WATER AUDIT OF KCAET CAMPUS

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PROJECT REPORT

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<u>DECLARATION</u>

We hereby declare that this thesis entitled **"Water Audit of the campus of Kelappaji College of Agricultural Engineering and Technology"** is a bonafide record of research work done by us during the course of academic programme in the Kerala Agricultural University and the thesis has not previously formed the basis for the award of any degree, diploma, association, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this project report entitled **"Water Audit of the campus of Kelappaji College of Agricultural Engineering and Technology"** is a record of project work done jointly by Ms. Chris Irene, Ms. Deepthi S Nair, Mr. Praneet Garg, and Ms. Shafeela Jasmin T.P under my guidance and supervision and that it has not previously formed the basis for any degree, diploma, fellowship or associateship or other similar title of another University or Society.

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<u>Dedication</u>

This thesis is dedicated to our profession

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SYMBOLS AND ABBREVIATIONS

<	Less than
>	Greater than
%	Percent
±	Plus or minus
≤	Less than or equal to
≥	Greater than or equal to
cm	Centimetre
et al.	And others
etc.	et cetera
Fig.	Figure
hr	Hour
WHO	World Health Organisation
FAO	Food and Agriculture Organisation
KAU	Kerala Agricultural University
KCAET	Kelappaji College of Agricultural Engineering and Technology
lpcd	Litre per capita per day
lpd	Litre per day
l	Litre
m	Metre
S	Second
Sl. No.	Serial number
viz.	Namely

CHAPTER 1

INTRODUCTION

Water is a precious natural national resource with almost fixed quantum of availability. With continuous growth in country's population, per capita availability of utilizable water is going down, whereas with ever-rising standard of living of people and all around rapid industrialization and urbanization, demand of fresh water is going up continuously. Unabated discharge of industrial effluents into water bodies is further aggravating the situation of scarcity of water of acceptable quality. In spite of the fact that fresh water is rapidly becoming scarce, it is continued to be used wastefully.

Declaring water conservation a national mission, in June 2003, the Prime Minister of India, appealed to all countrymen to collectively address the problem of alarmingly progressing water shortage, by conserving every drop of water and suggested for conducting water audit for all sectors of water use.

At the global level, about 60-70 percent of total annual water consumption is in irrigation sector. In India, water use for irrigation is about 83 percent of current level of total water utilization. Thus apparently there is ample scope of water saving in irrigation sector. Availability of natural resources, particularly land and water, for people of India is inequitable at global level. Presently, with 2.4 percent of land and 4 percent of water resources, India has to support 16 percent of world's population and 15 percent of livestock.

India gets an average precipitation of 4000 billion cubic meters (BCM) per annum. Precipitation is highly unevenly distributed with respect to time and space, over the country. As much as 75% of total average annual precipitation occurs in 4 months of monsoon period. Even during the monsoon months, about 50% of total annual rainfall takes place only in 15 days and in less than 100 hrs. As far as spatial unevenness is concerned, the average rainfall in Meghalaya is 10900mm, whereas, in Rajasthan it is as low as 100 mm against the national average annual rainfall of 1100 mm. On the other hand demand for fresh water is increasing in an alarming rate. It is not only due to rapid population growth, but also on account of many other factors such as rise in per capita water demand arising out of continuous upward movement of living standards, increased reliance on irrigated agriculture, massive urbanization, industrialization etc.

As per the present indication, population of the country may stabilize by the year 2050 at around 1.6 billion. The available utilizable water resource of the country is considered insufficient to meet all future needs. Under such a situation, in order to face the challenge of water deficit, apart from accelerating pace of development of available utilizable water resources, all out efforts, on the part of people from every walk of life, would need to be made to conserve every drop of water and improve efficiency in all areas of water use.

Water audit is an effective management tool for minimizing losses, optimizing various uses and thus enabling considerable conservation of water not in irrigation sector alone but in other sectors of water use such as domestic, power industrial etc. Water audit determines the amount of water lost from a distribution system due to leakage and other reasons such as theft, unauthorized or illegal withdrawals from the systems and the cost of such losses to the utility. Comprehensive audits can give the utility a detailed profile of the water supply system and water users, allowing easier management of resources and improved reliability. It is an important step towards water conservation and, if linked with a leak detection plan, can save the utility a significant amount of money and time.

Industries, educational and research institutions, commercial, complexes and many other government and non-government organizations utilize water for different purposes. Its needful utilization, supply and disposal are directly related to wastage and health of nearby flora and fauna. Therefore, routinely monitoring the water status of such organizations is very important. Conducting a water audit in a campus of an agricultural institute is of extreme importance and use, where proper and efficient use of natural resources like soil and water are of prime importance. A water audit in the campus of Kelappaji College of Agricultural Engineering and Technology shall help prevent unnecessary wastage of water in the campus premises, ensure efficient use of the source, which is the precious ground water and provide a good knowledge of water supply system in the campus. The location of college is in Tavanur, Kerala. Though being one of the highest rainfall receiving states of India (about 3000 mm), Kerala still faces per capita acute shortage of water due to reasons like high population rise, inefficient use of surface water, water contamination and over usage of groundwater. Thus, it becomes extremely helpful and useful to conduct a water audit in the college campus, to generate effective results.

The campus relies on groundwater usage as primary source of water. Thus a water audit will help conserve the groundwater by effectively using the amount available and analyze the wastage and the cause of wastage in the staff and student dormitories and the academic building and other uses.

1.1 WATER AUDIT

Water audit determines the amount of water lost from a distribution system due to leakage and other reasons such as theft, unauthorized or illegal withdrawals from the systems and the cost of such losses to the utility. Comprehensive water audit gives a detailed profile of the distribution system and water users, thereby facilitating easier and effective management of the resources with improved reliability. It helps in correct diagnosis of the problems faced in order to suggest optimum solutions. It is also an effective tool for realistic understanding and assessment of the present performance level and efficiency of the service and the adaptability of the system for future expansion & rectification of faults during modernization.

Elements of water audit include a record of the amount of water produced (total water supply), water delivered to metered users, water delivered to unmetered users, water loss and suggested measures to address water loss (through leakages and other unaccounted for water losses).

1.2 BENEFITS OF WATER AUDIT

i. Water audits provide decision making tools to utility managers, directors, and operators. i.e., knowing where water is being used in your system allows you to make informed decisions about investing resources such as time, labour and money.
ii. Water audits allow managers to efficiently reduce water losses in the system.
iii. It less the cost incur for electricity, chemicals, and maintenance cause due to losses in the system.
iv. Reducing water used at the source may even result in delaying or avoiding capital investments such as a new well, more treatment technology or additional water rights.

v. Water audits also identify which water uses are earning revenue for the utility and which water uses are not. Thus, System personnel can increase revenue by ensuring all appropriate uses are being accurately measured and billed. This leads to more financial capacity in the water system, reduced cost per customer and better management of the water resource.

vi. Creating awareness among water users i.e., customers can see and understand that the utility is taking proactive steps to manage wasted water.

vii. It is an effective educational and public relations tool for the water system.

1.3 IMPORTANCE OF WATER AUDIT

A portion of the total water use is leakage, some of it is due to inaccurate metering, some of it may be unauthorized use, and some of it is water delivered to customers. A water audit determines where the water ends up and how much of it got there. The level of detail in the water audit will vary based on the information on system has available. All water systems lose some amount of water for a variety of reasons. There are no accurate statistics for how much water is lost.

Water loss costs money, paid by the system and customers. Utilities cannot reduce their water loss to zero. Some water loss is unavoidable, and it is not worth the expense to try to eliminate every drop escaping your system. However, most of the loss that occurs in water systems can be better managed by using a water audit. Managing a water utility is similar to managing any other business. In India, the land, water resources and population are 2.4 percent, 4 percent and 16 percent respectively of those of the globe. On an average the 50 percent of rain fall is within 15 days and in less than 100 hr, and this water is used for 365 days. The present water availability of India is 1820 m3 per capita per annum reduces from 6000 m3 per capita in 1947. In the context of prevailing scenario, the water audit becomes an inevitable activity in India and in World. Thus it is a tool to identify public money wastage due to the water loss, un-authorized connections as an advantage over the optimized use of water resources with environmental protection.

1.4 OBJECTIVES OF WATER AUDIT

Objectives of water audit is to find out physical losses due to pipe leakage and over flow, losses due to metering errors, unauthorized connections and free water supply given by Municipal authority for public stand post and park in the distribution system.

1.5 STEPS OF WATER AUDIT

i. Water supply and usage study

Water audit comprises of preparation of layout of water sources, distribution network, and service/delivery points to water users and return flow of waste or excess water. The layout should include locations and capacities of flow measurement devices installed at key points, dimensions of pipes and fittings in `the water supply system, locations and particulars of flow control devices and history sheets of all measuring and control devices including pipes and fittings. A study of the availability of water sources and past consumption patterns for various sectors is necessary to understand the present water utilization and projecting future requirement. Data on development of sustainable source of water through rainwater harvesting and effluent recycling should also be taken into consideration.

ii. Process Study

Flow measurement devices may be installed at all strategic points so that water losses from various components such as raw water source, conveyance system from raw water source to treatment plant, from treatment plant to treated water storage system, treated water storage system to distribution networks, individual users, etc. could be assessed at regular intervals. Such studies will also prove useful for future extension, renovation and modernization of the system.

