



3.0 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.

3.1 – Transport of Materials Through Air, Soil and Water

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

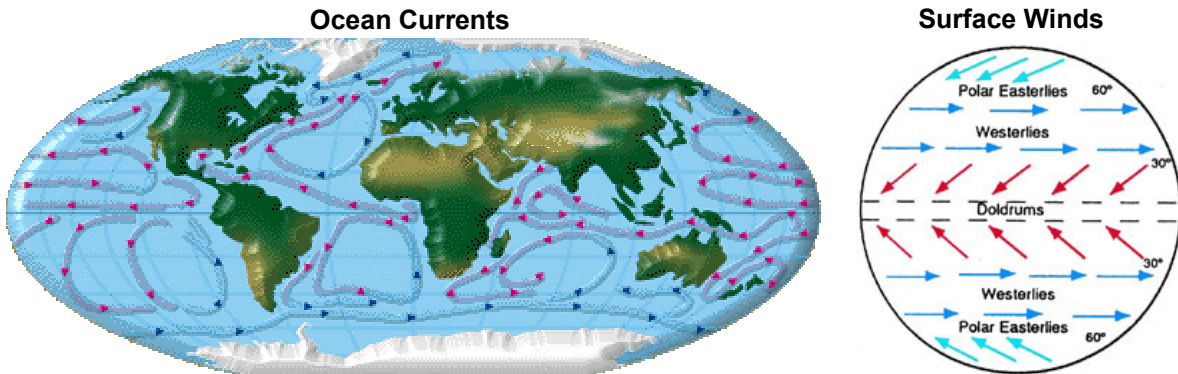
- **Release** of chemicals at the source
- **Dispersion** of the chemical into the atmosphere
- **Deposition** of the chemical in soil or water

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.



Transport In Groundwater <http://www.groundwater.org/kc/kc.html>

Water in Alberta - <http://www3.gov.ab.ca/env/water/index.cfm>

Water that soaks 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).

Certain contaminants (http://www.cee.vt.edu/program_areas/environmental/teach/gwprimer/gw-types.html) can 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.



Factors that affect the movement of contaminants in groundwater include 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.

Pollutants, which occur naturally or through human activities, can move more quickly through permeable soil.

Some Substances That Contaminate Groundwater

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

Transport In Surface Water <http://www3.gov.ab.ca/env/water/SWQ/index.cfm>

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.

Transport In Soil

Water is moved in one of four ways: evaporation, absorption by plants, runoff (into surface water) and 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)

Transport of Hydrocarbons In Soil

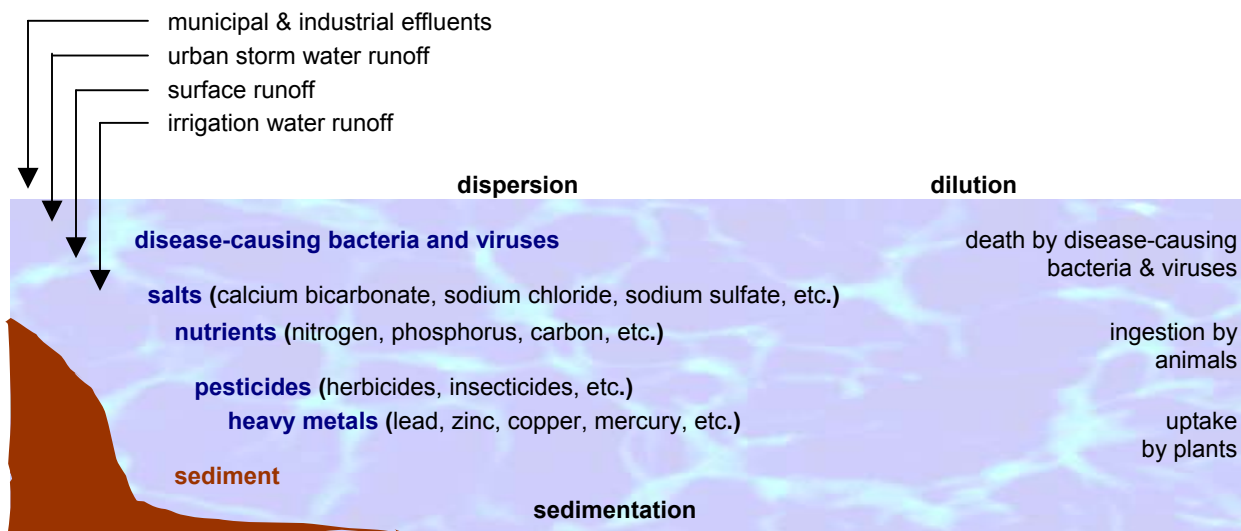
The daily use of hydrocarbons in vehicles and industry contaminates the soil. Some of these hydrocarbon emissions are carried by the air into the soil, or are carried by water where they can clog up soil pores – usually close to the source of the contamination. Hydrocarbons are toxic to plants and animals



