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Comparison Review of Methods of Water Distribution System For Efficient Water Supply

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ABSTRACT

As far as human history is concerned, man has tried to live near water sources for easy access. Following population growth, however, the residence of all near the water source became increasingly difficult, and eventually man began to live at a distance from water sources. Systems designed to supply water efficiently while meeting demand at adequate pressures are designed with the objective of minimizing the cost of water distribution. The main challenge is the lack of a reliable tool to predict zones of low pressure and contamination in water supply systems during daily operations. Pressure drops, leakages and contaminants can occur during water supply system operation. The purpose of this study is to understand the water distribution system's operations in relation to its pressure variations from the treatment plant to the consumer points. There is an explanation of the causes of water scarcity and its impact on various aspects of life in this paper, as well as a clarification of how geographic information systems can be used effectively to help in the management of this problem.

Keywords: Distribution System, Pipe Network, Pressure, Discharge, Efficiency.

1. INTRODUCTION

Living systems rely on water for survival, and this is why it is a key element of a country's socioeconomic progress. In the supply of water for both domestic and industrial use, a water distribution system plays a crucial role. A hydraulic component provides water access to consumers, such as pipes, valves, pumps, and tanks. Designing such systems involves numerous interrelated factors that must be taken into account during the design process. Minimum pressure requirements, Water demand, topography; Economics, system reliability, piping, energy efficiency, and pumping are all important design parameters. A primary goal of all engineers in charge of water distribution systems is delivering water at the correct pressure and in the right quantity. Water distribution systems typically degrade as they age, leaving them less able to deliver water, and the demands on them are increasing. In addition to the inadequate performance of a deteriorating network, there is the direct economic consequence of a failing system.

Two major types of water distribution systems exist: (i) Intermittent System: This system delivers water at periodic intervals throughout the day. Because of some negative pressure, the water quality is not as good as if there was continuous water supply. A few hours of water supply can occur in the morning or in the evening. A contaminated ground water may enter the distribution system through this system, posing significant health risks, (ii) Continuous system: There is no ground water contamination in the pipelines even if there are small leaks in the distribution system. Because the distribution system is continuously pressurized, contaminated ground water cannot enter the pipelines.

In order to maintain and operate existing water distribution systems properly, inspection, control, and planned maintenance and rehabilitation programs are required. Water distribution system reliability is not yet evaluated in a convenient way. The intended street plan and topography have traditionally been used to develop a water distribution network. The modeler models network flows and pressures, as well as flows into and out of the tank for crucial loading, using commercial software.

Water utilities' main job is to distribute the needed amount of water to individual consumers through a distribution network at a proper pressure. In both quantitative and qualitative terms, distributing drinking water in distribution networks is a technical difficulty. Each location in the distribution network must be provided with a constant flow of water that meets all qualitative and quantitative requirements. Water is only available for a few hours each day in most Indian cities, the pressure is inconsistent, and the water is of poor quality. Indian households face financial and health expenditures as a result of intermittent water availability, low pressure, and unpredictability (Bhave et. al, 1983).

2. OBJECTIVES

As per the study till now, which Water Distribution System is better to use on Local Level and Domestic Level with effective use of Water Cycle in the System.

TYPICAL WATER SUPPLY SYSTEM

Piped Water Supply System			
Source	**Treatment**	**Storage**	**Distribution**
Distant &Local	Local and raw bulk water treatment (primary/secondary)	Primary & Secondary storage	Gravity & Pumped
Ground Well Hand-pump Tube well	Primary Screening & Sedimentation	Elevated Surface Storage	Pipe/Tap
Surface River Rain Water Pond	Filtration-Sand & gravel	Ground Storage	Pipe & Support Post
Bulk Water Purchase Treated Raw	Chlorination-disinfection	Storage beneath the ground	Bottle & Tank

