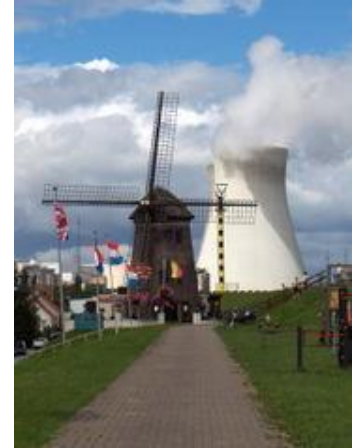


# Environment

**POWERPOINT SLIDESHOW**

**Secondary Science  
Program of Studies**



## ENVIRONMENTAL CHEMISTRY

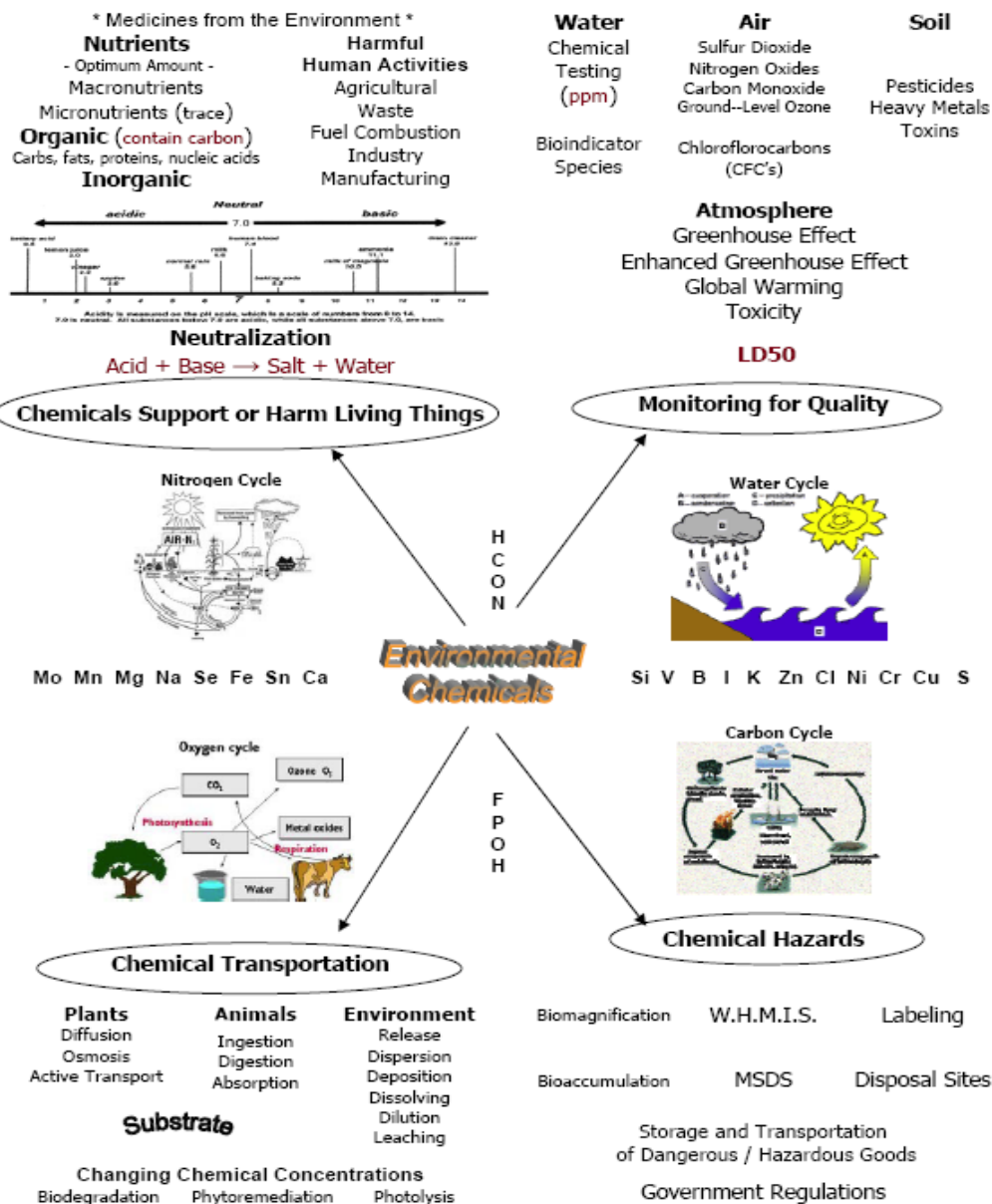
# Environment

## Concept Map

Shows the concepts covered within the framework of this unit

## Environmental Chemistry

## Environmental Chemistry Concepts





## ***Environmental Chemistry – Preamble & Misconceptions***

**Preamble:** The purpose of this slideshow is to introduce, review, reinforce and provide a study resource, that will help students and teachers become more familiar with the concepts and ideas that are required curriculum components.

**Misconceptions:** Before teaching or learning about the Key Concepts and Ideas presented in the PowerPoint slideshow **Environmental Chemistry**, the teacher and the student should be aware of common misconceptions held about these concepts/ideas. The chart on the next slide identifies the **Concepts/Ideas** that are covered in this slideshow – what the **Common Misconception** is and what the **Scientific Response** is, to clarify the student's and the teacher's understanding before the unit begins.

**Concept / Idea**

**Common Misconception**

**Scientific Response**



# ***Environmental Chemistry - Misconceptions***

<b>Concept / Idea</b>	<b>Common Misconception</b>	<b>Scientific Response</b>
<b>Decomposition</b>	<b>It disappears</b>	<b>Large molecules of different substances are broken down into much smaller molecules and can involve chemical change.</b>
<b>Diffusion Osmosis</b>	<b>Anything can be diffused Any nutrients can move through cell membranes</b>	<b>Only small molecules (water, carbon dioxide and oxygen can move freely in and out of cells, energy is required for other substances and the process is active transport</b>
<b>Landfill</b>	<b>Waste in landfills is safe</b>	<b>Landfills can produce leachates and toxic vapours that can be harmful.</b>
<b>Nutrients</b>	<b>Plants get their food from the soil</b>	<b>Plants actually use inorganic molecules (Carbon dioxide and water) to make organic molecules (6-carbon sugars) as food</b>
<b>Oceans</b>	<b>They are an infinite supply of water and resources</b>	<b>The continued vast resources of the oceans are affected by the elements in the environment and how they can change the composition of the oceans and interfere with those organisms that live or rely on the ocean for survival</b>
<b>Pollution</b>	<b>Anything natural is not a pollutant</b>	<b>Anything can be a pollutant that does harm to a living organism. This includes natural events, such as volcanoes and forest fires.</b>
<b>Producers</b>	<b>Only land plants are producers</b>	<b>Plants in all environments (aquatic or terrestrial) can be producers and some animals can be producers as well</b>
<b>Respiration</b>	<b>Only animals need oxygen Only animal cells use the process of cellular respiration</b>	<b>Plants need oxygen as well and use the process of cellular respiration to gain energy</b>



# **Environmental Chemistry - Outline**

## **Key Concept Categories**

### **Preamble - Misconceptions**

**Environmental Chemicals** - Types, Cycles, Activities

**Environmental Chemicals** - Issues and Viewpoints

**Treatment**

**Acids and Bases**

**Neutralization**

**Essential Life Chemicals**

**Chemical Intake/Output**

**Water Usage**

**Water Quality Indicators**

**Air Quality - Chemical Transport**

**Water Quality - Chemical Transport**

**Soil Quality - Chemical Transport**

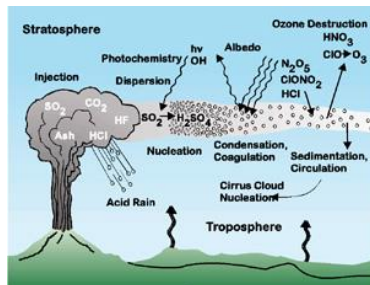
**Biodegradation**

**Environmental Effects**

**Hazardous Chemicals**

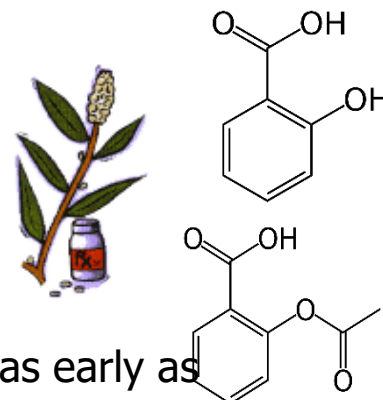
# Environmental Chemicals - Types

All living things are made of chemicals and depend on chemicals to survive. Without carbon dioxide and water, green plants could not produce sugar for food. Without oxygen, plants and animals could not carry out cellular respiration.



Forest fires and volcanoes release large quantities of carbon dioxide (volcanoes alone release 130 million tonnes of carbon dioxide each year), sulfur dioxide and ash, which can be harmful to living things. Some chemicals that we use can cause harm.

