Building services
(Cold-Hot water & supply system)

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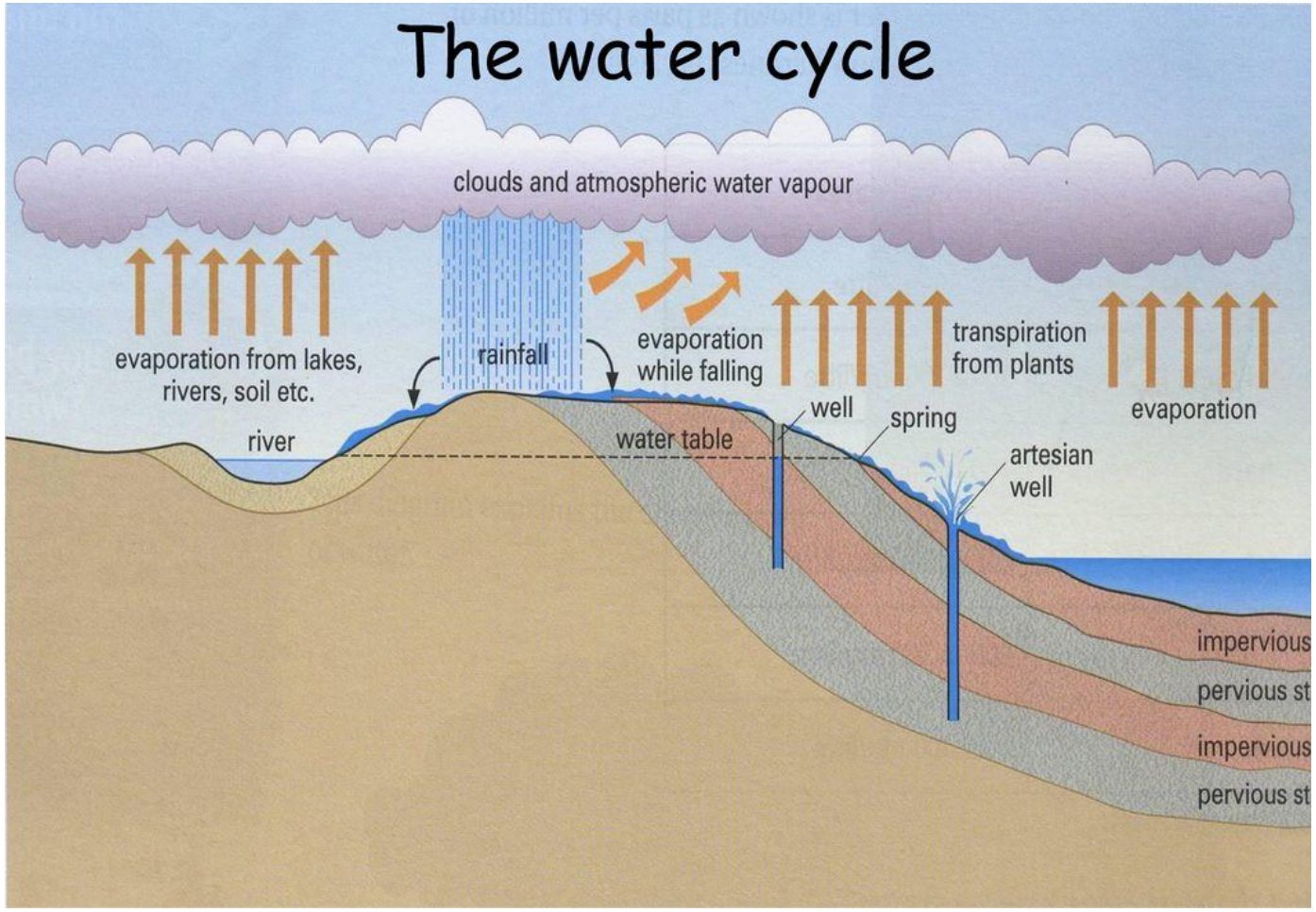
Sources of water supply

Surface sources : Lakes, streams, rivers, reservoirs, run off from roofs and paved areas.

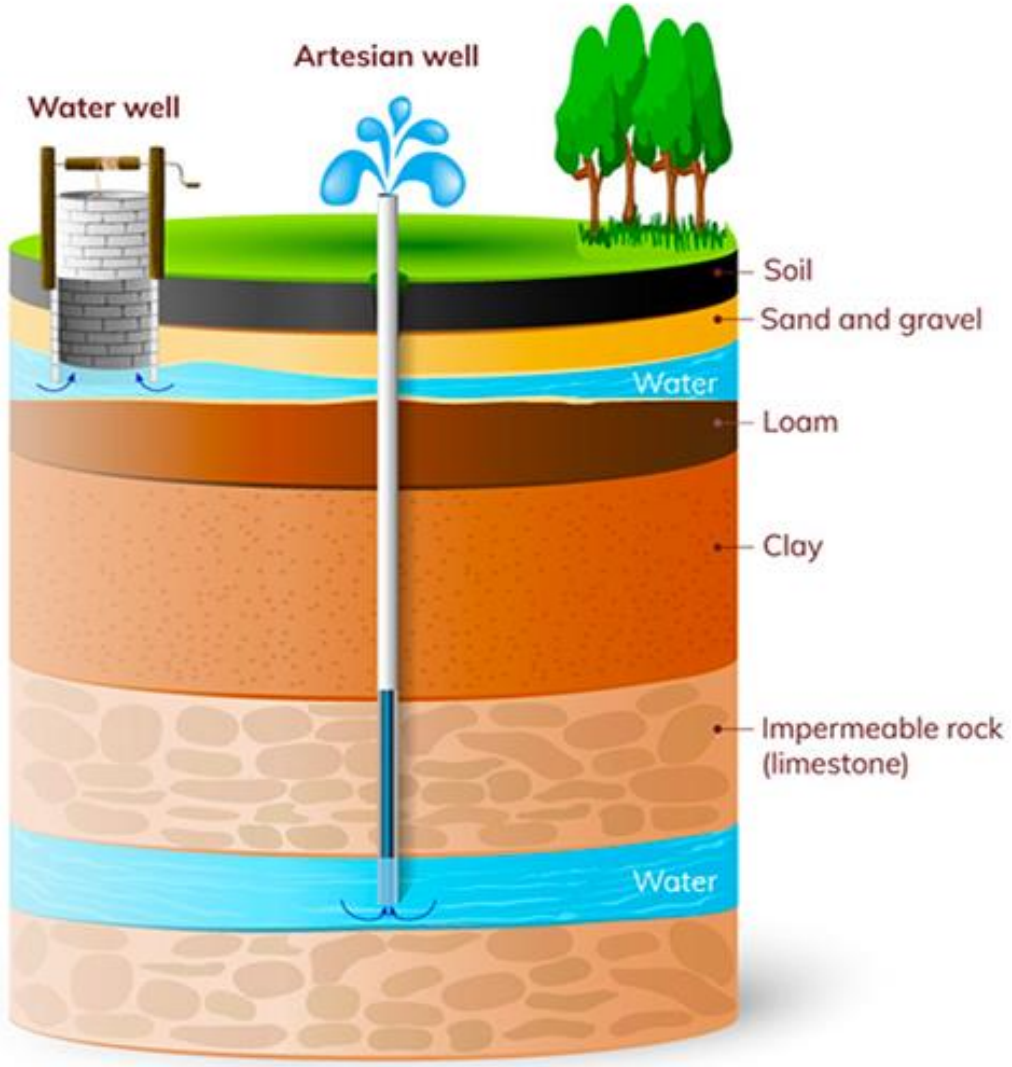
Underground sources: Shallow wells, deep wells, artesian wells, artesian springs, land springs