Water quality of the distribution system needs to be monitored regularly at strategic points to find out the level and nature of contaminants present in the supplied water. Depending on the types of application and degree of purity needed, the treatment system can be designed and developed. The water distribution system, leakage assessment etc. will form an integral part of this study.

iii. System Audit

The current water usages and systems for water use under various sectors such as irrigation, industry and commerce, hydropower, domestic water supply, thermal power and others need to be studied to check their operational efficiency and level of maintenance. The scope for any modification or up-gradation will depend on the status of existing systems. Measurement methodology from the intake point of the system through various sub-systems to the ultimate user points needs to be verified periodically for its suitability, efficiency and accuracy. Bulk metering should be done at the source for zones, districts etc. and revenue metering for consumers. This will help in identifying the reaches of the undue waste water generation.

iv. Discharge Analysis

The domestic wastewater, return flows from irrigation, and effluents from the industries need to be studied for conformity to environment standards, possibility of recovery of valuable by-products and the opportunity for recycling of waste water.

v. Water Audit Report

Adequate planning and standard procedures are necessary prior to undertaking the water audit of a system. A water audit can be accomplished on the basis of water allotted for a service and water actually utilized for that service. After assessing the loss of water and the efficiency of the system, steps needed for utilization of recoverable water loss may be listed. A cost-benefit study for optimum recovery of water loss may be performed. A water audit report may, invariably, contain:

a) Amount of water earmarked/made available to the service.
b) Amount of water utilized, both through metered and unmetered supplies.
c) Water loss and efficiency of the system along with reasons for such water losses.
d) Suggested measures to check water loss and improve efficiency.

An effective water audit report may be purposeful in detection of leak in distribution system, taking timely action for plugging such leaks and thereby reducing conveyance losses of water and improving efficiency of the system. Water audit of the system should be undertaken at regular interval of time, at least on an annual basis.

The main purpose behind this work undertaken by us is to determine the water losses in KCAET Campus by metering the different supply lines and comparing the readings with the actual water supply or the inflow.

The objectives of the water audit of the KCAET, Tavanur campus are as follows:

- Study of the water supply system, composed up of open and bore wells.
- Study of the complete water distribution system of the campus.
- Finding out the physical losses due to pipe leakage and overflow.
- Suggesting methods to reduce these losses.

CHAPTER 2

REVIEW OF LITERATURE

This chapter reviews the concepts and literatures available on water auditing and accounting carried out at different places and institutions and the investigations and inferences pertaining to per capita water requirement.

2.1 WATER CONSERVATION

Water conservation includes all policies, strategies and activities to sustainably manage the natural resource of fresh water, to protect the hydrosphere and to meet the current and future human demand. The water demand is greatly influenced by population, household size and growth and affluence.

The goals of water conservation include:

- Ensuring availability of water for future generations where the water withdrawal rate from the ecosystem does not exceed the natural replacement rate.
- Conservation of energy
- Conservation of habitats by minimizing human water use.

2.2 WATER AUDITING

2.2.1 Review of Water Auditing Methods:

There are two basic and most prevalent water auditing techniques which are American Water Works Association (AWWA) method and International Water Auditing (IWA) method

2.2.1.1 American Water Works Association (AWWA) method :

The AWWA method is basically divided into the following tasks :

1. **Measuring the supply:** The water sources are identified and the water output is measured from each source.
2. **Measuring the Authorized metered use:** The metered locations are identified and the metered water uses are calculated.

3. **Measuring the Authorized Unmetered use:** The unmetered consumers are identified and the amount of water used by them is calculated. The uses could be composed of firefighting and training, flushing mains, storm sewers and sanitary sewers.
4. **Measure Water losses:** The volumes of water that does not fit in the above three categories are the loss in the system. These losses can include accounting errors, unauthorized connections, evaporation of stored water, reservoir overflows, leaks or losses due to malfunctioning of the system.

<table>
<tr><td rowspan="9">System Input</td><td rowspan="4">Authorised Use</td><td rowspan="2">Billed Authorised Use</td><td rowspan="2">Revenue Water</td><td>Billed Metered Consumption</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorised Use</td><td rowspan="7">Non Revenue Water</td><td>Unbilled Metered Use</td></tr>
<tr><td>Unbilled Unmetered Use</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Metering Inaccuracies</td></tr>
<tr><td>Unauthorized Use</td></tr>
<tr><td>Leakage on Mains</td></tr>
<tr><td rowspan="2">Real Losses</td><td>Overflow on Storages</td></tr>
<tr><td>Leakage on Service Connections</td></tr>
</table>

5. **Analyze Audit Results:** Audit result comprises of calculation of two quantities, which are potential water system leakage, i.e., difference between total water loss and all measured losses. The second quantity calculated is the recoverable leakage, which is half of all the potential leaks that can be discovered and repaired.

2.2.1.2 International Water Association (IWA) Audit Method :

The IWA method can be represented with the help of a water balance diagram in which each column is a different notation for describing the same volume of water at some point of the delivery cycle of utility system.

The aligned row totals the same volume of water. When we perform IWA audit, we quantify each entry .i.e. volume of water. The IWA auditing is a “bottom up” approach. This type of audit requires sorting the most basic information that is gathered by a utility which is billing records, leak reports, information gathered during field visits etc. It is a costly affair and takes a lot of time but is able to identify all losses and is a highly efficient method.

2.2.2 Case Studies

Water Audit of Nagpur Municipal Corporation households

Gonarkar *et al*. (R A Gonarkar, 2011) in his article, laid out the methodology of performing a water audit. The study included performing the water audit in five steps which included source evaluation, calculation of authorized consumption, evaluation of apparent losses, evaluation of real losses and measurement of performance. The source evaluation included surveying and measurement of the input given to the complete system. This was then followed by computation of authorized consumption by studying the billed metered consumption. Evaluation of apparent losses followed next, resulting from inaccuracies in water flow measurement, errors in water accounting and unauthorized usage. After this evaluation of real losses was laid in the methodology for finding out the amount of water that physically escaped from the system. The last step of auditing included measurement of the performance of the system by interpreting the information that has been collected.

Water Audit of Municipal Committee of Ahmedpur

Amol A Kulkarni *et al.* (2014), conducted a water audit at Ahmedpur, Maharashtra. The total demand of the municipal committee area was 4.04 million liters per day, including the losses of about 15 percent. The sources of water included the raw water from Limboti dam and Mannar reservoir. The study of water audit revealed that the losses in the system resulted from the leaks in the air valves in raw water rising mains and the overflow at the source. Most of the distribution pipelines were made up of GI or PVC materials were leaking. Water was being supplied to the consumer without being metered and the control usage was not looked upon effectively. Water rates were fixed on a flat rate basis for the consumers. The real losses accounted for 42 percent, while the non-revenue water accounted to 65 percent of the total. Thus, this water audit helped an insight into the water losses occurring in the area.

Water Audit of District metered area of South Bangalore

K.S. Renukumar *et al.* (2014) conducted a water audit for the distribution network of District metered area of South Bangalore in order to overcome shortage, leakage and losses of water. It was used to find out the amount of water ending up at different locations. All the water losses occurring in the system were found up through auditing. The avoidable losses like the real losses occurring due to the corroded pipes and faulty joints were hence minimized.

Water Audit of Yagachi reservoir supply

C.G. Shruthi *et al*. (2013) conducted a water audit for Chikmagalur water supply scheme for Yagachi reservoir. The main objectives of the audit were to draft a water balance chart by measuring the system input and the distribution system flow rates. All the water sources for the Yagachi reservoir were identified. Loss measurement and leak detection were carried on along the distribution line with the help of ultrasonic leak detection method. A comparison between existing water tariff rate and proposed water tariff rate were made. The Infrastructure Leak Index (ILI) was found out to be less than one, which represented that the system was well maintained.

Water Audit of brewery industry at Ghana

Kenneth Bedu Addo *et al.* (2013) conducted a water audit for the brewery industry in Ghana. The methodology was derived from United Nations Environmental Programme (UNEP), titled 'Environmental Management in Brewery Industry'. A three phase process involving pre audit work, auditing and post audit work were adopted. The first stage aimed to maximize the productivity of the audit team and minimize the time spent in the brewery. The audit composed of going through the company records, discharge, usage, source assessment and collection of waste water samples. Thus, after the study, the fresh water consumed was calculated and turned out to be 5,32,693 cumecs. The waste water was also accounted, which turned out to be 4,49,853 cumecs.

