Unit F: Water

Lesson 1 – Understanding the Water Cycle and its Importance to the Environment

Use the slides below to answer the following questions:

Describe the water cycle

Describe the physical and chemical makeup of water

Identify bodies of flowing water

Identify bodies of non-flowing water

Understanding the Water Cycle and Its Importance to the Environment

Lesson

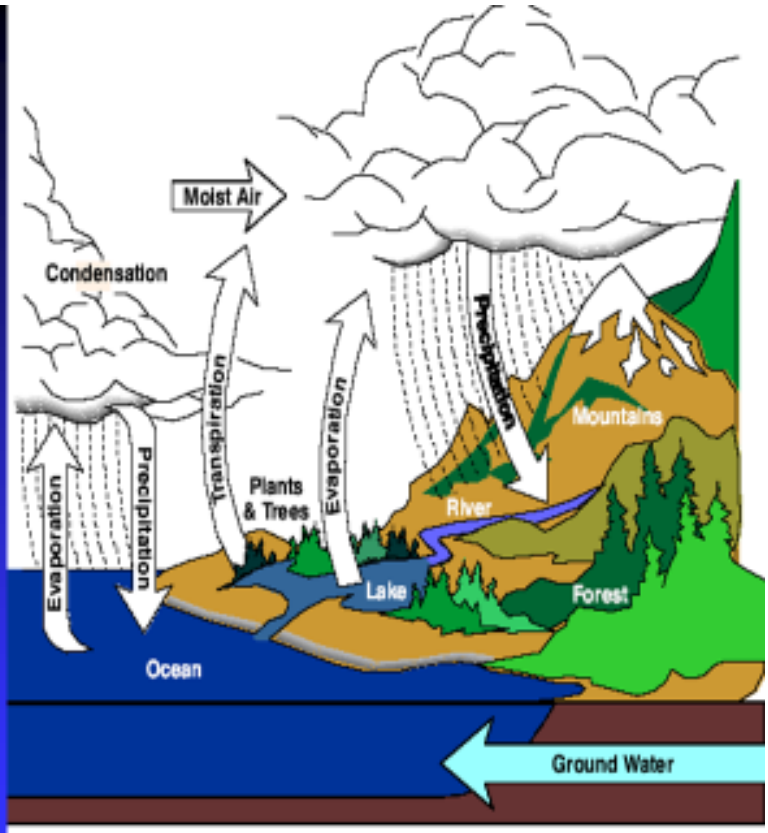
Learning Objectives

- Describe the water cycle.
- Describe the physical and chemical makeup of water.
- Identify bodies of flowing water.
- Identify bodies of non-flowing water.

Water Cycle

- The continuous movement of water from the earth to the atmosphere and back to the earth.
- The sun provides the energy for the water cycle, also known as the hydrologic cycle.
- The water cycle occurs in four overlapping spheres.

Water Cycle



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Water Cycle Spheres

- Hydrosphere
- Atmosphere
- Biosphere
- Lithosphere

Hydrosphere

- Water moves from the earth to the atmosphere through the processes of evaporation and transpiration.
- Evaporation is the transformation of water from its liquid form to its gaseous form as a result of coming in contact with heat or the air.
- Transpiration is the process of plants releasing water through their leaves is called.

Atmosphere

- Air that holds moisture until it falls as precipitation.
- Precipitation is the moisture from the atmosphere that is returned to the earth in the form of snow or rain.

Biosphere

- Includes all plant and animal life which are consumers of water.

Lithosphere

- Land where water falls as precipitation.

Physical and Chemical Makeup of Water

- Water, in its purest form, is tasteless, odorless, and colorless.
- It is a chemical compound made up of two atoms of hydrogen and one atom of oxygen.
- Its chemical symbol is H_2O.

Physical States of Water

- Solid form of water is called ice.
- Water freezes at 32F or 0C.
- Gaseous form of water is called water vapor or steam.
- When water boils it turns into water vapor or steam. Water boils at 212°F or 100°C.
- In between the gaseous and solid form, water is in its liquid form.

Chemical Make-up of Water

- Water that contains salt is called saline water.
  - Sodium chloride, potassium, and magnesium can raise the level of salts in the water.
  - The amount of salt in the water will determine its usefulness.
  - Water that is too high in salt cannot be used for drinking or irrigation.