Sources of water supply

Water well: well is a hole drilled into the ground to access water contained in an aquifer. A pipe and a pump are used to pull water out of the ground, and a screen filters out unwanted particles that could clog the pipe.

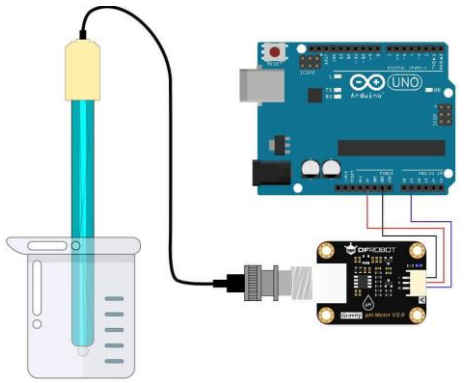
Artesian well: An artesian well is a well that brings groundwater to the surface without pumping because it is under pressure within a body of rock and/or sediment known



Acidity and Alkalinity in Water

Acid: a substance containing hydrogen which can be replaced by other elements. Litmus paper in the presence of acidic water turns red.

Alkali: a substance which will neutralise acid by accepting its hydrogen ions (H+). Litmus paper in the presence of alkaline water turns blue. More accurate definitions can be obtained by using hydrochemical electric metres.



These measure the amount of hydrogen ions (H+) in a relative proportion of water. This measure of acidity or alkalinity in solution is referred to numerically from 0-14 as the pH value.

pH < 7 indicates acidity

pH > 7 indicates alkalinity

pH = 7 chemically pure

Acidity and Alkalinity in Water

Rainwater: contaminated by suspended impurities as it falls through the air. These impurities are principally carbon dioxide, sulphur and nitrous oxides originating from domestic flue gases and industrial manufacturing processes. The mixture of these impurities and rainfall produce `acid rain', an occurrence frequently blamed for the destruction of plant life.

Surface and substrata water sources: contaminated by dissolved inorganic materials such as calcium, magnesium and sodium. These are responsible for water hardness

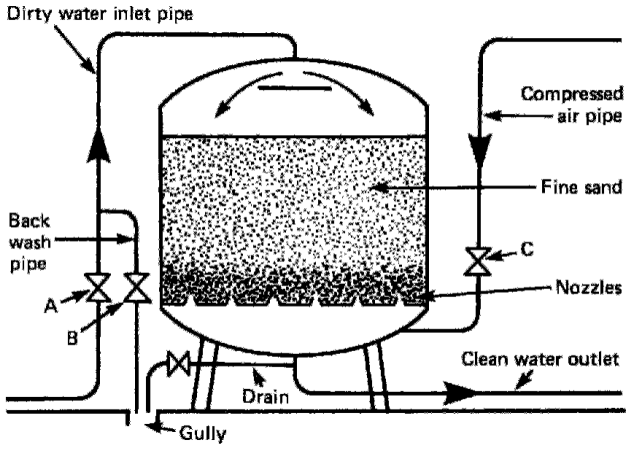
Acidity and Alkalinity in Water

The following table shows the quantity of pollutant microbes present during the stages of water processing:

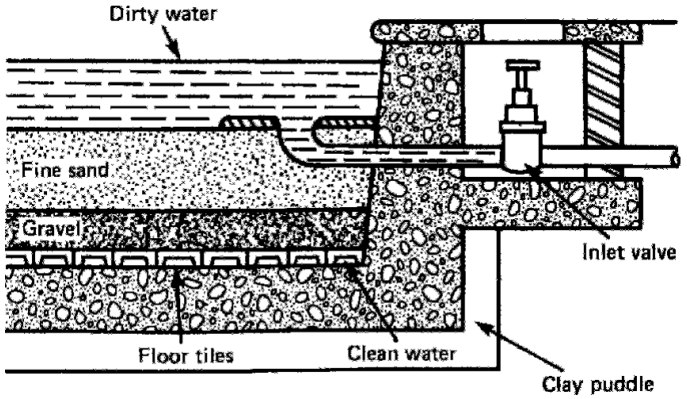
Source/process	Typical pollutant microbe count per litre
River	41 000
Impounding reservoir	1500
Primary filter	500
Secondary filter	50
Chlorination	0
Service reservoir	0
Distribution main	0