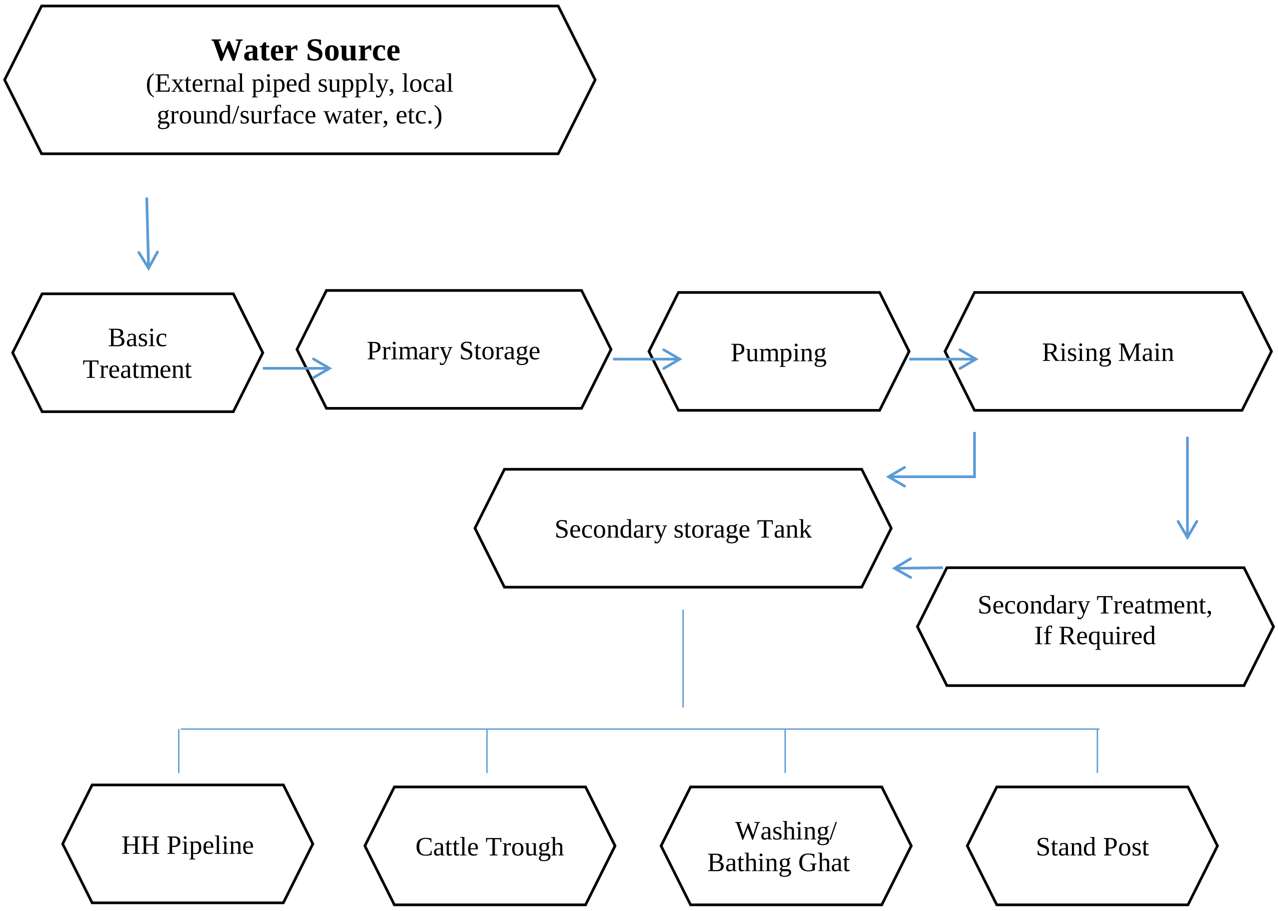

Fig.1: Typical water supply system in the Village/Town and flow chart

Sources	Water supply options include open wells, tube wells, hand pumps, ponds, dam sites, external pipes, and rainwater harvesting systems
Town-level/Village Treatment	Water treatment systems include reverse osmosis, chlorination, sedimentation and sand filtration.
Storage	Ground Service Reservoirs (GSR), Elevated Surface Reservoirs (ESR), Sump.
Distribution	Primary Water Line, Sub-Primary Water Line, Branch Pipe Line, Household Level Tape Stand Post, and Washing Unit.

