# Analytical Study of Non- Revenue Water of Tonk City, Rajasthan

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***Abstract***

*Tonk city is still in its developing phase. It does not have proper sewage system and its water utility is not able to sustain its services. The water which is being supplied is not sufficient to satisfy the water demand of Tonk city. The water distribution system is also being laid long time back and then after the distribution system is not able to cater the water demand of Tonk city. Since then the population has been raised manifold. The water utility is not able to cover all population of Tonk city with water service.*

*The water utility of Tonk city is managed, operated and maintained by Public Health Engineering Department. Negligence of department also lead to increase in non revenue water. This study aims at assessing the quantity, supply management options and measure awareness of NRW in Tonk water utility.*

*The study found that volume of NRW in Tonk city water distribution system made up to – of system input volume of which is apparent losses; is real losses; and is unbilled authorized consumption. Further analysis showed that unauthorized consumption stands for of NRW volume and its main causes are poor customer- utility relation and lack of monitoring measures. Although results showed that leakages makes up more than of NRW. This in turn is beyond the capacity of the utility. In consequence, the study recommended optimizing the speed and quality of repairs for reported leaks and involving the private sector to supply the right technology for achieving zoning in the network. For apparent loss reduction, the study recommended working on enhancing the customer-utility relation, customer confidence on the utility, monitoring measures, and the utility employees' commitment. For improved NRW management, the study suggested assessing NRW and drawing water balance annually, and getting use of the free NRW softwares with their associated performance indicators to allow better NRW monitoring.*

**Keywords -** *NRW volume, water utility*

## I. INTRODUCTION

Water represents about 70% of the whole earth surface yet it is limited in is availability as a freshwater to human benefits. The emphasis is on freshwater resources since it is freshwater resources that are used for consumption, agricultural and industrial purposes. Freshwater constitutes only about 2.70 per cent of the total water available on earth. And even with this it is only less than one per cent which is readily available to be accessed and used by man.

Water demand is rapidly increasing due to population growth, urbanization, economic development and climate change. The potential responses to this increasing demand are either meeting the new demand with new resources (supply side) or managing the consumptive demand to avoid the need of developing new resources (demand side).

It is already known that about one-fifth the world's population lack access to potable drinking water and that about eighty countries which constitute about forty percent of the world's population are already in serious water crisis situation.

The importance of fresh water resource to man's survival on earth cannot be over emphasized. It permeates though all aspects of man's life on earth. From its use as drinking water, for food production, for washing (as means of maintaining healthy life and dignity), for the generation of energy, as means of transport, for the production of industrial products to the maintenance of integrity and sustainability of the earth's ecological systems are all facts that cannot be denied of the fact that water indeed is life. The human body constitute about 50 to 60 percent of water and water is the most important need of the body next only next to air.

In spite of the importance of the fresh water resource to man's survival on earth, the resource throughout the world is fast depleting. Various factors accounts for the fast depletion of the fresh water resource. These factors include population growth, increase in agricultural irrigation pollution, over exploitation, urbanization and industrialization.

In the past man's attitude towards water as a free natural resource and subsequently the way and manner water resource were managed did not make things better but rather contributed to the limitation of fresh water resources available to man.

Perhaps the most important aspect of whole issue is not about the quantity of fresh water resource available on earth but rather the management and protection of resource is crucial issue that need to be considered seriously.

The traditional approaches of resource development are considered as unsustainable. In contrast, the demand management, through Water Demand Management (WDM), is considered sustainable. It provides a proper solution to the water scarcity problem through shifting the response from the traditional resource development to that of demand oriented management. (Marunga et al.2006).

Water Demand Management vies water use as a demand that can be adjusted through various policy and technical means (Tsinde Development Consultants, 2001). The main purpose of water demand management is to meet any of the following objectives:

economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability (Department of Water Affairs and Forestry, 2004).

Water demand management is defined as a management approach that aims conserve water by controlling demand through the application of measure such regulatory, technological, economical and social at all spatial and institutional levels (IUCN, 2002 as in Marunga, et al., 2006). Another proposed operational definition for water demand management contains five main components (1) reducing quantity or quality of water required to accomplish a special task, (2) adjusting the nature of task so it can be accomplished with less water or lower quality water, (3) reducing losses in movement from source through use to disposal, (4) shifting time of use to off-peak periods and (5) increasing the ability of the system to operate during drought seasons (Brooks, 2006)

Consequently, water loss reduction is component of water demand management which one of its aims is reducing the losses and improving the distribution efficiency of water distribution systems (Marunga, et al., 2006).

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### *A. General Background About India*

This study is carried out on the public water distribution system in Tonk city, India. It is located in Rajasthan and also known as City Of Nawabs of India. India is located in South Asia. It is the 7th largest country by area, second most populous country and the most populous democracy in the world. The country area size is 3,287,263 square km. The climate of India is predominantly tropical wet, tropical dry, sub-tropical humid and has an annual average rainfall of 650mm per year. Rajasthan is India's largest State by area. It is located on the north western side of the India, where it comprises most of the wide and inhospitable Thar Desert. The Aravalli range in the north western region of Rajasthan is a rain shadow area.

### *B. Overview Of Tonk Basin*

The Banas is the river of Rajasthan state in Western India. It is a tributary of the Chambal River, which in turn flows into the Yamuna, a tributary of Ganges. The Banas is approximately 512 kms in length. It is also known 'Van Ki Aasha' (hope of forests).

The Banas originate in veero ka math situated in Khamnor Hills of the Aravalli Range, about 5 kms from Kumbhal Garh in Rajasmand District. It flows north east through Mewar Region of Rajasthan and meets the Chambal near the village of Rameshwar in Sawai Madhopur District.

The Banas drains the basin of 45833 square kms and lies entirely within Rajasthan . It is a seasonal river that dries up during the summer but it is nonetheless used for irrigation. Banas drains the east slope of the central portion of the Aravalli Range and the basin includes all part of Ajmer, Bhilwara, Bundi, Chittorgarh, Dosa, Pali, Rajasmand, Sawai Madhopur, Sirohai, Tonk, Jaipur and Udaipur. The Bisalpur Dam is over the Banas river which fulfills the water demand of Tonk city. The Bisalpur dam was constructed in the 1990's by the Rajasthan State government. Bisalpur dam reservoir supplies irrigation water to SawaiMadhopur and Tonk districts. It also supplies drinking water to Ajmer and Jaipur district.

Tonk city is district headquarter situated at about 98km from state capital Jaipur towards North. It belongs to Ajmer Division. Tonk city is bounded by

Todaraisingh Tehsil towards west, Newai Tehsil towards North, Uniara Tehsil towards East and Malpura Tehsil towards west. It is at the elevation of 266m above the mean sea level. The climate of the Tonk district in Rajasthan is hot and dry. In summers the temperature goes as high as 45 degree Celsius while in winters it remains at 22 degree Celsius. The average rainfall of this area is 400 mm.

As per 2011 census, the town has a population of 165294 souls in 45 municipal wards. The population of the town is projected as per guidelines of Central Public Health and Environment Engineering Organisation (CPHEEO) taking average of projected population by all the four methods. The water demand for year 2011 comes to be 25.62 MLD.