Some chemicals are also used as medicine, such as Willow bark, which contains *salicylic acid*. A synthetic version of salicylic acid - *acetylsalicylic acid* - was developed by the Bayer company in 1898 and Aspirin was born.



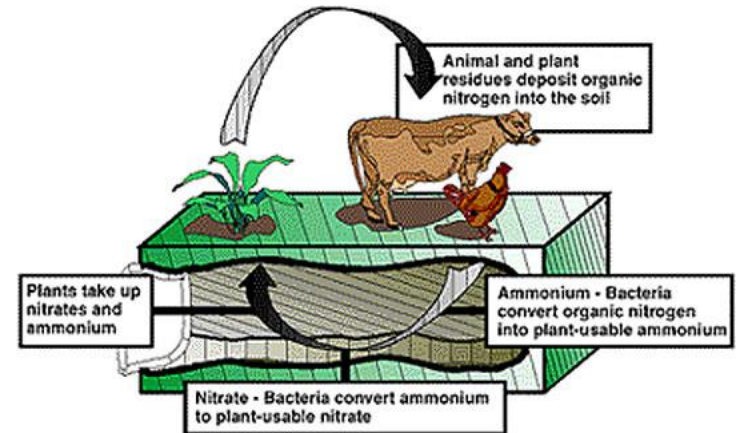
Hippocrates(希波克拉底) - now known as the 'Father of Medicine' - as early as 400B.C. - recommended willow bark be used to treat pain and fever. First Nations people used willow bark tea as a medicinal drink. Another medicine derived from plants found in the environment is *Echinacea Purposa* (紫錐花)- extract from the purple cornflower(矢車菊) to help stimulate the immune system.

# Environmental Chemicals - Cycles

## The Nitrogen Cycle

Nitrogen (  $N_2$  ) occurs naturally in the atmosphere as a gas. In order for living organisms to be able to use this nitrogen, the two atoms must be separated (**fixed**), so they can easily combine with other elements to form usable compounds.

**Nitrogen Fixation** is the process by which nitrogen gas is fixed in the atmosphere by lightning and fixed in the soil by certain types of bacteria (found in root nodules結節 of beans, Clover苜蓿 and alfalfa苜蓿).



After nitrogen fixation has occurred, plants can use the nitrogen-containing compounds, animals then eat the plants and make larger compounds called proteins, which decomposers can then break down into simpler compounds, to be used over again.

Eventually nitrogen is released back into the atmosphere to begin the cycle all over.

# ***Environmental Chemicals - Activities***

## **Processes/Activities Affecting Environmental Chemicals**

The chemicals in the air and food, that are used by living organisms, are changed by the processes of **cellular respiration** and **metabolism**.

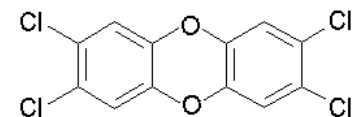
Human activities can cause **pollution** (any change in the environment that produces a condition that is harmful to living organisms) it can include too much of a harmless substance, or toxic materials not occurring naturally.

**Phosphates:** nutrients that enhance growth of plants (excess phosphates stimulate the growth of algae and weeds).

**Dioxins:** chemicals found in certain pesticides and industrial wastes can cause severe illness and possibly birth defects.

**Noise Pollution:** can cause hearing loss and other damage to living organisms.

**Thermal Pollution:** can eliminate species unable to tolerate the increase in temperature





# ***Environmental Chemicals - Human Activities***

Many chemicals are released into the air, water and soil every day.

Activities may include:

- Sanitation
- Agriculture
- Manufacturing
- Transportation
- Industrial Processes
- Water and Waste Treatment



These activities can change the concentration of different chemicals and cause an imbalance.

If this becomes a problem, an **issue** is born, which can have various **points of view**.

# ***Environmental Chemicals - Issues/Viewpoints***

## **Issues**

An issue is a matter about which people have different opinions or viewpoints.

- cause of the problem
- seriousness of the problem
- how to solve it

An issue is stated (in a statement that can be supported, or opposed) and is science-related, when science can provide relevant information on the issue.

## **Viewpoints**

Health-related - physical and mental well-being

Recreational - useable for leisure activities

Political - affects a govt. party or politician

Scientific - knowledge gained by observation & experimentation

Technological - problem solving/application

Ecological - concern for protection of ecosystems

Economic - concerned with money & jobs

Educational - acquiring & sharing knowledge

Egocentric - concern for self 自我中心

Ethical/Moral - right or wrong 道德

# ***Environmental Chemicals - Treatment***

## **Solid Waste Sanitary Landfill**

- 1** – Waste Control
- 2** – Landfill Area
- 3** – Septic System
- 4** – Gas Recovery (Methane)
- 5** – Remediation and Reclamation of land (soil)



# ***Environmental Chemicals - Treatment***

## **Solid Wastes**

Solid waste includes garbage from households, industries, commercial retailers, institutions and construction or demolition sites. Some of this waste can be recycled or reused, but most of it is placed in landfills. A small amount is incinerated (burned).

**Hazards** that occur when solid waste, are not properly disposed of include:

- air pollution (controlled emissions - scrubbers)
- leaching (prevented by plastic liners and compacted clay foundation at the landfill site)
- contamination (bacteria removes dissolved nitrates, phosphates and undissolved solids from effluent – which also includes: dissolved and undissolved materials from your kitchen, bathroom and laundry)

# ***Environmental Chemicals - Treatment***

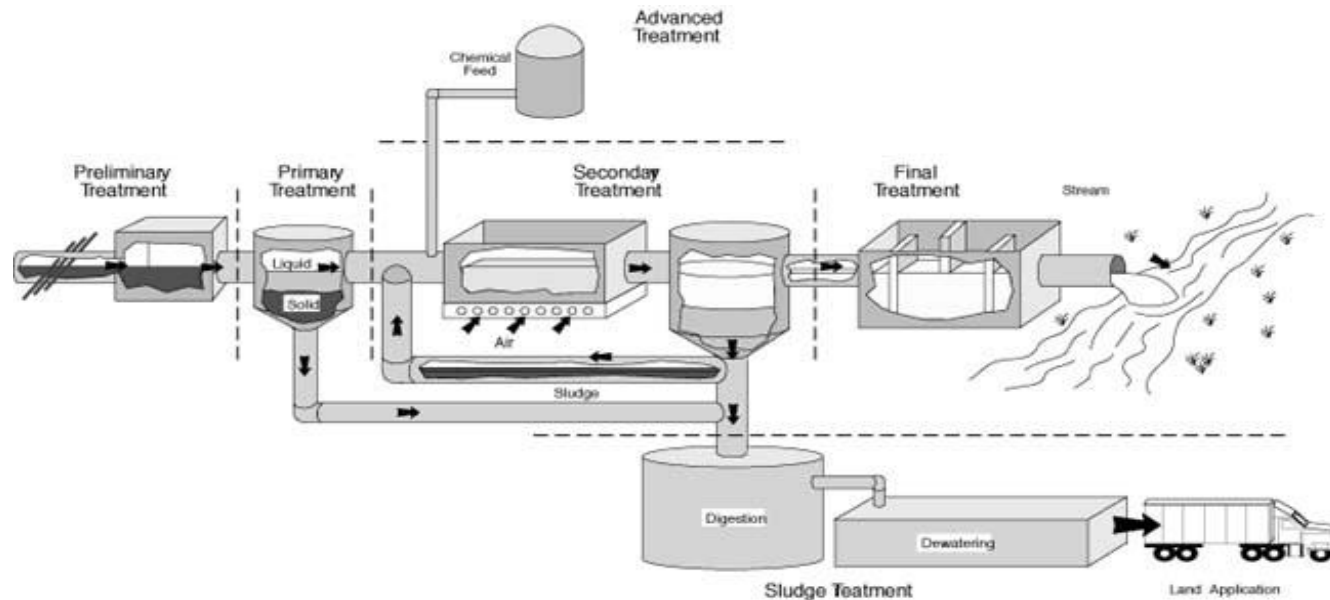
## **Waste Treatment Plant (Urban Areas)**

A facility treating sewage in three levels or steps.

**Primary** - **Physical** - filtering, sieving and settling - waste water can be further treated with chlorine and returned to the environment as effluent. Waste material, called sludge, can be recycled as fertilizer or landfill.

**Secondary** - **Biological** - bacteria and micro-organisms decompose most of the remaining biodegradable waste.

**Tertiary** - **Chemical** - UV radiation to kill all remaining bacteria and harmful organisms before returning the effluent to the water system.