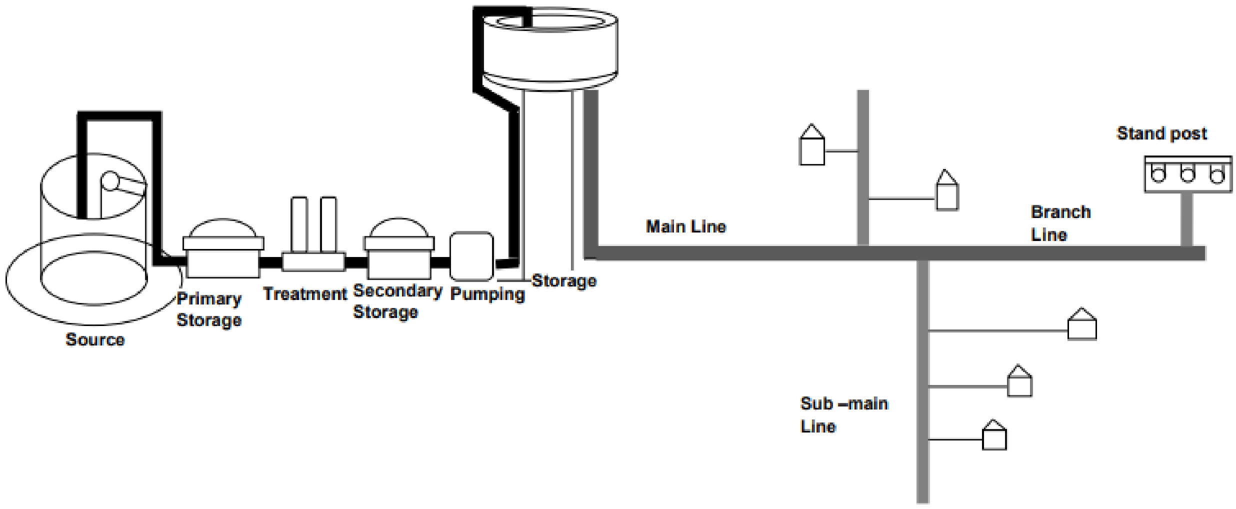

Fig.2 Basic Diagram of Flow of water

3. LITERATURE REVIEW

Using piped networks is one strategy to remove the hurdles to greater water access around the world. A piped, gravity-fed water distribution system may be a reasonably cost-efficient solution for assembly the objective of offering get admission to secure water in many rural regions in which mechanical electricity is inaccessible or impracticable to acquire. Because of its excessive reliance on topography, gravity-fed water distribution systems are capable of supply water at once to the supply of demand which includes homes, faculties or different accumulating locations. These systems are generally network-managed, techniques had been developed to assess the sustainability of such systems (Schweitzer, 2009; Suzuki, 2010;Schweitzer, 2012).

The maximum essential elements of a gravity fed water distribution system(WDS) are a water supply, which could be spring or river (Fig.3), a conduction line or a storage tank (Fig.3), a tap stands and a distribution line (Fig.5). Branched or looped networks can be used to connect distribution lines downstream from the water storage tank. While water traveling in a branched network is restricted to a single path, it may access a tap through multiple paths in a looped network. Looped networks may pose more difficulties in terms of predicting flow rate and pressure throughout, but provide the benefit of resuming service even when damage occurs upstream (Mihelcic, 2009).

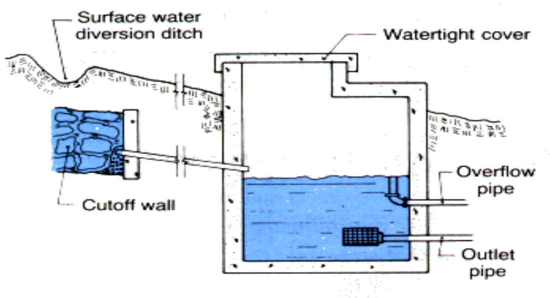

Fig.3: Cut-away view of a Concentrated Spring

(Source:- p2infohouse.org/ref/01/00076.htm)

