Health Canada Santé Canada

Guidelines for Canadian Drinking Water Quality:

Guideline Technical Document

Heterotrophic Plate Count

Prepared by the
Federal-Provincial-Territorial Committee on Drinking Water
of the
Federal-Provincial-Territorial Committee on Health and the Environment

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Other Guideline Technical Documents for the Guidelines for Canadian Drinking Water Quality can be found on the Water Quality and Health Bureau web page at http://www.healthcanada.gc.ca/waterquality.

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1.0 Guideline

No maximum acceptable concentration (MAC) is specified for heterotrophic plate count (HPC) bacteria in water supplied by public, semi-public, or private drinking water systems. Instead, increases in HPC concentrations above baseline levels are considered undesirable.

Note: Further information on how to apply this guideline is outlined in section 3.0, Application of the guideline.

2.0 Executive summary for microbiological quality of drinking water

2.1 Introduction

The information contained in this Executive Summary applies to the microbiological quality of drinking water as a whole. It contains background information on microorganisms, their health effects, sources of exposure, and treatment. Information specific to bacteria is included as a separate paragraph. It is recommended that this document be read in conjunction with other documents on the microbiological quality of drinking water, including the guideline technical document on turbidity.

2.2 Background

There are three main types of microorganisms that can be found in drinking water: bacteria, viruses, and protozoa. These can exist naturally or can occur as a result of contamination from human or animal waste. Some of these are capable of causing illness in humans. Surface water sources, such as lakes, rivers, and reservoirs, are more likely to contain microorganisms than groundwater sources, unless the groundwater sources are under the direct influence of surface water.

The main goal of drinking water treatment is to remove or kill these organisms to reduce the risk of illness. Although it is impossible to completely eliminate the risk of waterborne disease, adopting a multi-barrier, source-to-tap approach to safe drinking water will reduce the numbers of microorganisms in drinking water. This approach includes the protection of source water (where possible), the use of appropriate and effective treatment methods, well-maintained distribution systems, and routine verification of drinking water safety. All drinking water supplies should be disinfected, unless specifically exempted by the responsible authority. In addition, surface water sources and groundwater sources under the direct influence of surface water should be filtered. Drinking water taken from pristine surface water sources may be

exempt from filtration requirements (Health Canada, 2003). The performance of the drinking water filtration system is usually assessed by monitoring the levels of turbidity, a measure of the relative clarity of water. Turbidity is caused by matter such as clay, silt, fine organic and inorganic matter, plankton, and other microscopic organisms, which is suspended within the water. Suspended matter can protect pathogenic microorganisms from chemical and ultraviolet (UV) light disinfection.

Currently available detection methods do not allow for the routine analysis of all microorganisms that could be present in inadequately treated drinking water. Instead, microbiological quality is determined by testing drinking water for *Escherichia coli*, a bacterium that is always present in the intestines of humans and other animals and whose presence in drinking water would indicate faecal contamination of the water. The maximum acceptable concentration (MAC) of *E. coli* in drinking water is none detectable per 100 mL.

2.3 Bacteria

E. coli is a member of the total coliform group of bacteria and is the only member that is found exclusively in the faeces of humans and other animals. Its presence in water indicates not only recent faecal contamination of the water but also the possible presence of intestinal disease-causing bacteria, viruses, and protozoa. The detection of *E. coli* should lead to the immediate issue of a boil water advisory and to corrective actions being taken. Conversely, the absence of *E. coli* in drinking water generally indicates that the water is free of intestinal disease-causing bacteria. However, because *E. coli* is not as resistant to disinfection as intestinal viruses and protozoa, its absence does not necessarily indicate that intestinal viruses and protozoa are also absent. Although it is impossible to completely eliminate the risk of waterborne disease, adopting a multi-barrier approach to safe drinking water will minimize the presence of disease-causing microorganisms, reducing the levels in drinking water to none detectable or to levels that have not been associated with disease.

While *E. coli* is the only member of the total coliform group that is found exclusively in faeces, other members of the group are found naturally in water, soil, and vegetation, as well as in faeces. Total coliform bacteria are easily destroyed during disinfection. Their presence in water leaving a drinking water treatment plant indicates a serious treatment failure and should lead to the immediate issue of a boil water advisory and to corrective actions being taken. The presence of total coliform bacteria in water in the distribution system (but not in water leaving the treatment plant) indicates that the distribution system may be vulnerable to contamination or may simply be experiencing bacterial regrowth. The source of the problem should be determined and corrective actions taken.

In semi-public and private drinking water systems, such as rural schools and homes, total coliforms can provide clues to areas of system vulnerability, indicating source contamination as well as bacterial regrowth and/or inadequate treatment (if used). If they are detected in drinking water, the local authority responsible for drinking water may issue a boil water advisory and

recommend corrective actions. It is important to note that decisions concerning boil water advisories should be made at the local level based upon site-specific knowledge and conditions.

