EMERGING CONTAMINANTS

Polychlorinated biphenyls (PCBs) were first synthesized in 1881, and commercial production in the United States began in 1929. PCBs were used in the electrical industry, as well as surface coatings and plasticizers in sealants, caulking, rubber, paints and asphalt. By 1972, scientific evidence showed that PCBs were an environmental and human health hazard and, in 1977, the manufacturing and non-electrical use of PCBs was banned. PCBs are a chemical that gained a lot of attention when scientific evidence began to suggest that it was an extremely dangerous substance. Many chemicals do not receive the same media attention that PCBs did, but scientists are constantly studying new and emerging contaminants that have the potential to cause detrimental environmental and health effects.

In Canada, there are thousands of chemicals and substances available for industrial processes and consumer goods, with additional chemicals being developed every day. Because many of these chemicals are relatively new, the effects of many on human health and the environment, including water, are not known. In 1976, in the United States, the Safe Drinking Water Act introduced regulations on 22 contaminants, including arsenic, coliform bacteria, lead, mercury and turbidity. By 1979, the importance of monitoring trihalomethanes (THMs; which are by-products of chlorine) was known and regulations were put into place. 27 new regulations were developed in 1991, including regulations for asbestos, total nitrate/ nitrite and PCBs. In 1998, regulations were developed for chlorine and compounds of chlorine.

The American regulations and the Canadian guidelines are continually being changed, as scientists discover the effects of contaminants on environmental and human health. Many times, however, these regulations or guidelines are not developed until a number of people have become ill, or died, or the environment has suffered as a result of exposure to the contaminants.

Well, what kinds of contaminants are we dealing with?

There are tens of thousands of chemicals that scientists are continually researching. The United States Geological Survey, together with the Environmental Protection Agency, has identified the following four groups of contaminants for further study:

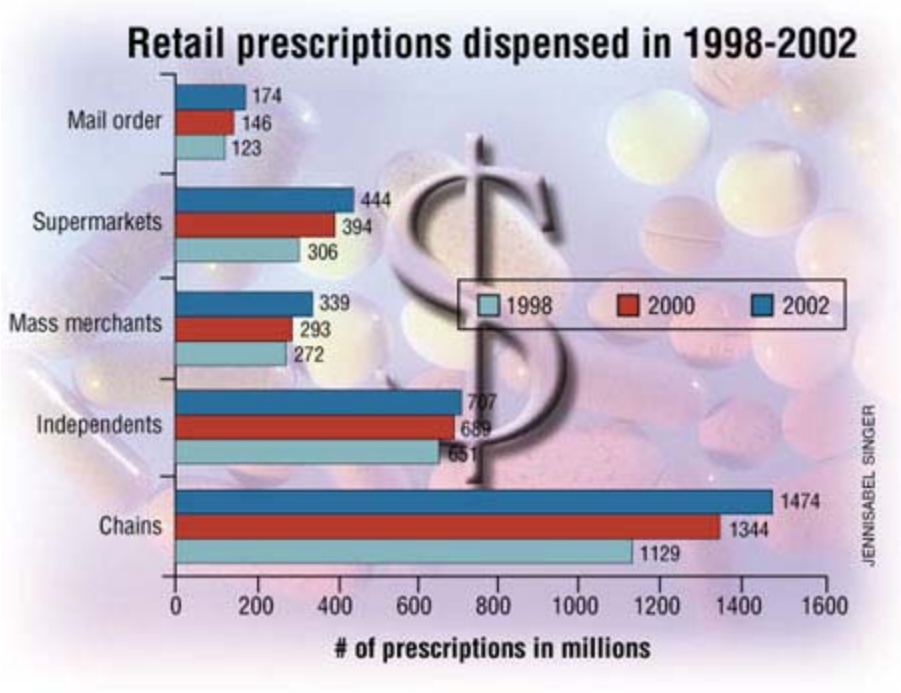
1. Veterinary and human antibiotics
2. Human drugs
3. Industrial and household products (such as insecticides, detergents, fire retardants, fuels)
4. Sex and steroidal hormones

An American study in 1999 and 2000 found that, of 139 streams that were tested in 30 states, 82 chemicals (including 31 different drugs) were found in 80 percent of the streams. The most common chemicals were steroids (anti-inflammatory drugs), antibiotics, nonprescription drugs, caffeine and insect repellent. Increased amounts of pesticides, pharmaceuticals, antibiotics and hormones have been found in Alberta's rivers and streams.

The grouping of pharmaceuticals and personal care products (often abbreviated PPCPs) has been receiving a great deal of attention recently. PPCPs include a wide variety of products, including prescription and non-prescription drugs, veterinary drugs, nutritional supplements, fragrances, cosmetics, antiperspirants, soap, sunscreen, and any other products consumed by individuals for personal health or cosmetic purposes.

It is likely that, as long as pharmaceuticals and personal care products have been used, they have been present in the environment. However, many PPCPs have been persistent in the environment for many years (because as they degrade, more are added), and the use of PPCPs is increasing. Because of the persistence and increased concentration of many PPCPs, scientists are beginning to notice harmful effects in the environment. For many years, pollution-reduction strategies were focused on the point sources of pollution that were easily identifiable, such as industries. And, as industries typically have strict controls on emissions, it is likely that large quantities of the PPCPs that are entering the environment are from individual consumers.