Filtration of Water

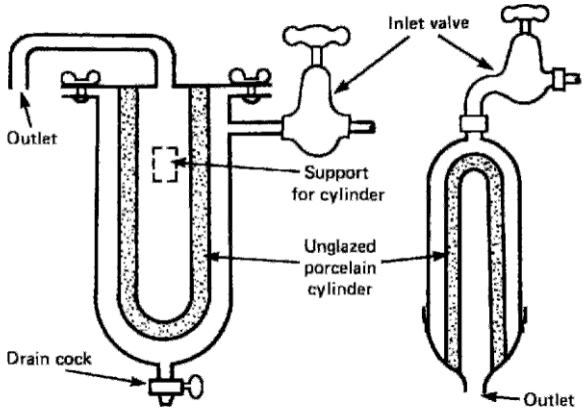
Pressure filter



Slow sand filter bed

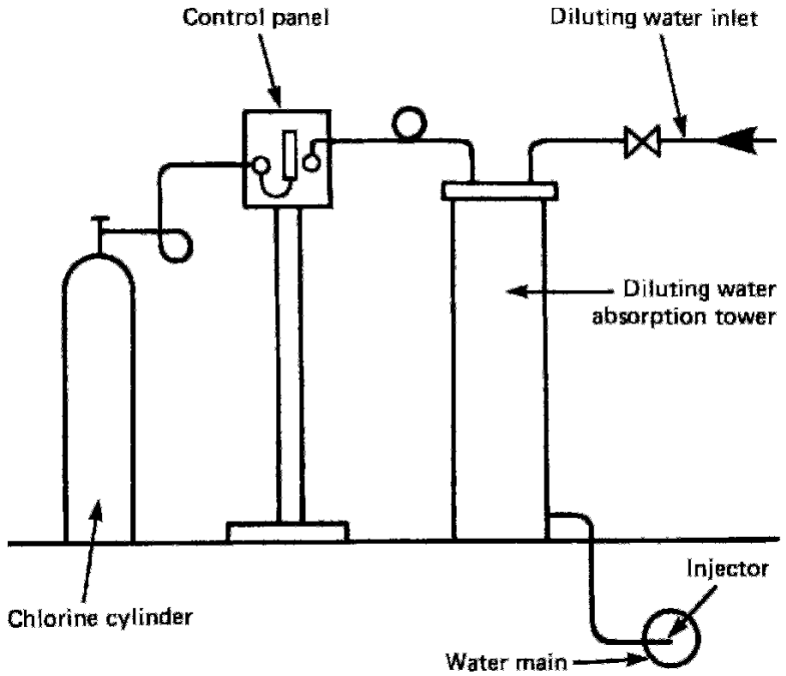


Small domestic filter

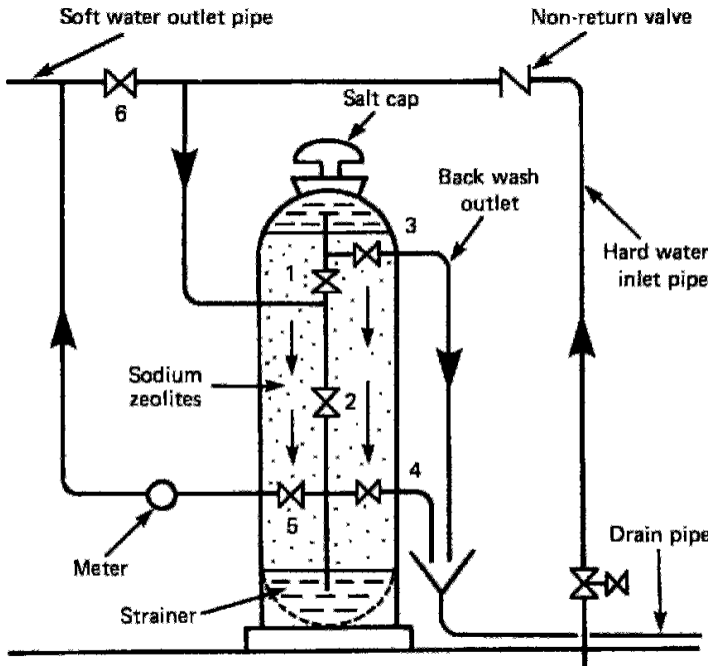


Sterilization and Softening

Sterilization by chlorine injection

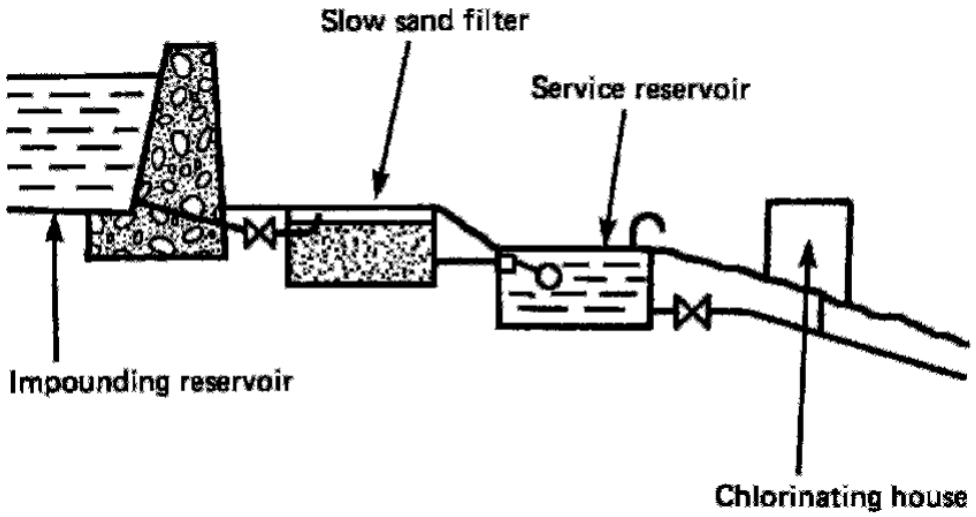


Softening of hard water by base exchange process

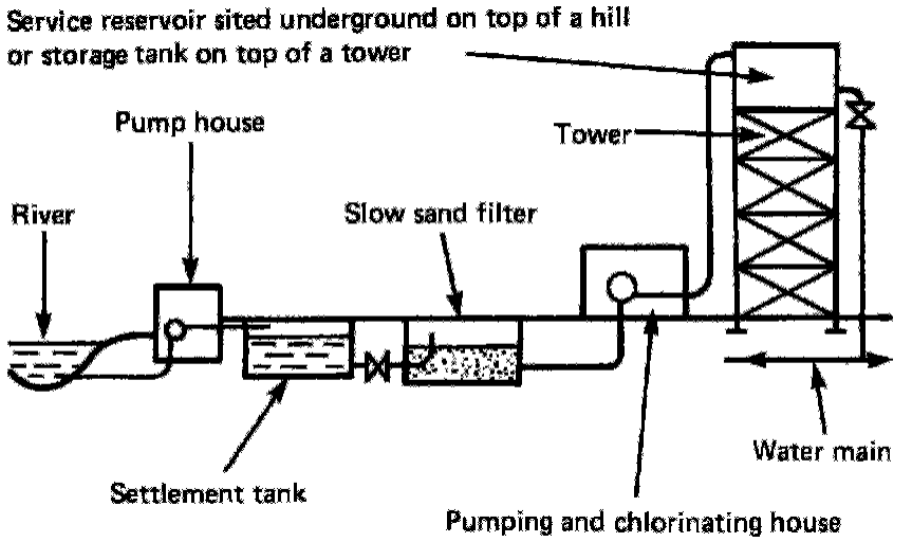


Storage and Distribution of Water

Gravitational distribution



Pumped distribution



Water Pump

Water pumps are mechanical or electromechanical devices that are designed to move water through pipes or hoses by creating a pressure differential.

