Efficient Water Supply Network System its Analysis, and Minimizations of Non-Revenue Water

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Abstract: Drinking-Water Supply is perhaps the main areas for mediation. The overall water supply addresses a critical part of worldwide energy utilization. This energy consumption, related to the collection, treatment, and transportation of water, entails a large number of costs. However, these costs are liable to be minimized with and/or without a reduction in energy consumption. The target of a public ensured water supply system is to supply protected and clean water insufficient amount, helpfully, and as financially as could really be expected. Water supplied should be free from pathogenic organisms, clear, palatable, and free from undesirable taste and odour, of reasonable temperature, neither corrosive nor scale forming, and free from minerals that could produce undesirable physiological effects. Water Supply in India is now previewed as a community-based demand-driven system, under which it is essential to enhance the capacity of the local community residing in villages and small towns to develop, manage & maintain their own water supply systems. It is the role of community groups is to make sure effective & participatory implementation of water supply system in their respective village/town. water quality control, financial management, and effective operation and maintenance of the water supply system established. Hence, it is inevitable that such community groups are aware of the basics of the water supply system, operation, and maintenance of water assets and water supply system as well as basics of sanitation and waste management. This study has been formulated in order to enhance the capacity of community groups for enhanced operation and maintenance of water supply and sanitation systems in their village/town. The module on Basics of Water Supply System provides insights on basics components of the water supply system, installation and distribution of water supply systems, estimation and measurement of components of the water supply system, and drinking water quality control. This study basically adds up and connect all the aspects related to water supply network system which in terms associated with the development of Villages/town. We always think of all the positives and forget to cover the negative outcomes. Most of the water supply system that is already present and is operational having major lacks in the whole system. If, those lacks were covered and monitored, and rectified in a shorter span of time will help the government and also the people to save unaccounted water getting wasted.

Index Terms - Non-Revenue Water, Leakages; Water losses, Monitoring system, District metering area.

I. INTRODUCTION

The reason for this paper is to give an audit of measures and strategies to accomplish water supply system effectiveness and minimizing NRW (Non-Revenue Water) factor. The paper summaries and explain the detail analysis done over the period of time for a particular desired network system and provide investigation over Non-revenue water, i.e., minimizing losses of water also covering all the parameters that gives perfect and desired Water supply network according to the demand.

Measures were received and point-by-point examination is done which gives lesser investment and reduces loss (any of kind), expenses, and energy utilization are introduced. The paper likewise investigates the utilization of pressure-driven reproduction and streamlining methodologies in water supply system, including points, for example actual demand prediction, and proper networks design for all type of piping network, pumps operation, real-time operations.

Although the extraordinary advances in the zone, there are neglected (or inadequately investigated) methodologies that can be tried and rectified for the water supply systems. There are likewise some significant issues, referenced in this paper, which ought to be considered to take care of explicit necessities of the entire system.

The water industry is confronting significant changes in its business climate, including a rising need to supplant maturing hardware set against falling interest and income because of the declining populace. One factor seen as basic to accomplishing continuous advancement under these conditions will be to lessen costs further by improving the productivity of capital ventures and activities. In light of these difficulties, I will be chipping away at innovative work and providing arrangements that encourage more prominent operational effectiveness, including energy-proficient water supply operation system and water circulation control system that help in manners that incorporate diminishing power costs and the heap on the climate. Suggestion of implementation of Non-Revenue water system, resulting reduction of water losses and minimizing its impact over the entire system.

II. LITERATURE REVIEW

B.Coelho, A.Andrade-Campos. (2013) conducted an experimental study on "Efficiency achievement in water supply systems". Their reason for the paper is to give an audit of measures and strategies to accomplish water supply system proficiency. The paper sums up and looks at past examinations to give the cutting edge to the reader. Measures with and without interest to decrease expenses and energy utilization are introduced. Their paper likewise investigates the utilization of pressure-driven reproduction and advancement procedures in water supply system, including subjects, for example, request expectation, network configuration, siphons activity, constant tasks, and environmentally friendly power creation. Although the extraordinary advances in the region, there are neglected (or ineffectively investigated) procedures that can be tried and might be applied in an enormous number of water system.

