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PERFORMANCE EVALUATION OF WATER DISTRIBUTION NETWORK

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Abstract: Evaluation of various failure conditions that may occur during the distribution of water to the consumers in Water Distribution Network is necessarily done. Measurements for the reliability of WDS is considered to resolve the problems that are arised in the network. Water is lossed due to leakage in pipelines is common phenomenon that is practically observed in WDS. A Performance Indicators are used to measure an efficiency of water consumption with respect to specific aspects of consumers activities and the behaviour of system. Under each set of demand loadings, Operation of system is taken into consideration specifically in the optimization. Nowadays Numerous Techniques have been adopted and developed for the estimation of WDS reliability. Advancements in the distribution network has reached to great extent that may help in the reduction of losses and leakages significantly. Certain calculations and measurements with respect to billed, unbilled, metered, unmetered, etc., are carried to determine the efficiency in terms of parameters like ILI, NRW.

The analysis of distribution network is applied to water utilization and supply data collected from the Detailed Project Report (DPR) named '24x7 water supply Project'. The approach showed that the consistency demand patterns are required to be made to reduce the leakages and losses in the system. However, the volume of leakage can be reduced to certain extent significantly whenever there is occurrence of leakage that has been detected within the minimum time after its occurrence and help to manage the basic strategies.

***Keywords*: - Performance Indicator, NRW, ILI, CARL, UARL, Real Losses, Apparent Losses.**

INTRODUCTION

The system used for distribution describe facilities used for supplying water from its source to usage point. It also used to deliver water to consumers with pressure, quantity and quality. Design of distribution system should be economical by taking various factors; such as type of pipe, pipe diameter etc. WDS are very essential infrastructure systems necessary for the sustenance of societies.

The amount of water lost is calculated by a research that evaluates water loss on the basis of a number of indicators, allowing for the gathering of data on the state of the water supply system. By calculating losses through the International Water Association (IWA), this method of percentage water losses index analysis was expanded.

It was suggested by indices of water balance and losses, an effective instrument for evaluating water losses. Analysis of losses on this basis, together with repair and modernization efforts, was necessary to lower costs associated with the distribution and production of water. A technical performance indicator for actual losses, the Infrastructure Leakage Index (ILI) was utilized in this instance to measure the system's annual losses in relation to the ratio of current annual losses. We calculated the ILI in accordance with the reference and also with the use of an AWWA excel spreadsheet, and we compared both sets of findings virtually and manually.

METHODOLOGY

The loss of water is the major reason to reduce the Performance/ Efficiency of water distribution Network.

Two major categories of losses:

1] Real Losses

2] Apparent Losses

1]Real Losses: -

During the supply of water from the reservoir to the consumer end through the distribution system, there are some losses get occurred due to leakage from pipes, fittings, and joints. Those losses are known as Real losses. Generally, real losses are more as compared to other losses.

2]Apparent Losses: -

These losses generally occur at the consumer end such as Assumptions of unmeasured water for social, unauthorized consumption (unlawful), inaccuracies related to customer metering, and unbilled water.

PERFORMANCE INDICATORS: -

1] Non-Revenue Water (NRW)
2] Infrastructure Leakage Index (ILI)
3] Unavoidable Real Losses (UARL)

1] Water that is not being sold (NRW):

In India today, NRW is a financial indicator used to assess the effectiveness (performance) of the water distribution system.
The NRW of Water Distribution network, per References
Total System Input is 625MLD,
Real Losses are 147.64MLD,
Apparent Losses are 214.36MLD,
Revenue Water is 241MLD, and Non-Revenue Water is 384MLD.
% NRW = Non-Revenue Water/ Total System input
= (384 / 625) x 100
% NRW = 61.44%

2] Infrastructure Leakage Index (ILI): -

The ILI is a technical indicator of 'Real' water losses from supplied community of water distribution network. The International Water Association (IWA), Water Loss Task Force (WLTF), helped to expand the ILI, which was first issued in 1999. It has been used in at least fifty different countries around the world.
The terms and aspects pertaining to the water stability of the water supply equipment need to be defined in order to explain and calculate the ILI as a performance metric. In order to identify "Real" water losses from the grant community, the water stability categorises all water consumption.
The water balance diagram, which was taken from the Benchloss NZ Manual, is suggested by the sketch.

IMPORTANCE OF ILI: -

- An ILI is a recently developed technical performance metric for real losses that quantifies the proportion of current annual real losses to specific system unavoidable actual losses each year.
- By dividing infrastructure management into repair, pipe, and possessions management based on the components of stress management, the ILI method offers an increased basis for technical correlation of leakage administration overall performance.
- As a percentage of device entry volume, there is no comparison between ILI and NRW. The low percentage of NRW is no longer always a sign of excellent loss control.

