

DIAGNOSIS FOR EQUITABLE WATER SUPPLY IN RAJKOT

**For
Performance Assessment
System
In
Gujarat**

June 2012

Submitted to
CEPT University, Ahmedabad

Submitted By
Urban Management Centre



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List of Abbreviations

CEPT	Centre for Environmental Planning & Technology
CI	Cast Iron
ESR	Elevated Service Reservoir
ft	Feet
GSR	Ground Level Service Reservoir
ICMA	International City/County Managers' Association
INR	Indian National Rupee
ISIP	Information System Improvement Plan
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
LPCD	Litres per capita per day
m	Metre
Mcft	Million cubic feet
MLD	Million Litres per Day
mm	Millimetre
MS	Mild Steel
O&M	Operation & Maintenance
PAS	Performance Assessment System
PIP	Performance Improvement Plan
ppm	Parts per million
PSC	Pre-stressed Concrete Pipe
RMC	Rajkot Municipal Corporation
SLB	Service Level Benchmarking
sqkm	Square Kilometre
UIDSSMT	Urban Infrastructure Development Scheme for Small & Medium Towns
ULB	Urban Local Body
UMC	Urban Management Centre
WDS	Water Distribution Station
WSS	Water & Sanitation System
WTP	Water Treatment Plant

Acknowledgments

UMC is grateful for the support received from Rajkot Municipal Corporation. The Municipal Commissioner, Engineers and all other staff provided valuable information and have shown interest in undertaking corrections in their system, based on the analysis of the PAS program. UMC also acknowledges support of the Mayor and other elected members of RMC.

UMC is also happy to have received financial and technical support from CEPT University under the Performance Assessment System (PAS) program. Special thanks to Meera Mehta and Dinesh Mehta from CEPT University for their advice and support for this study. The following team has been working on this project.

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Vinay Patel, Program Associate, UMC
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This is phase one of the project analysis. More in depth analysis and improvements will be undertaken in coming months after consultations with Municipal staff.

Manvita Baradi
Director, UMC

i. Introduction to Performance Assessment System (PAS)

Access to water and sanitation services in urban India is widespread, but little is known about the quality and level of service, and coverage of the poor households. For new investments in the sector to be effective, it is important to assess the performance of the existing system and ensure its sustainability and reach for the poor and unserved.

Need for the PAS program:

- Aggregate statistics suggest good coverage of water and sanitation in urban areas in India, but little is known about the quality, level and financial sustainability of service
- Accurate information on access of urban poor households to water and sanitation is unavailable
- Lack of WSS (Water and Sanitation System) information leads to not only improper monitoring and management of the utility but also misallocation of resources
- Difficult to assess impact of past investments

PAS aims to measure and monitor the performance of the services, and thus improve the overall performance of service delivery system in urban areas reaching the unserved population. The project includes all ULBs in Gujarat and Maharashtra, and is to be implemented by CEPT University (CEPT). Urban Management Centre (UMC) is undertaking all programmatic activities in Gujarat.

ii. Aims and Objective of PAS Programme

Aim:

- To measure and monitor the performance of the services and hence improve the overall performance of service delivery system in urban areas ensuring equity, especially reaching out to the deprived and unserved populations.

The key **objectives** of the **five-year long PAS Programme** are:

- To review the quality of services in ULBs i.e. water supply, sewerage, solid waste management and storm water drainage
- To establish a database system in ULBs which can be used by decision makers of ULBs and others (State, Central Government)
- To document the good practices of ULBs and sharing them across cities
- To provide assistance in improving the system of ULB through Performance Improvement Plans (PIPs) and Information System Improvement Plans (ISIP)
- PIP includes technical and managerial aspects of basic services i.e. water supply, sewerage, solid waste management and storm water drainage along with advocacy at local as well as state level
- To compare the indicators of services across the cities for receiving overall picture of the state. This will be used by decision makers to identify priorities for the state government

iii. Benefits to ULB

- Database will help identify the gaps in existing system, especially in quantification of procurement, processing, coverage, delivery and supply. Besides, it would also identify gaps in cost recovery mechanism service-wise, identification of non revenue water, equity regarding all the services, etc.
- Appropriate and qualitative database enables factual reporting on reforms-related evaluation and compliance under Jawaharlal Nehru National Urban Renewal Mission (JnNURM) and Urban Infrastructure Development Scheme for Small & Medium Towns (UIDSSMT), *Nirmal Gujarat*, *Garib Sammrudhi Yojana* and other Central and state-sponsored special programs

- Analytical and comparative study of the service performance related to water supply, sanitation, solid waste management and storm water drainage will help in understanding the grey and critical service areas highlighting its inherent deficiencies that could lead to measures for its rectification and overall improvement. Innovative measures adopted for its improvement could serve as best practices worthy of replication by other ULBs

iv. Data collection for PAS Programme

The UMC team visited all 166 ULBs, spending time on field during the year 2009-10, and followed up with ULBs to get the required information for the year 2008-09. The process adopted to capture data on water and sanitation services is mentioned below:


- Sensitisation meetings with chief officer and department heads through brief sharing of information on PAS program and objectives of field visit
- Discussion on questionnaire with chief officer and department heads
- Separate interaction with department officials and gathering of data/information
- Mapping on Google Earth – geo-specific data such as ward/zone/city boundaries, main water distribution lines, solid waste dumping site, locations of slums, water logging/flooding areas. etc.
- Site visit to water sources, water treatment plant, solid waste dumping site, etc.
- Visit to slum settlements for an understanding on access to services to the slum dwellers
- Wrap up meeting with chief officer to summarize the extent of data available with ULB

After the first round of data collection, the UMC team compiled the data of all 166 ULBs and summarized the indicators values in tabulation form for each class. The indicator value of Rajkot Municipal Corporation (RMC) compared with other Municipal Corporations and average of all ULBs of Gujarat against the national benchmark is mentioned in Table 1.

Table 1 Comparison of Rajkot with other Municipal Corporations in Gujarat, all ULBs in Gujarat and SLB Benchmarks

S. No.	Indicator Name	Unit	Value for Rajkot M. Corp.	Avg. of other M. Corps. In Gujarat	Avg of all ULBs (Gujarat)	SLB values
1	Coverage of water supply connections	%	76	71	64	100
2	Per capita supply of water	Lpcd	183	128	77	135
3	Continuity of water supply	Hrs	0.33	1.20	1.5	24x7
4	Quality of water supplied	%	98	98	96	100
5	Cost recovery (O&M) in water supply services	%	46	64	43	100
8	Coverage of water supply connections in 'slum settlements'	%	34	58	52	-
9	Extent of non revenue water	%	ND	35	30	15
10	Efficiency in redressal of customer complaints	%	97	95	98	80
12	Extent of functional metering of water connections	%	2.5	0.64	0.7	100
14	Efficiency in collection of water supply-related charges	%	51	51	49	90

(SLB – Service Level Benchmarks);

 Indicators where Rajkot performs better than Average of other Municipal Corporations and overall Average of ULBs in Gujarat

The above table shows that the performance of Rajkot Municipal Corporation in water provision is significantly higher than state average and comparable to average of municipal corporations in most of the indicators. Rajkot performs lower than the average of municipal corporations in continuity of water supply, cost recovery (O&M) and in water supply coverage in slum areas.

v. Need for Diagnostic Study for Equitable Water Supply in Rajkot

Rajkot is one of the major Municipal Corporation of Gujarat and has been the largest city in Saurashtra region. It has been growing at a rapid rate and faces the infrastructure challenges that any rapidly growing city in India would face.

Under the PAS program, related data has been collected by the field team. The data has also been reviewed by the RMC and suitably corrected wherever found necessary. Data related to properties, water connections and finance are accurate and based on the actual books of accounts and related documents of the office.

However, data related to basic services, like water supply, sewerage and sanitation are more ad-hoc, approximation derived and provided by the municipal staff without backup documents. With this consideration, it was found appropriate to undertake the study of the water supply system, in order to derive more exact data related to procurement, processing and distribution so that the required data values could be fed for derivation of indicator values. Rajkot has been specially considered for this assignment, as it has initiated many noteworthy activities and projects for overall improvement of its basic infrastructure.

RMC provides water supply for duration of 20 minutes daily to its consumers. RMC Although claims to have equitable water supply to all areas, irrespective of variables such as local topography, distance of consumer from water distribution stations (WDS), pressure at consumer end and likewise. There is a high possibility of this claim being based on approximate data and assumptions for computing the same.

From the comparison of SLB indicators, it could be concluded that Rajkot performs better in nearly all indicators when compared to other municipal corporations' average or overall average of Gujarat state. However, despite high values of indicators, the service delivery on ground was never computed or verified. Potentially, variations are likely between the data with RMC and on-ground service delivery. The reasons for this variation could be

- incorrect reporting
- faulty data recording practices
- use of obsolete water supply management practices
- faulty equipment being used for taking measurements



In the absence of cross checking data using back calculations with various associated indicators, data with low reliability is being used for planning and operations. This in turn could have resulted in multiplier effect and eventually led to large discrepancy between reported services and actual on-ground services reaching the consumers.

Objective of the Study

This study aims to conduct a rapid assessment through data collection of water supply system in Rajkot. Based on the findings of the assessment, this study would further recommend steps towards achieving equitable water supply in the city.

vi. Methodology for Conducting the Diagnostic Study in Rajkot

The team comprising of Ms. Manvita Baradi (Director, UMC) Mr. MC Mehta (Technical Advisor, UMC), Mr. Rajendra Jani (Management Consultant, Ramana Group) and Mr. Jon Bormet, International City/County Managers Association (ICMA) visited Rajkot on various occasions with other team members from UMC.

The objectives of the visit could be stated as follows:

- To undertake detail study of the present functioning of water supply utilities and their status in view of the PAS program
- Identify major impediments and identify possible interventions that would help improve the data collection for the defined indicators and the Benchmarking values
- To discuss the values obtained from the program data collected during the PAS team's visit, validate the data, and seek view points from the Municipal Commissioner, and Senior officials of RMC.
- To explore the possible interventions that could be made for improvement in the present functioning through Information System Improvement (ISIP) and Performance Improvement Plan-(PIP).



The team met the Municipal Commissioner and other department heads. Officials from the departments of water supply, health & solid waste, property tax, sewerage and accounts were present during numerous meetings. Detailed minutes of meetings conducted during the visits have been provided in Annexure 1.

During this visit and further subsequent visits by the team, data collection was done with reconnaissance and field surveys.

Selection of Pilot Study Area

Based on the observations during field visits and in consultation with RMC regarding the data recording practices of RMC, it was mutually agreed to compute the actual quantity of water received at the consumers' end. In order to do so, a pilot area falling under one of the distribution zones – Jubilee, serving the core area of the city was chosen. The choice was based on a number of factors as listed below:

- Jubilee serves the core area of the city with relatively high density as compared to the peripheral zones
- Jubilee WDS is served by Bhadar water supply system which is moderately old, i.e. neither the oldest nor the newest system
- Strict adherence at Jubilee WDS to filling out log information in the existing formats which record information such as level readings, pumping hours, amperes and voltages of various pumps and motors, etc.

- Availability of an operational computer at Jubilee WDS

Methodology

A two pronged approach has been adopted to conduct diagnosis of equitable water supply in Rajkot.