M. Farley* and R. Liemberger. (2005) conducted an experimental combined study on "Developing a non-revenue water reduction strategy: planning and implementing the strategy". The study managed the assignments needed to examine and evaluate the segments of non-revenue water (NRW). This study was an essential initial phase in an analytic way to deal with understanding the state of the organization, how it is worked, and the limitations following up on it. This subsequent part manages the undertakings and instruments needed to address the limitations and to build up a system to diminish NRW which is practicable and feasible, and which can be adjusted for any dispersion network anyplace on the planet. Not all utilities, especially those in agricultural nations, have the advantage of a very much created and proficiently oversaw network. Their paper manages the assignments needed to update the organization, and to survey and improve the operational strategies and practices, before the instruments and procedures to decrease NRW can be set up. Their paper talks about each progression of the system and its turn of events, from updating the organization by improved framework the board and drafting to the accessible procedures and hardware for checking and distinguishing genuine and obvious misfortunes.

M. Tabesh, A. H. Asadiyani Yekta & R. Burrows, (2009) conducted an experimental study on an "Integrated Model to Evaluate Losses in Water Distribution Systems". To assess non-revenue water (NRW) and losses in water distribution networks a philosophy is created by applying " annual water balance " and " minimum night flow " examinations. In this methodology, the primary NRW parts, for example, spillage from revealed and un-announced blasts and foundation spillage, with genuine or assessed information, empowering appraisal of files of spillage execution are assessed. Additionally, a novel strategy is presented in their paper that can decide the nodal and line spillage by utilizing a hydraulic simulation model. Perceiving the pressing factor reliance of spillage, the complete utilization is isolated into two sections, one pressing factor needy and the other autonomous of nearby pressing factor, and the water driven conduct of the organization is investigated. A computer code is created to assess all parts of water losses dependent on the proposed system. For a superior portrayal of the outcomes and the board of the framework, the yields are sent out to a GIS model. Utilizing the capacities of this GIS model, the organization guide and characteristic information are connected and factors influencing network spillage are recognized. Also, the impacts of pressing factor decrease are examined. The model is shown by a genuine contextual analysis. The outcomes of the study show that the recommended model has conquered the deficiencies of the current systems by representing the spillage and other NRW parts in water conveyance networks all the more all things considered.

S. Bandyopadhyay. (2016) conducted an experimental study on "Sustainable Access to Treated Drinking Water in Rural India". The study focusses on country drinking water supply which is a diligent general wellbeing challenge in India, yet with moving shapes. Pathogenic pollution of surface waters and water in shallow springs was looked to be tended to through gigantic cylinder well projects during the 1980s and 1990s. Notwithstanding, synthetic tainting of water in more profound springs is currently far and wide, frequently connected with irreversible general wellbeing harm, and is compelling one more re-examine. While government arrangements are as yet cantered around the undeniably scant "elective safe sources," there is developing acknowledgment of the need to decontaminate water for homegrown utilization, even in rustic territories. Notwithstanding, admittance to safe drinking water is generally seen as an administration obligation. Yet, excepting Gujarat, huge scope provincial drinking water plans dependent on territorial water supply have not emerged. Decentralized arrangements face difficulties of suitable innovation, the board limit, financing choices, and natural effects. Models of public-private associations, local area oversaw frameworks, and social undertakings have arisen in light of the current situation. These models are investigated, with the assistance of contextual analyses, in his study comprehend what should be done, and by whom, for a feasible and versatile arrangement.

