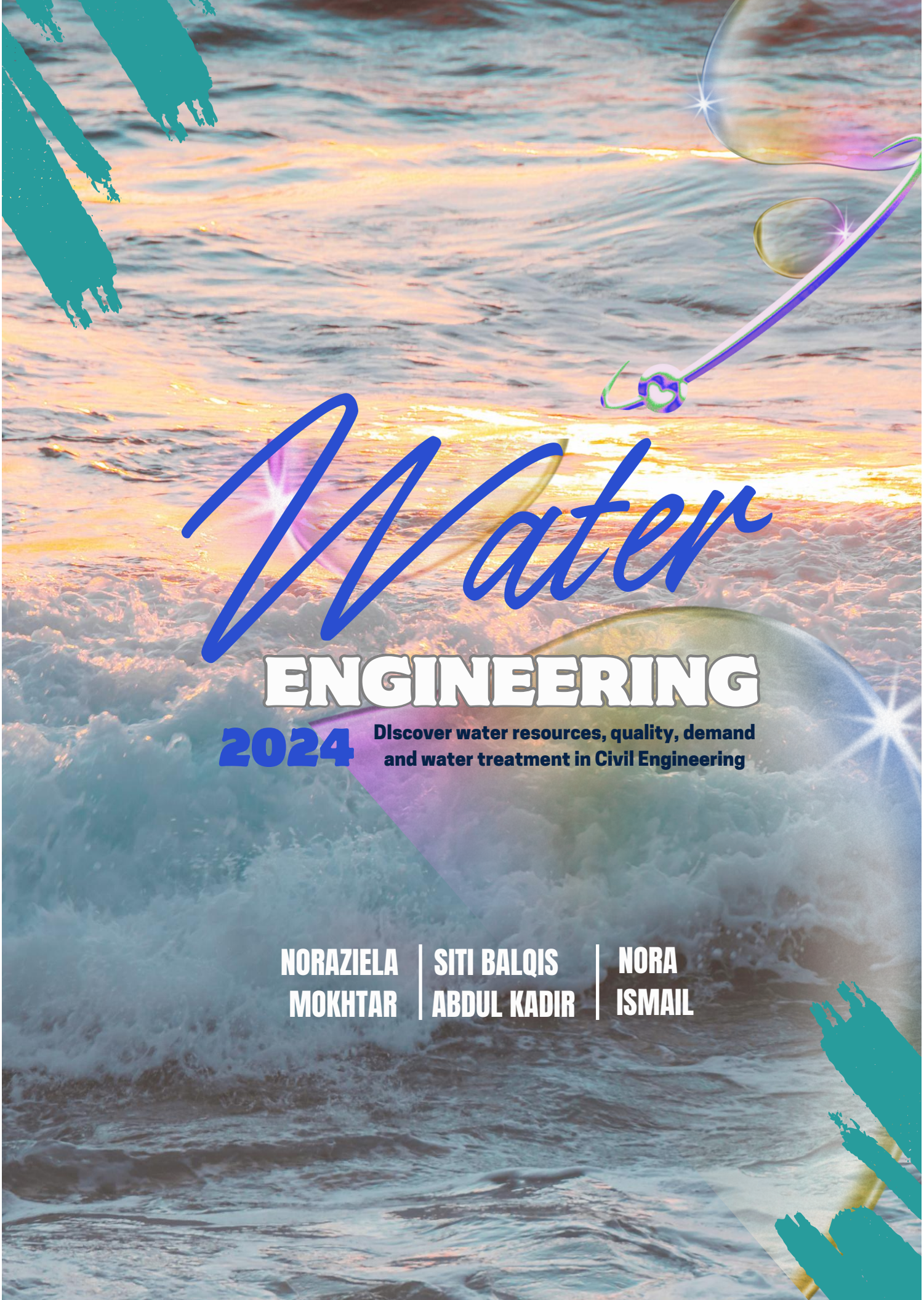
Water
ENGINEERING
2024
DIscover water resources, quality, demand and water treatment in Civil Engineering
NORAZIELA MOKHTAR
SITI BALQIS ABDUL KADIR
NORA ISMAIL

POLITEKNIK MALAYSIA
PORT DICKSON

WATER ENGINEERING

2024

CIVIL ENGINEERING

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We are deeply grateful to all those who have contributed to the production of this Water Engineering ebook. All the support and dedication have been instrumental in bringing this project to fruition. Thank you all for your unwavering contributions. Please enjoy reading.

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AUGUST
2024

PREFACE

This ebook on Water Engineering in Civil Engineering offers a comprehensive overview of water resources management, usage, and treatment processes. It is designed to serve as an essential guide for students, professionals, and researchers.

The e-book begins with an in-depth exploration of water resources, discussing the availability, distribution, and management of this critical resource. It highlights the importance of sustainable practices to ensure the long-term viability of water supplies.

Next, the book examines various water usage patterns, focusing on domestic, industrial, and agricultural demands. It emphasizes the need for efficient water use and the implementation of conservation measures to address growing water scarcity.

Accurate population estimation is crucial for effective water resources planning. The book provides methodologies for estimating current and future population sizes, which serve as a foundation for demand forecasting and infrastructure development.

The ebook delves into techniques for forecasting water demand, incorporating factors such as population growth, economic development, and climate change. It underscores the importance of accurate demand predictions to ensure that water supply systems can meet future needs.

Finally, the book covers the water treatment process, detailing the various stages and technologies involved in purifying water for safe consumption. It addresses the challenges of maintaining water quality and the importance of adhering to regulatory standards.

Overall, this ebook aims to equip readers with a solid understanding of the principles and practices of water engineering in civil engineering, preparing them to tackle the complex challenges of managing and preserving water resources in an ever-changing world.

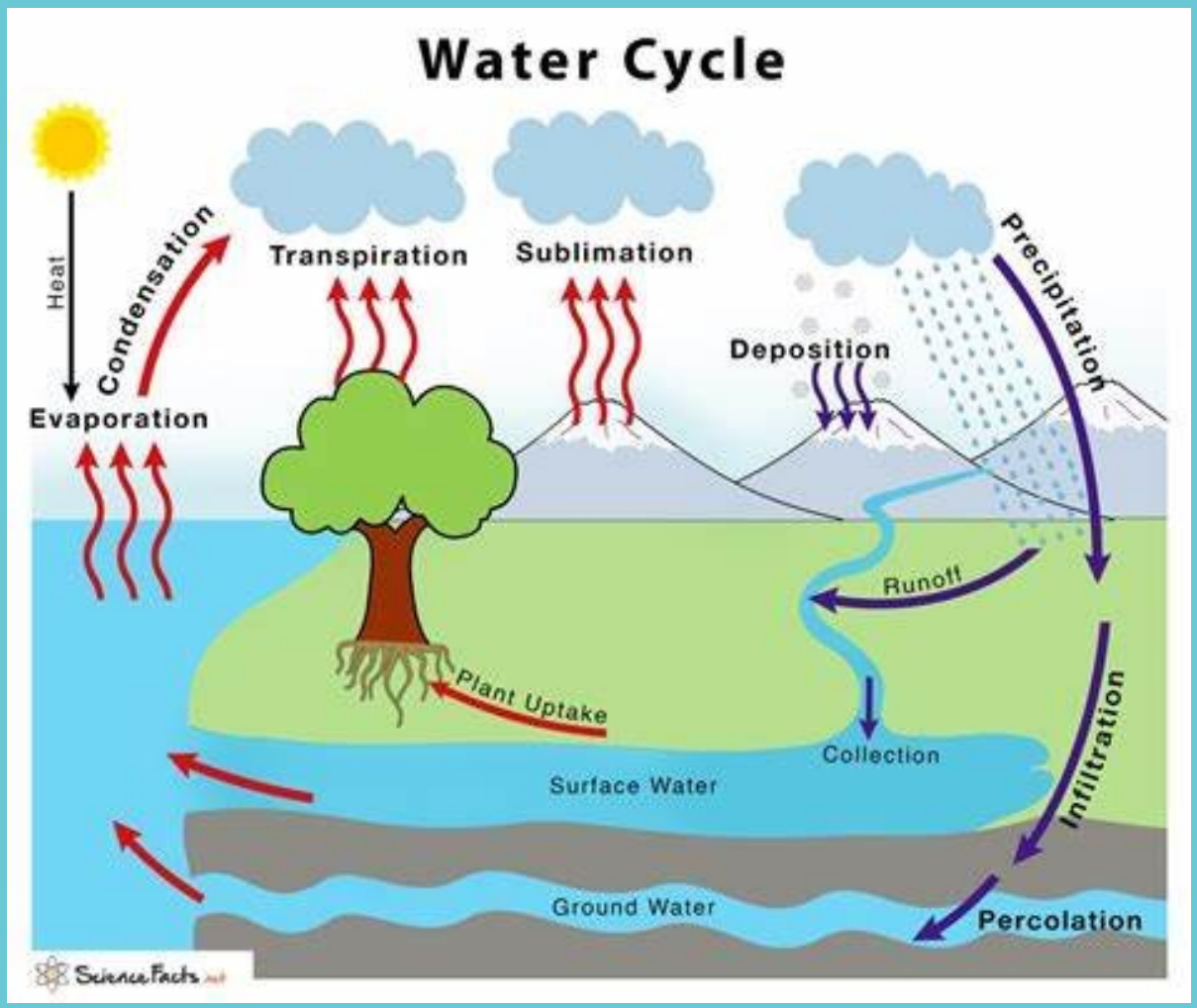
TABLE OF CONTENTS

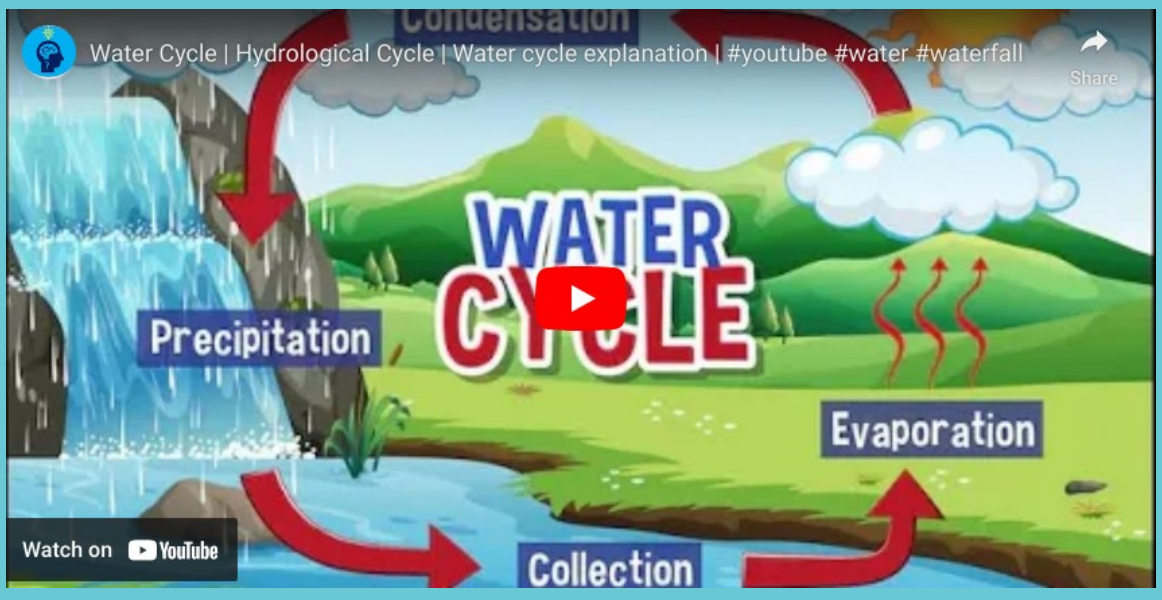
1

WATER RESOURCES & QUALITY

WATER CYCLE

Surface water is a portion of the water cycle, also known as the hydrologic cycle, which is the flow of water into and out of the surface of the Earth. Surface water bodies are fed by precipitation and water runoff. Water bodies lose water as a result of evaporation and seepage into the earth, however.




Water Cycle | Hydrological Cycle | Water cycle explanation | #youtube #water #waterfall
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THE IMPORTANCE OF WATER RESOURCES

1. To control the hydraulic to convey water to where it is needed.

2. To design works in open channels, pipe networks, groundwater flow, and hydraulic structures to control the flow of water.

3. To protecting water projects might include beaches from tsunamis and erosion, keeping harbors clear of silt,

4. design of well fields for municipal, industrial and agricultural use, and locks and dams for navigation.

5. To provide benefits multi-purpose projects such as flood control, hydroelectric power, recreation, irrigation, water supply, and enhancing the environment.

THE IMPORTANCE OF WATER USAGE

1. DOMESTIC

2.INDUSTRIAL

3. COMMERCIAL

4. AGRICULTURAL & FARMING

5. PUBLIC

6. NON-REVENUE WATER (NRW)

TYPE OF WATER RESOURCES

A. SURFACE WATER

Surface water refers to any body of water that is present on the surface of the Earth, encompassing freshwater found in rivers, streams, wetlands, reservoirs, creeks, and lakes as well as saltwater found in the ocean. Surface water mostly consists of rivers.

Figure 1 Sg. Pahang, Malaysia

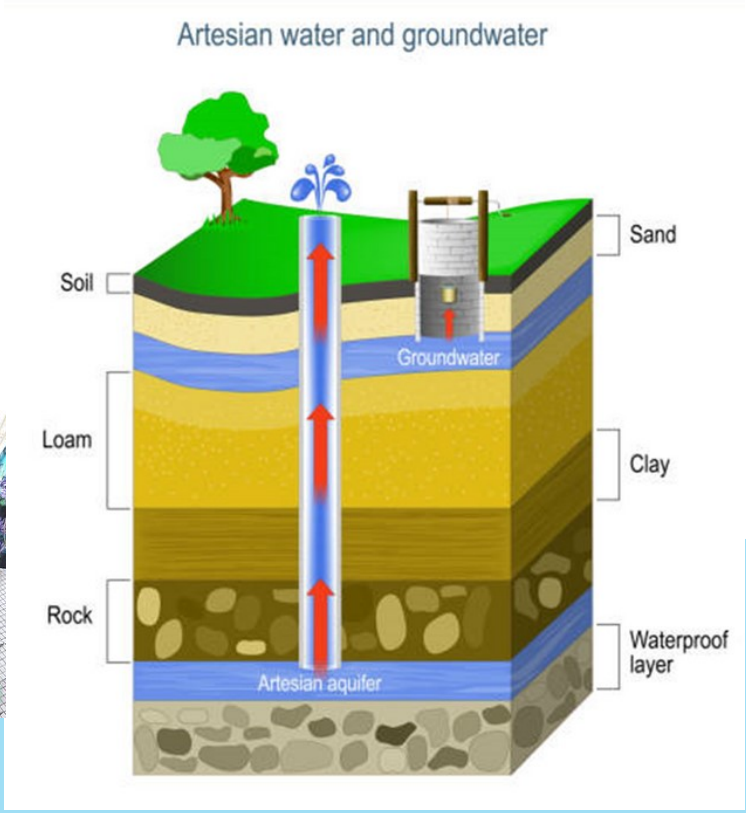
Figure 2 Terusan Wan Mat Saman Kedah

Figure 3 Wetland Putrajaya

Figure 4 Kenyir Dam

B. GROUND WATER

Groundwater is the term for water that seeps deeply into the earth. Groundwater is freshwater found in the pore spaces beneath rocks and dirt. Water is also present in aquifers that are below the water table.