3.2 – Changing the Concentration of Harmful Chemicals In the Environment

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. To do this **biodegradation** may be an effective alternative.



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.

Factors Affecting Biodegradation

During the winter, biodegradation is slow, because *temperature* is one factor that affects the rate of biodegradation. Other factors include *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.

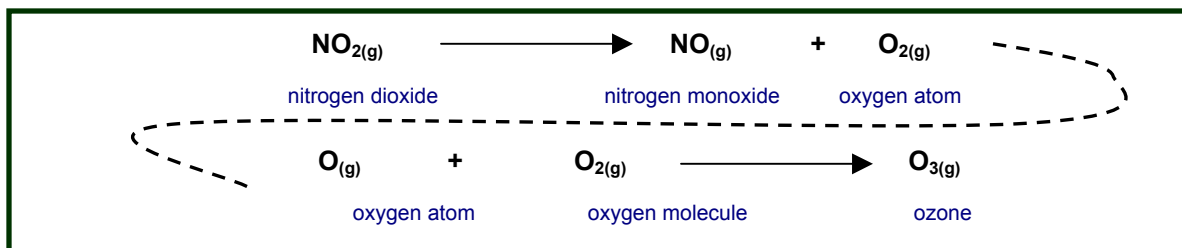


Phytoremediation

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

Photolysis

Photolysis is the breakdown of compounds by sunlight. The formation of ozone is an example of this process (outlined below)



Another example of photolysis is photodegradable plastic. Photodegradable plastic is made of chemicals that react when exposed to sunlight. In three months, the plastic becomes a fine powder that is easier to dispose of. (This type of plastic will only degrade if it is exposed to sunlight – if it is buried, it will last in its original shape for hundreds of years.)

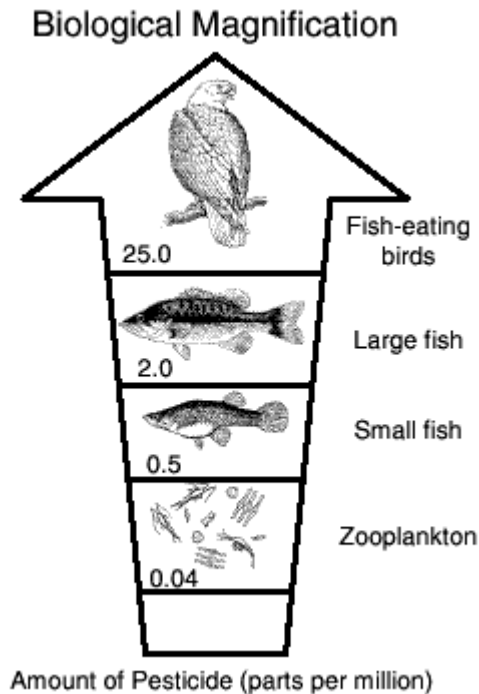


3.3 Hazardous Chemicals Affect Living Things

Chemicals can accumulate in living organisms. The increased concentrations mean that chemicals can remain in the environment for long periods of time.

Biomagnification

Biomagnification (or bioaccumulation) is the increase in the concentration of a chemical or element as it moves up the food chain.