III. OBJECTIVES

A. Efficient Water Supply System.

B. Control of Non-revenue Water in Water Supply System

IV. MATERIALS AND DATA COLLECTED

X and Y two project in consideration which are two types of water supply schemes where X Project is a project having a water supply system which is designed considering all necessary requirement with bare minimum possibility of extension with less revenue available. Project X is a water supply scheme which does not have non-revenue water management and necessity of water is dependent only on the resource, and the other available sources are the water obtained from the current water supply schemes. Thus, this water supply system is considered as the system to analyse to understand the things that left out or not taken into considered while designing the system.

This project X which has population of 59,654 of which 32,390 are males while 27,264 are females.
The current water supply system developed is for the population of 70,000, which is project till 2043. And the current water demand is taken of around 40,000 people.
The source is a Reservoir which is around 13.350km away from the treatment plant.
The water requirements taken for the project up to the year 2043 shall be 5.90MLD.
Entire water 5.90 MLD shall be taken from Reservoir.
After treatment 5.60 MLD clear water is accessible for supply to X town. In the existing system following components are being adopted.

- Intake well and Raw Water Pumping Station.
- Raw water pipeline- D.I K9 250mm-8350m
- Treatment Plant- 4.70 MLD
- Clear water sump and Pump House including substation. - 4.50 MLD

- PUMPS- 2 NONS- 53KW
- Feeder Network- DI-3670m (100mm to 300mm)
- Storage Reservoir- 1800KL
- Distribution Network- 110mm to 180mm- 36000km- HDPE PN-6

The project Y is a water Supply scheme with production and distribution Network with House Connections for Non-Revenue Water Reduction and 24x7 water supply scheme
Population to be benefitted 3,17, 833 (2021), Intermediate 3,79, 327(2031), Ultimate 5,00,183(2046).
The source is a man-made canal which is Gang Canal. The water is this taken from canal and then taken to Raw Water Reservoirs (RWR).

- RWR-1(372 ML), RWR-2 (309 ML)
- DI PIPE K9 of 37.280km of Raw water pipe uses to pump raw water from raw water reservoir to the water treatment plant facility.
- WTP- Water Treatment Plant 20 MLD Capacity.
- DI PIPE K7 4.290 Km of clear water used to pump clear water to water tanks or storage facilities or clear water reservoir.
- Clear water reservoir (4nos.) 2100KL, 500KL, 1500KL, 1600KL
- Pump houses
- Distribution Network of 414.805 Km.
- Domestic water meter 5000 Nos.
- Metering a) EMFM- 41 Nos. b) BFM-40 Nos.
- Total No of District metering area (DMA)-39 Nos.
- Pressure transmitters 39 Nos.




Fig.1 House Service Meter Fig.2 Pressure Gauge Fig.3 Bulk Flow Meter Figure.4 Butterfly Valve

V. METHODOLOGY

All the components of District metering area selected and installed in the system consisting of Pressure Flow meter, Pressure-Flow Control Valve, Isolation Sluice Valve Electromagnetic Flow Meter, Pressure - Flow Control Valve, Up Stream, Down Stream Pressure Sensor, Vandalism Sensor, inlet and outlet Sluice Valve, Bulk Flow Meter.

For 24X7, NRW Pressure maintained at 12m at any time, Efficient control over losses/unauthorized connections, Rectification on leakages in the system.

Repair, analysis, rectification activities. Field test (flow & pressure). Analysis of data (calculated & observed). Visual inspection of water network. Identification of leakages.

VI. TESTS PERFORMED

The series of tests performed for both the projects is an investigative method of obtaining the correct data and which is obtained by working along with the filed representatives and the management respective.

The Project X the test performed are mostly the initial input obtained as the project supply was partial and was not a 24x7 scheme. Water was given to the people was mostly in intervals and for an hour or two.

The test performed area given below.

- Understanding the mechanism of the system.
- Identification of project management.
- Understanding of source water availability and distribution water system.
- Understanding the current water supply system and feedback of the new one.
- Survey of the work done for the project.
- Hydrotests of the loop system.
- Disinfection.
- Identification of leakages and rectifying them.
- Consumer feedback of the water quality and water pressure that is being supplied.
- Identification of potential losses.