### *C. Overview Of Tonk Domestic Water Supply*

Before the early 2000, Tonk city water supply was being satisfied by the Open wells and Tube wells in the city. The ground water of Tonk city is highly turbid and rich in fluoride contents. Due to increasing population and overexploitation of ground water, the depletion in ground water table is huge. After Bisalpur Dam came into the operation in the year 1999, it was when the water supply was partially relied over the water from Bisalpur Dam.

Presently Tonk city is getting 5.00 MLD water from 66 sources ( 24 open wells and 42 tube wells) located at Banas river basin and in the city and 10 MLD Bisalpur water from Nathari Offtake of Bisalpur – Dudu water supply project. There are 10 service reservoirs in the UWSS Tonk, by which water is distributed @ 77 LPCD (approximately). The city has experienced a very fast growth of population during the previous few decades. The aerial extension has also increased considerably. Consequently, challenges to the situation of water supply have also increased drastically. As per the census data of year 2011, population of Tonk is 165294 souls. Supplying water to such a large population is a very challenging job, which due to overexploitation of existing ground water sources has become a very tedious job. The water availability from existing sources and water from Nathri HW is works out to be 22 MLD only, thus leaving a deficit of 10.62 MLD in the year 2011.

As per CPHEEO guidelines per capita water supply level of 135 LPCD should be ensured in a city. And if 15 % losses are also added then gross per capita water demand comes out be 155 LPCD but at present, the amount of water distributed is lacking far behind the amount which should be distributed according to the CPHEEO guidelines. In such case it is required to reduce the losses so that this gap can be filled somehow.

At present following major problems are faced in regular production and distribution of the available water to the residents of Town and requires immediate attention:

- As the last Reorganization of the urban water supply system of Tonk was commissioned in the year 1992 and subsequent addition of population in core city and expansion of town requires up gradation of all components of the water supply scheme.
- The duration of water supply is 48 hours.
- No proper distribution of the available water causes tail end pressure problems almost in all corners of the town distribution zones.
- Insufficient storage capacity with improper distribution pipe lines causes unequal distribution of water among all consumers of the zone.
- To regulate the distribution of water with present assets in terms of storage and pipelines, number of actual distribution zones exceeds two to three times and regular breakdown increase the supply intervals in local distribution zones.
- Due to regular extraction of coarse sand from river the rising main of the local sources (AC pipes) exposes and causes regular breakdown.
- Impacts of intermittent supply that consists of network deterioration, prolonged periods of negative pressures accompanied by water quality deterioration and inadequate pressure in some parts of the network.

Accordingly, Tonk water distribution system has deficiency in water quality, water quantity, and pressures in the network. City is undergoing continuous expansion. Still there is vast area which requires connectivity with the water supply system but due to lack of network at those places, people are compelled to either dug a well in their vicinity or bring the water from far places. Digging the wells in the area will further leads to depreciation in the ground water table level and bringing the water from far places would eventually be a burden over people’s pocket. Rich would find a way out of the shortage of water in an area but it is the poor who is mainly affected by the scarcity of the water. In some areas due to scarcity of water, people are forced to drink brine water of the tubewell as the quality of water in Tonk city is little higher on the saltier side. This eventually leads to diseases like high blood pressure, cardiovascular diseases, kidney problems and bone problems.

### *D. Problem Statement*

Non- Revenue water’s assessment and management in Tonk’s water distribution system affect explicitly the sustainability of the water service in the city and implicitly the scarce water resources in the basing.

Facing ever-increasing urban populations and expanding service areas, many water utilities in Asia and the Pacific continue to struggle with providing clean drinking water to their consumers. Common water supply problems in Asian cities are related to the sources and use of raw water, intermittent supply, and the quality of tap water at the consumer’s end. One of the major challenges facing water utilities is the high level of water loss in distribution networks. If a large proportion of water that is supplied is lost, meeting consumer demands is much more difficult. Since this water yields no revenue, heavy losses also make it harder to keep water tariffs at a reasonable and affordable level. This situation is common in many Asian cities. "Non-Revenue Water" (NRW)—defined as the difference between the amount of water put into the distribution system and the amount of water billed to consumers—averages 35% in the region's cities and can reach much higher levels.

### *E. Study Importance And Justification*

In reference to the above mentioned context of NRW problem in Tonk water distribution system, if an efficient NRW management is supplied, the following results could be achieved:

- At the environmental level: This water is eventually drawn from the hydraulic structure i.e. Bisalpur dam and hydraulic structures are not considered good for the environment as it could leads to sudden draught and flood like situation on the downstream side. Even it leads to the devastation of the aquatic lives in the river. A significant amount of water would be saved. This contributes to prolong life of the basin and therefore, participates in Tonk basin's continuity and sustainability by preventing water wastage of an amount of about 25-30% of the basin's safe yield. Besides, it minimizes the gap between water demand and water supply in Tonk basin in general where there is potential of service expansion.
- At the economic level: NRW management and reduction would save a considerable amount of water which was earlier being wasted out in the environment. It would also reduce the cost which was inculcated earlier in the production, treatment and transportation of the water. This would change the future scenario of the Tonk city.
- At the utility level: The amount of money which was saved by the management and reduction in the NRW could be used in the development of the Tonk city and this will lead to further capital investments, maintenance budget and employee's incentives that have a positive impact on the level of service in general. This further gain in revenue in the form of self generated cash flow by means of reducing the production and operation costs via producing less water with saved water to meet the same demand.It will also contribute to more stable supply system which extends the operational age of the network and it improves the customer services and reduces customer complaints.
- At the societal level: Proper NRW management could save substantial amount of NRW, and as result, further considerable proportion of the city population shall be covered with the water service. As the Tonk city requires the water network expansion in present time therefore, the cost which would be saved by NRW reduction can be used in the expansion of water supply system such that the whole population can be benefitted of the potable water and at least 135 LPCD demand could be ensured which is only 77 LPCD at present. Thus, pro – poor water network expansion could be prioritized in order to mitigate the impact of the absence of the water service on the poor segments of Tonk city.

This will leads to fair and equity distribution in the city by means of reducing illegal connections and simultaneously providing the same quality of service for all users since leakage affects the quality, pressure and quantity of the water service.
These dimensions of NRW management if taken into consideration would lead to proper tackling of the NRW assessment and management issue in the area and potential advantage would be:

- The findings of this research shall help PHED and administration of Tonk city to get a deeper understanding of NRW and breakdown of its component.
- The study would encourage in developing a model of NRW assessment, control, reduction and management for the water distribution network in the Tonk water utility PHED.
- NRW reduction policies and management options should be suggested in the study in order for Tonk water utility to confront the high percentage of NRW.
- This research shall help in increasing the awareness of the public towards their duty of conservation of water so that high percentage of NRW could be reduced from their side.
- The research will contribute in gaining the attention in International domain too. As Japan International Cooperation Agency (JICA) is doing various works in developing countries to curb environment related issues like NRW, solid waste disposal, poor quality of water etc. JICA has supported India in the past economically and technically by reducing NRW in various cities like Goa, Indore etc.

