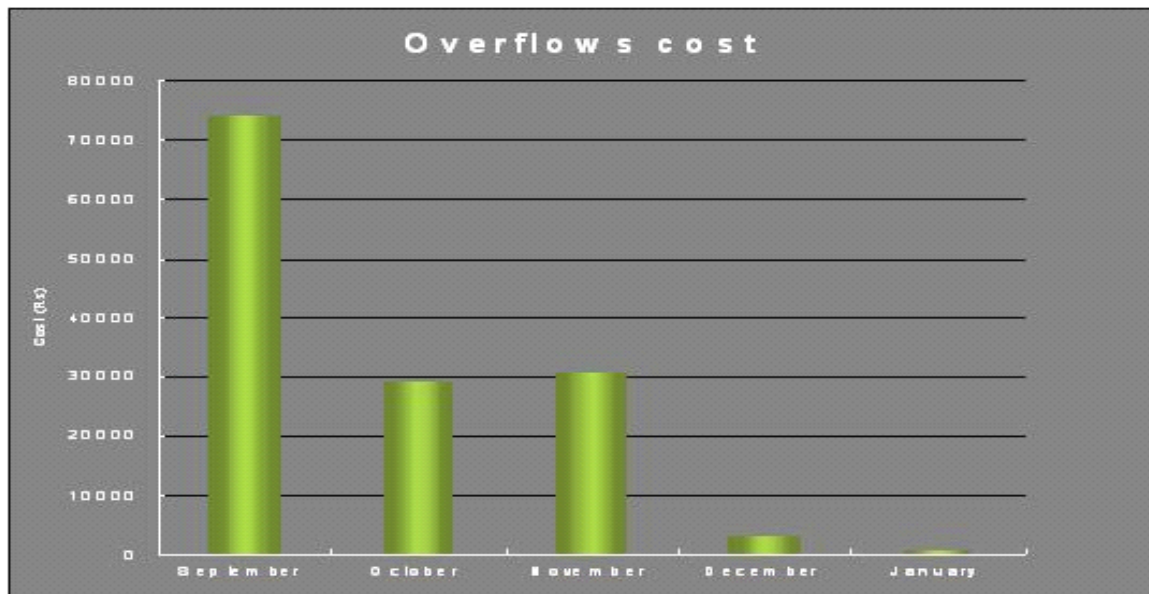
- The low chlorine areas were reduced.
- Overflows were brought down to nearly 0%.
- Unaccounted For Water (UFW) is brought down from 40% to 18%.

The specific results of VMC Water SCADA are depicted below:

**Chart-7: Reduction in Low Chlorine Areas**



**Chart-8: Reduction in Overflows Cost**



**Table-4: Reduction in Unaccounted For Water (UFW-16 MGD Plant)**

Date	Plant Out Flow(KL) per day	Sum of All Reservoirs (KL) per day	UFW (KL) per day	Plant Out Flow (MGD) per day	Sum of all reservoirs (MGD) per day	UFW (MGD) per day	% UFW per day	Date	Plant Out Flow(KL) per day	Reservoirs / booster not covered with flow meter(KL)	Sum of All Reservoirs (KL) per day	Grand Sum of Reservoirs and direct connections	UFW (KL) per day	% UFW per day
1-Nov-09	55,441	26,949	28,492	12.20	5.93	6.27	51.39	1-Feb-10	60,903	9,972	30,712	40,684	20,219	33.20
2-Nov-09	59,548	27,658	31,890	13.10	6.08	7.01	53.55	2-Feb-10	58,325	9,972	31,018	40,990	17,335	29.72
3-Nov-09	61,823	29,354	32,469	13.60	6.46	7.14	52.52	3-Feb-10	63,419	9,972	32,577	42,549	20,870	32.91
4-Nov-09	61,050	28,512	32,538	13.43	6.27	7.16	53.30	4-Feb-10	62,615	9,972	31,822	41,794	20,821	33.25
5-Nov-09	60,984	27,741	33,243	13.41	6.10	7.31	54.51	5-Feb-10	63,204	9,972	36,876	46,848	16,356	25.88
6-Nov-09	60,168	30,579	29,589	13.24	6.73	6.51	49.18	6-Feb-10	62,150	9,972	36,800	46,772	15,378	24.74
7-Nov-09	59,851	28,392	31,459	13.17	6.25	6.92	52.56	7-Feb-10	62,810	9,972	39,164	49,136	13,674	21.77
8-Nov-09	56,426	27,105	29,321	12.41	5.96	6.45	51.96	8-Feb-10	63,178	9,972	36,671	46,643	16,535	26.17
9-Nov-09	61,407	28,128	33,279	13.51	6.19	7.32	54.19	9-Feb-10	62,477	9,972	33,090	43,062	19,415	31.08
10-Nov-09	54,872	26,512	28,360	12.07	5.83	6.24	51.68	10-Feb-10	62,877	9,972	34,942	44,914	17,963	28.57
11-Nov-09	61,710	28,309	33,401	13.57	6.23	7.35	54.13	11-Feb-10	64,236	9,972	35,642	45,614	18,622	28.99
12-Nov-09	56,890	28,671	28,219	12.51	6.31	6.21	49.60	12-Feb-10	61,532	9,972	34,313	44,285	17,247	28.03
13-Nov-09	63,687	29,922	33,765	14.01	6.58	7.43	53.02	13-Feb-10	54,504	9,972	29,390	39,362	15,142	27.78
14-Nov-09	62,518	27,964	34,554	13.75	6.15	7.60	55.27	14-Feb-10	61,396	9,972	36,737	46,709	14,687	23.92
15-Nov-09	62,654	28,610	34,044	13.78	6.29	7.49	54.34	15-Feb-10	59,570	9,972	33,422	43,394	16,176	27.15
16-Nov-09	54,610	25,211	29,399	12.01	5.55	6.47	53.83	16-Feb-10	61,034	9,972	34,679	44,651	16,383	26.84
17-Nov-09	56,436	27,841	28,595	12.41	6.12	6.29	50.67	17-Feb-10	59,217	9,972	33,504	43,476	15,741	26.58
18-Nov-09	57,760	27,234	30,526	12.71	5.99	6.71	52.85	18-Feb-10	62,461	9,972	36,475	46,447	16,014	25.64



19-Nov-09	59,337	28,237	31,100	13.05	6.21	6.84	52.41	19-Feb-10	62,195	9,972	35,993	45,965	16,230	26.10
20-Nov-09	61,477	27,946	33,531	13.52	6.15	7.38	54.54	20-Feb-10	60,405	9,972	34,734	44,706	15,699	25.99
21-Nov-09	59,052	25,215	33,837	12.99	5.55	7.44	57.30	21-Feb-10	61,783	9,972	34,093	44,065	17,718	28.68
22-Nov-09	58,361	27,219	31,142	12.84	5.99	6.85	53.36	22-Feb-10	61,066	9,972	33,303	43,275	17,791	29.13
23-Nov-09	57,151	26,319	30,832	12.57	5.79	6.78	53.95	23-Feb-10	61,405	9,972	34,260	44,232	17,173	27.97
24-Nov-09	62,340	29,232	33,108	13.71	6.43	7.28	53.11	24-Feb-10	61,243	9,972	33,367	43,339	17,904	29.23
25-Nov-09	64,102	28,148	35,954	14.10	6.19	7.91	56.09	25-Feb-10	62,819	9,972	33,772	43,744	19,075	30.37
26-Nov-09	64,607	28,066	36,541	14.21	6.17	8.04	56.56	26-Feb-10	63,009	9,972	33,048	43,020	19,989	31.72
27-Nov-09	60,669	27,934	32,735	13.35	6.14	7.20	53.96	27-Feb-10	62,120	9,972	32,804	42,776	19,344	31.14
28-Nov-09	62,304	27,559	34,745	13.71	6.06	7.64	55.77	28-Feb-10	63,453	9,972	33,036	43,008	20,445	32.22

## **CHAPTER-V**

### **PERSPECTIVES AND WAY AHEAD**

The officials of the VMC concerned with the water supply system showed much interest in the project. The executive agency also worked with certain innovative ideas as the water SCADA projects are new in India. That is why; the executing agency developed and installed pressure equipment to get further information though it is not in the contract. The entire project was viewed in a broader perspective of information management-information acquisition, accurate and on-line measurement, report generation and alerting the officials concerned on the faults for taking corrective actions continuously. Alarms were specifically installed at each reservoir to alert the ground staff on overflowing status. This has helped the staff in attending to the problem immediately.

