Science Focus 8 - Unit 5

Teaching Notes

Created by Edquest Resources 2004

Topic 1 – A World of Water (pgs. 364 – 374)

Living systems need water to survive. Ecosystems depend on it. The land is changed by it. Industry uses large amounts of it. Climate and weather are determined by it. Our **'blue planet'** - as viewed from space - is unique among the planets in our solar system, because 74% of its surface is covered by water.

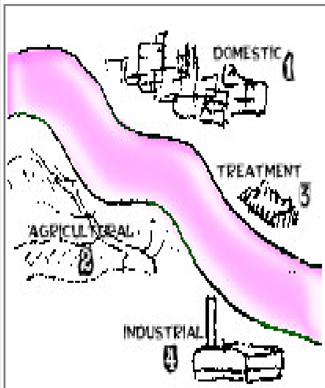
However most of the water on the Earth (about 97%)r is saltwater

How Do You Depend On Water?

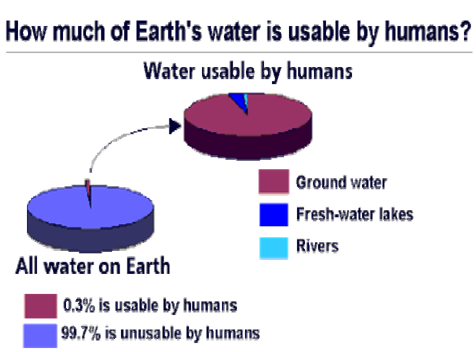
Human body cells need water to function. All organisms need water to survive and all organisms have varying amounts of water in their mass; humans 65%, apples 84% and watermelon 98%. The water in your body does not stay constant. You lose water (sweat and elimination of wastes) and you gain water – almost 2.5L per day. Water is vital for survival of all living things.

The Major Uses Of Water

There are **direct** (domestic or personal use) and **indirect** (industrial and agricultural) ways that humans use water. Many indirect uses can have negative effects on Earth's water supply. There are **benefits** and **costs** to using water.

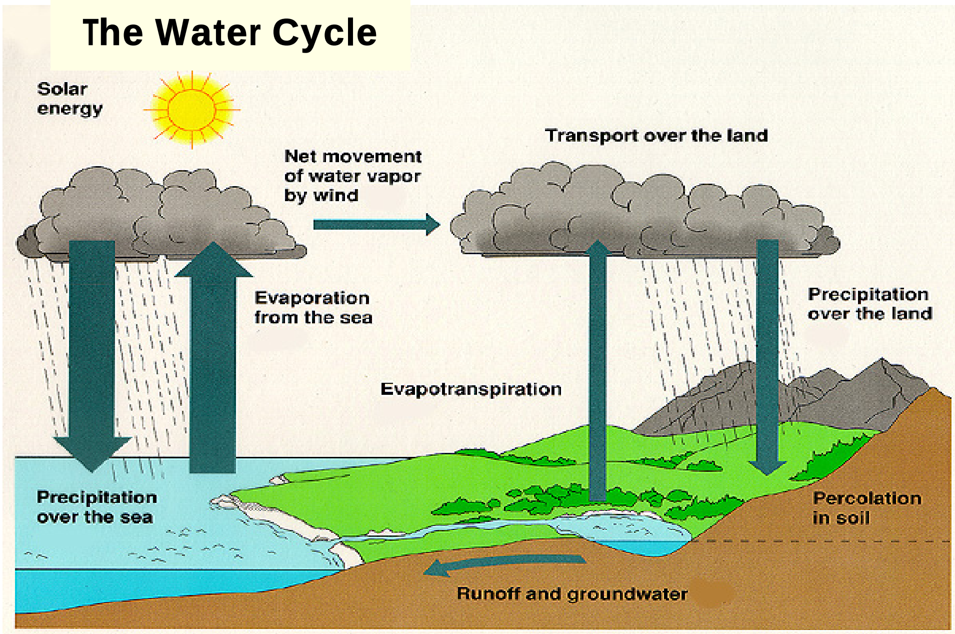


Water Use	Direct/Indirect	Benefit (+)	Cost (-)
Agriculture (irrigation) 73%	indirect	Food Economy Jobs	Soil salinity Decreases vegetation Depletes groundwater supplies
Industry (coolant, solvent, washing, diluting pollutants) 22%	indirect	Jobs Consumer Products & Services	Pollution contributor Depletes groundwater supplies
Domestic 5%	direct	Convenience Jobs	Cost



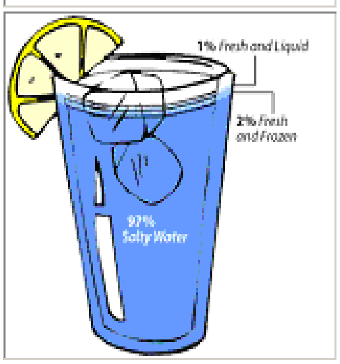
Negative effects may include:

- Pollution of surface and groundwater
- Depletion of groundwater supply



The Water Cycle controls the distribution of water on the Earth. The Sun's energy drives the water cycle. Each year 520,000 km^3 of surface water moves through the cycle as water vapour.

The Distribution of Water On Earth (Water quantity – the amount of water)

Water source	Model	Percent of total water	Potable, or not?
Oceans		**97.20%**	Saltwater
Icecaps, Glaciers		**2.15%**	Frozen
Ground water		**0.63%**	Fresh - but not entirely accessible
Rivers, lakes, Inland seas, soil moisture and in the atmosphere		**0.02%**	Potable - some with Indirect access however
Total water	.	100%	

Water Enough For All

Water quality – the characteristics that make water suitable or unsuitable for different uses
Four countries (Brazil 18%, Canada 9%, China 9%, and United States 8%) hold nearly half of the Earth's renewable supply of freshwater.

Managing Our Water Resources

Management of our water resources means managing our water sheds by protecting them. By balancing the water needs of people, industries, wildlife and the environment. You will learn more about watersheds in Canada and Alberta in Topic 2 and 3.

Topic 1 Review
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Topic 2 – Earth's Frozen Water (pgs. 375 – 388)

What is a Glacier?

Large bodies of moving mass of ice and snow are called **glaciers**. An ' **Ice Cap** ' is a glacier that forms on an extensive area of relatively level land that flows out from its source. An ' **icefield** ' is an upland area of ice that feeds two or more glaciers. (The Columbia Icefield, in the Rocky Mountains, feeds 6 glaciers, is the source of three of Canada's major rivers and replenishes three different oceans.)

How Do Glaciers Form?

All glaciers begin as snowflakes. These snowflakes accumulate, becoming grains, ice crystals and the weight of the snow creates pressure that gradually changes the ice crystals into glacial ice.

Valley Glaciers

Glaciers form high in the mountains and move through valleys between mountain peaks. These are called **valley glaciers**.

Continental Glaciers

Those covering large areas of land are called **continental glaciers** or icecaps. **Continental glaciers** cover Antarctica and Greenland.

Glacial Features

The shapes that develop in flowing ice are unique. Where a glacier flows over a steep cliff and breaks up, an **icefall** results. A **crevasse** is a fissure, or crack, in the ice.

Glacial Movement

The movement of glaciers depends on the climate. In colder climates, little melting occurs and the glacier continues to grow or move forward (this is called an **advancing glacier**). If the climate is warmer, the glacier melts faster than it grows and leaves the rocks, soil and large boulders it once contained. These glaciers are called **retreating glaciers**.

Pack Ice and Icebergs

Pack ice is a sheet of ice that is rarely more than 5 meters thick that breaks easily. This usually happens in freezing sea water when large pieces break off as they move into warmer water. **Icebergs** are large chunks of ice that break loose, or **calve**, from continental glaciers as the glaciers flow into the ocean. These chunks are visible as they move through the ocean, melting faster below the surface than above.