## II. ANALYSIS OF NON- REVENUE WATER IN TONK WATER UTILITY

### *A. Introduction*

This chapter discusses why the suggested approach was used for NRW assessment in Tonk water distribution system. Afterward, thorough and detailed methods for calculating the volumes of different NRW components are presented in this chapter. At the end of this chapter, results of the analysis are discussed and conclusions are drawn.

### *B. Research Question*

This research will answer the question of the amount of water which is lost in the system i.e. NRW volume. And also will try to find out the cost which can be saved if the proper NRW management can be carried out in the Tonk city.

### *C. Research Method*

This section demonstrates why the city is not able to reduce the NRW up till now. And what are the methodology which are present to evaluate NRW and the methodology which is suitable corresponding to the situations in the Tonk city.

### *D. Methodologies To Evaluate NRW*

#### *1. Top Down Approach*

As presented in chapter 2, top down approach tries to estimate the apparent losses and unbilled authorized consumption first, then it calculates the real losses. In this management technique, the evaluation process goes from top to down i.e. NRW is known for it and apparent losses are evaluated then that evaluated apparent losses are subtracted from the total NRW.

In this method, estimation of apparent losses, unauthorized consumption is assumed from 0.25% to 1% of the system input volume. But in real, in mostly developing countries it has been found that unbilled authorized consumption comes out to be a huge volume of water due to poor infrastructure.

Therefore, this assumption is inappropriate with respect to the Tonk city and also for many developing countries as the voume of unauthorized consumption is likely to be higher than the volume of calculated by this assumption. This method showcases the result very far from the reality.

Therefore, applying the top down approach should not represent the real trends of NRW components because of the very little assumption of unauthorized consumption that does not fit in Tonk city case. Further, assuming the value of unauthorized consumption does not help Tonk water utility to design the appropriate prioritizing and reduction policies for the apparent losses based on the component base analysis.

Henceforth, top down approach with its assumption of unauthorized consumption from 0.25%- 1% of the system input volume is not an appropriate method for NRW assessment in Tonk water distribution system.

#### *2. Bottom Up Approach*

Bottom up approach uses Minimum Night Flow (MNF) analysis. This in turn, requires performing field tests between 02:00 am and 04:00 am in which most users do not use water and then the leakages in the MNF period is carried out by subtracting an estimate legitimate night uses from the MNF.

MNF analysis could not be implemented under the current conditions of Tonk water network because of the following reasons:

1. In Tonk city, the water supply is intermittent and also insufficient. Therefore, in such case public sometimes uses ground water sources due to uncertainty in water supply to satisfy their water demand. Therefore many a times during experiment their tank will be filled by the ground water for the times with no supply. And there is no method which can be used to find out the amount of water which is being used by the public by the ground water means as those sources are for general public therefore, that water cannot be metered in Tonk city.

2. This approach takes the reading during night time but due to shortage of service reservoir it is not possible to satisfy the water demand of the city by just distribution of water during day time. At some places, it is found that supply get started at 03:00 am. Therefore, this loss cannot be find out accurately as during night the amount of water consumed by public will interfere with the study of NRW.

MNF cannot be conducted because water had not yet been reaching the remote customers tanks. Therefore, Tonk water utility lacks adequate knowledge for such a purpose.

#### *3. Component- Based Analysis*

This research shall analyse the NRW in Tonk water utility by the method of component based study. This is data based study. Although due to lack of data maintenance, shortage of employee and unawareness towards NRW in Tonk city, this method has some errors in studies.

In this method, various components of NRW are found out with the help of various sources and afterwards, amount of different components of water losses are summed up to get total NRW. But there will be some amount of uncertainty in the result therefore results will differ from the reality. These uncertainties will increase and accumulate with the lack of data availability and accuracy in Tonk water utility. As a result, using this method for NRW assessment would produces unrealistic results.

#### *4. The Used Methodology*

To sum up the above mentioned points, there are only three methods for NRW assessment. In the context of Tonk water distribution system, these methods when used for NRW assessment would not produce satisfactory results due to various reasons. Top down approach has the assumption of unauthorized consumption of 0.25%- 1% only of the system input volume, which is not the case in Tonk city. This leads to underestimate of the quantity of the apparent losses in Tonk water network especially as this value is likely to have much higher percentage.

Bottom up approach requires hydraulic conditions that are not met by Tonk water supply system's current conditions due to various reasons and is not possible to calculate MNF of the entire city due to intermittent supply.

The third method, component based analysis, is a data based analysis. NRW data in Tonk water utility lacks accuracy and completeness. It is also recommended that the component based approach should not be used on its own due to its high level of uncertainty.

Therefore, none of the method could supply acceptable results for NRW assessment. In such context we would adopting a method which follows general law of nature i.e. Water Balance or Water Auditing method.

This method is based on the basic law of nature i.e. conservation of mass. According to this law, mass can neither be created nor be destroyed, it just changes from one form to another or from one state to another state.

In the same way, it can be understood that the water which is putted in the distribution system will either reach the customer and get accounted and revenue or that water can get lost in the transmission process, either in the form of real loss like leakages, evaporation loss or in the form of apparent loss like unbilled authorized consumption and fault in taking the reading from the water meter etc. which will not be accounted for revenue. That is why this water is termed as Unaccounted for Water (UFW).

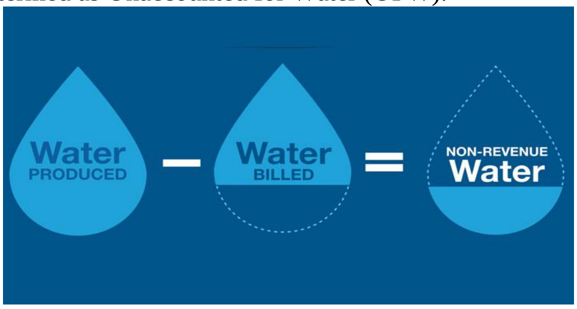


**Figure 2.1 Overview of Water Balance Audit**

Therefore, a water balance audit is used to determine how much water is being lost or unaccounted for water in a distribution system. In order to make this distribution, information about the amount of water produced is compared to the amount of water distributed and billed. The difference between the two is generally termed as "water loss". Water balance audit real usefulness is in helping to make water systems more efficient.

It is not possible to find out the components of NRW individually in Tonk. Therefore, this study would provide the total NRW volume of the Tonk city.

General water balance equation is

$$\mathbf{Q_{input} - Q_{output} = Q_{loss}}$$

Where,

$Q_{input}$ = system input volume

$Q_{output}$ = billed authorized consumption

$Q_{loss}$ = real losses (leakages, evaporation losses), apparent losses (unbilled authorized

Consumption, faulty readings of the meter)

**Figure 2.2 Component of Real Loss- Leakages**

### *5. The Assessment Steps*

The primary step is to define the time period for which the study is carried out. Then the volume of water which is produced in the said time period in that area is noted down on the daily basis. Then the volume of NRW is calculated by subtracting volumes of billed water from produced water.