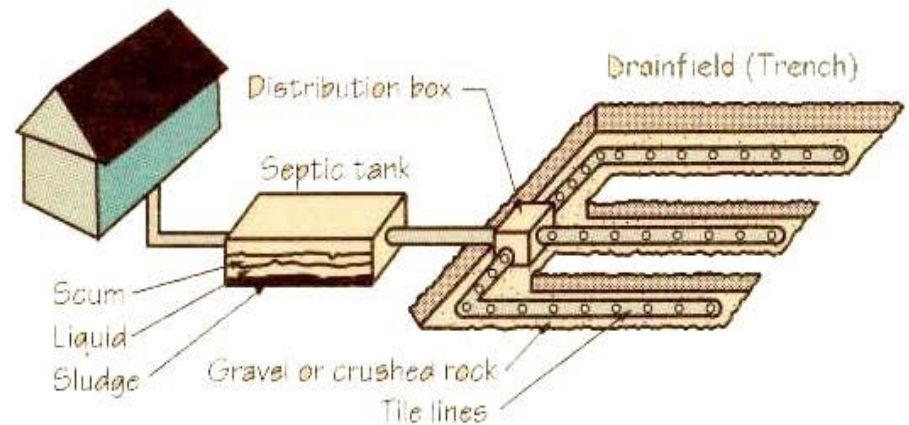


# Environmental Chemicals - Treatment

## Septic System (Rural Areas)

A septic system mimics the way **decomposers** normally recycle biodegradable wastes and consists of:

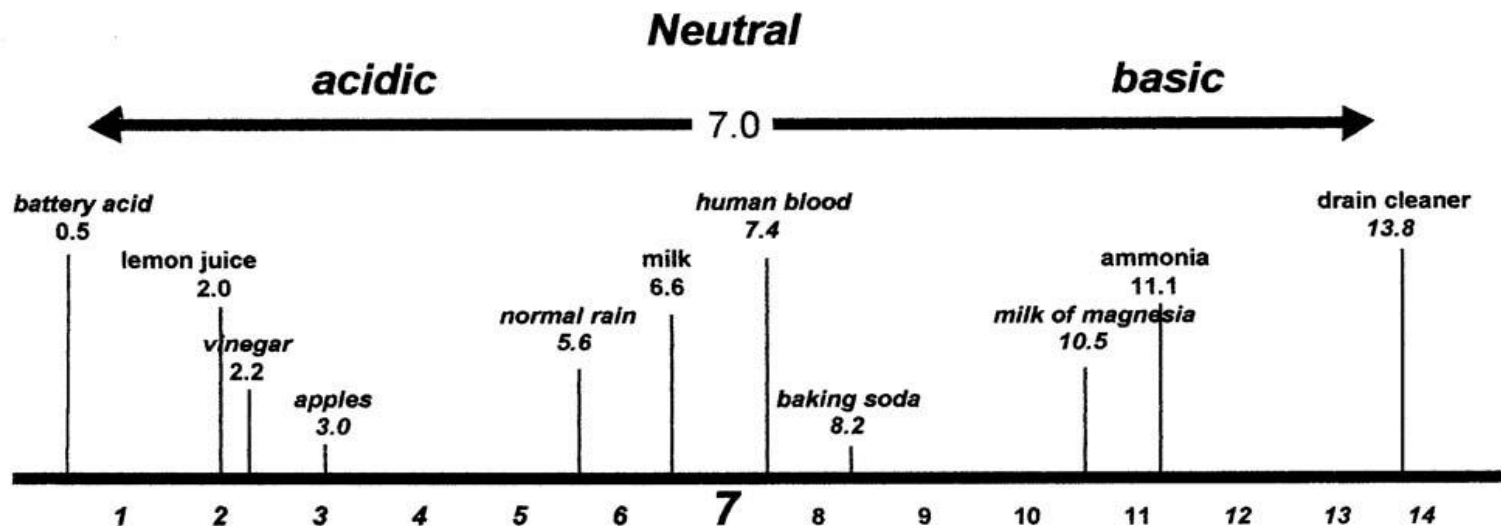
- A **Septic tank** (that traps grease and large solids which are decomposed by bacteria and later removed, along with the lighter scum, by a professional septic tank pumper). (**primary treatment**)
- A **Distribution box** (for liquid waste)
- A **Drainfield**, all connected by pipes with holes at the bottom of each line, allowing the wastewater to drain into gravel trenches for temporary storage. These pipes (conveyance lines) lead into a drainage area containing gravel. Bacteria and other micro-organisms in the gravel and soil break down the organic waste and use it as a source of food.



The **effluent** then slowly seeps into the subsurface soil where it is further treated and purified (**secondary treatment**). A properly functioning septic system does not pollute the groundwater.

# Acids and Bases

**pH** is a measure of the concentration of *hydrogen ions* in a solution.



Acidity is measured on the pH scale, which is a scale of numbers from 0 to 14.  
7.0 is neutral. All substances below 7.0 are acidic, while all substances above 7.0, are basic

**Acids** taste sour, are soluble in water and undergo similar chemical reactions.

**Bases** taste bitter, are soluble in water, feel slippery, react with acids.

**Neutral** substances are bland, and have a pH of around 7

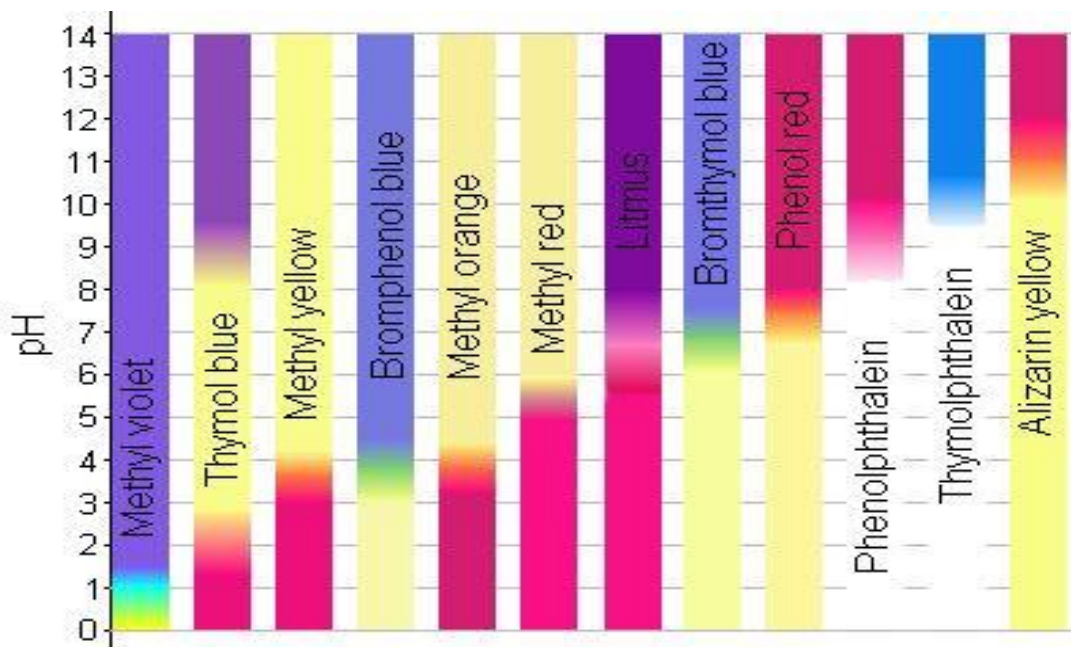


# Acids and Bases

## Indicators

To identify a substance as an acid, a base, or neutral, an indicator is used.

It changes color according to the type of substance it is put into. Indicators can be solids, such as **litmus paper**, or **universal indicator** (which change color over a wide pH range can identify many different substances and is more precise), or they can be **liquids**, such as phenol red.





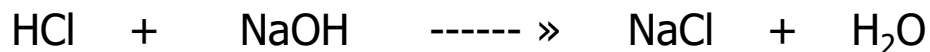
# Neutralization

Acids and bases react together when they are mixed.  
This type of reaction is called **neutralization**.

When the acid and the base are used up, **salt** and **water** are produced.

Acid in your stomach has a normal pH of 2. This acid helps in the digestion of food and kills off bacteria. If you eat too quickly, or are under stress, your stomach produces an excess amount of gastric acid (giving you heartburn). To neutralize the excess acid, an **antacid** tablet, which is a mild base, is swallowed. (eg. Tums, Roloids, Milk of Magnesia, Pepto Bismal)

Hydrochloric Acid + Sodium Hydroxide -----» Salt + Water



# ***Chemical Intake/Output - Plants***

**Organisms Take In Chemical Substances** - Plants take in *inorganic compounds* to make *organic compounds*. Consumers use the organic compounds made by plants for their energy, growth and repair. When organisms take in these compounds, other substances are also taken. These substances may be harmless or harmful.

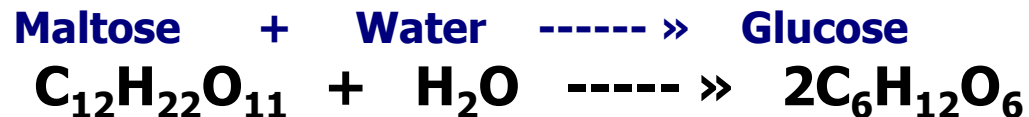
**Diffusion** - Nutrients enter the roots by diffusion - the movement of molecules from an area of *high concentration* to an area of *low concentration*. This action continues until the areas are equal concentrations. (No energy is required for this to occur).

**Osmosis** - Water moves through plants by a special type of diffusion, called osmosis. In this process, water moves through the walls of the plant's roots from an area where there are more water molecules to an area where there are fewer water molecules. As the plant uses the water it draws more up from its roots.

