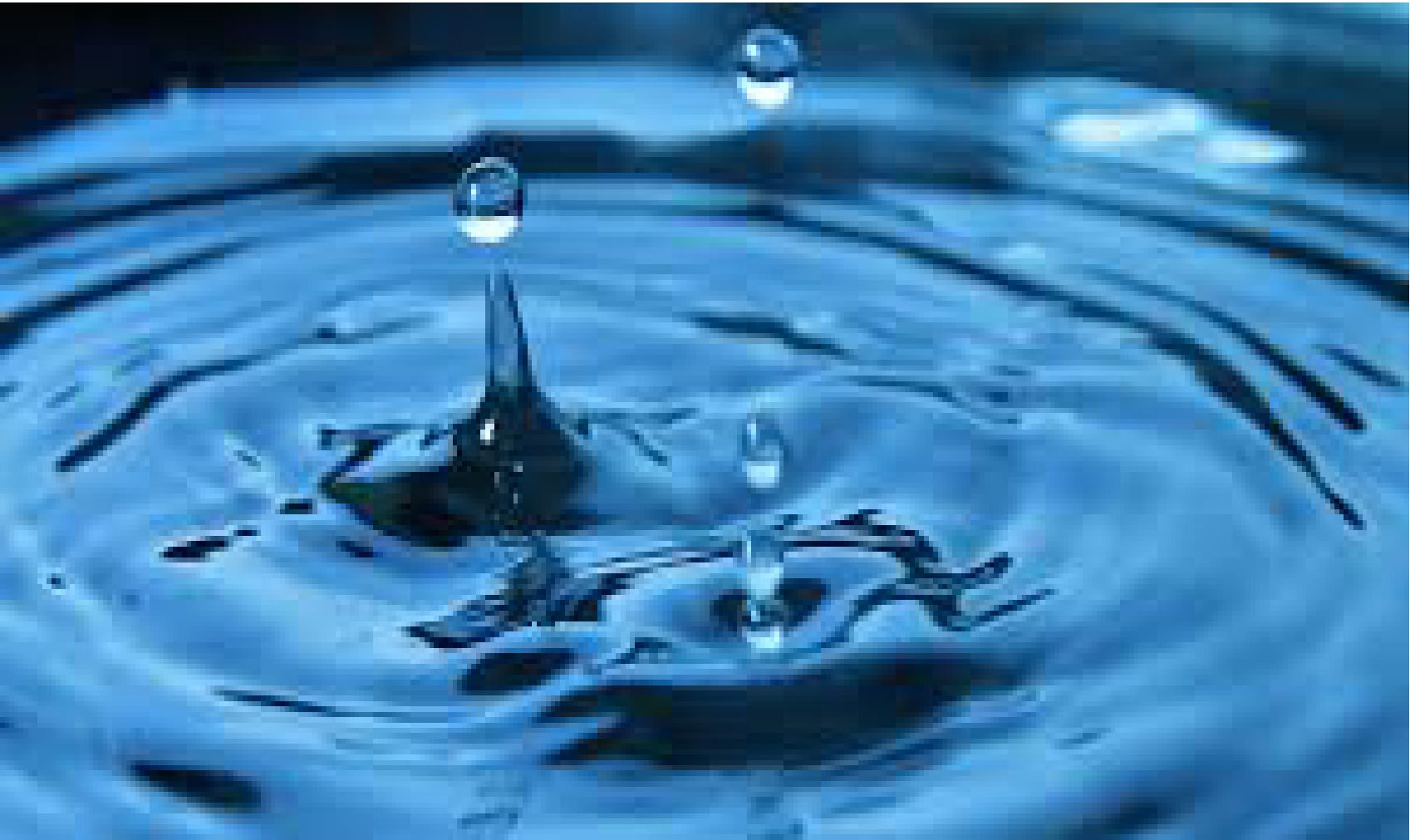
معهد المستقبل العالي للهندسة بالفيوم

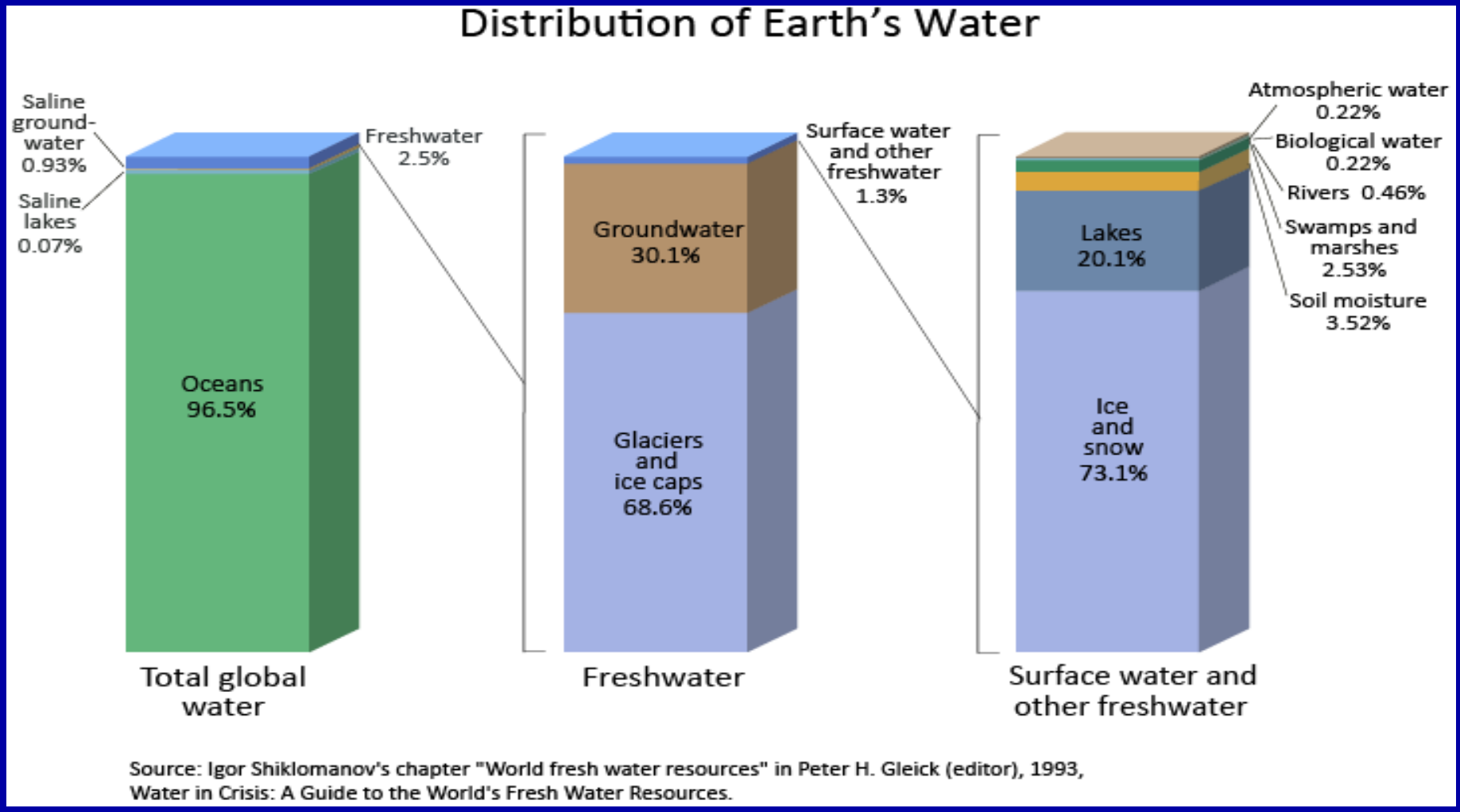
FUTURE HIGH INSTITUTE OF ENGINEERING IN FAYOUM

Water resources

Dr-Abdelrahman Ragab



distribution of earth's water graph



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources.