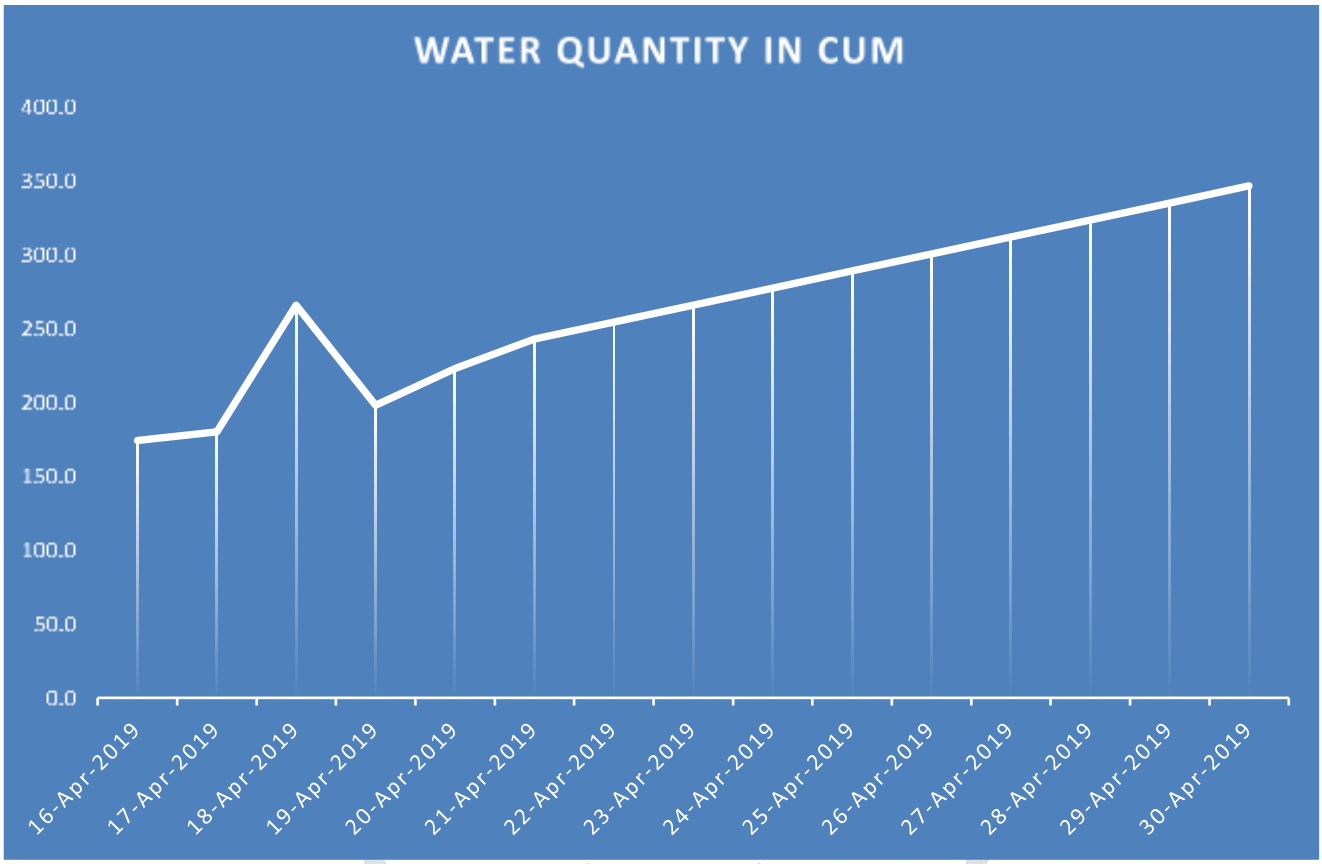
Project Y the work done was assessment of understanding the water supply system that consist of NRW (Non-Revenue Water) system which is a 24x7 system having all times of necessary monitoring system which helps to reduce the water losses and maintaining the quality. For this project the DMA (District metering area) 35 is an area of project Y which is focused to achieved the NRW system with reducing the potential water losses. Reducing the water losses and improving the water efficiency.