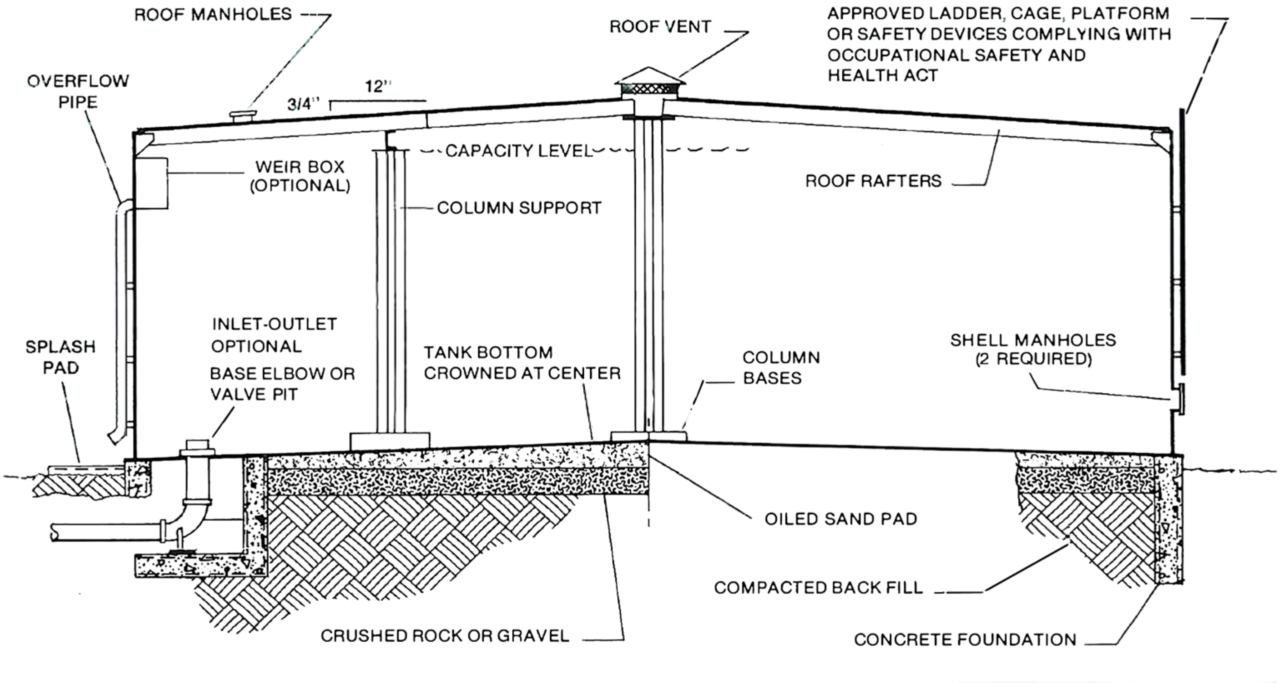

Fig.4: A Typical Storage tank

(Source:- steeltank.com/Products/FieldErectedTanks/SteelWaterStorageTanksASelectionGuide/tabid/853/Default.aspx)

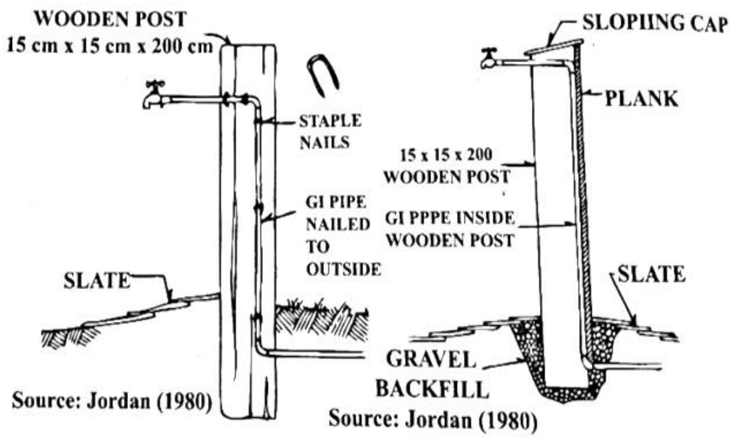

Fig. 5: Tap Stand

(Source:- slideshare.net/YogeshSN3/valve-and-fittings)

To overcome any friction and tiny losses in the transmission line, the water must be able to flow freely, there needs to be enough head between the source and the tank. A similar situation applies to the pipe between the tank and the faucet.