Water Audit of city of Kalol at Gujarat

Roshan Shah *et al*. (2009), conducted a water audit in the city of Kalol, Gujarat, in order to analyze the supply system and find out the leaks and losses in the distribution system. The audit involved finding out all the sources to the households and identifying the productive uses and the needless waste. The system input was found out to be 17.26 million liters per day, with a pumping capacity of 750 cumecs per hour with 17 hours of pumping. Next was to find out the various receiver capacities and discharges received on the usage end, thereby, finding out the leaks and losses in the distribution lines and further finding out ways to curb these losses.

Water Audit of consumers of Sydney Water Company

The Sydney Water Company conducted a program, named, “Every Drop Counts” between 2000 and 2002, involving more than 200,000 households in Australia. The program hired several certified plumbers, to check leaks and provide water audits and general water conservation advice to the households. Replacements of inefficient showerheads and installation of tap flow regulators and toilet cistern flush was done. Customers were charged $ 22 AUD per visit and the service was completely free of cost for people with low income. The program achieved savings of approximately 12 percent of estimated indoor water demand.

Water Audit of households of New York and Jordan Valley

The Toilet Retrofit programs in New York and Jordan Valley Conservation district showed a huge impact of toilet leakage on water saving potential. Under the New York City’s Toilet Rebate Program, at least 70 percent of the toilets in apartment buildings were found to be inadequate and required immediate replace. Nearly 50,000 apartment buildings participated and had their toilets replaced through the program. A check by Department of Environmental Protection showed a decline of losses by 37 percent. In a similar program conducted in Jordan Valley, the losses declined by about 30 percent due to a water audit conducted across all households of the valley.

<u>Study of Water utility companies and industries in Great Britain</u>

Thonton *et al*. (2002) conducted a study on impact of privatization of water utility companies, on the quantification of water losses throughout the Great Britain. The nation having experienced severe droughts in 1995 and 1996, lead to beginning of National Leakage Detection initiative with setting up of minimum leakage targets. After five years of employment of various leak detection techniques and conduction of nationwide audits, the losses dropped by 40 percent. The complete method consisted of the following:

- Completing annual water loss calculations for every utility system in the nation.
- Requiring a standard format (IWA method) for carrying out calculations, using performance indicators and confidence grading of data.
- Publishing water losses results, creating public accountability for the efforts.

<u>Water Audit of households of Philadelphia</u>

Kunken *et al.* (2002) conducted a water audit under by the Philadelphia Water Department (PWD). The water audit was conducted primarily to counter the huge leakage occurring in the water supply system and was of AWWA type. George Kunkel, of the PWD, became chair of AWWA Leak Detection and Water Accountability committee in 1998 and along with many international experts within a few years, was able to restore maximum amount of leakages in the system. PWD water audit according to the IWA methodology, determined that the utility experienced 94.7 MGD of non-revenue water. This quantity was further broken down to be equivalent to 18.6 MGD of apparent losses, 70.2 MGD of real losses and 5.9 MGD of authorized usage. These losses equated a financial loss of $ 16.7 million. The application of IWA to Philadelphia was important because it was the first time that this audit was used in North America. The IWA audit technology was further refined during the usage.

<u>Water Audit of households of Sao Paulo by a Sewer company</u>

De Freitas *et al*. (2002) conducted a water audit under the Sao Paulo Water and Sewer Company, which provides water and sewer services to the metropolitan region of Sao Paulo, which is inhabited by 17 million people. The audit was conducted according to the IWA methodology, which produced great benefits to the company. The first audit revealed that 14 percent of the apparent losses were occurring due to fraudulent practice of illicit connections. In order to stop these practices, the number of checks per month was increased, which resulted in mere 5 percent losses left. After the inspection strategy, SABESP began paying contractors based upon their quality of work and conducted repairs throughout the line, thereby increasing the overall efficiency of the system.

CHAPTER 3

MATERIALS AND METHODS

This chapter deals with the materials used and the various methodologies used for the study. The methods performed in order to obtain the water audit of the KCAET campus in chronological order is as follows:

3.1 SOURCE EVALUATION

Source evaluation is the first step in determining any water audit. It involves analyzing the different types of sources of water available and the amount of supply, these sources are giving to the distribution line. A system may own multiple wells, springs or surface water sources. The identification of the source of the system aims at a better understanding of the distribution line and thereby aids in performing the audit procedure.

For the college campus, there is a total of four wells available which supply water across the distribution line. There is an open well which operates throughout the year in all seasons, and three bore-wells, which primarily operate only during the summer season and remains inactive for most of the year.

The different water sources in the campus are mentioned below,

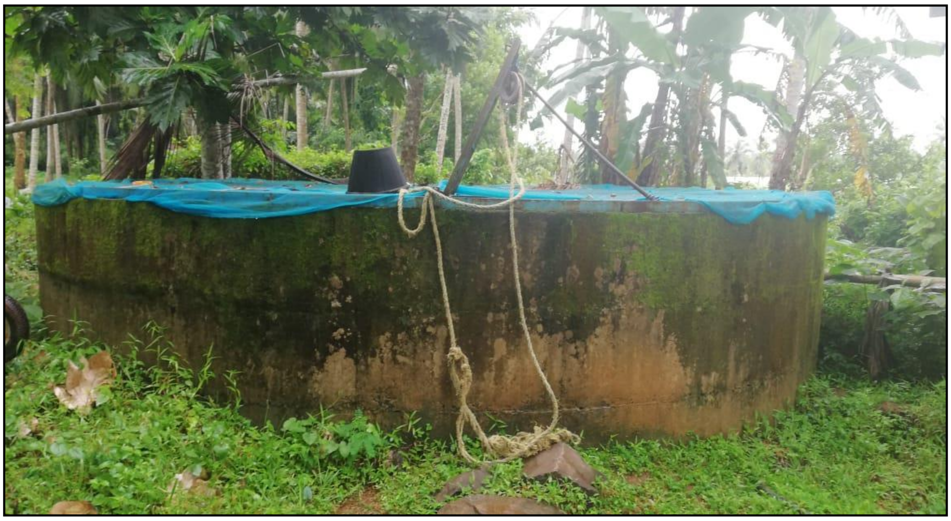

Fig. 3.1 Open well near farm office: 10.854934 N, 75.9858506 E

Fig. 3.2 Bore well with a submersible pump in coconut farm: 10.855970 N, 75.984573 E

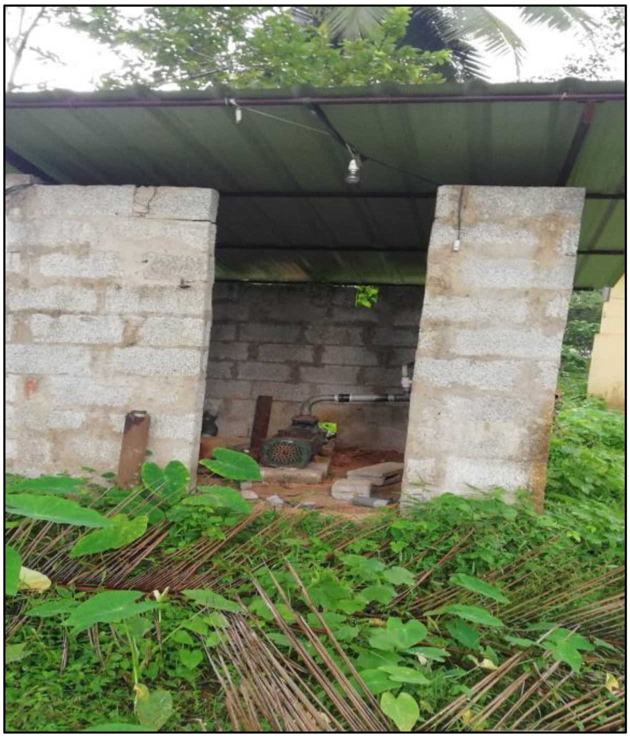

Fig 3.3 Bore well with centrifugal pump: 10.856614 N, 75.884458 E

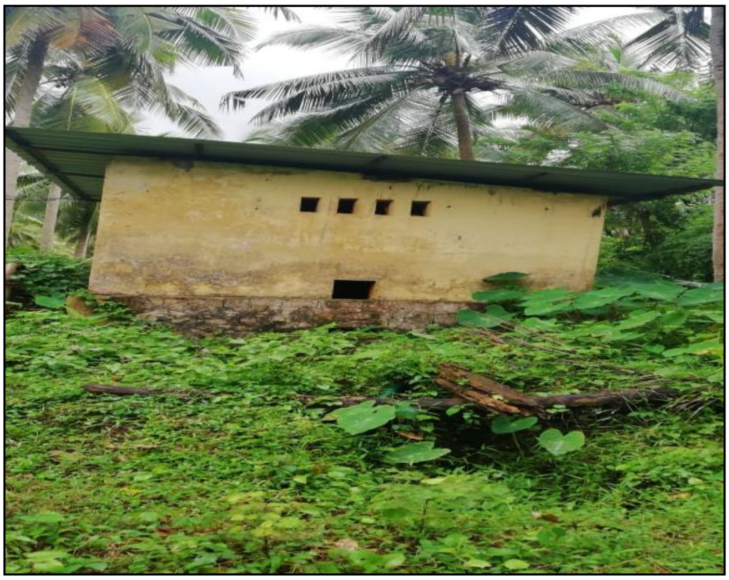

Fig. 3.4 Bore well with centrifugal pump: 10.856203 N, 75.984063 E

The open well, being operational for most of the time and the other wells yielding temporarily, the discharge of the open well was only taken as a relevant source.