Categories of Saline Water

- Freshwater
- Saltwater
- Brackish water

Freshwater

- Water with less than 3.0 parts per thousand (ppt) of salt.
- Most commonly found in drilled wells, streams, and lakes.
- Only 3 percent of the water on the earth is considered freshwater, of this 3 percent only 1 percent is available for use.

Saltwater

- Water with 16.5 ppt or more of salt.
- Some ocean and sea water is as high as 33 to 37 ppt.
- Saltwater makes up about 97 percent of the earth's water.

Brackish Water

- A mixture of saltwater and freshwater.
- Brackish water is found where freshwater flows into the ocean or other bodies of saltwater.
- An estuary is the area where a freshwater stream flows into the ocean or a saltwater lake.

Usable Water

- Two main ways that salt water and contaminated water can be turned into usable water: distillation and desalination.

Usable Water

- Distillation is the boiling of water and collection of its vapor.
- The vapor then turns into liquid when cooled.
- The liquid is pure at this point.

Usable Water

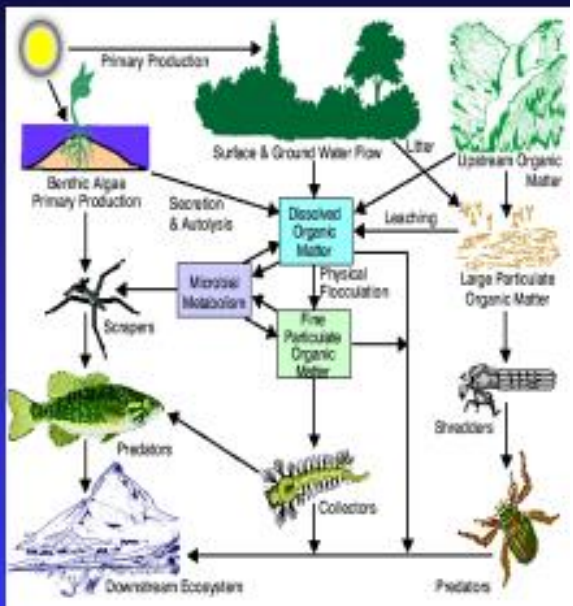
- Desalination is the removal of salt from water.
- It involves the process of distillation but is not economical on a large scale.

Flowing Bodies of Water

- One of the most important parts of the water cycle is the stream.
- Streams are flowing bodies of water that are useful resources for irrigation, factories, and local water systems.

Food Web in Streams

- Most streams are freshwater and they can flow through a natural or man-made channel.



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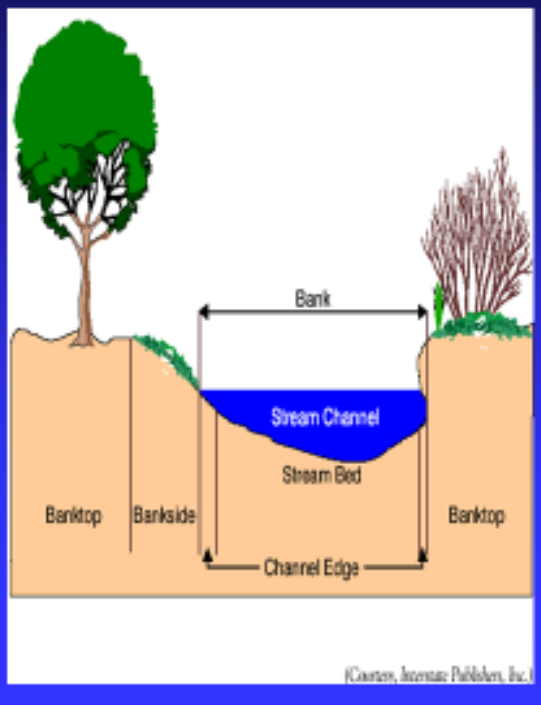
Types of Streams

- Stream type is determined by the volume and velocity of the movement of water, or streamflow.
- The four types of streams are rivers, creeks, brooks, and canals.

Cross Section of a Stream

- The rate of flow in a stream is called a current.