Determination of NRW is carried out by first defining the assessment period. Then produced water (system input volume) was adjusted to production meters inaccuracies. Billed consumption (metered and unmetered) was obtained and computed. By subtracting billed consumption from the produced water, at last NRW is computed.

#### *a) Time period:*

For the purpose of assessing NRW in general, one year period is recommended by AWWA as it is long enough to include seasonal variations and reduces the effects of lag time in customer meter readings (AWWA, 2009). But this carried out for the period of October, 2017 to May, 2018. Hence the data of the study are represented on the monthly basis.

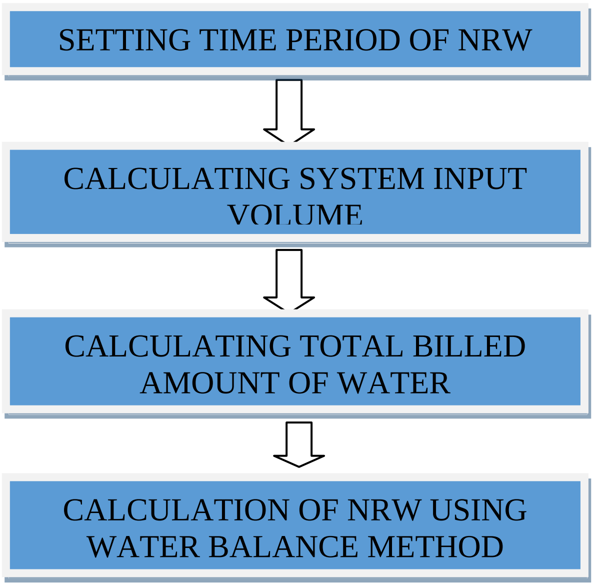


**Figure 2.3: Process of Determination of NRW**

*b) System Input Volume*

The system input volume (produced water) was adjusted for production meter inaccuracies. Since, it is not possible for the time frame of this study to conduct accuracy analysis and experiments for the production meters. This estimation is justified by the following:

- There is no maintenance programmed for production meters. The production meters are examined or maintained only once they are stopped or too low readings are obtained.

- Some meters are not installed according to their manuals that require minimum straight distance before water meter or specified sizes of pipe diameters.

- Water flow is of low level in the production pipes because of regression of wells production as a result of water scarcity in the basin.

*c) Billed Metered and Unmetered Consumption*

Metered consumption and the estimated unmetered consumption of customers with flat rate policy were obtained from the billing records of Tonk water utility. Then the billed water (metered and unmetered) was summed.

*6. Water Distribution and Billing System in Tonk City*

There are 45 municipal wards in the Tonk city. However, the pattern which is being followed by the PHED, Tonk is by dividing the water distribution scheme in three different areas known as Chowki in local language. Junior Engineer is the reporting officer of each chowki namely Bambhor Gate, Headquarter and Jail chowki. There are pump station in each chowki from where the water is pumped to the whole city.

The water production details are taken from these pumping stations by noting down the amount of water which is being pumped to the service reservoirs and ultimately to the entire city.

The bill type which is distributed in the Tonk city is C series, F series, IND series and M series i.e. Commercial type, Flat rate type, Industrial type and Metered type respectively. The acronyms given to the bill type are on the basis of the type of connection on the consumer end.

Further, commercial connection is divided into 7 sub zones from $C_1$ to $C_7$ , flat rate connection are also divided into 7 sub zones from $F_1$ to $F_7$ , industrial connection are divided into $IND_1$ , $IND_4$ , $IND_5$ , $IND_6$ and metered connection are divided into 7 sub zone from $M_1$ to $M_7$.

The bills which are generated for commercial and industrial connection subzones are on the monthly basis whereas flat rate and metered connections bills are generated once in 2 months.

Flat rate and metered type bill connections are domestic type connections. Therefore, for the sub zones $F_1$, $F_2$, $F_4$, $F_6$, $M_1$, $M_2$, $M_4$, $M_6$ bills are generated together and in the next month bills are generated for sub zones $F_3$, $F_5$, $F_7$, $M_3$, $M_5$, $M_7$.

And in the closing year i.e. in the month of March, bills are distributed to all the sub zones.

## III. BENEFITS OF NRW MANAGEMENT

The benefits of reducing NRW include:

• Need for less water to be produced, treated, and pumped, translating into the postponement of the expansion of capacity—producing less water also translates immediately into cost savings on O&M, due to savings in energy and treatment costs.

• Reduction in apparent losses, which will result in more water being billed and more revenue for utilities—it has also been shown that water metering and adequate rates reduce wasteful consumption, which will likely decrease total consumption.

• Adequate understanding of consumption patterns, which will allow utilities to optimize distribution systems.

• Better knowledge of real consumption, which will improve demand projections.

• Reduced sewage flows and pollution.

These benefits depend on adequate pricing of water resources and services. Subsidies for water extraction, discharge of wastewater, capital investment, and operation of water supply systems lower the cost of water as perceived by utilities and thus remove an incentive to reduce physical losses. Low water prices will also help poor people to deposit the amount on time so thereby, NRW will be reduced.

## IV. OBSERVATIONS

***A. Production Details***

As discussed in the earlier chapter, it came to know that the system input volume is recorded by taking the readings of operation of pump. It has been found that due to scarcity and insufficiency of water and lack of adequate service reservoirs, the pumps, even of 100 Horse Power capacities is being operated almost 20 to 21 hours a day. This increases the cost of production and transmission of water. There is loss of water at each level, from source to pumping station then from pumping station to service reservoir and at last when the water is putted in the distribution system. There is maximum amount of real losses in the pipes as water distribution network is of several kilo meters.

And it is not possible to lay a single pipe of this huge length. Therefore, we are constraint to use small length pipes with joints at the connections. These connections are the main cause of leakages due to higher pressure. Illegal connections are also one of the reasons which cause leakages in the pipes. In Tonk city it has been found out that due to negligence of the concerned department, the illegal connection numbers are very large. In some parts of the city public have more than one connection without authorisation. These connections are left open when not in use. This also leads to contamination of water which eventually is the burden on the economy as the water is produced but it will not be used by anyone in the society. That water would be wasted out in the environment leading to increase in NRW and also many health related issues will be found like water logging, breeding of mosquitoes over water logged water.

**Figure 4.1 Contamination of Water Due to Open Connections**

The production detail can be seen in the table below, the production amount is from 1st of October, 2017 to 31st May, 2018. And the amount of water which is produced is represented in the tabular form on daily basis.

As we know, the demand of water is not constant throughout the year. The demand varies even in a day. So by this table, it can be inferred that demand of water is reduced during the winter season and increased during the summer season.