Surface Water

Advantages

- Easily accessible
- Large volumes of water
- Surface reservoirs for storage

Disadvantages

- Exposure to contaminants
- Expensive filtration

Groundwater

Advantages

- Less treatment
- Consistency
- Availability

Disadvantages

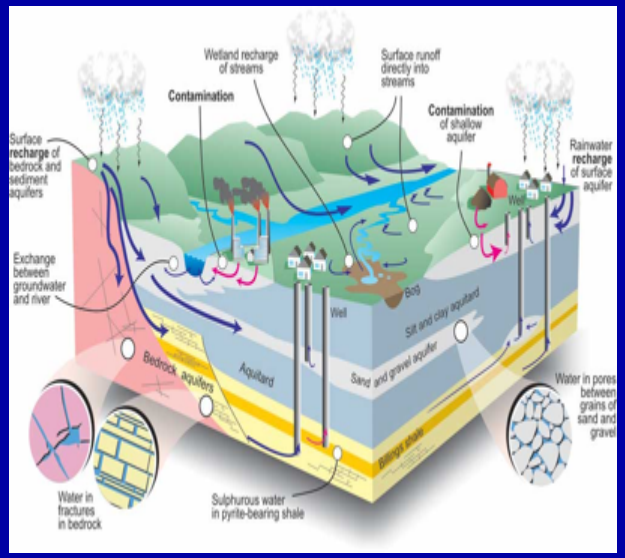
- Chemical contamination
- Hardness
- Multiple wells
- Location

Water Resources Engineering

- Storm sewers
- Water resource planning
- Dams
- Irrigation systems
- Water distribution systems
- Groundwater modeling

Water resources engineering

Hydraulic Engineering



Groundwater Engineering

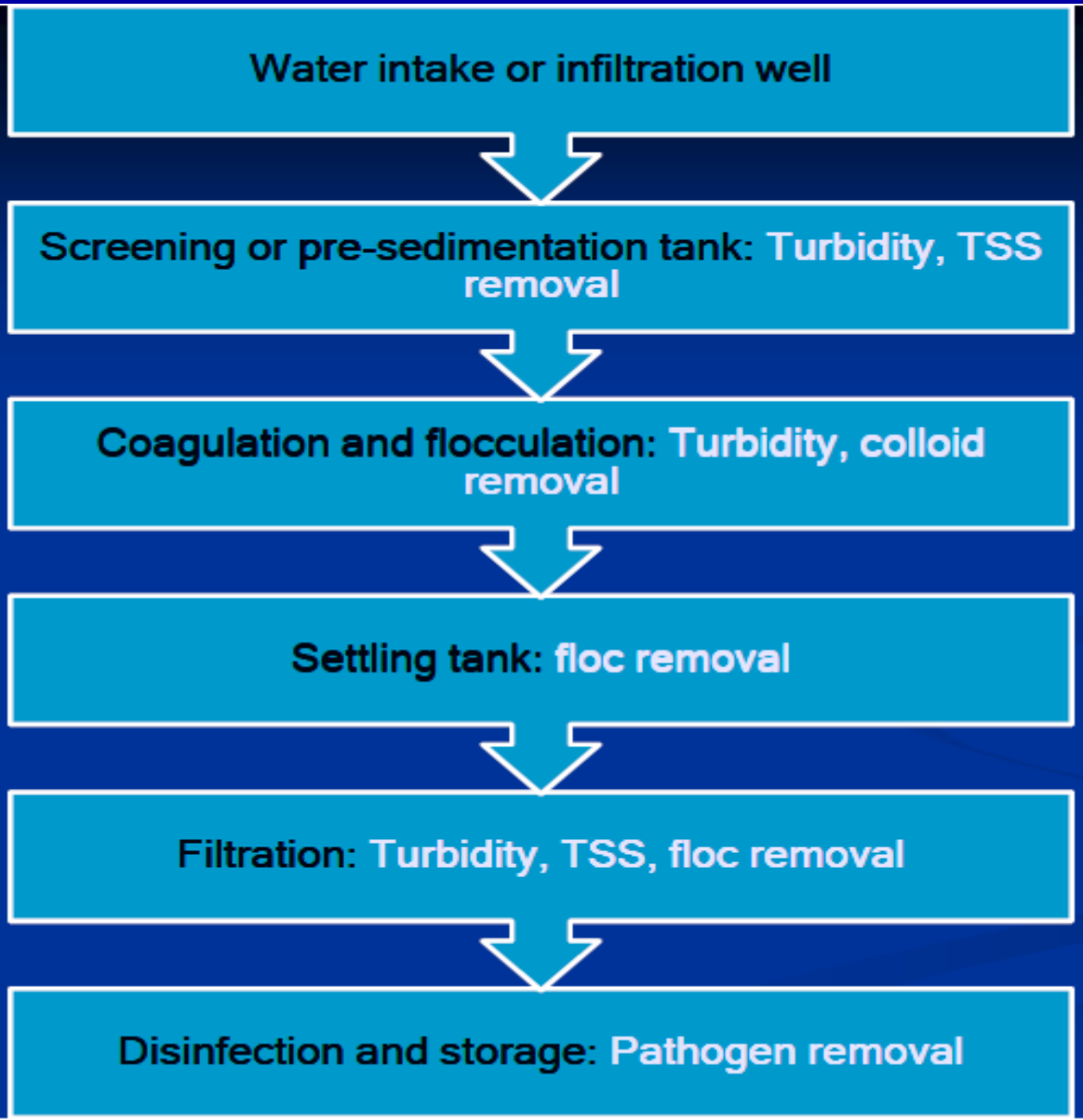
River Engineering

Water Resource Engineer

Duties

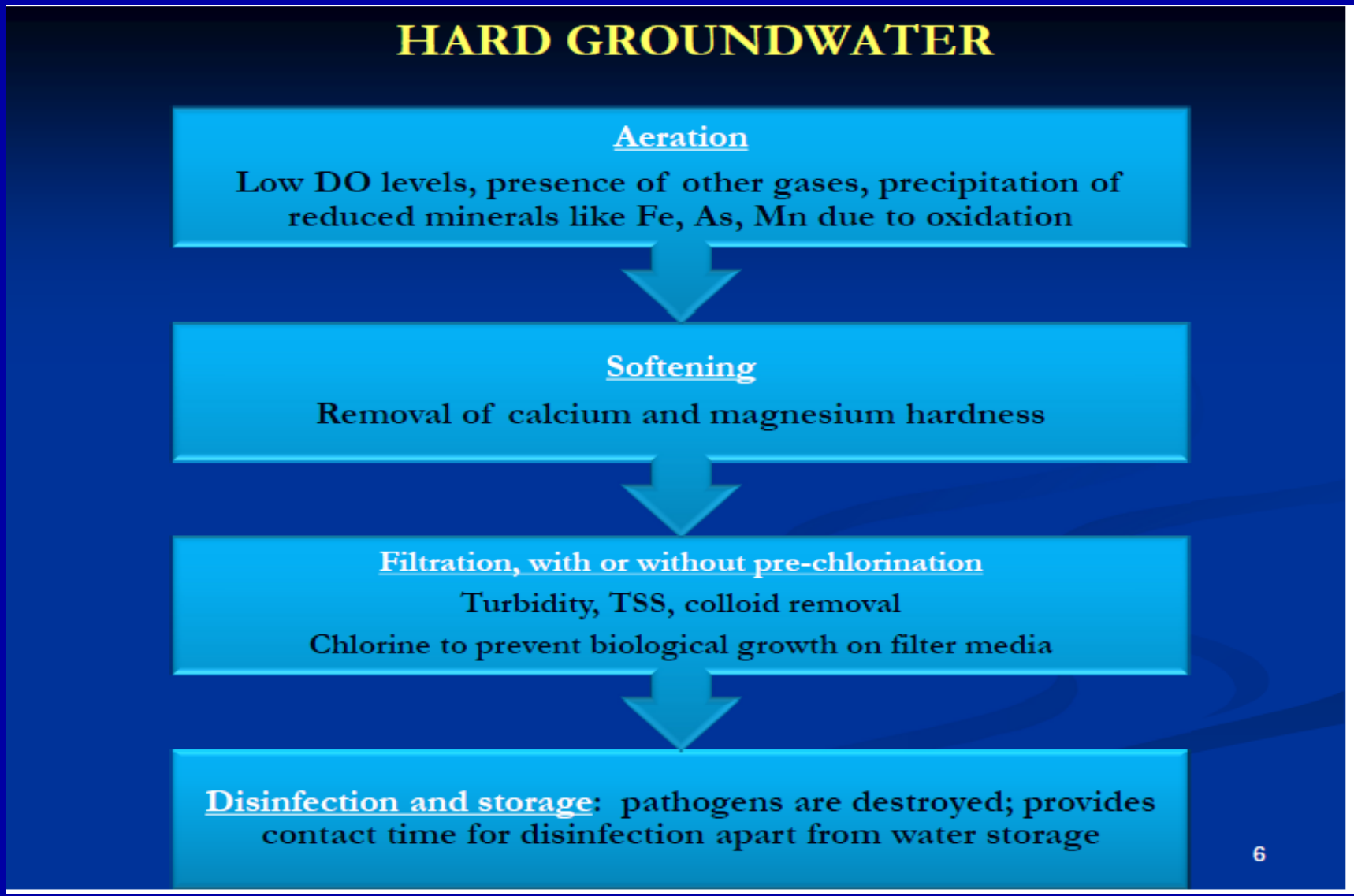
- Data collection
- Hydrologic and hydraulic modeling
- Perform watershed assessments
- Preparation of drainage and water quality technical reports
- Conduct stormwater utilities feasibility studies and implementation
- Perform drainage calculations for design discharges, open channels, weirs and collection systems
- Perform storm water quality related design (BMPS)