Test performed are as follows:

- Understanding the mechanism of the system.
- Identification of project management.
- Understanding of source water availability and distribution water system.
- Understanding the current water supply system and feedback of the new one.
- Hydrotests of the loop system.
- Disinfection.
- Identification of leakages and rectifying them.
- Consumer feedback of the water quality and water pressure that is being supplied.
- Identification of potential losses.
- House service connection rectification and monitoring.
- Achieving Q1=ΣQ; Q=0
- Disinfection- chlorination (50ppm for 24 hrs).
- Survey of total plots, house service connection consumer detail, open plot identification.
- GIS updating (Survey data upload) + including addition of survey data in system.
- Bulk flow meter reading.
- NRW 24 Hour test.
- Scada data collection (Master control centre).
- OHSR indicator (LIT FIXING)- Level indicator transmitter.

Sl. No.	Date	150 mm BFM		Water Quantity in CUM	Remarks
		Initial Reading	Final Reading		
1	16-Apr-2019	69234.6	69409.0	174.4	6 Hours supply
2	17-Apr-2019	69409.0	69589.2	180.2	6 Hours supply
3	18-Apr-2019	69589.2	69855.1	265.9	10 Hours supply
4	19-Apr-2019	69855.1	70053.2	198.1	10 Hours supply
5	20-Apr-2019	70053.2	70276.3	223.1	11 Hours supply
6	21-Apr-2019	70253.2	70496.1	242.9	12 Hours supply
7	22-Apr-2019	70461.5	70716.0	254.4	13 Hours supply
8	23-Apr-2019	70669.9	70935.8	265.9	14 Hours supply
9	24-Apr-2019	70878.2	71155.7	277.4	15 Hours supply
10	25-Apr-2019	71086.5	71375.5	289.0	16 Hours supply
11	26-Apr-2019	71294.9	71595.4	300.5	17 Hours supply
12	27-Apr-2019	71503.2	71815.2	312.0	18 Hours supply
13	28-Apr-2019	71711.5	72035.1	323.5	19 Hours supply
14	29-Apr-2019	71919.9	72254.9	335.0	20 Hours supply
15	30-Apr-2019	72128.2	72474.8	346.6	21 Hours supply

(Table 1. Bulk flow meter reading)



(Figure 05 Bulk Flow Meter Reading Chart)

S. No	Date	Water Supply (In CUM)	No of Hours Water Supplied
1	16-Apr-19	174.4	6
2	17-Apr-19	180.2	6
3	18-Apr-19	265.9	10
4	19-Apr-19	198.1	10
5	20-Apr-19	223.1	11
6	21-Apr-19	242.9	12
7	22-Apr-19	254.4	13
8	23-Apr-19	265.9	14
9	24-Apr-19	277.4	15
10	25-Apr-19	289	16
11	26-Apr-19	300.5	17
12	27-Apr-19	312	18
13	28-Apr-19	323.5	19
14	29-Apr-19	335	20
15	30-Apr-19	346.6	21
Sum =		3988.9	208

(Table 2 Bulk Flow Meter Readings)

Interpolated Water Supply for 24 Hr (in cum)	**460.257**
Interpolated Water Supply for 24 Hr (in liters)	**460.257 X 1000**

	Town X	DMA 16 (Town Y)
Present Population Served	**40,000**	**8,000**
Water Supplied (In liters)	**5600000**	**460257**
Water Supplied per Capita (Liters/Capita)	**140**	**57.53**
NRW monitoring (YES/NO)?	**NO**	**YES**
Preferred	**NO**	**YES**
Percentage Water Saved / capita from wastage in DMA 16	**58.91**	