Iceberg floating in pack ice

How Glaciers Shape The Land

Glacial Erosion

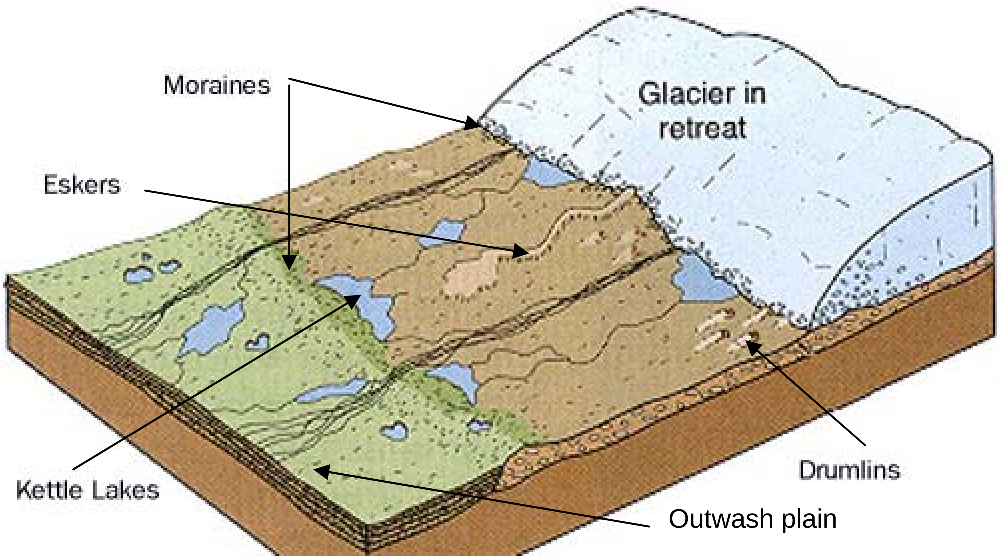
As glaciers **advance or retreat**, they create specific glacial features across the landscape.

Evidence of Valley Glaciers

Valley glaciers carve (erode) bowl-shaped basins, called **cirques** in the sides of mountains. When two or more glaciers act on a mountain – eroding it from two different directions, a ridge forms, called an **arête**. If it forms a sharpened peak it is called a **horn**.

Glacial Deposition

The collection of rocks, boulders, sand, clay and silt that is left behind as a glacier slows down and melts is called **till**.



Both of these sites about Glaciers have actual photographs of the features that a glacier creates.

http://www.glacier.rice.edu/land/5_glaciallandforms.html

http://oz.plymouth.edu/~sci_ed/Turski/Courses/Earth_Science/chp5.html

This is another glacial feature, an **erratic** - just outside Calgary, near Okotoks, AB.

Meltwater Features

Meltwater - water formed by the melting of snow and ice – carves channels in and throughout glaciers. A **millwell** is a rounded drain in the ice that is chiselled by a stream as it plunges downward.

The Importance of Glaciers

Icefields, glaciers, and snow – high up in the mountains – act as natural **reservoirs**, collecting snow in the cold months and releasing it as meltwater as it warms up. This meltwater helps run hydroelectric plants, irrigate crops, water cattle and supply drinking water. Glaciers slow the water cycle and provide important clues to understand historical climate patterns.

Ice Ages

The Earth has had 7 major Ice Ages over the last several million years. During this time glaciers covered approx. 28% of the Earth's surface.

In the last Ice Age, Canada was completely covered by a continental glacier.

At the peak of the Ice Age the average temperatures around the world were 5^{o}C colder than they are now.

Ice Ages and Climate Change

A small change in the average temperature is enough to start a chain of events that can produce an Ice Age.

- There might be reduced thermal energy from the Sun.
- There might be increased volcanic activity – adding clouds of ash into the atmosphere, thus reducing how much thermal energy from the Sun reaching Earth.
- Mountain building may cause more snow to accumulate and reflect sunlight – thus reducing the temperature.
- The movement of Earth's tectonic plates alters the shape of the oceans and affects ocean currents, causing less mixing of hot and cold water.
- A change in the tilt of the Earth's axis may also alter the temperature.

Climate Changes Today

The **greenhouse effect** and **global warming** are two unrelated events that affect the average temperature on the Earth.
The **greenhouse effect** is the natural warming of the Earth caused by gases in the Earth's atmosphere trapping heat. Without it, life would not be able to survive.
Global warming is the increase of these greenhouse gases, which causes more heat to be trapped and the temperature around the world increases – causing ice caps to melt producing widespread flooding.

Topic 2 Review
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WRAP-UP p. 389

>>>> A good review of Topics 1 – 2 in this Unit <<<<

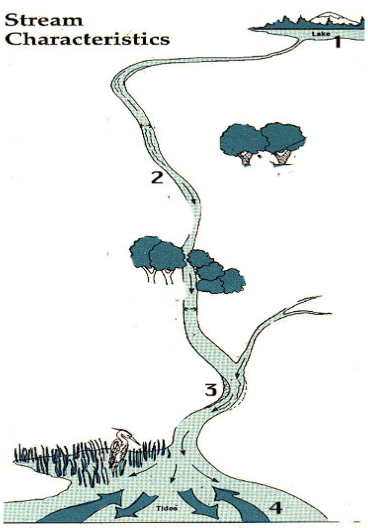
Topic 3 – Fresh Water Systems (**pgs. 390 – 409**)

Freshwater systems exist above ground as **surface water** and below ground as **groundwater.** Water exists in all three forms on the Earth: solid, liquid and gas. It is found underground, on the surface and in the air. Water affects living and non-living things within the Earth's environments.

Lakes, Ponds and Wetlands

A **lake** and a **pond** are holes in the ground filled with water. A lake is deeper than a pond and sunlight does not reach the bottom, whereas in a pond sunlight will penetrate right through to the bottom, depending on the **clarity** of the water. The clarity is determined by the amount of suspended solids in the water. In lowland areas, **wetlands** exist. They are saturated with water most of the time. Wetlands provide habitat for a vast diversity of living organisms.

Streams and Rivers



Streams and rivers are fast flowing waterways and vary in speed, temperature, clarity, the nature of their banks and their bottoms. Rivers and streams that flow quickly are usually rich in oxygen.

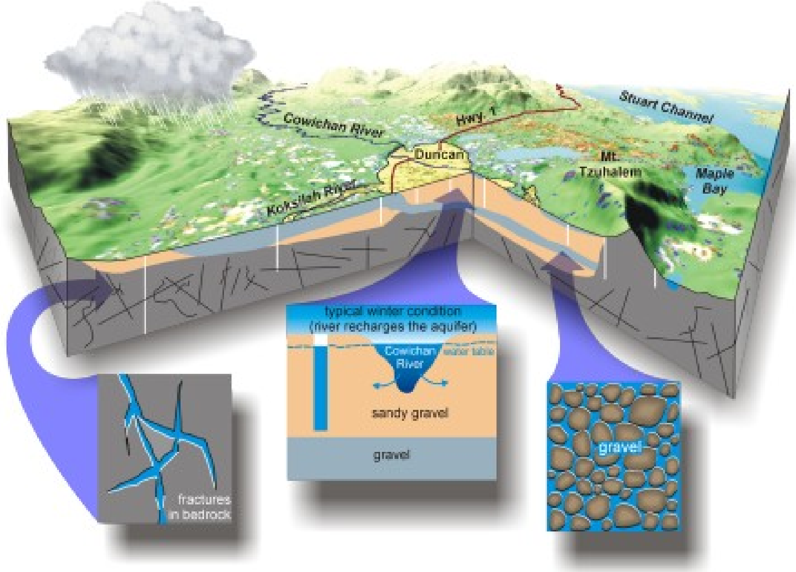
A **stream profile** is a description of its characteristics, including flow rate, steepness of stream's bed, and erosion rate of its banks.

The source of a river may be high in the mountains, where a glacier is melting. As small streams form together into one channel, the volume and speed of the river grows. In the early stages, the river is flowing very quickly and usually fairly straight. As the river reaches lower elevations it begins to slow, causing curves to form (***meanders***), until it reaches a fairly flat flood plain and the sediment it has picked up is deposited in a fan-shaped deposit called a **delta**.

