



Water Quality

Ambient Water Quality Guidelines for Methyl Tertiary-Butyl Ether (MTBE)

Overview Report

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Summary

This document is one in a series that establishes ambient water quality guidelines for British Columbia. It is based on a technical report prepared for the British Columbia Ministry of Environment, Lands and Parks (now called Ministry of Water, Land and Air Protection) by Komex International Ltd. This overview

report assesses those guidelines for use in British Columbia and makes amendments where appropriate to suit BC conditions. The guidelines are safe conditions or levels that have province-wide application and are set to protect various water uses. This report sets guidelines for methyl tertiary-butyl ether (MTBE) to protect drinking water, freshwater and marine aquatic life, recreation, and livestock watering.

A major use of the guidelines is to set ambient water quality objectives. The objectives are the guidelines modified or adopted to protect the most sensitive designated water use in a particular body of water. The objectives are used in the preparation of waste management plans, pollution prevention plans, waste management permits, orders, or approvals. The latter three are the only documents that have legal standing. The guidelines are also used in contaminated site remediation.

Tables

Table 1: Summary of Water Quality Guidelines for MTBE

Water Use	Recommended Guidelines
Raw Drinking Water (aesthetics)	0.02 mg / L maximum
Recreation and Aesthetics	0.02 mg / L maximum
Livestock Watering	11.0 mg / L maximum
Wildlife, Irrigation	Insufficient Data
Aquatic Life (freshwater)	3.4 mg / L maximum
Aquatic Life (marine, estuarine)	0.44 mg / L maximum

For livestock watering, concentrations above the taste and odour thresholds that are below the livestock guideline may result in certain livestock avoiding water, reducing consumption and suffering associated adverse effects.

Introduction

Major sources of MTBE in the environment include leaking underground storage tanks containing reformulated gasoline and atmospheric release from refining/blending facilities. Reformulated gasoline commonly contains between ~10% to 15% MTBE (volume/volume). Some retailers in British Columbia have distributed reformulated gasoline since 1995.

MTBE is volatile, has a high aqueous solubility, and a low specific gravity. MTBE has a distinctive, terpene-like odour and low odour and taste detection thresholds. The low organic carbon partition coefficient of MTBE indicates it is adsorbed poorly to aquifer material. Thus, little to no attenuation of MTBE is expected in a saturated medium with typical organic carbon contents. MTBE has a low octanol/water partition coefficient which indicates that it will not accumulate in human or animal fat tissue. Laboratory microcosms, field-scale tests, and empirical site data have shown that MTBE biodegrades slowly in both aerobic and anaerobic environments. MTBE can be considered a "persistent variable" because it has an extended biodegradation half-life.

Human drinking water and recreation guidelines were developed based on a summary of guidelines from other jurisdictions. Freshwater aquatic life, marine aquatic life, and livestock watering guidelines were developed using Canadian Council for Ministers of the Environment protocols (where applicable) and published toxicity data.

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 goals:

1. to provide guidelines for the evaluation of data on water, sediment, and biota
2. to provide guidelines for the establishment of site-specific ambient water quality objectives

Ambient water quality objectives for specific waterbodies will be based on the guidelines and also consider present and future uses, waste discharges, hydrology/limnology/oceanography, and existing background water quality. The process for establishing water quality objectives is more fully outlined in *Principles for Preparing Water Quality Objectives in British Columbia*, copies of which are available from the Water Quality Section of the Environmental Quality Branch.

Neither guidelines nor objectives which are derived from them have any legal standing. The objectives, however, can be used to calculate allowable limits or levels for contaminants in waste discharges. These limits are set out in waste management permits and thus have legal standing. The objectives are not usually incorporated as conditions of the permit.

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:

- Raw drinking, public water supply and food processing
- Aquatic life and wildlife
- Agriculture (livestock watering and irrigation)
- Recreation and aesthetics
- Industrial (water supplies)

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.