**Active Transport** - Plants need high concentrations of some nutrients in their roots. These nutrients may have higher concentrations in the roots than in the surrounding soil. To maintain these high concentrations, plants move more nutrients into their roots from areas of lower concentration (in the soil) by a process called **active transfer**. This process requires energy.

# ***Chemical Intake/Output - Animals***

25 different elements are used by animals for growth and function. Some organisms **absorb** their nutrients through various processes in much the same way as plants do. The process of taking in the nutrients (elements and compounds) humans need is called **ingestion**. These compounds are broken down chemically in the digestive system by a process called **hydrolysis**. A substance that has been broken down by hydrolysis has been hydrolyzed.



Nutrients such as glucose and amino acids are then absorbed through cell membranes and into the bloodstream, which carries them to where they will be used or stored.

**Taking In Nutrients** - Where organisms live often affects how and when they can obtain the nutrients they need. Some organisms get the nutrients they need often by restricting other organisms from getting the same nutrients (reducing the competition). Some organisms attach themselves to their **substrate**, others obtain their nutrients from their substrate.

**Substrates** - A substrate is a material on which an organism moves or lives.

# Water: Usage

## Categories of Water Use:

- human drinking water
- recreation
- livestock drinking water
- irrigation
- protection of aquatic life
- industrial, manufacturing
- electrical power generation

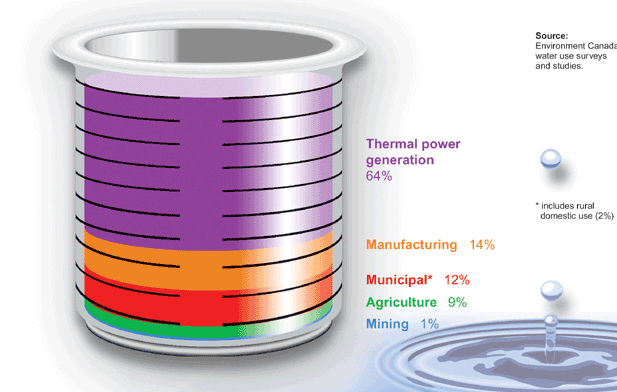
## Monitoring Water Quality

Clarity may be one indicator, but clear water does not indicate what chemicals are present. Water Quality is determined using biological and chemical indicators according to what the water is going to be used for.

## Microbiological Indicators

Microscopic organisms (bacteria) can cause serious health problems if they are Present in sufficient numbers. Samples are taken to identify their presence to avoid contamination of the water supply.

The five main water users in Canada, 1996



# ***Water: Quality Indicators (Biological)***

## **Aquatic Environments**

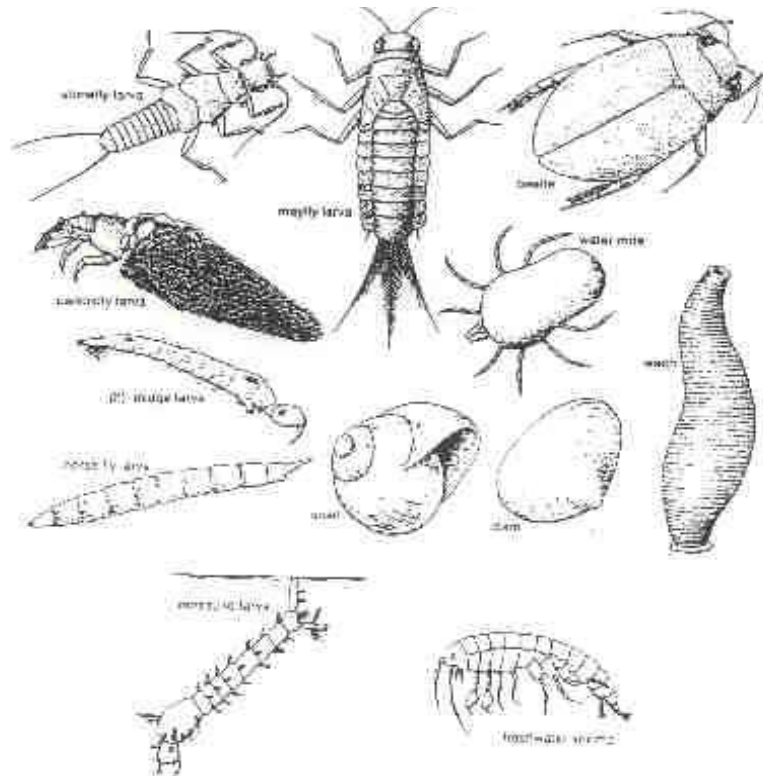
The place where aquatic organisms live varies, depending on the pH level and the amount of dissolved oxygen present.

... there will likely be no **fish** in water that has a pH below 5.0

... **worms** and **midge larva** thrive in polluted water, as they require only small amounts of dissolved oxygen for survival

## **Biological Indicators**

Species of aquatic organisms (invertebrates – animals without a backbone) require certain amounts of oxygen in the water to survive.



# Water: Quality Indicators (Chemical)

## GROUNDWATER CONTAMINANTS



## Factors Affecting Water Quality

Nitrates and Phosphates	Animal Manure (Nitrogen)
Dissolved Oxygen	Erosion and Deposition
Pesticides	Acid Rain
Salts (runoff from urban areas)	Heavy Metals

## Point and Nonpoint Sources of Contamination find their way into aquifers via infiltration.

- 1 Runoff from farm fields carries nitrogen and phosphorus from agricultural fertilizer as well as pesticide residues into streams and rivers.
- 2 Underground storage tanks can leak petroleum products into the soil, which eventually contaminate the underground water supply.
- 3 Rain and snow wash salt, oil, and other contaminants into the sewers or waterways. Treatment plants cannot remove all harmful chemicals from wastewater. Some of these chemicals, found in pharmaceutical wastes and industrial products, can act as endocrine disruptors and can produce harmful effects on aquatic life in very tiny amounts.
- 4 Stormwater carries animal wastes, pesticides and fertilizer residue from suburban neighborhoods into our groundwater and sewers.
- 5 Landfills can leach toxic chemicals, fecal bacteria, and many other contaminants if they are not properly sealed.
- 6 Manufacturing plants discharge numerous harmful byproducts—lubricants, solvents, metals, corrosives.
- 7 Dissolved pollutants in the atmosphere can be carried hundreds or thousands of miles from industrial and municipal centers before being deposited as precipitation.
- 8 Contaminated shallow groundwater will usually flow to the surface at springs and in wetlands, transporting contaminants to surface waters many miles from their sources. Deep aquifers can contain naturally occurring contaminants such as barium, radium, chloride, and arsenic.
- 9 Septic tanks separate solid human waste from liquid. The effluent percolates through a drainfield where most bacteria are destroyed. But leaking septic systems or soils that drain poorly allow untreated bacteria into the environment.

# ***Water: Quality Indicators (Chemical)***

## **Measuring Chemicals in ppm**

The concentrations of chemical indicators is usually measured in parts per million. One part per million means that one unit of an element or chemical can be found in one million units of solution ... parts per million (ppm), or in milligrams per Litre (mg/L).

## **Dissolved Oxygen**

**Abiotic factors** - water temperature, rate of flow (turbulence), obstacles in the water, wind, amount of photosynthesis by water plants.

**Biotic factors** - number of organisms using oxygen

Most organisms need 5 milligrams per Litre (5 ppm) of dissolved oxygen to survive. The diversity of species often gives us a relative idea of the amount of dissolved oxygen present. A large number of different species means a high level (likely 8 ppm or more) of dissolved oxygen, whereas a few species indicates a low level (below 5 ppm) of dissolved oxygen.

## **pH Testing**

Acidity is measured on the pH scale with 7.0 being neutral - anything below 7 is acidic, While anything above 7 is basic.

# ***Water: Quality Indicators (Chemical)***

## **Phosphorus and Nitrogen**

Phosphates and Nitrates often enter the water supply by sewage and runoff – They increase the growth of algae and weeds in the water. This then increases the food supply for bacteria, which decompose the plants, as they die. The presence of more and more bacteria uses up the available supply of dissolved oxygen and many of the aquatic organisms die as a result.

## **Acid Rain & Acid Shock**

Sulfur and nitrogen oxides emitted from industries (such as smelters) combine with water vapor in the air to produce sulfuric and nitric acid. These pollutants then fall to the ground as acid rain (with a pH lower than normal rain - which is about 5.6)

- ... causes chemical changes in the soil reduces soil fertility
- ... retards tree growth
- ... kills organisms in lakes & streams
- ... corrodes exposed metal surfaces
- ... breaks down stone and limestone
- ... leaches toxic chemicals from the soil

A decrease of one unit indicates the acidity has been multiplied by a factor of 10.

Periods of extreme acidity (like in the spring when the acid snow melts and the acidic water enters the waterways) are called acid shock.