**Table 4.1 Production of Water in the Month of October, November & December 2017**

| AMOUNT OF WATER (MLD) | | | |
|---|---|---|---|
| DAYS | OCTOBER | NOVEMBER | DECEMBER |
| 1 | 15.10 | 18.11 | 12.88 |
| 2 | 14.48 | 21.25 | 19.01 |
| 3 | 15.08 | 11.11 | 20.10 |
| 4 | 14.69 | 14.90 | 18.51 |
| 5 | 13.75 | 12.23 | 19.08 |
| 6 | 20.38 | 19.67 | 20.43 |
| 7 | 13.82 | 21.92 | 18.99 |
| 8 | 12.83 | 16.35 | 18.72 |
| 9 | 15.29 | 21.72 | 19.35 |
| 10 | 21.42 | 22.68 | 17.02 |
| 11 | 21.71 | 20.65 | 19.16 |
| 12 | 21.71 | 20.22 | 18.07 |
| 13 | 19.05 | 19.38 | 19.62 |
| 14 | 12.67 | 22.01 | 18.13 |
| 15 | 11.77 | 20.43 | 16.73 |
| 16 | 19.54 | 20.83 | 13.57 |
| 17 | 19.73 | 18.51 | 19.20 |
| 18 | 19.81 | 21.16 | 17.79 |
| 19 | 11.48 | 19.80 | 17.78 |
| 20 | 12.61 | 22.69 | 16.24 |
| 21 | 14.23 | 19.69 | 18.31 |
| 22 | 14.04 | 18.89 | 14.54 |
| 23 | 20.31 | 17.27 | 17.27 |
| 24 | 19.49 | 20.32 | 15.07 |
| 25 | 19.86 | 17.99 | 14.63 |
| 26 | 21.50 | 17.54 | 15.64 |
| 27 | 21.42 | 19.37 | 16.63 |
| 28 | 17.13 | 18.03 | 15.33 |
| 29 | 19.31 | 17.94 | 14.75 |
| 30 | 17.30 | 17.59 | 15.70 |
| 31 | 19.13 | | 18.48 |
| TOTAL | 530.57 | 570.61 | 536.80 |

**Table 4.2 Production of Water in the Month of January, February, March 2018**

| AMOUNT OF WATER (MLD) | | | |
|---|---|---|---|
| DAYS | JANUARY | FEBRUARY | MARCH |
| 1 | 17.47 | 16.54 | 21.04 |
| 2 | 18.04 | 17.71 | 18.33 |
| 3 | 16.16 | 18.65 | 17.72 |
| 4 | 9.12 | 18.67 | 17.31 |
| 5 | 14.35 | 18.10 | 16.89 |
| 6 | 18.58 | 18.26 | 17.62 |
| 7 | 22.01 | 16.98 | 17.80 |
| 8 | 14.29 | 17.86 | 17.72 |
| 9 | 19.84 | 18.15 | 17.55 |
| 10 | 18.21 | 17.68 | 17.57 |
| 11 | 17.69 | 17.22 | 18.21 |
| 12 | 15.95 | 17.26 | 17.44 |
| 13 | 6.36 | 17.10 | 16.33 |
| 14 | 10.32 | 17.57 | 18.17 |
| 15 | 23.69 | 17.10 | 18.54 |
| 16 | 15.54 | 17.59 | 18.07 |
| 17 | 18.31 | 17.78 | 16.07 |
| 18 | 17.43 | 17.29 | 16.02 |
| 19 | 15.32 | 17.73 | 16.92 |
| 20 | 16.30 | 17.38 | 18.25 |
| 21 | 16.79 | 17.83 | 18.24 |
| 22 | 15.89 | 16.47 | 17.17 |
| 23 | 19.06 | 17.84 | 18.76 |
| 24 | 17.73 | 16.98 | 17.56 |
| 25 | 17.85 | 17.50 | 15.72 |
| 26 | 18.19 | 15.09 | 16.46 |
| 27 | 18.01 | 17.96 | 16.67 |
| 28 | 18.70 | 16.92 | 13.06 |
| 29 | 17.00 | | 11.87 |
| 30 | 18.77 | | 11.07 |
| 31 | 17.71 | | 10.72 |
| TOTAL | 520.79 | 489.31 | 520.87 |

**Table 4.3 Production of Water in the Month of April, May 2018**

| AMOUNT OF WATER (MLD) | | |
|---|---|---|
| DAYS | APRIL | MAY |
| 1 | 17.43 | 19.76 |
| 2 | 17.00 | 17.54 |
| 3 | 16.35 | 14.78 |
| 4 | 17.05 | 19.65 |
| 5 | 20.37 | 20.09 |
| 6 | 19.12 | 18.78 |
| 7 | 19.79 | 18.66 |
| 8 | 16.36 | 17.65 |
| 9 | 17.40 | 16.98 |
| 10 | 16.21 | 19.54 |
| 11 | 15.32 | 14.45 |

| | | |
|---|---|---|
| 12 | 18.31 | 13.67 |
| 13 | 18.43 | 17.87 |
| 14 | 17.53 | 19.02 |
| 15 | 14.62 | 18.91 |
| 16 | 21.02 | 16.55 |
| 17 | 20.45 | 17.91 |
| 18 | 17.32 | 17.34 |
| 19 | 14.54 | 17.32 |
| 20 | 13.54 | 19.62 |
| 21 | 14.89 | 12.81 |
| 22 | 13.45 | 11.72 |
| 23 | 17.54 | 17.43 |
| 24 | 21.55 | 14.34 |
| 25 | 20.21 | 15.63 |
| 26 | 15.71 | 17.45 |
| 27 | 19.62 | 17.85 |
| 28 | 17.98 | 15.88 |
| 29 | 18.55 | 16.49 |
| 30 | 15.63 | 19.56 |
| 31 | | 13.23 |
| TOTAL | 523.29 | 528.48 |

***B. Billing Details***

As discussed in chapter 2, the bills are distributed to the sub zones either once in a month or once in two months. The bill generated is just of 60% percentage of the volume of water which is produced every month approximately. Out of which, it has been witnessed that only 50% approximately revenue comes to the department of the produced water. This situation of Tonk city is really devastating.

This study will also provide the data regarding the cost of water for which the bill has been generated and the amount which is being deposited against the consumption. It is evident that 100% revenue generation from water distribution is not possible but the gap between the amount of consumption and amount deposited against consumption is increasing day by day, month by month and year by year. This gap will only be able to fill if water department of the city understand the economic loss due to increasing NRW and become strict towards collection of revenue.