River

- The largest stream.
- Have high streamflows.

Creek

- A stream that is smaller than a river.
- Often flow into rivers, lakes, and oceans.

Brook

- A small stream.
- Often flow into creeks, rivers, lakes, and oceans.

Canal

- An artificial waterway built for transportation, to relieve flooding, or to divert the flow of water.

Stream Hydrology

- The study of flowing water and its environment.
- The physical, chemical, and biological properties of the water and the surrounding environment are tested.
- The ecosystems, including food webs, are studied.

Stream Ecosystems

- Many ecosystems can be found in streams.
- Species within the streams survive on nutrients that are provided by the areas surrounding the stream.
  - These nutrients move with the flow of the stream.

Stream Structure

- Determines how water moves within the stream and through the earth.
- A stream is an important part of watershed or catchment.
- The edge of a watershed is known as a drainage divide.

Stream Structure

- The area through which water flows in a stream is called a channel.
  - A channel is usually formed with rock or soil and it is the sides and bottom of the stream.
- The bottom of the channel is called the stream bed, the sides are called the stream banks.

Stream Structure

- When a channel is not large enough to hold the flow of water the area that overflows is called a flood plain.

Non-Flowing Bodies

- These bodies may be natural or artificial.
- Non-flowing bodies of water influence the weather and climate of an area.
  - Commerce, food supply, and recreational activities can also be influenced by the non-flowing bodies of water in an area.

Non-Flowing Bodies

- Bodies of water that do not flow still have water movement.
- The internal movement is caused by temperature changes and salinity.

Types of Non-Flowing Bodies

- Seven types of non-flowing bodies of water are oceans, lakes, ponds, reservoirs, sloughs, marshes, and estuaries.
- As in flowing streams, non-flowing bodies of water may contain a variety of ecosystems.

Types of Non-Flowing Bodies

- The ecosystems at the bottom of the body of water will vary from those at the top.
  - This is due to the varying water temperature, salinity, and other characteristics.

Oceans

- Large bodies of saltwater.
- Cover almost 75 percent of the surface of the earth.

Lakes

- Bodies of freshwater that are surrounded by land.
- Vary in size, some are natural and others are man-made.

Ponds

- Non-flowing bodies of water that are smaller than lakes.
- Commonly manmade and used as a source of recreation or for use by livestock.

Reservoirs

- Large bodies of stored water.
- Commonly used to generate electric power.

Sloughs

- Thick, muddy areas of shallow water.

Marshes

- Areas of land covered with shallow water and plants such as cattails.
- Do not contain trees and are similar in nature to sloughs.

Estuaries

- Areas where freshwater streams flow into the ocean or a saltwater lake.

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Lesson 2 – Determining Uses of Water

Use the slides below to answer the following questions:

Explain the importance of water.

Define potable water.

Identify methods of water management.

Determining Uses of Water

Lesson

Learning Objectives

- Explain the importance of water.
- Define potable water.
- Identify methods of water management.

Importance of Water

- Water is one of the three basic needs for the life of humans.
  - Without water, we could not survive.
- Plants and animals also need it to survive.
- There are several uses of water including life processes, daily living, agriculture production, climate, manufacturing, transportation, and recreation.

Life Processes

- In order for living organisms to carry out their life processes they need water.
- Most animals are made up of 60 to 70 percent water, most plants are made up of 70 to 95 percent water.

Daily Living

- Water is needed for daily living, approximately 100 gallons a day for most people.
- Water is used for bathing, washing, cooking, and waste removal.

Agriculture Production

- Water is used in agriculture production for the irrigation of crops and the watering of animals.

Climate

- Water is capable of moderating the climate in the immediate area.
- It does so by regulating and transferring heat.
- Large bodies of water can also cause storms, high winds, and hurricanes.

Manufacturing

- Water is used in the manufacturing of products such as steel, paper, and food processing.

Transportation

- Water serves as a mode of transportation for boats, ships, ferries, and barges. These vehicles transport both people and products.

Recreation

- Recreational activities such as swimming, boating, and fishing all take place in the water.

Potable Water

- Water that is safe for human use and consumption.
- Potable water contains minerals so it is not pure.
- These minerals can cause variations in the odor, taste, color, pH, alkalinity, and hardness of the water.