The two most common types of pumps used for pumping water are:

1. centrifugal pumps
2. positive displacement pumps.

Recommended pressure for water booster pump

Low Water Pressure	Appropriate Water Pressure	High Water Pressure
Less than 40 psi	40 to 60 psi	Above 60 psi

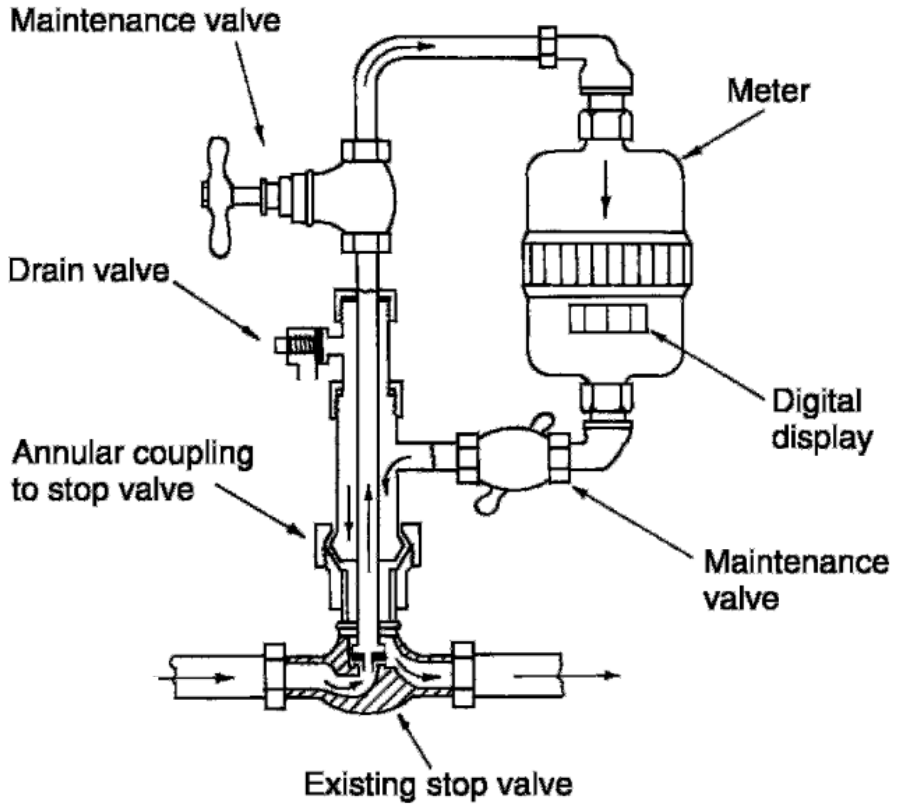
1psi =6894.76 pascal

1psi =0.0689476 Bar

1Bar =100000 pascal 100Kpa=1bar

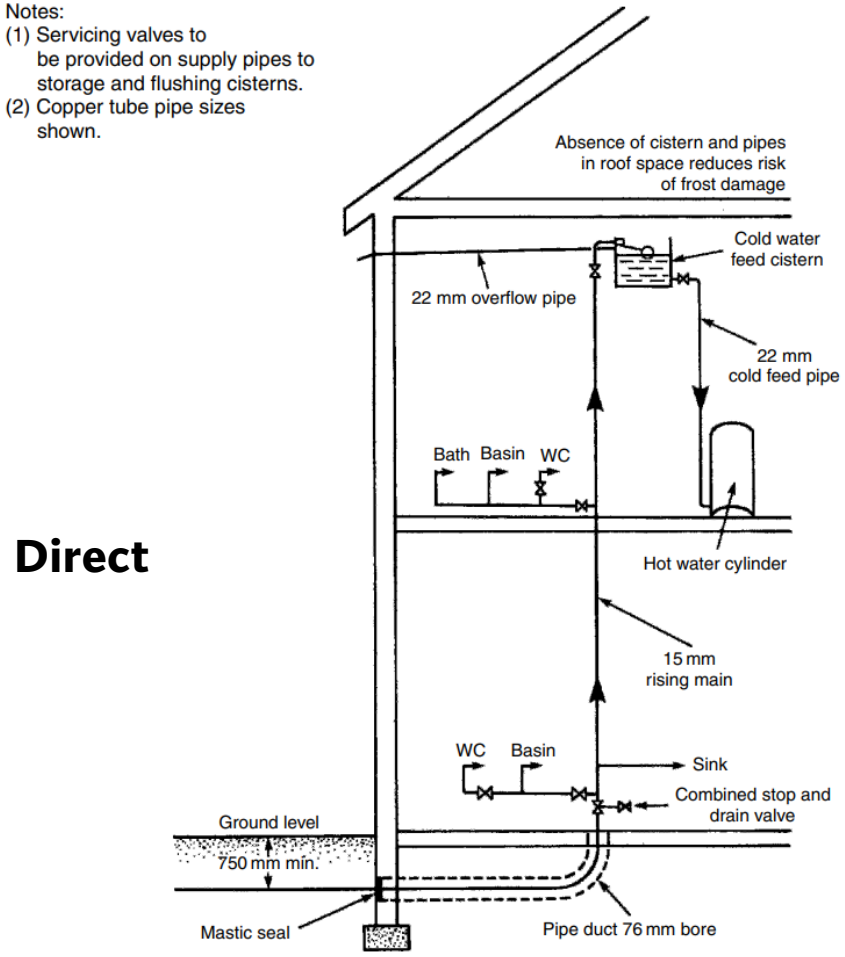
Water meter

Water meters are installed at the discretion of the local water authority. Most require meters on all new build and conversion properties, plus existing buildings that have been substantially altered. In time, in common with other utilities, all buildings will have a metered water supply. Meters are either installed in the communication pipe or by direct annular connection to the stop valve. If an underground location is impractical, the water authority may agree on internal attachment to the rising main.