Many gravity-fed water distribution systems necessitate the addition of specific components in order to overcome potential water delivery challenges. Break-pressure tanks, for example, may be required to overcome high gains in head in order to avoid pipe ruptures due to excessive pressure, clean-out or air release valves may be used to prevent sediment or air blockage in pipes, and settling tanks or filter systems may be used for water sources with significant sediment (such as creeks or rivers). Furthermore, incorporating some form of disinfection device, such as a chlorinator, into a community to improve the quality of the drinking water is commonly recommended. (Orner, 2011; Orner et al, 2017). One of the many advantages of a system like the one described above is the simple maintenance techniques and materials necessary for future repair and upgrades. Because there are no mechanical or electrical components in this system, the most difficult problems that a community may face are pipe, tank, or clogged pipes and valves. To fix these, all you need is to learn how to cut and glue PVC parts together. In Pumping system, water is supplied via continuous pumping. Treated water is routed straight into the distribution main at steady pressure, with no intermediate storage. The supply can be disturbed if there is a power outage or a pump failure. As a result, in addition to electrical pumps, diesel pumps must be maintained. Only in cases when there is a consistent power source, a steady water supply, and an intermediate storage system cannot be established can such a system work.

A pumping system is often designed to meet the network's highest demands, therefore the maximum demand flow (Q_{max}) and maximum total dynamic head required (H_{max}) are used to meet the network's demand flow and pressure needs. The total dynamic head is defined as the entire equivalent head to be pumped, which includes the suction head, the static head, the head losses caused by pipe system friction, and the node pressure necessary. However, there are numerous methods for determining the number of pumps required at a pumping station. The operation of pumping stations accounts for a large portion of the energy consumed by metropolitan water networks. Pump stations use 20% of the world's electricity. Pumping energy expenses account for over 95% of total energy consumption in water networks, while operational costs account for 90% of the entire cost of the pumps' cycle life.

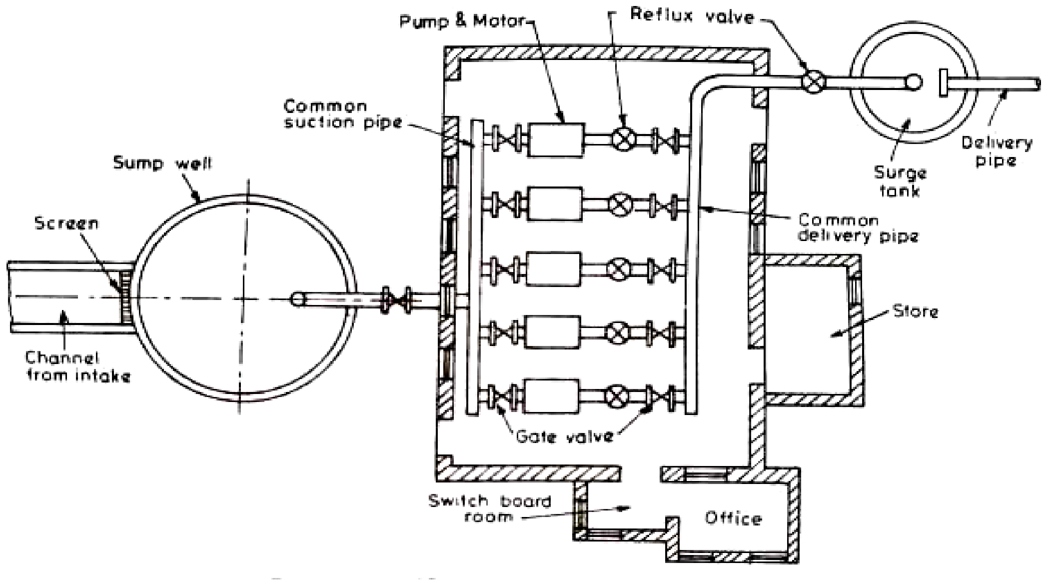

Fig.6: A typical view of Pumping Station of Pumping System

(Source:- https://theconstructor.org/environmental-engg/water-supply/pumping-stations-in-a-water-distribution-system/79506/)

As you can see (Fig.6) high pressure pumps and Motors are use in pumping system for providing constant flow of the water around the system without any inconvenience to the consumer and it takes lot energy to run the whole system. Simultaneously it increase the running cost of the system. So, now days Photovoltaic (PV) pumping system in use for reducing the cost through Renewable Energy and This System is not recommend highly because in long run it'll cost you high.