The site-specific water quality objectives are, in most cases, the same as guidelines. However, in some cases, such as when natural background levels exceed the guidelines, the objectives could be less stringent than the guidelines. In relatively rare instances, for example if the resource is unusually valuable or of special provincial significance, the safety factor could be increased by using objectives which are more stringent than the guidelines. Another approach in such special cases is to develop site-specific guidelines by carrying out toxicity experiments in the field. This approach is costly and time-consuming and therefore seldom used.

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

The guidelines apply to the ambient raw water source before it is diverted or treated for domestic use.

The Ministry of Health regulates the quality of water for domestic use after it is treated and delivered by a water purveyor.

Guidelines relating to public health at bathing beaches are the same as those used by the Ministry of Health, which regulates the recreation and aesthetic use.

Recommended Guidelines

These guidelines are based on information presented in the consultant's technical report and are summarized in Table 1.

1. Raw Drinking Water Supply

The aesthetic objective for MTBE of a maximum 0.02 mg/L in ambient water to be used for drinking is based on the US EPA drinking water advisory level of 0.02 mg/L to 0.04 mg/L for taste and odour thresholds.

Rationale

The most sensitive endpoint for drinking water is the taste and odour threshold. The lower end of the range for taste and odour threshold published by the United States Environmental Protection Agency was adopted. This concentration yields no objectionable taste or smell. No adverse health effects are expected at this concentration.

A review of information from regulatory agencies worldwide was completed to determine what guidelines were being used by other jurisdictions for acceptable levels of MTBE in drinking water. The only water quality guideline found for Canada was in Ontario, which reports a value of 0.70 mg/L in "Guideline for use at Contaminated Sites". This guideline does not consider aesthetics due to low odour and taste thresholds for MTBE and this was not considered for the BC guideline.

Guidelines were identified from most jurisdictions in the United States. The United States Environmental Protection Agency has issued a drinking water advisory for MTBE which recommends a range of 0.02 mg/L to 0.04 mg/L based on taste and odour thresholds. The California Department of Health Sciences has reported a drinking water guideline of 0.013 mg/L, which protects the public for a maximum acceptable excess cancer risk of 1 in 1,000,000. This latter guideline was recalculated to be 0.021 mg/L using receptor parameters from the Canadian Council for Ministers of the Environment and the California Environmental Protection Agency cancer slope factor ($0.0018 \text{ (mg/kg-d)}^{-1}$). The health-based human drinking water guideline was calculated assuming a lifetime exposure weighted for five human life stages and a maximum acceptable excess cancer risk of 1 in 1,000,000.

2. Recreation

The guidelines for drinking water, based on aesthetics, of a maximum 0.02 mg/L, in ambient water, is to be used for recreation.

Rationale

No guidelines for MTBE in water for recreational uses were found. Since the guideline that we have proposed for drinking water is based on taste and odour thresholds, these will also apply to waters used for primary-contact recreation where individuals will not want aesthetically displeasing waters.

3. Fresh Water Aquatic Life

The maximum concentration should not exceed 3.4 mg/L.

Rationale

For freshwater aquatic life, toxicological data were identified for vertebrates [rainbow trout (*Oncorhynchus mykiss*), fathead minnow (*Pimephales promelas*), Japanese medaka (*Oryzias latipes*), common frog (*Rana temporaria*), carp (*Leuciscus idus melanotus*)]; invertebrates [water fleas (*Daphnia magna* and *Ceriodaphnia dubia*), rotifer (*Brachionus calyciflorus*)]; and plants [green alga (*Selenastrum capricornutum*)]. The lowest chronic LOEC was 342 mg/L for the 5-day reproduction endpoint for *Ceriodaphnia dubia*. The lowest LC₅₀ in the acute data set was 340 mg/L for 48 hour *Ceriodaphnia dubia* survival.

