



## Water Quality

### Ambient Water Quality Criteria for Polycyclic Aromatic Hydrocarbons (PAHs)

#### Overview Report

Prepared pursuant to Section 2(e) of the Environment Management Act, 1981

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#### Summary

This report is one in a series that establishes ambient water quality criteria for British Columbia. It includes an overview which is followed by the main body of the report. This document sets criteria for polycyclic aromatic hydrocarbons (PAHs) to protect freshwater and marine aquatic life.

Criteria for drinking water sources is available from the [ambient water quality guidelines website](#). Recreation, wildlife, irrigation and livestock guidelines were not set in this document because pertinent information about the effects of PAHs on these water uses is lacking. Guidelines for fish tissue for human consumption have been archived due to out-of-date guideline derivation methods. There are no CCME (Canadian Council of Ministers of the Environment) guidelines for any of the water uses for which we have set PAH criteria.

Aquatic life is the most sensitive water use affected by polycyclic hydrocarbons. In particular, aquatic organisms are very vulnerable to the phototoxic effects of PAHs that accumulate in their tissues. The criteria for PAHs are summarized in Table 2. and Table 3. A more detailed discussion of the criteria is presented in the main body of the report.

## Tables

**Table 1: Summary of Criteria for Polycyclic Aromatic Hydrocarbons (PAHs)**

Water Use	PAHs	Recommended Concentration
Wildlife Water Supply	—	None proposed
Livestock Water Supply	—	None proposed
Irrigation Water Supply	—	None proposed
Primary Contact Recreation	—	None proposed

**Table 2: Summary of Aquatic Life and Sediment Criteria for Polycyclic Aromatic Hydrocarbons (PAHs)**

PAH	Fresh Water (chronic)	Fresh Water (phototoxic)	Marine Water	Sediments (Fresh Water)	Sediments (Marine)
Naphthalene	1 µg/L	NR	1 µg/L	0.01 µg/g	0.01 µg/g
Methylated naphthalene	NR	NR	1 µg/L	NR	NR
Acenaphthene	6 µg/L	NR	6 µg/L	0.15 µg/g	0.15 µg/g
Fluorene	12 µg/L	NR	12 µg/L	0.2 µg/g	0.2 µg/g
Anthracene	4 µg/L	0.1 µg/L	NR	0.6 µg/g	NR
Phenanthrene	0.3 µg/L	NR	NR	0.04 µg/g	NR
Acridene	3 µg/L	0.05 µg/L	NR	1 µg/g	NR
Fluoranthene	4 µg/L	0.2 µg/L	NR	2 µg/g	NR
Pyrene	NR	0.02 µg/L	NR	NR	NR
Chrysene	NR	NR	0.1 µg/L	NR	0.2 µg/g
Benz[a]anthracene	0.1 µg/L	0.1 µg/L	NR	0.2 µg/g	NR
Benzo[a]pyrene	0.01 µg/g	NR	0.01 µg/g	0.06 µg/g	0.06 µg/g

***NR - not recommended due to insufficient data  
\*sediment containing 1% organic carbon***

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## ***Preface***

**THE MINISTRY OF ENVIRONMENT, LANDS AND PARKS** (now called Ministry of Water, Land and Air Protection) develops province-wide ambient water quality guidelines for variables that are important in the surface waters of British Columbia. This work has the following goal:

- To provide guidelines for the evaluation of data on water, sediment, and biota

The definition adopted for a guideline is:

***A maximum and/or a minimum value for a physical, chemical or biological characteristic of water, sediment or biota, which should not be exceeded to prevent specified detrimental effects from occurring to a water use, including aquatic life, under specified environmental conditions.***

The guidelines are province-wide in application, are use-specific, and are developed for some or all of the following specific water uses:

- Drinking water sources
- Aquatic life
- Wildlife
- Agriculture (livestock watering and irrigation)
- Recreation and aesthetics

The guidelines are set after considering the scientific literature, guidelines from other jurisdictions, and general conditions in British Columbia. The scientific literature gives information on the effects of toxicants on various life forms. This information is not always conclusive because it is usually based on laboratory work which, at best, only approximates actual field conditions. To compensate for this uncertainty, guidelines have built-in safety factors which are conservative but reflect natural background conditions in the province.

Guidelines are subject to review and revision as new information becomes available, or as other circumstances dictate.