# ***Water: Quality Indicators (Chemical)***

## **Pesticides**

When pesticide chemicals remain in the environment, a toxin is created. Several pesticides mixed together can have a cumulative effect and become very toxic. A toxic substance is poisonous. Dioxins are chemicals found in certain pesticides and industrial wastes can cause severe illness and possibly birth defects.

## **Measuring Toxicity**

Toxins, or poisons are substances that produce serious health problems, or death when introduced into an organism. Scientist measure toxins in **LD50** amounts. LD stands for 'Lethal Dose' and 50 represents 50% of the subject group that will die if they are given the specified dose, all at once.

**Noise Pollution:** can cause hearing loss and other damage to living organisms.

**Thermal Pollution:** can eliminate species unable to tolerate the increase in temperature

# ***Water: Quality Indicators (Chemical)***

## **Heavy Metals**

Heavy metals have a density of 5g/cm<sup>3</sup> or more. Examples include: mercury, copper, lead, zinc, cadmium and nickel. These metals occur naturally and are also processed into a wide variety of products. Heavy metals can be toxic to a wide range of organisms, so concentrations are constantly monitored. Heavy metals can enter the water supply by the action of acid rain and improper solid waste disposal (which can leach heavy metals into the groundwater). Heavy metals are especially toxic to children causing abnormal development, brain damage or even death.

## **Suspended Solids**

- Turbidity
- unpleasant appearance
- blocks sunlight
- decreases oxygen production

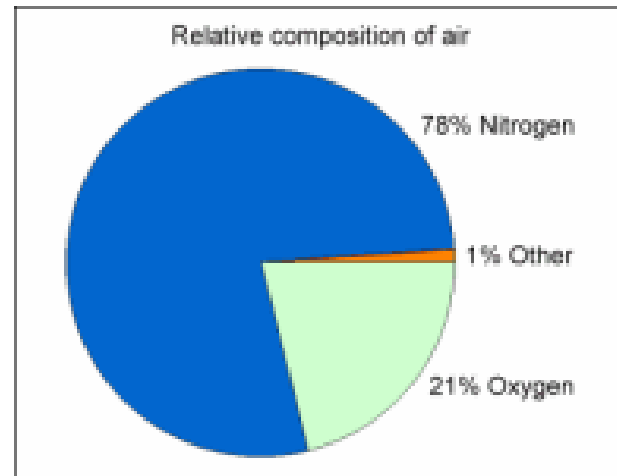
**Testing:** Use the filtration method to separate the sample into residue and filtrate.

# ***Air: Quality (Monitoring)***

Air quality can be measured in two ways: by measuring the levels of pollutants in the air and by estimating the amount of emissions from pollution sources.

## **Air Quality**

### How Air Quality Affects Us



## **Mobile Laboratory**

### Alberta Government Air Quality Monitoring - Mobile Lab

# ***Air: Quality (Pollution)***

## **Sulfur Dioxide**

Sulfur Dioxide (  $\text{SO}_{2(g)}$  ) is a major air pollutant (forming **smog** and **acid rain**). It can affect your respiratory system and irritate your eyes. It is produced through industrial processes. Scrubbers are used to reduce sulfur dioxide emissions by up to 99%. They use limestone to convert it to a useful product – gypsum.

## **Nitrogen Oxides**

Nitrogen Oxides (  $\text{NO}_{x(g)}$  ) are mixtures of NO and  $\text{NO}_2$  and are major contributors to **smog** and **acid rain** as well. Vehicle emissions and the burning of fossil fuels are the main contributors of Nitrogen Oxides.

## **Carbon Monoxide**

Carbon Monoxide (CO) is called the '**silent killer**' because it is a colorless, odorless gas. It is caused by the burning of fossil fuels and not enough oxygen to produce carbon dioxide ( $\text{CO}_2$ ). Motor vehicles are the main producers of CO, but other sources include the burning of wood (forest fires produce large quantities) in fireplaces and stoves, natural gas, industrial processes, airplanes and cigarettes. If inhaled, CO reduces the amount of oxygen in the blood and can cause headaches, sleepiness, chest pains, brain damage and death. Catalytic converters are used to convert CO into  $\text{CO}_2$ .

# ***Air: Quality (Greenhouse Gases)***

## **Ground-Level Ozone**

**Ozone** (  $O_{3(g)}$  ) is an odorless, colorless gas that has 3 oxygen atoms.

It protects us from harmful ultraviolet rays from space, but at ground-level it can be harmful, because it can affect the respiratory system, deteriorates plastics and can have serious effects on crops. Ground-level ozone forms from reactions between oxygen, nitrogen oxides and compounds that are **volatile organic compounds** (VOC's), in the presence of sunlight and heat. Fuel combustion is the major source.

## **Monitoring The Atmosphere**

Chemicals in the air can cause mild to serious effects in local areas, but chemicals in the atmosphere can have serious global effects. Ozone depletion and climate change are the primary concerns internationally.

## **Carbon Dioxide As A Greenhouse Gas**

Carbon dioxide occurs naturally in the environment, but increasing amounts that are being produced by various human activities is creating a concern globally. The increasing population and increasing use of fossil fuels is creating some issues.

# ***Air: Quality (Global Warming)***

## **The Greenhouse Effect**

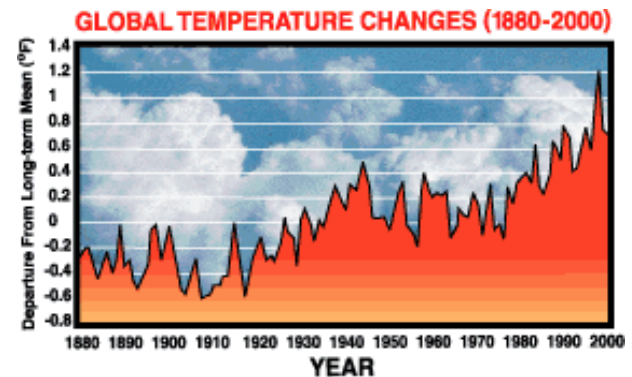
The Greenhouse Effect is a naturally occurring event, the result of greenhouse gases (water vapor, carbon dioxide, and other gases) trapping some of the outgoing energy - retaining heat in a way somewhat similar to the glass panels of a greenhouse – helping to maintain the Earth's average surface temperature of 15° C.

## **The Enhanced Greenhouse Effect**

Many scientists support the theory that the enhanced greenhouse effect is causing temperatures to increase around the world. Human activities – essentially, the burning of fossil fuels is the primary reason. Monitoring stations are set up to record the higher levels and governments are trying to find ways to reduce the emissions of carbon dioxide which is fueling this enhanced greenhouse effect and depleting the ozone layer.

## **Global Warming**

It is not just human activities that are contributing to global warming, but volcanoes and forest fires are also part of the cause.



# ***Air: Quality (Ozone Depletion)***

## **The Ozone Layer**

Ground-level ozone can have dangerous effects. Atmospheric ozone is the chemical that occurs high in the atmosphere where it maintains a shield around the Earth protecting everyone from harmful **UV radiation** from the Sun. The ozone layer is a natural formation 15 to 50 kilometers above us. Since the late 1970's Scientists who have been monitoring this protective layer, have noticed that it is becoming thinner. They have also discovered 'holes' in the layer. This results in more UV radiation getting through to the surface of the Earth and increasing the likelihood of more organisms getting skin cancer and cataracts. It is also affecting the plankton population – which is an important food supply for many animals.

## **Chlorofluorocarbons** ( CFC's )

The thinning of the atmosphere is caused by our use of chlorofluorocarbons These chemicals eventually get into the upper atmosphere where they are broken down into elements like chlorine – which destroys ozone. (1 chlorine atom can destroy 100, 000 ozone molecules).

Many countries have signed agreements to reduce their use of these chemicals.  
( **KYOTO ACCORD** ) (United Nations Conference on Global Warming – Bali, Indonesia)

# ***Air: Quality (Transportation of Chemicals)***

Potentially harmful substances are spread and concentrated in the environment in various ways. The source of a pollutant may be in one place, but it can show up in many other places around the world.

## **Transport of Environmental Substances**

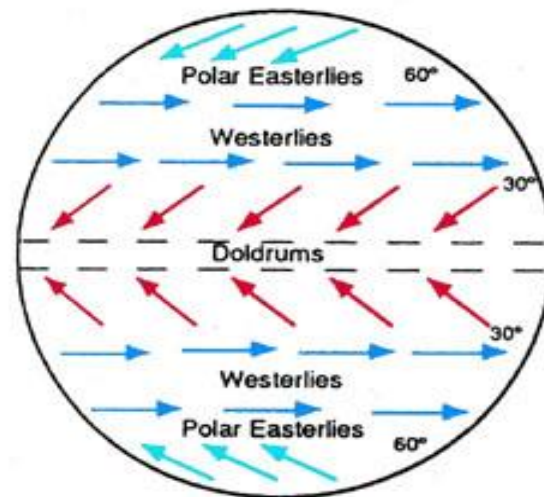
There are three stages of transport of substances in the environment:.