Odor and Taste

- Commonly the result of the water source.
- Sometimes, they can be the result of the addition of chemical to the water by the local water system.
- Other causes are pollution, organic sulfur, and microorganisms.

Color

- Colored water may not look appetizing but that doesn't mean it's not safe to drink.
  - However, it may not be useful for activities such as washing clothes.
- Colored water may be the result of minerals such as iron and calcium in the water, sediment, organic matter, and plankton.
- Larger particles can be easily removed through filtration.

pH

- The measurement of the acidity or alkalinity of water.
- Water is often treated so that it remains in the pH range of 7.0 to 7.8, or almost neutral.
- Water pH can be determined using a pH meter.

Hardness

- The concentration of calcium and magnesium ions in water.
- The higher the concentration of ions, the harder the water.
- Hardness can be reduced through a process referred to as softening.

Methods of Water Management

- Before consumption, potable water from some sources needs to be treated, while water from other sources needs little or no treatment.
- Often times, water that is being used in the home or business may go through additional treatment before use.

Methods of Water Management

- Water pumped from wells usually needs little treatment besides adding chlorine for disinfection and softeners to reduce hardness.
- The level of treatment needed should be determined by sending a sample to a laboratory.

Methods of Water Management

- Surface water commonly requires more treatment than well water.
- The four steps in treating surface water include
  - Screening to remove objects
  - Presedimentation and sedimentation to remove sediment from the water
  - Chlorination to disinfect the water
  - Final filtration to make the water potable

Methods of Water Management

- Water that is used on homes and businesses may also go through additional filtration processes.
- In the home, filters can be placed on the faucet or where the pipes enter the house.

Methods of Water Management

- In a business, additional complex filtering may take place before water flows through machines such as ice makers.

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Lesson 3 – Identifying Water Sources and Quality Standards

Use the slides below to answer the following questions:

Identify sources of water.

factors used to determine water quality.

Describe when and what to test for.

Identifying Water Sources and Quality Standards

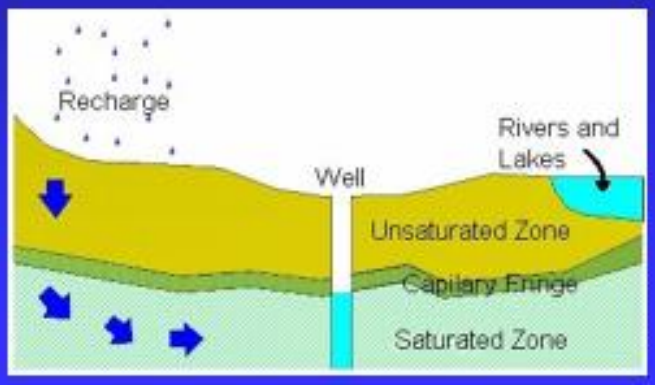
Lesson

Learning Objectives

- Identify sources of water.
- Describe factors used to determine water quality.
- Describe when and what to test for.

Sources of Water

- Two main sources of water are surface water and ground water.



Surface water

- Can be found on the surface of the earth in lakes, streams, rivers, and oceans.
- Can be either freshwater or saltwater.
- Main source is precipitation.
- Good for human consumption and agricultural use.
  - Surface water should be treated before use.

Groundwater

- Water from within the earth.
- May be located a few feet or thousands of feet within the earth.
- Provides much of the freshwater we use.
- Can usually be used with little treatment.

Water Quality

- Condition of water for a particular use.
- Affected by how people use and abuse water resources.

Water Quality Factors

- Odor and Taste
- Color
- pH
- Hardness
- Turbidity
- Heavy Metals
- Chemical Residues
- Coliform Bacteria

Odor and Taste

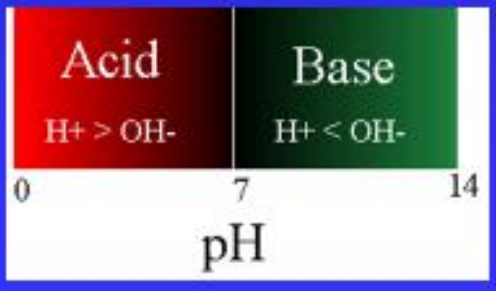
- The result of the water source.
- Bad odor and taste in water may result from pollution, sulfur, or microorganisms.