Topography Website:
http://education.sdsc.edu/optiputer/teachers/shapingtopography.html

Water Underground

Groundwater is found below the surface in small pores between rocks and soil.



Freshwater links: The Watershed Concept

A **watershed** is all the area of land that drains into one main body of water. It can contain many smaller streams, rivers and even lakes, which all eventually drain into a larger lake, sea or ocean. The location of the highest land on the continent determines the direction that a watershed drains.

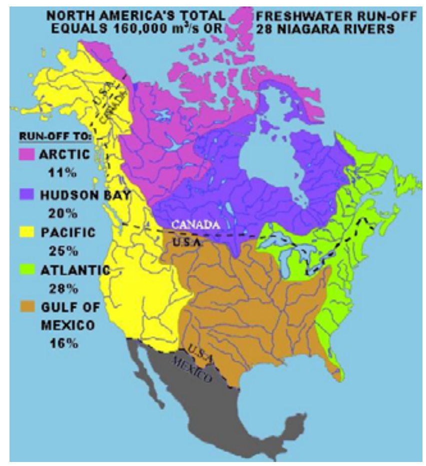
This high land is called the **Continental Divide.**

In North America it is in the **Rocky Mountains**.

On the west side of the divide, the rivers all flow into the Pacific Ocean. On the East side of the divide, the rivers flow into either the Arctic Ocean or the Atlantic Ocean.

A **watershed** (also called a drainage basin) is a region of interconnected rivers and streams.

Streams and Drainage Systems: http://www.tulane.edu/~sanelson/geol111/streams.htm



Watersheds In Canada
Canada has **9%** of the world's freshwater.

The upstream areas of a watershed are called **headwaters** and the end point is called the **outflow,** usually at the mouth of a river.

A **reservoir** is an artificial lake.
It is used for storage and management, because many of the larger populated centers in Alberta are far from major river systems.

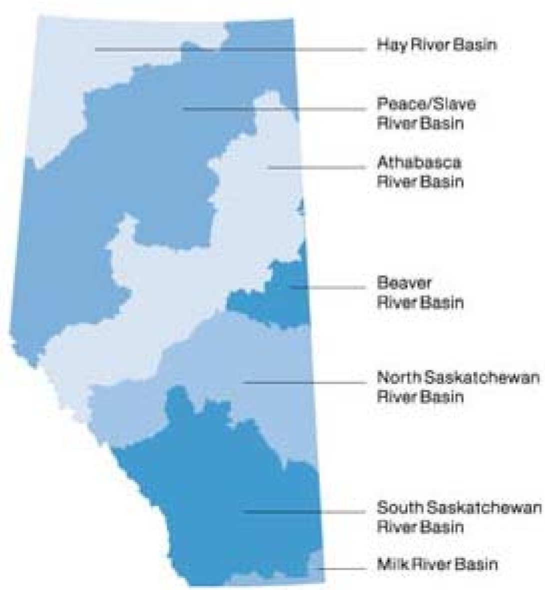
Watersheds In Alberta

There are 7 major watersheds, or river basins, in **Alberta.**

Peace/Slave River Basin
Athabasca River Basin
Hay River Basin
(flows into the Arctic Ocean)

Beaver River Basin
North Saskatchewan River Basin
South Saskatchewan River Basin
(flows into the Hudson's Bay)

Milk River Basin
(flows into the Gulf of Mexico)



Watersheds and Land Use

Storm drains in a city act as a watershed to remove water from the streets after a heavy rainfall. The paved roadways change the run-off patterns in a city, because the water would normally seep into the ground. Logging can also affect watersheds. GIS (Geographic Information Systems) are used to store data and generate maps showing a river's watershed, allowing them to predict what would happen if run-off patterns changed. The amount of water discharged by a watershed is influenced by soil conditions, vegetation, and human activity.

Run-off and Erosion

Moving water is a powerful force. When water wears away rock the fragments are carried as sediment and deposited elsewhere. A river's **sediment-load** is the amount of water-borne materials (rock, soil, organic matter) it carries. The faster the river flows, the more water-borne materials it can carry. Factors that can affect the amount of sediment-load are vegetation, steepness the geological characteristics of the banks and bottom.

Deposition

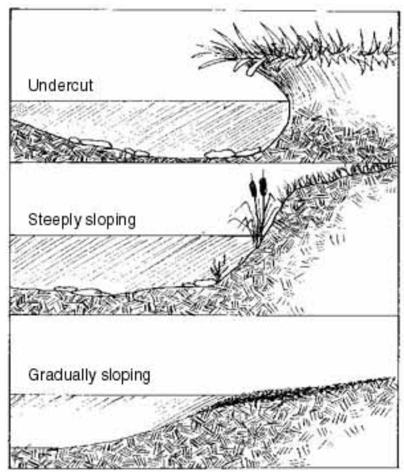
As a river slows water-borne materials are deposited as **sediment.**
(Review - **Stream Characteristics**)
The volume and speed of water in a river determines how the landscape can be shaped and changed.

River Flow Monitoring

Streamflow is the amount of water (volume) that flows past a certain point over a period of time (velocity). Watershed managers measure this streamflow over a period of years to calculate the average.

This is important because it helps scientists analyze water quality and predict flooding, drought conditions and design water control projects (such as irrigation or drainage projects).

The greater the river's rate of flow the higher the sediment load it has. Sediment is classified as suspended, rolling or bouncing or stationary.



Why Is Monitoring Sediment Important

Sediment monitoring plays a major role in understanding and determining the movement of toxic substances in the water. By studying the quantity, quality and characteristics of sediment, scientists can determine the sources of pollutants and measure their impact on the aquatic environment.

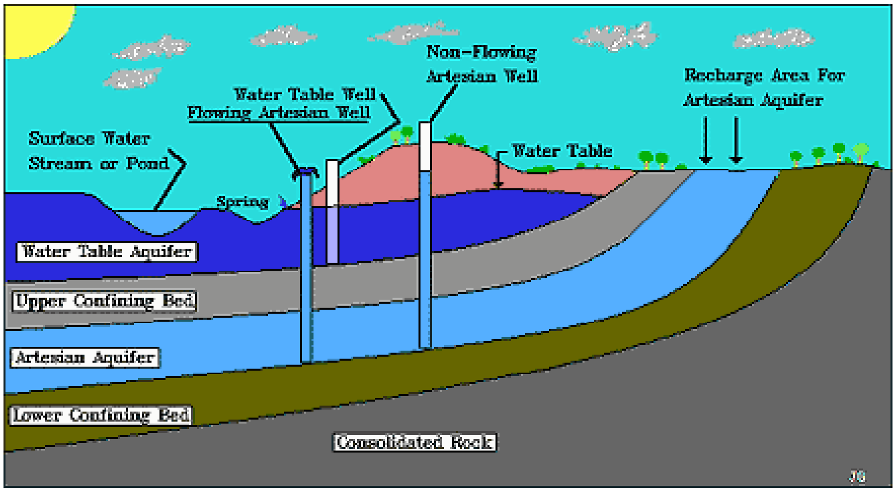
- Pollutants released into fish habitats can cause abnormalities or death in fish
- Farming practices can increase the sediment-load of a stream and add sediment-borne chemicals to the waterway
- Deposition of sediment can decrease water depth, making navigation more difficult
- Sediment can affect the delivery of water, by wearing out pumps and turbines

Sediment can carry harmful toxins far from their source and change the landscape quite dramatically.

Reducing Erosion and Stream Sediment Load

Sediment from construction can be prevented from entering the waterways by setting up a **de-sedimentation site**. **Dredging** can remove sediment from the river bottom, so the river can flow more easily. Restoring an eroded river can be achieved by planting **native vegetation** along its banks, reinforce the banks with **logs**, or rock baskets - **rip-rap** - that could include discarded concrete and boulders. **Deflector Logs, Log Dams and Digger logs** ((which force the water down, carving a deeper channel) are also used. **Wetlands** store excess water and slow the rate of run-off. They also trap and neutralize harmful chemicals in run-off.