There are many people working on the optimization of the pumping cost and the majority of studies on pumping optimization in water supply systems concentrated on optimizing pump scheduling with fixed speed pumps (FSPs) to reduce operation costs. Pump scheduling optimization is a procedure that begins with a pump model and a predetermined number of pumps. The challenge therefore entails choosing a number of pumps to operate in a pumping station and determining the current state of the pumps (switch on/off) at each time interval. This collection of pumps must meet objectives such as reducing the amount of electric energy used and meeting the demands of the water network.

The SPVWPS (Solar Photovoltaic Water Pumping System) is a great alternative to electric and diesel water pumps. The SPVWPS saves money over time as compared to diesel, gasoline, or electricity-based pumps. The photovoltaic cell system, which uses the photovoltaic effect to convert sunlight directly into electric energy, is a helpful and long-term solution to the world's energy and environmental challenges. Using this green energy technology for water pumping is the key to assuring energy, water, and environmental security. Because water is the fundamental source of agricultural output, a combination of solar energy and water pumps could be very useful. Pumps and storage reservoirs are used in a combined gravity and pumping system. Pumped and store treated water in an elevated distribution reservoir. The treated water is then delivered to the user using gravity. The reservoir holds excess water during low demand periods and supplies water during peak demand seasons. This technique is quite widespread since it is productive, cost-effective, and dependable. Where there are changes in topography in a town/village, such methods are used. The minimum residual pressure in a distribution system for a single-story building should be 7m, 12m for a two-story building, and 17m for a three-story building. In this system water is mainly water supply through two types i.e., One-way system (In this system, water is pumped to an elevated reservoir and then gravity feeds it to the customers.) As shown in Fig.7, the distribution network is connected to an elevated reservoir but not to direct distribution pumps. and a two-way communication system (In this system, separate pumps are provided for direct distribution and elevated reservoirs, with the elevated reservoir serving as a backup in the event of an emergency, power outage, or other occurrence.). The majority of the time, a one-way method is used.

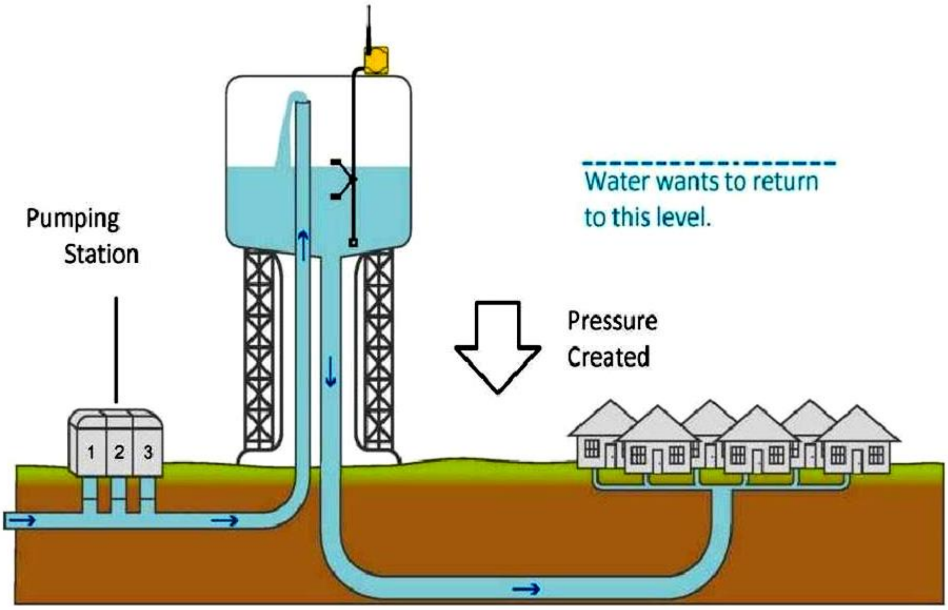

Fig.7: One way System

(Source:- dreamcivil.com/water-distribution-system/)