- On one hand, UMC would compute water quantities flowing through the Jubilee WDS, while
- On the other hand conduct sample bucket surveys at consumer end with RMC to ascertain the exact quantity reaching the consumers

In case of minor variations, the claims of RMC would be verified as correct and actions for streamlining the information documentation processes would be recommended.

In case of significant variations found between what RMC claims to be supplying to consumers and assessment done under this study, recommendations would be made to ascertain city wide information for water supply and re-assess the system from the perspective of equity.

1. Rajkot City Profile

City Profile and Demography

City's population as per 2001 is 1003315 and spread area of 104.86 sqkm it is located on the bank of Aji river, and a reservoir constructed damming the river on the South East of the city is one of the major source of water supply. city falls within the arid zone, and the monsoon is very erratic, confronting the city with frequently occurring water scarcities. Geologically, the city is located on hard basaltic rocky strata having small confined aquifer that yields poor water in quantity as well as quality. City's main water sources are surface water sources located near around the city as well as located at a distance of 70-80 km.

Table 2 Population Growth of Rajkot City

Year	Population	Growth Rate
1901	36,151	-
1911	34,191	-5.42%
1921	45,845	34.08%
1931	59,122	28.96%
1941	66,353	12.23%
1951	1,32,069	99.04%
1961	1,94,145	47.00%
1971	3,00,112	54.58%
1981	4,45,076	48.30%
1991	5,59,407	25.69%
2001	10,02,000	79.12%
2011	14,84,500	48.15%
2021	22,07,000	48.67%

City has encountered a very rapid urban growth rate as seen from the following table. Decades of 1941-51 saw the highest growth rate of 99.04%, the decade of 90's saw the growth rate of 79.12% and the city crossed the one million mark. Growth of population has also resulted from the city limit expansion undertaken by RMC merging surrounding rural hamlets of Nana Muava, Mavdi and Raiya.

Topography

Northern part of the city has topography that is plain with gentle slope towards north and west. The average elevation attained in the district is 130 meters above mean sea level. The general topography of RMC varies between the RLs 125 m to 158 m from south-east to north-west. The city of Rajkot is situated along the Aji River, which is seasonal in nature. The main tributary of Aji in the area is Khokhadadi located on southwest side of Rajkot city.

Hydrology

The ground water occurs under confined conditions. Depth of tube wells ranges from 30 to 120 meters below ground level, whereas depth to water level ranges from 20 to 100 meter below ground level. The seasonal fluctuations in the water table ranges from 1.8 to 12.0 meters. The yield from the tube wells ranges from 2.50 to 10.00 cubic meters/day. In hard rock areas the availability of ground water in a particular year is the direct response to intensity of monsoon and quick response is seen in such aquifers. In the years of normal and above normal rainfalls the water level decline. The seasonal availability of ground water also varies widely.

2. Existing Water Supply System

2.1. Water Sources

RMC is drawing water from various sources viz. Bhadar, Aji-I, Nyari-I, Nyari-II, Lalpari & Randarda Lake and from Narmada canal based pipeline.

Aji-I with Twin lake of Lalpari & Randarda Water Supply Scheme:

This was the first water supply scheme for the city commissioned by the then Saurashtra Government in 1955. Upon commissioning, people were supplied treated water through individual water connections to cater to their daily water needs. Even after a lapse of 50 years, the scheme serves as one of the major source. The availability of water from the said reservoir is 20.43 MLD. Similarly, Rajkot Municipal Corporation is getting about 6.81 MLD from twin lakes of Lalpari and Randarda. Thus, total quantity available at Aji-I head work in normal year is around 27.24 MLD.

Table 3 Sources of Water for Rajkot City

S. No	Particulars	Aji-1	Nyari-1	Nyari-II	Bhadar
1	Distance form City	5 kms.	8 kms.	22 Km	65 kms.
2	Live storage	1007 Mcft.	945 Mcft.	450	7030 Mcft.
3	Dead storage	21 Mcft	20 Mcft.	45	45 Mcft.
4	Total Storage In MCFT	1028	965	500	7075

Nyari-I Water supply Scheme:

City's increasing demographic growth rate necessitated further augmentation of water resources as Aji source remained inadequate. RMC undertook reservoir construction in 1975 as Nyari-I, fully owned by RMC. Western part of the city is being served by this scheme. The present availability of water from the reservoir is 25.90 MLD inclusive of around 4.5 MLD from the seepage.

Detail study has further revealed potentials of more yield (of around 4.54MLD) from the reservoir by raising 1 mt height of the dam. The proposal costing around INR 15 crores is under active consideration of RMC enabling 31.78 MLD of water from Nyari-I.

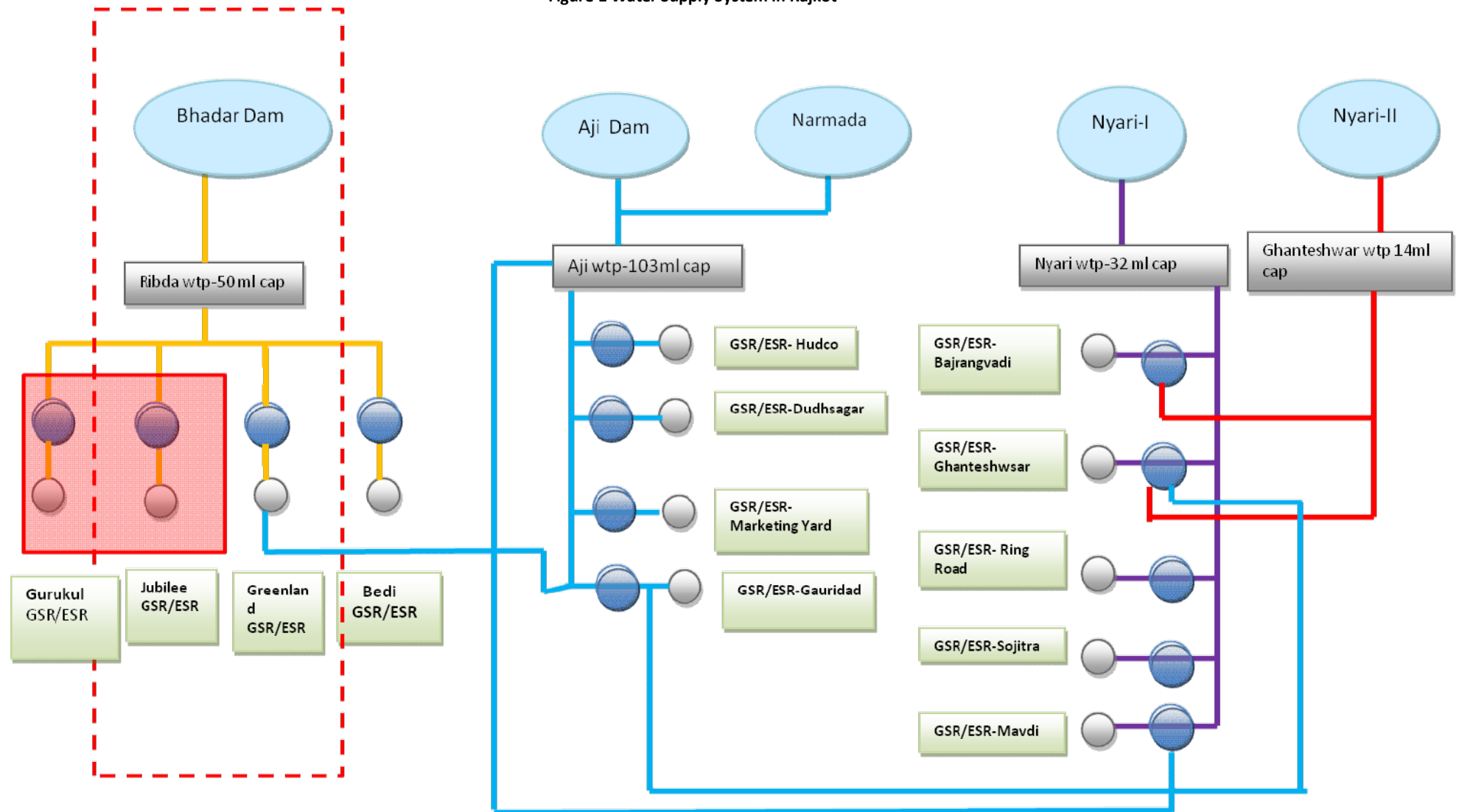
Bhadar Water supply Scheme:

To meet the increased demand of water for better functioning of the underground drainage scheme, need was felt to further augment the water sources. In 1988, RMC undertook the Bhadar dam (located at a distance of 60 Kms from the city) based water supply scheme. This scheme has remained the main stay for the city. The scheme was expeditiously completed within 135 days during the scarcity period of 1988. Water of Bhadar reservoir is mainly utilized for irrigation purpose; however, Government of Gujarat has reserved allocation of 45.54 MLD to meet the drinking water needs of the city, however depending on the available storage in the dam. After commissioning of the scheme Aji and Nyari system got connected to ensure easy and immediate transferability of water. Around 45 MLD of water is normally available from the scheme.

Nyari-II Water Supply Scheme:

Due to the expansion of the city limit and merging of the surrounding rural areas in 1998, the water demand on this count increased by 11.35 MLD. Against this demand, upon the request made by RMC, State Government acceded to an allocation of 6.8 MLD from the dam and 4.5 MLD from the seepage water. The water so obtained from Nyari-II dam is served to the newly merged areas of Nana Mava, Raiya and Mavdi. A water supply scheme based on this drawl from Nyari-II was prepared and implemented at a cost of INR 15 crores.

Figure 1 Water Supply System in Rajkot



Drinking Water from the Narmada Canal:

Under the Narmada reservoir based pipeline scheme implemented by the State Government through its Nodal agency GWIL, an allocation of 169 MLD has been made for the city of Rajkot. It has been planned to provide the agreed quantum from the Dholidhaja-Dwarka pipeline. However, in view of the urgency of providing the city the required water quantity and the planned tapping from the agreed point was time consuming, an alternative was executed by giving the tapping from the Maliy-Jamnagar section of the main pipeline, and the city is being provided around 40 MLD of water from this point near Nyari. RMC on its part erected storage, treatment and transmission facilities at a project cost of INR 15/crores. During scarcity period Rajkot Municipal Corporation is provided water from various other irrigation reservoirs namely; Aji-3, Demi-I and Demi-II, Fophal etc.

2.2. Treatment Facility

There are four water treatment plants to cater to the needs of the people for potable good quality water. The plants are located at Ribda, Aji, Nyari and Ghanteshwar. Ribda Filter Plant, which is about 25 kms. away from the city has 50 MLD design capacity. Aji Filter plant is located near Aji dam site, has three water treatment plants with total design capacity of 103 MLD. Nyari Filter Plant, within the city, has three water treatment plants with total 32 MLD design capacity. Filter Plant at Ghanteshwar which is located near city out skirt has water treatment design capacity of 14 MLD. The total water treatment capacity is 199 MLD against total city supply of 140 MLD. All these WTPs are equipped with most modern facilities, which have latest kind of instrumentation devices.