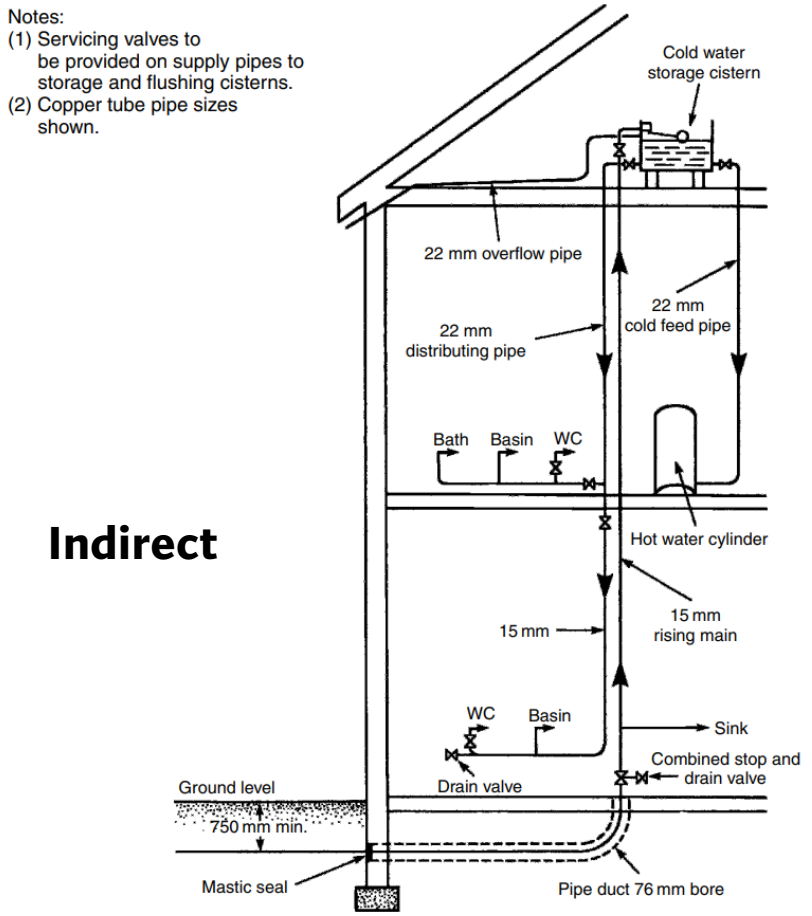


Cold Water Supply: Direct & Indirect system

Direct

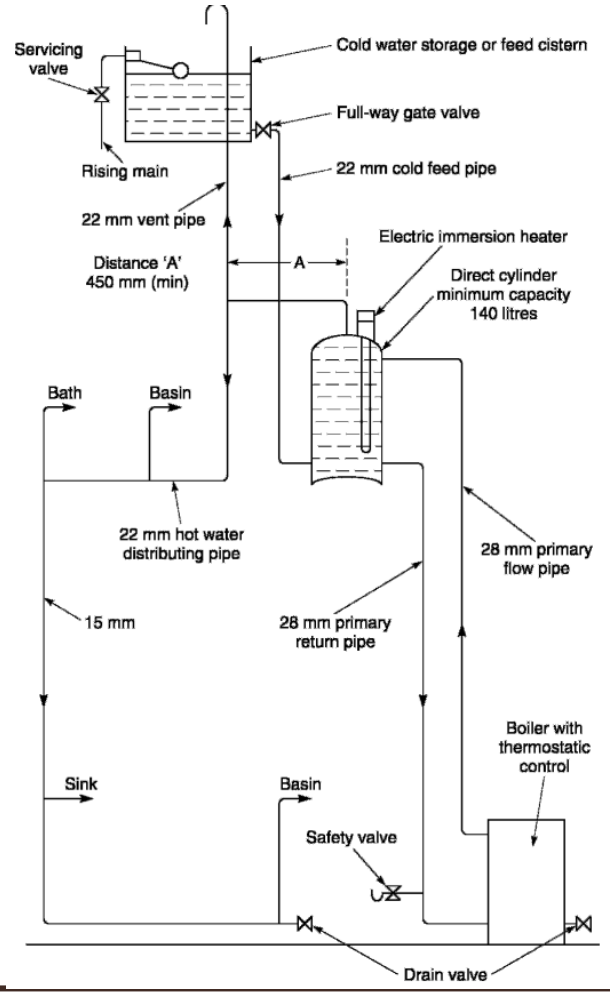


Indirect

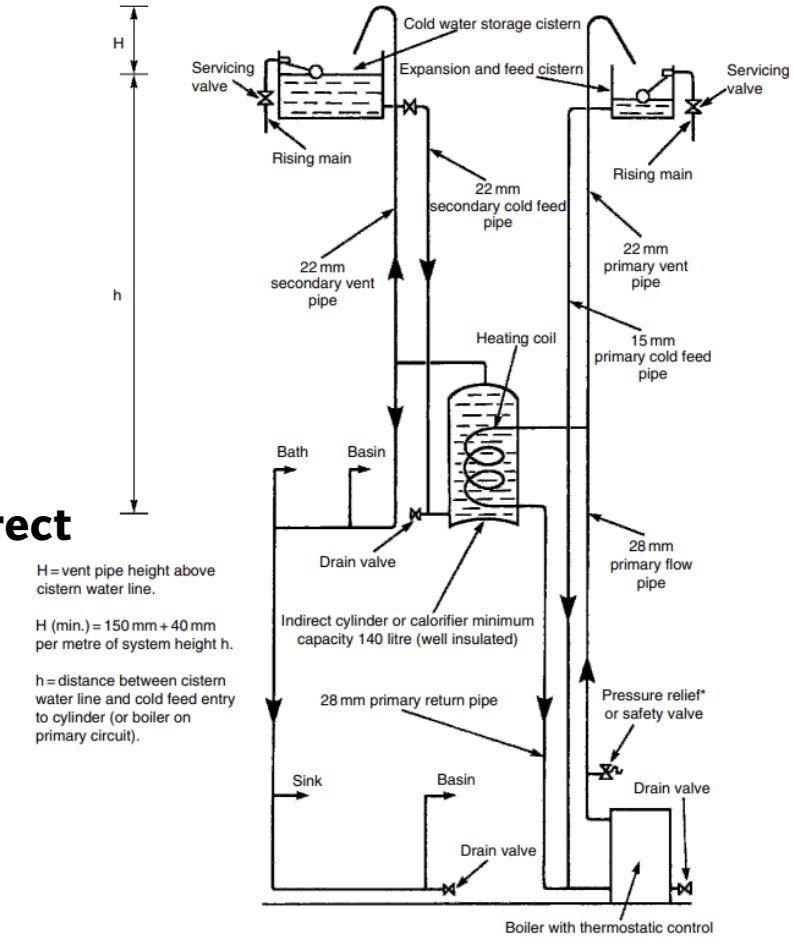


Hot Water Supply: Direct & Indirect system

Direct



Indirect



H = vent pipe height above cistern water line.