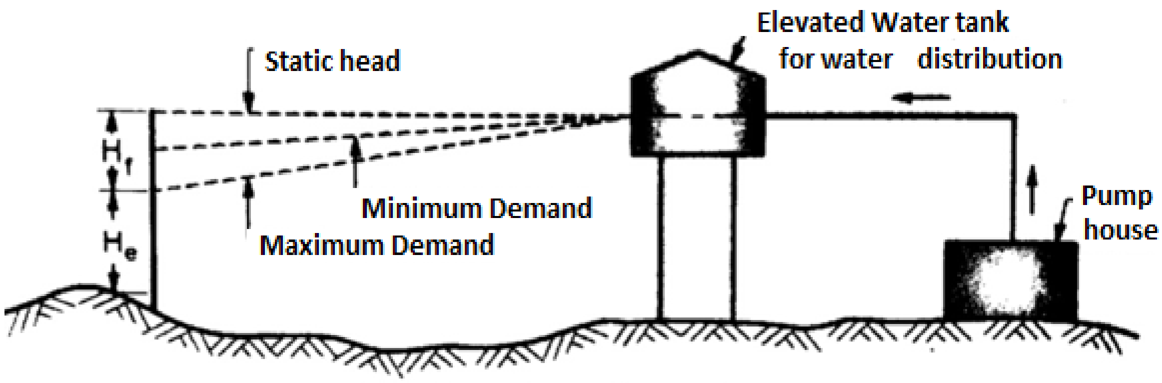

Fig.8: Combined Distribution System

(Source:- ques10.com/p/31994/classification-of-water-distribution-system-1/)

- Some Components used in combined water distribution System

1. Underground storage reservoir or covered finished water reservoir
2. Surface reservoir (ground storage tank)
3. Water Tower
4. Stand pipe
5. Pumps
6. Sumps

4. COMPARISON OF WATER DISTRIBUTION SYSTEM ON THE BASIS OF EFFICIENCY AND

Gravity System	Pumping System	Combined System
In this system, gravity is used to transport water from a high-level supply to low-level zone consumers.	The cleaned water is delivered straight into distribution mains rather than being kept in high-level reservoirs. A high-lift pump is used to force water into the mains.	According to the supply hours, water is pumped and stored in the elevated services reservoir (ESR) to give water to the public by gravity in this system.
The service reservoir and low-level zone should be adequate to generate appropriate pressure at the consumer's tap. The strategy also cuts down on waste and leaks.	The water supply to the town may be disrupted if the pump and electric supply fail. To minimize this, it is preferable to install some diesel-powered pump units.	Water is supplied even if the pump and power go out.
Pumping is no longer necessary. The approach is cost-effective, dependable, and low-maintenance. The difference in head availability between the two heads is required for effective system operation.	The pumps must run at varying speeds throughout the day since the water level varies during the day. The flow must be regulated by only running the needed number of pumps out of the total number of pumps installed, which necessitates a constant presence at the pumping station.	Pumping at constant rate increases efficiency in the system due to constant pressure in the storage double force act there i.e., Gravity and Mechanical force.
If the source is not at a sufficient elevation to generate gravity flow, it is not acceptable because it can’t generate enough pressure to high water supply.	This System is not economical as compare to others because it has high maintenance cost with high initial cost and it require special supervision.	It doesn’t require special supervision that’s why this system mostly prefers for Water Distribution System because it’s less economical also.

Table 1: Efficiency Comparison

5. RESULT

There are Systems that runs indefinitely. A continuous water delivery system is the best way to ensure that the community has access to water at all times of the day. A sufficient volume of water is always available for consumers to use as well as for emergencies such as firefighting in this system.

6. CONCLUSION

-The system must be cost-effective to maintain and run.

-All customers should have access to enough water.

-During an emergency, such as firefighting, it should be able to draw adequate water.

-The system should be completely impermeable, with as little leakage as feasible.

-During the distribution, any form of water pollution should be avoided.

-It should be kept as far away from the sewer lines as feasible.

-The pressure in the system should be enough, but not so high that pipes and fittings may rupture.

-The distribution system should be set up in such a way that water is available even when repairs and maintenance are being performed.

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