**Figure 4.2 Illegal Connections in an Area**

**Table 4.4 Billing Details Of The Month October 2017**

| Sr. No. | Subzone | Consumption (KL) | Amount Of Consumption | Dep. Amt. Of Consumption | Comp. Against Dep. Amt. |
|---|---|---|---|---|---|
| 1 | C1 | 1725 | 163186 | 21436 | 1101 |
| 2 | C2 | 110 | 16551 | 635 | 45 |
| 3 | C3 | 210 | 16174 | 4022 | 165 |
| 4 | C4 | 765 | 48747 | 17439 | 485 |
| 5 | C5 | 2814 | 240403 | 39104 | 1680 |
| 6 | C6 | 915 | 117256 | 21270 | 505 |
| 7 | C7 | 394 | 75877 | 1813 | 150 |
| 8 | CG | 308 | 26767 | 2765 | 263 |
| 9 | F1 | 19774 | 978258 | 73125 | 9782 |
| 10 | F2 | 22962 | 1349248 | 76994 | 11548 |
| 11 | F3 | 0 | 0 | 0 | 0 |
| 12 | F4 | 32946 | 1318931 | 122217 | 16364 |

| | | | | | |
|---|---|---|---|---|---|
| 13 | F5 | 0 | 0 | 0 | 0 |
| 14 | F6 | 20002 | 826395 | 76995 | 10994 |
| 15 | F7 | 0 | 0 | 0 | 0 |
| 16 | GQ | 3904 | 140745 | 16546 | 1810 |
| 17 | IND1 | 113 | 101273 | 1479 | 25 |
| 18 | IND4 | 110 | 4125 | 964 | 35 |
| 19 | IND5 | 144 | 22003 | 1165 | 56 |
| 20 | IND6 | 35 | 2098 | 2098 | 35 |
| 21 | M1 | 103854 | 3193407 | 386615 | 57128 |
| 22 | M2 | 42034 | 1712342 | 137573 | 21390 |
| 23 | M3 | 0 | 0 | 0 | 0 |
| 24 | M4 | 80194 | 1918695 | 315951 | 47702 |
| 25 | M5 | 0 | 0 | 0 | 0 |
| 26 | M6 | 128274 | 2961508 | 466647 | 71028 |
| 27 | M7 | 0 | 0 | 0 | 0 |
| 28 | MB | 302 | 7185 | 0 | 0 |
| 29 | SG | 14741 | 537288 | 153190 | 7963 |
| TOTAL | | **476630** | **155778462** | **1940043** | **260254** |

Difference between the billed consumption and paid billed consumption= 216376 KL
Difference between amount for billed consumption and paid consumption = 13838419

**Table 4.5 Billing Details Of The Month November 2017**

| Sr. No. | Subzone | Consumption (KL) | Amount Of Consumption | Dep. Amt. Of Consumption | Comp. Against Dep. Amt. |
|---|---|---|---|---|---|
| 1 | C1 | 1725 | 174377 | 24750 | 1060 |
| 2 | C2 | 110 | 18008 | 494 | 45 |
| 3 | C3 | 210 | 16500 | 2838 | 145 |
| 4 | C4 | 765 | 44723 | 13251 | 527 |
| 5 | C5 | 2784 | 262439 | 55478 | 1849 |
| 6 | C6 | 915 | 115912 | 24835 | 360 |
| 7 | C7 | 394 | 80738 | 7209 | 253 |
| 8 | CG | 308 | 27895 | 2765 | 263 |
| 9 | F1 | 0 | 0 | 0 | 0 |
| 10 | F2 | 0 | 0 | 0 | 0 |
| 11 | F3 | 37898 | 2207057 | 128036 | 18364 |
| 12 | F4 | 0 | 0 | 0 | 0 |
| 13 | F5 | 11446 | 545185 | 60598 | 6238 |
| 14 | F6 | 0 | 0 | 0 | 0 |
| 15 | F7 | 13398 | 353661 | 54939 | 8088 |
| 16 | GQ | 3784 | 145170 | 20866 | 1918 |
| 17 | IND1 | 113 | 107305 | 2632 | 53 |
| 18 | IND4 | 110 | 5501 | 2784 | 50 |
| 19 | IND5 | 144 | 25648 | 2041 | 78 |
| 20 | IND6 | 35 | 2098 | 2098 | 0 |
| 21 | M1 | 0 | 0 | 0 | 0 |
| 22 | M2 | 0 | 0 | 0 | 0 |
| 23 | M3 | 73548 | 3905526 | 274492 | 39314 |
| 24 | M4 | 0 | 0 | 0 | 0 |
| 25 | M5 | 103758 | 1777745 | 424510 | 66138 |
| 26 | M6 | 0 | 0 | 0 | 0 |
| 27 | M7 | 29782 | 824661 | 113710 | 18686 |
| 28 | MB | 302 | 15090 | 7185 | 0 |
| 29 | SG | 14741 | 576031 | 158350 | 1779 |
| TOTAL | | **296270** | **11231270** | **1383861** | **165208** |

Difference between the billed consumption and paid billed consumption= 131062 KL
Difference between the amount for billed consumption and paid consumption = 9847409

**Table 4.6 Billing Details Of The Month December 2017**

| Sr. No. | Subzone | Consumption (KL) | Amount Of Consumption | Dep. Amt. Of Consumption | Comp. Against Dep. Amt. |
|---|---|---|---|---|---|
| 1 | C1 | 1725 | 182206 | 22205 | 1127 |
| 2 | C2 | 110 | 19626 | 494 | 45 |
| 3 | C3 | 210 | 18004 | 1986 | 105 |
| 4 | C4 | 765 | 44666 | 11835 | 535 |
| 5 | C5 | 2739 | 266215 | 51532 | 1960 |
| 6 | C6 | 865 | 108972 | 19683 | 530 |
| 7 | C7 | 418 | 80660 | 5752 | 236 |
| 8 | CG | 308 | 29017 | 2765 | 263 |
| 9 | F1 | 19774 | 1031251 | 120994 | 10854 |
| 10 | F2 | 22962 | 1412064 | 122548 | 13128 |
| 11 | F3 | 0 | 0 | 0 | 0 |
| 12 | F4 | 32946 | 1393755 | 172904 | 18218 |
| 13 | F5 | 0 | 0 | 0 | 0 |
| 14 | F6 | 19962 | 853449 | 95971 | 11814 |
| 15 | F7 | 0 | 0 | 0 | 0 |
| 16 | GQ | 3784 | 147956 | 12143 | 1724 |
| 17 | IND1 | 113 | 112210 | 2028 | 53 |
| 18 | IND4 | 115 | 4471 | 368 | 20 |
| 19 | IND5 | 144 | 28416 | 2696 | 94 |
| 20 | IND6 | 35 | 2098 | 2098 | 0 |
| 21 | M1 | 105395 | 3417794 | 457244 | 64185 |
| 22 | M2 | 41908 | 1814763 | 198134 | 23956 |
| 23 | M3 | 0 | 0 | 0 | 0 |
| 24 | M4 | 80884 | 2044296 | 441473 | 53544 |
| 25 | M5 | 0 | 0 | 0 | 0 |
| 26 | M6 | 127384 | 3091359 | 658976 | 79778 |
| 27 | M7 | 0 | 0 | 0 | 0 |
| 28 | MB | 302 | 15744 | 7185 | 0 |
| 29 | SG | 14741 | 606831 | 207258 | 11820 |
| TOTAL | | **477589** | **16725823** | **2618272** | **293989** |

Difference between the billed consumption and paid billed consumption= 183600 KL
Difference between the amount for billed consumption and paid consumption =14107551