H (min.) = 150 mm + 40 mm per metre of system height h.

h = distance between cistern water line and cold feed entry to cylinder (or boiler on primary circuit).

Valves Used for Water

1. **Globe-type:** is used to control the flow of water at high pressure. To close the flow of water the crutch head handle is rotated slowly in a clockwise direction gradually reducing the flow, thus preventing sudden impact and the possibility of vibration and water hammer.
2. **The gate or sluice valve** is used to control the flow of water on low-pressure installations. The wheel head is rotated clockwise to control the flow of water, but this valve will offer far less resistance to flow than a globe valve. With use, the metallic gate will wear and on high pressure installations would vibrate.

Valves Used for Water

3. The **drain valve** has several applications and is found at the lowest point in pipe systems, boilers and storage vessels.

For temperatures up to 100ƒC valves are usually made from brass. For higher temperatures gun metal is used. Brass contains 50% zinc and 50% copper. Gun metal contains 85% copper, 5% zinc and 10% tin.

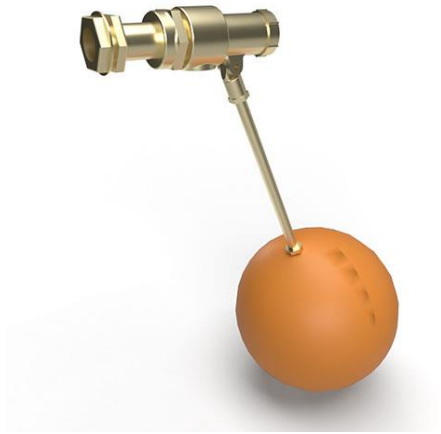
4. **Float valves** are automatic flow control devices fitted to cisterns to maintain an appropriate volume of water.

a) The **diaphragm type** is the least noisy as there is less friction between moving parts.

Valves Used for Water

b) The **Portsmouth and Croydon-type** valves have a piston moving horizontally or vertically respectively.

c) Croydon float valve



Roof Tanks

Roof tanks should be elevated enough above the roof level to have enough for the upper apartment, otherwise booster pump is needed.

Material of roof tanks

1-Concrete tanks.

2-Galvanized tanks.

3- PPr (Polypropylene Random Copolymer pipes)tanks.

Cold Water Storage Calculation

Building purpose	Storage/person/24 hrs
Boarding school	90 liters
Day school	30
Department store with canteen	45
Department store without canteen	40
Dwellings	90
Factory with canteen	45
Factory without canteen	40
Hostel	90
Hotel	135
Medical accommodation	115
Office with canteen	45
Office without canteen	40
Public toilets	15
Restaurant	7 per meal

Cold Water Storage Calculation

Number of occupants/ liter per person= Total required capacity

At the design stage, the number of occupants or users sometimes is unknown, therefore, for calculating the number of occupants, the standard area per person for each building type is divided by the net area of the building.

Cold Water Storage Calculation

Example calculation of daily domestic water requirement, Suppose we have 24 floors & each floor consists of 4 flats,

2 of them having 3 bedrooms.

2 of them having 2 bedrooms.

+1 Mad each flat.

As a rule of thumb, we take 2 persons/bedroom.

Total number/floor = 2×3×2+2×2×2+4 = 24 Persons/floor.

Total number of occupants= 24× 24 + 5 (labors+ concierges etc...) = 581 Persons.)

From table W-1 the daily water requirement is between 90 liters/ day (Dwelling)

The daily water for the whole building is:

> 90×581 = 52290 liter /day

Pipe sizing

Correct pipe sizes will ensure adequate flow rates at appliances and avoid problems:

Oversizing

- Additional and unnecessary installation costs
- Delays in obtaining hot water at outlets
- Increased heat losses from hot water pipes

Undersized

- Inadequate delivery from outlets
- Some variation in temperature and pressure at outlets (e.g. showers and other mixers)
- Some increase in noise levels

Pipe Sizing by Formula

$$d = \sqrt[5]{\frac{q^2 \times 25 \times L \times 10^5}{H}}$$

where: d = diameter (bore) of pipe (mm)
q = flow rate (l/s)
H = head or pressure (m)
L = length (effective) of pipe (m)
(actual length + allowance for bends, tees, etc.)

Flow rate

Recommended flow rates for various sanitary appliances (litres/sec)

WC cistern	0·11
Hand basin	0·15
Hand basin (spray tap)	0·03
Bath (19 mm tap)	0·30
Bath (25 mm tap)	0·60
Shower	0·11
Sink (13 mm tap)	0·19
Sink (19 mm tap)	0·30
Sink (25 mm tap)	0·40

gallon per minute to liters per second

1 gallon per minute= 0.0631 liters per second

Pipe Sizes and Resistances

Steel pipe (inside dia.)		Copper tube (mm)		Polythene (mm)	
Imperial (")	Metric (mm)	Outside dia.	Bore	Outside dia.	Bore
$\frac{1}{2}$	15	15	13·5	20	15
$\frac{3}{4}$	20	22	20	27	22
1	25	28	26	34	28
$1\frac{1}{4}$	32	35	32	42	35
$1\frac{1}{2}$	40	42	40		
2	50	54	51·5		
$2\frac{1}{2}$	65	67	64·5		
3	80	76	73·5		

Effective pipe length

Measure pipe length + equivalent pipe length

Bore of pipe mm	Equivalent pipe length			
	Elbow m	Tee m	Stopvalve m	Check valve m
12	0.5	0.6	4.0	2.5
20	0.8	1.0	7.0	4.3
25	1.0	1.5	10.0	5.6
32	1.4	2.0	13.0	6.0
40	1.7	2.5	16.0	7.9
50	2.3	3.5	22.0	11.5
65	3.0	4.5	—	—
73	3.4	5.8	34.0	—

Flow rate

Determine the effective pipe length if the water supply system with a measured pipe length 4.75 meter has the following fittings: two elbows two tees, one stop valve, two taps and two check valves. Knowing that equivalent pipe length for elbow = 0.8 ,tee = 1 ,stop valve =7, tap = 3.7 and check valve = 4.3?