Color

- For most people, clean, clear water is their first choice. However, colored water may be safe to drink.
  - Colored water is often the result of mineral presence.
  - Minerals that may change the color of water include iron, magnesium, an calcium.
- Other factors that may alter water color include sediment, organic matter, and plankton.

pH

- The pH of water is commonly between 5.5 to 8.6.
- The safest pH level for pipes and pumps is 7.0 to 7.8.



Hardness

- The presence of calcium and magnesium ions in water.
- The greater the presence of these ions, the harder the water.
- Hard water leaves residue in hot water pipes and water heaters.

Turbidity

- The solid material suspended in water.
  - These materials may be soil particles or microscopic organisms.
- Turbid water is not clear; light cannot pass through the water.
- To remove turbidity, the water has to be filtered and the particles allowed to settle.

Heavy Metals

- Including mercury and lead, may be hazardous to the water supply.
- Lead was once commonly used to seal joints, now that lead may leak into the water supply within the pipes.
  - These pipes should be replaced.

Chemical Residues

- Chemical residues from various chemicals including pesticides can be dangerous to human health.
- However, the extent of these dangers is still unknown.

Coliform Bacteria

- An indication of fecal contamination in the water supply.
- The contamination may result from human or animal waste getting into the water.
- Water contaminated with coliform bacteria is not fit for consumption.
- Coliform bacteria can be destroyed by boiling the water.

What to Test for and When

- Testing your household water supply is important to the health of everyone within the house.
- Invisible contaminants in the water may be hazardous.
- Visible contaminants can be harmful to both people and household items.
- Other pollutants may not be harmful but may leave the water unfit to drink or cook with.

Testing Household Water Supplies

- No matter the problem, water testing will help determine how to solve it.
- Regular water tests that should be done on a yearly basis include coliform, nitrate, and pH.
- Regular water tests that should be done every three years include tests for sulfate, chloride, iron, manganese, and lead.

Testing Household Water Supplies

- In special situations, water should be tested more frequently and more thoroughly.
- Examples of such situations include the location of the water source to agricultural use, drilling, and landfills or dumps.
- Each of these may be responsible for contamination to local water supplies.

Specific Areas of Testing

- Bacteriological
- Mineral
- Chemical

Bacteriological testing

- Determines the presence of bacteria that may cause disease.
- The most common bacteria to test for is coliform.

Mineral Testing

- Determines the level of mineral impurities in the water.
- Large amounts of minerals can be hazardous and may reduce the usefulness of the water.
- Common minerals to be tested for include calcium, iron, copper, zinc, manganese, and magnesium.

Chemical Testing

- An expensive process, therefore it is usually only done when contamination is suspected.
- Common chemical pollutants include petroleum products and agricultural and industrial chemicals.

Unit F: Water

Lesson 4 – Identifying and Reducing Water Erosion

Use the slides below to answer the following questions:

Explain the difference between point and non-point source pollution.

dentify sources of water pollution.

dentify ways that water can be preserved and protected.

Identifying and Reducing Water Erosion

Lesson

Learning Objectives

- Explain the difference between point and non-point source pollution.
- Identify sources of water pollution.
- Identify ways that water can be preserved and protected.

Pollution

- Can come from a number of sources and is a problem to all aspects of the environment.
- It can be obvious, as in the form of a tanker spilling oil in the middle of the ocean.
- It can be virtually invisible, as in the form of acid rain.

Point Source Pollution

- Pollution that comes from an obvious source is easily identifiable and can be easily stopped.
- An example is the disposal of wastewater from factories. This water can be treated and cooled before it is released.

Non-point Source Pollution

- Pollution that comes from sources that are not easily identifiable or from a number of sources.
- An example is the runoff of wastewater carrying pesticides from a farm field.

Sources of Water Pollution

- Water can be polluted by a number of sources. These sources can even cause the water to be hazardous to the health of those that consume or use it.
- The different types of water pollutants include sediments, pathogens, organic wastes, inorganic substances, organic chemicals, and thermal pollution.