**Table 4.7 Billing Details Of The Month January 2018**

| Sr. No. | Subzone | Consumption (KL) | Amount Of Consumption | Dep. Amt. Of Consumption | Comp. Against Dep. Amt. |
|---|---|---|---|---|---|
| 1 | C1 | 1725 | 193047 | 19667 | 1039 |
| 2 | C2 | 110 | 21265 | 368 | 20 |
| 3 | C3 | 210 | 20614 | 3080 | 110 |
| 4 | C4 | 765 | 46182 | 11214 | 527 |
| 5 | C5 | 2809 | 255978 | 46892 | 2047 |
| 6 | C6 | 885 | 108874 | 11454 | 505 |
| 7 | C7 | 347 | 80571 | 2948 | 198 |
| 8 | CG | 308 | 30198 | 2765 | 263 |
| 9 | F1 | 0 | 0 | 0 | 0 |
| 10 | F2 | 0 | 0 | 0 | 0 |
| 11 | F3 | 37868 | 2301444 | 129832 | 18360 |
| 12 | F4 | 0 | 0 | 0 | 0 |
| 13 | F5 | 111446 | 565878 | 46849 | 6022 |
| 14 | F6 | 0 | 0 | 0 | 0 |
| 15 | F7 | 13398 | 374434 | 58474 | 8472 |
| 16 | GQ | 3784 | 162819 | 25057 | 2069 |

| | | | | | |
|---|---|---|---|---|---|
| 17 | IND1 | 113 | 117802 | 2028 | 53 |
| 18 | IND4 | 115 | 5976 | 2408 | 55 |
| 19 | IND5 | 144 | 30469 | 6923 | 114 |
| 20 | IND6 | 35 | 2098 | 2098 | 0 |
| 21 | M1 | 0 | 0 | 0 | 0 |
| 22 | M2 | 0 | 0 | 0 | 0 |
| 23 | M3 | 73290 | 4087182 | 272781 | 20694 |
| 24 | M4 | 0 | 0 | 0 | 0 |
| 25 | M5 | 104118 | 1913560 | 486955 | 69030 |
| 26 | M6 | 0 | 0 | 0 | 0 |
| 27 | M7 | 29782 | 892666 | 134654 | 19016 |
| 28 | MB | 302 | 16530 | 14370 | 0 |
| 29 | SG | 14641 | 591983 | 81418 | 6342 |
| TOTAL | | **296195** | **11819570** | **1362235** | **174936** |

Difference between the billed consumption and paid billed consumption= 121259 KL
Difference between amount for billed consumption and paid consumption = 10457335

**Table 4.8 Billing Details Of The Month February 2018**

| Sr. No. | Subzone | Consumption (KL) | Amount Of Consumption | Dep. Amt. Of Consumption | Comp. Against Dep. Amt. |
|---|---|---|---|---|---|
| 1 | C1 | 1715 | 191381 | 50423 | 1200 |
| 2 | C2 | 110 | 23065 | 1635 | 70 |
| 3 | C3 | 210 | 22218 | 3576 | 95 |
| 4 | C4 | 765 | 48399 | 9587 | 523 |
| 5 | C5 | 2669 | 262915 | 61392 | 2007 |
| 6 | C6 | 885 | 116832 | 15447 | 570 |
| 7 | C7 | 347 | 76636 | 13483 | 181 |
| 8 | CG | 308 | 31373 | 2765 | 263 |
| 9 | F1 | 19774 | 1027647 | 60476 | 9502 |
| 10 | F2 | 22992 | 1421101 | 143344 | 18402 |
| 11 | F3 | 0 | 0 | 0 | 0 |
| 12 | F4 | 32758 | 1401936 | 143344 | 18402 |
| 13 | F5 | 0 | 0 | 0 | 0 |
| 14 | F6 | 19962 | 877828 | 89451 | 11080 |
| 15 | F7 | 0 | 0 | 0 | 0 |
| 16 | GQ | 3760 | 159485 | 84525 | 2528 |
| 17 | IND1 | 113 | 123478 | 2028 | 53 |
| 18 | IND4 | 115 | 5335 | 472 | 40 |
| 19 | IND5 | 144 | 28295 | 1923 | 94 |
| 20 | IND6 | 35 | 2098 | 2098 | 35 |
| 21 | M1 | 105896 | 3551463 | 408333 | 62206 |
| 22 | M2 | 41770 | 1854657 | 173763 | 22954 |
| 23 | M3 | 0 | 0 | 0 | 0 |
| 24 | M4 | 80604 | 2033272 | 357839 | 52258 |
| 25 | M5 | 0 | 0 | 0 | 0 |
| 26 | M6 | 127988 | 3032756 | 562592 | 76652 |
| 27 | M7 | 0 | 0 | 0 | 0 |
| 28 | MB | 302 | 10065 | 10065 | 302 |
| 29 | SG | 14641 | 689863 | 413183 | 13962 |
| TOTAL | | **477863** | **16992098** | **2427754** | **287185** |

Difference between the billed consumption and paid billed consumption= 190678 KL
Difference between amount for billed consumption and paid consumption = 14564344

**Table 4.9 Billing Details Of The Month March 2018**

| Sr. No. | Subzone | Consumption (KL) | Amount Of Consumption | Dep. Amt. Of Consumption | Comp. Against Dep. Amt. |
|---|---|---|---|---|---|
| 1 | C1 | 890 | 93278 | 30345 | 266 |
| 2 | C2 | 60 | 12065 | 2098 | 6 |
| 3 | C3 | 110 | 11514 | 4566 | 53 |
| 4 | C4 | 350 | 271082 | 6456 | 50 |
| 5 | C5 | 1607 | 145778 | 40976 | 218 |
| 6 | C6 | 465 | 57104 | 10986 | 211 |
| 7 | C7 | 347 | 41234 | 9566 | 121 |
| 8 | CG | 308 | 15098 | 4568 | 165 |
| 9 | F1 | 9765 | 532789 | 37987 | 1987 |
| 10 | F2 | 12154 | 793546 | 47345 | 1065 |
| 11 | F3 | 19874 | 1187645 | 80987 | 6423 |
| 12 | F4 | 16447 | 756234 | 149803 | 1765 |
| 13 | F5 | 5897 | 270923 | 56789 | 600 |
| 14 | F6 | 10897 | 423980 | 109864 | 1321 |
| 15 | F7 | 7668 | 183987 | 67898 | 1432 |
| 16 | GQ | 1568 | 106243 | 31093 | 176 |
| 17 | IND1 | 54 | 57809 | 8094 | 27 |
| 18 | IND4 | 64 | 2967 | 3097 | 42 |
| 19 | IND5 | 61 | 21345 | 8095 | 17 |
| 20 | IND6 | 35 | 1908 | 4857 | 9 |
| 21 | M1 | 53950 | 1723980 | 456789 | 20760 |
| 22 | M2 | 21908 | 911230 | 198749 | 10456 |
| 23 | M3 | 33290 | 2078234 | 298756 | 28789 |
| 24 | M4 | 40884 | 1034908 | 437689 | 22689 |
| 25 | M5 | 54118 | 934678 | 523456 | 38906 |
| 26 | M6 | 67384 | 1576759 | 649867 | 40076 |
| 27 | M7 | 19782 | 491345 | 134566 | 6457 |
| 28 | MB | 102 | 7896 | 10873 | 78 |
| 29 | SG | 7641 | 298764 | 189750 | 3789 |
| TOTAL | | **387680** | **14044323** | **3615965** | **187954** |