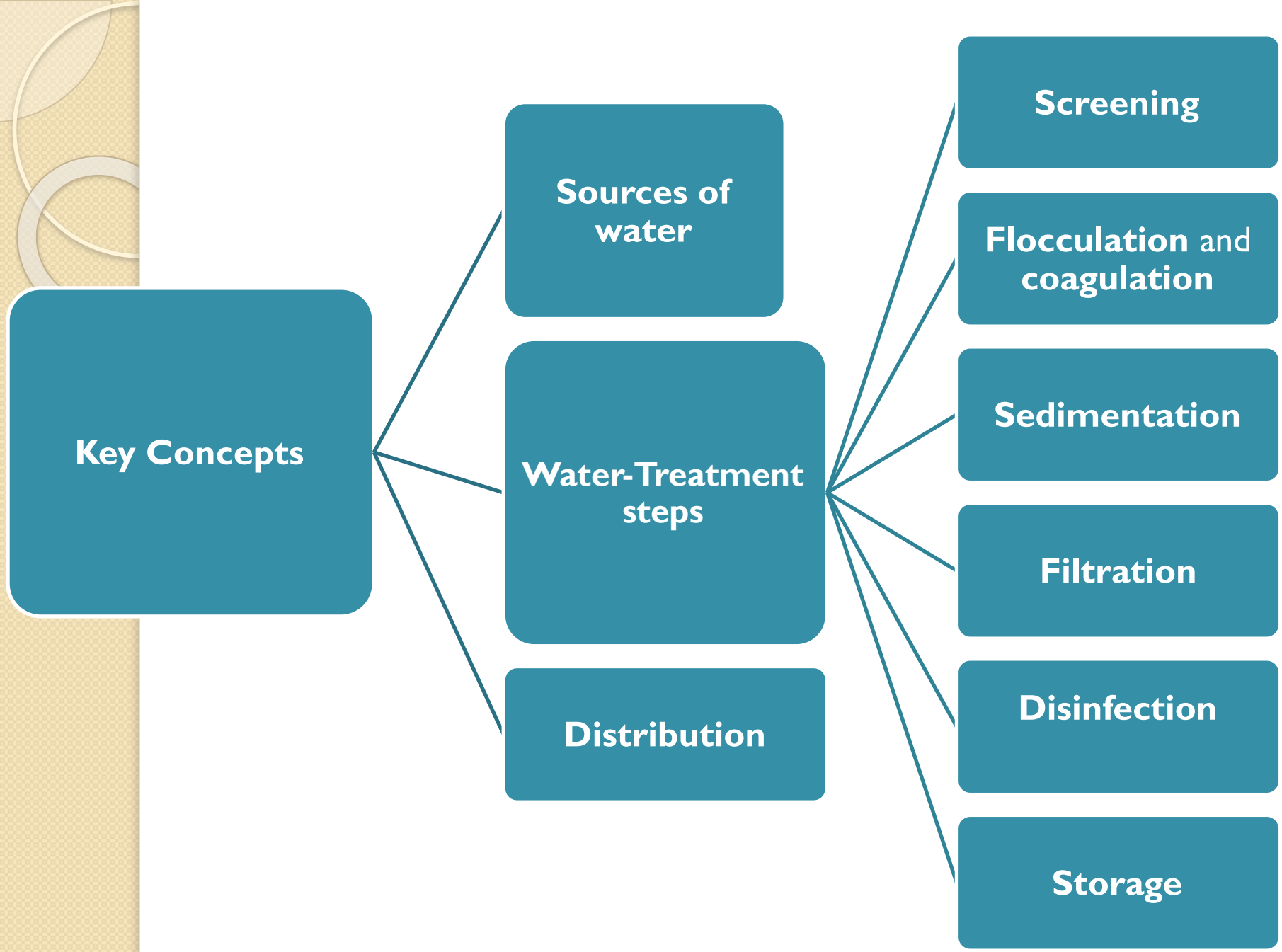
Surface Water Treatment Processes



TURBID SURFACE WATER

Surface Water Treatment Processes




Key Concepts
Sources of water
Water-Treatment steps
Distribution
Screening
Flocculation and coagulation
Sedimentation
Filtration
Disinfection
Storage

Introduction

Water is perhaps the most important nutrient in our diets.

But some water sources cannot safely be used to meet our requirement for drinking water.

Water is Not Really Pure H_2O

Why is it necessary to treat freshwater before we drink it or use it for other applications?

The answer is that our water supplies are not pure, i.e., these supplies contain other species that may make the water unsuitable for human use.

H_2O is certainly the largest and most important component of any water source, but this molecule is hardly the only chemical present in the water supply.

It may be surprising to learn that water treatment does not eliminate all of the impurities from water.

In fact, the treatment process itself contributes additional impurities to the water. However, the impurities added during the treatment process generally help to make water more suitable for human use.

Furthermore, many freshwater sources are not suitable for humans to drink. Many serious diseases, such as cholera, are caused by drinking water that contains parasitic microorganisms.

Water containing large amounts of industrial waste or agricultural chemicals (*e.g.*, pesticides) can also be toxic and unfit for drinking.

Hence, humans have a great need for a reliable source of clean freshwater for drinking.

In addition to the water needed for drinking, humans use much larger amounts of clean water in other applications.

These other uses of freshwater include household use (*e.g.*, cooking and cleaning), industry, agriculture (*e.g.*, irrigation).

In response to this need for reliable supplies of clean and usable freshwater, governments at all levels have formed organizations and passed legislation to monitor, treat, and protect our water supplies, like(The Clean Water) established the policy of contracting water-treatment facilities and implemented enforcement procedures to ensure that our water supplies would be kept clean for human use.

Objectives of water treatment

- The principal objective of water treatment is to provide **potable water that is chemically and biologically safe for human consumption.**
- It should also be free from unpleasant tastes and odors

Chemical Safety:

- **Removal of contaminants:** This includes inorganic substances like heavy metals (lead, arsenic, etc.), salts, and dissolved gases.
- **Disinfection:** Killing or inactivating harmful microorganisms like bacteria, viruses, and parasites.

Biological Safety:

- **Removal of pathogens:** Ensuring the water is free from disease-causing organisms.
- **Control of algae and other biofouling:** Preventing the growth of organisms that can clog pipes and reduce water quality.

Aesthetic Quality:

- **Removal of tastes and odors:** Eliminating unpleasant flavors and smells caused by chemicals or organic matter.
- **Clarity and color:** Ensuring the water is clear and free from discoloration.