Antibiotics sales in the United States to drugstores and hospitals rose from $3.7 billion in 1988 to $5.6 billion in 1993. According to IMS Health, a study of retail pharmacies in 12 key markets found a ten percent growth in drug sales between March 1999 and February 2000. Though different studies will have different statistics regarding the increase in drug sales, nearly all studies will show an increase in the amount of drugs and pharmaceuticals that are being sold around the world. According to the American Academy of Dermatology, the average adult in the United States uses at least seven different skin-care products each day!



Increased Sales of Prescription Medications in the United States from 1998 to 2002;
http://www.uspharmacist.com/index.asp?show=article&page=8_1148.htm

One reason for an increase in the use of medications is the aging of the baby boomers. Other chemicals that may emerge in increasing concentrations in the next several decades are those used for embalming processes. Decomposing bodies, in cemeteries, can release bacteria, by-products from the decaying process and the chemicals used for embalming. As well, most funeral directors release wastewater to municipal wastewater treatment plants. However, there are some chemicals that are quite dangerous, and some people still dispose of funeral home wastewater through floor drains or by pouring the chemicals onto the ground. The effects of these contaminants are of significant concern because of the impact that they could have on

groundwater. For more information about groundwater contamination, see the Groundwater fact sheet. The typical chemicals that are used for embalming are formaldehyde, phenol, methanol and glycerin, but there are others, such as chloroform, that are used as well.

Chloroform is a trihalomethane (a chlorine by-product) that can cause birth defects, eye and respiratory irritation, liver and kidney damage and cancer when inhaled or ingested. When chloroform is dumped down the drain, it enters the environment with little or no treatment. Chloroform can degrade fairly quickly in the atmosphere (though it produces harmful by-products), but when it enters soil, it quickly seeps into the groundwater, with minimal degradation. There are a significant number of municipal water treatment systems that have problems with excessive chloroform and other THMs in their drinking water sources; these treatment facilities must then ensure that they remove the THMs from the drinking water, which can be done in a number of ways, including with the use of activated carbon, ozonation and aeration.

But what's the harm?

Scientists aren't entirely sure what the harm is yet; these contaminants are still emerging issues. However, they do know that PPCPs are highly water soluble (meaning that they can easily dissolve in water) compared with other chemicals. While PPCPs are found in concentrations of parts per billion or parts per trillion, this amount has been enough to harm the environment and aquatic life. Scientists attribute this to the fact that some PPCPs have continually been present in the environment for years, because as some PPCPs break down in the environment, more are added. As well, there are some PPCPs that do not break down.

Many emerging contaminants, including many PPCPs, are labeled as hormone disrupters. This means that these contaminants include synthetic hormones (such as estrogen or androgen), and when ingested, can interfere with the natural hormonal processes in animals or humans. PPCPs have been shown to contribute to infertility, delayed reproductive development, and kidney and liver damage in animals. Synthetic estrogen, present in PPCPs, has been found to cause hormone disruption in fish. Scientists have found less male fish than anticipated in streams and some of the male fish have been found with female reproductive characteristics, and they are predicting that synthetic estrogen is resulting in the feminization of male fish. For more information about the PPCPs that are being found in Ontario's water sources, read the article called Look at everyday chemicals in water, Ontario told.

Another aspect of PPCPs that has received attention recently is the concern that overuse and misuse of antibiotics are leading to the release of resistant pathogens. In 1999, the United States Geological Survey found ampicillin-resistant bacteria in every American river that was tested. Ampicillin is a common antibiotic used to fight bacterial infections. There is concern that pathogens that are antibiotic-resistant will lead to further increases in antibiotic use, which is the beginning of a "snowball effect" of increased antibiotic use and increased bacterial resistance to antibiotics.

PPCPs, while spending a lot of time in the media spotlight, are not the only category of emerging contaminants that are of concern. Many clear plastics, including those used to make water bottles, are made from polyethylene terephthalates (or PET). This plastic has been found to contain several dangerous chemicals, including bisphenol A. It has been shown that small amounts of the chemical can leach from the plastic into water or food. Bisphenol A is also a hormone disrupting chemical, and has been found to act as a synthetic estrogen, which could contribute to increased amounts of prostrate and breast cancer, as well as miscarriages and birth

defects. Bisphenol A is an ingredient in plastic water bottles; with the huge increases in sales of bottled water over the past several years, that results in a large amount of bisphenol A in landfills, where it can leach into nearby water sources. For more information about the chemicals found in water bottles, see the fact sheet about Bottled Water. For more information about bisphenol A, in particular, read the article from The Globe and Mail, titled "'Inherently toxic,' chemical faces its future."

Can't the wastewater treatment plants get rid of these chemicals?

As with all pollutants, there are a number of ways in which PPCPs can get into the water. Antibiotics and medications that are ingested will be excreted and enter the water through wastewater. Up to 90 percent of oral medications pass through the body unchanged. Externally applied personal care products can be washed away (showers, laundry, etc.) and also make their way to the water through wastewater.