Difference between the billed consumption and paid billed consumption= 199726 KL
Difference between amount for billed consumption and paid consumption = 10428358

**Table 4.10 Billing Details Of The Month April 2018**

| Sr. No. | Subzone | Comp (KL) | Amt. Of Comp. | Dep Amt. of Issuing Comp. | Comp. against Dep. Amt. |
|---|---|---|---|---|---|
| 1 | C1 | 1725 | 204567 | 26789 | 890 |
| 2 | C2 | 110 | 20987 | 678 | 78 |
| 3 | C3 | 210 | 17456 | 3190 | 178 |
| 4 | C4 | 765 | 48234 | 14567 | 567 |
| 5 | C5 | 2784 | 289876 | 58906 | 2345 |
| 6 | C6 | 915 | 187973 | 25678 | 676 |
| 7 | C7 | 394 | 129873 | 8908 | 219 |
| 8 | CG | 308 | 27908 | 2985 | 234 |
| 9 | F1 | 0 | 0 | 0 | 0 |
| 10 | F2 | 0 | 0 | 0 | 0 |
| 11 | F3 | 37898 | 224567 | 134567 | 19084 |
| 12 | F4 | 0 | 0 | 0 | 0 |
| 13 | F5 | 11446 | 547893 | 61234 | 7898 |
| 14 | F6 | 0 | 0 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 15 | F7 | 13398 | 358769 | 57869 | 8947 |
| 16 | GQ | 3784 | 174568 | 22355 | 1984 |
| 17 | IND1 | 113 | 199873 | 2794 | 53 |
| 18 | IND4 | 110 | 5921 | 2945 | 55 |
| 19 | IND5 | 144 | 26789 | 2345 | 79 |
| 20 | IND6 | 35 | 2390 | 2456 | 0 |
| 21 | M1 | 0 | 0 | 0 | 0 |
| 22 | M2 | 0 | 0 | 0 | 0 |
| 23 | M3 | 73548 | 4098742 | 289847 | 40985 |
| 24 | M4 | 0 | 0 | 0 | 0 |
| 25 | M5 | 103758 | 1876354 | 435678 | 67834 |
| 26 | M6 | 0 | 0 | 0 | 0 |
| 27 | M7 | 29782 | 876839 | 134567 | 18973 |
| 28 | MB | 302 | 16783 | 7456 | 0 |
| 29 | SG | 14741 | 598234 | 167830 | 2098 |
| TOTAL | | **300054** | **99834596** | **1463644** | **173177** |

Difference between the billed consumption and paid billed consumption= 126877 KL
Difference between amount for billed consumption and paid consumption = 98370952

**Table 4.11 Billing Details of the Month May 2018**

| Sr. No. | Subzone | Comp (KL) | Amt. Of Comp. | Dep Amt. of Issuing Comp. | Comp. against Dep. Amt. |
|---|---|---|---|---|---|
| 1 | C1 | 1725 | 182245 | 22256 | 1127 |
| 2 | C2 | 110 | 19634 | 495 | 45 |
| 3 | C3 | 210 | 18045 | 1956 | 105 |
| 4 | C4 | 765 | 44634 | 11837 | 535 |
| 5 | C5 | 2784 | 266245 | 51454 | 1960 |
| 6 | C6 | 915 | 108933 | 195674 | 530 |
| 7 | C7 | 394 | 80690 | 5456 | 236 |
| 8 | CG | 308 | 29098 | 2984 | 263 |
| 9 | F1 | 20947 | 1031245 | 120994 | 10854 |
| 10 | F2 | 23457 | 1412055 | 122532 | 13128 |
| 11 | F3 | 0 | 0 | 0 | 0 |
| 12 | F4 | 32456 | 1393775 | 172904 | 18218 |
| 13 | F5 | 0 | 0 | 0 | 0 |
| 14 | F6 | 20948 | 853449 | 95971 | 11814 |
| 15 | F7 | 0 | 0 | 0 | 0 |
| 16 | GQ | 3784 | 147956 | 12143 | 1724 |
| 17 | IND1 | 113 | 112245 | 2028 | 53 |
| 18 | IND4 | 110 | 4434 | 368 | 20 |
| 19 | IND5 | 144 | 28490 | 2696 | 94 |
| 20 | IND6 | 35 | 2045 | 2098 | 0 |
| 21 | M1 | 105986 | 3417756 | 457244 | 64185 |
| 22 | M2 | 42108 | 1814745 | 198134 | 23956 |
| 23 | M3 | 0 | 0 | 0 | 0 |
| 24 | M4 | 81884 | 2044267 | 441473 | 53544 |
| 25 | M5 | 0 | 0 | 0 | 0 |
| 26 | M6 | 129855 | 3091367 | 658976 | 79778 |
| 27 | M7 | 0 | 0 | 0 | 0 |
| 28 | MB | 302 | 157678 | 7185 | 0 |
| 29 | SG | 14741 | 606856 | 207258 | 11820 |
| TOTAL | | **484081** | **16867887** | **2794116** | **293989** |

Difference between the billed consumption and paid billed consumption= 190092 KL
Difference between amount for billed consumption and paid consumption = 14073771

## V. RESULTS

NRW is that volume of total produced water which is not generating any revenue. NRW can be found out by calculating the difference between the paid billed consumption against the total production.

Therefore,
NRW= Total Production – Paid Billed Consumption
NRW (%) = {NRW (ML)/Total production (ML)}X100

The NRW data for the time period of October 2017 to May 2018 is shown in the table below:

**Table 5.1 NRW Volume and NRW Percentage**

| Sr. No. | MONTH | NRW (ML) | NRW (%) |
|---|---|---|---|
| 1 | October | 270.31 | 50.94 |
| 2 | November | 274.34 | 48.07 |
| 3 | December | 242.81 | 45.23 |
| 4 | January | 224.59 | 43.12 |
| 5 | February | 207.52 | 42.41 |
| 6 | March | 133.19 | 25.57 |
| 7 | April | 223.23 | 42.66 |
| 8 | May | 234.49 | 44.37 |

Total NRW in the study time period= **1810.48 ML**
Total production of water in study period= **4220.72 ML**
Therefore, NRW percentage = **57.10%**

## VI. CONCLUSIONS

From the above results following conclusions can be drawn:

- By calculating the NRW volume, it can be inferred that NRW management policies are not properly implemented in Tonk city.
- Due to negligence of the Water Department, the NRW is increasing at a rapid rate.
- The water distribution system was laid long back and due to the age of infrastructure the quality of pipelines have been deteriorated which leads to leakages and bursts every then and now.
- Due to lack of awareness among general public about the importance of fresh water as its availability is less than 2% on the earth, many open and abandoned connections were found during the study period.
- Majorly Tonk is a poor city, therefore people are unable to pay the water bill and instead they opt for water theft.
- Due to shortage of employee in the Department, proper maintenance of the records is not there.
- Due to carelessness of the meter reader, inaccuracies in the reading taken which further can increase NRW.
- Tampering in meter by any notorious element can also lead to increase in NRW.

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