Water treatment objective is to produce both "potable"and"palatable".

Potable:Water that can be consumed in any desired amount without concern for adverse health effects.

Potable does not necessarily mean that the water tastes good.

Palatable:it is a water that is pleasing to drink but not necessarily safe.

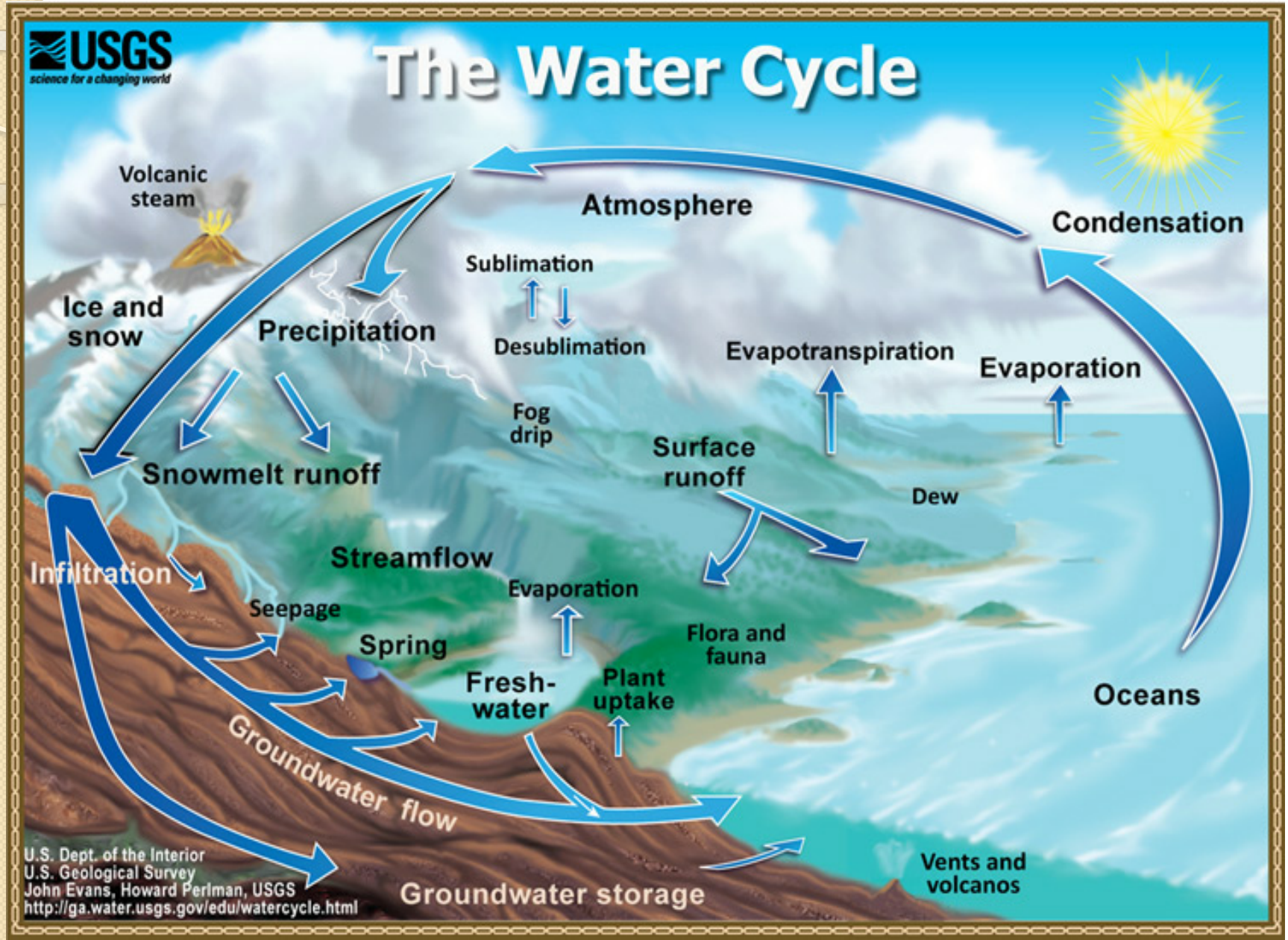
Water treatment aims at producing water that satisfies a set of drinking water quality standards at a reasonable price to the consumers.

•Removal of solids in water:

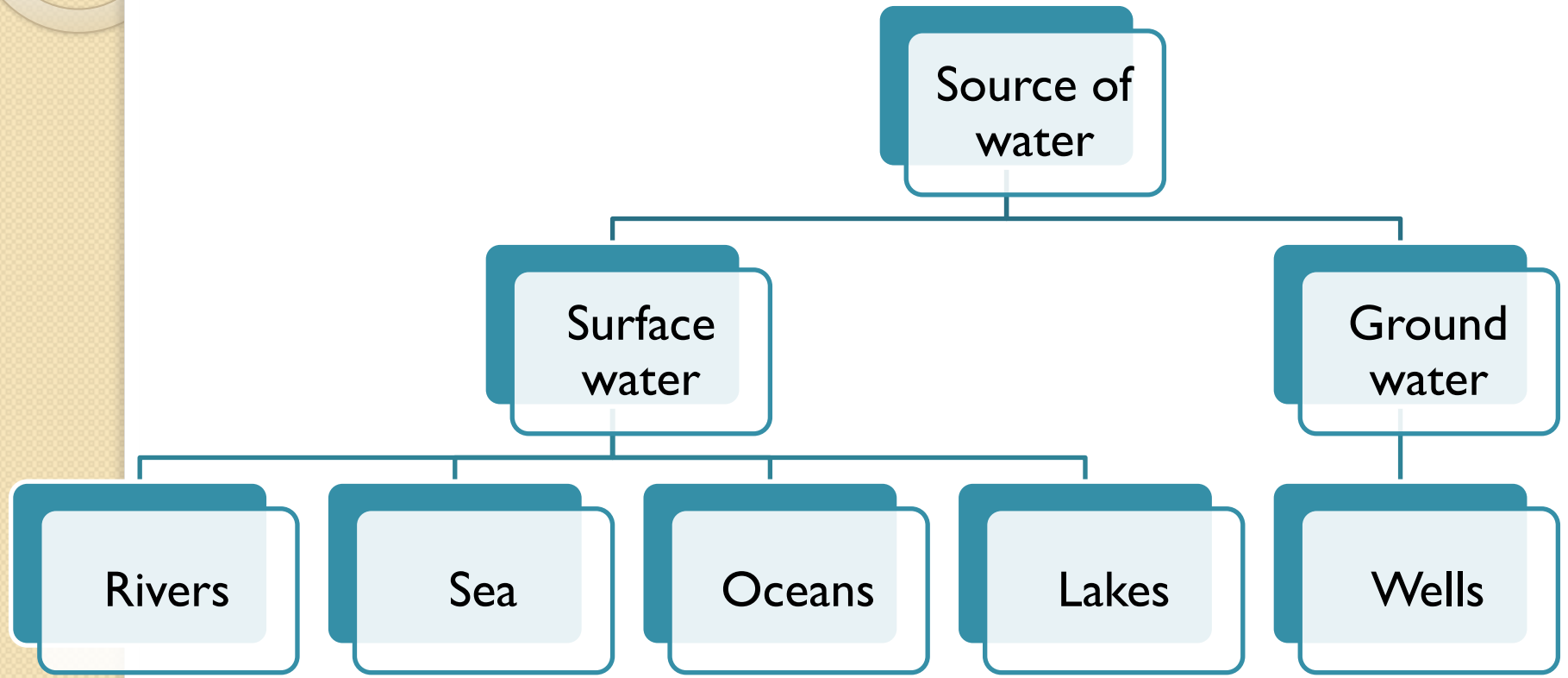
Solids may be suspended, dissolved or colloidal.

Some of the dissolved solids should stay in water at healthy concentrations.

Sources of water



Where does the water that we use come from?



As stated above, saltwater is not suitable for human use. (The high salt concentration makes it unsuitable for most human applications, and removal of the salt is costly).