CALCULATION OF ILI: -

Calculating ILI is as follows:

$$ILI = \frac{CARL}{UARL}$$

where,

ILI stands for Infrastructure Leakage Index
Current Annual Real Losses (CALL)
Unavoidable Real Losses, or UARL.

Current Annual Real Losses (CARL): -

It is calculated as follows:

$$CARL = \frac{\text{Real Losses X } 1000}{T_p} \quad \text{(lit/day)}$$

$$CARL = \frac{\text{Real Losses} \times 1000}{T_P N_C} \quad \text{(lit/service connection /day)}$$

where,

T_p = No. of days in WDN is pressurised upto period of water balance calculation
Nc = No. of service connection

Unavoidable Annual Real Losses (UARL): -

$UARL = [18L_m + 0.8N_C + 25L_P] \times P$ (lit/day)

$UARL = \left[18\frac{L_m}{N_C} + 0.8 + 25\frac{L_P}{N_C}\right] \times P$ (lit/service connection/day)

where,

Lm = It is the main pipe's length in kilometres (without service pipes).
Nc = It is the number of service connections.
Lp = Distance (km) between the customer's water metre and
P = the property line. operating pressure on average (m),

Table 1: - Component of Unavoidable Real Losses (UARL)

Infrastructure Components	Background Losses	Reported Bursts	Unreported Bursts	Total UARL	Units
Mains	9.6	5.8	2.6	18	Lit/km mains/day/meter of pressure
Service Connections, meters at edge of street	0.60	0.04	0.16	0.80	Lit/connection/day/meter of pressure
Underground pipes between edge of street and customer meters	16.0	1.9	7.1	25	Lit/km u.g. pipe/day/meter of pressure

Assess the effectiveness of Nagpur's water distribution system using the ILI calculation and the AWWA Excel sheet.
A technical indicator provides the information needed to calculate ILI. For the Nagpur Municipal Corporation in Nagpur, the required information is gathered from DPR regarding water audit, leak identification, and leak control.
The following information is collected from References:
Mains Length (Lm) = 2100 km
231200 Numbers of Service Connections (Nc)
Total Service Connection Length (Lp) = 0.01 km
Average Supply Pressure (P) = 13.5 m
The number of days that WDN is under pressure is 365 days.

Real Losses: -

Real Losses = 147.64 MLD

$= 147.64 \times 10^6 \times 10^{-3} \times 365$

$= 53.8886 \times 10^6$ m^3/year

Average Pressure(P): -

$P = \frac{25 + 2}{2} = 13.5$ m

Current Annual Real Losses (CARL): -

$CARL = \frac{\text{Real losses} \times 1000}{T_P N_C}$

$= \frac{53.8886 \times 10^6 \times 1000}{365 \times 23100}$

$= 638.581$ lit/service connection/day

Unavoidable Annual Real Losses (UARL),

$UARL = \left[18\frac{Lm}{Nc} + 0.8 + 25\frac{L_P}{N_C}\right] \times P$

$= \left[18 \times \frac{2100}{231200} + 0.8 + 25 \times \frac{0.01}{231200}\right] \times 13.5$