Under the water supply monitoring mechanism, hourly check for turbidity, residual chlorine content is done at the source. Chemical analysis and bacteriological tests are being carried out regularly. At intermediate levels residual chlorine content is being checked regularly in each of the three zones. At the consumer end the residual chlorine content is being maintained around 0.2 ppm.

2.3. Water Distribution Stations

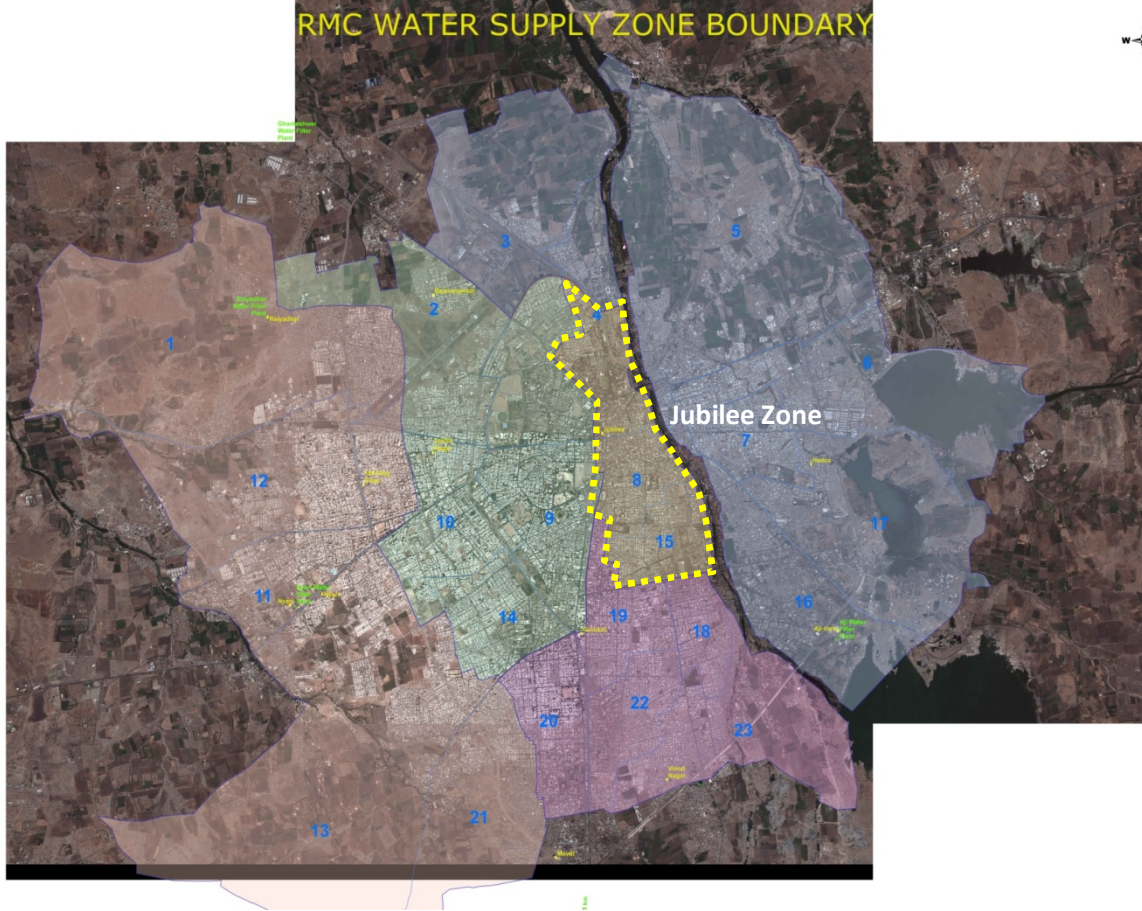
RMC water supply distribution system is divided into 5 major Water Districts; namely Jubilee, Gurukul, Nyari, Aji and ring road. The details of the zonal distributions are as below:

Table 4 Details of Water Distribution Zones in Rajkot

Water Supply Zone	No. of Ground Level Service Reservoirs (GSR)	No. of Elevated Storage Reservoir (ESR)	Election Wards Covered
Jubilee	2	2	1, 2, 3, 13[P], 15[P], 16
Gurukul	2	2	2[P], 4[P], 6, 7, 8, 9[P], 10[P]
Nyari	5	1	9, 10, 11, 12, 13, 14, 21
Aji	8	-	4, 5, 6, 17, 18, 19, 20
150 Feet Ring Road	1	1	22, 23

City distribution network comprises of 80-mm pipe to 863 mm sizes of pipeline with pipe material AC Pressure, MS, PSC as well as CI pipes.

Figure 2 Water Supply Zones in Rajkot Municipal Corporation



3. Quantity Estimation at Consumer End by Monitoring Existing System

The purpose of this assessment is to verify the claims of RMC related to equitable water supply in terms of lpcd provided to its citizens. To assess the same, exact quantity of water supplied to sample area chosen – Jubilee, needs to be ascertained using principles of hydraulics, pumping capacities of various equipments, storage capacity and level marking during the supply hours.

In order to compute the quantity of water received at the consumer end, the quantities need to be tracked from procurement stage through to the outlet of distribution system. To capture the relevant data in this cycle, existing format used by RMC for recording information may not be appropriate. Hence, for the purposes of this exercise, alteration to RMC's existing formats have been suggested and in some cases, new formats have been proposed.

A stage wise assessment to be conducted for assessing quantity of water received at consumer end has been shown in the diagram below:

Figure 3 Stages of Water Supply to be Assessed for Computing Water Quantity Supplied through WDS

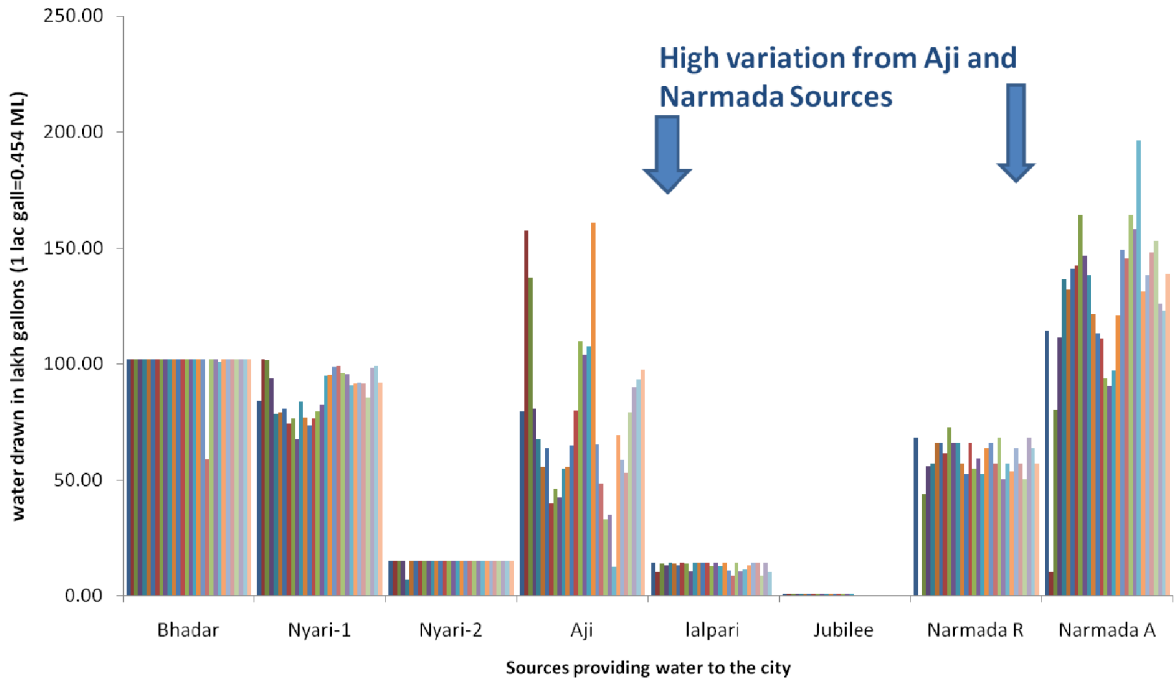


3.1. Water Allocation and Source Monitoring

Main water sources for the city are surface reservoirs, namely Aji, Bhadar and Nyari dams, mainly irrigation reservoirs. Aji reservoir primarily caters to the drinking water needs of the city and is entirely under the control of RMC, whereas other reservoirs are under the control of Irrigation Department.

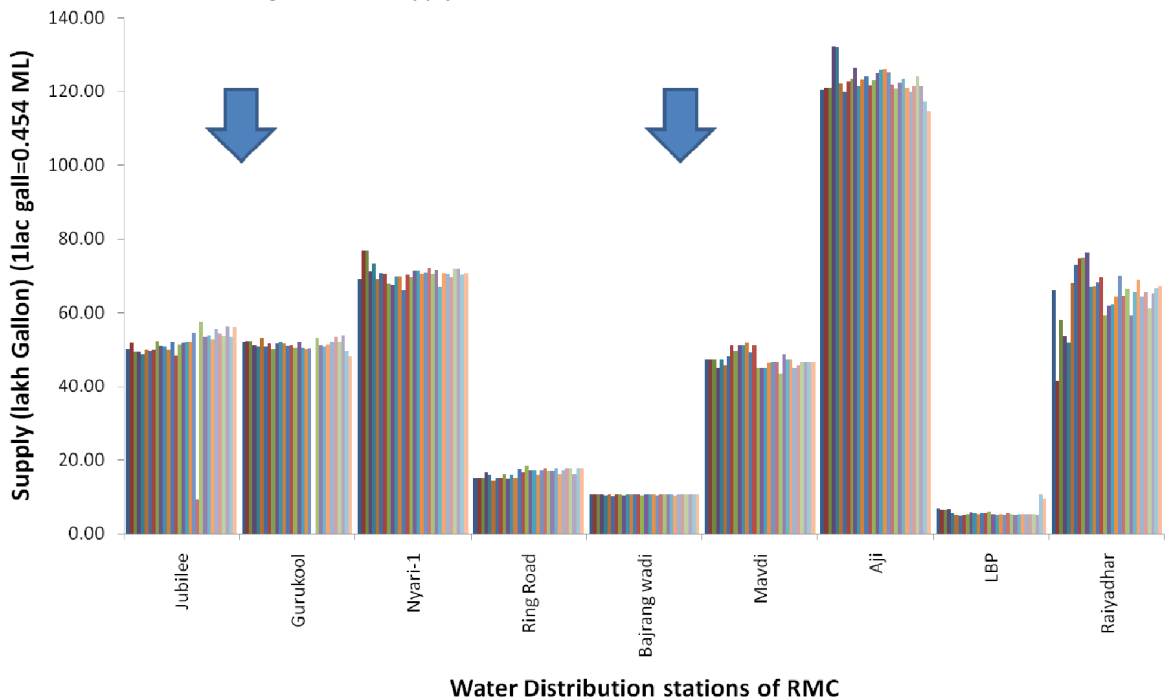
RMC claims that despite water being sourced from different sources, distribution of water has been equitable on a monthly basis. This has been made possible by establishing a series of inter-linkages between sources, treatment facilities and distribution stations. The figure below shows the variation in drawl of water from various sources in April 2011.