Water found in the forms of ice and vapor are not readily accessible for human use.

This leaves only about 0.3% of the water on the Earth as liquid freshwater.

The vast majority (approximately 98.5%) of the Earth's freshwater is contained in underground supplies known as **groundwater.**

The remaining freshwater sources, including rivers and lakes, are collectively known as **surface water.**

The amount of water that we use from groundwater and surface water varies from region to region.

Generally, groundwater is cleaner and requires less treatment, but surface water is easier to obtain.

Treatment of the Public Water Supply

There are six major steps in the treatment of our water: screening, **(flocculation** and **coagulation),** sedimentation, filtration, and disinfection, storage

Schematic of a Water-Treatment Plant

Screening

Surface water (water from lakes and rivers) often has large debris, such as sticks, leaves, fish, and trash, floating in it.

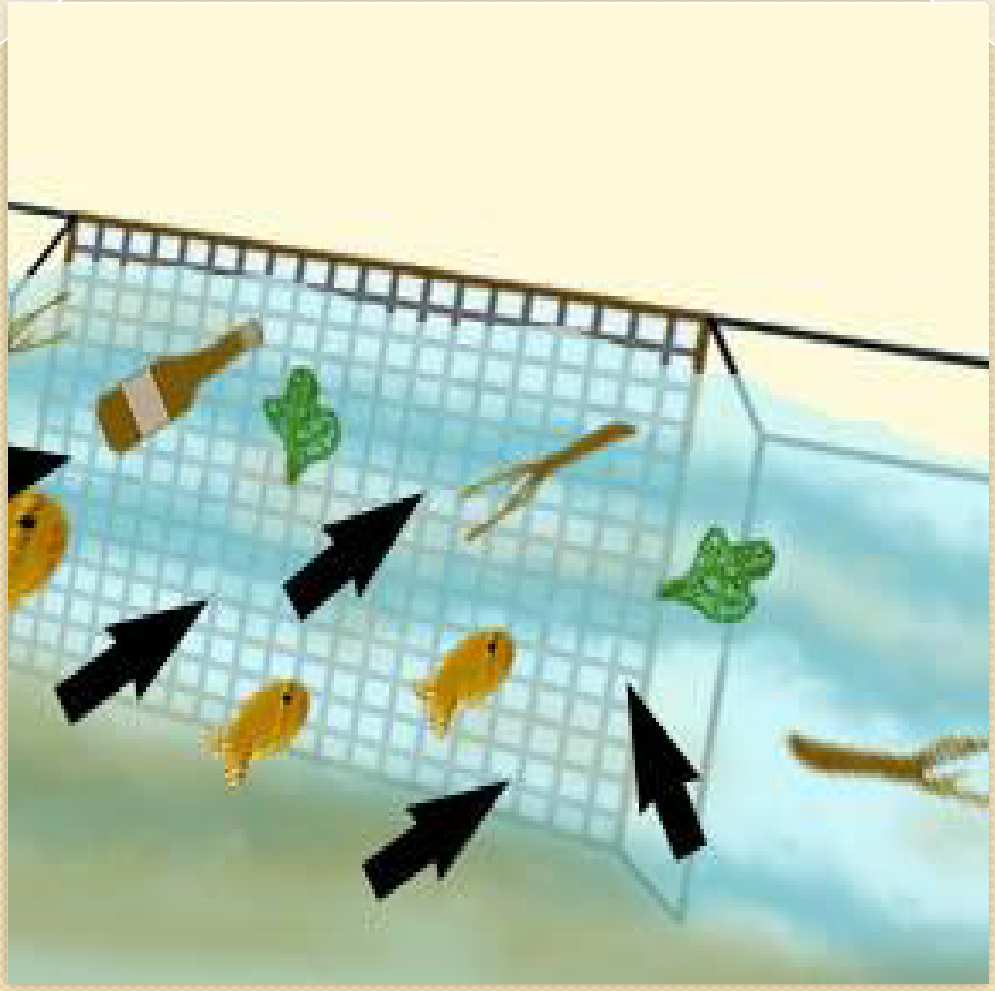
These objects can clog or blockage the water-treatment system and must be removed before the water enters the treatment plant.

Treatment facilities that use surface water have large screens, covering the site of water intake.

The debris is too large to pass through the holes in the screens.

Thus, as the water enters the plant, the large debris is removed.

The screens must be cleaned periodically to remove any objects that have become stuck, so that they do not clog the screen and impede water flow into the plant.



This drawing shows some of the large objects in surface water that are removed as the water passes through a screen into the water-treatment facility

flocculation and **coagulation**

Sometimes the insoluble particles are too small to settle out quickly enough to use sedimentation alone.

Two processes, known as **flocculation** and **coagulation**, are used to create larger particles that will settle quickly to the bottom.

To remove these particles from the water, coagulation must be used.

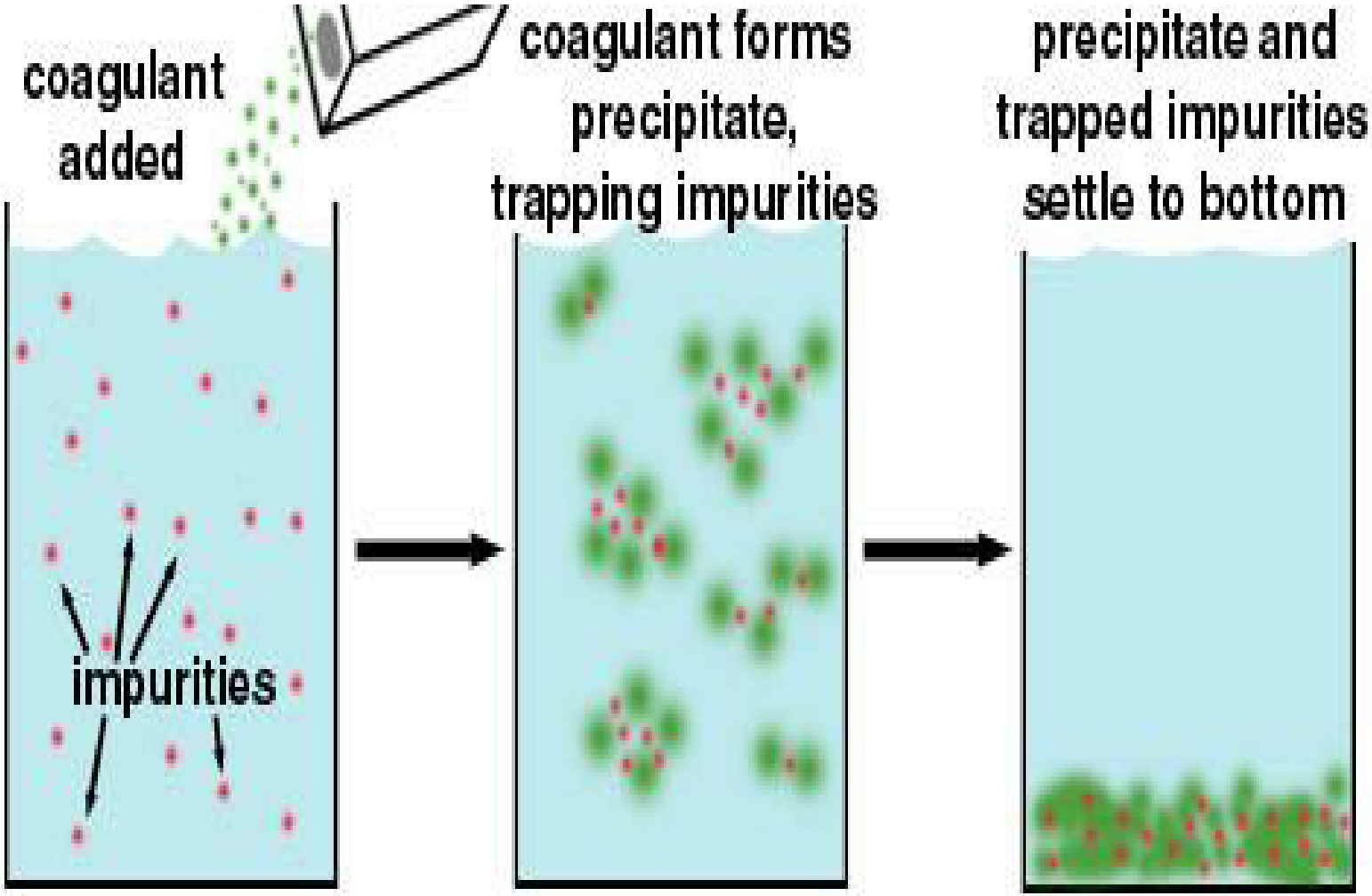
Coagulation is the process of gathering particles into a cluster or clot, often achieved by the addition of special chemicals known as **coagulants.**

The most common coagulant used in water-treatment facilities is **aluminum sulfate** (alum, $Al_2(SO_4)_3$).