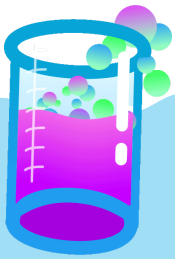
WATER QUALITY CHARACTERISTIC

PHYSICAL

- Turbidity
- Suspended Solid
- Taste and Odour
- Colour
- Temperature

CHEMICAL

- Total Dissolved Solid (TDS)
- Alkalinity
- Hardness
- Fluoride
- Metal
- Inorganic and Organic Matter
- Nutrient



BIOLOGICAL

- Bacteria
- Protozoa
- Virus
- Fungi and Algae

PHYISICAL CHARACTERISTIC

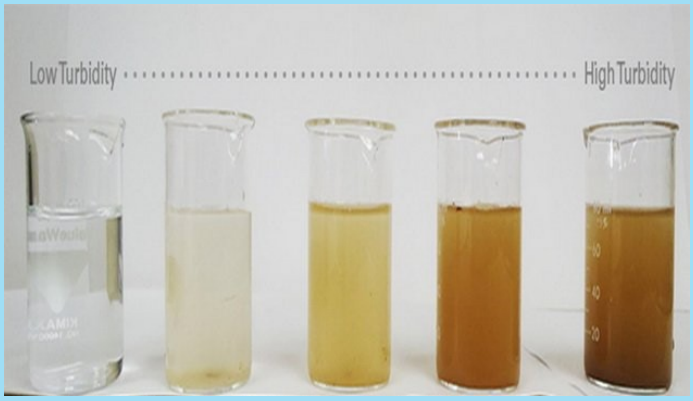
TURBIDITY

Table: WHO Guideline and National Water Quality Standards for Malaysia (DOE)

Parameters	Unit	WHO Guidelines	National Water Quality Standard of Malaysia for Drinking Water
Turbidity	NTU	5	<5
Colour	TCU	15	<15
pH		6.5-8.5	6.5-9.0
Free Residual Chlorine	mg/l	0.3-5.0	0.2-5.0
Ammoniacal Nitrogen	mg/l	1.5	<1.5
Fluoride	mg/l	1.5	0.4-0.6
Aluminium	mg/l	0.9	<0.2
Manganese	mg/l	0.08	<0.1

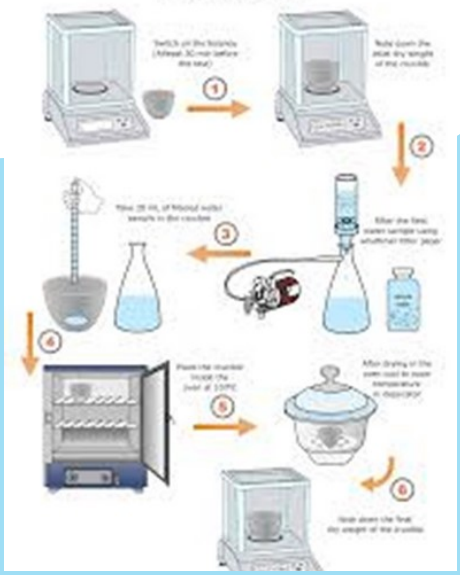
(Source: WHO and Ministry of Health, National Drinking Water Quality Standard)

- **Turbidity is a measurement of the amount of suspended and colloidal particles in water that transmits light. It matters for both aesthetic and health-related reasons.**



SUSPENDED SOLID

- The residue left over after the water evaporates and it is dried to a consistent weight between 103 and 105 degrees Celsius is known as the total solids content of water. The weight of the residue left over after the water evaporates and the residue is ignited at 500 °C is known as the organic fraction, also known as the volatile solids content.
- This temperature will cause the volatile solids to oxidize and escape as gas. Similar to inert ash are the inorganic (or fixed) solids. Three categories exist for solids: filterable, suspended, and settleable.
- Based on the size of particles and the amount of suspended solids retained on regular glass-fiber filters, suspended solids and filterable solids are categorized.



TASTE & ODOUR

- **Humans judge the quality of water by its taste and odor. The four flavors that humans perceive are sour (hydrochloric acid), salty (sodium chloride), sweet (sucrose), and bitter (caffeine).**
- **More smell clues are detected by humans than tastes. Compounds that produce tastes and odors during biodegradation are generated when organic materials, including runoff and falling leaves, are dumped directly into water bodies.**

Compound	Chemical Formula	Odor quality
Amines	CH_3NH_2, $(CH_3)_3H$	Fishy
Ammonia	NH_3	Ammoniacal
Diamines	$NH_2(CH_2)_4NH_2$, $(CH_2)_5NH_2H_{25}$	Rotten eggs
Mercaptans		
(E. g, methy1 and ethy1)	CH_3SH, $CH_3(CH_2)SH$	Decayed cabbage
Organic sulfides		Rotten cabbage
Skatole		Fecal matter

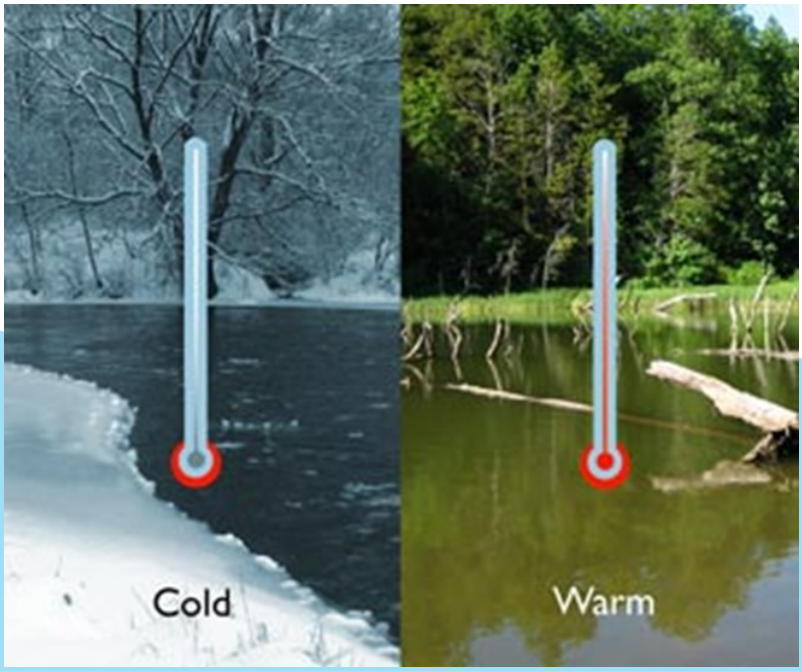
10

COLOUR

- Another physical feature that can be used to assess the quality of water is its colour. Pure water has no colour. When foreign materials like organic matter from soils, plants, minerals, and aquatic life are present, the flavor of the water changes.
- True colour and apparent colour are the two categories for color in water. When suspended stuff is removed from the water, the dissolved solids that are left behind give it its true colour.
- Apparent colour is the colour that suspended matter contributes to. True colour in water treatment is the hardest to get rid of.

TEMPERATURE

- Groundwater and surface water are heated in a variety of ways. There are synthetic and natural ones among them.
- The solubility of oxygen in water, the rate of bacterial activity, and the transfer rate of gases to and from the water are all influenced by increases in heat or temperature in surface water.
- Temperature fluctuations are common in surface waters. Chemical dissolution and reaction rates are influenced by temperature.

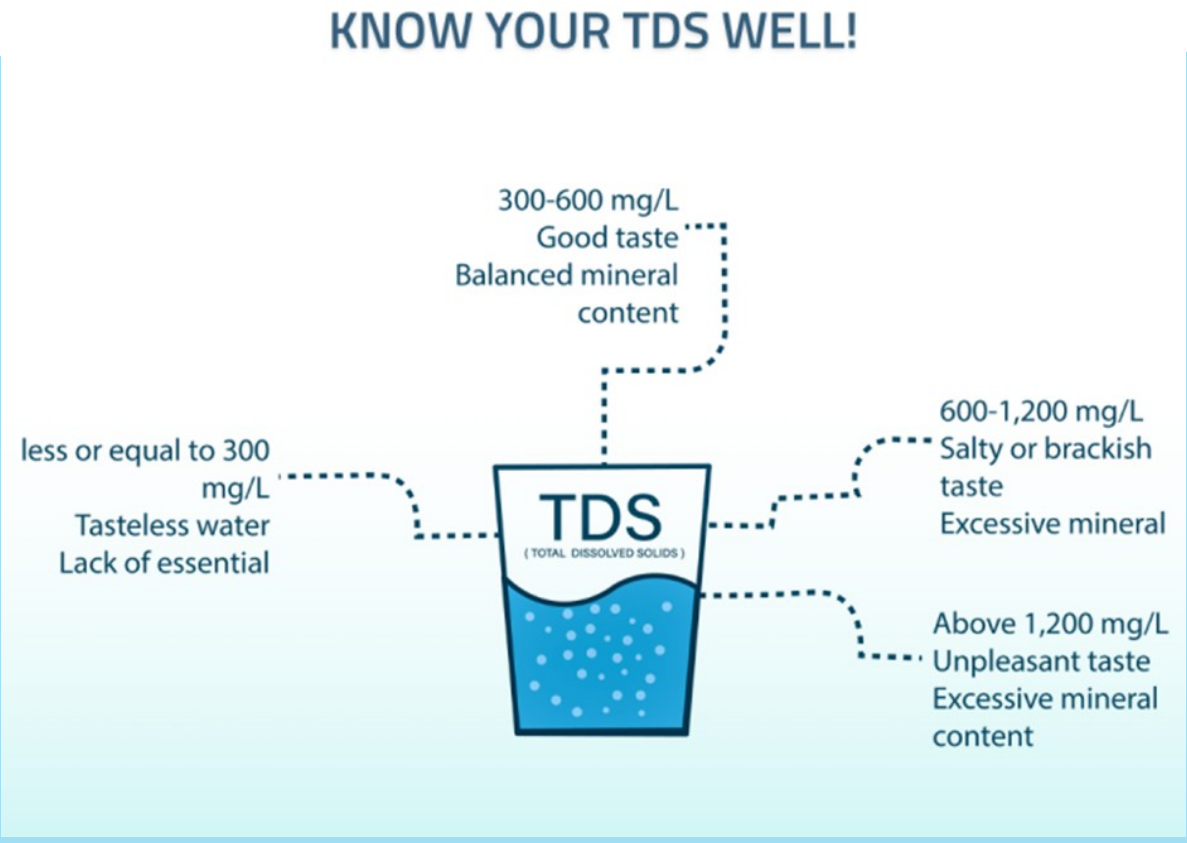


SPECIES	TEMPERATURE RANGE	SPECIES	TEMPERATURE RANGE
Redbreast sunfish	80° to 84° F	Smallmouth bass	67° to 71° F
Flathead catfish	78° to 82° F	Striped bass	65° to 75° F
Blue catfish	77° to 82° F	White bass	65° to 75° F
Channel catfish	75° to 80° F	Walleye	65° to 75° F
Bluegill	75° to 80° F	Northern pike (under 7 lbs.)	65° to 70° F
Spotted bass	73° to 77° F	Northern pike (over 7 lbs.)	50° to 55° F
Redear sunfish	73° to 77° F	White sturgeon	65° to 70° F
Black, white crappies	70° to 75° F	Wiper	64° to 66° F
Largemouth bass	68° to 78° F	Sauger	62° to 72° F
Muskie	67° to 72° F	Shad	60° to 65° F

CHEMICAL CHARACTERISTICS

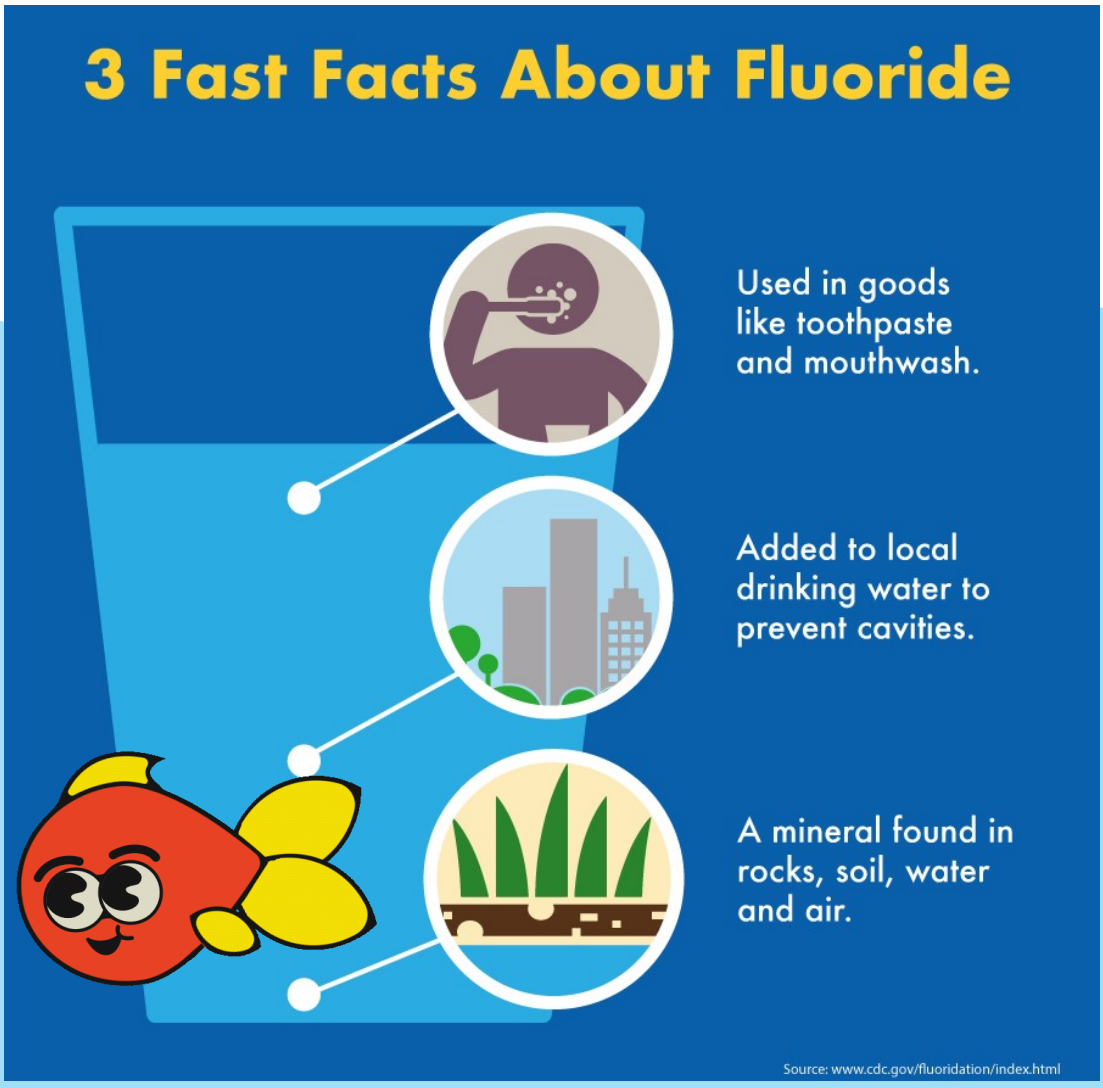
TOTAL DISSOLVED SOLID

- **Both organic and inorganic substances can dissolve. These materials can be found in the soil, on surfaces, and in the environment and can come into contact with water.**
- **The organic substances that dissolve in water are derived from organic gases, organic compounds, and the decomposition products of vegetation.**
- **Reverse osmosis, electrodialysis, distillation, and ion exchange are methods for extracting dissolved solids from water.**