Sediments

- Loose particles of sand, silt, and clay that may be suspended in the water.
- These particles cloud the water and block the light needed by the organisms.

Pathogens

- Living and nonliving things that can cause disease.
- Water polluted with pathogens can be deadly.
- Examples of pathogens include viruses and protozoa.

Organic Wastes

- Can cause water pollution when they are present in large amounts.
- These wastes are pollutants because as they decay they use the oxygen in the water.
  - If the oxygen is used for decomposition it cannot be used by the other species.

Inorganic Substances

- Natural inorganic substances that can cause water pollution include acids and salts.
- Man-made inorganic substances that can cause water pollution include nitrate and phosphate fertilizers.

Organic Chemicals and Elements

- Are hazardous to most species.
- Organic chemicals include oil, solvents, pesticides, and detergents.
  - These materials enter water sources through the careless acts of people.

Thermal Pollution

- Caused by thermal effluent.
- Thermal effluent is the warm wastewater produced in factories where it has been used to cool machines and equipment.
- If the water is too warm upon entry into the body of water, it can cause the death of living organisms in the water.

Preserving and Protecting Water

- Water will be a valuable resource for many years if people take care of it.
- There are many things that people can do to help preserve and protect their water resources.

Ways to Protect Water

- Avoid waste
- Avoid pollution
- Dispose of wastewater properly
- Install conservation practices
- Have good equipment
- Reuse water
- Renewing wastewater

Avoiding Waste

- Can be as easy as shutting off the water when you're brushing your teeth, taking a shorter shower, or installing a low flow toilet that uses less water per flush.

Avoid Polluting

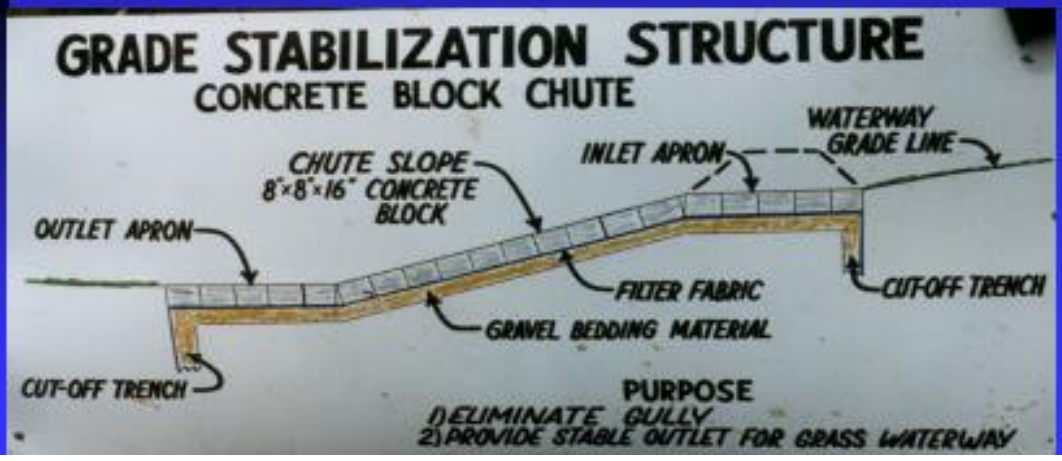
- People should be careful when applying pesticides and other chemicals.
- It's also important that detergents and soaps be used and disposed of carefully.

Wastewater Disposal

- Can be disposed of by pumping the wastewater into lagoons and treatment facilities.

Conservation Practices

- Such as building terraces and applying mulches can help conserve both soil and water.



Good Equipment

- That is free of defect including leaks is important.
- Faulty equipment can also cause energy waste.

Reuse Water

- Can help preserve our water resources.
- An example of reusing water would be to use thermal effluent to raise fish.

Renewing Used Water

- Can be accomplished by filtering the water and reusing it to help promote microbe growth in reservoirs.

Unit F: Water

Lesson 6 – Conducting Water Quality Tests

Use the slides below to answer the following questions:

Define water quality monitoring.

Identify types of physical monitoring.

Explain water testing.

Conducting Water Quality Tests

Lesson

Learning Objectives

- Define water quality monitoring.
- Identify types of physical monitoring.
- Explain water testing.