Figure 4 Variations in Water Drawl from various Sources, April 2011



As evident from the figure above, there have been high variations in drawl from Aji and Narmada sources of water. The figure below shows the water supplied from each distribution station in the city over the same period of time.

Figure 5 Even supply of water from various Distribution Stations



It is evident from the above graphs that despite the variations in drawl from various sources, distribution of water has been even due to successful operation of inter-linkages at various levels in the network.

Water Allocation Process

The Irrigation Department gives due priority to the drinking water needs of the city while planning for annual overall water requirement apart from irrigational needs. The process relies upon the replenishment received from the previous monsoon. Water allocation is planned to satisfy water demand (irrigation and urban), especially in case of inadequate replenishments from the catchment area. This calls for careful water budgeting and requires closer monitoring on the part of authority.

Depletion statements pertaining to the monthly demand and drawl for the drinking needs as well as the irrigation needs are computed. Evaporation and absorption losses are taken into account during budgeting. Existing depletion statements comprise of

- estimated drawl
- losses due to evaporation and absorption

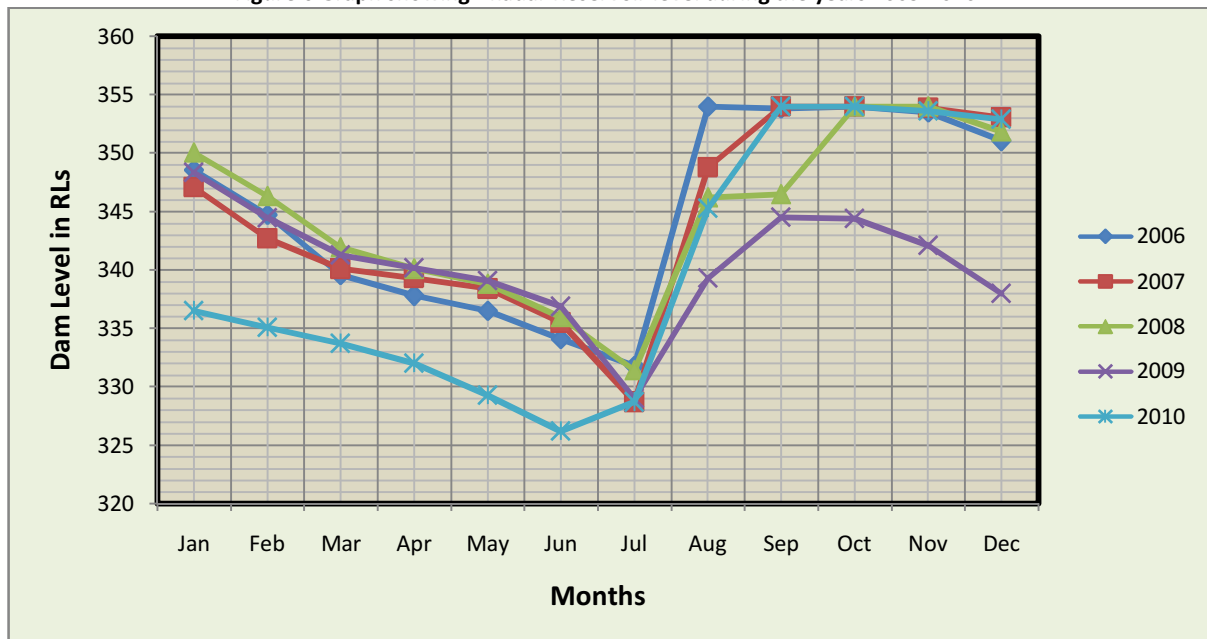
In case of RMC, Bhadar reservoir (an irrigation dam under the control of the Irrigation department) has been taken up for the study. Data related to its storage capacities, past monthly levels as well as the depletion statements of last two years made available by concerned department of RMC have been analyzed for the study. Salient features of the reservoir are as under.

Table 5 Relevant Features of Bhadar Dam

S. No.	Description	Value	Unit
1	Distance from the city	60	Km
2	Live storage of the dam	7,030	Million cubic feet
3	Dead storage of the dam	45	Million cubic feet
4	Total storage of the dam	7,075	Million cubic feet
5	Water allocation for the city	10	Million Gallon per day
6	Average drawl for the city	45	Million Litre per day
7	Pipe line scheme commissioned	1988	Year

Irrigation Department has maintained the water level data of Bhadar Dam since 1985. Figure 6 shows the water level in Bhadar Dam (as water source) between 2005 and 2010. Similar records are available since 1985.

Figure 6 Graph showing Bhadar Reservoir level during the years 2005-2010



Irrigation Department and RMC have storage capacity information of Bhadar reservoir at varying depths. This information alongwith the level readings is being used to assess the available quantity of water. Further, by integrating the evaporation and absorption losses, a depletion state is prepared and water sufficiency can be predicted for the year ahead.

Limitations of the present data keeping system:

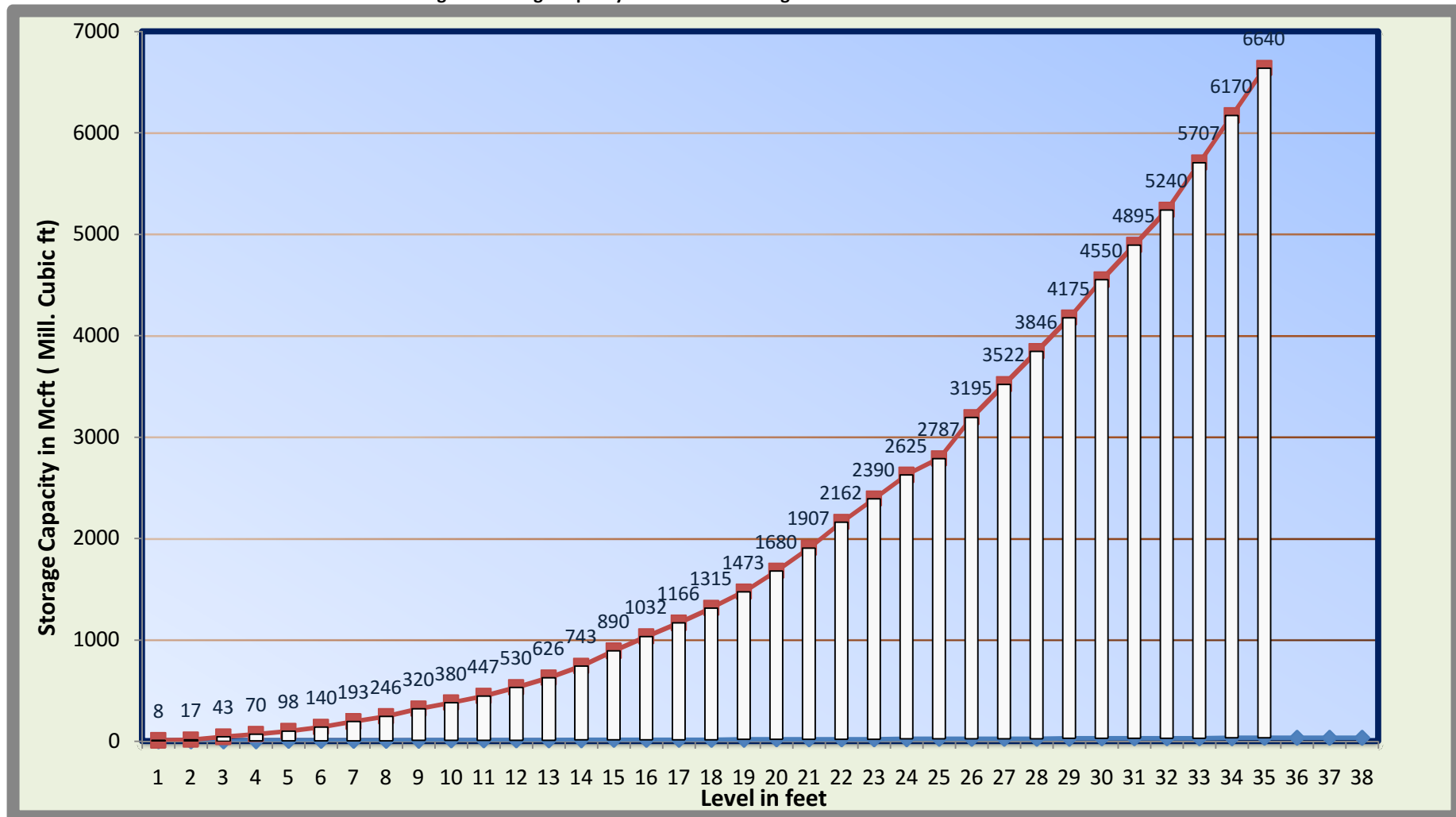
Depletion statements are however, not used for appropriate monitoring and hence, any mid way course correction for drawl of water are not done. Any alterations in the losses or drawl during non summer months may eventually lead to acute shortages on ground whereas, initial water allocations may suggest adequate quantities in the reservoir.

Intervention for Information System Improvement Plan:

From the available information related to storage capacity and levels, an appropriate graphics have been prepared displaying storage capacity vis-a-vis the depth of water. Actual levels could be easily compared with the levels estimated in the depletion statement, and allows for mid course correction of the drawl.

Most of such relevant information is normally available but not interpreted or easily accessible for planning and decision making.

Figure 7 Storage Capacity Chart of Bhadar Irrigation Dam w.r.t to Reservoir Level



For the purposes of computing water quantity from Bhadar Dam, 45 MLD is reported to be drawn by RMC from Bhadar to various WTPs. Water supplied to various WTPs comes from different sources.

3.2. Water Treatment Monitoring

There are four water treatment plants located at Ribda, Aji, Nyari and Ghanteshwar. Ribda Filter Plant is located around 25 km from the city has 50 MLD design capacity. The total water treatment capacity available with RMC is 199 MLD against total city supply of 140 MLD. All WTPs are equipped with most modern facilities, which have latest kind of instrumentation devices.

The Ribda plant has been constructed along with the Bhadar Pipe line project, as it was necessitated while drawing raw water from the Bhadar dam. The table below shows the designed capacities of all four WTPs of Rajkot.

Table 6 Details of Water Treatment Plants in Rajkot

S. No.	Plant location	Design capacity In MLD
1	Aji Dam	103
2	Ribda	50
3	Nyari	32
4	Ghanteshwar	14
	Total	199

Data is recorded at the inlet of Ribda WTP. Treatment losses occurring at Ribda WTP are recorded using various formats including back wash. A sample format used for recording back wash details are shown in Table 7.

