



Water Quality

Water Quality Guidelines for Total Gas Pressure: First Update

Overview Report

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Summary

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This updated report is based on a recent technical report prepared by a consultant on behalf of the Department of Fisheries and Oceans. The consultant's report was reviewed by several stakeholders from the provincial Ministry of Water, Land and Air Protection, Department of Fisheries and Oceans, and Environment Canada and the results were accepted. This updated report is one in a series which establishes ambient water quality guidelines for British Columbia. Guidelines are safe conditions or levels of contaminants, applicable province-wide, which protect various water uses. This summary provides the guidelines for total gas pressure (TGP), also referred to as dissolved gas supersaturation, to protect aquatic life in fresh and marine waters. No guidelines are established for drinking water, wildlife, livestock watering, irrigation, recreation and aesthetics, or industrial water uses since TGP did not affect adversely these uses. The recommended guidelines are summarised in Table 1.

Table 1: Summary of Guidelines for Total Gas Pressure (TGP)

Water Use	Recommended Guideline
Drinking Water Supply	None Proposed
Freshwater and Marine Aquatic Life	Maximum $\Delta P \leq 76$ mmHg (or $\leq 110\%$ at sea level)
Background Levels Higher Than Recommended Guidelines	No increase in ΔP or %TGP
Hatchery Environments	Maximum $\Delta P = 24$ mmHg (or 103% at sea level; $\Delta P = 0$ mmHg when pO_2 is ≤ 100 mmHg)
Wildlife	None Proposed
Livestock Water Supply	None Proposed
Irrigation	None Proposed
Primary-contact Recreation	None Proposed

ΔP = excess gas pressure in mm of Hg

pO_2 = partial pressure of dissolved oxygen in mm of Hg

Excess TGP produces a class of physiological signs referred to as gas bubble trauma which are harmful or fatal to fish and other freshwater and marine organisms. Fish are the most sensitive organisms in marine and freshwater environments to adverse effects of dissolved gas saturation. TGP guidelines for fish should protect all aquatic life. The guidelines need to reflect the diverse conditions where TGP may affect aquatic life such as variable water column depths, situations with background levels higher than the guidelines, and for fish hatcheries (due to the higher densities of fish and subsequent higher stress

levels encountered in these environments). The Canadian Council of Ministers of the Environment (CCME) had adopted the 1994 British Columbia guideline.

A major use of 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 permits, orders, or approvals, which are the only documents to have legal standing. The objectives, however, are not usually part of the permit.

Preface

The Ministry of Environment is developing province-wide ambient water quality guidelines for variables that are important in the surface waters of British Columbia. This work has the following goals:

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

The ambient water quality objectives for specific water bodies will be based on several factors: existing water quality guidelines, present and future uses of the water bodies, waste discharges, background water quality conditions, hydrology/limnology/oceanography, and other site-specific conditions. The process for establishing water quality objectives is more fully outlined in the "Principles for Preparing Water Quality Objectives in British Columbia" document, copies of which are available from the Water Protection Section, B.C. Ministry of Water, Land, and Air Protection, Victoria.

Neither guidelines nor objectives which are derived from them have any legal standing. The objectives can be used in calculating the limits to be allowed in waste discharges. These limits are set out in waste management permits, orders or approvals which do have legal standing. The objectives are not usually incorporated as conditions of the permit.

The definition for guidelines 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 condition."

The guidelines are use-specific, have province-wide application, and are being developed for the following water uses:

- Drinking, public water supply and food processing ¹
- Aquatic life and wildlife
- Agriculture (livestock watering and irrigation)
- Recreation and aesthetics ²
- 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 rarely totally 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.

Given this procedure for setting guidelines, water quality objectives, in most cases, will be the same as the 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 would be to develop site-specific guidelines by carrying out toxicity experiments in the field. This approach is costly and time-consuming and therefore seldom used.

The guidelines will be subject to review and revision as new information becomes available, or as other circumstances dictate.

¹ The guidelines apply to the ambient raw water source before it is diverted or treated for domestic use. The Ministry of Health Services regulates the quality of water for domestic use after it is treated and delivered by a water purveyor.

² Guidelines relating to public health at bathing beaches will be the same as those used by the Ministry of Health Services which regulates their use.

Recommended Guidelines

These guidelines are based on information presented in a technical report and are summarised in Table 1.

1.0 Freshwater Aquatic Life

A. For Surface Water Environments: The maximum ΔP should not exceed 76 mmHg regardless of water pO_2 levels. For sea level conditions, this corresponds to a TGP of 110%.

B. For Background Levels Higher Than the Recommended Guidelines: If the natural background levels of dissolved gas exceed the recommended guidelines, there should be no increase in ΔP or %TGP over the background levels. This guideline was not altered.

C. For Hatchery Environments: It is recommended that the excess gas pressure (ΔP) guidelines be defined by the equation:

$$\Delta P = 0.15 pO_2$$

This corresponds to a sea level ΔP of 24 mmHg or TGP of 103% at $pO_2 = 157$ mmHg (i.e., the threshold for swim bladder over-inflation under sea level normoxic conditions and zero water depth). If pO_2 levels in the hatchery drop to 100 mmHg, the guidelines should be a maximum ΔP of 0 mmHg. This guidelines was not altered.

2.0 Marine Aquatic Life

There are limited data from the literature which describe the effects of dissolved gas supersaturation on marine fish. However, the available data indicate that marine fish display the same signs of gas bubble trauma as do fresh water fish. Also, marine invertebrates display a similar level of sensitivity to dissolved gas supersaturation as adult fish. No data are available which would indicate the effects of dissolved gas supersaturation on marine plants or algae, but it is not anticipated that these would be any more sensitive than either marine fish or invertebrates. Therefore, suggested guidelines for the protection of marine aquatic life are the same as those recommended for the protection of fresh water fish (see Section 1.0). This guideline was not altered.

Application of Guidelines for Aquatic Life

The recommended guidelines are based on laboratory data involving fish exposed to dissolved gas supersaturation in shallow water environments and often in confined spaces. Local conditions may influence total gas pressure levels that cause gas bubble trauma and mortality in fish. Site-specific water quality objectives should be derived where more stringent or relaxed TGP guidelines are called for due to local conditions

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