2*0.8=1.6M
2*1=2M
1*7=7M
2*3.7=7.4M
2*4.3=8.6M

} 26.6+4.75=31.35M

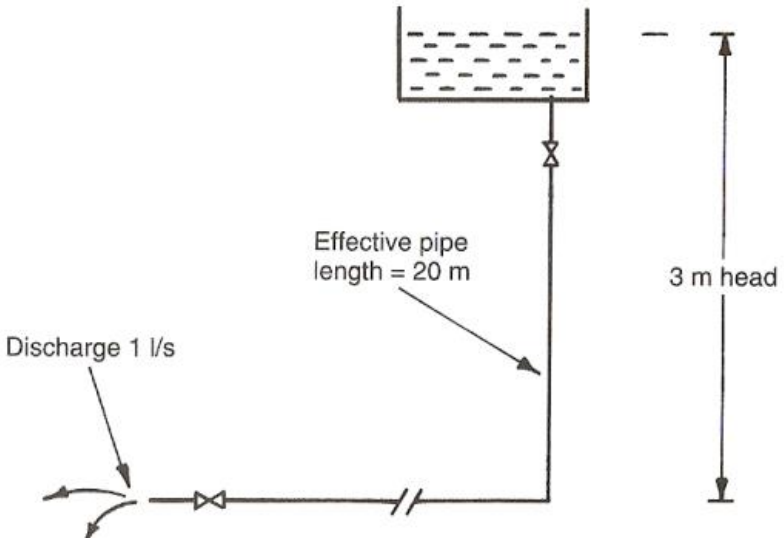
Pipe sizing

Determine the pipe size by Thomas Box Formula:

Answer: Using Thomas Box formula,

$$d = \sqrt[5]{\frac{(1)^2 \times 25 \times 20 \times 10^5}{3}} = \underline{\mathbf{27.83\ mm}}$$

Hence, the nearest commercial size is 32 mm bore steel or 35 mm outside diameter copper.



Pipe materials

Classification of pipe materials

- **Metallic**

Copper

Stainless steel •

- **Thermoplastics**

PVC-U, PVC-C

Polyethylene (PE)

Medium Density Polyethylene (MDPE)

High-Density Polyethylene (HDPE)

Crosslinked Polyethylene (PEX)

Polybutylene (PB)

Acrylonitrile Butadiene Styrene (ABS)

Pipe materials

Classification of pipe materials

❖ **Composite**

Lined galvanised steel

Crosslinked Polyethylene/Aluminium/Crosslinked Polyethylene Composite Pressure Pipe (PEX-AL-PEX**)**

High Density Polyethylene/Alumnium/ High Density Polyethylene (HDPE-AL-HDPE

Pipe materials

Copper pipes (BS EN 1057)

❖ Advantages:

High-pressure capability

Good formability

Good corrosion resistance

High strength & and durability to withstand external loading

Ease of jointing

Smooth surface: low resistance to water flow

Suitable for conveying hot water

❖ Disadvantages:

Soft water can cause internal corrosion attack (give rise to ‘blue’ water)

Pipe materials

Stainless steel (BS 4127)

❖ Advantages:

High-pressure capability

Good corrosion resistance

High strength and durability

Ease of jointing

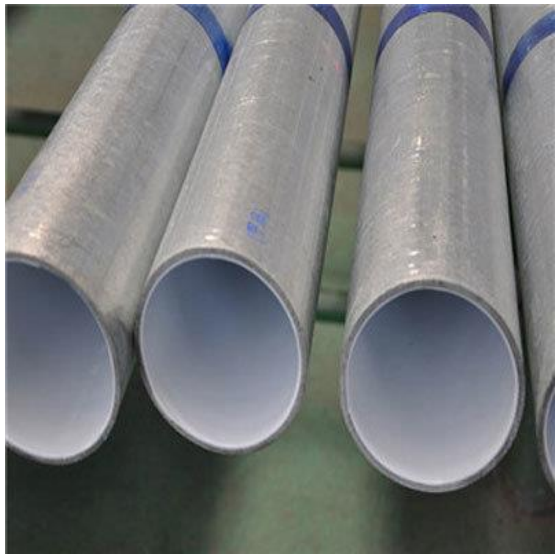
Good resistance to accidental damage

Suitable for conveying hot water

❖ Disadvantage:

More expensive than copper

Pipe materials



Lined galvanized steel

❖ Advantages

Good resistance to internal corrosion and encrustation.

Smooth surface: lower resistance to water flow.

Can be used in vulnerable conditions e.g. exposure to direct sunlight and traffic loads.

Readily compatible with existing commonly used unlined steel pipe

❖ Disadvantages:

Heavyweight

Susceptible to impact damage (great care in handling)

Higher skills required for cutting, threading, jointing

Pipe materials

PVC-U (BS 3505 Class D)

Advantages:

Good corrosion resistance

Light weight, low cost

Ease of jointing

Smooth surface: low resistance to water flow

Not a conductor of electricity (no galvanic/oxidative corrosion)

Disadvantages:

Brittle, susceptible to impact damage

Long drying time of solvent cement in jointing

Low abrasion resistance

Permeation/degradation by certain organic contaminants

UV degradation on prolonged exposure to sunlight

Not suitable for hot water supply

Pipe materials

PVC-C (BS 7291)

Advantages:

Suitable for conveying hot water

Good corrosion resistance & chemical resistance

Light weight

Smooth surface: low resistance to water flow

Not a conductor of electricity (no galvanic/oxidative corrosion)

Can be connected to other materials easily.

Disadvantages:

Brittle, susceptible to impact damage

Long drying time of solvent cement in jointing Can be flammable.

Reduction in strength & rigidity with increase of temperature.

Permeation/degradation by certain organic contaminants.

Can be attacked by detergents & oxidizing agents.