- **Release** of chemicals at the source
- **Dispersion** of the chemical into the atmosphere
- **Deposition** of the chemical in soil or water

## **Transport In Air**

The direction and distance that airborne chemicals travel are determined by various factors, including:

- The properties of the chemical pollutant
- The wind speed
- The direction of the prevailing winds
- The distribution of particles may also be limited by lack of wind or precipitation.





# ***Water: Quality (Transportation of Chemicals)***

## **Transportation of Chemicals In Groundwater**

<http://www.groundwater.org/kc/kc.html>

Water soaking into the soil is collected in a zone called the **groundwater zone**. The top of the groundwater zone in the soil is called the **water table**.

Groundwater moves sideways, up or down and can move very slowly (1 meter per year) or very quickly (1 meter per day). Some contaminants remain collected in the groundwater for long periods of time (because they are heavy metals), posing problems if the groundwater is used for drinking, agricultural purposes or industrial use.

One factor that affects the movement of contaminants in groundwater includes the number and connection of pores (tiny spaces between soil grains) in the soil. When the pores are packed together very tightly and are not connected, the soil is considered impermeable. If the pores are connected the soil is permeable and water can move through easily.

# ***Water: Quality (Transportation of Chemicals)***

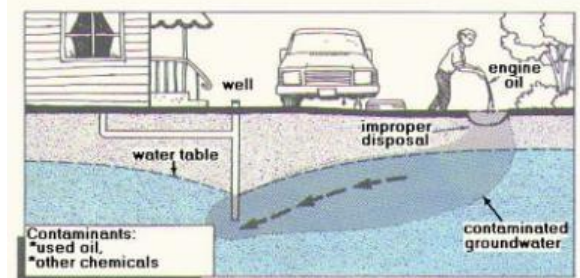
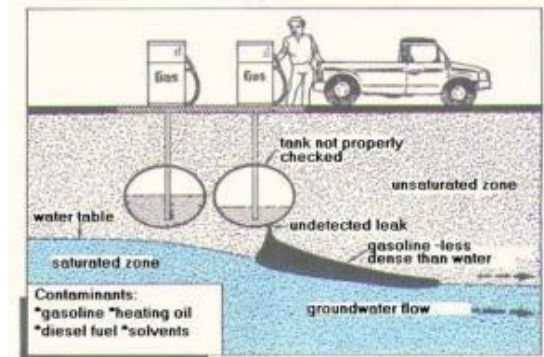
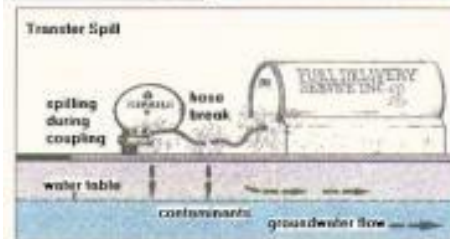
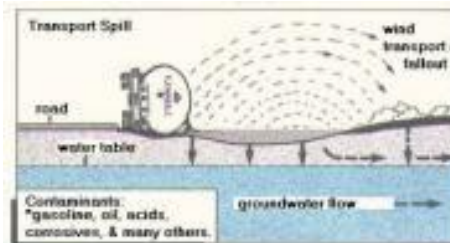
**Pollutants, which occur naturally or through human activities, can move more quickly through permeable soil.  
Some Substances That Contaminate Groundwater**

<b>Substance</b>	<b>Source</b>	<b>Examples</b>	<b>Occurrence</b>
<b>Minerals</b>	<b>Rocks and Soil</b>	<b>Iron, Calcium, Selenium</b>	<b>Natural</b>
<b>Organic Substances</b>	<b>Soil</b>	<b>Pesticides, solvents</b>	<b>Natural &amp; Human Activities</b>
<b>Leached Substances</b>	<b>Landfill sites, mines</b>	<b>Heavy metals, organics</b>	<b>Human Activities</b>
<b>Leaked substances</b>	<b>Underground storage tanks, pipelines</b>	<b>Gasoline, Natural gas, oil</b>	<b>Human Activities</b>
<b>Inorganic substances</b>	<b>Run-off</b>	<b>De-icing roadways, sewage, industrial processes</b>	<b>Human Activities</b>
<b>Micro-organisms</b>	<b>Septic tanks, sewage treatment ponds, runoff</b>	<b>Bacteria, viruses, Protozoans</b>	<b>Human Activities</b>
<b>Chemicals</b>	<b>Household</b>	<b>Nitrates, phosphates, detergents, cleaners</b>	<b>Human Activities</b>

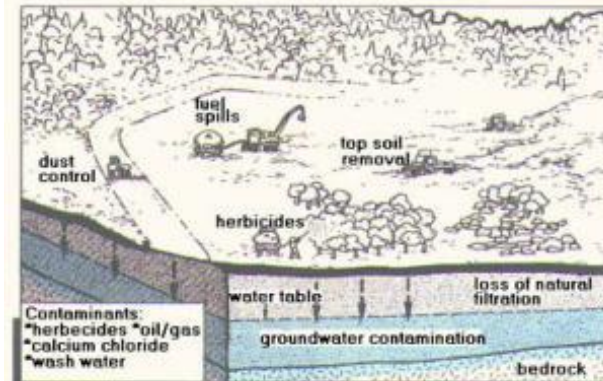
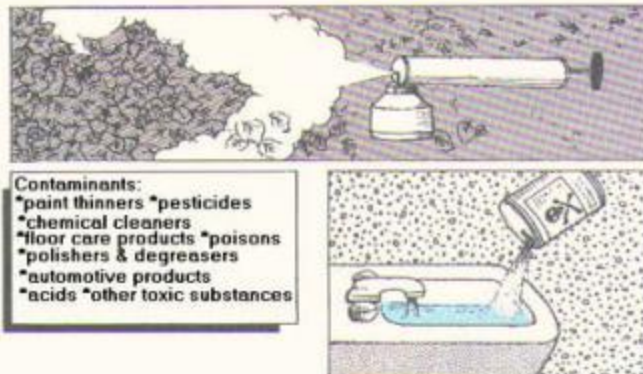
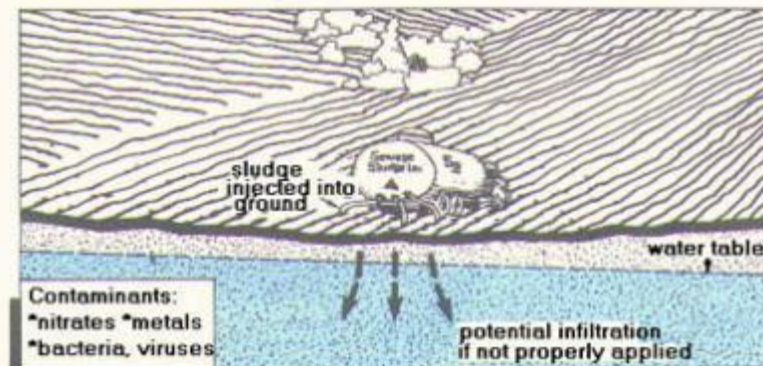
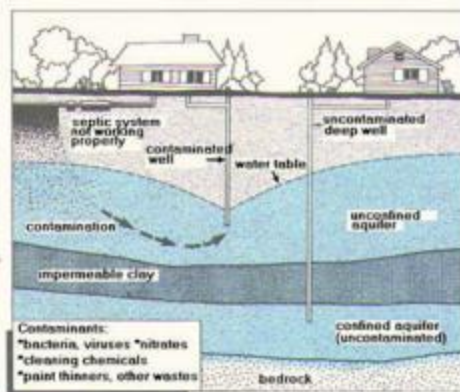
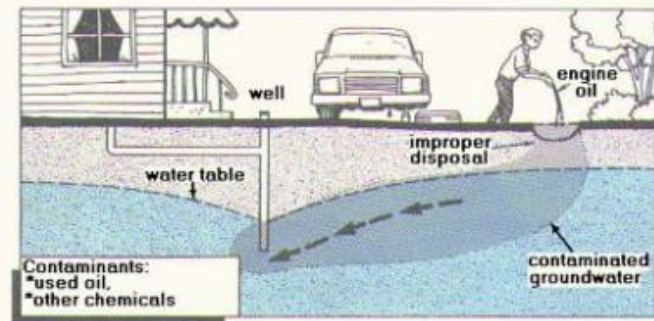
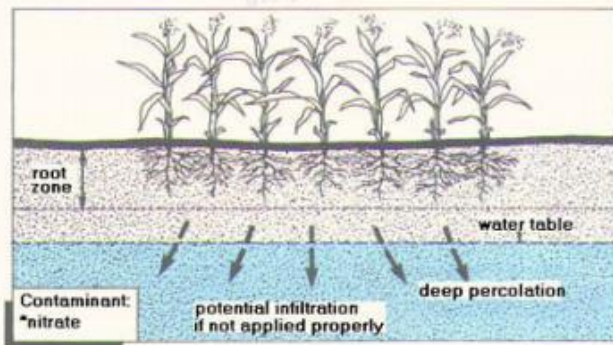
# ***Water: Quality (Transportation of Chemicals)***

## **Transportation of Chemicals In Surface Water**

Hazardous chemicals can enter surface water from the air, the groundwater, runoff from agricultural fields and industrial sites and outflow from storm sewers and sewage treatment plants. A substance that dissolves in water easily may be carried by water a fair distance and dispersed over a wide area. Substances that do not dissolve easily may sink to the bottom and be concentrated close to the source, affecting organisms in the immediate area. Because humans use water for drinking and agricultural use, it's quality is monitored regularly.