Table 7 Ribda WTP back wash details recorded in the Jubilee supply formats

રાજકોટ મહાનગરપાલીકા
ભાદર જળાશય આધારિત પાણી પુરવઠા યોજના
જયુબીલી ઝોન વારીગૃહ

કુલ કુલ પામ્પીંગ સ્ટેશન		ભાદર ડેમ સાઈટ												ગોંડલ પામ્પીંગ સ્ટેશન						સિલ્કા	કોન ટેન્ક	જયુબીલી ઝોન
કામ ટેડ	વચાન ટેડ	GSR	કેમ ટેડ	નોડો ટેડ	પેલેવ	મોટર મેનરીયા						પેલેવ	મોટર મેનરીયા						નોડો	કેમ ટેડ	કોન ટેન્ક	જયુબીલી ઝોન
S.R.કોડ	ESR	ESR	ESR	33KV	M1	M2	M3	M4	M5	M6	33KV	M1	M2	M3	M4	M5	M6	કેમ ટેડ	કેમ ટેડ	કોન ટેન્ક	જયુબીલી ઝોન	
-	૨૭૧	૨૭૦	-	૩.૫	૨૮	-	૨૮	૨૮	૩૦	૩૦	૩.૭	-	૩૬	૩૨	૩૩	-	૩૩	૧૩૫	૨	૩૦/૧૦	૩	૩૦/૧૦
-	૨૬૦	૨૬૦	-	૩.૫	૨૮	-	૨૮	૨૮	૩૦	૩૦	૩.૫	-	૩૬	૩૨	૩૩	-	૩૩	૧૩૫	૨	૩૦/૧૦	૩	૩૦/૧૦
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-	૨૧૦	૩૧૦	-	૩.૫	૨૮	-	૨૮	૨૮	૩૦	૩૦	૩.૫	-	૩૬	૩૨	૩૩	-	૩૩	૧૩૫	૨	૩૦/૧૦	૩	૩૦/૧૦
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-	૨૧૦	૩૧૦	-	૩.૫	૨૮	-	૨૮	૨૮	૩૦	૩૦	૩.૫	-	૩૬	૩૨	૩૩	-	૩૩	૧૩૫	૨	૩૦/૧૦	૩	૩૦/૧૦
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Figure 8 Sample format used for recording Quality details at WTPs in RMC

Raw Water ✓
Settled water
Filter water
Filter plant

PH: R.W. Aji, R.W. L/R, R.W. Namada, S.W. F1, S.W. F2, F.W.

Dose: PAC Sol., Alum., CaOCl₂, Residual Cl₂

Turbidity: R.W. Aji, R.W. L/R, R.W. N, S.W. F1, S.W. F2, F.W. F1, F.W. F2

Total storage bfr supply
General Storage

Chemist

Flow meter reading

નર્મદા આધારીત પા. પુ. યોજના

કુદરતી સાગર ના ડિસ્ક્રીમિ-૧ની વિ

સમય	આણંદ લાઇન પાણીનો ક્લો	મીટર ડોટલાઈનર	હડાણ મીટર રીડીંગ પછીનો ક્લો/ડોટલાઈનર	કુદરતી સાગર ના ડિસ્ક્રીમિ-૧ની વિ
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પાણી વિતરણ :- ચાલુ સમય બંધ સમય ડિસ્ક્રી નંબર આવક (ક્લો) આણંદ :- લા. રા. :- હડાણ :-

વિશેષ નોંધ :-
 $x - y = z$ MLD = water produced

- Noting Ph of the water quality.
- Noting Turbidity of the in water at raw, settled and filtered stage of the process.
- Noting alum used during the shifts and stock available

As shown in the above fig. the information related to water treatment process merely comprises of water quality and the chemical used and its stock. Water treatment process related parameters do not get recorded in this format.

Rate of filtration (which is not derived currently) would also indicate the efficiency of the filtration process. It could well lead to the prescribed designed parameters, and would provide the information about the corrective measures needed to improve the overall performance of the bed or the plant as a whole.

All these parameters could be easily captured if there are appropriate formats for the recording and reporting purpose. Model format is shown in the following tables, and it could be suitably structured for the specific requirement and also look to the ease and convenience of the operating staff.

In the absence of appropriate formats to record relevant data, treatment losses could not be computed.

3.3. Water Distribution Monitoring

RMC has 13 water zones for distribution of water supply. Each of the zones has water distribution stations which are operational 24x7 and has a plant operator and helper staff working in three shifts.

Rajkot has dedicated supply zones for each of their water sources. Though there are inter-linkages between supply zones, these inter-linkages are operational only when there are problems of procurement for a particular source.

The central office uses computers for recording and reporting, although it remains mainly confined to the Central offices. Though, RMC maintains uniformity in record keeping and reporting practices followed at water installations, there is variation observed due to dissimilar equipments and its delivery parameters.

Operational records are maintained at the Jubilee WDS on an hourly basis and include broad parameters like

- pumping hours
- water quantity supplied during the day
- pump starting and shutting details
- Ampere and voltmeter readings.
- level of water at the source (Bhadar Dam)

Limitations of the present practice of record keeping

There are no direct recordings of water quantities received from WTPs. The total water quantity received and distributed during the day is derived on the basis of the tank volume difference and discharge capacities of pumps. This data is recorded in formats which are manually filled by the operators and the contractual staff of RMC. The format is presented in Table 8.

Water quantity supplied to a zone can be estimated using the existing formats. However, data of water supplied to each sub-zone is not derived. Hence, spatial variations in water supply within a water zone cannot be assessed.

In the absence of information about water supplied to a sub zone (and eventually lpcd supplied), the only criterion for monitoring the system is its supply duration.

The reasons for absence of any assessment at consumers' end are as below:

- There is no data regarding pressure available at consumers' end and supply duration does not provide any information of the quantity being provided
- Sub-zones of the water supply system do not coincide with administrative boundaries of RMC. Population in each sub-zone is not known and hence, the demand of water is also not known.
- Water supply at the consumer's end is also dependent on local topographic conditions. No such overlay of topography, sub-zones and supply duration is available with RMC.

Information related to Water quantity processed during the day would be useful where the supply to the downstream area is for longer duration say 6-8 hours. But in case of RMC, as well as other cities in the country where the supply duration is drastically curtailed to few minutes or one/two hours, and the supply is provided through zoning at different time of the day, it would be important to derive the water quantity supplied to each of

Due to the above reasons, the current data recorded does not help the decision maker to make appropriate clusters of sub-zones to achieve equitable water supply. Information regarding the supply timing of each sub-zone is not collated to gain a broader picture at the central level.

The UMC team worked with all assistant engineers of the Jubilee WDS and collated information regarding supply timing to sub-zones in the table below providing a clearer picture of the peak load for water supply.

Table 8 Existing Log Sheet Maintained at Jubilee Headwork

Provides details of chlorination at Jubilee ww; does not provide the details of the dose ppm.

Provides details of Bhadar dam level on date and its storage capacity

Merely records the voltage and ampere of each motor pump, but does not leads to not to further derivation or utilization

Records total pumping hrs at various installation & water qty derived, (based on pumping capacity .

Sump level is recorded every hour, but water qty processed is not recorded. Howit is related to other further processes is not clear.

Records the water quantity's opening balance, income, total and the supply made and the balance storage left.

Proposed Changes in the existing data format

In order to compute volume of water supplied, a column has been added (highlighted in red) in the existing format which computes the water quantity supplied on the basis of tank levels recorded by the operator.

Computation of water quantity at the Jubilee and Gurukul Head works

Total Water Supply from a tank = tank storage + pump discharging water into the tank

Calculation of Tank Storage

The column highlighted in red shows the volume of water supplied.

Calculation of Pump Discharge

Columns to capture the time of functioning of each of the pumps were added to calculate discharge.

The operation time of pumps has been recorded to compute exact water supplied. The calculation model (MS Excel based) is sensitive to computing the water supplied from the tank only when the valves are opened. The time of the opening and closing of the valve is also recorded.

The following table shows the computed water supplied from each of the four pumping stations of Jubilee, Gurukul, Gondal and Bhadar pumping stations of the Bhadar Dam water stream.

As all the subzones of the entire city area are provided water for 20 minutes supply duration, water quantity has been computed for the same interval. Computing this volume in each sub-zone would capture inequity in distribution.

The following table shows a sample of the water computed for every 20 minutes.

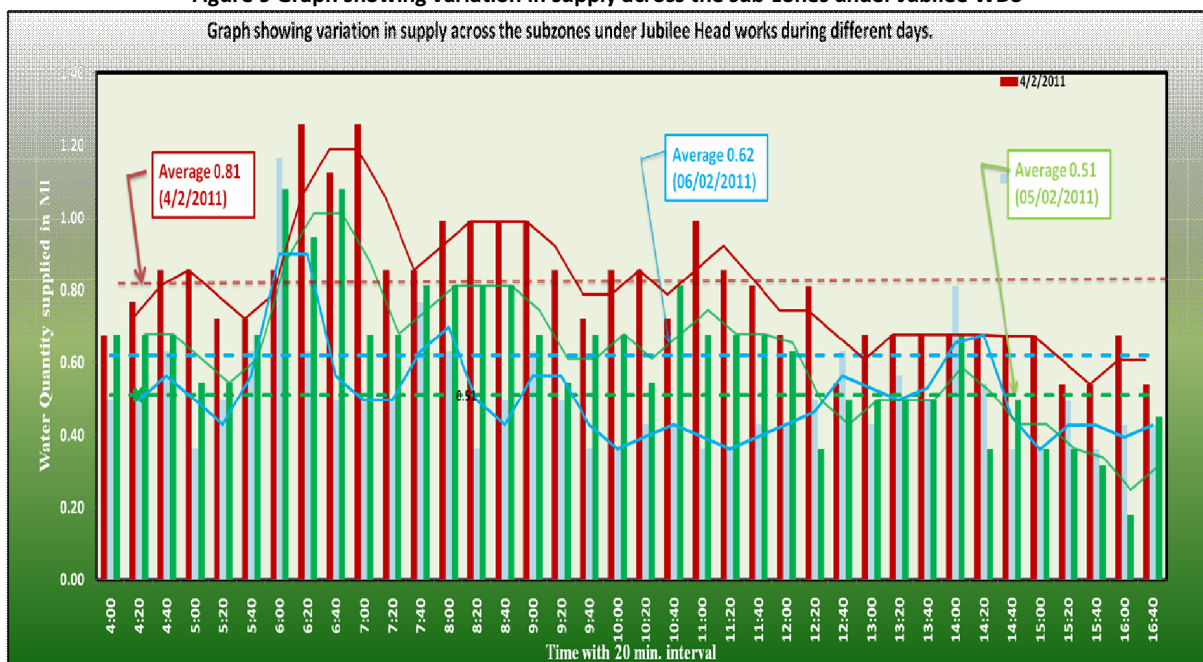
Table 9 Sample of sheet used for recording supply volumes to each zone at 20 minute interval