Watershed Management and Groundwater



A groundwater system is similar to a river system. Connecting pores in rocks and soil enable the water to seep through – making it **permeable**. This is called an **aquifer**. When the water reaches the bedrock, which is **impermeable**. The layer of porous rock, in which the connecting pores are full of water, forms the **water table**.

Wells and Springs

As the illustration shows above, wells are dug to reach the aquifer, below the water table. If too many wells are dug too close to each other, they may deplete the aquifer and the wells will dry up. If the water in an aquifer flows naturally to the surface, it is called a **spring**. Hot springs occur when this water is heated by rocks that come into contact with molten material below the Earth's surface.

(Banff Hot Springs)

Aquifer Depletion

Underground aquifers supply water to many cities, farming communities and industries. If too much is used, the aquifer can become depleted, drying up creeks, springs and wells for many kilometres. Responsible use of water is essential in order to sustain this natural resource.

Groundwater Contamination

Contaminants in groundwater can spread the effects of dumps and spills far beyond the **point source**. **Non-point sources** are those where a pollutant comes from a wide area (run-off from agricultural land is an example). **Hydrogeologists** are scientists who study groundwater by drilling **test wells** to determine groundwater availability, movement, quantity and quality.

Too Little Water

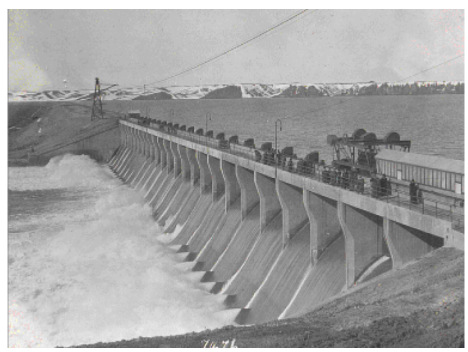
When there is too little water, (like in Southern Alberta) management projects, such as **irrigation** help to maintain a constant supply of water for agricultural purposes.

The Western Irrigation District supplies water to farmers, ranchers, acreage owners and industries through a complex system of **irrigation canals**.

There are *four major types of irrigation* used in Southern Alberta. **Flood irrigation** is still used somewhat by farmers in the sugar beet industry, but is not widely used in other types of crop production. In flood irrigation, the canals near a farm are opened up onto a field, where the field is thus flooded with a few inches of water. Modern irrigation uses pipes and sprinkler systems. Water is pumped from a canal into a series of pipes, and is distributed by sprinklers. There are *three major types of sprinkler irrigation* used in Southern Alberta. The first is the ***hand move pipes***, where farmers have to periodically move pipes from one site of irrigation to another, in a regular fashion as not to over irrigate a section of farm. The second type is ***wheel move irrigation*** where the pipe and sprinkler system is attached to wheels where a motor drives the piping system forward over a field. The third system gaining world popularity with farmers is ***pivot irrigation***. Like wheel move irrigation, there is a system of pipes and sprinklers which are then mounted on wheels with a motor(s), moving in a circular or pivotal fashion much like the hands of a clock. Pivot irrigation is advantageous because it allows the system to continually irrigate without the need to control how far it will go in one direction.

Irrigation canals also provide storm water removal systems and municipal water for several towns.

Too Much Water



When a river system has too much water in it, **flooding** may occur. The likely place for this to occur is in the part of the river called the **flood plain**. Dams are used to control the flow of a river for many purposes, to generate hydro-electricity, reduce flooding and provide irrigation. Many environmental considerations go into the building of a dam. The environmental standards are designed to protect the rivers, streams and their habitats. The controlled flow of a river can provide flood relief, but can also reduce diversity of aquatic organisms, because less oxygen may be dissolved in the slower moving stretches of the river.

Topic 3 Review
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Topic 4 – The Oceans (**pgs. 410 – 430**)

70% of the Earth's surface is covered by the Oceans.

The oceans are in constant change. Surface water and water deep down on the bottom of the ocean floor, is constantly moving across the surface of the Earth, affecting climate, and the diversity of life.

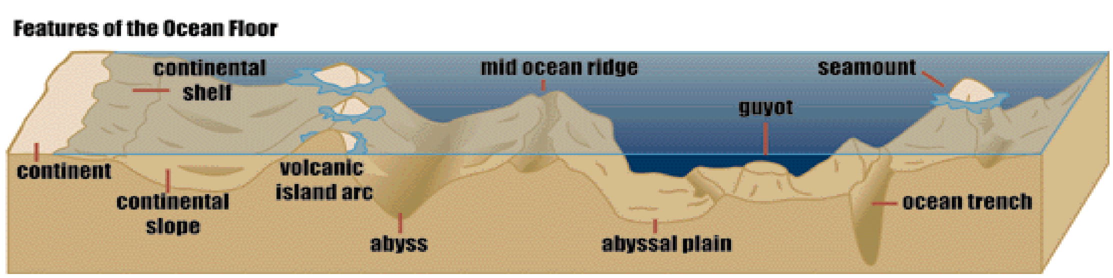
A Sea Full of Salt

Ocean water is salty. 1kg of ocean water contains about 35g of dissolved salts (35ppt). The most common salt is sodium chloride, but other salts are also present. The measure of the amount of salts present in a given amount of a fluid is called **salinity**. The salts end up in the oceans because as water moves across the land, salts are dissolved in the freshwater and then deposited eventually in the ocean. Another source of chemicals in ocean water is volcanoes. The lava and gases that erupt from these volcanoes on the floor of the ocean add more chemicals directly into the water, whereas the volcanic eruptions on land add chemicals into the atmosphere, which are then distributed through the atmosphere, eventually falling back to the Earth with precipitation – landing in the oceans.

Ocean Basins

The oceans form the largest ecosystem on the Earth. Most of the ocean is pitch-black because light can only penetrate about 100m. Scientists have been able to map out the floor of the ocean with sophisticated instruments, so we can 'see' what it is like.

A Journey On The Ocean Floor



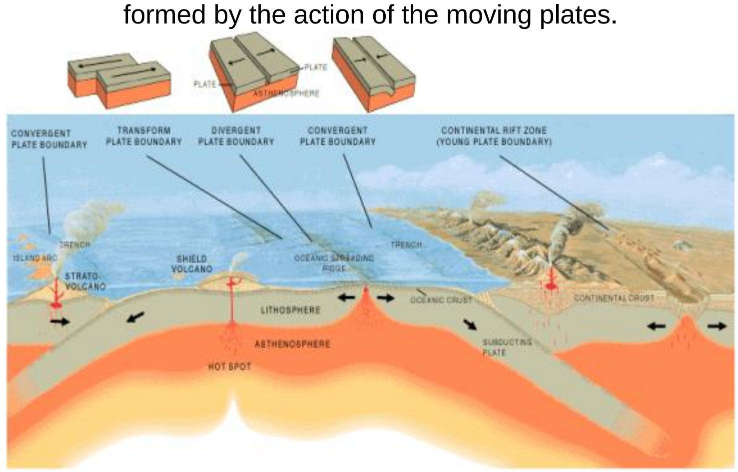
The origin and formation of the ocean basins are due to mainly the movement of the Earth's tectonic plates.

(**Grade 7 – Planet Earth**)

The Theory of Plate Tectonics explains how the **lithosphere** (crust of the Earth) is in pieces and these pieces (*plates*) are moving because of **convection currents** in the **magma**.

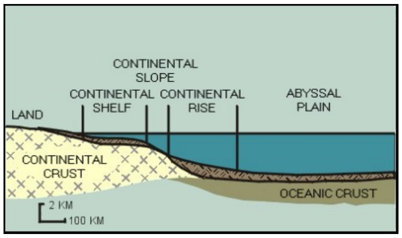
Some of these plates are *moving toward* other plates, some are *moving away* and some are *moving in opposite directions* beside each other.