Toxicological data were sufficient to develop an Interim guideline that meets Canadian Council for Ministers of the Environment requirements. The recommended guideline is based the application of a 100-fold safety factor to the lowest LC₅₀ in the acute data set (340 mg/L for *Ceriodaphnia dubia*). Using the reproduction endpoint for *Ceriodaphnia dubia* (342 mg/L) and a 10-fold safety factor yields a value of 34 mg/L. Due to the small number of data, the recommended guideline was based the lowest guideline value developed from either data set.

4. Marine and Estuarine Aquatic Life

The maximum concentration should not exceed 0.44 mg/L.

Rationale

Toxicological data were not sufficient to meet Canadian Council for Ministers of the Environment requirements. However, we found the quality of the toxicological data to be satisfactory to develop a Preliminary guideline. The recommended guideline is based the application of a 100-fold safety factor to the lowest LC₅₀ in the acute data set (44 mg/L for *Mysidopsis bahi*).

For marine aquatic life, toxicological data were identified for vertebrates [sheepshead minnow (*Cyprinodon variegatus*), bleak (*Alburnus alburnus*), inland silverside (*Menidia beryllina*)] and invertebrates [opossum shrimp (*Neomysis mercedis* and *Mysidopsis bahia*), copepod (*Nitocra spinipes*), amphipod (*Chaetogammarus marinus*)]. The lowest LC₅₀ in the acute data set was 44 mg/L for *Mysidopsis bahia* survival.

5. Crop Irrigation

No water quality guideline for this use is recommended, as there are insufficient data on the adverse effects of MTBE to plants.

6. Livestock Watering

The maximum concentration should not exceed 11 mg/L.

Rationale

Toxicological data were not sufficient to meet Canadian Council for Ministers of the Environment requirements. For livestock watering, mammalian toxicological data were identified for laboratory animals but not for livestock species. The study used by several jurisdictions in the United States as the basis of their human health drinking water criteria was selected as the most appropriate toxicological study. The study exposed Sprague-Dawley rats to MTBE for 90 days via an oral route of exposure. The study reported NOAEL and LOAELs of 100 and 300 mg/kg bw/day, respectively. We found the quality of the toxicological data to be satisfactory to develop a preliminary guideline.

The recommended guideline is based on Canadian Council for Ministers of the Environment protocols with the application of additional safety factors. The TDI was calculated by applying a 100-fold safety factor to the geometric mean of the NOAEL and LOAEL. The 100-fold safety factor was determined using a factor of 10 to extrapolate from subchronic to chronic data, and an additional factor of 10 to extrapolate from rodent data to livestock. The recommended guideline was based on dairy cattle, which have a high water consumption to body weight ratio. It should be noted that concentrations above taste and odour thresholds that are below the livestock guideline may result in certain livestock avoiding water, reducing consumption, and suffering adverse effects.

Application of the Guidelines

The guidelines can be used to assess water quality impacts or as starting points to develop site-specific objectives. The water quality guidelines recommended in this document are primarily based on controlled, laboratory bioassays that do not account for factors that may modify the toxicity of MTBE in the field.

Setting Water Quality Objectives

Care must be exercised when the water quality guidelines are applied to assess environmental impacts of MTBE, since there may be situations where MTBE concentrations are continuously renewed (e.g., discharge from an industrial operation). In these types of situations, a site-specific study should be undertaken and appropriate site-specific water quality objectives developed based on species present and actual MTBE persistence and concentrations.

In many cases, water quality objectives will be the same as the guidelines. When concentrations of MTBE in developed waterbodies are constantly maintained due to a continuous source or an

environmental condition that prevents its degradation, then water quality objectives that are more stringent than the recommended guidelines may be justified. In some cases, socioeconomic or other factors may justify objectives which are less stringent than the guidelines. Site-specific impact studies would be required in such cases.

Methods (e.g., water effects ratio, resident species toxicity in the field, etc.) are available to adapt the recommended guidelines to a given site by considering these factors. Where necessary, these methods can be employed to set site-specific water quality objectives. Because these approaches are costly and time consuming, they are seldom used.