$= 13.007$ lit/service connection /day

Infrastructure Leakage Index (ILI),

$ILI = \frac{CARL}{UARL}$

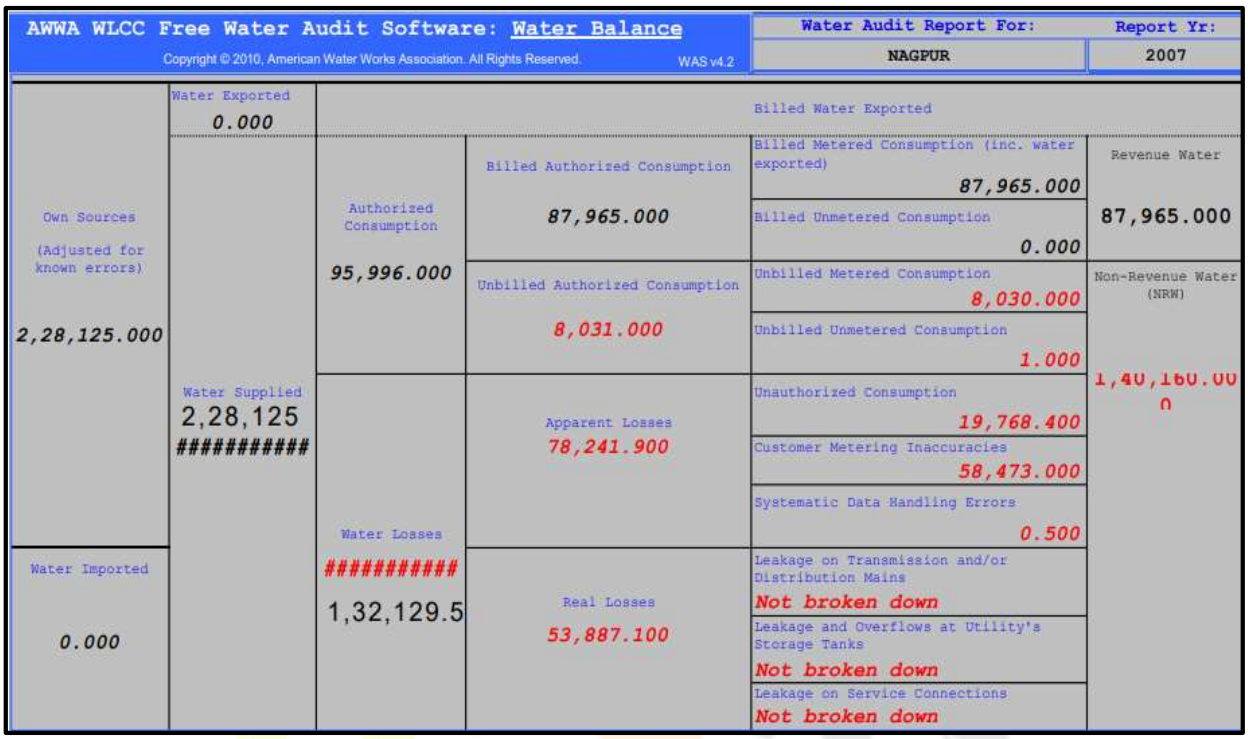
$= \frac{638.581}{13.007}$

$= 49.095$

Calculations of ILI by using AWWA Excel Sheet: -

- Length of Mains (Lm) = 2100 km
- No. of Service Connection (Nc) = 231200 Nos
- Total Length of Service Connection (Lp) = 0.01 km
- Avg. Pressure at Supply (P) = 25.5 m
- Number of days in which WDN is pressurized (Tp) = 365 days

Water Balance Sheet: -



AWWA WLCC Free Water Audit Software: Water Balance

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Water Audit Report For:	Report Yr:
NAGPUR	2007

Own Sources (Adjusted for known errors) 2,28,125.000	Water Exported 0.000		Billed Water Exported		
	Water Supplied 2,28,125 ##########	Authorized Consumption 95,996.000	Billed Authorized Consumption 87,965.000	Billed Metered Consumption (inc. water exported) 87,965.000	Revenue Water 87,965.000
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 8,031.000	Unbilled Metered Consumption 8,030.000	Non-Revenue Water (NRW) 1,40,160.000
				Unbilled Unmetered Consumption 1.000	
		Water Losses ########## 1,32,129.5	Apparent Losses 78,241.900	Unauthorized Consumption 19,768.400	
				Customer Metering Inaccuracies 58,473.000	
				Systematic Data Handling Errors 0.500	
Water Imported 0.000			Real Losses 53,887.100	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

RESULT AND CONCLUSION

The NMC conduct one project that is known as "24 x 7 Water Supply Project". For this project, NMC take some data from available existed survey like “water audit, leak detection and leak reduction for NMC”. Under the 24 x 7 Water Supply Project, the NMC enhance the supply side efficiency via maintenance of water production facilities & the distribution network. In India the NRW is mostly used for determining the water supply efficiency. But worldwide the ILI is used for measuring the efficiency as performance indicator. We take the case study on the "24 x 7 water supply project" and got some information required for the project. Also took some important data which is necessary for determining the efficiency.

We calculated the Current Annual Real Losses (CARL) = 638.581 lit/service connection/day, Unavoidable Annual Real losses (UARL) = 13.007 lit/service connection/day. The percentage of Revenue Water is equal to 38.56% and non-revenue water is equal to 61.44 %. We calculated the ILI as per reference and also with the help of AWWA Excel Sheet are matched, manually as well as virtually i.e., ILI is equal to 49.095. From the calculations, we got the efficiency of water distribution as per ILI. But we got Two different values because of the Average Pressure at supply(P) is different from Manually Calculation and AWWA Sheet. In AWWA sheet we cannot put the Average Pressure at supply(P) less than 25 m.

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