



Water Quality

Ambient Water Quality Guidelines (Criteria) for Colour

Overview Report

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

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Summary

This document is one in a series which establishes ambient water quality guidelines, formerly known as criteria, for British Columbia. It is based on the report submitted by The Cadmus Group, Inc. of Ottawa under contract to the Water Management Branch in May, 1997. The contract was funded by Forest Renewal BC. The guidelines are safe conditions or levels of a variable which have province-wide application and are set to protect various water uses. This report sets guidelines for colour to protect drinking water, freshwater and marine aquatic life, wildlife, and recreational waters. Guidelines for irrigation, livestock watering, and industrial water uses were not set in this document due to the lack of pertinent information on effects of colour on these water uses. The guidelines are summarized in Table 1.

A major use of the guidelines (criteria) is to set ambient water quality objectives. The objectives are the criteria/guidelines modified or adopted to protect the most sensitive designated water use in a particular body of water. The objectives guide waste management plans, pollution prevention plans, forestry activities under the Forest Practices Code, waste management permits, orders, or approvals. The latter three are the only documents that have legal standing.

Tables

Table 1: Summary of Water Quality Guidelines for Colour

Water Use	Colour Units	Recommended Criteria
Drinking Water Supply (without treatment for	True	15 mg/L Pt

colour removal)		
Aquatic Life Fresh, Marine and Estuarine	Apparent	30-day average transmission of white light greater than or equal to 80% of background
Aquatic Life Fresh, Marine and Estuarine	True	30-day average true colour of filtered water samples shall not exceed background levels by more than 5 mg/L Pt in clearwater systems or 20% in coloured systems
Wildlife	Apparent	30-day average transmission of white light greater than or equal to 80% of background
Wildlife	True	30-day average true colour of filtered water samples shall not exceed background levels by more than 5 mg/L Pt in clearwater systems or 20% in coloured systems
Recreation and Aesthetics - fresh, marine and estuarine	Apparent	Secchi disc sighting range greater than or equal to 1.5 m (30-day average)
Recreation and Aesthetics - fresh, marine and estuarine	True	15 mg/L Pt (30-day average)

15 mg/L platinum is the existing Ministry of Health value.

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 Water Quality Section of the Water Management 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 a technical appendix and are summarized in table 1. The Canadian Council of Ministers of the Environment (CCME) did not recommend colour guidelines for any of the water uses given here.

1. RAW DRINKING WATER SUPPLY

In this document, the colour guideline for raw drinking water is based on aesthetic considerations. Most people can detect colour in water at 15 mg/L Pt.

It is recommended that the true colour in raw drinking water should not exceed 15 mg/L Pt. This is the current Canadian (Health Canada)/British Columbia drinking water guideline and it applies to systems in which background colour is less than or equal to 15 mg/L Pt.

2. AQUATIC LIFE

The aquatic life guidelines are expressed in terms of apparent and true colours. They apply to freshwater, estuarine, and marine aquatic systems. The proposed guidelines/criteria are mean levels based on a minimum of five weekly samples taken over a period of 30 days.

2.1 Apparent Colour

To protect freshwater, estuarine and marine aquatic life, it is recommended that the 30-day average transmission of white light shall be greater than or equal to 80% of background levels as measured historically or at appropriate reference sites.

This recommendation is based on the fact that relatively small changes in light attenuation by dissolved organic matter and/or suspended particulates can have a profound impact on the depth of the euphotic zone (i.e., the zone with sufficient light to support photosynthesis, generally one percent of ambient light). Whereas percent transmission of light is an easy parameter to measure, the choice of less than 20% reduction in the transmitted light as the desirable target is arbitrary.

2.2 True Colour

To protect freshwater, estuarine and marine aquatic systems, it is recommended that the 30-day average true colour of filtered water samples (0.45 mm) should not exceed the background level by more than 5 mg/L Pt (or 5 true colour units) in clearwater systems (background levels less than or equal to 20 mg/L Pt) or by more than 20% in coloured systems (background levels greater than 20 mg/L Pt).

This recommendation is based on the fact that increase in true colour of about 5 mg/L Pt in clearwater systems have a profound impact on the depth of the euphotic zone and photosynthetic rates of algae and macrophytes.

3. WILDLIFE

The recommended criteria/guidelines for wildlife, dependent on aquatic systems for sustenance and reproduction, are the same as the aquatic life criteria specified in Sections 2.1 and 2.2.

The available information indicates that changes in water colour could lead to some species avoiding habitats. Also, the aquatic life criteria should be protective of wildlife because the changes in colour associated with declines in loon abundance and reproductive success (about 50% increase in colour) are greater than those specified in the criteria.

4. LIVESTOCK WATER SUPPLY

Apparent or true colour guidelines/criteria for livestock water supplies are not recommended in this document due to the lack of pertinent information in the literature.

5. IRRIGATION

Apparent or true colour guidelines/criteria for irrigation waters are not recommended in this document due to the lack of pertinent information in the literature.

6. RECREATION AND AESTHETICS

The colour criterion/guidelines are expressed in terms of apparent and true colours. The proposed criteria/guidelines are mean levels based on a minimum of five weekly samples taken over a period of 30 days.