Water Quality Monitoring

- Studying of water to detect changes in its quality.
- The physical, chemical, and biological make-up of the water source should be monitored regularly.
- Regular monitoring will help determine what changes are taking place and how to stop these changes or make other corrective measures.

Water Quality Monitoring

- Water testing can be done by the landowner, by a lab, or by private testing companies.

Small pH Testing Meter | Phosphate Testing Meter | Coliform Testing Kit

Physical Monitoring

- Includes the visual and other physical observations of the water.
- Monitoring the odor of the water source and the course and any changes in the course of the water source are also examples of physical monitoring.

Visual Monitoring

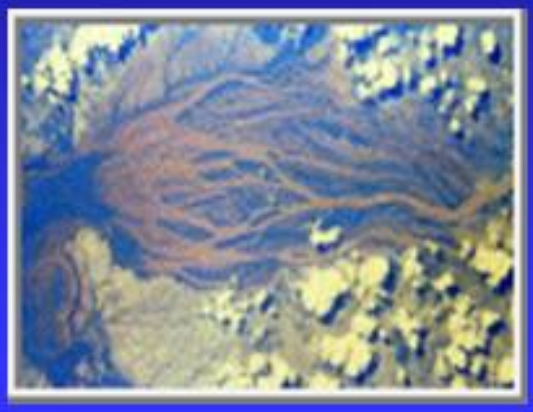
- Determining changes in water by looking at it.
- These changes may be in the color or the presence of sediment or other materials.

Changes in Color

- May result from the presence of algae or bacteria.

Presence of Sediment

- May also change the color and turbidity of the water.



Foam Forming

- Would indicate the presence of decomposition.

Observation of Dead Animals

- Could also be considered visual monitoring.

Test for Odors

- As simple as smelling the water.
- The odor of rotten eggs would indicate high levels of sulfur.
- Sewage and chlorine are other obvious odors that would result from sources of pollution in the water.

Change of Course

- A change of the water course source is usually due to erosion.
  - These changes may cause adverse affects to the water supply.
- One way to prevent changes in course is biological engineering.
  - Biological engineering is using plants to stabilize creek or stream banks.

Water Testing

- Can be done for a couple dollars or a couple hundred dollars.
- The type and extent of the testing will determine the overall cost.
- Examples of different water tests that can be conducted include hardness, dissolved gases, nitrates and nitrites, and acidity.

Hardness of Water

- Reported in parts per million (ppm).
  - Less than 100 ppm is most desirable.
  - Water with 250 ppm or more are considered hard and require treatment.

Dissolved Gases

- Carbon dioxide and hydrogen sulfide present in a water sample can result in a fowl odor or taste.
- They can be tested for, but results are not usually reported unless the odor and taste of the water becomes objectionable.

Nitrates and nitrites

- Present in the water when organic matter begins to break down.
- Nitrate levels above 10 milligrams per liter indicate contamination.
- Nitrite levels above 0.0005 milligrams per liter indicate contamination.

Water pH

- The acidity of water refers to the pH level.
- Water with a pH of less than 7.0 is acidic and can be harmful to plumbing fixtures.
- Water can also be discolored when the pH is too low.

Unit F: Water

Lesson 7 – Tracking Groundwater Contamination

Use the slides below to answer the following questions:

Define groundwater.

List causes of groundwater contamination.

Explain the severity of groundwater conservation.

Tracking Groundwater Contamination

Lesson

Learning Objectives

- Define groundwater.
- List causes of groundwater contamination.
- Explain the severity of groundwater conservation.

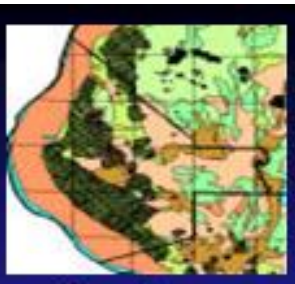
Groundwater

- Water found between soil particles and rocks within the earth.
- Comes from precipitation.
  - Rain falls or snow melts, some of the water evaporates, some is taken up by plants, some of it runs off into gutters, ponds or streams, and the rest seeps down into the earth to become groundwater.