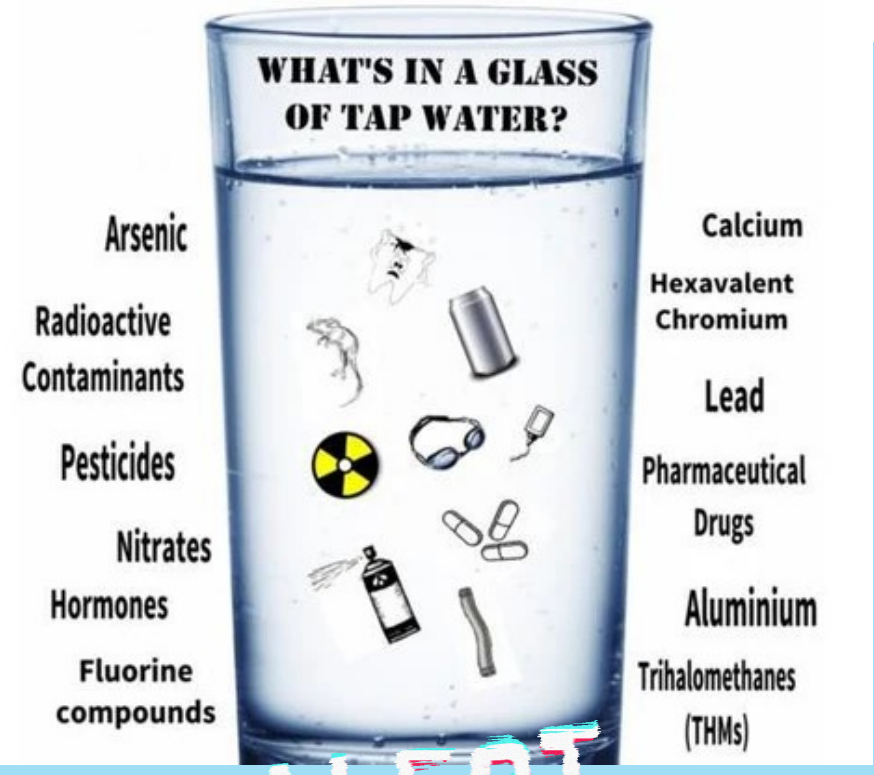
FLOURIDE

- Small doses of fluoride (approximately 1.0 mg/L in drinking water) have certain advantages.
- Research indicates that children between the ages of 12 and 15 can see a 65% reduction in tooth decay when they consume water with the recommended level of fluoride.
- Teeth discolouration may occur when high dosages (>2.0 mg/L) are taken. Fluoride has no effect on teeth in adulthood.



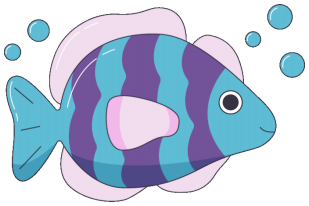
METAL (INORGANIC COMPOUNDS)

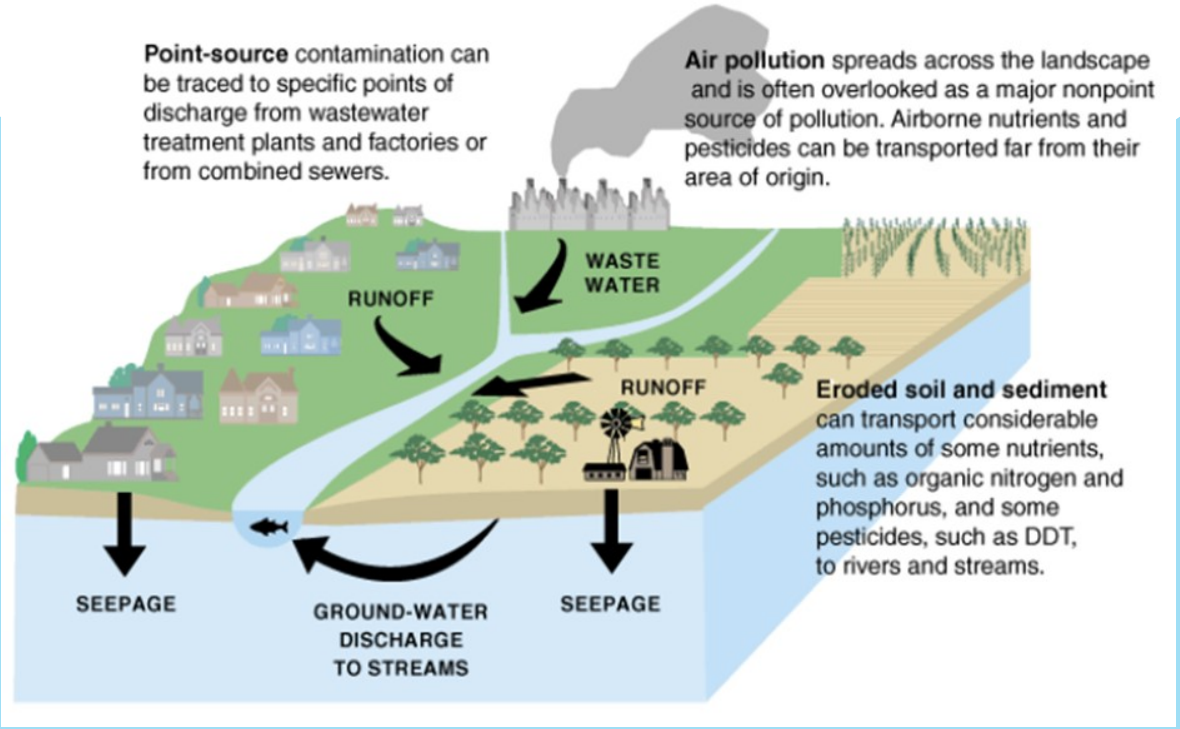
- Groundwater and surface water absorb metal ions when they come into contact with metal-containing rock or soil, which typically takes the form of metal salts.
- Hazardous metals in drinking water can be detrimental to humans and other living things, even at low concentrations. The following hazardous metals can dissolve in water: arsenic, barium, cadmium, chromium, lead, mercury, and silver.
- Organisms at the top of the food chain are most at risk from these metals because they are concentrated along the food chain.



ORGANIC MATTERS

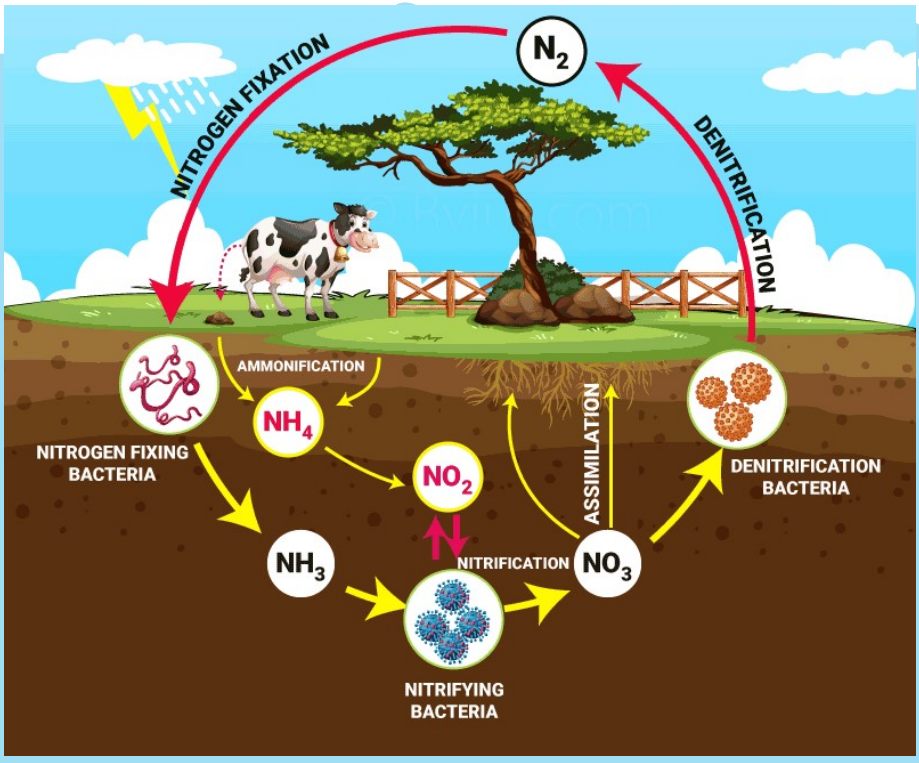
- The main source of organic chemicals found in water is synthetic carbon-containing compounds like dioxin, polychlorinated biphenyls (PCBs), and dichlorobiphenyl-trichloroethane (DDT), which are all harmful organic compounds.
- Due to their inability to quickly decompose in natural ecosystems, these synthetic substances frequently persist and accumulate in the environment. Numerous of these substances can result in birth abnormalities and cancer in humans.



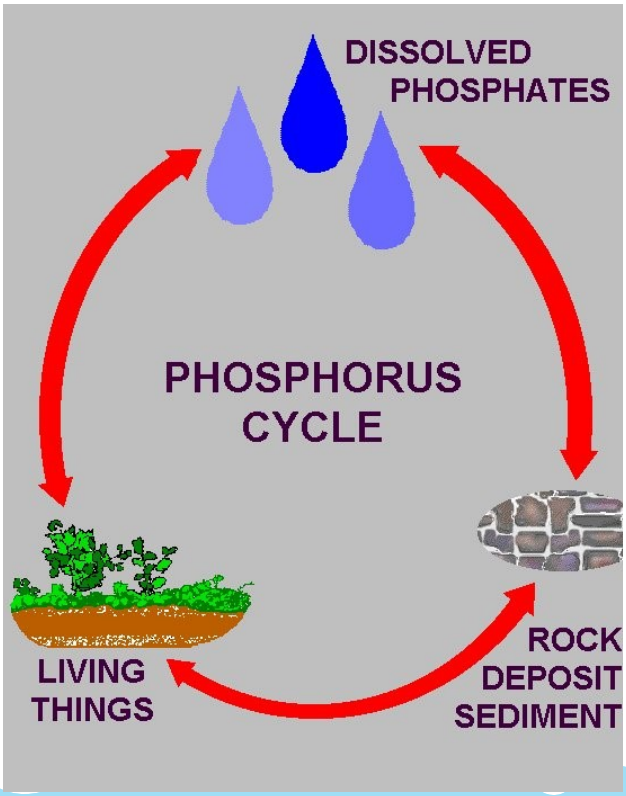


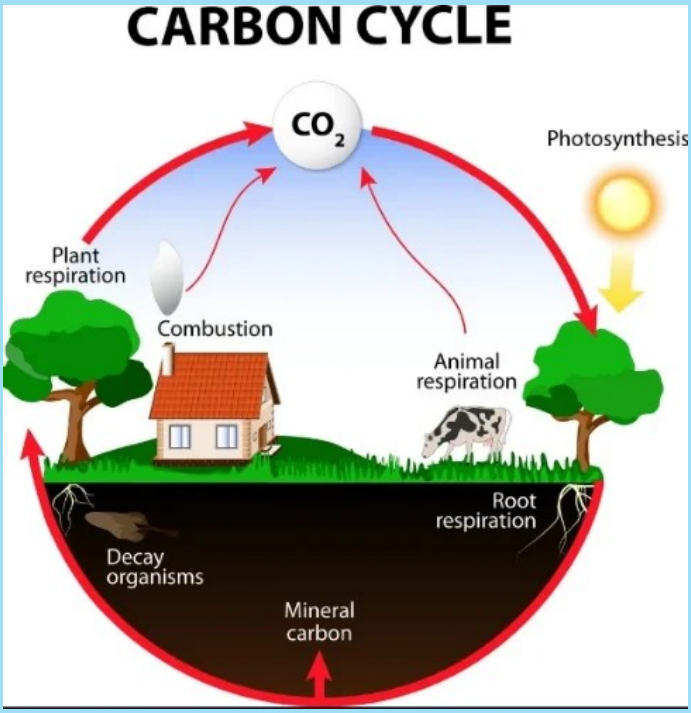
NUTRIENTS (NITROGEN, PHOSPHOROUS & CARBON)

- Alkalinity, the decomposition products of organic waste, and dissolved carbon dioxide from the environment are some of the natural sources of readily available carbon.
- The most frequent type of nitrogen in water is nitrate (NO3). Drinking water containing nitrates can cause fatal nitrate poisoning and other severe health issues. Blue-baby syndrome is the term for the BLUE discolouration that occurs when an infant experiences oxygen shortage due to nitrite replacing oxygen in the circulation.
- Phosphorus occurs naturally as phosphate. Phosphates found in detergents, fertilizers, feedlot runoff, and municipal wastewater discharges are major sources of phosphorus.