3.2 MEASUREMENT OF SOURCE DISCHARGE

On observation of the distribution system in the campus, it was found that the source i.e., the open well water was pumped directly into the big overhead tank near the ladies' hostel. Due to the incapacity to install a metering system in the outlet of the open well pump, the elevation difference of the overhead tank was taken during pumping and no pumping in order to find out the discharge of the open well into the overhead tank.

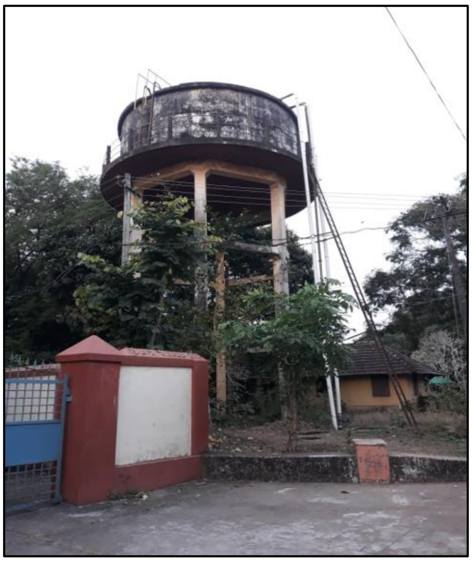

Fig. 3.5 Overhead tank near Ladies' Hostel

The discharge was found out with the help of float in the tank attached to a rope, the level difference was measured with the help of a scale which indicates the loss or gain in the level of water in the tank. The area of the water tank was found out from the records in the Engineering Division of the college. The level difference was noted down for a particular time period for a few days during pumping and no pumping, which indicated the supply and usage, and only during usage respectively. Multiple readings assured a nearly accurate average value. The respective discharge was obtained with the product of the level differences with area and further difference of the two discharges.

3.3 ANALYSIS OF THE DISTRIBUTION SYSTEM

The overhead tank being the main receiver of the source, all the connections in the campus received water from the overhead tank. Measurement of water received and utilized, required metering of all the receivers. The main receivers in the distribution system were canteen, ladies' hostel, men's hostel, Krishi Vigyan Kendra (KVK), the Precision Farming Development Centre (PFDC), polyhouses in farm, staff quarters and other residential quarters.

A total of six locations were selected for metering in order to obtain maximum information about the water usage. The locations were selected on the basis of,

- Ease of meter installation
- Maximization of distribution area covered by the meter
- Alterations in water pressure caused by installation
- Non feasibility of other methods than metering

3.4 METERING OF THE SELECTED DISTRIBUTION POINTS

Metering of the selected distribution points served as an effective discharge measuring system. There were a total of six 15mm, single jet meters installed.

The six locations selected for metering were,

3.4.1 Canteen

The canteen being a primary user of water, with more than 100 visitors per day on an average, stood as an effective meter installation site. The usage was primarily for cooking, drinking, sanitation and washing of utensils. The materials required for metering the supply to canteen were,

- A Class ‘B’ 15 mm single jet water meter
- Hacksaw
- Star-bond
- 1 to 0.5 inch reducer socket, 2 units
- PVC Pipe 8 gauge, 0.5 inch diameter
- 0.5 inch Female Threaded Adapter (FTA), 2 units

The water meter was installed behind the canteen in the main inlet pipe to the storage tank of the canteen. The water supply was turned off by closing the valve, while the metering installation proceeded. The inlet pipe to the main tank was cut, long enough to accommodate a meter and its side pipe extensions attached to the FTA and reducers. The meter extensions were bonded to the cut pipe with the help of star-bond and after a few minutes of drying up, the valve was turned on again.

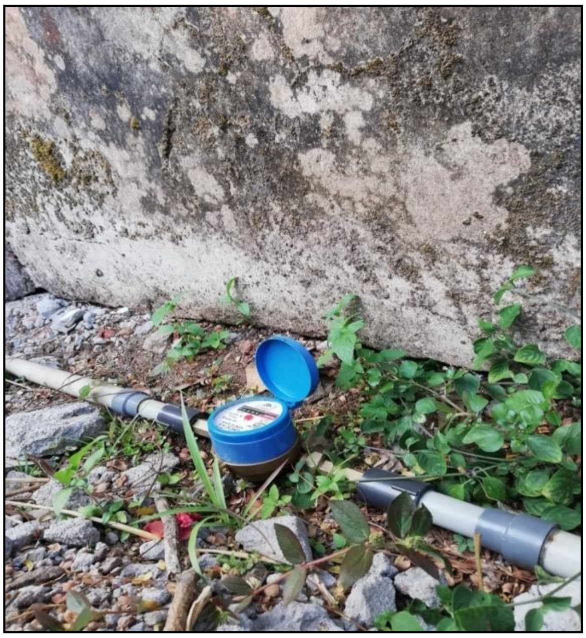

Fig. 3.6 Water meter at Canteen

3.4.2 Near Shade House at PFDC

The PFDC Shade House, located near the college gate, was a primary user of water, comprising of area of 70 x 12 sq. feet. The shade house being primarily used as a nursery, was irrigated by sprinkler and drip system. The metering of the shade house also ensured the estimation of usage of water in other poly and shade houses of the PFDC along with the sanitation and drinking requirements.

The materials required for metering the supply to the shade house were,

- A Class 'B' 15 mm single jet water meter
- Elbows of 1 inch diameter, 4 units
- Hacksaw
- Star-Bond
- 1 to 0.5 inch reducer, 4 units
- 0.5 inch Female Threaded Adapter (FTA), 2 units
- PVC pipe 8 gauge, 0.5 inch diameter

The pipe being very close to the ground level, installation of water meter in the shade house required the usage of elbows. The valves supplying water to the shade house were closed and the pipe was cut. The leaked water was drained out. The elbows were inserted and bonded with the help of star-bond. The water meter side extensions were fitted with the reducers and FTA. It was then adjusted according to the length of the cut portion and fitted with elbows. This was followed by insertion of the meter with its extensions into the elbows fixed along the cut portion. After a few minutes of drying up of the bond, the valve was turned on again.

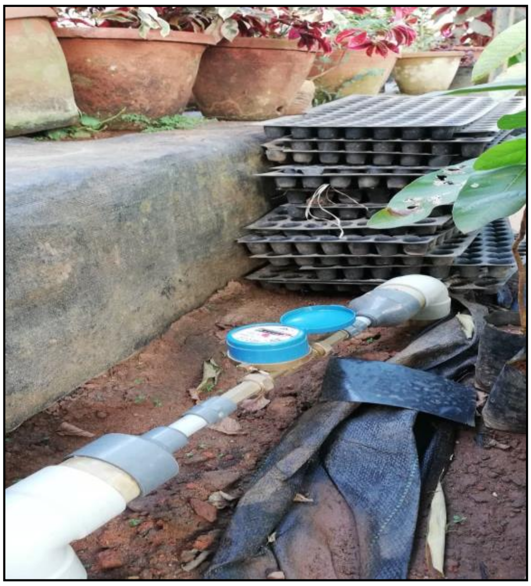

Fig. 3.7 Water Meter near Shade House of PFDC

3.4.3 KVK

The Krishi Vigyan Kendra (KVK) forms an important part of the college campus. Water is primarily used for growing various crops in the premises of KVK along with the drinking and sanitation requirements of the building. The meter was installed in the supply line, giving water to the KVK.

The materials used for metering the supply were:

- A Class 'B' 15 mm single jet water meter
- 40 mm Elbow, 4 units
- Hacksaw
- Star-Bond
- 40 mm to 20 mm reducer, 2 units
- PVC Pipe - 8 gauge
- 20 mm FTA, 2 units

The pipe being very close to the ground level, installation of water meter required the usage of elbows. The valves supplying water to the KVK were closed and the pipe was cut. The leaked water was drained out. The elbows were inserted and bonded with the help of star-bond. The water meter side extensions were fitted with the reducers and FTA. It was then adjusted according to the length of the cut portion and fitted with elbows. This was followed by insertion of the meter with its extensions into the elbows fixed along the cut portion. After a few minutes of drying up of the bond, the valve was turned on again.