These salts react with ions naturally found in the water to produce small flocs .

These flocs are caught with each other forming a larger mass that will settle to the bottom via sedimentation.

Mechanism of Coagulation



Sedimentation

In the precipitation step, the particles to be removed are part of the chemical reaction forming the precipitate.

In the coagulation step, the particles to be removed are not part of the reaction forming the precipitate; they are simply trapped in the precipitate that is formed from added chemicals.

Sedimentation

Sedimentation Tank

Circular Clarifiers

Filtration

Often, the particles generated by the precipitation reactions described above are too small to settle efficiently by sedimentation.

One strategy that is frequently employed to remove these solids is **gravity filtration** .

In this process, water containing solid impurities is passed through a porous medium, typically layers of sand and gravel.

The force of gravity is used to push the water through the medium.

The small water molecules pass through the holes between sand and gravel pieces.

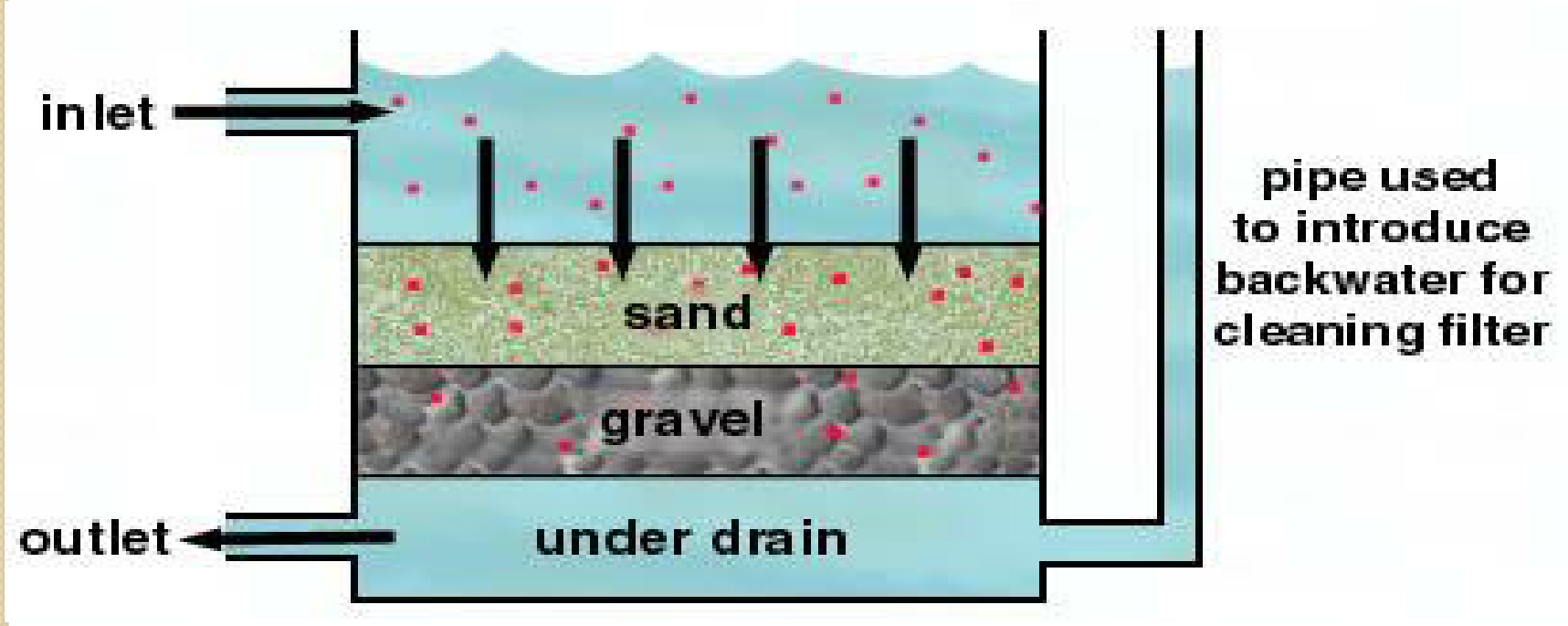
However, the solids (from precipitation) get stuck in the holes.

The water that passes through the bottom of the filter no longer contains those solid impurities.

Gravity filters at water-treatment plants have a pipe feeding into the under drain, the bottom layer where the clean water is collected.

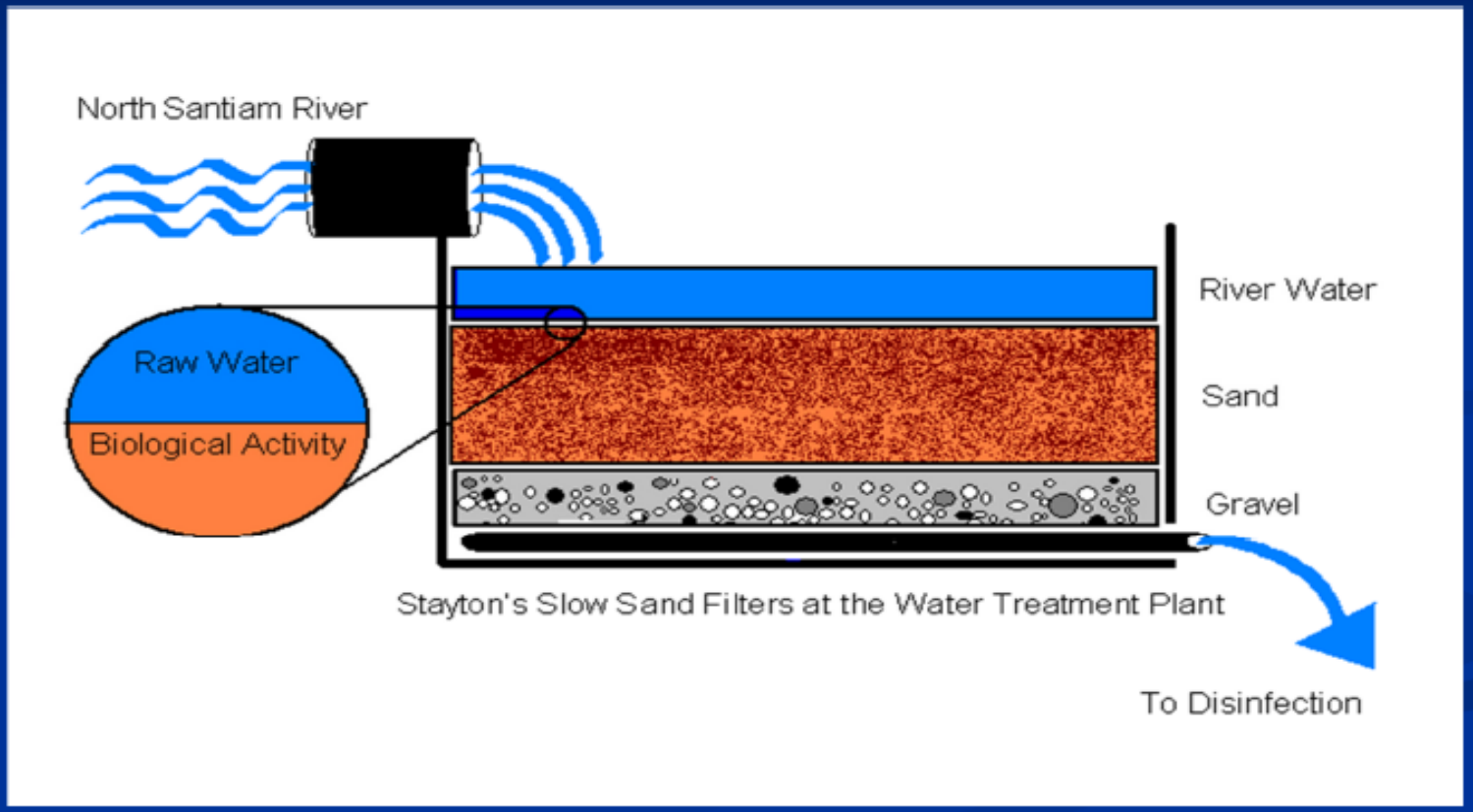
By adding water to the filter through this pipe, clean water can be forced upward through the filter to remove the solids that have collected in the filter. This process is used to clean the filter.