Depending on the level of treatment that wastewater receives, only some facilities can successfully remove some contaminants. For example, a secondary level of wastewater treatment can remove up to 95 percent of estrogen from waste, but not all wastewater treatment facilities are equipped for secondary treatment.

Other substances, such as most PPCPs, are not broken down or removed in wastewater treatment processes. Municipal wastewater treatment facilities, even those with secondary and tertiary treatments, are not able to remove PPCPs from the wastewater. For more information about the types of wastewater treatment, see the Wastewater Treatment fact sheet. Triclocarbon is an ingredient in antibacterial hand soap, and is toxic when ingested; scientists have found that wastewater facilities can remove only about 25 percent of triclocarbon from water.

The PPCPs that can be removed from the wastewater will end up in the sludge, which is often applied to fields as fertilizers. And while some PPCPs will be broken down by the bacteria that digest the sludge, others cannot be broken down as easily. These PPCPs can then contaminate the soil that the fertilizer is applied on, and enter water sources through runoff and downward percolation to groundwater.

Not all wastewater gets treated; many contaminants end up in lakes and streams after they are washed down street gutters with stormwater, picked up in agricultural runoff, leached from landfills or directly discharged in sewage from cruise ships. For more information about the sources of water pollution, see the Water Pollution fact sheet.

But if the wastewater treatment plant can't get rid of the chemicals, then the drinking water treatment facilities will remove them, right?

A typical municipal water treatment plant includes processes of coagulation and flocculation, sedimentation, filtration and disinfection, usually with chlorine. PPCPs, in general, cannot be removed by coagulation and filtration. Several types of PPCPs can be removed by chlorine, but many more are unaffected by chlorine. There is evidence to suggest that ozonation may be effective in oxidizing PPCPs, which may form substances that are non-toxic. Nanofiltration, ultrafiltration and powdered activated carbon (PAC) are also processes that have been able to successfully remove PPCPs. However, compared to the typical municipal water treatment plant, there are few facilities that are using these processes to treat drinking water. For more information about how these water treatment processes work, including what kinds of

contaminants they can remove, see Conventional Water Treatment: Coagulation and Filtration, Chlorination, Ozonation, UV Irradiation and Nanofiltration, Ultrafiltration and Reverse Osmosis.

Current concentrations of PPCPs are generally found in the order of parts per billion and parts per trillion, which is the equivalent to one drop in an Olympic swimming pool. There is no drinking water standard for PPCP compounds, and most water treatment plants are not equipped to test for these compounds in parts per billion or parts per trillion concentrations. While scientists reassure that PPCPs in the order of parts per billion and parts per trillion are not dangerous concentrations, the persistent presence of PPCPs in the environment and the water is of concern.

What can I do?

With all of the new products and consumer goods that are available, it is sometimes difficult to know how to properly dispose of things, so that they do not harm the environment. There are several things that individuals can do to reduce water pollution.

- Return old or unused medication to pharmacies, where it may be properly disposed of. Or, many cities have designated days throughout the year where hazardous and toxic wastes can be dropped off at certain locations.
- Find out what kinds of recycling services are offered in your community. Then recycle all that you can. Here are a few things that various Canadian cities have recycling services for:
  - Paper, magazines and cardboard
  - Glass
  - Cans
  - Plastics (including shampoo bottles, peanut butter jars, slurpee cups, straws, chocolate bar wrappers, packing Styrofoam)
  - Batteries
  - Appliances
  - Furniture
  - Clothing and household items
  - Plastic grocery bags
  - Building materials and renovation fixtures
  - Propane tanks
  - Scrap metal
  - Tires
  - Engine oil, filters, antifreeze
  - Electronics, including computers and cell phones
  - Chemicals and hazardous wastes (including drain cleaners, lighter fluid, pesticides)
  - Fluorescent light bulbs
  - Yard waste
  - Vehicles
  - Paint
- Cut down on the amount of pharmaceuticals and personal care products that you use.
- Avoid clothes and furniture with stain resistant chemicals.
- Reduce consumption of pre-packaged foods and over-packaged goods.
- If your tap water is safe, drink tap water instead of bottled water.

The Safe Drinking Water Foundation has educational programs that can supplement the information found in this fact sheet. Operation Water Drop looks at the chemical contaminants that are found in water; it is designed for a science class. Operation Water Flow looks at how water is used, where it comes from and how much it costs; it has lessons that are designed for Social Studies, Math, Biology, Chemistry and Science classes. Operation Water Spirit presents a First Nations perspective of water and the surrounding issues; it is designed for Native Studies or Social Studies classes. Operation Water Health looks at common health issues surrounding drinking water in Canada and around the world and is designed for a Health, Science and Social Studies collaboration. Operation Water Pollution focuses on how water pollution occurs and how it is cleaned up and has been designed for a Science and Social Studies collaboration. To access

more information on these and other educational activities, as well as additional fact sheets, visit the Safe Drinking Water Foundation website at www.safewater.org.

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