This illustration shows how features on the ocean floor were formed by the action of the moving plates.



Continental Shelf and Slope

Ocean basins do not begin at the coastline, but many kilometres out at sea.



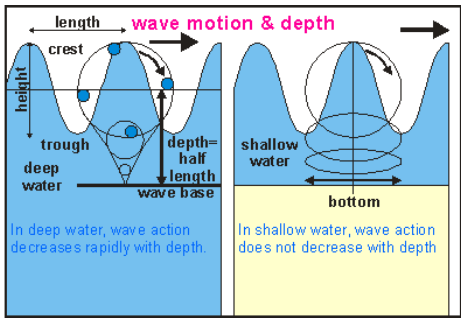
The **continental shelf** is the submerged part of a continent and stretches out from the coast 30 - 300km or more. These shelves gradually slope away from the land before dropping steeply at the edge of the shelf. From the edge of the shelf, the **continental slope** (usually less than 200km wide) plunges 3km at a steep angle to the ocean floor (**abyssal plain**).

Ocean Waves

Waves are surface movements ***"a disturbance, or variation transferring energy progressively from point to point in a medium"*** occurring whenever a force comes in contact with water. A boat on the surface of the water will cause a **'wash'** or 'wave action' - which can affect other objects in the water, as well as the shoreline.

There are different kinds of waves:
http://members.aol.com/nicholashl/waves/waves.htm

Causes of Water Waves
Most waves are caused by the wind (a force). Stronger forces cause larger waves. As ocean waves move closer to the shore their bottoms drag on the ocean floor and their tops rise and break onto the shore (causing damage by their force).
http://gpc.edu/~pgore/Earth&Space/waves-tides-currents.html



The Movement Of Water Waves
Waves are changes in patterns that move along the water's surface. Although waves can move a very long distance, the water doesn't move - it acts as the medium for the 'wave action' to occur. Within each wave the particles of water move in a circular motion. Waves begin on the open sea. The smooth waves near the shore are caused by winds and storms far out at sea and are called **swells**.
All about waves (animations): http://id.mind.net/~zona/mstm/physics/waves/partsOfAWave/waveParts.htm
Water Waves (dynamics of movement): http://www.eng.vt.edu/fluids/msc/my_pages/ocean/w_waves.htm

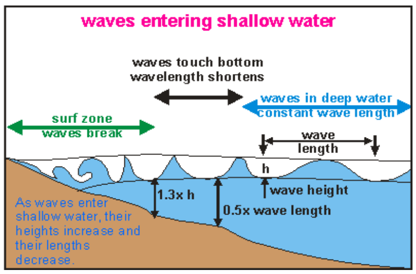
Tsunamis are very large waves caused by undersea earthquakes, seabed slides, or large volcanic eruptions. They occur approx. every 5-15 years but have no definite pattern and cannot be predicted.
http://www.es.flinders.edu.au/~mattom/IntroOc/notes/figures/animations/pngtsunami.gif

Tsunamis means **'harbour wave'** .

Breaking Waves

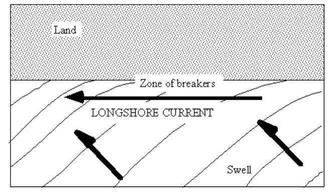
As waves get closer to the shore, the illustration shows what happens. Waves that collapse on the shore are called **breakers**.

Surfers use these forward motions of the crest to ride a wave to shore.



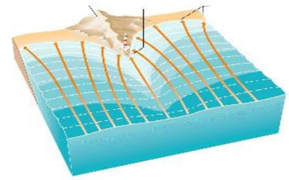
How Waves Change Shorelines

The force of waves crashing against a shoreline can cause changes to the shape of the shoreline, whether it is hard rock or soft rock. Erosion and deposition reshapes the shoreline dramatically. Waves collide with the shoreline at slight angles, creating a **longshore current**, which carries the sediment along the shore, redepositing it on its journey.



Erosion - animation showing the formation of a cliff
http://www.eng.vt.edu/fluids/msc/my_pages/ocean/w_waves.htm

Sea caves and **arches** can be formed by the action of waves eroding rock along the shore

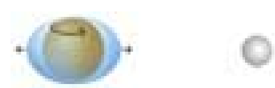


How Beaches Are Formed

The type of rock that the shoreline is made of will determine if it will have a sandy beach or not. Rock fragments eroded along the shore rub against each other and get polished and smoothed into tiny pebbles or grains of sand. If the shoreline is steep and rocky, these fragments of sand get washed back to sea. If the shoreline has a gentle slope, then a beach can be formed by the deposition of these tiny fragments of sand. Most fragments of sand are quartz, but also are made up of an assortment of other minerals, shells and coral. Waves are changing the shores constantly and as a result many beaches have had to have **sea walls**, **breakwaters, jetties** and **barriers** built to prevent the sand from being washed back to sea.

Tides

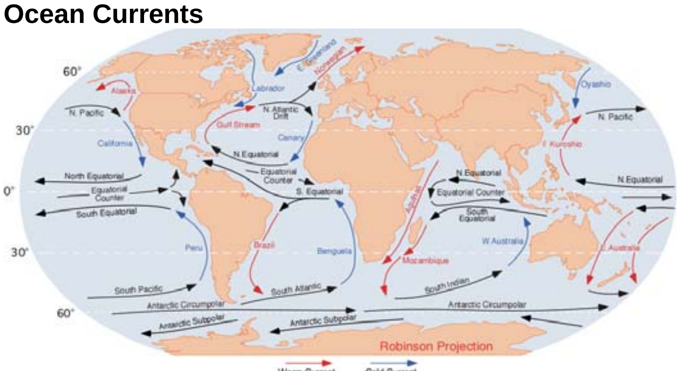
The water level along the coast of continents changes constantly. This water level is called a **tide**. **High tide** is the highest level the water will reach on shore, while **low tide** is the lowest level it will reach onshore. Usually there are two high tides and two low tides each day. The largest tidal movements are **spring tides**, whereas the smallest tidal movements are called **neap tides**. The difference in level between high tides and low tides is called **tidal range**.



(Click on image to see full view)

What Causes Tides? The gravitational force of the moon and the rotation of the Earth on its axis cause tides.
Animation http://www.pbs.org/wgbh/nova/venice/tides.html

Ocean Currents

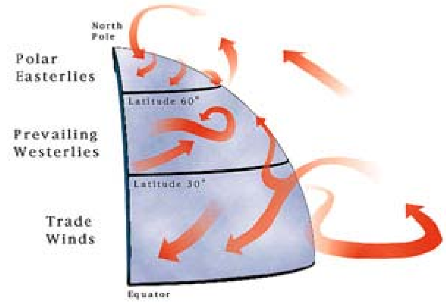


Surface Currents (WINDS)

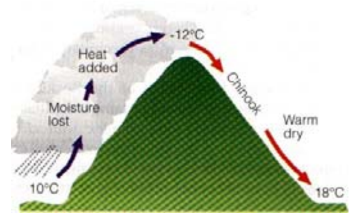
Currents of water are driven by winds. The steady flow of ocean currents results from major wind patterns.

There are three factors that influence the direction of winds and surface currents:

- Uneven heating of the atmosphere (convection)
- Rotation of the Earth (bending)
- The continents (deflecting)

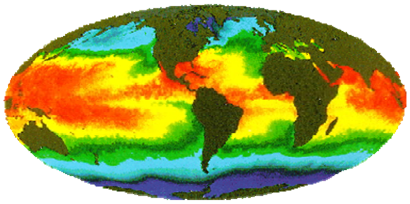


A **Chinook** is a warm dry wind crossing the mountains from west to east.

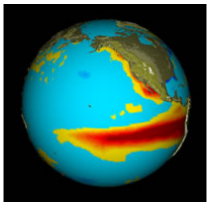


Ocean Temperature and Currents

The temperature of the ocean current not only affects the air temperature, but they also affect the amount of precipitation that an area receives. Almost all of the heat in the ocean comes from the Sun. Temperature vary throughout the ocean getting much colder as you go deeper.