		Pmp dis=	0.544 ML/Hr	5.448	1mt	1.49 MI	1.35 M/mt						
Water Supply Details under Bhadar supply based -Details- Jubilee Zone Head works													
Jubilee Pumping station													
Sr.No	Time	Chlorine	Motor ampere					GSR	GSR Water volume in ML	Canal Rd ESR DG	Canal Rd ESR Water Vol	Supply	Canal Rd ESR Water Vol
			ppm	Voltage	M1	M2	M3						
	1		430						3.3		3.5		0
	01:20								3.6	0.45	3.5	0	0
	01:40								3.7	0.15	3.5	0	0
	02:00:00		425						3.7	0	3.5	0	0
	02:20								3.7	0	3.5	0	0
	02:40								3.75	0.07	3.5	0	0
	3	st	430						3.75	0	3.5	0	0
	03:20					0.333	0.333		3.75	0	3.5	0	0
	03:40					0.333	0.333		3.85	0.15	3.5	0	0
	4	st	430			0.333	0.333		3.85	0	3.4	0.134	0
	04:20			0.333		0.333	0.333		3.9	0.07	3.3	0.134	0.68
	04:40			0.333		0.333	0.333		3.6	0.45	3.4	0.134	0.68
	5	st	430	0.333		0.333	0.333		3.5	0.15	3.5	0.134	0.68
	05:20			0.333		0.333	0.333		3.4	0.15	3.5	0	0
	05:40			0.333		0.333	0.333		3.35	0.15	3.5	0	0
	6	st	425	0.333		0.333	0.333		3.3	0.15	3.5	0	0
	06:20			0.333					1.2	0.15	3.5	0	0
	06:40								1.3	0.15	3.5	0	0
									1.5	0.3	3.5	0	0
									1.7	0.3	3.5	0	0
	23:40								2	0.45	3.5	0	0
	24		425						2.2	0.3	3.5	0	0
	:20												0
	:40												0
				11.66	0	11.32	8.991	6.993		8.344		9.11	23.65
Head works			Pump hrs	Qty lgal	P Hrs Rev	Qty MI	Qty in lgal					Jubilee	
Jubilee			38.96	46.65	38.96	23.65	52.5					Opening bal.	14.23
Gurukul			40.55	48.36	42.24	20.57	45.67					inflow	46.23
Bhadar			118	100.7	120	46.31	102.8					total	60.46
Gondal			120	102	120	46.31	102.8					supply	49.2
greenland jubilee				0								store	11.26
Jubilee well				1									
Lal Bahadur Supply				5.32									
										GSR inflow rate at Jubilee	0.596	ML	

Inference

From the graph below, water quantity supplied has been computed. However, as population in each sub-zone is not available, water received at consumers' end cannot be further computed. In order to do so, sub-zones need to be mapped with demographic details to assess the water received per capita per day.

Figure 9 Graph showing variation in supply across the sub-zones under Jubilee WDS



Moreover, this model does not account the losses incurred in the distribution network – WDS onwards. For the purposes of this diagnosis, the water quantity received cannot be assessed to reasonable accuracy and hence the alternate methodology - conducting bucket surveys at consumer end has been believed to be more accurate.

4. Quantity Assessment at Consumer End through Surveys

Water provided from the water treatment plant or water distribution station to the consumer is monitored on the basis of supply time duration. In absence of meters installed at the consumer end, it is difficult to assess approximate water quantity reaching the consumers. This mainly results into inequitable distribution of water in different parts of the city. The inequity arises out of varied topographical features of the city, density of population, inadequate size of the transmission or the distributor mains and the excessive discharge leading to higher friction losses occurring in the network.

RMC has numerous zones and subzones where water is supplied for only 20 minutes in each of the subzones. The zones and subzones receive water from different ESRs located in different parts of the city and through extensive and elaborate valve operating by the valve men at varied timings.

RMC's Initiatives for assessing the consumer end water quantity

Recently RMC has undertaken an elaborate exercise of assessing the water quantity at the consumer end by measuring the water quantity received in a known volume container of water – normally a bucket or pot of 7-10 litre capacity. Deputy engineers are given responsibility of this measurement exercise undertaken with the help of the subordinate staff and the data is reported to the higher office in prescribed format. Each of the sub-zones falling in different time slots is taken up for this assessment exercise. Time from the Mobile phone stop watch is observed for filling up of the container of known volume, and the water availability for supply duration of 20 minutes is derived and noted and reported on daily basis.

Higher authorities take stock of the results and identify area of above, normal or below average quantity of water received at the consumer end. The said assessment exercise for measurement of approximate water quantity received at the consumer end makes an interesting reading and the general inference is shown in the below mentioned details.

Deriving hydraulic parameters from observed data

The above observation of water quantity measurement at the consumer end enables further hydraulic computation of the residual head at the point of consumer discharge and also helps in deriving the pressure in the municipal main from which the connection has been tapped. However, these derived values are based on broad assumption of connection length of 10 ft, and the size of the connection assumed to be ½ inch dia. and the C value of the connection is assumed to be 80.

Hydraulic formula used – Basic Hazen William formula

$$V = 0.85 \cdot C \cdot H \cdot R^{0.63} \cdot S^{0.54}$$

Formula for pressure computation

$$\begin{aligned} HL &= \text{Friction Head loss} \\ &= L \cdot (Q/C)^{1.81} / 0.0994 / d^{4.87} \end{aligned}$$

Where Q= discharge measured in cumec

D= diameter of the connection in m (assumed 0.012 m)

L= length of the connection in m (assumed 3.23 m)

C= Co-efficient of friction (assumed to be 80)

Strategy adopted for overall technical evaluation

Since RMC has already initiated consumer end water quantity measurement in different zones and wards of the city, the information obtained from this data has been utilized for the evaluation. In order to do so, the following details need to be used:

- Volume (of container used for survey)
- time in seconds taken to fill the container
- details of the consumer's connection size
- exact location of sample
- connection length
- approximate elevation

The quantity measured with the connection size and length details enables deriving the residual head and the approximate pressure at the tapping point of the connection under observation with the help of the above stated formula. In this case, field observations taken by the RMC team, the measured water quantity has been considered. House hold size of 5 people has been considered for deriving the LPCD (litres per capita per day). From the water quantity measurement, discharge in cumec has been derived and also the length of the connection has been assumed to be standard 3.28 mt length and the C value of 80 has been considered for deriving the required hydraulic parameter of residual head and pressure at the tapping point of the connection.

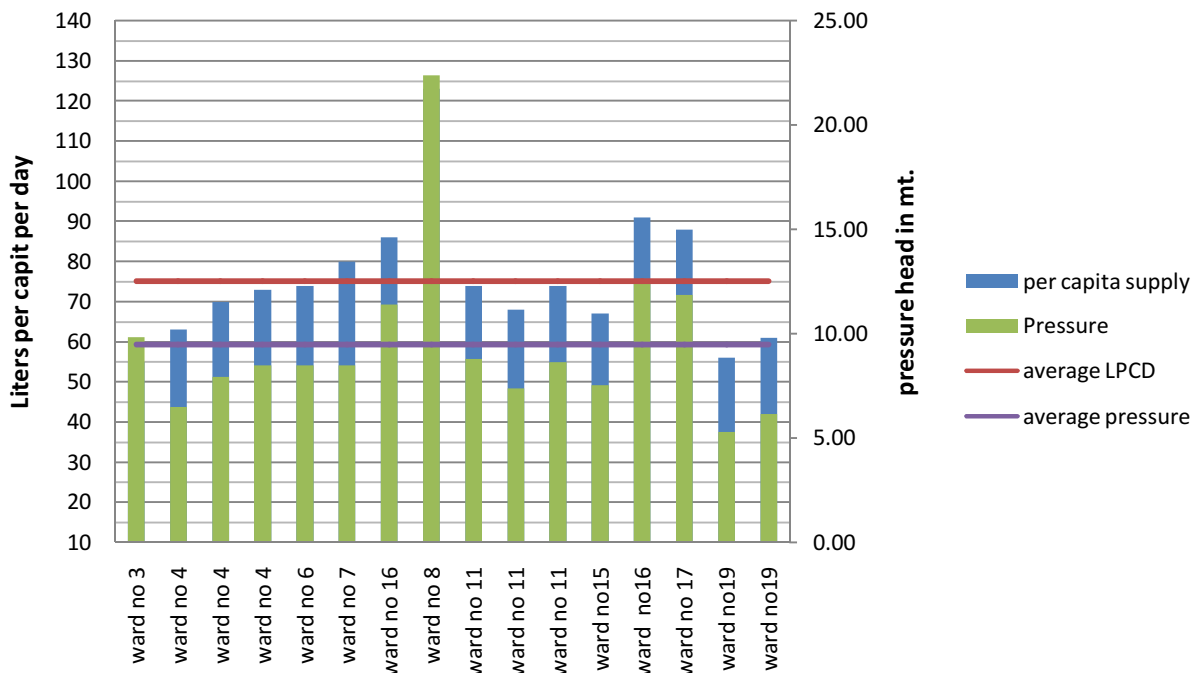


The observation of various wards of RMC has been limited to two observations per each time slot in a ward. However, RMC's field team records number of locations in a particular time slot in each of the ward. Average maximum and minimum values for each of the statement related to each ward have been derived and shown in Table 10, and comprehensive statement of all Ward No. 19 is shown in Annexure 2.

Table 10 Details of supply at consumer end with LPCD, residual pressure & pressure derived

Ward no	Quantity assessed in supply time			LPCD			Derived pressure		
	max	min	Avg	max	min	avg	max	Min	avg
3	500	275	393	100	78	55	14.90	4.90	9.83
4	375	172	315	75	34	63	8.70	2.10	6.50
4	435	230	352	87	46	70	11.50	3.52	7.94
4	400	350	369	80	70	73	9.85	7.70	8.49
6	380	360	368	76	72	74	9.00	8.10	8.50
7	450	350	399	90	70	80	9.85	7.70	8.49
16	520	350	431	104	70	86	16.00	7.60	11.40
8	800	450	617	160	90	123	35.7	12.30	22.40
11	600	320	372	120	64	74	20.9	6.51	8.79
11	450	235	339	90	47	68	12.25	3.57	7.38
11	400	320	372	80	64	74	9.85	6.51	8.64
15	705	260	336	141	52	67	28.00	4.42	7.54
16	475	450	459	95	91	91	13.55	12.25	12.63
17	475	415	441	95	83	88	13.55	10.54	11.86
19	360	213	284	72	42	56	8.10	3.10	5.30
19	375	245	308	75	49	61	8.78	3.96	6.15
	481.25	312.19	384.69	96.25	63.88	75.19	14.41	6.55	9.49

Figure 10 Graph showing average per capita supply in different wards of RMC



Inference

- Water quantity received at the consumer end is around 200-600 litre in 20 minute supply duration in different wards of the city.
- Quantity derived from the above observation considering a household size of 5 person is **55 – 123 LPCD**

RMC supplies water to different areas of the city with good pressure, however the supply duration is limited to 20 minutes only. In order to maintain this pattern of supply, it needs extensive valve operation throughout the city and also has to monitor this operation precisely. Maximum water quantity supplied ranges around 493 whereas the minimum ranges around 394, per capita supply is around 100 lpcd maximum and the minimum of around 65 lpcd averaging at around 80 lpcd.

The pressure as derived appears to be much on the higher side and this is apparent from the field visits revealing a forceful jet emerging out of the connections upon opening the taps. The areas near and around the Jubilee water Head works receive higher water quantity which is around 650-700 litres within the supply duration, and also have higher pressure than the average observed. Despite adequate pressure people tend to draw water at ground or 3 to 4 feet above the ground level resulting in dissipation of the higher head available.

Main reason for sudden dip in pressure is the short duration of water supply. Consequently, RMC has to incur high energy costs to cater to the high pressures at the consumer end which ultimately gets dissipated when people draw water at ground level. People in turn also spend heavily on pumping the water quantity received by them for maintaining the adequate pressure in the household.

5. Conclusion and Way Forward

Management of Even Water Supply at City Level

This diagnosis study involved verifying the claim made by RMC that water is being supplied to all sub-zones in an equitable manner. RMC claims that this has been possible due to various levels of inter-linkages established in the system.