NUTRIENTS (NITROGEN,PHOSPHOROUS & CARBON)



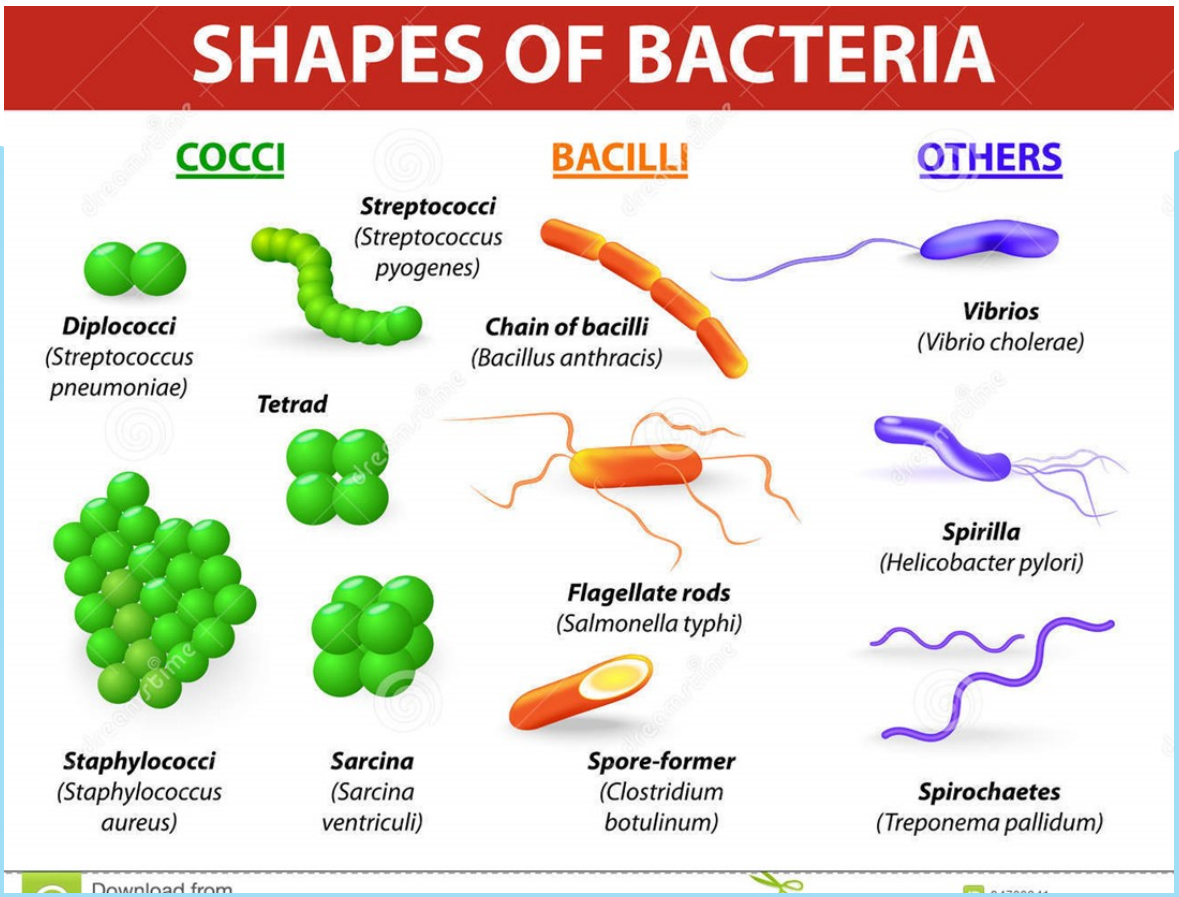


BIOLOGICAL CHARACTERISTICS

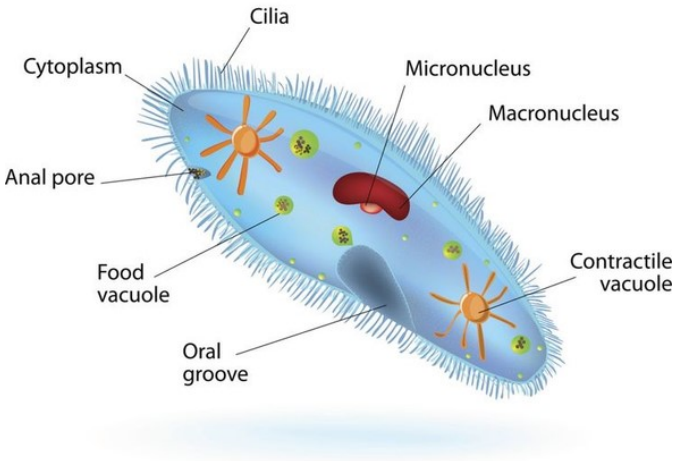
Pathogenic Organisme

The five major types of pathogens include viruses, bacteria, protozoa, fungi, algae, and helminthes.

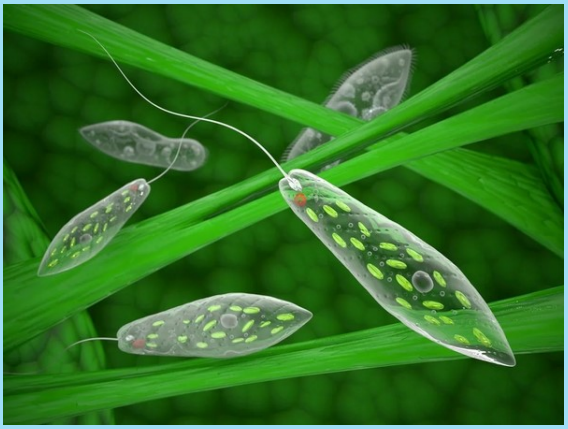
BACTERIA



PROTOZOA

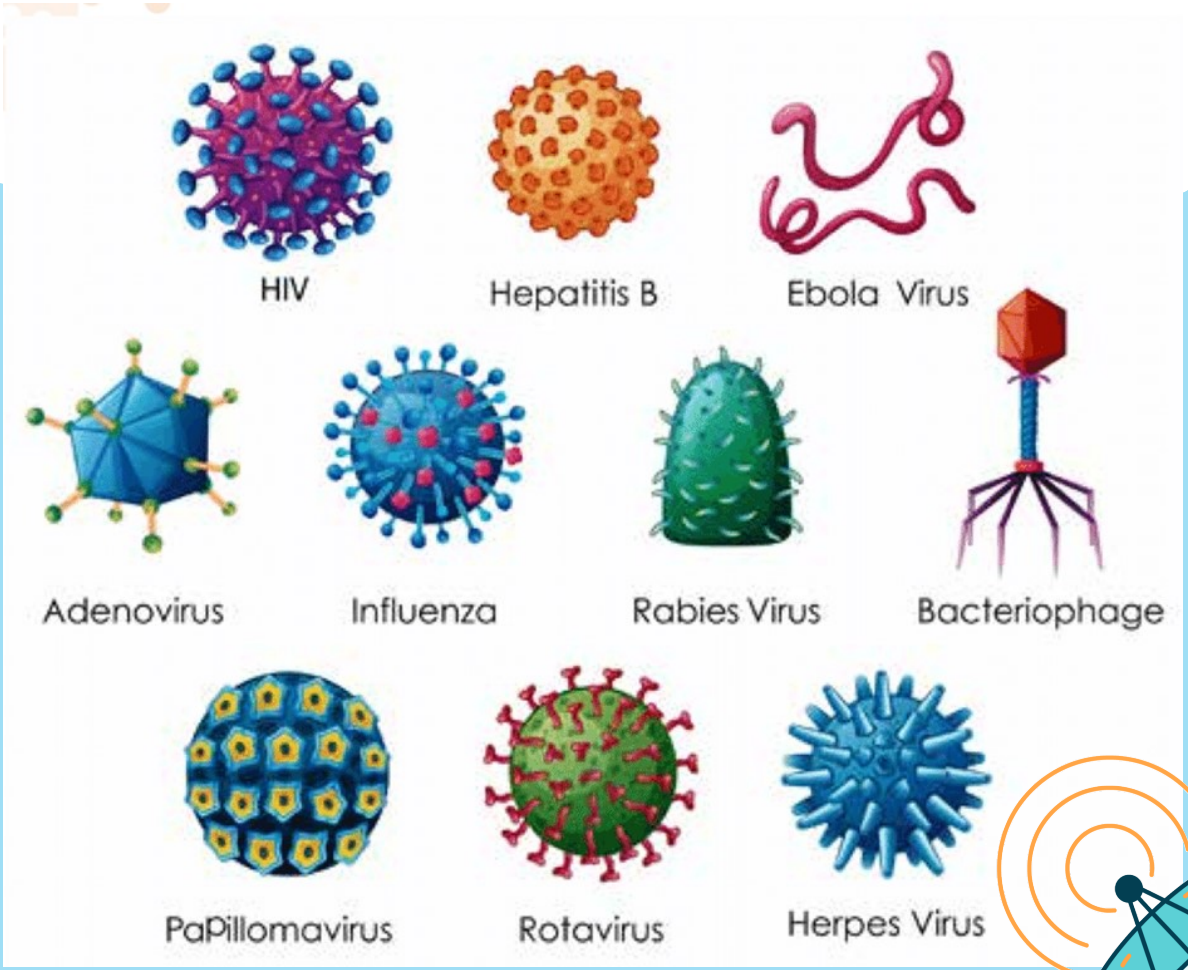


- **Single-celled, mobile, self-sufficient organisms known as protozoa can be microscopic or macroscopic, pathogenic or non-pathogenic, and free-living or parasitic.**
- **The length of protozoa can vary from two to several hundred microns. Few of them are parasitic, but they are widely spread and incredibly adaptive in natural waters.**
- **Few protozoa cause illness in humans; the majority are innocuous. Aquatic protozoa are difficult to deactivate by disinfection and require filtration in order to be removed because they produce cysts under unfavorable environmental conditions.**



VIRUS

- A virus is a dangerous microbe that can cause illness in humans and animals and can be found in water sources.
- These viruses can persist in aquatic environments for long periods of time and are frequently derived from polluted human or animal feces.
- Hepatitis A, rotavirus, enterovirus, and norovirus are common waterborne viruses.
- At 20 degrees Celsius, certain viruses can survive for up to 41 days in water and wastewater. Treatment and disinfection procedures are used in safe drinking water practices in order to get rid of or neutralize dangerous viruses.



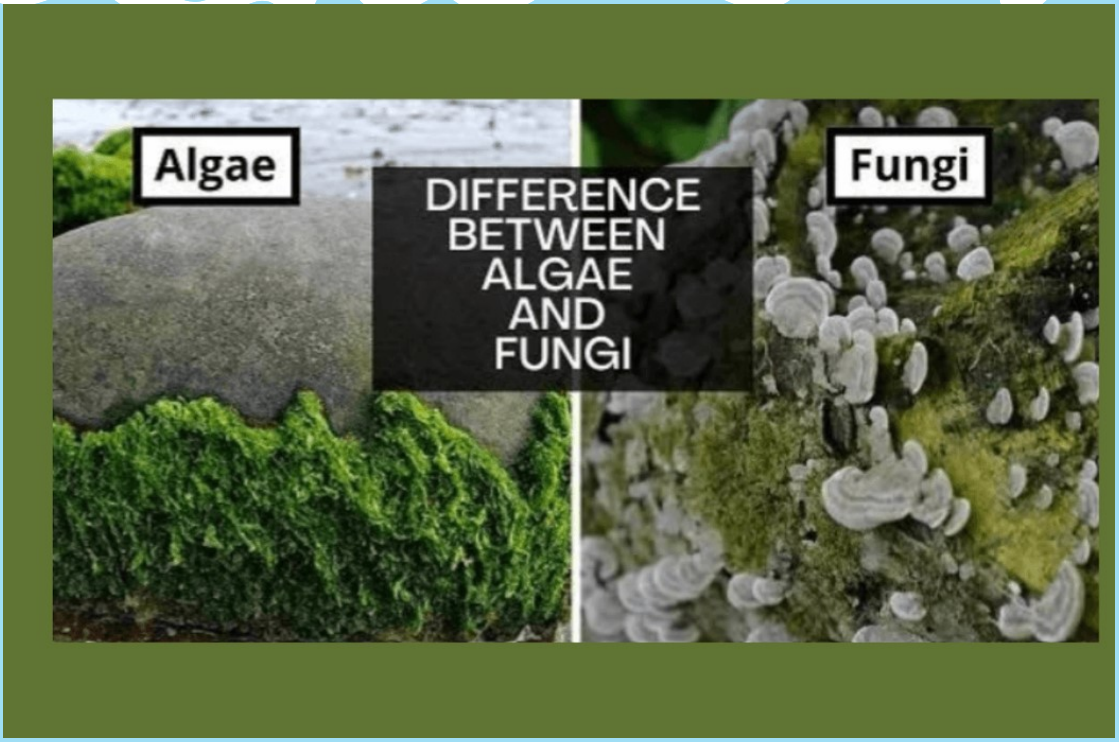
FUNGI & ALGAE

Fungi:

- Important in decomposing organic matter to a simple form.

Algae:

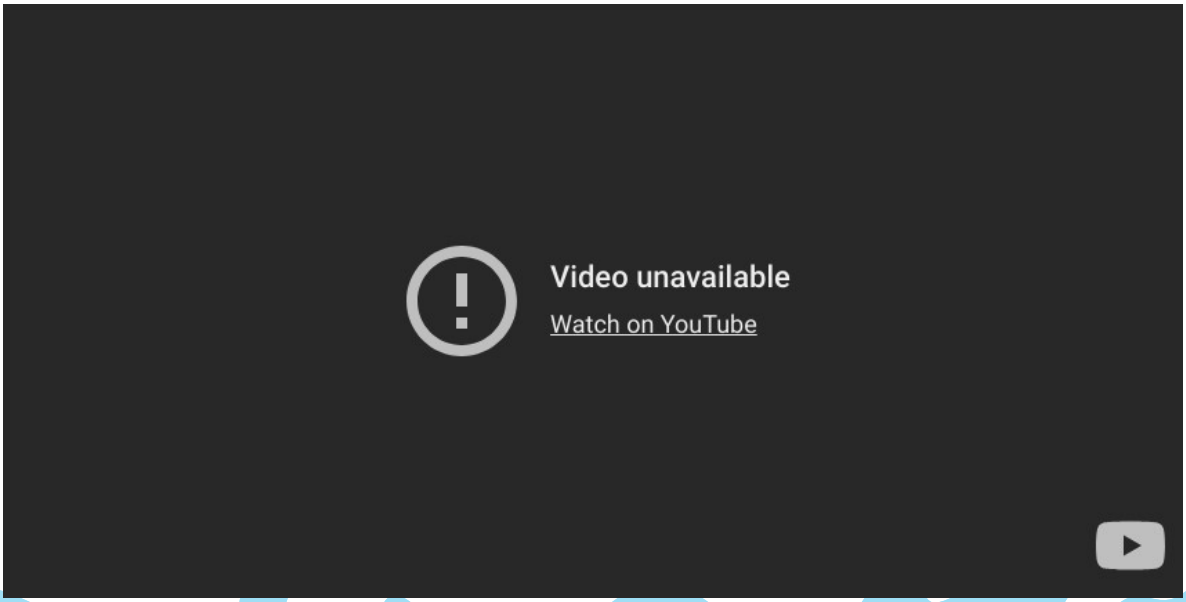
- beneficial in oxidation ponds, but when decomposed, may result in taste and odor issues as well as eutrophication events.



HOW HUMAN IMPACT RESULTS IN A REDUCTION OF FRESH WATER AND DEGRADATION OF WATER QUALITY?


