Guidelines at a Glance

Canadian Sediment Quality Guidelines March 2005

Dioxins and Furans

This fact sheet describes the interim Canadian Sediment Quality Guidelines for dioxins and furans to protect freshwater and marine life. It is part of the series *Guidelines at a Glance*, which summarizes information on toxic substances and other parameters for which there are Canadian Environmental Quality Guidelines.

The National Guidelines and Standards Office of Environment Canada coordinates the development of Canadian Environmental Quality Guidelines in cooperation with the Canadian Council of Ministers of the Environment (CCME).

Where do dioxins and furans come from?

Dioxins and furans are chemical compounds that contain chlorine and can occur in 210 different configurations, called congeners. Dioxins and furans do not have a known use. They are produced unintentionally by human activities, including waste incineration, chemical manufacturing, petroleum refining, fuel combustion in vehicles, wood burning, and electric power generation. In the past, pulp and paper mill effluents were a major source of dioxins and furans, but regulations that came into effect in 1992 significantly reduced this source. Dioxins and furans are also produced by natural events such as forest fires and volcanic eruptions. In 1997, nearly half of the dioxin and furan load to Canada's environment was produced by releases to the atmosphere from combustion sources. Atmospheric transport can occur over long distances, taking dioxins and furans far from their original source.

Dioxins and furans are considered toxic under the Canadian Environmental Protection Act, and federal toxic management policies aim to virtually eliminate them from the Canadian environment.

What happens to dioxins and furans released into the environment?

Dioxins and furans are hydrophobic, meaning that they repel water. Because of this characteristic, dioxins and furans released into aquatic environments become attached to organic particles and get into the fatty tissues of aquatic organisms, including fish, insect larvae, shrimp-like crustaceans, and snails, among others. Dioxins and furans attached to organic particles may stay suspended in the water or may sink down to the sediment.

Dioxins and furans are chemically stable in sediments and may remain undegraded for a long time. Therefore, sediments are a long-term source of these chemicals to aquatic food webs. Sediment-dwelling organisms can take up dioxins and furans directly from the water and the sediment and by eating contaminated prey. Dioxins and furans accumulate in the lipids (fats) of organisms, but unlike polychlorinated biphenyls (PCBs), they don't seem to magnify in aquatic food webs.

What effects can dioxins and furans have on sediment-dwelling forms of aquatic life?

Dioxins and furans affect sediment-dwelling invertebrates (e.g., insect larvae, shrimp-like crustaceans, snails) by reducing the length and weight of individuals, causing growth deformities, and at high dioxin and furan levels, causing death. Effects on populations of invertebrates include altering their abundance and changing the ratio of immature to sexually mature individuals. These effects were all found on freshwater invertebrates. There are not enough data to make any conclusions about adverse effects on marine sediment-dwelling invertebrates.

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Dioxins and Furans

What levels of dioxins and furans are safe for plants and animals that live in or near Canadian sediments?

A variety of different dioxins and furans typically occur together in the environment, so their combined effects should be considered. Some dioxins and furans are more toxic than others. The Canadian Sediment Quality Guideline (CSeQG) for dioxins and furans is based on the 17 congeners that are thought to be the most toxic. The toxicity of a mixture of dioxins and furans can be expressed by converting the concentration of each dioxin and furan to an equivalent toxicity of the most toxic one known (the dioxin 2,3,7,8-TCDD). Each converted toxicity is called a dioxin and furan toxic equivalent (TEQ). The TEQs are based on data from measuring the responses of fish to many different dioxins and furans. There is not yet enough information available to determine TEQs for invertebrates. The TEQ gives a standardized toxicity for dioxins and furans.

The interim CSeQG for freshwater sediments is 0.85 nanograms of dioxin and furan TEQs per kilogram of dry sediment. A probable effect level (PEL) was also determined as an additional assessment tool. The PEL for freshwater sediments is 21.5 nanograms of dioxin and furan TEQs per kilogram of dry sediment. Insufficient toxicity data were available for marine sediments, so the interim CSeQG and the PEL for freshwater sediments have been adopted for marine sediments.

If the level of dioxin and furan toxic equivalents measured in freshwater or marine sediments is less than the guideline, one would not expect to see adverse health effects in even the most sensitive species. In places where the interim CSeQGs for dioxins and furans are exceeded, adverse effects will not necessarily occur. Whether effects will occur depends on the amount by which the guideline levels are exceeded, the sensitivity of individual species, and the sediment characteristics (e.g., organic carbon content, sediment particle size). Further investigation at a particular site is needed to determine whether or not there is a negative impact. Where dioxin and furan concentrations exceed the PEL, however, it is likely that adverse effects will occur. Also, some dioxins and furans have toxic effects similar to the effects of some polychlorinated biphenyls (PCBs), which are also synthetic compounds. PCBs often occur together with dioxins and furans at a site, so guidelines for PCBs should also be considered.

How do levels of dioxins and furans in Canadian sediments compare to the guidelines?

Most monitoring of sediments for dioxins and furans has been done at contaminated sites, particularly at sites near pulp and paper mills. Recent data are not available, but a monitoring program took place from 1986 to 1993. At sites upstream of pulp mills, dioxins and furans were not detected. At downstream sites, dioxins and furans were measured at 158 (British Columbia), 126 (Ontario), 47 (Quebec), 15 (Maritimes), and 3.7 (Alberta) nanograms of dioxin and furan TEQs per kilogram of dry sediment.

Some information is also available for marine sites. In a study of bottom sediments near pulp and paper mills, the two most contaminated sites in British Columbia had dioxin and furan levels of 101 (Hecate Strait) and 127 (Howe Sound at Squamish) nanograms of dioxin and furan TEQs per kilogram of dry sediment. The most contaminated Atlantic site from the same study was at Port Hawksbury, Nova Scotia, with a level of 10.5 nanograms of dioxin and furan TEQs per kilogram of dry sediment.

How can CSeQGs be used to make a difference?

In general, Canadian Sediment Quality Guidelines can be used by Canadian federal, provincial, and territorial governments on a voluntary basis to set local guidelines, dredging disposal limits, and clean-up targets. CSeQGs are most commonly used in environmental assessments as benchmarks or yardsticks to which measured levels are compared. Anyone can use the guidelines to determine if the level of dioxin and furan toxic equivalents measured in a sediment sample has the potential to cause adverse environmental effects.

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