# Water: Quality (Transportation of Chemicals)





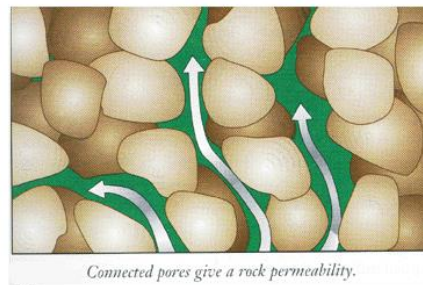
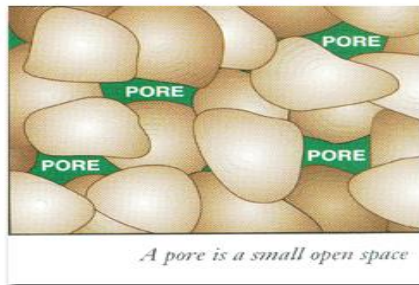
# ***Soil: Quality (Transportation of Chemicals)***

## **Transportation of Chemicals In Soil**

Water is moved in one of four ways:

- evaporation
- absorption by plants
- runoff (into surface water)
- soaking into soil dissolving substances (leachate)

The type of soil plays an important role in how quickly water passes through it. Packed clay is **impermeable** (so fluids won't pass through it). That is why **sanitary landfill sites** use a layer of packed clay to prevent leaching.



Organic material can absorb fluids and slow their movement through the soil. Hazardous chemicals can be changed by what other chemicals are present in the soil. (acids can be neutralized by naturally occurring bases – like limestone)

# ***Soil: Quality (Transportation of Chemicals)***

## **Chemicals In Soil - Contamination**

### **A 2001 Case Study: Lynnvview Ridge (Calgary) Lead Contamination**

Imperial Oil, while operating an oil refinery between 1922 and 1976, contaminated Lynnvview Ridge, a Calgary neighbourhood. Nearly half of the residential properties tested were above the federal lead guidelines. Imperial Oil proposed various remediation options including a massive removal of all contaminated soil and the installation of vapour-extraction systems. Angry Lynnvview Ridge residents rejected Imperial Oil's plans and instead demanded that the company buy their houses. Some municipal council members supported the buy out, one even stating that "Its Imperial Oil here, we're not talking a poor company". In late summer of 2001 Imperial Oil Ltd offered to buy 240 homes at 20% above the market-value assessment (an average of \$170,000 for each home). Homeowners could also opt for a \$10,000 payment to live elsewhere while Imperial cleans up the site. The company will spend about \$10-million over five years to clean up the soil in the neighbourhood.

Environmental Bureau of Investigation

<http://www.e-b-i.net/ebi/index.cfm?DSP=content&ContentID=5605>

Environmental Protection Orders

<http://www.gov.ab.ca/acn/200106/10894.html>

& <http://www.gov.ab.ca/acn/200308/15045.html>

Land Center Library – CBC News

<http://www.cbc.ca/news/story/2001/07/17/lynnviewca010717.html>

# ***Soil: Quality (Transportation of Chemicals)***

## **Hydrocarbons In Soil**

The daily use of hydrocarbons in vehicles and industry contaminates the soil. Some of these hydrocarbon emissions are carried by the air into the soil, or are carried by water where they can clog up soil pores – usually close to the source of the contamination. Hydrocarbons are toxic to plants and animals.

## **Changing Concentration of Harmful Chemicals**

The concentration of chemicals in the environment can be changed using different techniques.

- **Dispersion** is the scattering of a substance away from its source.
- **Dilution** reduces the concentration of a pollutant by mixing it with large quantities of air or water.

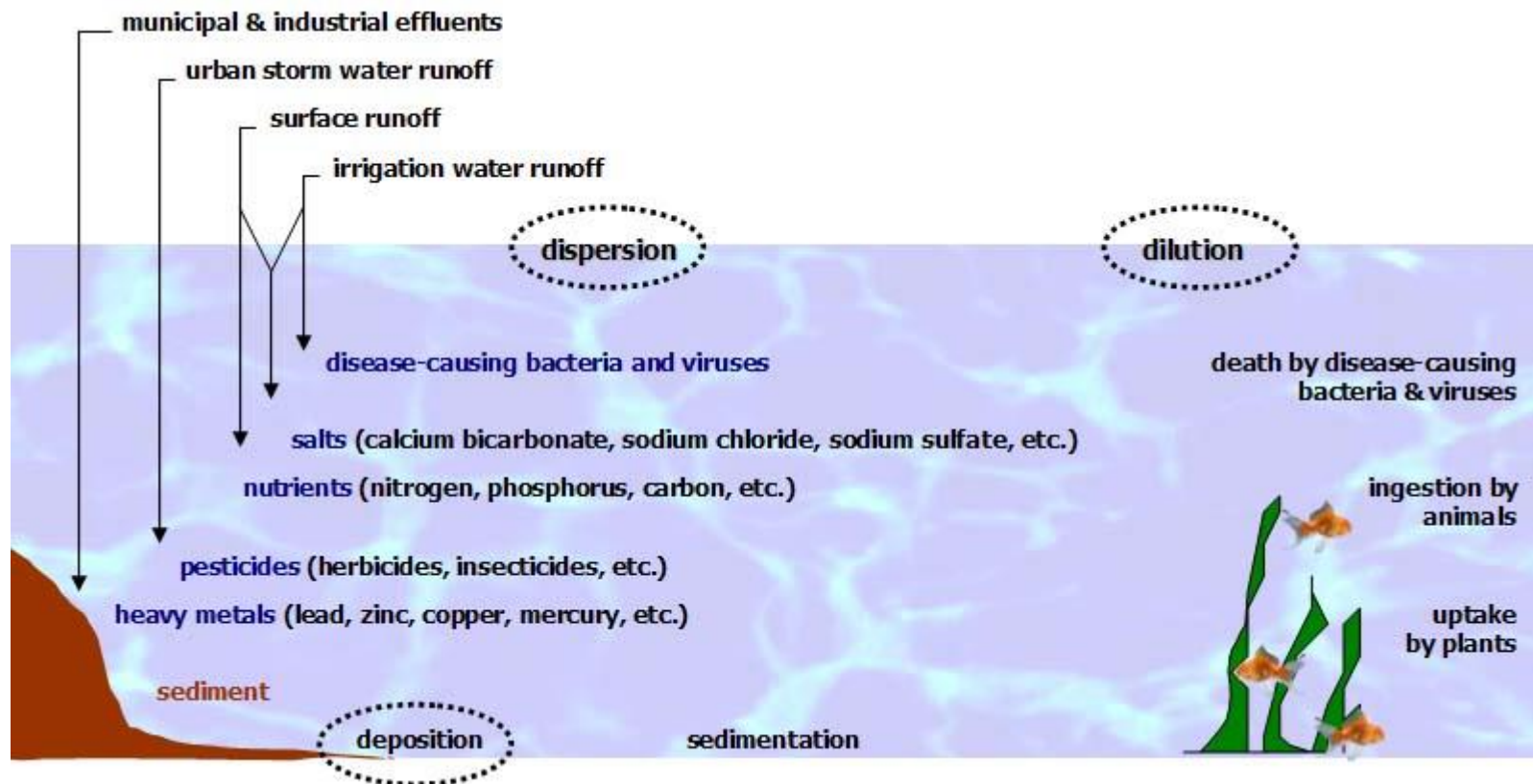
A fast flowing river or air mass can disperse and dilute a chemical very quickly.

Regulations set by governments require that acceptable levels of pollutants be achieved.

# ***Soil: Quality (Transportation of Chemicals)***

## **Changing Concentration of Harmful Chemicals**

Chemicals released into the water system are dispersed, diluted or deposited  
(If deposition occurs, the chemicals become part of the sediment load in the water system)







# ***Biodegradation***

## **Biodegradation**

Biodegradation occurs in the environment because living things (earthworms, bacteria and fungi) are actively breaking down organic substances, including many pollutants. Micro-organisms are especially important in the biodegradation of pollutants. The existing organic molecules provide carbon atoms, which are used to build biological compounds, such as carbohydrates and proteins. This is a multi-step process in which the large organic molecules are broken down (hydrolyzed) either inside or outside bacteria.

## **Bacteria**

Some bacteria grow and reproduce only when oxygen is present. They use the oxygen for the process of aerobic biodegradation. When oxygen is not present – in an anaerobic environment (like deep in landfill sites) - some bacteria remove chlorine from harmful chlorine-containing compounds, such as PCB's (polychlorinated biphenyls - human made oils used in electrical equipment), by replacing them with hydrogen atoms – which can then be used as food for the bacteria.