HMM


Brainstorm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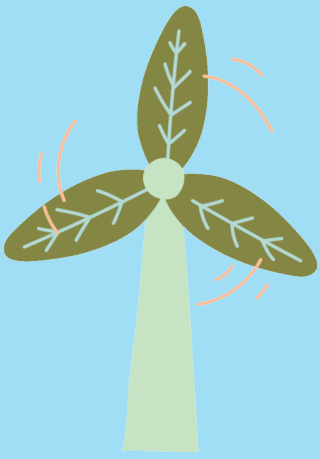
CONSTRUCTION

INDUSTRIAL



AGRICULTURAL

MUNICIPAL SOLID WASTE

HUMAN BEHAVIOR

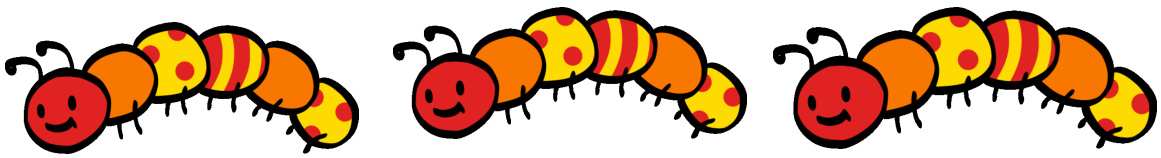
ACTIVITIY 1

QUIZ 5 MINUTES

-PREPARE THE PAPER

-WRITE YOUR NAME AND MATRIC NO.

ANSWER WITH HANDWRITING



1. GIVE THREE EXAMPLES THE SOURCES FROM WATER SURFACES.
2. LIST FOUR(4) WATER CHARACTERISTICS OF EACH ITEM BELOW:
   - PHYSICAL,
   - CHEMICAL AND
   - BIOLOGICAL
3. EXPLAIN THE IMPACT RESULTS IN A REDUCTION OF FRESHWATER AND DEGRADATION OF WATER QUALITY TO:
   - HUMAN AND
   - INDUSTRIAL

2

USAGE & DEMAND OF WATER SUPPLY

WATER USAGE & DEMAND

Water is a vital necessity for human life and various industrial sectors.
Although the largest portion of Earth's water is saltwater found in the oceans, freshwater is crucial for most human and biological activities. Freshwater is sourced from rivers, lakes, and groundwater. The water cycle replenishes this supply by transferring water from the oceans to the land as freshwater.

Water usage is diverse and varies by location, but the demand for water is increasing as the global population grows. Sometimes, the local water supply cannot meet the demand, leading to significant issues. Factors such as climate conditions (including drought and global warming), water management practices, and over-exploitation place significant pressure on water supplies. Diverting water resources to boost supply can often negatively impact water quality and local ecosystems. To prevent a global water crisis, water conservation measures and scientifically sound water management practices are essential.

FACTORS INFLUENCE WATER DEMAND

1. Population

The increase in population in an area affects the water demand, especially in developed areas. For example, the number of population in Seremban in 2020 is 625,588 people compared to only 49,118 people in Rembau.

2. Industries & Commerce

Industrial sectors use large amounts of water such as power generation, refineries, construction, metal-based industries and mining. These sectors use raw water and treated water which may be subject to varying quality levels.

3. Climate

Hot and dry weather is a factor that affects the high demand for water. However, hot and dry weather factors can also cause river water levels to shrink and become a water use crisis.

4. Awareness

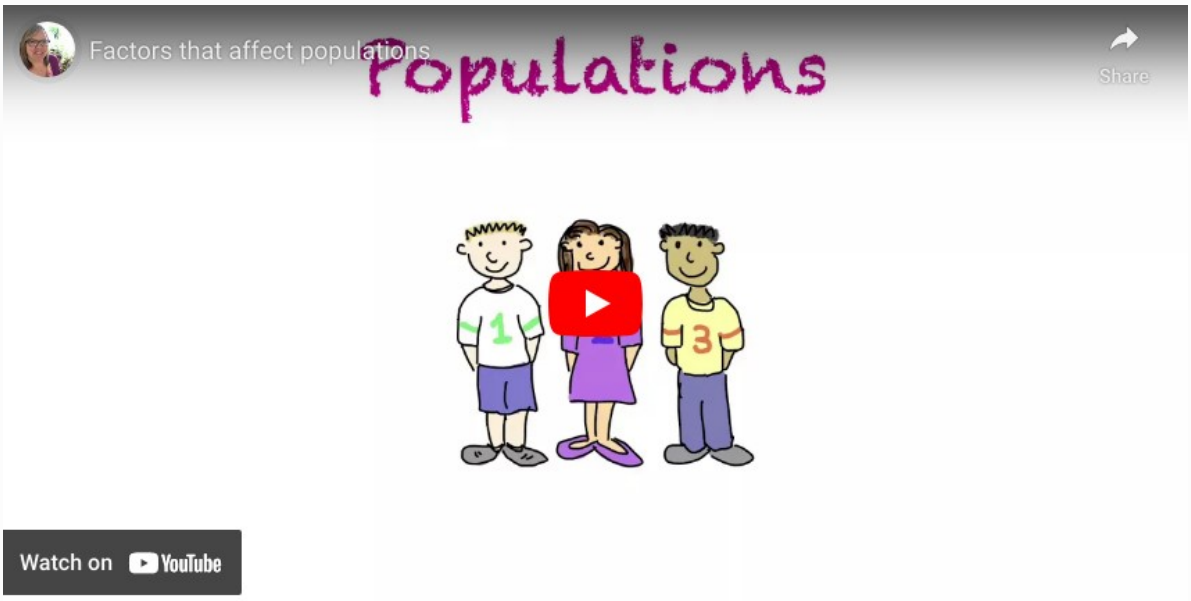
Water awareness as being cognizant of how much water is used daily through direct use and indirect use. Additionally, water awareness includes the realization of water quality threats such as agricultural run-off and the recognition that fresh water is a limited recourse.

5. Water Quality

Good water quality is a contributor to high water demand. Clean water with sufficient pressure encourages the unlimited use of water among consumers.

FACTORS AFFECTING

THE POPULATION GROWTH



https://youtu.be/jiPivM1PEhM?si=vgvhA_CZJgtd-kgW

POPULATION GROWTH ESTIMATION

A. ARITHMETIC INCREASE METHOD

- Assumption used when population increase with constant rate.
- The arithmetic increase method gives the lowest value of the population forecasted.

The formula for forecasting the population by arithmetic increase method is,

$$Pn = Po + nX$$

Where,

Pn = Population after 'n' number of decades,
Po = Initial population,
n = Number of decades, and
X = Arithmetic mean (average) of population increase over the 'n' decades

POPULATION GROWTH ESTIMATION

A. ARITHMETIC INCREASE METHOD

EXAMPLE

Based on the data given below, estimate the population growth for the resident Bestari for the year 2040 using the Arithmetic Method.

Year	1990	2000	2010	2020	2030
Population	12,550	14,756	18,215	21,943	26,434
		2,206	3,459	3,728	4,491

$$\frac{2{,}206 + 3{,}459 + 3{,}728 + 4{,}491}{4}$$

3,471 person / 10 year

P_{2040} = 26,434 + 3,471
= 29,905 persons

POPULATION GROWTH ESTIMATION

B. GEOMETRIC INCREASE METHOD

In this method, the percentage increase in population from decade to decade is assumed to remain constant.

Population after 'n' decades (Pn) is given by,

$$P_n = P_o \times (1 + \frac{r}{100})^n$$

EXAMPLE

Based on the data given below, estimate the population growth for the resident Indera Bayu for the year 2030 using the Geometric Increase Method.

Year	1980	1990	2000	2010	2020
Population	86,300	101,900	130,000	141,500	147,750
		15,600	28,100	11,500	6,250

POPULATION GROWTH ESTIMATION

B. GEOMETRIC INCREASE METHOD

Year	Population	Population Growth	Percentage of population growth
1980	86,300		
		15,600 →	**15,600** / 86,300 x 100% = 18.1%
1990	101,900		
		28,100 →	**28,100** / 101,900 x 100% = 27.6%
2000	130,000		
		11,500 →	**11,500** / 130,000 x 100% = 8.8%
2010	141,500		
		6,250 →	**6,250** / 141,500 x 100% = 4.4%
2020	147,750		

15,600 / 86,300 x 100% = 18.1%

128,100 / 101,900 x 100% = 27.6%

11,500 / 130,000 x 100% = 8.8%

6,250 / 141,500 x 100% = 4.4%

$$\frac{18.1\% + 27.6\% + 8.8\% + 4.4\%}{4} = \underline{14.7\%}$$

$$P_{2030} = 147{,}750 + (14.7/100 \times 147{,}750)$$
$$= \underline{169{,}469 \text{ persons}}$$

Exercise

Predict the total population in the year 2040 and 2050 using Arithmetic Increase Method based on given data:

Year	Total Resident (people)
1960	24 000
1970	27 500
1980	31 500
1990	38 000
2000	42 500

Estimate the populations of Bandar Baru SME using Geometric Increase Method in 2020 and 2030 based on the data below.

Year	Population
1970	20 500
1980	31 234
1990	50 022
2000	76 447
2010	80 125

WATER DEMAND FORECASTING

Water demand is defined as the total volume of water required by users within a specific area over a given period of time. It encompasses all the water needed by distribution system for various purposes such as residential, industrial, agricultural, and environmental uses. Water demand is influenced by factors such as population size, climate conditions, economic activities, and water use practices.

Understanding water demand forecasting is crucial for effective water resource management and planning.

The basic formula for water demand to be used as follows:

$$WD_n = P_n \times q \times F1 \times F2 \ldots + D_m$$

where,

- WD_n = water demand at the end of year "n"
- P_n = projected population at the end of year "n"
- q = per capita consumption at the end of year "n"
- F1 = service factor at the end of year "n"
- F2 = design factor at the end of year "n"
- D_m = additional demand at the end of year "n"

WATER DEMAND FORECASTING

Meanwhile,

Pn = projected population at the end of year "n"

$$P_n = P_o \times (1 + r)^n$$

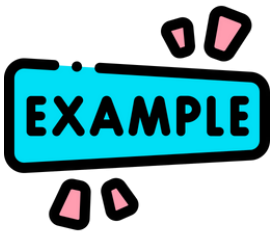
P_n = Population estimation at year 'n'

P_o = Total population for the year before

r = Increased of population rate

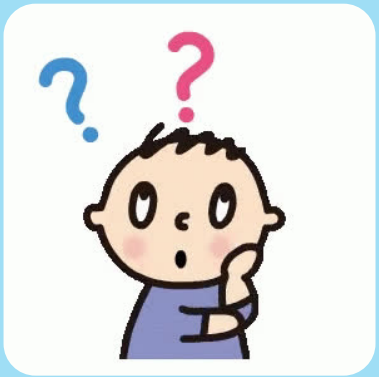
n = number of years

WATER DEMAND FORECASTING



The following data obtained from Kampung Lubok in 2023. Calculate the water demand in 2028.

- Total household = 6000 households
- Average household member = 6 people
- Per capita water consumption = 270 liters/day
- Population growth = 2.65% per year
- Industrial water needs = 1/3 of the population needs
- Design factor = 2.4
- Percentage of Non-Revenue Water = 15%
- Water supply coverage = 97%



WATER DEMAND FORECASTING

P_o = 6000 x 6 = 36,000 people

r = 2.65% a year = 2.65/100 = 0.0265

n= 2023- 2028 = 5 years

$P_n = P_o \times (1 + r)^n$

$P_{2028} = 36000 (1 + 0.0265)^5$

= 41,030 People

Given,

q = 270 liter/capita/day F1 = 97% = 0.97

F2 = 2.4 Dm = 15%= 0.15

Industrial = 1/3 of the population needs

$WD_n = P_n \times q \times F_1 \times F_2 \ldots + D_m$

WD_{2028} = (41,030 x 270 x 0.97 x 2.4) + [1/3 (41030 x 270 x 2.4)] + 0.15 [(41030 x 270) + (1/3 x 41030 x 270)]

= 25.79 x 10^6 + 8.86 x 10^6 + 2.22 x 10^6

= **36.87 x 10^6 liters/ day**

ACTIVITIY 2

EXERCISE 1

The following data are obtained from Taman Panchor Jaya in 2020. Calculate the water demand in 2030 if:

- Average household members = 5 people
- Total household = 5000 unit
- Population growth = 2.65 % per year
- Per capita water consumptions = 275 liter/capita/day
- Industrial water needs = 1/3 of the population needs
- Design factor = 2.4
- Percentage of NRW = 15 %
- Water supply coverage = 97 %

EXERCISE 2

The data given are collected from Taman Seri Astakona in year 2015. Calculate the water demand in 2025.

Total Household	=	3500 unit
Average Household member	=	6 people
Water usage per capita	=	220 l/ person/ day
Population growth rate	=	3.4% per year
Light industries demand	=	230 000 l/day
Design factor	=	0.98
NRW percentage	=	12%
Water supply coverage	=	92%

EXERCISE 3

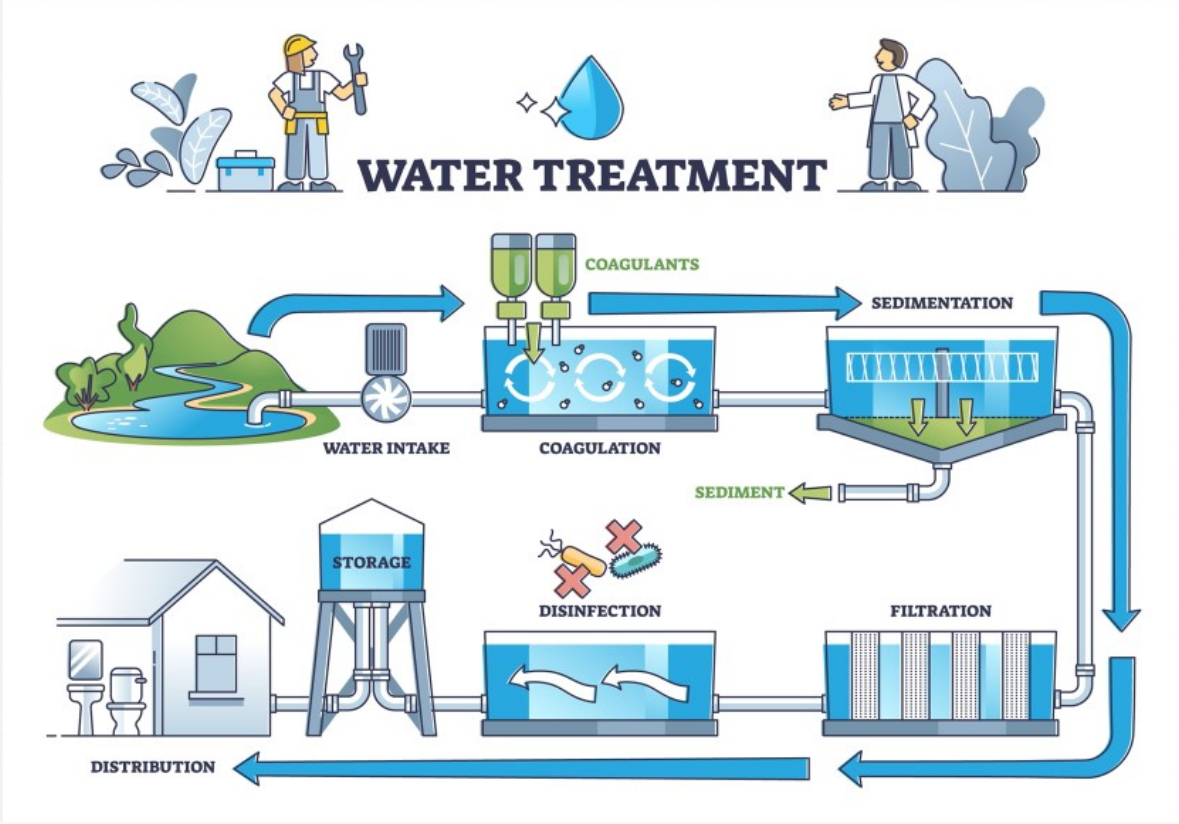
Taman Sri Bayu has 1000 houses, calculate the daily water demand if the water coverage is 100%, given the following:

- Water consumption per capita = 275 liter/day/person
- Average household = 6 persons per house
- Design factor = 1.5
- NRW = 5%
- Additional water demand = ½ from the requirements of the population


3
WATER
TREATMENT

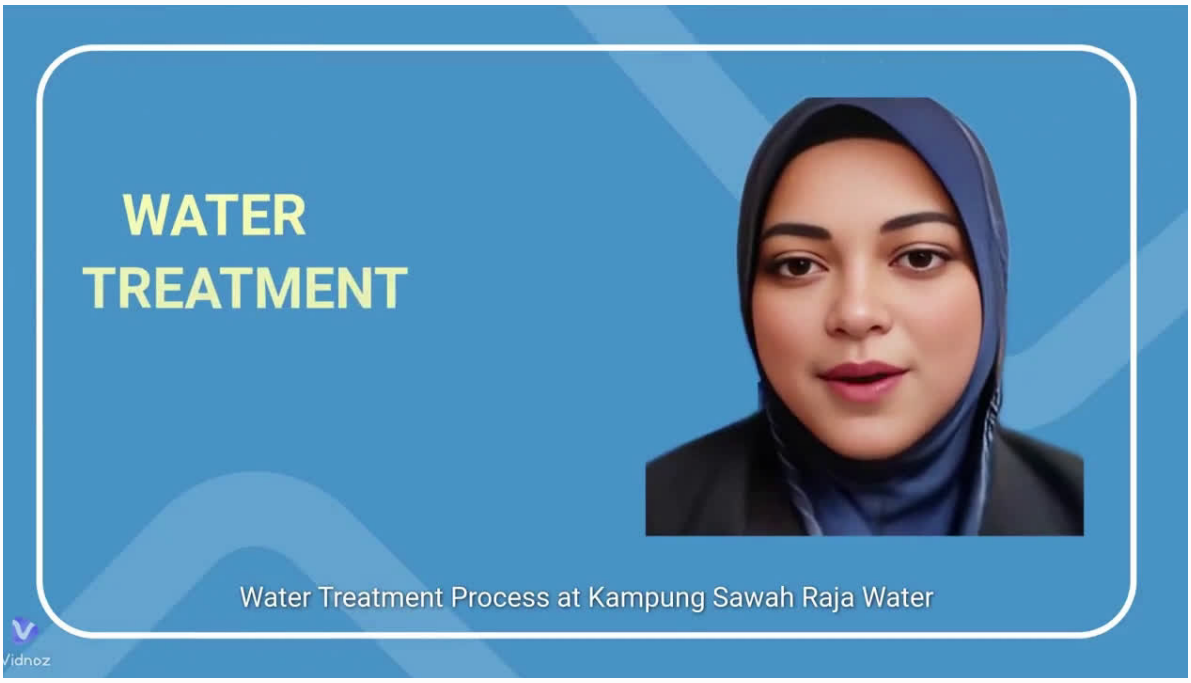
WATER TREATMENT

- Water treatment is the process of improving the quality of water to make it acceptable for a specific end-use.
- The use of water can be drinking, industrial water supply, irrigation, river flow maintenance, water recreation, or many other uses.
- The primary goal is to remove contaminants and undesirable components, or to reduce their concentration so that the water becomes fit for its desired end-use.



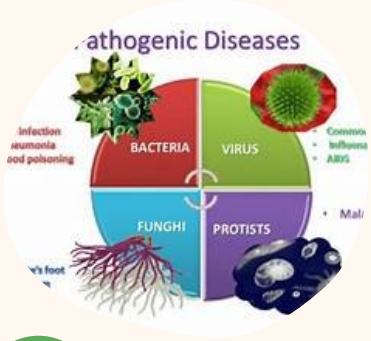
WATER TREATMENT PLANT NEGERI SEMBILAN

VIDEO
WATER TREATMENT PLANT



PURPOSES OF WATER TREATMENT

1. PREVENT POLLUTIONS



2. ELIMINATE ORGANISM CAUSE DISEASES

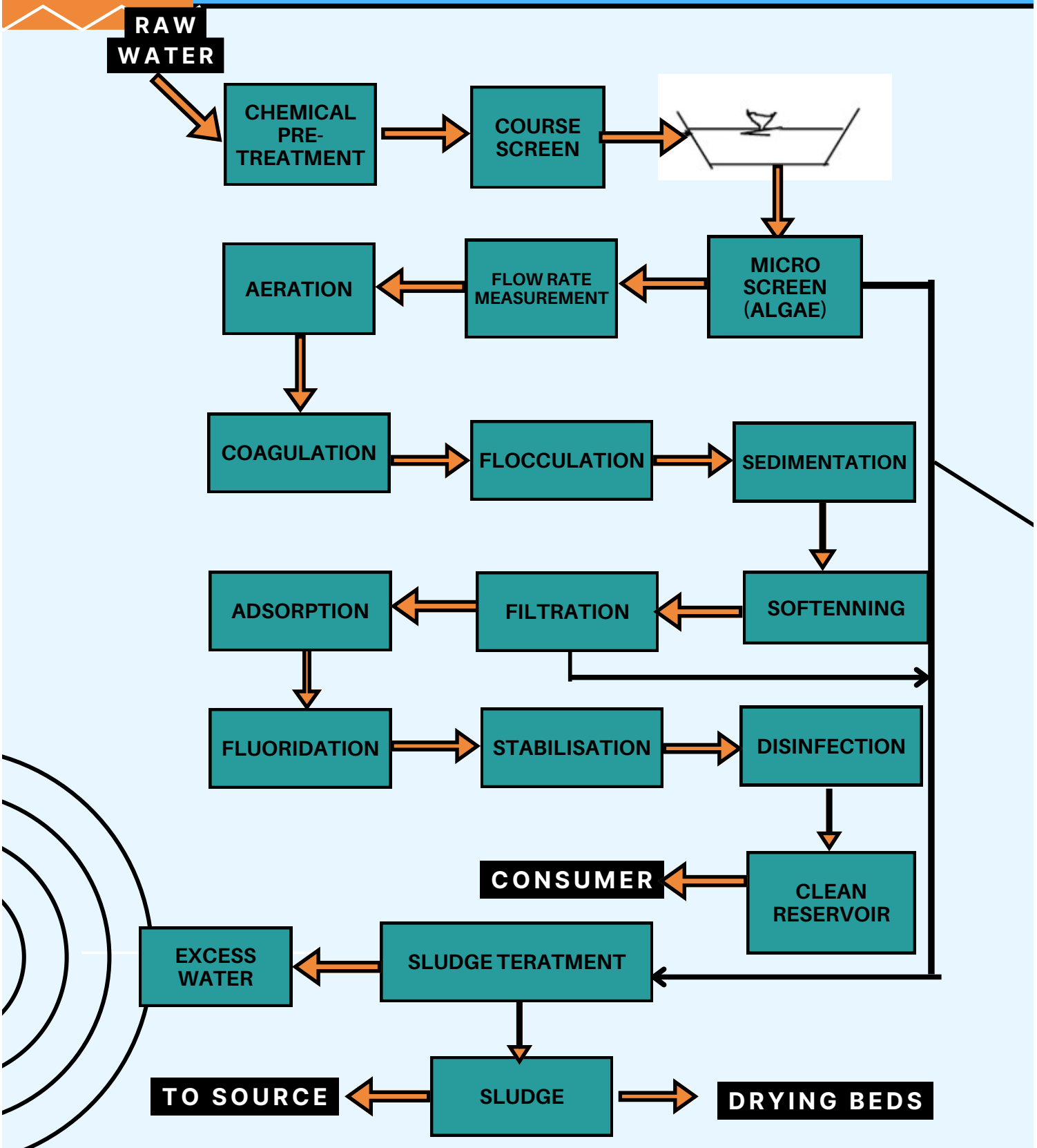
3. ELIMINATE ODOUR, TASTE AND COLOUR

4. ELIMINATE DISSOLVED GASSES WHICH CAUSE POLLUTION OF WATER

5. REDUCE CORROSION

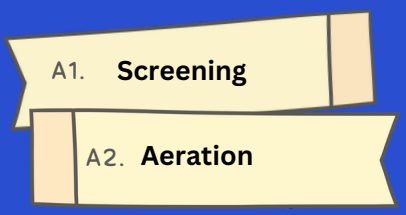
6. SAVE FOR DOMESTIC USE

TYPICAL WATER TREATMENT PROCESS



PRE, MID & POST
WATER TREATMENT

PRE



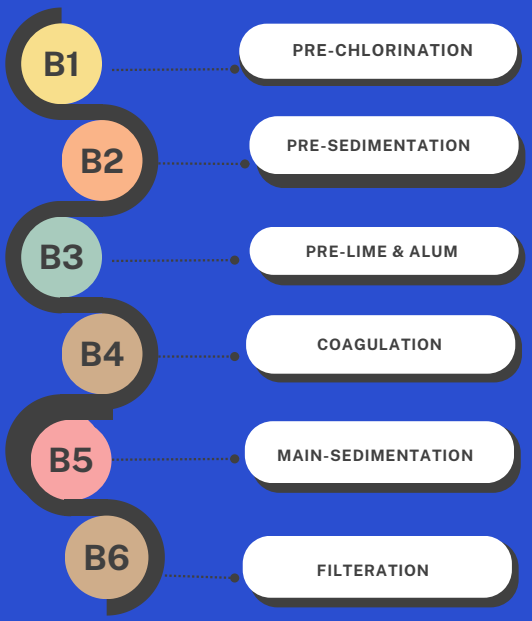
A-PRE TREATMENT

- A1 - SCREENING
- A2 - AERATION

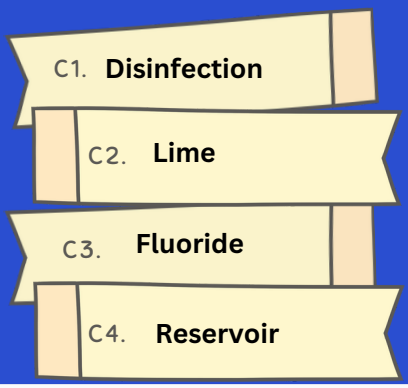
MID

B- WATER TREATMENT

B-TREATMENT



POST



C - POST TREATMENT

- Disinfection
- Lime
- Fluoride
- Reservoir

A1

WATER SCREENING

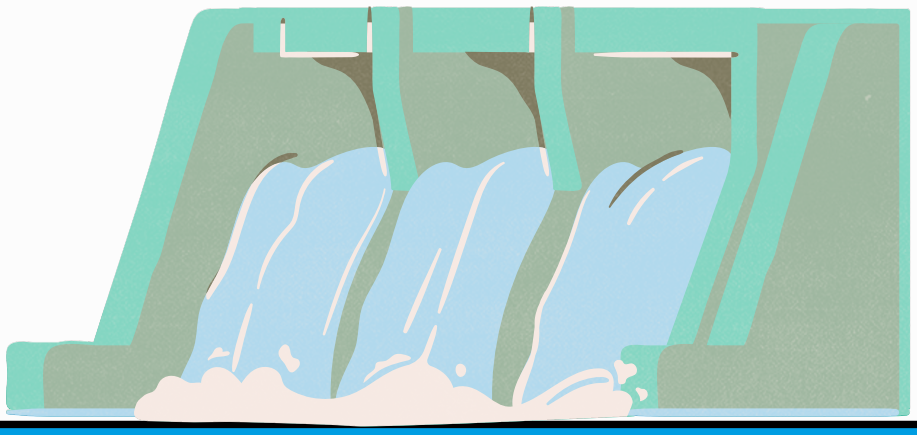
Screening is located at the intake; from river/reservoir to water treatment plant (WTP).

Screening not only prevent possible equipment damage but also improve overall process efficiency.

2 TYPES OF SCREENING

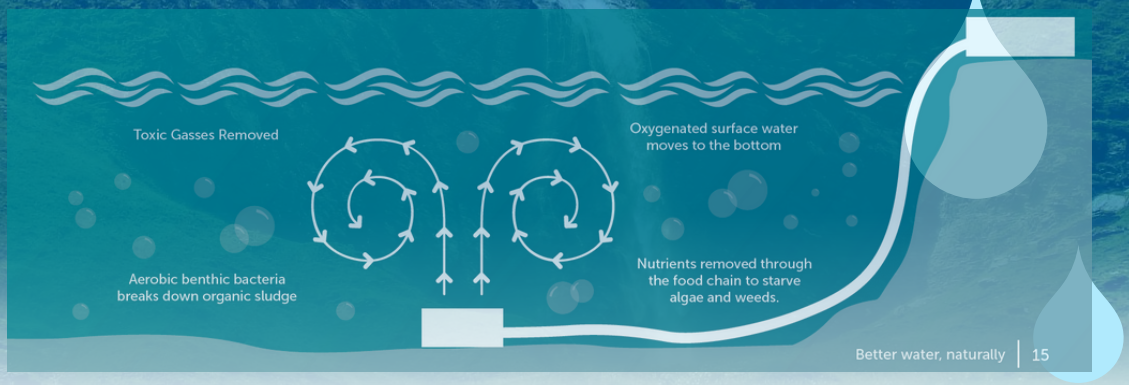
Course screen – to screen large debris such as log, big trunk and etc.

Fine screen – to avoid fine debris such as leaves, rubbish and etc. from blocking water intake which can caused damage to pump station equipment/Water Treatment Plant



A2 AERATION

Aeration in water treatment refers to the process of adding air or oxygen to water in order to improve its quality.



PURPOSES OF AERATION:

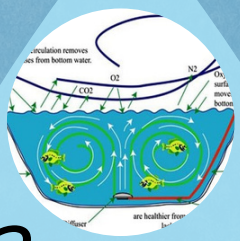
1. to increase dissolve oxygen content in water
2. to eliminate odour & taste (cause by algae hydrogen gas)
3. to eliminate corrosion character (caused by carbon dioxide gas)
4. to eliminate odour & colour (caused by ferum dioxide & mangan dioxide)

#SaveWater

EXAMPLES OF AERATOR

1 Cascade aerator

Allowing water to flow downwards over a series of steps of baffles.

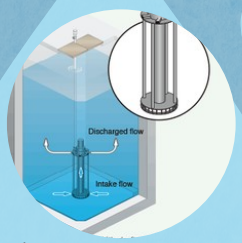


2 Spray aerator

Direct the water upward, vertically or at an inclined angle in such a manner that the water is broken into small drops.