Water containing solid impurities (red) enters the filter through an inlet at the top and is forced by gravity through layers of sand and gravel. The solids get trapped between the sand and gravel pieces. The water that emerges into the under drain at the bottom of the filter is cleaned of these solids and exits the filter through an outlet at the bottom



Filtration

Slow sand filters



Filtration

Disinfection

Disinfection is the destruction of pathogenic organisms.

Disinfection Methods

Heat Treatment: good emergency procedure for small quantities of water.

Major disadvantages- no residuals disinfectant/ high energy costs

Types of Filtration

- Slow Sand
- Conventional Filtration
- Direct Filtration
- Diatomaceous Earth
- Membrane Filtration
- Bag and Cartridge Filters

Disinfection

- Chlorine
- Ozone and Ultraviolet Radiation
- Chlorine Gas
- Sodium Hypochlorite
- Calcium Hypochlorite

Radiation Treatment: Ultraviolet radiation

is not expected to cause any undesired disinfection by-products in contrast to for example conventional chlorination or recently lots of interest in disinfection gained electrochemical oxidation.

Efficiency of UV systems in disinfection is based on the fact that DNA molecule absorbs UV light which leads to the breakage of DNA and further to fast destruction of bacteria, disadvantages is no residual disinfectant, require a close contact between UV source and water.

Ozone: Ozone is effect over a wide pH range and rapidly reacts with bacteria, viruses, and protozoans and has stronger germicidal properties then chlorination.

Has a very strong oxidizing power with a short reaction time.

Ozone can eliminate a wide variety of inorganic, organic and microbiological problems and taste and odor problems.

The microbiological agents include bacteria, viruses, and protozoans.

but has disadvantages There are higher equipment and operational costs.

Ozonation provides no disinfection residual to inhibit or prevent regrowth.

zone is less soluble in water, compared to chlorine, and, therefore, special mixing techniques are needed.

Disinfection by Chlorine

Disinfection is the destruction of pathogenic organisms.
It is accomplished by the addition of a strong oxidant, usually some form of chlorine.

A pathogenic organism is disease-producing organism.

Water-borne diseases caused by bacteria typhoid, dysentery, cholera.

Water-borne diseases caused by viruses

hepatitis.

Water-borne diseases caused by protozoans

Giardiasis.

Chlorine (Cl_2) is a major disinfectant that is cheap and kills most of the serious disease-causing bacteria in the water.

However, chlorine disinfection results in a wide variety of by-products.

One class of chlorination by-products, known as trihalomethanes (THM's), are suspected carcinogens. Because of concern about these by-products in the water supply, chlorine is now kept to minimum levels.

Storage

A **water tank** is a container for storing liquid. providing storage of water for drinking water.

By design a water tank or container should do no harm to the water. Water is susceptible to a number of negative influences, including(bacteria, viruses, algae, corrsion).

A correctly designed water tank works to mitigate these negative effects.

Various materials are used for making a water tank.

Large water tanks are usually made of concrete, but the chlorine that is added to the water to kill bacteria, neutralizes the surface of the concrete walls, promoting corrosion of some of the bars and causing degradation of equipment.

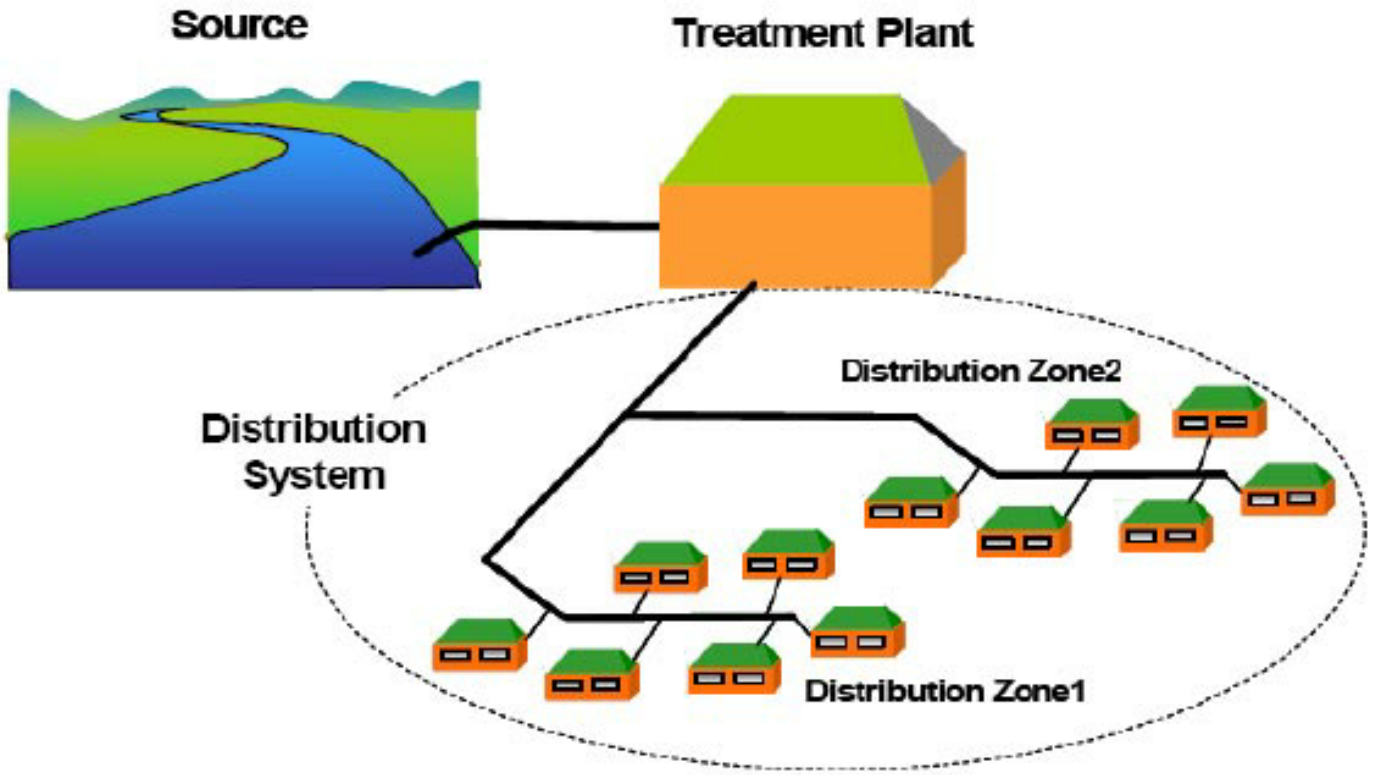
This makes it necessary to conduct repeated repairs at great expense.