(Table 3 TOWN X & Y Comparison)

VII. Problem Statement and Its Solution

Problem statement:

- The project report presented here has been designed for finding out the actual population-based water demand for the year 2043 and correction of discrepancies, more prominent operational effectiveness, including energy-proficient water supply activity frameworks and water dispersion control frameworks that help in manners that incorporate decreasing power costs and the load on the environmental condition of X area.
- Water Demands considered for lesser public without even actual survey taken.
- No proper discharge calculations, head calculations, electromechanical equipment's Kw calculations.
- Population forecasting method followed is A.P method which gives lower population expansion result and should only be adopted where city is expected to grow very low which seems to be wrong as X is now developing and it's an industrial area so population expansion will be higher.
- Distribution network doesn't cover the genuine zone according to the map and survey done.
- Water supply system is purely calculated as per the actual financial aspects not as per the demands and no modern techniques and technologies is been adopted while designing the whole project.
- X does not have sewer water system and existing water system is being damaged and most of the piping network is more than 10-15-year-old which is C.I and corroded. So, the system is totally dependent on the new system.
- No proper schedule is followed for the supply of water to consumer as seen during survey.
- Non-revenue water accounting is not seen in any aspects of the project.

Solution:

- Comparison is been placed for another system "Y" which has all the aspects of efficient water supply system which also has non-revenue water accounting.
- Water Demands considered as per relevant data and survey assessment.
- Distribution network cover the actual area as per the map and survey done. Even future expansion was also considered.
- Water supply system is purely public demand based and 24x7 system with all modern techniques and technologies is been adopted while designing the whole project.
- Y has sewer water system and existing water system is also in good condition to support the new system during operation and maintenance period.
- Proper planning & schedule is been followed for the supply of water to consumer as seen during survey.
- Non-revenue water accounting is been done through NRW protocols and proper data management is been done which helped in reduction of NRW water.
- Data management and data collection for individual customer and physical and financial accounting is been done to check the discrepancies if any.
- GIS mapping
- Water meter audits
- BFM reading daily monitoring
- Frequent/ Weekly Consumer meter reading
- Month wise NRW calculation and assessment
- Detection and rectification of leakages
- Penalty to the defaulters and law breakers
- Public consultation

VIII. Conclusion

The ends drawn from these examinations are as per the following: - During an on-field evaluation of my work referenced in here through my finishing up articulations of the board of diminishing the non-revenue water was the greatest tested I looked during this on-field appraisal I have been dispensed to. From a natural supportability viewpoint, decreasing non-revenue water is a key perspective as by far most of the countries are as of now defying water inadequacies. Non-revenue water will be water that was managed at this point not charged to a customer because of water adversities or unbilled affirmed use.

The end of non-revenue water isn't effectively feasible, yet it is significant to diminish non-revenue water until the monetary breakdown is been reached. This is cultivated when the insignificant cost of diminishing NRW outperforms the irrelevant preferences of lessening water losses. Right when the monetary ideal is reached with high NRW, for instance when water creation is unobtrusive, water administration associations have fewer financial inspirations to diminish NRW.

This can be an issue understanding that an old establishment with high non-pay water improves the likelihood of making sub-par quality water and encountering system interferences. It seems, by all accounts, to be sure that the test in NRW water is both a specific and a financial issue. This is the place where the private area could be of help, and a wide extent of choices are open from Public-Private Partnerships, (for example, administration concession plans) to support gets that cut-off subcontracting of explicit exercises.

Last, anyway not least, rules and helpers could lead water administration associations to do a reasonable non-pay water decline program. Every one of those sources of info accommodated the framework will help in understanding the essential mix-ups, translations, and presumptions that ought to be and ought not be considered when arranging and completing of the whole water supply system.

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