# ***Biodegradation***

**Factors Affecting Biodegradation** include: temperature, soil moisture, pH, oxygen, supply and nutrient availability.

**Bioreactors** are a new technology that speeds up the rate of biodegradation by adding water to organic waste in a sanitary landfill site. Planting vegetation also encourages faster biodegradation because the populations of bacteria and fungi are larger around plant roots and this higher level means more microbial activity.



**Phytoremediation** is a technique that can be used to reduce the concentration of harmful chemicals in the soil or groundwater. Plants are used to clean up metals, hydrocarbons, solvents, pesticides, radioactive materials, explosives, and landfill leachates. The plants absorb and accumulate large amounts of these chemicals. When the plants have matured, they are harvested, then burned or composted. In some cases, the metal can be recycled.

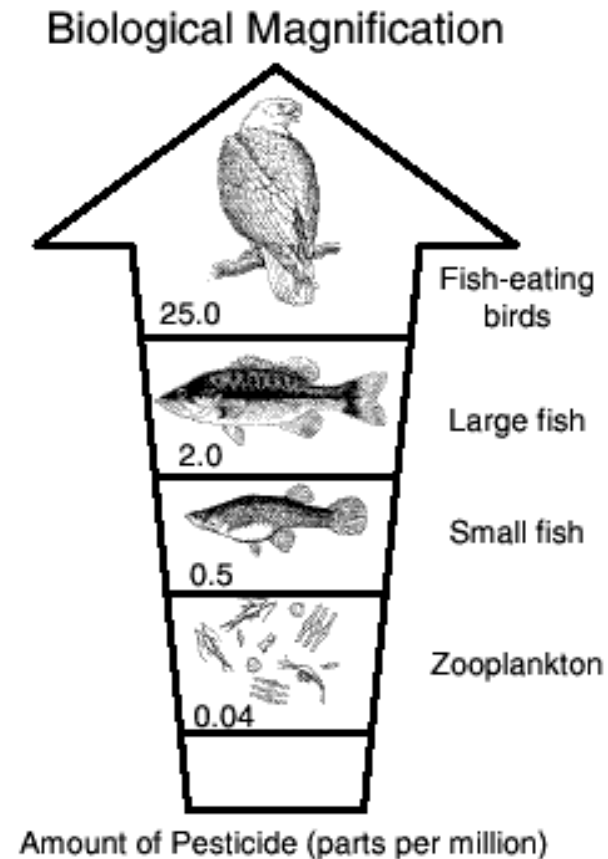
When most of the harmful chemicals are removed by phytoremediation from the soil, other plants can be planted.

# Environmental Effects

**Photolysis** is the breakdown of compounds by sunlight. The formation of ozone and photodegradable plastic are examples of this process. These substances react when exposed to sunlight. It becomes a fine substance that is much easier to dispose of.

## **Biomagnification** (or **bioaccumulation**)

This process is the increase in the concentration of a chemical, or an element, as it moves up the food chain.





# ***Hazardous Chemicals***

## **Hazardous Household Chemicals**

Chemicals used in the home and garden can be hazardous to your health.

Some of these can be found in the **HOUSEHOLD PRODUCTS DATABASE**

<http://householdproducts.nlm.nih.gov/products.htm>

## **Common Household Hazardous Waste Product Categories**

Household cleaners

Personal hygiene products

Pet-care products

Paint and paint products

Pesticides and fertilizers

Automotive fluids

- \* Improper storage, transport and disposal of these household products can contribute to burns, heart problems, kidney failure, lung (respiratory) ailments, cancer and even death.

## **Government Regulations**

Regulations are designed to protect consumers and reduce the risk of hazardous chemicals. The regulations reflect current scientific research done on the products and how they might interact with other products.

# ***Hazardous Chemicals - Labels***

## **Workplace Hazardous Materials Information System**



### **MSDS - Material Safety Data Sheets**

An MSDS information sheet for the product gives a detailed description of the product – its composition, physical appearance, and chemical characteristics. It also describes the precautions that should be taken when handling, transporting and disposing of the product, as well as health effects, first aid treatment and what to do in case of a spill.

### **Eco-Label - Established in 1988, Canada's "Environmental Choice"**

Eco-Logo program helps consumers identify products and services that are less harmful to the environment.



# Hazardous Chemicals - Labels

## Transporting Hazardous Materials



Figure 2  
POISON Placard

If a controlled product is transferred at the workplace to other containers, the employer may need to apply a workplace label to the new container. Workplace labels provide the following information: product identification; information for safe handling and a statement indicating that the MSDS is available.

## Supplying Hazardous Materials in the Workplace

### Toilet Bowl Cleaner

**DANGER:** Corrosive — produces chemical burns. Contains Hydrochloric Acid. Do not get in eyes, or on skin or clothing. May be harmful or fatal if swallowed. Do not breathe vapor or fumes. Keep out of reach of children. Fumes are corrosive to metal.

**STORAGE AND DISPOSAL:** Store in original container out of reach of small children. Keep securely closed in a cool, well-ventilated area. Do not reuse empty container. When empty, discard in trash or recycle.

## Disposal

### HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL

Northeastern University  
Office of Environmental Health & Safety  
229 Forsyth Building  
Boston, Massachusetts 02115  
(617) 373-2769  
<http://www.dac.neu.edu/oehs/oehs.htm>

Investigator: \_\_\_\_\_ Phone #: \_\_\_\_\_  
Dept: \_\_\_\_\_ Room # / Bldg: \_\_\_\_\_  
Date Container Filled: \_\_\_\_\_ Container Size(s): \_\_\_\_\_  
Principal Constituents (Give % and Full Chemical Name): \_\_\_\_\_

Hazardous Waste Classification (Check at least one):

- ☐ Ignitable (Includes flammable liquids, solids and gasses)
- ☐ Corrosive (pH of 2 or less, or 12 or greater, and/or can corrode steel)
- ☐ Reactive (Is unstable, can detonate or reacts violently with water)
- ☐ Toxic (Contains heavy metals or pesticides)
- ☐ Listed (Appears on the F, U, P, or M List)
- ☐ Other (Specify): \_\_\_\_\_

# ***Hazardous Chemicals - Storage***

## **New Product Regulations**

When new products are produced, the supplier must apply for approval to make it available to the consumer. The information about the product must include: intended use, physical and chemical properties, active ingredient(s), instructions for use, safety precautions, health effects, environmental effects, toxicity to humans and first aid instructions in case of poisoning.

## **Storage of Hazardous Chemicals in the Home**

- Leave original label on the product
- Keep out of reach of children (locked up)
- Containers should be in good condition and secure
- Store in a cool, dry, well-ventilated place
- Never store flammables or gas in glass containers
- Store different classifications of chemicals on separate shelves in separate locations
- Keep oxidizers away from flammables
- Keep upright
- Store chemicals in proper place when not in use
- Discard old products
- Place rusted or leaking containers inside a second container – dispose of both



# ***Hazardous Chemicals - Transport & Disposal***

## **Transportation Of Consumer Goods**

When it is purchased and when it is disposed of present transportation issues for consumers. Care should be taken to ensure that passengers are not at risk – from spills, leaks, fumes or accidental handling (by children or pets). Place the product upright and secure in the trunk (car) or box (truck). When disposing of many products, never mix them into one container – try to keep them in their original containers with their original labels.

## **Disposal Of Hazardous Chemicals**

Never pour hazardous chemicals down the drain, or into the soil. Don't throw them into the garbage. The hazardous products may not be treated by the sewage treatment system or septic system and as a result could be released into the soil or enter the surface water system and harm living organisms downstream.





# ***Hazardous Chemicals - Drop-off***

## **Materials Accepted at Municipal Household Chemical Drop-off Locations**

Many common household products in your home are hazardous. Make sure your household chemicals are clearly labeled and sealed properly, if possible in the original containers. These household chemicals pose a danger to the drop-off location workers, your family, your pets, your neighborhood and the environment.

**Products for your vehicles** - Antifreeze, Automotive batteries, Brake and transmission fluid, Gasoline, Rust inhibitors/removers, Solvents, Used motor oil

**Hobby and health care products** - remover, Photographic chemicals, Propane tanks, Waterproofers

**Gardening Products** - Ant and rodent killer, Fertilizers, Weed killer

**Cleaning products** - Bleach and ammonia, Cleaning solvents and spot removers, Disinfectants, Drain, toilet and window cleaners, Hot tub and swimming pool chemicals, Oven cleaners, Septic tank cleaners

**Paint and building products** - Alkyd, latex and oil-based paints, Asphalt and roof tar, Lacquers, stains and varnishes, Paint thinners, strippers and solvents, Wood preservatives

# ***Hazardous Chemicals - Treatment***

## **Hazardous Waste Collection Sites**

Materials that cannot be recycled are packaged into larger containers and are then transported to incinerators like the one in Swan Hills.



## **Swan Hills Special Hazardous Waste Treatment Facility**

<http://www.shtc.ca/>

## **Solid Waste Garbage**

Follow the **GARBAGE** guidelines that have been created to avoid toxic or hazardous products being placed in a sanitary landfill, where they might burn, explode or escape as a leachate into the groundwater and eventually come back to haunt us.