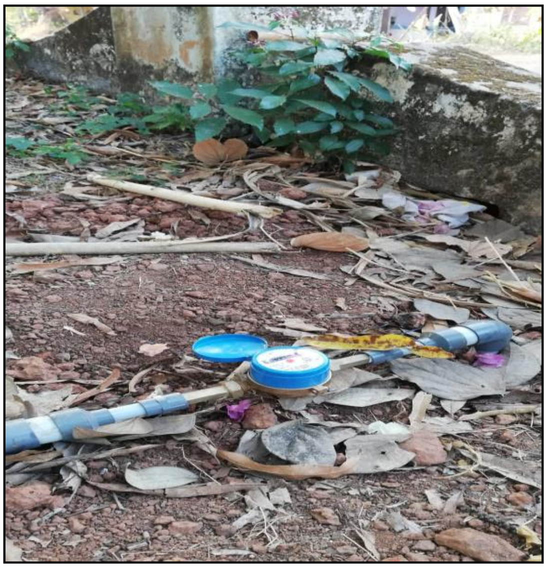

Fig. 3.8 Water Meter at KVK

3.4.4 Farm Nursery

The water supply to the farm is primarily used for irrigation of crops and dairy requirements. The shade houses and rain shelters at the farm, growing a variety of crops use the bulk of supply to the farm. Thus, a water meter was useful in determining the amount of water utilized by the nursery and dairy.

The materials used for metering the supply to the farm nursery were,

- A Class ‘B’ 15 mm single jet water meter
- 1 inch Elbows, 4 units
- 1 to 0.5 inch reducer, 3 units
- 0.5 inch FTA, 2 units
- PVC Pipe – 8 gauge, 0.5 inch diameter
- Hacksaw
- Star-bond

The pipe being very close to the ground level, installation of water meter required the usage of elbows. The valves supplying water to the poly houses were closed and the pipe was cut. The leaked water was drained out. The elbows were inserted and bonded with the help of star-bond. The water meter side extensions were fitted with the reducers and FTA. It was then adjusted according to the length of the cut portion and fitted with elbows. This was followed by insertion of the meter with its extensions into the elbows fixed along the cut portion. After a few minutes of drying up of the bond, the valve was turned on again.

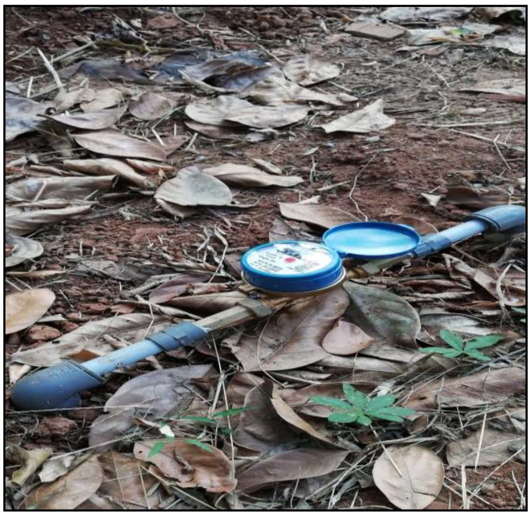

Fig. 3.9 Water Meter at Farm Nursery

3.4.5 Staff Duplex

The metering of the supply to the 3 staff houses besides the football ground was completed by installing a water meter in the supply line to the houses. The discharge measured at the 3 houses gave a rough estimate of the amount of water utilized by most of residential buildings in the campus. A water meter was installed in the supply line near the saw-tooth greenhouse.

The materials used for metering were,

- A Class ‘B’ 15 mm single jet water meter
- Elbows
- Hacksaw
- FTA
- Bush
- Star-bond
- PVC Pipe – 8 gauge

Fig. 3.10 Water Meter at Staff Duplex

The pipe being very close to the ground level, installation of water meter required the usage of elbows. The valves supplying water to the houses were closed and the pipe was cut. The water leaked was drained out. The elbows were inserted and bonded with the help of star-bond. The water meter side extensions were fitted with the reducers and FTA. It was then adjusted according to the length of the cut portion and fitted with elbows. This was followed by insertion of the meter with its extensions into the elbows fixed along the cut portion. After a few minutes of drying up of the bond, the valve was turned on again. Due to high pressure in the supply, a load was given on the pipe in order to prevent the meter to dissociate from the main pipe

3.4.6 Staff Apartments' Supply

There are a total of three buildings for the staff apartments. The metering of a single quarter in any building would help estimating the usage in all the other quarters. Thus, the supply to a single quarter in the central building was metered in order to estimate the water supply to all the apartments.

The materials used for metering were,

- A Class 'B' 15 mm single jet water meter
- Elbows
- Reducer
- FTA, 2 units
- 8 gauge PVC pipe
- Hacksaw
- Star-bond

The pipe being very close to the floor, installation of water meter required the usage of elbows. The valves supplying water to the apartment was closed and the pipe was cut. The elbows were inserted and bonded with the help of star-bond. The water meter side extensions were fitted with the reducers and FTA. It was then adjusted according to the length of the cut portion and fitted with elbows. This was followed by insertion of the meter with its extensions into the elbows fixed along the cut portion. After a few minutes of drying up of the bond, the valve was turned on again. Due to high pressure in the supply, a load was given on the pipe in order to prevent the meter to dissociate from the main pipe line.

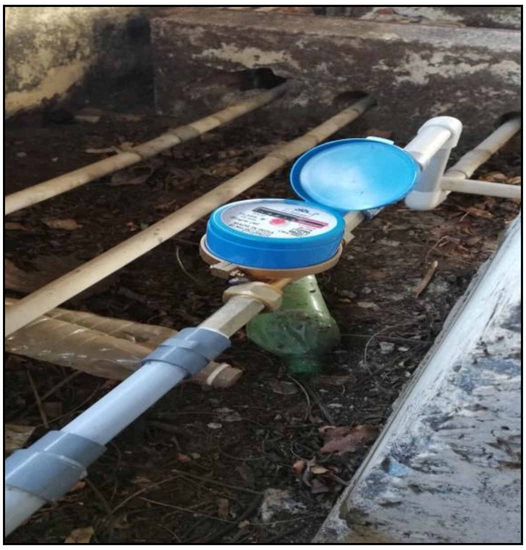

Fig. 3.11 Water Meter at Staff Apartment

3.5 CALCULATION OF THE ACTUAL WATER SUPPLY AND USE

Calculation of the actual water supply included the calculation of meter readings and estimated readings of identical points, along with the measurement of main supply. The procedure for calculation was as follows,

3.5.1 Calculation of the Main Supply

The main supply was calculated by measuring the fluctuations in supply of the main overhead tank during times of pumping and no pumping. The difference between the two gave the discharge of main pump into the overhead tank.

The overhead tank had a float connected to a hanging weight whose displacement (up or down), gave the depth of water pumped per unit time, into or out of the main tank. The area of the tank was found out with the help of records available at the engineering division of the college. The product of the area and change in water level, gave the total discharge into or out of the pump. The water that was pumped out gave the value of water supply to all the distribution points or receivers.

3.5.2 Calculation of Actual Water used at Distribution Points

The calculation of actual amount of water used at various distribution points was done with the help of meter readings, depth calculation method or by estimation of water usage with reference to the meter readings and compatibility of locations and conditions. The method of measurements at various distribution points was as follows,

3.5.2.1 Canteen

The water usage at the canteen was calculated with the help of readings taken from the meter. The readings were taken at the interval of 24 hours, at 5 pm for one month. The ratio between the consecutive day readings and the duration .i.e. 24 hours gave the value of discharge.

3.5.2.2 Men's Hostel

The water usage at men's hostel was calculated by the tank depth measurement method. There were a total of 4 tanks in the hostel with 2 tanks each in old and new hostel. The discharge was calculated by closing the valves of the tanks and measuring the fall in depth for a period of 1 hour. Readings were taken during morning and evening, with the average of all the readings calculated. The product of the readings and the area of the tank was taken, which gave the total volume of water used up. The ratio of the volume and time interval gave the value of water used per unit time.

3.5.2.3 Ladies' Hostel

The water usage at ladies' hostel was calculated by the tank depth measurement method. There were a total of 2 tanks in the hostel. The discharge was calculated by closing the valves of the tanks and measuring the fall in depth for a period of 1 hour. Readings were taken during morning and evening, with the average of all the readings calculated. The product of the readings and the area of the tank was taken, which gave the total volume of water used up. The ratio of the volume and time interval gave the value of water used per unit time.

3.5.2.4 KVK

The water usage at the KVK was calculated with the help of readings taken from the meter. The readings were taken at the interval of 24 hours, at 5 pm for one month. The ratio between the consecutive day readings and the duration .i.e. 24 hours gave the value of discharge to the KVK building and the KVK nursery and garden.

3.5.2.5 PFDC

The water usage at the PFDC was calculated with the help of readings taken from the meter. The readings were taken at the interval of 24 hours, at 5 pm for one month. The ratio between the consecutive day readings and the duration .i.e. 24 hours gave the value of discharge to the PFDC building, garden and the shade houses.

3.5.2.6 Farm Nursery and Dairy

The water usage at the farm was calculated with the help of readings taken from the meter. The readings were taken at the interval of 24 hours, at 5 pm for one month. The ratio between the consecutive day readings and the duration .i.e. 24 hours gave the value of discharge to the farm nursery and dairy.