The first level of inter-linkage is done when water is brought from various sources to four WTPs. The second level of inter-linkages involves connecting each WTP with all WDS. By establishing this set of linkages, it is believed that RMC has managed efficient use of its treatment facilities. With these inter-linkages, RMC has proved its claim of even water supply through all WDS despite variations in the drawl from different sources.

Maintaining Equitable Water Supply at Consumers' End

RMC also claimed supply at consumers' end to be equitable. RMC's claim for this was based on the total volume of water supplied from a WDS and was equally divided by the population served by each zone. This calculation did not account variables such as local topography, distance from WDS, size of connection, number of households served by each connection, etc.

Moreover, the losses in the distribution network from WDS downstream are unknown and hence, the actual bulk volume reaching the consumers is also a broad estimate.

Each zone of water supply is further sub-divided into sub-zones. No details regarding population, number of households, number of connections, etc. are available with RMC to arrive at a reasonably accurate estimate of water quantity received at sub-zonal level, let alone consumers' end.

UMC made attempts to assess the actual water quantity reaching the consumers using 2 methods

1. Quantity Estimation at Consumer End by Monitoring Existing System
2. Quantity Assessment at Consumer End through Survey

The first method (Quantity Estimation at Consumer End by Monitoring the Existing System) involved assessment of data recorded by RMC at various levels using their existing formats and modifying some existing formats wherever necessary, to capture all relevant data. However, there are certain stages of the supply system, like distribution network, where no data recording is undertaken. Hence, quantity estimation at consumers' end was not possible to be undertaken using this method.

Nevertheless, quantity estimation at sub-zonal level has been done using the existing and modified data formats. It was found that there is variation in water received by each sub-zone and hence, supply is not even.

The second method (Quantity Assessment at Consumer End through Survey) involved conducting sample survey at random but evenly spread locations in Jubilee WDS zone. The results revealed very high variation of water received with the lowest being 55 lpcd and the highest at 123 lpcd.

As verified by the above two assessments, it was concluded that water supply system of RMC is partially equitable, i.e. at zonal level. Despite fluctuations in drawl of water from source, RMC has managed to keep the supply to all zones consistent. However, at sub-zonal and consumer level, the water supply system showed large variations in the quantity of water received.

Way Forward

Although, the study revealed the equity of RMC's water supply at various levels, the area of assessment was geographically and demographically restricted to Jubilee WDS and its sub-zones. Equity of water supply can be established only after conducting a city wide survey and assessment using available data.

In addition to conducting consumers' end surveys, mapping the finding would be of crucial relevance whereby areas which are underserved can be addressed. Also, for a comprehensive picture at the city level and to further elaborate parameters related to equity, more detailed studies need to be conducted. These studies could include (but not limited to):

1. GIS based mapping of entire water supply system (with all technical information such as pipe sizes, topography, inter-linkages, etc.)
2. Mapping all zones and sub-zones alongwith demographic information
3. Survey to assess the number of users against each connection
4. Water Audit, including energy audit of water supply system and asset management plan for water supply utilities
5. Leak detection study for the entire system

With the above stated activities, detailed assessment of equity of water supply system in Rajkot city can be conducted. Based on the findings of such a study at the city scale, appropriate plans can be made to improve data recording practices, standard operating procedures, use of real-time data for efficiently running the system and planning for future.

Annexures

Annexure 1 Minutes of Meeting for Various Meetings conducted between September 5-9, 2010, Rajkot

Meeting 01 – Meeting with Mr. Vijay Anandkat, City Engineer, RMC

Date: September 05, 2010

UMC Team – Ms. Manvita Baradi, Mr. Arvind Singh, Mr. M. C. Mehta and Ms Urvi Patel

Experts- Mr. John from ICMA, Mr. Rajendra Jani Management Consultant

RMC – Mr. Vijay Anandkat, City Engineer, RMC

- Mr. Anandkat, in-charge of the Projects presented the RMC details pertaining to the City's overall profile, the sector demand and the present Projects taken up under JnNURM for bridging the deficit between present demand and supply, as well as the infrastructure facilities to be provided for the future demands. Besides, the action taken under the reform program prescribed under the JnNURM project was also presented.
- Broad overview of the present functioning of the utilities was also presented. Major issues confronting the city and the Municipal Administration were also brought out.
- Other issues discussed with Mr. Anandkat are as under-
 - JnNURM project linked reforms are to be achieved within 7 yrs, funds receivable likely to be affected if the reforms as committed are not undertaken.
 - Population growth rate is excessive-approximately 46% per decade.
 - City divided into 3 zones, East, Central and West Zone each comprising of 7-9 election wards in each zone.
 - Against the present demand of around 160-180 MLD water – 225 MLD capacity is available which could cater to another 3-4 lac population in future.
 - Major issues in water supply are mainly related to no metering except the ones at the source., intermittent supply of only 20 minutes results in focused attention that entails major time devotion, poor ground water quality.(around 1200 TDS), major expenditure for water is for energy and bulk purchase from Narmada pipe network.
 - Special efforts undertaken by RMC to switch over to 24x7 water supply through PPP model, but the same has been presently stalled in view of people's resistance and reluctance.
 - MoU signed with private party for STP with tertiary treatment facility enabling recycling and reusing the treated sewage water for the industrial units around the city on BOOT basis.
 - Special E-Gov measures undertaken by RMC to address the citizen complaints expeditiously, and establishing civic centers in every zone for easy accessibility and convenience of the citizens.
 - GIS for the city under process for implementation which would provide vital details of all infrastructure as well as tax related issues, enabling speedy recovery of dues, and also tracking the infrastructure activities of RMC.

6th Sept –

- Madahpur sewage treatment plant-Visit to the Sewage treatment plant of 40 MLD capacity undertaken under the JnNURM program at estimated cost around INR 12 crores and executed cost of around INR 16/ crores, catering to around 3.5 lac population.-the plant constructed by Ms Ganon Dunkerly has been recently commissioned before one year.

Meeting 02 – Meeting with Municipal Commissioner, RMC and Senior Officials

Date: September 06, 2010

Venue: Conference Room, West Zone.

- Following the brief introduction, documentary on the PAS program was shown to the Commissioner and senior officials present in the meeting.
- Commissioner highlighted various development works presently undertaken by RMC under JnNURM program.
- Special e-governance activities undertaken especially ones related to expeditious complaint

redressal.

- Under long term planning, projects related to sewerage, water supply, infrastructure has been undertaken.
- Special emphasis on the reforms prescribed under the JnNURM program is being followed.
- Corporation has obtained CRISIL rating.
- Several town planning schemes are planned to be undertaken for the city in the near future.
- Rajkot has been placed at 21st position out of 100 fastest growing cities in the world.
- Rajkot is planned to be hub for educational, medical, commercial, and tourism activities.
- While the city is expected to see enormous growth, the infrastructure projects would also be taken up extensively, however, the institutional strengthening would become the utmost priority, supported with better management and skilled working. Necessary support in this regard is expected.
- Subsequently, PAS details with its program objectives and also the video film was presented.
- Under the program, the data collected by the field team during their visit to the city was also presented and the indicator values emerging out of the data provided was also presented.
- Some of the concerns related to the cost recovery, and collection efficiencies were expressed by Commissioner, however, the data for the year ending 2009-10 should also be worked out to see if the emerging values show any difference. The officials were instructed to work on the data and provide the same and show the result in the ensuing *Chintan Baithak* organized by the Corporation of 9th of this month.
- Commissioner however appreciated the findings and felt it was the need to identify the present status of utility functioning, which he very much desired.

Meeting 03: Meeting Deputy Municipal Commissioner, RMC and other Senior Officials of RMC

Date: September 06, 2010

Further discussions were held with DMC along with other senior officials, and briefly the following points were discussed.

- DMC also reiterated the need to augment the management skill to cope up with the increased infrastructure demand.
- Especially the ones needed for the drainage infrastructure, related to outsourcing contracting.
- The present structure of Technical wing of RMC is such that three City Engineers of RMC are in total charge of water supply, sewerage maintenance, roads, and the supporting staff of Deputy Engineer and Engineers and Assistant Engineers are looking after all of these three departments besides the capita works of each department. This pattern needs a closer look for its efficiency as the departmental heads and the supportive staff remains fully engaged in the major as well as minor maintenance works, and the water supply remains exhaustive as the sensitive nature of the supply needs a very thorough and focused supervision and monitoring.

Field Visit & Meeting 04 – Visit to Pumping Installation at Nyari, WTP and WDS at Aji.

Date: September 07, 2010

Following details were observed-

- Pumping station at Nyari, constructed under JnNURM project draws water from Narmada Pipe line passing nearby. The off take is 1200 mm dia. and is capable of providing around 40 MLD of water. However, the present drawl is limited to around 23-25 MLD. There are 6 pumping sets with 4 working and 2 stand bye. There is flow meter digital type which records the Narmada water flow on hourly basis. The delivery main also has a pressure gauge that records pressure of the delivery main while pumping. The water is delivered to Nyari water treatment plant located at approximately 10 kms distance. The details of pump operation, the flow and pressure are only recorded on hourly basis. The pumping station under guarantee period is operated by the contractor staff.
- Aji site – Site is the source of water, water treatment plant and water distribution station catering to some areas of the city, besides the other water distribution stations it supplies water.
- Source- Aji dam water and Narmada water available.

- The filtration plant has been constructed in three stages, the oldest being 18 yrs old.
- The site has location advantages as it is situated on higher elevations, hence the advantage taken to supply water from its clear water reservoirs to the nearby areas through gravity.
- Measuring instruments are installed at the WTP site which records the water quantity every hour, and the reports the daily water quantity from different sources to the central office.
- Installation also has full fledged laboratory for carrying out chemical as well as bacteriological analysis on regular basis. The samples brought from the city also get analyzed at the plant laboratory.
- The formats are well maintained which provides the details of total water quantity procured.
- The water quantity pumped from Aji dam is quantified on the basis of pumping discharge and the pumping hours.
- Details of water levels are recorded on hourly basis at different reservoirs which supplies water to the downstream area as well as the different water distribution stations located in different parts of the city catered by the Aji Zone.

Meeting 05 – Meeting with the City Engineers of all Zones at the Central Zone office

Date: September 07, 2010

Following points were discussed:

- The present practice of RMC for the record keeping especially one related to water procurement, processing and distribution was briefly reviewed. The records are well maintained and documented and sometime the analysis is aptly carried out for decision making.
- The complaint cell of RMC is very well maintained and monitored on daily basis.
- So is the case with water quality examination and checks, moreover, RMC has in house facilities for water analysis, including bacteriological testing.
- In order to maintain pressure in the distribution network, RMC has adopted extensive sub-zoning of the city into around 40-50 subzones per election ward out of total 23 election wards. However, this entails extensive valve operation retaining manpower requirement on much larger scale. Besides it also requires heavy expenditure towards valve maintenance and repairs. It also requires closer supervision of the field staff on day-to-day basis.
- Objectives of the PAS program were explained to the officials and how it would help them to know the present functioning status of the utilities under their control.
- The indicator values would enable them to take appropriate decisions related to coverage of network, connections, continuity and quality of water supply, cost of water, income from water, etc. These details are not collected by RMC presently.
- The present system allows them to procure data related to procurement from different sources and supply to different water distribution stations on daily basis.
- However, the downstream data where actual water distribution takes place is not properly quantified, and water supplied to the sub zones is not quantified on individual basis, but day's aggregate is only available.
- The objective of the program is to suggest improvement plan whereby information required for the indicator value gets emerged.
- Some case study was also presented related to the logsheet data that would enable viewing data appropriately so that it would provide a comparative idea of the total water quantum drawn from different sources as well as supplied from different WDS to the city. (The format was well taken up by the officials who also sought soft copy of the same).
- Similarly, water depletion graph showing the depletion and the actual drawl and the level would enable to apply correction so that the estimated value of drawls is adhered to. This aspect was also well received by the officials who found it could be well applicable.
- Details related to the friction losses encountered in the mains during particular supply (discharge) and how it is related to the square of the discharge value was also explained and by installation of pressure gauges, how it could help in deriving the friction loss data and monitor the supply for pressure improvement also evoked considerable interest.
- It was also discussed and highlighted how important is the data related to water quantity

supplied to each of the subzones, as it would help in deriving the per head supply to different areas of the city, and compare them on city wide basis. In order to obtain this data, it was important to quantify water quantity from the level measured on hourly basis.