El Niño



Warm air (warm currents) hold more moisture than cold air (cold currents).

Ocean and Climate

The currents that affect Labrador and Scotland are surface currents. If they start near the equator (like the North Atlantic Current does), they are warm. If they start near the North Pole, they carry very cold water (like the Labrador Current does). When the current flows to their respective shores, they can influence the climate of the land.

Warm and Cold Currents

Warm ocean currents transfer heat to the atmosphere. Water has a very high **heat capacity** – meaning it takes a long time to heat up and a long time to loss heat. Large bodies of water act as heat reservoirs in the winter, remaining relative warmer than the nearby land. This difference in temperature can affect the convection currents producing breezes that can alter the processes of evaporation and condensation near the shoreline. A cold current can do the opposite.

Topic 4 Review
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WRAP-UP p. 431

>>>> A good review of Topics 3 – 4 in this Unit <<<<

Topic 5 – Living In Water (pgs. 432 – 447)

Diversity refers to the variety of different kinds of organism species (both plant and animal) living in a particular ecosystem or environment. Large bodies of water like oceans and lakes have layers or zones. Some organisms live in only one or two zones, while other organisms can live in all three.

Lakes and Ponds

Lake Diversity (see diagram in textbook SF p.432)

Lake Zones	Species you might find in this zone
Upper Zone - is the area of a lake from the shore down to where the aquatic plants stop growing Plants	- bulrushes, water liliesAnimals - small fish, clams, insects, snails, worms, leeches, and frogs
Middle Zone - is the open water area that still has light penetration.	- Phytoplankton are food for fish that live here. Some of the fish that live in this zone also travel to the deeper zone.
Lowest/Deep Zone - is where no light penetrates, so no plants grow there. Food for organisms living in this zone comes from the zones above, in the form of waste.	- Deep water fish (large size species)

Freshwater Diversity

(Pond Life)

Rivers and Streams
Streams and rivers usually alternate between areas where water is calm (pools) and areas where water is moving quickly (riffles). Because of the constantly moving environment, organisms often attach themselves to rocks as their habitat.

Oceans

Ocean Diversity (see diagram in textbook SF pgs. 433)

Ocean Zones	Species you might find in this zone
Estuary - one of the most diverse and richest ecosystems. This is where freshwater and saltwater mix to form brackish water.	- Marshes grow here providing habitat for many different kinds of plants, insects and other animals that can tolerate the brackish water.- These ecosystems are also rich in bird life, because of all the food and shelter available
Intertidal Zone - is the shoreline of an ocean.	Plants and animals living in this zone must be able to withstand the pounding of the waves and the rise and fall of tides.Animals with special adaptations live in this zone.
Continental Shelf - is warmer water than out in the deep ocean and this area has full light penetration.	Many varieties of plants and animals live in this zone because of the rich nutrients available. Phytoplankton are food for fish that live here. Some of the fish that live in this zone also travel to the deeper zone.
Oceanic Zone - is where very little light penetrates, so no plants grow there.	Food for organisms living in this zone comes from the zones above, usually in the form of waste. Deep water fish (large size species)

Saltwater Diversity

Oceans have similarities to lakes in terms of zones, but with greater differences in water motion, salinity and depth, diversity is much greater in the oceans.

(Coral Reef - 2nd most diverse ecosystem in the world)

Adaptations for an Aquatic Life

An **adaptation** is *a physical characteristic or behaviour of a species that increases that species' chances of survival in a particular environment*. All living things are adapted to live in particular environments. In Canada lakes are affected by extreme changes in temperature. Organisms living in the freshwater ecosystem of a lake or pond must be able to adapt to these changes in order to survive. As changes occur within their environment, those organisms that can adapt to the changes have a better chance of surviving than those organisms that cannot adapt to the changes. Many aquatic organisms filter the water to get their food.

There are **five factors** that have led to the development of adaptations by aquatic species.

Temperature	Fish that live in cold water have adapted to the temperature. Their body would overheat in warm water. Fish that live in extremely cold water (Arctic) have a natural **antifreeze** that keeps their blood and tissues from freezing. In the very deep parts of the ocean, near volcanic vents, organisms can actually survive in extremely hot water.
Light	Most organisms need light. Plants need light to photosynthesize (make food). In the deepest parts of the ocean some organisms have adapted to the absence of light by producing their own light from spots on their bodies called **photophores**.
Pressure	As you travel deeper in the ocean, the pressure increases. Those animals that have adapted to different regions of the ocean would perish in other regions because they would be unable to survive the pressure difference.
Salinity	The salt content of the ocean water can be very high. Those organisms that live in this ecosystem cannot survive in freshwater. Freshwater organisms cannot live in saltwater, because the salt makes fluid leave their bodies. Salmon can survive in freshwater (where they are born) and saltwater (where they live most of their lives).
Water Movement	Some organisms are able to live in fast moving water. Some organisms are adapted to dig themselves into the sand for protection. (Clams do this) Clams show at the edge of the surf line when you pound the beach with a shovel handle or your foot. They may squirt sand and water out of the hole where they are located. Barnacles attach themselves to rocks or other objects in the water. Many aquatic animals use the buoyancy of the water to help them move and their streamlined shape in the water reduces drag.

Aquatic Plants

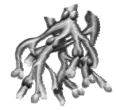
There are two types of aquatic plants: those attached to the bottom and those that float freely in the water (*phytoplankton*). Aquatic plants need sunlight and therefore can only survive in water where sunlight can penetrate.

Attached Plants

Attached plants are rooted in the soil on the bottom of a pond, or at the edge of a lake. Seaweed attach themselves to the bottom, using their ***'holdfast'***. Getting oxygen to waterlogged roots is accomplished by open channels in their spongy stems. Stomata are holes in the leaves where water and air can pass in and out (Review of Plants for Food and Fibre – Grade 7). A thin, flexible stem allows the plant to move with currents and waves. Aquatic plants must push their flowers above the water surface, so that insects or the wind can spread pollen and seeds.

Seaweeds

Seaweeds are marine plants, that do not have roots, flowers or leaves. They do photosynthesize and use the energy of the sun to create food.



Phytoplankton

Phytoplankton are tiny plants that live on the surface of lakes and oceans and produce oxygen. Their tiny irregular shape, and long spines are adaptations that help them stay in the zone of water where light can penetrate. **Diatoms** are one example of this type of aquatic plant.

Nutrients in Water

All aquatic plants need nutrients, such as nitrates and phosphates. These nutrients can be washed into the water from the land, or be provided from ***detritus*** – the decaying bodies of plants and animals. Nutrients are not always abundant throughout the year. The growth cycle of aquatic plants depends on the availability of sunlight and nutrients (which can be moved by currents, wind, and wave action).

Temperature Mixing

When temperatures cool in the fall, the surface water becomes denser, sinking to the bottom, allowing nutrients to resurface. This increases the phytoplankton growth. Cold water holds dissolved gases better than warm water – meaning higher oxygen levels in the surface waters in the fall.

A Steady State

The level of nutrients and salts in oceans is in a steady balance. Not only does it get added to the water as described earlier, but it is also taken out of the water. *Chlorine* is released into the atmosphere as it leaves the ocean in the form of *salt spray*. Some dissolved salts react (combine) with suspended solids and fall to the bottom as solid sediment.

Other chemicals, like *calcium* and *silica*, are removed from the water by animals that need these nutrients to make bones or shells.