3.5.2.7 Staff Apartments/Flats

The water usage at a single staff quarter was calculated with the help of readings taken from the meter. The readings were taken at the interval of 24 hours, at 5 pm for one month. The ratio between the consecutive day readings and the duration .i.e. 24 hours gave the value of discharge. The total usage of all the apartments was obtained by taking the product of the total number of apartments in all the three buildings and the value of discharge at one apartment. This included the assumption of almost same usage by all apartments.

There were a total of 6 apartments in a building which summed up to a total of 18 apartments in the campus, each of which was assumed to receive an equal discharge of water.

3.5.2.8 Staff Quarters

The water usage at two staff houses was calculated with the help of readings taken from the meter. The readings were taken at the interval of 24 hours, at 5 pm for one month. The ratio between the consecutive day readings and the duration .i.e. 24 hours gave the value of discharge. The total usage of all the houses was obtained by taking the product of the total number of staff houses in the campus and the value of discharge at the two houses and then dividing the result by 2. This included the assumption of almost same usage by all houses. There were a total of 13 occupied houses by the staff in the campus.

3.6 CALCULATION OF PER CAPITA AND TOTAL WATER REQUIREMENT

The per capita water requirement was calculated with the help of set standards by WHO, for domestic use and using estimated values for irrigation purposes and dairy. The total water requirements were obtained by multiplying the number of people in the distribution point, with the per capita water requirement for domestic purposes. For irrigation purposes, the total water requirement was obtained by multiplying the area of irrigation with the water requirement per area of the distribution point.

The total water requirement gave the ideal amount of water that needed to be pumped into the system and was calculated by following steps,

- Survey of the distribution points of campus
- Finding the number of people contributing to water usage at every distribution point
- Finding out the areas of irrigated distribution points like KVK, PFDC and farm.
- Finding out the number of animals in the farm dairy
- Finding out the standard values for domestic and irrigation uses
- Calculation of total water requirements with above data.

The standard values were obtained from the prescribed values of World Health Organization (WHO) and average irrigation requirements for shade houses and poly houses. The standard values of dairy were also obtained by per animal requirement values.

The standard values for domestic uses were as follows:

Table 3.1 Prescribed Water Requirement Standards

Type of Usage	Minimum water Requirement (lpcd)	Maximum water Requirement (lpcd)	Average water Requirement (lpcd)
Drinking	2	8	5
Sanitation	30	50	40

Cooking	2	6	4
Bathing	8	32	20
Washing clothes	10	30	20
Washing utensils	15	35	25

Average amount of water required for irrigation by drip systems in rain shelters and shade house was found out to be 1.5 mm per day on an average. For garden use, it was taken as 2 mm per day. For the farm dairy, average water requirement per animal was found out to be 135 liters per day, including the drinking and washing purpose.

Thus, the ideal water requirement for the campus was found out and a comparison was made between the actual water usage, ideal water requirement and the amount of water supplied.

CHAPTER 4

RESULTS AND DISCUSSION

Water is a basic nutrient of the human body and is critical to human life. It supports the digestion of food, adsorption, transportation and use of nutrients and the elimination of toxins and wastes from the body (Kleiner, 1999). Water is also essential for the preparation of foodstuffs and requirements for food preparation are included in the discussion of consumption requirements. Domestic water supplies are one of the fundamental requirements for human life. Without water, life cannot be sustained beyond a few days and the lack of access to adequate water supplies leads to the spread of disease. Children bear the greatest health burden associated with poor water and sanitation.

It is important to distinguish quantities of water required for domestic purposes (which primarily influence health and productivity), and quantities of water required for other purposes (such as agriculture, industry, commerce, transport, energy and recreation). Overall, the requirements for domestic supply typically constitute a very minor component of total water withdrawals (Gleick, 1993; 1996).

In the WHO Guidelines for Drinking-Water Quality, Guideline Values for chemical contaminants are based on the assumption of a 60 kg adult consuming 2 litres per day from drinking water, which would be equivalent to 3 litres per capita per day including food consumption (if the ratio cited by Kleiner were applied) as shown in Table 4.1. Where specific guidance is needed for vulnerable populations, a figure of 1 litre per day for a 10kg child or 0.75 litre per day for a 5kg child are used (WHO, 1993; p31).

Table 4.1 Daily fluid intake reference values in litres per capita (IPCS, 1994)

	Normal conditions	**High average temp.**	**Moderate activity**
Adults	1.0-2.4, average 1.9 (including milk); 1.4 (excluding milk)	2.8-3.4	3.7
Adult male	2	-	-
Adult female	1.4	-	-
Child (10 years)	1.0	-	-

To prepare rice using the adsorption method (i.e., only sufficient water to cook the rice is added), 1.6 litres is required for 600 g per capita per day.

More water may be required to ensure that other foodstuffs can be cooked, although defining minimum quantities is difficult as this depends on the nature of the food being prepared. For instance, Gleick (1996) suggests that on average 10 litres per capita per day is required for food preparation, whilst Thompson et al. (2001) show that in East Africa only 4.2 litres per capita per day were used for both drinking and cooking for households with a piped connection and even less (3.8 litres per capita per day) for households without a connection. Taking into account drinking needs, this suggests that between 1.5 and 2 litres per capita per day is used for cooking.

4.1 CALCULATION OF THE ACTUAL WATER SUPPLY AND USE

The water use by various users in the campus was estimated based on the standards given by World Health Organization (WHO) as given in Table 4.2.

Table 4.2 Per capita water requirement as per WHO

Litre per capita per day (lpcd) minimum, maximum and average water requirement as per World Health Organization (WHO) -			
Type of Usage	Minimum water requirement (lpcd)	Maximum water requirement (lpcd)	Average water requirement (lpcd)
Drinking	2	8	5
Cooking	2	6	4
Bathing	8	32	20
Sanitation	30	50	40
Washing of clothes	10	30	20
Washing of utensils	15	35	25
Average Per Capita Water Requirement Per Day (lpcd)			114
Minimum Per Capita Water Requirement Per Day (lpcd)			67
Maximum Per Capita Water Requirement Per Day (lpcd)			161

4.1.1 Calculation of the main supply

Average level difference in the Overhead tank between 11 pm and 4.30 am (in 5.5 hours) = 60 cm

Average level difference in the OH tank in 1 hr= 10.9 cm

Radius of the tank= 3.3m

Hence the discharge from the tank = Level difference x Area of tank

$= 0.109 \times 3.14 \times 3.3^2$

$= 3.73 m^3/hr = 3727.0\ l/hr$

Hence the discharge from the tank in 5.5 hrs (11 pm to 4.30 am) = 20500 *l*

From 11 pm to 4.30 am there will be less usage, so 70-80% of 20500 lpd can be accounted as losses from the OH tank.

If this loss occurs throughout the day= 89448 lpd x 0.75 = 67086 *l* will be lost.

OH tank level reading at 7.30 am (when pumping was stopped) = 22 cm

OH tank level reading at 9 am (just before the next pumping was started) = 60 cm

Level difference in 1.5 hr = 38 cm

Therefore level difference in 1 hr = 25.33 cm

Hence usage from the tank in = $0.25 \times 3.14 \times 3.3^2 = 8.5486\ m^3/hr$

= 8548.6 l/hr

If this usage occurs for 18 hrs a day, the water used per day = 153875 l/day

4.1.2 Calculation of discharge in men's hostel water tanks

No. of tanks = 4

Radius of the tank = 65cm

Area of the tank = $3.14 \times 0.65^2 = 1.327\ m^2$

Depth difference in first tank in 1hr = (56-8) = 48 cm

Hence the discharge from the tank in 1 hr = $0.63696\ m^3/hr$

= 636.96 l/hr

Depth difference in second tank in 1 hr = (60-10) = 50 cm

Discharge from the second tank in 1 hr = 1.327 x 0.50 = 663.5 l/hr

Depth difference in third tank in 1 hr = (55-9) = 46 cm

Discharge from the third tank = 610.42 l/hr

Depth difference in fourth tank = (62-14) = 48 cm

Discharge from the fourth tank in 1 hr = 636.96 l/hr

Total discharge from 4 tanks in one day = 2,547.84 x 24

= 61148.16 *l*

4.1.2.1 Estimation of water requirement

Number of Inmates of Men's Hostel = 101

Total Average Water Requirement in litre per day for Men's Hostel = 101 x 114

= 11514 *l*

4.1.3 Calculation of discharge in ladies hostel water tanks

No. of tanks = 2

Area of tank = 22.5 m^2

Depth difference in first tank in 1 hr = (110-88) = 22 cm

Discharge from the tank in 1 hr = 22.5 x 0.22 = 4.95m^3/hr

= 4950 l/hr

Depth difference in second tank in 1 hr = (108-84) =24 cm

Discharge from the tank in 1 hr = 5400 l/hr

Total discharge from the 2 tanks in one day = (4950 x 24) + (5400 x 24)

= 248400 lpd

4.1.3.1 Estimation of water requirement

No. of inmates in LH = 198

Average per capita water requirement per day = 114 *l*

Total Average Water Requirement in litre per day for Ladies' Hostel = 198 x 114

= 22572 *l*

4.1.4 Calculation of actual water used at distribution points

The water meter readings taken from the six water meters installed at various locations for a period of one month is given in table 4.3.