Groundwater

- Provides most of the freshwater people use.
- It also feeds streams and springs.
- Groundwater may be stored in large, underground rock formations called aquifers.

Aquifers



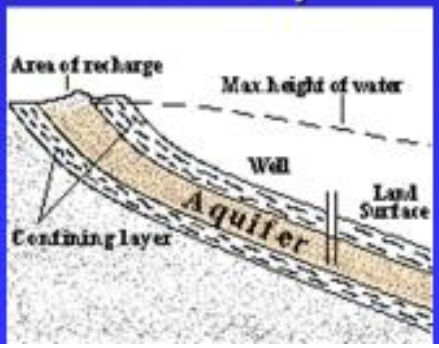
- Permeable rock materials that groundwater travels through.
  - Aquifer comes form two Latin words: aqua or "water", and ferre, "to carry."
  - A layer of sand and gravel or a deposit of sandstone or limestone.

Unconfined Aquifer

- Groundwater is able to move readily through.
- Water table is the top of an unconfined (unpressurized) aquifer, below which the pore spaces are generally saturated.
  - Perched water table is when the groundwater collects on top of an impermeable layer above the water table.

Confined Aquifer

- Groundwater sandwiched between two layers of of impermeable rocks.
- Artesian wells are wells that have drilled into a confined aquifer.



Artesian Wells

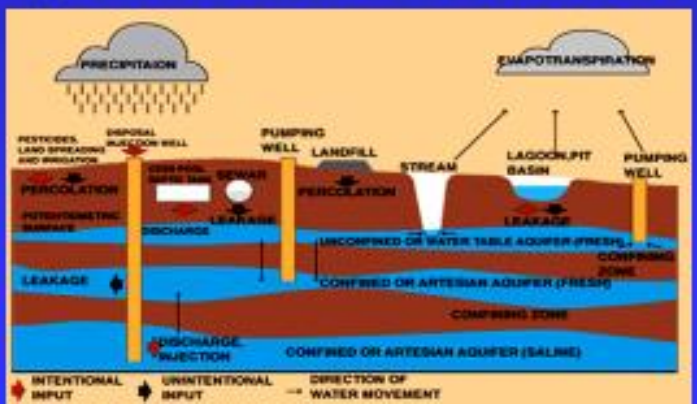
- When a well is drilled, the water level rises above the level of the confined aquifer due to the difference in elevation from the point of recharge to the point of discharge (the well).
- A flowing artesian well is when there is enough pressure to push the water above the surface of the ground.

Percolation

- The downward movement of water through the soil.

Groundwater Contamination

- Three of the main sources of groundwater contamination are agricultural activities, human activities, and natural sources.



Agriculture Activities

- Include the practice of irrigation and the application of fertilizers and pesticides.
- Irrigation causes pollution because of the salts the irrigation water contains.
  - As the water percolates through the soil, it takes the salts with.

Agriculture Activities

- Fertilizers can become pollutants when they are applied too heavily.
  - The fertilizer that the plant cannot use becomes a pollutant.
- Pesticides can also become pollutants when applied too heavily.

Human Activities

- Include waste disposal, septic systems, and land fills.
- Wastes can become pollutants when not disposed of properly.
  - Examples of wastes include septic systems, landfills, and illegal dumping.

Human Activities

- Septic systems are not only one of the largest sources of waste, they are also full of bacteria, viruses, and the organic chemicals used to break down the wastes.
- Landfills are for either municipal or industrial use. Municipal landfills include wastes collected from households.
  - Industrial landfills include wastes that may be contaminated with a number of hazardous chemicals.

Natural Sources

- Include nitrates, nitrogen, and minerals.
- Nitrates and nitrogen in ground water come from the natural decomposition process of organic materials.
  - They can be hazardous to babies and young children.
- Minerals in the groundwater are considered pollutants in high concentrations.
  - An example of damage caused by minerals includes staining of fixtures and sediments on pumps and pipes.

Severity of Groundwater Contamination

- Cannot be truly measured.
  - Too many factors are involved to determine the overall level of contamination.
- Factors such as soil types, type of contaminant, amount of precipitation, and location of contamination can determine the severity of contamination in the area.
- Overall, the more shallow the aquifer, the more likely it is to become polluted.