6.1 Apparent Colour

To protect recreational water uses in freshwater, estuarine, and marine environments, it is recommended that the 30-day average Secchi disk sighting range should be greater than or equal to 1.5 m.

This recommendation is based on public perception. Studies in the literature have indicated that a minimum water quality of 1.4 to 1.5 m Secchi disc depth is required before the water is considered to be suitable for bathing by the public.

6.2 True Colour

To protect recreational water uses in freshwater, estuarine and marine aquatic environments, it is recommended that the 30-day average true colour of filtered water samples (0.45 mm) should be less than or equal to 15 mg/L Pt.

This recommendation is based on the fact that yellow waters are poorly regarded and blue to green waters are preferred by recreational water users. In general, waters with true colour less than or equal to 15 mg/L Pt are in the blue to green colour range.

7. INDUSTRIAL WATER USES

No water quality criteria are recommended for apparent and true colour for the industrial water uses due to the lack of pertinent information in the literature.

Application of Criteria for Aquatic Life

1. MEASUREMENT OF APPARENT AND TRUE COLOUR

Percentage transmission of light is an easily measured parameter that indicates the amount of photosynthetically active radiation available to primary producers at lower depths. Transmission of white light is a function of both components of apparent colour, dissolved and particulate matter, and is, therefore, a useful monitoring tool for this parameter.

The measurement of transmitted light requires simultaneous measurements of light intensity at the surface and a selected depth (generally below one metre to avoid effects from surface agitation). Percent transmittance is based on total white light and is thus a composite for all visible wavelengths, each of which is variously influenced by water, dissolved matter and particulate matter. Transmission of white light will exhibit a considerable spatial, year-to-year, and seasonal variation in aquatic systems. Thus, it was deemed that a value relative to the background be used as the ambient water quality criterion for apparent colour, since it would be a more useful quantity to address environmental problems, than a single absolute value.

True colour is influenced by turbidity and the absorbance of the wavelength used to measure this parameter. The common practice of filtration through a 0.45 mm filter should be satisfactory to eliminate the influence of turbidity on true colour for most waters; however, repeated filtration may be required for

very turbid waters. The wavelength of choice should exhibit equal absorbance for natural coloured waters and the platinum-cobalt (Pt-Co) reference solution. For natural waters with a high concentration of humic and fulvic acids, this occurs around 410 nm and 440-470 nm. However, the single wavelength of 456 nm is recommended because the influence of turbidity (after filtration) is negligible at this wavelength.

True colour can be measured by comparator and colorimetric methods; however, comparator or visual assessment methods are not as precise. Most operators find it difficult to distinguish visually between colours that differ by less than 5 mg/L Pt. Colorimetric methods are based on the calibration of absorbance of the water sample at a variety of single wavelengths, usually against the Pt-Co standard. Colour is dependent upon such factors as pH, temperature, exposure to light, and storage time that affect the solubility and stability of the dissolved and particulate fractions of the sample. Although most methods recommend simultaneous recording of pH, pH standardization is not desirable because the resultant colour in a pH adjusted water will differ from the colour of the in-situ water. In-situ single wavelength analysis at 456 nm with the results calibrated against the Hazen measurement scale is the preferred analytical methodology for true colour.

The sampling design needed to determine the influence of human activities on apparent and true colour measurements must be flexible. Some considerations include availability of historical data and/or reference sites, nature of the anthropogenic activity (e.g., point versus non-point sources), and various legal and economic issues. Short-term (less than 24 hours) changes in colour can arise due to natural events (e.g., storms) and are unlikely to have serious impact on primary producers (algae, macrophytes). Therefore, when testing whether a particular anthropogenic activity has caused an increase in colour above the recommended water quality criteria/guidelines, several samples (n greater than or equal to 5) should be taken over a given period to assess the adverse effects.

2. ASSESSMENT OF EXISTING WATER QUALITY

The water quality guidelines recommended in this document are primarily based on controlled, laboratory tests and observations made in certain aquatic systems. Colour is also known to modify the toxicity of certain contaminants, such as metals. For instance, the toxicities of aluminum, copper, and zinc are reduced in coloured waters because they form complexes with humic substances that render these metals unavailable. Conversely, mercury availability, bioaccumulation in fish and hence toxicity increase as water colour increases. This is also likely true for other metals. Although these effects may be not be important in water columns where colour levels are below the recommended criteria, they may play a significant role in determining toxicity of contaminants in waters that are naturally highly coloured. Appropriate considerations must be given to these aspects when the existing water quality is assessed in an aquatic environment.

3. SETTING WATER QUALITY OBJECTIVES

Colour levels in natural environments can vary widely. For instance, the relatively undisturbed Yakoun River and its tributaries on Graham Island, British Columbia have a true colour varying from 13 to 922 true colour units. Obviously, these natural variations must be considered in setting site-specific water quality objectives. When colour in undeveloped waterbodies is less than the recommended water quality guidelines, then the guidelines, or more stringent values if justified, should apply. 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.