Nutrient Pollution

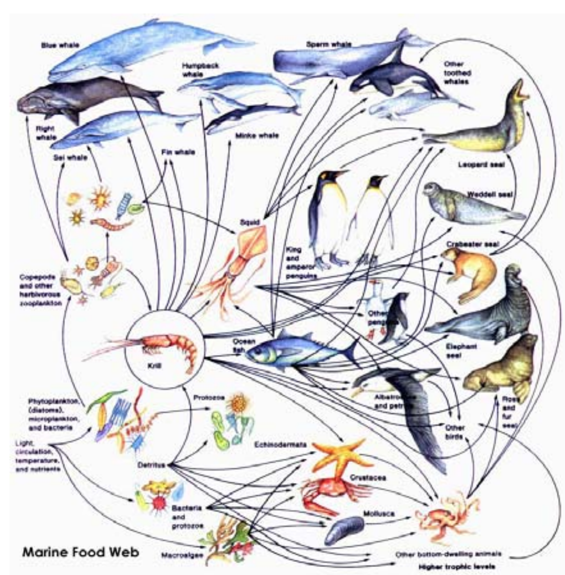
Too many nutrients can cause problems in aquatic environments. An increase in **algae** growth (*algal bloom*) covers the surface of the water, blocking out the light. As the algae dies, they are decomposed by bacteria, which use up all the oxygen. This cycle continues until a balance is achieved one again.

Aquatic Food Chains

The study of populations looks at groups within a particular species.

A **population** is a group of organisms of the same species that live in a particular area.

Natural changes in animal populations are not unusual, but the rapid decline in a species is a cause for concern. What caused the decline is important to know because it affects other species within the ecosystem as well. A change in a population can mean an increase or a decrease in the number of individuals in that population. It can also mean the change in the number of males and females, or a change in the numbers of old and young individuals. A population within an ecosystem changes as a result of something happening in that ecosystem.



Marine Food Web

There are three types of population changes: **seasonal, short-term** and **long-term**.

Seasonal Changes - There are *dramatic changes* in populations of freshwater organisms between the seasons in northern regions (Canada) because of extreme temperature changes. Because of these extreme shifts in temperature, populations swell in the summer and disappear in the winter. The disappearance of a population may mean only that surviving individuals are dormant, or hibernating in the winter months. Breeding cycles can also cause seasonal changes in populations.

Short-Term Changes - Short-term changes *take place over a relatively short period of time and don't last very long*. They happen irregularly and may be part of a natural event, or caused by human activities. **El NiÑo** is a natural event that might adversely affect fish populations. An oil spill can have short-term effects and long-term consequences if the clean-up is not done effectively.

Long-Term Changes - Long-term changes in populations also result from natural events or human activities. A landslide can change the course of a river or stream. Addition of a new species (zebra mussels introduced by accident) to an area (the Great Lakes) may result in overpopulation of that species because there are no natural enemies. These *changes can cause ripple effects because of the interactions that occur within every ecosystem*.

Fishing

Fishing can affect the balance of fish populations. Over-fishing, specialized fishing, introduction of new species and pollution can all affect the fish populations. When the population of specific species of fish are modified by any of the reasons above, the populations of other species will also be affected within the same ecosystem.

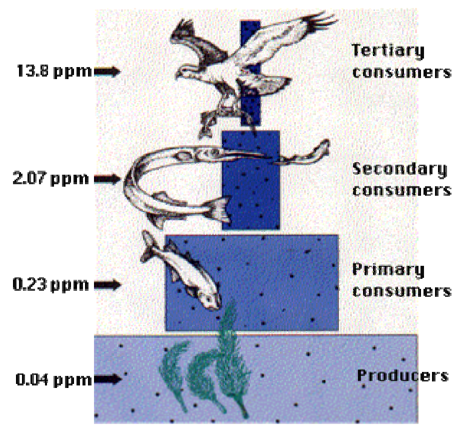
Toxins In Aquatic Habitats

Residues from pesticides, fertilizers and industrial chemicals can find their way into the water system. When this happens, the concentrations of these toxins can be magnified as they move up the food pyramid.

This is called **biomagnification**.

Animals that have a large amount of fatty tissues are highly susceptible to the toxins effects. This is because the toxins are stored in the fatty tissues.

The accumulation of these toxins can cause serious health problems or even death.



The numbers are representative values of the concentration in the tissues of DDT and its derivatives (in parts per million, ppm)

Exploring Aquatic Habitats

Highly advanced underwater technologies have enabled scientists to explore more of what could not be seen. The discovery of organisms living near ***sea-floor vents*** on the ocean bottom was spectacular. In the darkness of this region, organisms were using the chemical energy from the sea-floor vents to produce food and oxygen through a process called **chemosynthesis**. These organisms then become the producers for the ocean floor food chain.

Topic 5 Review
p. 447

Topic 6 – Water Quality and Management (pgs. 448 – 468)

What Determines Water Quality?

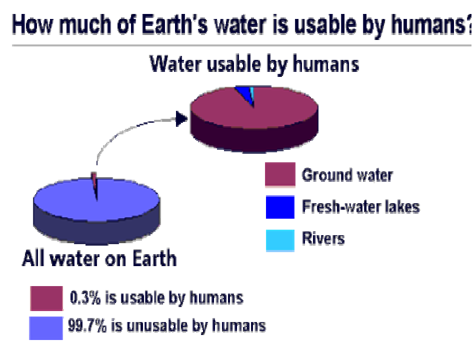
Water contains **dissolved solids** (salts such as sodium, calcium and magnesium). If it contains a lot of calcium and magnesium it is called **hard water**, whereas **soft water** contains less. Hard water can cause *scaly deposits* in pipes, fixtures and appliances.

Other factors that can affect water quality include: organisms, chemicals and sediments. When changes occur in the environment, the water supply can be affected. The quality can change when natural events or human activities affect what is being added or taken from the water.

The presence of different substances (**toxic substances**) that do not normally occur in the water supply, determines how people will use it.

Water and People

Water is recycled around the world through the **water cycle**. This doesn't mean that any one area will always have the same amount of water. In fact, it means just the opposite. No one area can expect the same amount of water year after year. This is because of other **natural cycles** and **human intervention** (use) that can cause changes to occur. People are part of the water cycle.

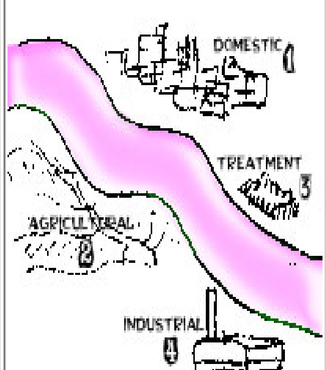


How we use water determines the substances that are added to it when it is returned.

There are **direct** (domestic or personal use) and **indirect** (industrial and agricultural) ways that humans use water. Many indirect uses can have negative effects on Earth's water supply, such as:

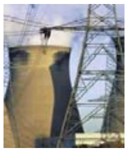
- Pollution of surface and groundwater
- Depletion of groundwater supply

There are **benefits** and **costs** to using water. **The Major Uses Of Water**



Water Use	Direct /Indirect	Benefit (+)	Cost (-)
Agriculture (irrigation) 73%	indirect	Food Economy Jobs	Soil salinity Decreases vegetation Depletes groundwater supplies
Industry (coolant, solvent, washing, diluting pollutants) 22%	indirect	Jobs Consumer Products & Services	Pollution contributor Depletes groundwater supplies
Domestic 5%	direct	Convenience Jobs	Cost

Power stations - can discharge warm water into lakes or rivers (thermal pollution) killing organisms that cannot tolerate the increased temperature.



Runoff - from farmland contains fertilizers that can cause excessive plant growth. It may also contain toxic chemicals (pesticides and herbicides) that can kill living organisms. Runoff - from cities contains large amounts of oil and salt, which can affect plants and animals in the water.

Factories - may add toxic chemicals (which can cause tumors, birth defects, sterility and even death) or, add to the thermal pollution problem.

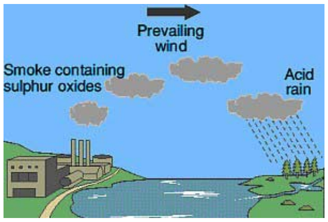
Habitat destruction takes away the places where animals and plants can live and interact in an aquatic ecosystem.