A Case Study: Lynnview Ridge (Calgary) Lead Contamination

Environmental Report on Lynnview Ridge

http://www.calgary.ca/DocGallery/BU/environmental_management/land.pdf

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.landcentre.ca/lcframedoc.cfm?ID=5190>



A Case Study: The Exxon Valdez Oil Spill

Exxon Valdez

- 1989 the Exxon Valdez tanker ran aground on Bligh Reef in Prince William Sound Alaska
- Spilled 11 million gallons of crude oil – largest spill in U.S. history and caused more environmental damage than any other spill in history



Aerial view of Exxon Valdez with containment boom

- Spill plume traveled
- 450 miles –
- contaminating
- 1,100 miles of
- shoreline



Oil spill plume



Crude Oil - A mineral oil consisting of a mixture of hydrocarbons of natural origin, yellow to black in color, of variable specific gravity and viscosity; often referred to simply as crude. Crude oil needs to be processed at an oil refinery, before the products it is made of, can be separated and used.

Besides the reading the information in the **Science In Action 9 Textbook** (pgs. 250-252) the following **Internet Links** will also help you understand how chemical spills in the environment can be extremely long lasting and harmful.

Exxon Valdez Oil Spill Facts (This is an especially comprehensive facts site)

<http://www.oilspill.state.ak.us/facts/>

Prince William Sound

<http://library.thinkquest.org/10867/home.shtml>

Environmental Update

<http://www.valdezscience.com/>

Explore North

<http://www.explorenorth.com/library/weekly/aa032499.htm>

How do they clean up an oil spill?

<http://www.epa.gov/oilspill/oiltech.htm#Chemical>



3.4 Hazardous Household Chemicals

Chemicals used in the home and garden can be hazardous to your health. Some of these include:

Household cleaners	Personal hygiene products	Pet-care products	Paint and paint products	Pesticides and fertilizers	Automotive fluids
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HOUSEHOLD PRODUCTS DATABASE - <http://householdproducts.nlm.nih.gov/products.htm>

A Sample List of Products Used in the Home
http://www.checcnet.org/healthhouse/education/articles-detail.asp?Main_ID=650
Common Household Hazardous Waste
<http://www3.gov.ab.ca/env/waste/aow/hhw/common.html>

Identifying of HHW



Look for these Signal Words:

- Toxic
- Warning
- Caution
- Flammable
- Corrosive
- Reactive
- Danger



Caution

Poison

Improper storage, transport and disposal of these 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.



Labels (see Toolbox 1 – Science In Action p. 477)

Learn about Chemicals in your home
<http://www.epa.gov/kidshometour/index.htm>




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.

Different labels are used for different purposes:

Transporting	Supplying	Using in the Workplace	Disposal
 <p>Figure 2 POISON Placard</p> <p>Transporting Hazardous Materials Test</p>	<p>Toilet Bowl Cleaner</p> <p>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. Furnes are corrosive to metal.</p> <p>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.</p>	<p>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.</p>	<p>HAZARDOUS WASTE FEDERAL LAW PROHIBITS IMPROPER DISPOSAL Brockton University Office of Environmental Health & Safety 400 Forsyth Building Boston, Massachusetts 02115 (617) 375-2339 http://www.brockton.edu/ehs/ehs.htm</p> <p>Investigator: _____ (Phone #) _____ Date: _____ Room # / Bldg. _____ Date Container Filled: _____ Container Size(s): _____ Principal Constituents (Give % and Full Chemical Name): _____</p> <p>Hazardous Waste Classification (Check of least one) <input type="checkbox"/> Ignitable (Includes flammable liquids, solids and gases) <input type="checkbox"/> Corrosive (pH of 2 or less, or 12 or greater, and/or can corrode steel) <input type="checkbox"/> Reactive (Is unstable, can detonate or reacts violently with water) <input type="checkbox"/> Toxic (Contains heavy metals or pesticides) <input type="checkbox"/> Liquid (Appears on the F, U, P, or M List) <input type="checkbox"/> Other (Specify): _____</p>

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.



http://www.environmentalchoice.com/index_main.cfm



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 chemical in proper place when not in use
- Discard old products
- Place rusted or leaking containers inside a second container – dispose of both

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 Waste Collection Sites

<http://www.landcentre.ca/foundation/hazardous/legab.cfm>

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.townofswanhills.com/aswt.html>

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.

Summarize the **Solid Waste Garbage Guidelines** on p. 258 in your Science In Action 9 Textbook.