Table 4.3. Water meter readings taken from different locations

Date	Canteen	Duplex	Quarters	Farm Nursery	PFDC	KVK
28-Dec	23783	4556	347	19712	10898	45324
29-Dec	25927	5441	1056	22305	11663	45328
30-Dec	27428	6780	1356	24704	12961	52672
31-Dec	29768	7596	2119	26841	14589	54100
01-Jan	33111	10961	2295	30509	16325	55051
02-Jan	33235	13897	2807	33147	16910	59000
03-Jan	36214	16280	3538	36701	17400	62564
04-Jan	38181	18290	3927	40362	19174	67394
05-Jan	43479	20143	4220	42303	19765	77965
06-Jan	45470	23152	4510	45850	21325	79904
07-Jan	49131	25074	4780	48350	22441	79915
08-Jan	50163	27497	5240	49456	22600	85445
09-Jan	51426	30145	5526	50420	23045	89564
10-Jan	53790	32501	5856	55237	23777	92585
11-Jan	58164	34924	6203	59874	24676	96442
12-Jan	59832	35469	6685	62584	25369	98457
13-Jan	61112	36485	6954	64935	26800	99468
14-Jan	62178	38678	7124	66789	28058	108081
15-Jan	64582	40123	7356	69874	29784	109569
16-Jan	67032	41820	7756	72896	30189	112894
17-Jan	71367	42362	8123	74659	30985	116594
18-Jan	75968	43659	8457	78819	31418	119865
19-Jan	78820	45365	8745	81459	32164	121524
20-Jan	80457	49875	9023	84562	33896	131456
21-Jan	82850	53663	9375	l88915	35032	139420

22-Jan	87340	56367	9734	91199	35613	139427
23-Jan	92111	58284	10187	94567	36258	149242
24-Jan	97636	60252	10492	97935	36917	150862

4.1.4.1 Canteen

The water supplied to the canteen for 28 days was estimated to be 97,636 *l* as per the water meter fitted.

Water supplied to canteen = 3487 lpd

Estimation of water requirement

On an average about 100 people visit the canteen in a day.

Per capita requirement per day = (5+4+25) = 34 *l*.

Water requirement for 100 people = 3,400 lpd

Water supplied is 87 *l* more than water required.

4.1.4.2 Staff Duplex

The water is being supplied to 2 houses from the line where the second water meter was fitted.

The average amount of water supplied for 28 days = 60252 *l*

Water supplied per day = 2151.85 *l*

Calculation of water supplied to the entire houses

There are 15 houses in KCAET campus.

Amount of water supplied to one house = 1075.93 lpd

Therefore, total estimated water supply to 15 houses = 16138.93 *l*

Estimation of water requirement

Average per capita water requirement per day = 114 *l*

No. of residents in a house = 4 no.

Average water requirement per day per house = 456 *l*

Average water requirement for 15 houses = 6840 lpd

Water loss in supply line will be higher by 9298.93 lpd

4.1.4.3 Staff Flats

The water supplied to one flat in 28 days= 10,492 *l*

Water supplied to one flat per day = 374.7 *l*

Calculation of water supply for entire flats

Total no. of flats= 18

Total water supplied to 18 flats = 18 x 374.7 = 6,744.85 lpd

Estimation of water requirement

No. of residents in one flat = 3 no.

Total no. of residents = 54

Average per capita water requirement per day = 114 *l*

Water requirement per day = 114 x 54 = 6,156 *l*

Therefore water supplied is 588.85 *l* more than the water required.

4.1.4.4 Farm nursery and dairy

Total water supplied to Farm nursery during 28 days = 94,567 *l*

Water supplied to farm nursery per day= 3,377.4 *l*

Estimation of water requirement (Appendix I)

No. of workers in farm = 37

Average per capita requirement of workers = (2.5+20) = 22.5 *l*

Total water requirement for workers = 37 x 22.5 = 832.5 *l*

Average water requirement for irrigation per day in farm nursery = 220.449 *l*

Average water requirement per day at dairy = 2160 *l*

Total water requirement in farm nursery per day = 3212.95 *l*

Hence, the water supplied is 164.44 L more than the per day requirement.

4.1.4.5 PFDC Nursery

Total water supplied in PFDC for 28 days = 36,917 *l*

Water supplied to PFDC = 1,318.46 lpd

Estimation of water requirement (From Appendix II)

No. of PFDC and sales counter staff = 8

Average water requirement per day for building = 22.5 *l*

Average water requirement per day = 22.5 x 8 = 180 *l*

Average water requirement for irrigation in PFDC per day = 125 *l*

Average water requirement for irrigation of main garden = 200 *l*

No. of staff in Food Laboratory = 8

Average water requirement in Food Laboratory = 180 *l*

Total water requirement per day = 180+125+200+180 = 685 *l*

Water supplied will be more than requirement by 633.46 *l*

4.1.4.6 KVK

Total water supplied in KVK for 28 days = 150862 *l*

Water supplied in KVK = 5387.92 lpd

Estimation of water requirement (Appendix III)

Average water requirement for irrigation in KVK = 62.47 *l*

Average water requirement in building = 1350 *l*

Total water requirement per day = 1350 + 62.47 = 1412.47 *l*

In KVK there is a water loss of 3975.45 lpd

Table 4.4 Comparison of measured and estimated values at different locations

LOCATION	MEASURED VALUE (lpd)	ESTIMATED VALUE (lpd)
CANTEEN	3487.00	3400.00
DUPLEX	16138.93	6840.00
APARTMENT	6744.85	6156.00
FARM NURSERY	3377.40	3212.95

PFDC NURSERY	1318.46	685.00
KVK	5387.92	1412.47

From the table we can conclude that there is some variations in measured and estimated value at different locations. In canteen the measured value from water meter reading is 3487 l/day but estimated is 3400 l/day. Therefore there is an excess usage or loss of 87 l/day from the canteen. Whereas in the staff duplex, a large variation around 9298.93 l/day is seen. This implies that there is a greater loss of water or more usage than what is estimated in the duplex. In the case of apartment, not much of a difference is found and there is only a difference of 588.85 l/day. But in farm nursery the water wastage is 164.45 l/day. In PFDC nursery and KVK the water loss were 633.46 and 3975.45 l/day respectively when compared to the estimated water requirement.

4.1.4.7 Academic Block

Water meters could not be installed in the supply line of the academic block due to the pressure alterations that will be caused by them. Hence comparison of readings could not be done in this case.

But, we have estimated the average water supply to the academic block based on per capita water requirement.

Average water requirement per day per person according to WHO = 22.5 *l*

No. of people utilising the academic block water supply per day = 350

Average estimated water requirement in the academic block per day = 22.5 x 350

= 7,875 *l*.

No. of Engg. Division staff = 8

Average estimated water requirement at Engg. Division per day = 22.5 x 8 = 180 *l*

Total water requirement = 7875 + 180 = 8055 lpd

4.2 COMPARISON AND SUGGESTIONS

Table 4.5 Comparison of discharge of water from overhead tank and its usage at different locations

SOURCE	DISCHARGE (lpd)	DISTRIBUTION POINTS (lpd)	DISCHARGE (lpd)
Overhead Tank	153875	CANTEEN	**3487.00**
		DUPLEX	**16138.00**
		APARTMENT	**6744.85**
		FARM NURSERY	**3377.40**
		PFDC NURSERY	**1318.46**
		MH	**61148.40**
		KVK	**5387.92**
		ACADEMIC BLOCK	**8055.00**
TOTAL	153875	TOTAL	**105656.63**

By comparing the discharge coming from the overhead tank everyday with that reaching the different distribution points, it is found that there is a difference of about 50,000 *l*. This implies that a huge quantity of water is being lost every day or is unauthorisedly utilized by people for different purposes. This has to be seriously looked into by the authorities or we will have to face acute water shortage in the near future. We also found that during the time period of 5.5 hrs (from 11 pm to 4.30 pm), when there is not much usage of water, a loss of 20,500 *l* is occurring every day. This might also be a reason contributing to the difference in discharge and the water usage.

4.3 SUGGESTIONS TO MINIMISE LOSSES

4.3.1. Inspection of complete water distribution system to detect leakage

Leakage on main line can be calculated by taking the difference between the system supply and the discharge received by the main tank. The leakage and losses in the intermediary distribution lines can be similarly found out by subtracting the discharge of water received by all the small tanks in various buildings from the supply of main tank. The amount of effort needed to perform a leak detection survey depends heavily on the information available, such as system maps, inventory of pipes and fittings, and history of repairs.