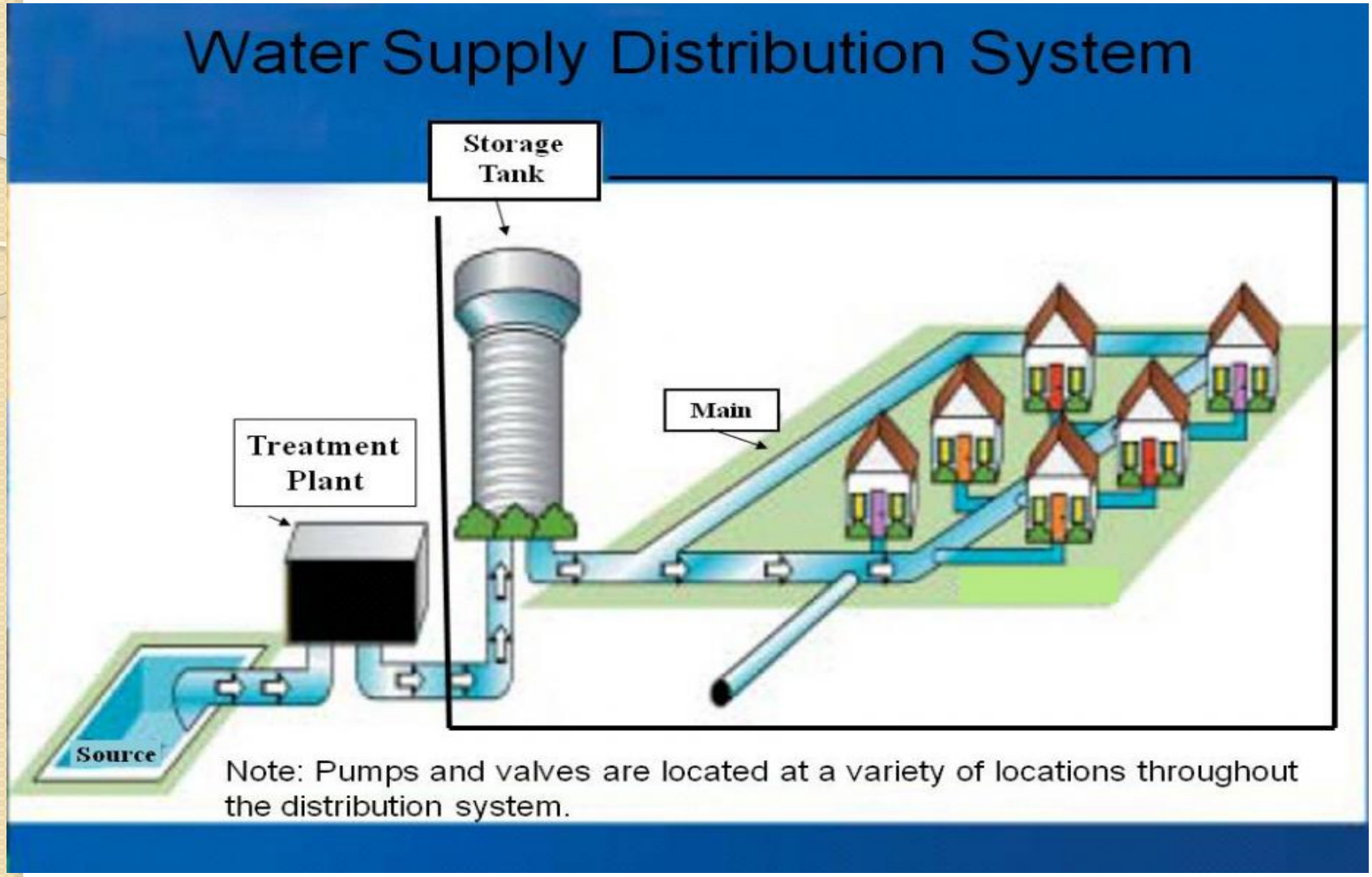
Stainless steel was found to be superior in: ease of construction, resistance to earthquakes,ability to be made watertight, corrosion resistance, and durability.

a comparison was made of total construction costs plus maintenance costs, the results indicated that stainless steel was the best option, based on a useful life of at least 60 years.

Stainless steel tanks

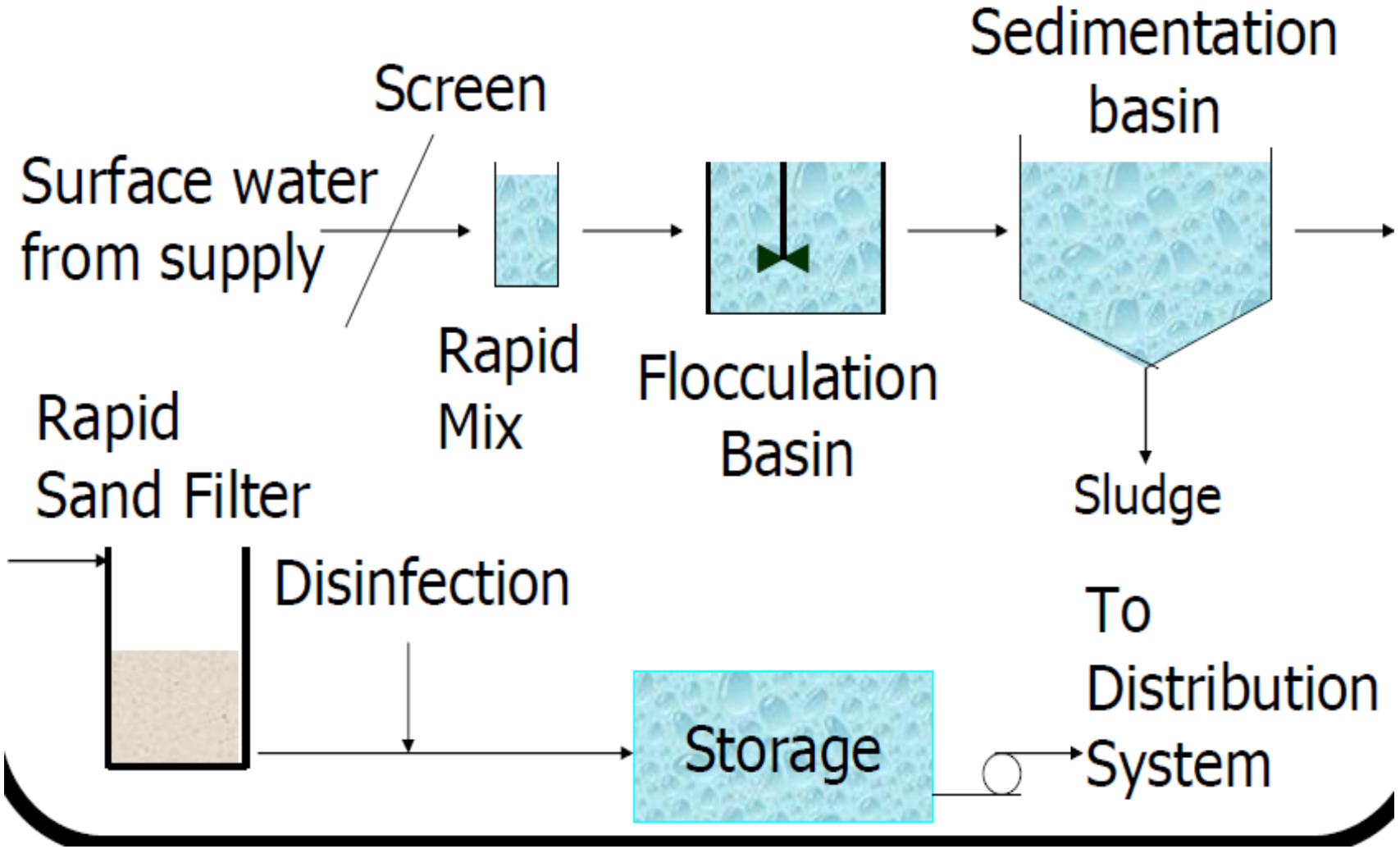
Distribution





Water Distribution Systems consist of interconnected pipes

Conclusion


Screen
Surface water
from supply
Rapid
Mix
Flocculation
Basin
Sedimentation
basin
Sludge
Rapid
Sand Filter
Disinfection
Storage
To
Distribution
System

:References •

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youtube)) Science channel

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