UV degradation on prolonged exposure to sunlight

Pipe materials

MDPE (BS 7291) (medium-density polyethylene)

Advantages:

Good corrosion resistance

Good formability

Light weight

Fusion & mechanical joint available

Smooth surface: low resistance to water flow

Strong & tough

Flexible & durable, light & easy to handle

Good resistance to impact

Disadvantages:

Fusion jointing requires skilled installers & special equipment

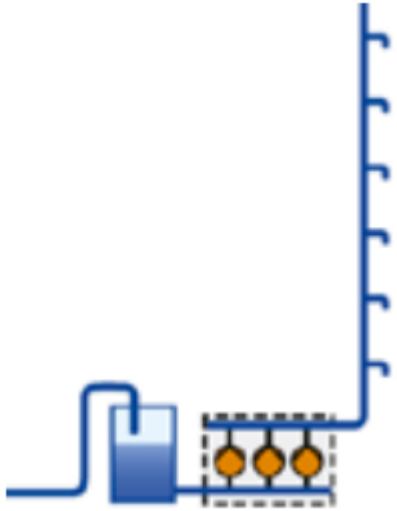
Subject to creep

Strength decrease with time (at a very slow rate)

UV degradation on prolonged exposure to sunlight

Permeation/degradation by certain inorganic & organic contaminants

Water distribution in high rise building

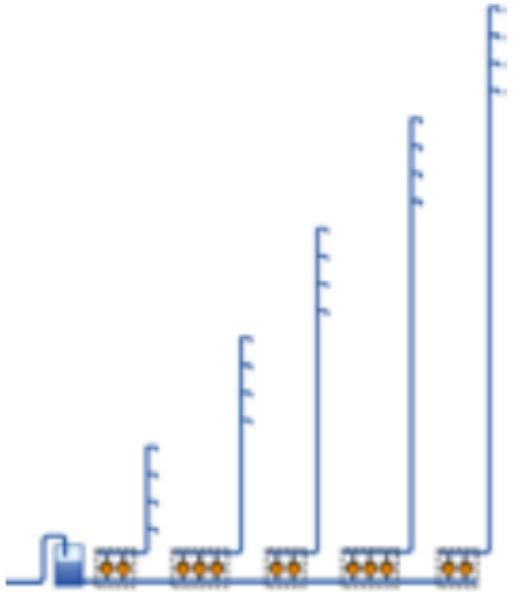


1. Single booster system

A water tank is placed in front of the pump system and filled with water from the mains. This allows the capacity of the mains to be lower than the building's peak demand, ensuring constant pressure even in peak flow situations. The break tank is filled with water during low consumption periods and ensures a uniform water supply to the booster pumps at all times.

Advantages	Disadvantages
• No space required for boosters on upper levels. • Only one (or a few) riser pipe(s) in the building.	• High pressure-graded pipes and booster sets • Pressure relief valves have to be fitted • High operational costs

Water distribution in high rise building



2. Zone-divided system.

The supply system is split into several zones supplying a maximum of 12 floors each. This ensures adequate water pressure on all floors without using pressure relief valves. The minimum pressure on the upper floor in each zone is kept at 1.5 - 2 bar. The maximum pressure on the lowest floor in each zone does not exceed 4 - 4.5 bar.

Advantages	Disadvantages
• No space required for boosters on upper levels • Less vulnerable in the event of pump failure • No pressure reduction valves	• More riser pipes in the building • High pressure-graded pipes and booster sets for upper floors.

Water distribution in high rise building

3. Roof tanks .

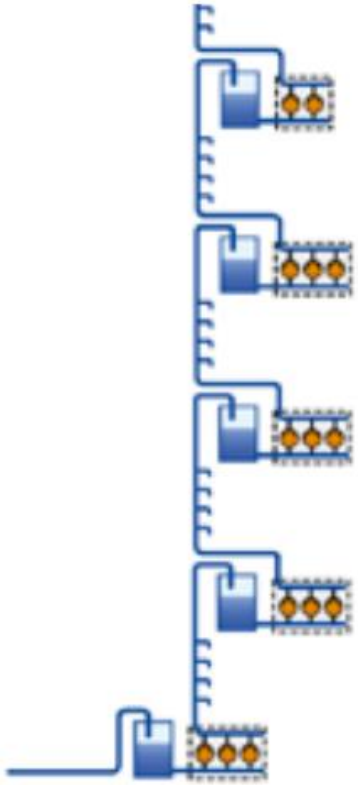
Ensure both water pressure and water supply in case of power failure. This solution requires pressure reduction valves on each floor in order to avoid undesired high static pressures at the tap, which creates unacceptable noise while tapping. In this model the upper six floors require a separate booster system in order to create sufficient pressure. The static pressure there is too low due to the insufficient geometric height to the roof tank.

Advantages	Disadvantages
• Only one discharge from booster set to top • Space saving	• Insufficient pressure on the uppermost floors • Excessive pressure on the lowest floors • Pressure reduction valves have to be fitted • Need for higher pressure grade of pipe work • Space requirement for tank • Risk of microbiological growth in roof tank

Water distribution in high rise building

4. Series-connected systems with intermediate break tanks

draw on several other systems, utilizing centrally-placed break tanks to supply both the taps in its own boosting zone and all the zones above it. With this system, a building is divided into smaller and more manageable pressure zones of 12 floors each. Every zone is then served by its own booster set. No pressure reduction valves are required and in case of electrical breakdown the tanks will be able to supply pressure and water for up to 12 hours. However, the tanks take up valuable space within the building, reducing the room available for revenue generation.

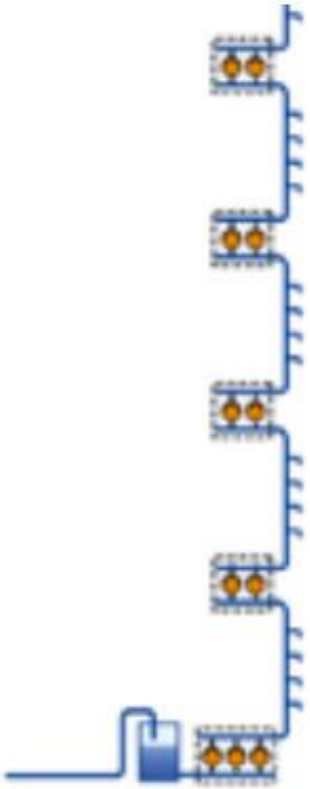


Advantages	Disadvantages
• Low cost operation • Low pressure in each zone • Manageable pressure zones • High system resilience • Low power consumption of pumps and reduced load on power grid • Low pressure-graded pipes	• High initial investment • Booster sets and tanks require space on service floors • Risk of microbacterial growth in break tanks

Water distribution in high rise building

5. A series-connected system

A series-connected system operates on the same principles as the previous system, but without the intermediate break tanks. This enables an effective usage of power because the water is only pumped to the zone where it is used and not past it. However, complete control is very important. When a consumer draws water on the upper floors, the booster systems must deliver the water from the bottom of the building.



Advantages	Disadvantages
• Low-cost operation • No space is required for tanks • Low pressure in each zone • Manageable pressure zones • Low power consumption of pumps and reduced load on power grid • Low pressure-graded pipes	• Vulnerable in case of pump failure

Water distribution in high rise building

Burj khalifa

THANK YOU