3 Ventury aerator

A venturi aerator increases the amount of dissolved oxygen in the water. This is done by use of the Bernoulli principle whereby air is sucked into a high-velocity area of a pipe and injected into the water stream.



4 Draft tube aerator

The draft tube and related components can be made of steel and hot dip galvanized or made from various grades of stainless steel.

5 Rotating brush aerators

The rotating brush introduces oxygen into the water and induces a strong horizontal flow. Baffles are often installed downstream of the brush rotor to ensure uniform aeration.

6 Air diffusion aerator

Rectangular concrete tanks in which perforated pipes, porous diffuser tubes or various patented impingement or spurger devices are inserted near bottom of the aeration basin

#SaveWater

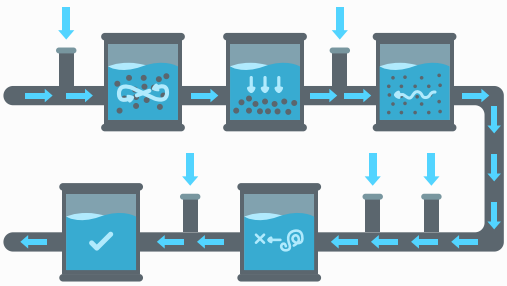
B1

PRE-CHLORINATION

Pre-chlorination for drinking water is the process of adding chlorine to raw water at the early stages of the treatment process, typically before sedimentation and filtration.

The purpose of pre-chlorination

- **Heavily polluted waters**
- **Bleaches coloring matters**
- **Neutralize free ammonia in the water.**
- **Oxidize soluble iron and manganese**
- **Control the growth of algae and bacteria**

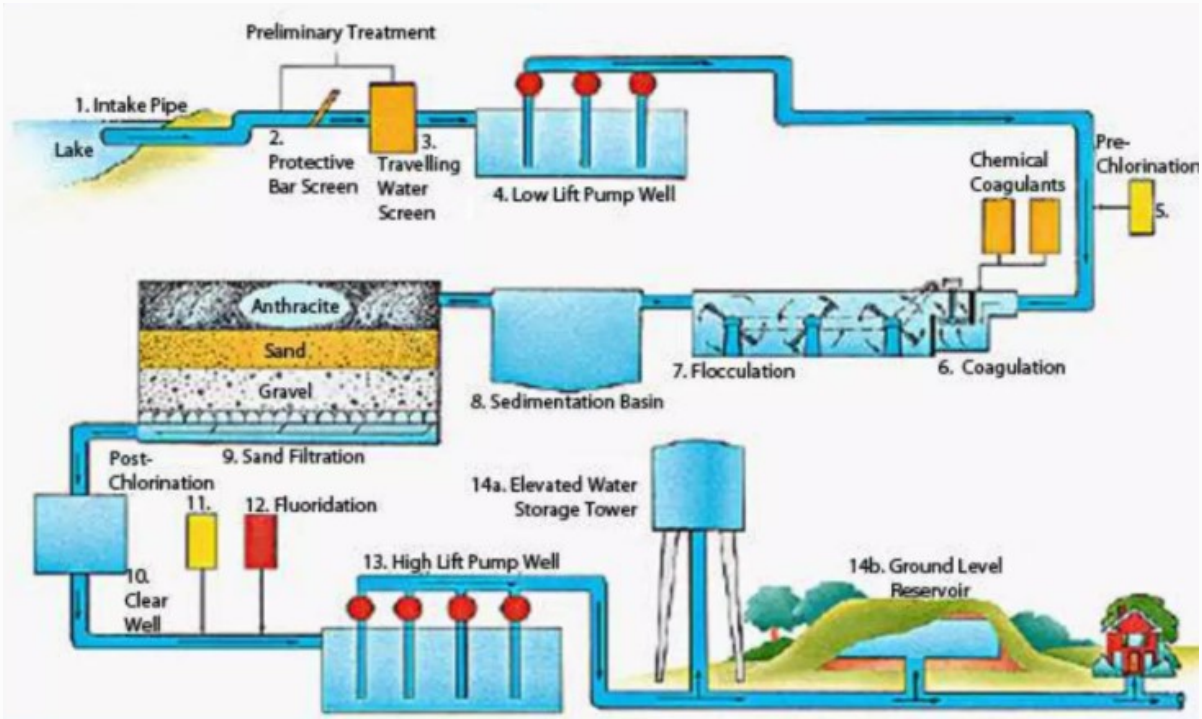


B2

PRE-SEDIMENTATION

Pre-sedimentation is a treatment process typically takes place in a basin or tank where water flow is slowed, allowing heavier particles to settle at the bottom due to gravity. This helps to reduce the load on subsequent treatment processes and improves the overall efficiency and effectiveness of the water treatment system.

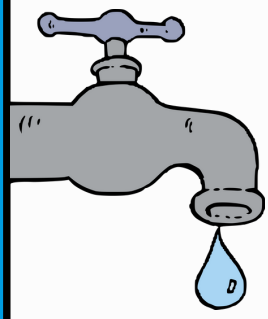
If the suspended solid content is too much in water @ caused turbidity
Water retention 30 - 60 minute.



RAPID MIXING

Rapid mixing for drinking water is a treatment process where chemicals such as coagulants are quickly and thoroughly dispersed into the raw water to initiate the coagulation process. This step involves the use of mechanical or hydraulic mixers to ensure that the coagulants are evenly distributed throughout the water, promoting the formation of small, destabilized particles that can then aggregate into larger flocs. Rapid mixing is a crucial initial stage in water treatment as it sets the stage for effective flocculation and subsequent removal of suspended solids and impurities.

chemicals are quickly and uniformly dispersed in water.

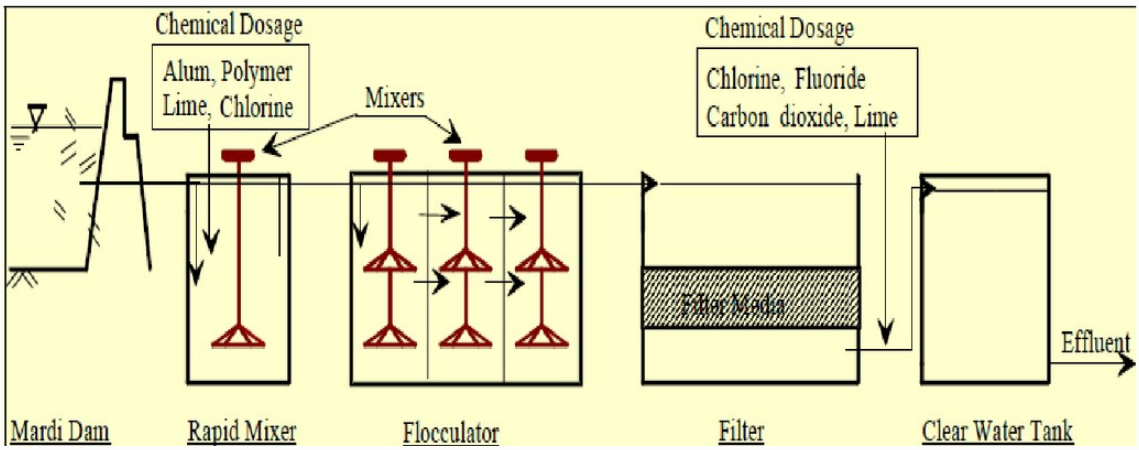


B3

PRE-LIME & ALUM

Lime mix in water to neutralize acid content in water. It purpose is to make the process affectivE

(Aluminum Sulfate-Al3SO4) is a chemical substance for the following treatment; coagulation & flocculation.



(Source : Abdullahi et al., 2012)

COAGULATION PROCESS

B4

The purpose of the process is to form microscopic particles.

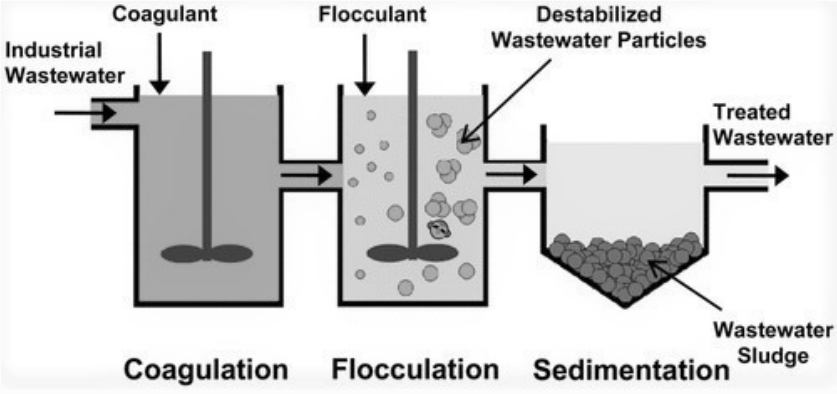
Coagulant consist of positive charged ions which work on the negative charges of particles to be removed.

The coagulant and dosage selected for a particular water should be based on ‘jar test’.

2 methods are usually used:-

a-static baffles

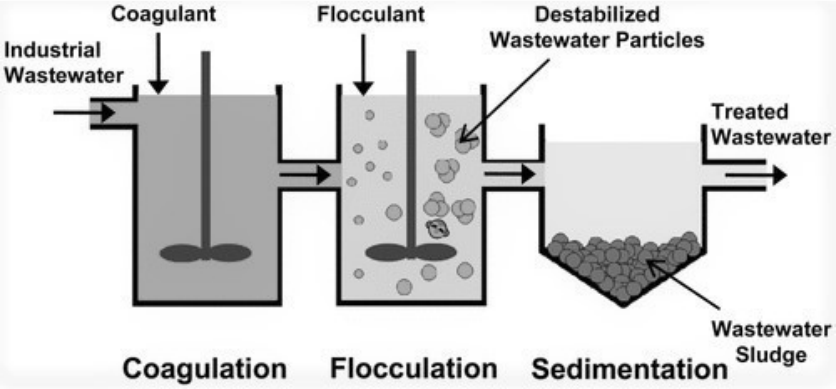
b-dynamic/moving baffles



FLOCCULATION PROCESS

- **The objective is to provide for the increase in the number of contacts between coagulant particles**

- **Collision of particles leading to the formation of floc large enough to settle in the sedimentation tank.**



B5

MAIN-SEDIMENTATION

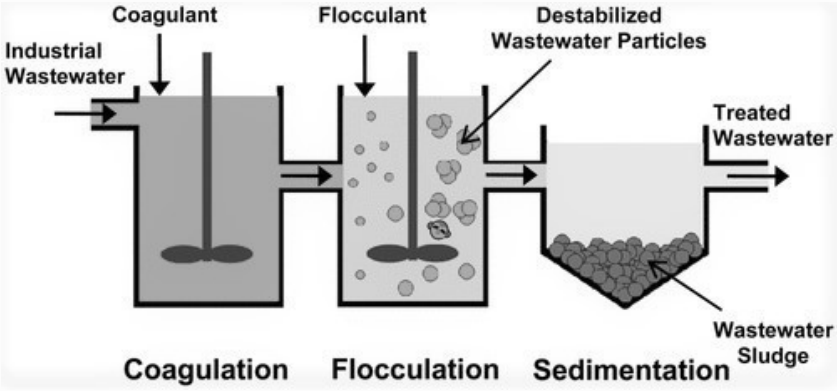
To remove the suspended material from water by the action of gravity.

Basically there are three (3) types of sedimentation process:

1)**Particles concentration is very low & settle as individual particles**

2)**Particles concentration is low & particle flocculate during settling.**

3)**Particles concentration tend to settle as a mass and form a layer call 'blanket'**



B6

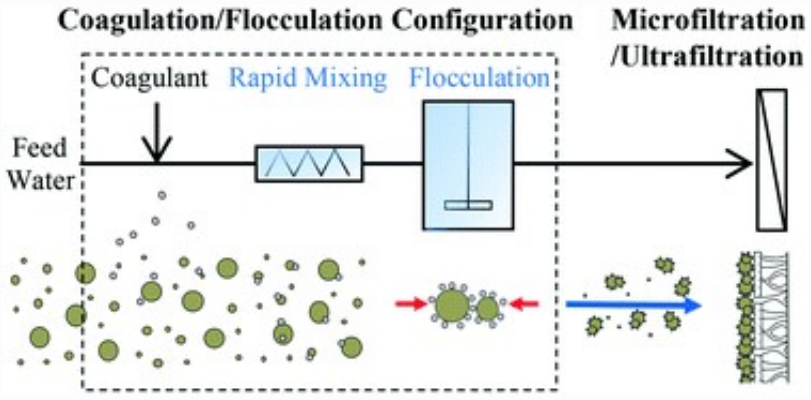
FILTRATION PROCESS

Filtration is a passage of water through a porous medium to remove suspended solids.

Needed in order to provide second barrier against the transmission of water borne disease.