- It was also explained how regular scheduling of sewerage network maintenance, especially the manhole cleaning aspect could assist in keeping the manholes free from silt deposition, which otherwise lead to choke up of the drain resulting into overflows, which calls for immediate cleaning when complaints are lodged.
- It was also explained how deriving the values for cost of water would enable to assess the main components that constitutes to the cost, how it could help in taking remedial measures for cost cutting, especially the energy efficiencies of the machinery consuming more power that greatly affects the cost can be suitably addressed, if more efficient pumps are installed otherwise.
- How indicator related to the non revenue water help in identifying the major contributing factors i.e. the illegal connections, line leakages, non-functional meters etc and enables decision making for its remedial measures. Case study of water balance derived for BMC was also shown.
- It was also explained how the future funding of the projects either from the state or central government would be linked to all these aspects and funding would be based on the action taken by ULB to address all these above mentioned issues.

Annexure 2 Details of Water Quantity Measurements taken during Consumer End Survey

Details of water quantity measurement undertaken at Consumer end by RMC												
Sr no	Date	Zone	Ward no	Name of the conn.holder	Address	Supply time	supp.dur. In min.	Derived qty in ltrs	App. LPCD	approx Discharge	Ressidual head	App. Pressure
1	7/2/2011		19		anadngr-bharwadwas	3:40-4:00	20	360	72	0.0003	0.3590	8.096
2	7/2/2011		19		anjali pk mn rd nr patanja	4:00-4:20	20	300	60	0.00025	0.2493	5.771
3	7/2/2011		19		andngr bemaliya sonal da	4:20-4:40	20	300	60	0.00025	0.2493	5.771
4	7/2/2011		19		andngr 11-20 qtr qtr 14 s	4:40-5:00	20	300	60	0.00025	0.2493	5.771
5	7/2/2011		19		andngr kala pathr qtr,B/a	5:00-5:20	20	286	57.2	0.00024	0.2266	5.281
6	7/2/2011		19		andngr 1-10 qtr qtr 4	5:20-5:40	20	324	64.8	0.00027	0.2908	6.658
7	7/2/2011		19		bhaktingr police choke ar	5:40-6:00	20	353	70.6	0.000294	0.3452	7.806
8	7/2/2011		19		narayangr st-1- 9	5:00-5:20	20	213	42.6	0.000178	0.1257	3.056
9	7/2/2011		19		narayangr jupadpatti	5:30-5:50	20	273	54.6	0.000228	0.2064	4.844
10	7/2/2011		19		dhebar col.mandirval(har	6:00-6:20	20	297	59.4	0.000248	0.2443	5.665
11	7/2/2011		19		dhebar col.avinash pan st	6:20-6:40	20	286	57.2	0.000238	0.2266	5.281
12	7/2/2011		19		hasanwadin so st-3	7:00-7:20	20	296	59.2	0.00025	0.2427	5.629
13	7/2/2011		19		gopalngr umiya ahsish st-	7:40-8:00	20	266	53.2	0.00022	0.1960	4.616
14	7/2/2011		19		gopalngr sri ram st-8	8:00-8:20	20	250	50	0.00021	0.1731	4.114
15	7/2/2011		19		shivkrupa, srmjivi so st-2	8:20-8:40	20	324	64.8	0.00027	0.2908	6.658
16	7/2/2011		19		rameshwar kr, srmjivi so	8:40-9:00	20	300	60	0.00025	0.2493	5.771
17	7/2/2011		19	dinesh gandhi	gitangr mn rd bhagwat kr	9:00-9:20	20	333	66.6	0.00028	0.3072	7.005
18	7/2/2011		19		vinay ashish,bhktingr st-1	9:20-9:40	20	218	43.6	0.00018	0.1316	3.191
19	7/2/2011		19	rajeshbhai	kothariya col st-2	8;00-8:20	20	250	50	0.00021	0.1731	4.114
20	7/2/2011		19		kothariya col st-8	8:20-8:40	20	285	57	0.00024	0.2250	5.247
21	7/2/2011		19		kothariya col st-14	8:40-9:00	20	245	49	0.00020	0.1663	3.963
22	7/2/2011		19		kothariya col st-19	9:00-9:20	20	254	50.8	0.00021	0.1787	4.237
23	7/2/2011		19	amit vyas	master so st-10	9:20-9:40	20	279	55.8	0.00023	0.2156	5.044
24	7/2/2011		19	mahendr solar	master so st-7	9:40-10:00	20	250	50	0.00021	0.1731	4.114
25	7/2/2011		19		yogeswar kr, master so st	10:00-10:2	20	273	54.6	0.00023	0.2064	4.844
							Average value	284.6	56.92		0.2	5.3
							Max.	360	72		0.4	8.1
							Min.	213	42.6		0.1	3.1
							Broad assumption					
							Assumed conn. size	0.012	mt			
							Approximate conn. Length	3.5	mt			
							Assumed C value	80				

Annexure 3 Filter Plant Hourly Details

Filter plant hourly details-																										
Time →		City:				Plant:				Year:				Month:				Total								
		AM												PM												
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4		5	6	7	8	9	10	11	12
Sr.No	Details																									
1	Raw water in m3/hr																									
2	Tank sludging																									
	T1																									
	T2																									
	T3																									
	T4																									
3	Water consumed-ml																									
4	Filter Runing-m3/hr																									
	F1																									
	F2																									
	F3																									
	F4																									
5	Filter head loss in mt																									
	F1																									
	F2																									
	F3																									
	F4																									
6	Filter wash																									
	F1																									
	F2																									
	F3																									
	F4																									
7	Water consumed-ml																									
8	Chemical parametre																									
	RC																									
	Ph																									
9	Filter water output in cum/h																									
10	Clear water Reservoir.level																									
11	Power outages																									
Remarks		1st Shift operator						2nd shift operator						3rd shift operator												
		Supercisor						Deputy Engineer						Water works Engineer												

Annexure 6 Details of Areas served between 3:30 am and 5:40 am

Supply time	Ward No. 3	Ward No. 4	Ward No. 5	Ward No.6	Ward No.7	Ward No. 8	Ward No. 15
3.30-4.00					Housing bd,b/h vima hosp.		
4.00-4.20					sakti so sivam pk-1, kabirvan so-1,2,3 kbvn so-1,2,3		
4.20-4.40	Santoshinagar-Mafatiyapara				Sivam pk-2, kbrvn-2, mehulngr prjpati vadi		
4.40-5.00	Santoshinagar-Mafatiyapara, Shital Park, Shiv Drasti Park, Radhe Park, Gangotri Park, Saibaba Society/Bhag(1)			Manchan gr, Ram Soc.-1	sidhinh pk vijaysinh, mehlngr prjpati vadi, avenue pk vijayshi		
5.00-5.20	Santoshinagar-Mafatiyapara, Santoshinagar-On Main Road		rampk bhg-2 seri1,2,3 & 80 ft rd, miyanvas bhg-3, jayprksh bhg-2, kachi luvana vadi seri, jeevandhara, n-mahaskti so.	Ram Soc.-2	sdguru rnchodngr seri-5, navjivn pk, mayurngr mn rd,kbirvad mn rd, jria deri, mayurngr mn rd,jmaipara b/h pow.house,ambika seri-1,2,3,4,5, chunarwad mhkali hall	Lakhaji Road Raghuvir Para Street-5-6-7, Lakhaji Raj Main Road, Dhebar Road, Sanganva chowk, Kamdar Street, 8 & 6 Raghuvir Para, Dhebar Road, Silivali Street, 5-Raghuvir Para, Suthar Street, Dhebar Road, para bazar Main Road	Gundawadi
5.20-5.40			chamunda so bhg-1, girdhar-gathia-omshanti school, jayprkashngr bhg-3 seri-2 b/h	manharpura, hanumn pra	sitaram soc seri-1,2,3,4,5,6,chunarwa c mkali hall, bhojalrm tp rd, bhojalrm mn rd, bhojalrm seri-5,gadhiangr tp rd, gadhiangr	Sangnava chowk Near Rajeshree Cinema, Lohanawali street, Bhupendra Main Road, Sanganva Chowk, Kotak street No. 4-5-6, Kotak street -6-3-2 etc.	Kevdawadi , Gundawadi ,Part-1, Gundawadi Part-2, Kumbharvada vistar, Jayraj Plot,

Annexure 7 Sample of Data Format maintained by Assistant Engineers

૧	૪-૦૦ થી ૪-૩૦	ખોડિયારપરા ૧,૨,૯, ૨૧,૨૨, ૨૩,૩૩,૩૪	ભાવનગર રોડ, જી.આઈ.ડી.સી. મેઈન રોડ કોર્નર આઈ.ટી.આઈ.ની દિવાલ પાસે, નાવાની સામે.	૧૩" ૮"	ખોડિયારપરા મે. રોડ કમાણી ચોક	૪" ૨"	(કોન્ટ્રાક્ટરના માણસો)
૨	૪-૦૦ થી ૪-૩૦				ખોડિયારપરા ૯નાં ખુલે -- ૨૧નાં ખુલે -- ૨૩નાં ખુલે -- ૨૬નાં ખુલે -- ૨૭નાં ખુલે	૪" ૪" ૩", ૬", ૬" ૪" ૪"	
					ખોડિયાર પરા રામનગર-૩૩ પાસે	૬", ૬", ૪"	
૩	૪-૦૦ થી ૪-૩૦	વિજયનગર સોસાયટી ૬ થી ૧૦	ચોરાળા નાવા પાસે	૮"	ચોરાળા રોડ શાળા નં. ૨૯, આર.કે.ના-૪નાં ખુલે (દરગાહ પાસે)	૬"	(કોન્ટ્રાક્ટરના માણસો)
૪	૪-૦૦ થી ૪-૩૦	કસ્તુરબા હરીજનવાસ ૧ થી ૬	કસ્તુરબા હરીજનવાસ ચોકમાં, રામાપીર મંદિર પાસે	૮"	કસ્તુરબા ભંગી હરીજનવાસ -૬, ટેલીફોનની પેટી સામે	૬"	(કોન્ટ્રાક્ટરના માણસો)

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