The major part of the success is considered to be its tangible benefits in the form of saving water by reducing UFW and the related costs involved. The demonstrated benefits have convinced the officials concerned at various levels in the VPC to appreciate the project.

#### **Replicability**

The water SCADA in Vijayawada has demonstrated the potential benefits and could act as inspiration for other similarly placed Mission cities under JnNURM in India. These projects could be replicated in the million plus cities where the water distribution network is large involving several reservoirs and huge service areas. The SCADA reform has good potential and could be replicated with certain customization changes in the cities.

#### **Impact of the Reform**

The tangible benefits achieved like elimination of the overflows and considerable reduction in UFW indicate that the water SCADA in Vijayawada has demonstrated the potential for improving the water supply management. The availability of the online information made the supervisory staff more relaxed and at the same time alerted them to take corrective measures. Though its installation cost may appear high, the benefits especially, the reduction of the UFW and overflows result in monetary benefits like savings from the wastage apart from crucial saving of treated water. With the reduction of the UFW to the levels, actual water supply position also improved. The actual water supply which was 24 MGD before implementation of the Water SCADA is now increased to 33 MGD, a net gain

of 9 MGD of water. Approximately 150 lpcd of is currently supplied to the estimated present population of 10 lacs, which is fairly above the minimum standard of 140 lpcd. Moreover, the intangible benefits like effective supervisory control and improved quality of water are of immense value to the local citizens who consume water. All the officials interacted with the researcher expressed their satisfaction of the benefits.

### **Way Ahead**

An important aspect of the reform is its utility for the introduction of the 24/7 water supply. Effective online monitoring coupled with metering of all the consumers are essential prerequisites for the success of the 24/7 water supply. The water SCADA in Vijayawada will go a long way in this respect.

However, from the point of sustainability of the project on a continuing basis, the financials will have to be worked out. There is a feeling among the officials of the VMC that some financial measure is required to meet the additional cost of maintaining the SCADA on a continuing basis. A SCADA cess or increase in the water tariff appear to be some useful measures. In Vijayawada, only non-domestic connections are metered. There is need for extending the metering system to all the consumers for equitable distribution of water and also for making the water supply system no-loss-no profit activity at least. Unless this is done, no water reform could yield the desired results on a sustainable basis. Further, about 30 boosters are working un-necessarily which could be avoided by rationalization of the valve switching. This could save considerable money being spent on the scarce energy by the VMC. In fact, it is observed that the operationalization of the SCADA has brought-out the need for several such measures which have potential for saving money and optimizing the water supply system. A further in-depth hydraulic study may be initiated to gain further insights into the operation of the system.

To  
Shri A.K. Mehta, I.A.S.  
Joint Secretary to Government (LSG)  
Ministry of Urban Development, Government of India,  
Nirman Bhawan, Moulana Azad Road,  
New Delhi – 110 018.

Sub:- RCUES, Hyderabad - Documentation of Best Practices under JnNURM –  
Submission of Research Report – Regarding.

\* \* \*

The RCUES, Hyderabad has been focusing on core areas identified under JnNURM Scheme in its research and training activities. As part of this programme, the RCUES is documenting best practices in Mission Cities in the areas like financial resource mobilization, solid waste management and urban water supply management. The RCUES has documented a best practice on **Water SCADA – An Innovative IT Solution for Improving Urban Water Supply Management : The Case of Vijayawada Municipal Corporation, Andhra Pradesh**. A copy of the report is submitted for your kind perusal and information.

Yours sincerely,

Director.

Encl: Copy of the Report.