## ***Introduction***

Polycyclic (or polynuclear) aromatic hydrocarbons (PAHs) are organic compounds composed of two or more benzene rings fused together. Theoretically, a large number of compounds can belong in the PAH category. The environmentally significant PAHs, however, are those molecules containing two to seven benzene rings. Naphthalene (molecular weight, 128.16 g) is an example of a PAH molecule having two benzene rings; coronene (molecular weight, 300.34 g) is an example having seven.

Several factors determine the physical, chemical and biological characteristics of PAHs. The low molecular weight PAHs—those containing two to three benzene rings, for example, naphthalenes, fluorenes, phenanthrenes and anthracenes are acutely toxic to aquatic organisms, whereas the high molecular weight PAHs—those containing four to seven rings—are not. However, several high molecular weight PAHs are known to be carcinogenic (e.g., B[a]P).

Among the large number of PAHs, only a few are manufactured in Canada and the USA. Forest fires and prairie fires, agricultural burning, and fossil-fuels are the major contributors of PAHs to the environment.

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## ***Recommended Guidelines***

The following criteria are based on information presented in the main body of the technical report. The Canadian Council of Ministers of the Environment (CCME) did not recommend PAH guidelines for any of the water uses given here.

### **AQUATIC LIFE**

#### **Water**

***To protect freshwater aquatic life from phototoxic and long-term effects, and to protect marine aquatic life from long-term effects, it is recommended that PAH concentrations in water should not exceed those in Table 2.***

### **SEDIMENT**

***To protect aquatic life from the harmful effects of PAHs in sediment, it is recommended that PAH concentrations in freshwater and marine sediments containing 1.0% organic carbon should not exceed those shown in Table 3. For a sediment with an organic carbon content other than 1.0%, an appropriate criterion can be obtained by multiplying the recommended criterion by the actual organic carbon content of the sediment (e.g. if the sediment had 5% organic carbon***

***you would multiply the sediment guideline value in Table 3 by 5).***

## **WILDLIFE**

PAH criteria for wildlife are not recommended in this document due to the lack of pertinent information in the literature.

## **LIVESTOCK**

PAH criteria for livestock watering are not recommended in this document due to the lack of pertinent information in the literature.

## **IRRIGATION**

PAH criteria for irrigation waters are not recommended in this document due to the lack of pertinent information in the literature.

## **RECREATION**

PAH criteria for recreation waters are not recommended in this document due to the lack of pertinent information in the literature.

## **DRINKING WATER SOURCES**

See Guideline Summary: Drinking Water Sources on the [ambient water quality guideline website](#) for current PAH guideline recommendations.

## ***Application of the Guidelines***

### **PHOTOTOXIC vs LONG-TERM CRITERIA**

The ecological significance of photo-induced toxicity of PAHs on aquatic environments has not been fully explored. However, it is evident from data presented in the literature that phototoxicity is relatively more severe and hazardous to aquatic organisms in clear shallow waters than are long-term effects in the absence of solar UV radiation. Juveniles of most fish are found in shallow areas of the littoral zone or on the surface as pelagic larvae, and would be extremely vulnerable.

Therefore, we recommend that the criteria developed to protect freshwater aquatic life from phototoxic effects, if available, should take precedence over the criteria to protect against long-term effects. If PAH levels in a specific waterbody exceed the phototoxic criteria, but the aquatic life does not show adverse

effects of PAHs introduced by human activities, the long-term criteria should be applied to manage and control further deterioration of water quality.

### **ASSESSMENT OF EXISTING WATER QUALITY**

The water quality criteria recommend in this document are based primarily on controlled, laboratory bioassays in which the toxic effects on organisms were measured in terms of PAH levels in water. However, the PAH body burden of aquatic organisms in their natural environments is the result of exposure to both water and food sources. PAHs associated with the sediment fraction are also available to the organisms under favourable environmental conditions.

Thus, PAH concentrations in water alone should not be taken as a true reflection of the potential PAH problem in a given waterbody. Other assessment techniques are required, which include the measurement of PAH concentrations in fish and/or sediment, and long-term bioassays with resident species using local water.

The guidelines for PAHs in fish and sediment can be used as parameters for the assessment of existing water quality. Long-term bioassays are complex and costly. They are likely to be undertaken for waterbodies with high resource values, which are threatened by a controllable point-source of PAH pollution.