Types of filtration:
a)Pressure filter system
b)Gravity Filter System
- **Slow Sand filter (SSF)**
- **Rapid Sand Filter (RSF)**

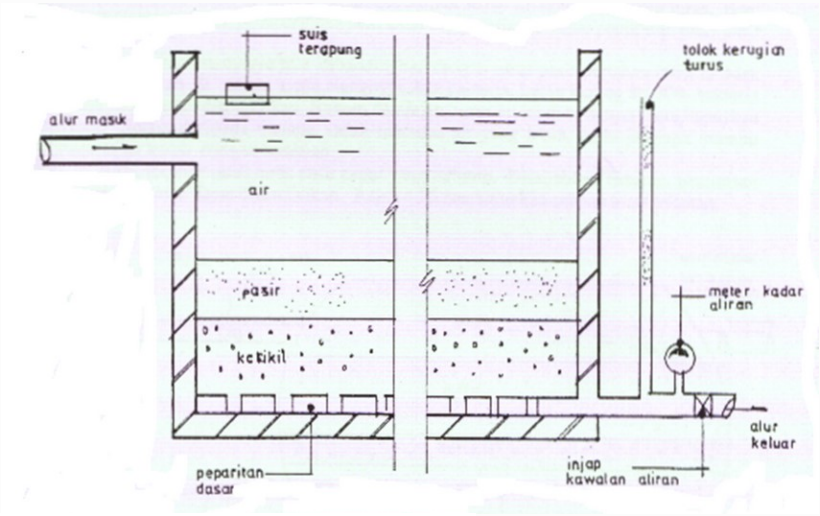
Four (4) process during filtration:-
a)Mechanical screen
b)Flocculation and sedimentation.
c)Biological metabolism
d)Electrolyte reaction

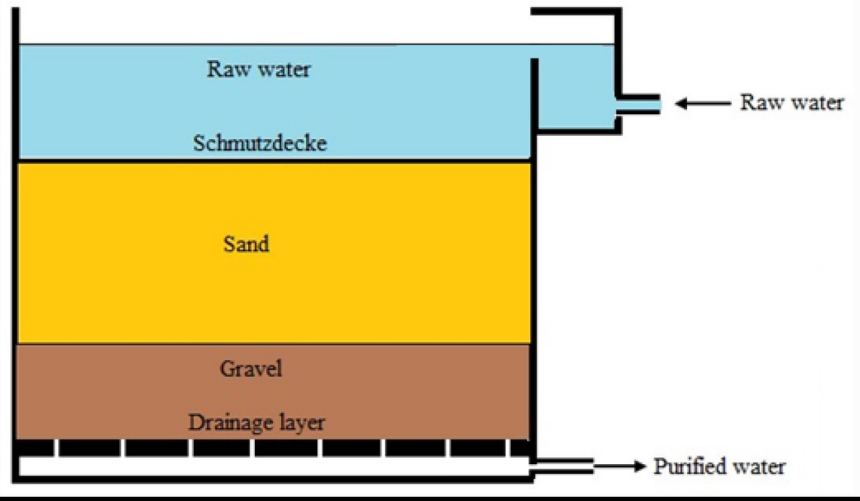


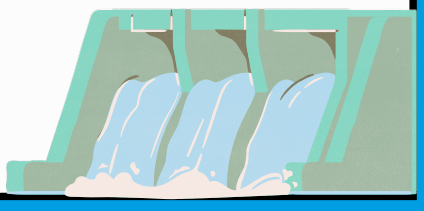
(Source : Dell et al., 2020)

SLOW SAND FILTER

- **Slow sand filtration is a simple and reliable process. They are relatively inexpensive to build, but do require highly skilled operators.**
- **The process involves slowly percolating untreated water through a bed of porous sand, where the influent water is introduced over the surface of the filter and then drained from the bottom.**

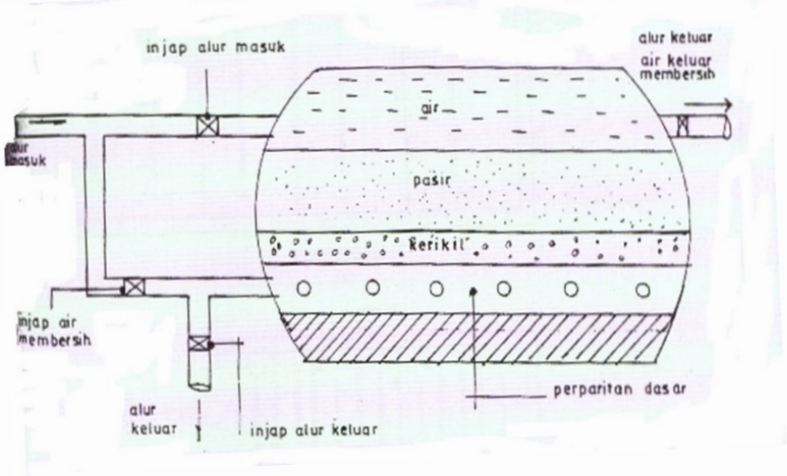


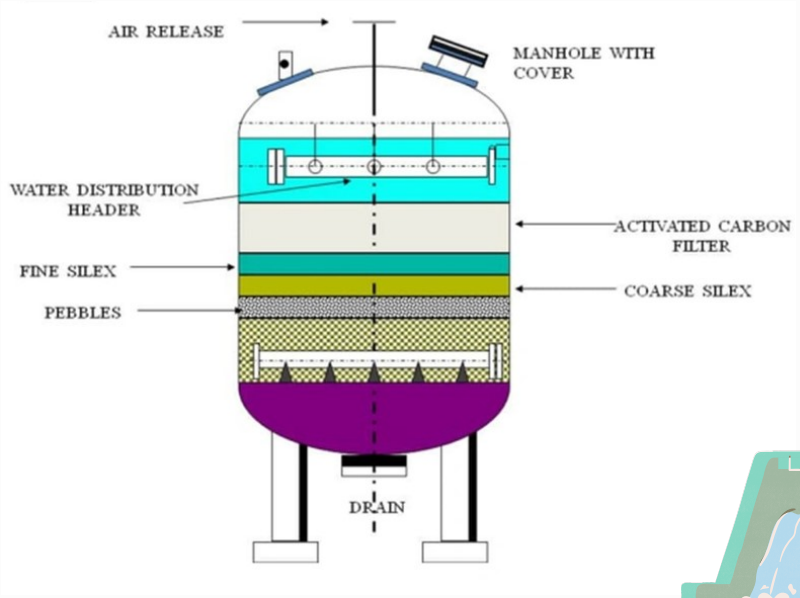


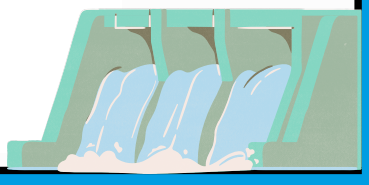


PRESSURE FILTER

Pressure filters are designed and manufactured with various filtering media, such as sand or activated carbon. These filters serve multiple purposes, including functioning as polishing units in industrial water treatment after physical-chemical processes, as pretreatment units for drinking water, and as tertiary treatment systems for domestic wastewater.

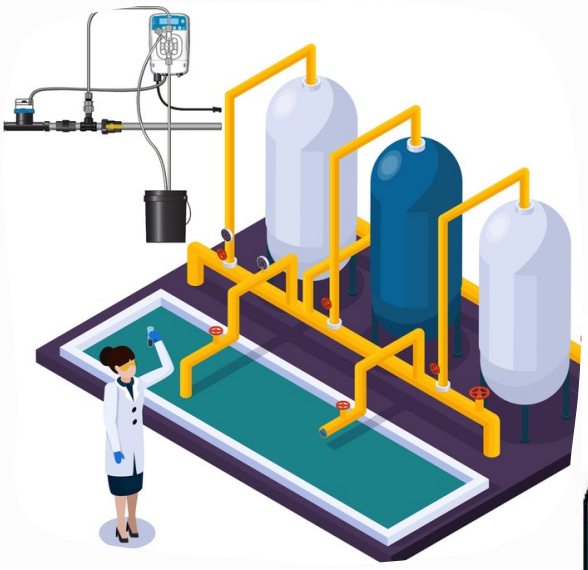


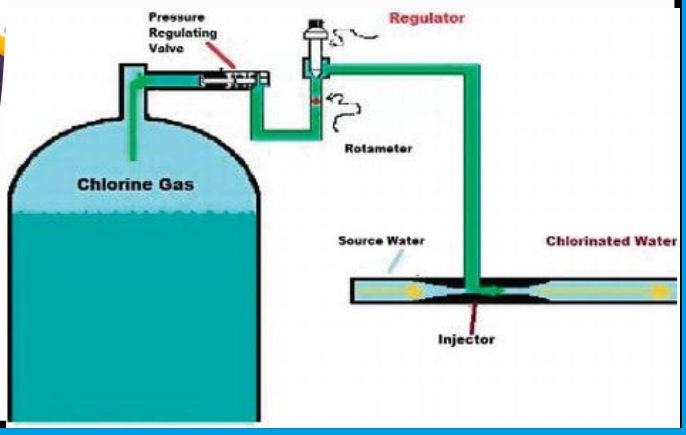




C1 DISINFECTION PROCESS

- Disinfection is a procedure designed to kill or inactivate harmful microorganisms, ensuring that water is safe for drinking.
- This process usually involves chemical treatments, such as chlorine or chloramine, or physical methods, like ultraviolet (UV) light or ozone, to remove pathogens.
- The method selected depends on the water's characteristics, contamination level, and regulatory requirements.



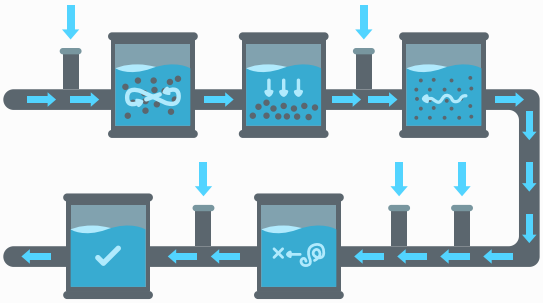


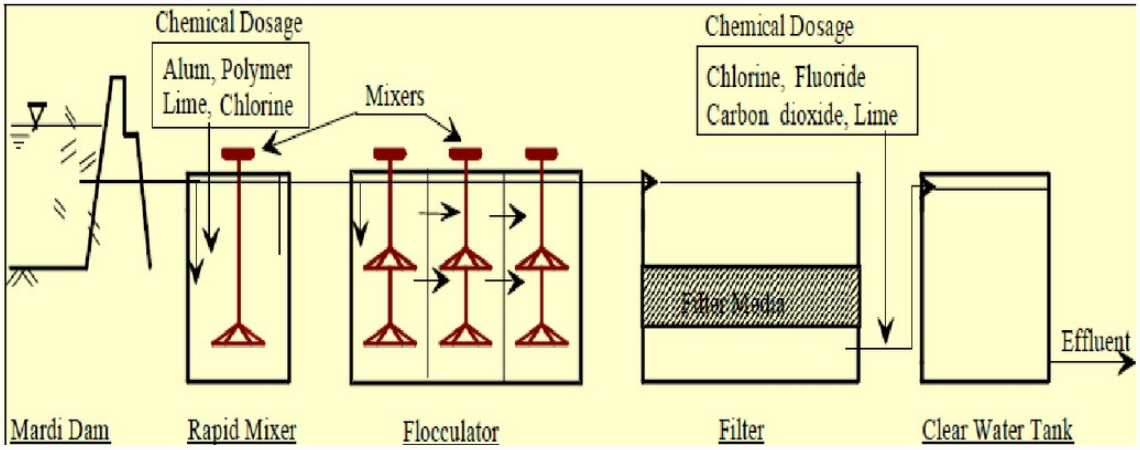
C2

LIME PROCESS

To neutralized acid content in water.
If the water too acidic it may corrode piping system

Hydrated lime is widely used to adjust the pH of water to prepare it for further treatment.



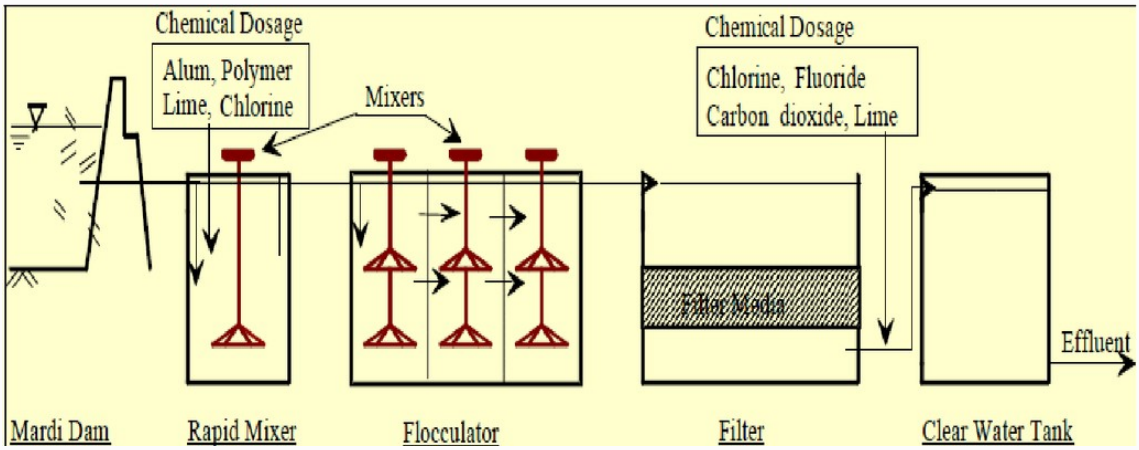


(Source : Abdullahi et al., 2012)

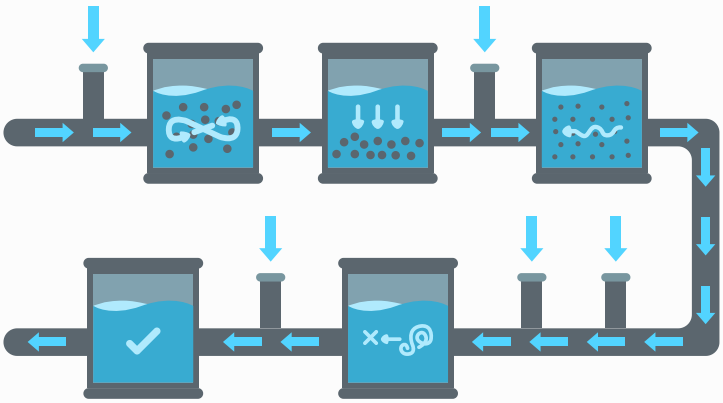
C3

FLUORIDE PROCESS

Is used to raise the amount of fluoride so that children have high resistance towards tooth decay

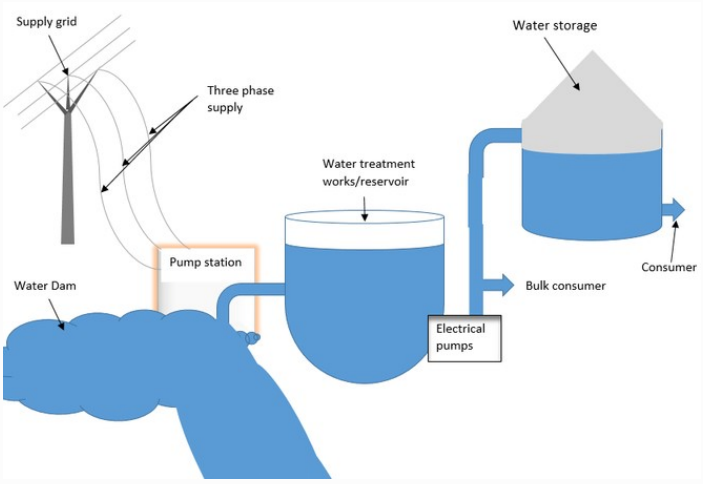


(Source : Abdullahi et al., 2012)



C4 RESERVOIR

- A reservoir for water supply is a natural or artificial storage area designed to collect and hold water for various uses, primarily for providing a consistent and reliable source of drinking water.
- These reservoirs can be formed by damming rivers or streams, creating lakes, or constructing large tanks and ponds.
- The stored water in reservoirs is crucial for managing the supply, especially during periods of low rainfall or drought.
- It also allows for the initial settling of sediments and some natural purification before the water undergoes further treatment processes to ensure it is safe for consumption.
- Reservoirs help balance water availability, support agricultural irrigation, facilitate industrial processes, and maintain ecological systems.



(Source : Patrick, 2018)

ACTIVITY 3

THINK – PAIR – SHARE (TURN & TALK)

1.Coagulation is a chemical process that physically makes sedimentation more efficient. Determine FIVE (5) types of chemical substance that can enhance flocculation process.

2.Explain the chlorine residue for water supply

3.Discuss the treatment plant layout and site factor of the following:

a. Planning and environmental constraint factor
b. Plant design site factor
c. Environmental factor

Student has a minute or two to think about the question below. Then, turn and discuss with someone sitting next to you (choose a friend to discuss with), and then share with the whole class.

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