4.3.2. Replacement of old fittings and joints

If the fittings and joints in the pipelines are too old, they have to be replaced in order to mitigate losses due to leakage.

4.3.3. Replacement of corroded pipes

If it is seen that the pipes are corroded, they have to be replaced immediately so that leakage losses are prevented.

4.3.4. Recycling the waste water for further use

Waste water, for instance the water used for washing the floors of the dairy barn, can be recycled and used again.

4.3.5. Spread awareness among workers, staff and students

This is important as if awareness is spread about the loss of water in our campus among all the people who are a part of it, losses due to over usage of water can be prevented to a great extent.

4.3.6. Close the outflow valves of the OH tank during the night time

It has been estimated that about 21000 *l* of water leaves the OH tank from 11 pm to 4.30 am when there is only little usage of water. The valves can be closed during this time period and opened again at the time of pumping in the morning.

CHAPTER 5

SUMMARY AND CONCLUSION

Water as we know is the most important entity required for the existence of life on the planet. Globalization and technological development have taken mankind leaps and bounds in most of the aspects but have also deteriorated the natural resources, essential for life, one of them being water. The project of water audit carried out in the Kelappaji College of Agricultural Engineering, Tavanur aims to counter the depleting water resources and ill usage of water by identification of the problems, leak points, losses, wastage and giving suggestions to minimize the same.

The evaluation of water sources which pumped water throughout the campus was the foremost step of the water audit of the campus. The source of water in the campus were mainly wells (both open and filter point wells) and there was no supply from outside. The evaluation of water sources helped in the identification of the heart of distribution system and helped learn the nature of supply in the campus. The open well was the major source of water, operational for most part of the year and pumped water into the overhead tank near the ladies' hostel. The Overhead tank supplies water to most of the distribution points in the campus including men's hostel, farm nursery and dairy, PFDC, KVK, academic block, staff quarters and apartments, except the ladies' hostel.

The water supply, usage and requirement were required to be measured at distribution points. The methods used were metering the supply and calculation of water usage by falling and increasing depth of water in storage tanks while pumping and no pumping. A total of six Class 'B' single jet, 15 mm water meters were used in order to meter the supply to canteen, KVK, PFDC, farm nursery and dairy, staff quarters and apartments. The readings of these water meters were taken at an interval of 24 hours, for a time period of 1 month. At other points like the ladies' and men's hostel and the overhead tank the difference in depths were noted during pumping and no pumping for a few days at time intervals of 1 hour, in order to obtain the discharge with the help of measured areas of the tanks. For finding out the ideal requirements at all the distribution points, the WHO standards for per capita were used for household supply, while the garden and irrigation use was measured by FAO standards per area.

The total supply to the distribution points of the overhead tank was calculated by measuring the difference in depth of the tank levels at pumping and no pumping and thereby calculating the volume. The supplies at men's and ladies' hostel were measured in the same way. The supply to rest of distribution points were measured with the help of meter readings obtained at a day's interval. For calculation of the total supply at places like apartments and houses where only one or two of them were metered, the discharge values were estimated by taking the total discharge as the product of the discharge a single point and the number of points. The per capita requirement was found out with the help of product of standard average usage with the number of people contributing to the usage at the distribution point. The irrigation and garden requirements were found out by product of the standard value with the area irrigated or watered. The dairy requirements were also found out similarly by taking the product of number of animals and the standard usage per animal.

The difference between the supply from overhead tank and sum of the usages at the distribution points, yielded the amount of water losses occurring per day, which amounted to 50000 *l* for one day, approximately. The comparison between the water required and the actual water used was also made at every distribution point. The canteen used about 100 *l* of more water per day. The water supplied to quarters exceeded the requirement by a whopping 9000 *l*. The apartments used an extra water of 600 *l* per day. The farm supply exceeded the requirement by 150 *l*, while the excess was 600 *l* and 4000 *l* for PFDC and KVK respectively.

The results depicted a bulk of water wasted by leaks or real losses and over usage of water at most of the distribution points. Methods like inspection, replacement and repairs of corroded pipes and ill fittings were suggested. Generating awareness to limit wastage of water at households and hostels were also suggested.

Water audit study is indeed a very efficient way towards water and thereby environment conservation by keeping a check on the losses incurred and finding out ways to minimize them. It can also help reduce the capital and operating costs of pumps as an added advantage. Thus, a water audit should be performed in almost all major water supply systems in order to conserve the most precious resource for mankind which is water.

CHAPTER 6
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APPENDIX I

Average water requirement as per World Health Oganization (WHO) for Farm dairy, building and nursery

Type of Usage	Minimum water requirement (lpcd)	Maximum water requirement (lpcd)	Average water requirement (lpcd)
Drinking	1	4	2.5
Sanitation	15	25	20
Average depth per day required by plants in shade houses and rain shelters m/day		0.0015	
Average water requirement for dairy for drinking and washing in liters/cow		135	
Average water requirement for pot farming in m/day		0.0015	
Average Water Requirement per day (lpcd) for building		22.5	
Minimum Water Requirement per day (lpcd) for building		16	
Maximum Water Requirement per day (lpcd) for building		29	
Number of workers in building premises		37	
Number of cows in dairy (cows+(calves/2))		16	
Area under pot farming		74.32	
Area irrigated under 1^{st} shade house (sq.m)		23.225	
Area irrigated under 2^{nd} shade house (sq.m)		8.545	
Area irrigated under 1st rain shelter (sq.m)		14.864	
Area irrigated under 2nd rain shelter (sq.m)		23.225	
Area irrigated under low tunnel		2.787	
Average water requirement per day in liters at building		832.5	
Average water requirement for irrigation in farm nursery		220.449	
Average water requirement at dairy		2160	

APPENDIX II

Average water requirement as per World Health Oganization (WHO) for PFDC, Food lab, Engg. Division and academic block

Type of Usage	Minimum water requirement (lpcd)	Maximum water requirement (lpcd)	Average water requirement (lpcd)
Drinking	1	4	2.5
Sanitation	15	25	20
Average depth per day required by plants in shade houses and rain shelters m/day		0.0015	
Average depth per day for garden irrigation in m/day		0.002	
Average Water Requirement per day (lpcd) for building		22.5	
Minimum Water Requirement per day (lpcd) for building		16	
Maximum Water Requirement per day (lpcd) for building		29	
Number of PFDC and sales counter staff		8	
Number of people utilizing academic block water supply		350	
Number of Engineering division staff		8	
Number of Food lab staff		8	
Area under PFDC garden in sq.m		25	
Area under Academic block garden		100	
Area irrigated under PFDC shade house		50	
Average water requirement per day in liters at PFDC building		180	
Average water requirement for irrigation in PFDC in liters		125	
Average water requirement per day in liters at Academic block		7875	
Average water requirement for irrigation of main garden		200	
Average water requirement at Engg. Division		180	
Average water requirement at Food Laboratory		180	

APPENDIX III

Average water requirement as per World Health Oganization (WHO) for KVK

Type of Usage	Minimum water requirement (lpcd)	Maximum water requirement (lpcd)	Average water requirement (lpcd)
Drinking	1	4	2.5
Sanitation	15	25	20
Average depth per day required by plants in shade houses and rain shelters m/day		0.0015	
Average depth per day for garden irrigation in m/day		0.002	
Average Water Requirement per day (lpcd) for building		22.5	
Minimum Water Requirement per day (lpcd) for building		16	
Maximum Water Requirement per day (lpcd) for building		29	
Number of staff members		25	
Number of KVK workers		35	
Area under garden in sq.m		9.29	
Area irrigated under 1st shade house		14.21	
Area irrigated under 2nd shade house		5.3	
Area irrigated under rain shelter		9.75	
Average water requirement per day in liters at building		1350	
Average water requirement for irrigation in KVK in liters		62.47	

*Only 50 percent of mentioned requirements are taken due to operational time limited to 8-9 hours.

INTRODUCTION

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RESULTS AND DISCUSSION

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APPENDICES

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ABSTRACT OF PROJECT REPORT

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ABSTRACT

The project of water audit carried out in the Kelappaji College of Agricultural Engineering, Tavanur aims to counter the depleting water resources and ill usage of water by identification of the problems, leak points, losses, wastage and giving suggestions to minimize the same. The evaluation of water sources which pumped water throughout the campus was the foremost step of the water audit of the campus and then water meters were installed at suitable distribution points to measure the usage. Water meter indicates the measured value of water usage at that particular location. The readings of these water meters were taken at an interval of 24 hours, for a time period of 1 month. At the same time estimated value of water usage is calculated by using the standards specified by WHO. A comparison of the measured and estimated values was done to get the losses. Also the discharge from the overhead tank was compared with the water usage at different locations and the wastage of water from overhead tank was calculated. The results depicted a bulk of water wasted by leaks or real losses and over usage of water at most of the distribution points. Some suggestions to curb these losses are inspection of complete water distribution system to detect leakage, replacement of old fittings and joints as well as replacement of corroded pipes, generating awareness to limit wastage of water at households and hostels etc.