Sewage - contains large amounts of nitrogen, which causes micro-organism populations to increase. These micro-organisms use up the oxygen in the water and may organisms can die as a result.

Oil Spills - from ships transporting oil from place to place can cause harm to plants and animals in, on or near the water.

Acid Precipitation (Acid Rain)

A wide range of species depends on the quality of water for survival. Some species can tolerate certain changes because those changes are within their **range of tolerance**. Other species may have a very different range of tolerance to certain conditions, like increased **pH level** and will not be able to survive when the water quality changes. Not only the species that cannot tolerate an increased **acid level** dies, but also those species which depend on that species for survival (in the food chain) will also perish.

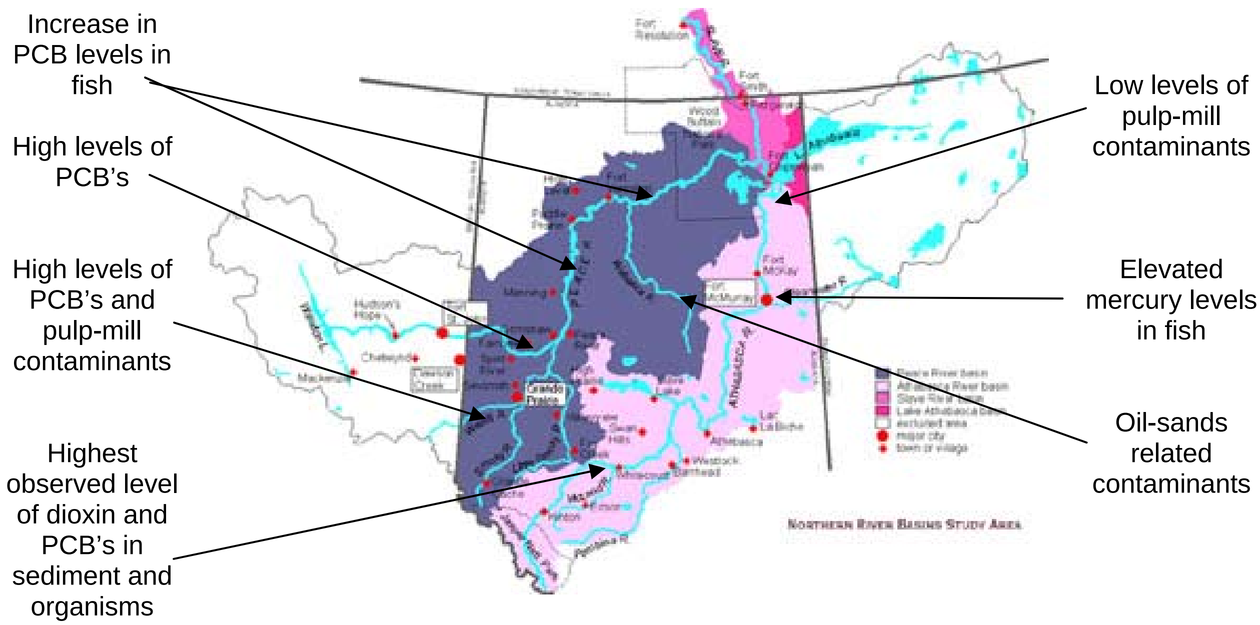


Measuring Water Quality

Besides the pH level of the water there are other indicators, or variables that determine the quality of the water. The table lists some below …

Basic properties	Solids	Acidity	Nutrients	Toxic substances	Organisms
temperature rate of flow oxygen level colour odour	sediments turbidity	pH	phosphorus nitrogen dissolved solids	heavy metals chemicals	bacteria plants animal species

Water sampling (like that done in the *Northern River Basin Study*) has given scientists evidence that toxic substances are in our water supply – in large and small doses.



Organisms In Water

The diversity of aquatic organisms in a water system helps to indicate the quality of the water. The level of dissolved oxygen will determine which species will be able to survive and, which ones will perish. High levels of dissolved oxygen would likely see a vast diversity of aquatic organisms. However, not all of these species are positive indicators, because some micro-organisms can cause disease and death.

Bioindicator Species

Organisms that are affected by changes in the environment or in the quality of the water help us to identify what is positive and negative. These organisms are called **bioindicator species** because they can tell scientists how different environmental factors can influence normal growth and development of a species.

The **River Watch Web Site** helps to identify many of these bioindicator species for flowing streams and rivers. http://www.riverwatch.ab.ca/how_to_monitor/macroinvertebrates.cfm

Monitoring Water Quality

One way to help guard against problems with water quality is to monitor the water supply. To **monitor** means to observe, check, or keep track of something for a specific purpose. Town and city water supplies have to be monitored on a regular basis to ensure that the quality of the water remains high.

Ongoing Monitoring

Ongoing monitoring of a site helps scientists observe change. The information they gather is then interpreted and suggestions are made to help the ecosystem recover. This can be through regulations to limit human activities in this ecosystem or develop technologies, which can address the problem and protect the environment. The studies they undertake are long-term and all encompassing, so that as many of the interactions as possible that are affected, will be addressed.

Water technicians (**freshwater biologists**) regularly measure the level of chemicals in the water and the numbers and kinds of different species of organisms. They also make observations on how it looks and smells. In this way they can identify potential problems in the water supply and adjust the treatment of the water to eliminate them. Research scientists use monitoring techniques (evidence of toxins in the water and living organisms) to help them develop technologies to help protect the environment.

Guidelines are established by many different levels of government to monitor the 'safe' levels of substances that can be added to the water system. Water quality standards are set for …

- Drinking water for people
- Protection of organisms living in or near water
  Drinking water for livestock
- Irrigation of crops
- Recreational uses (swimming, boating, fishing, etc.)

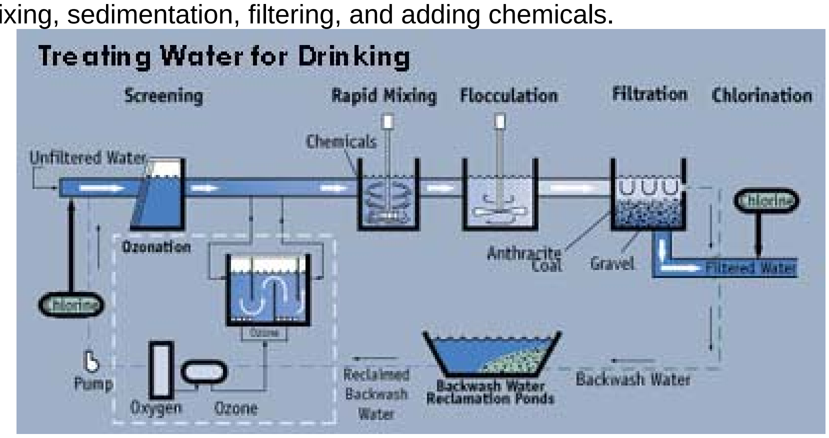
Water Management

Water systems everywhere need to be monitored and cleaned up if they are causing a problem. The **solutions** to many of the problems may already be available, or new technologies should be developed to address the concern. Most importantly **people must work together to solve the problems**, because our water supply is our life source and without it, we will all perish. Maintaining a reliable and safe water supply is called **water management**.

Water for Life – Alberta's Water Management Strategy
http://www.waterforlife.gov.ab.ca/

Purifying Water

As you saw at the beginning of this topic, humans use water in many different ways. To make water safe to drink, or **potable**, for humans it has to be treated. The treatment of water involves screening, mixing, sedimentation, filtering, and adding chemicals.



After water has been used by humans, the solid and liquid waste **- sewage -** , has to be treated again before it goes back into the water system as **effluent**. In rural areas an underground treatment system for this sewage involves using a **septic tank**.

Sustaining Water Resources

Three additional processes are used to increase the potable water supplies in different parts of the world. **Desalination** (removing salt from water) **Distillation** and **Reverse Osmosis.** We all have an impact on the water supply – responsible use of water will help to sustain this valuable resource.

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