The heterotrophic plate count (HPC) test is another method for monitoring the overall bacteriological quality of drinking water. HPC results are not an indicator of water safety and, as such, should not be used as an indicator of adverse human health effects. Each system will have a certain baseline HPC level and range, depending on site-specific characteristics; increases in concentrations above baseline levels should be corrected.

There are naturally occurring waterborne bacteria, such as *Legionella* spp. and *Aeromonas hydrophila*, with the potential to cause illnesses. The absence of *E. coli* does not necessarily indicate the absence of these organisms, and for many of these pathogens, no suitable microbiological indicators are currently known. However, the use of a multiple-barrier approach, including adequate treatment and a well-maintained distribution system, can reduce these bacterial pathogens to non-detectable levels or to levels that have never been associated with human illness.

2.4 Health effects

The health effects of exposure to disease-causing bacteria, viruses, and protozoa in drinking water are varied. The most common manifestation of waterborne illness is gastrointestinal upset (nausea, vomiting, and diarrhoea), and this is usually of short duration. However, in susceptible individuals such as infants, the elderly, and immunocompromised individuals, the effects may be more severe, chronic (e.g., kidney damage), or even fatal. Bacteria (e.g., *Shigella* and *Campylobacter*), viruses (e.g., norovirus and hepatitis A virus), and protozoa (e.g., *Giardia* and *Cryptosporidium*) can be responsible for severe gastrointestinal illness. Other pathogens may infect the lungs, skin, eyes, central nervous system, or liver.

If the safety of drinking water is in question to the extent that it may be a threat to public health, authorities in charge of the affected water supply should have a protocol in place for issuing, and cancelling, advice to the public about boiling their water. Surveillance for possible waterborne diseases should also be carried out. If a disease outbreak is linked to a water supply, the authorities should have a plan to quickly and effectively contain the illness.

2.5 Exposure

Drinking water contaminated with human or animal faecal wastes is just one route of exposure to disease-causing microorganisms. Outbreaks caused by contaminated drinking water have occurred, but they are relatively rare compared with outbreaks caused by contaminated food. Other significant routes of exposure include contaminated recreational waters (e.g., bathing beaches and swimming pools) and objects (e.g., doorknobs) or direct contact with infected humans or domestic animals (pets or livestock). Although surface waters and groundwater under

the direct influence of surface water may contain quantities of microorganisms capable of causing illness, effective drinking water treatment can produce water that is virtually free of disease-causing microorganisms.

2.6 Treatment

The multi-barrier approach is an effective way to reduce the risk of illness from pathogens in drinking water. If possible, water supply protection programs should be the first line of defence. Microbiological water quality guidelines based on indicator organisms (e.g., *E. coli*) and treatment technologies are also part of this approach. Treatment to remove or inactivate pathogens is the best way to reduce the number of microorganisms in drinking water and should include effective filtration and disinfection and an adequate disinfectant residual. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable without major fluctuations.

It is important to note that all chemical disinfectants (e.g., chlorine, ozone) used in drinking water can be expected to form disinfection by-products, which may affect human health. Current scientific data show that the benefits of disinfecting drinking water (reduced rates of infectious illness) are much greater than any health risks from disinfection by-products. While every effort should be made to reduce concentrations of disinfection by-products to as low a level as reasonably achievable, any method of control used must not compromise the effectiveness of water disinfection.

3.0 Application of the guideline

HPC results give an indication of overall water quality in public, semi-public[1], and private systems. HPC results should be used as a useful tool for monitoring the overall quality of the water, both immediately post-treatment and in the distribution system. It should be noted that HPC results are not an indicator of water safety and, as such, should not be used as an indicator of potential adverse human health effects.

In groundwaters not under the direct influence of surface water, HPC levels are generally low and stable over time. In surface water and groundwaters under the direct influence of surface water, HPC should be minimized through effective treatment and disinfection and remain constant over time.

In both disinfected and non-disinfected systems, sudden increases in HPC above normal baseline levels can indicate a change in raw water quality or a problem such as bacterial regrowth

[1]For the purposes of this document, a semi-public water supply system is defined as a system with a minimal or no distribution system that provides water to the public from a facility not connected to a public supply. Examples of such facilities include schools, personal care homes, day care centres, hospitals, community wells, hotels, and restaurants. The definition of a semi-public supply may vary between jurisdictions.

in the distribution system or plumbing. Steady increases in HPC over time indicate a gradual decline in raw water quality or in the condition of the system. Additionally, increases in HPC in disinfected systems can indicate a problem with drinking water treatment.

If an increase in HPC values does occur, the system should be inspected and the cause determined. Boil water advisories[2] should not be issued based solely on HPC results. Corrective actions should be taken, if deemed necessary, after discussions with the responsible authority.

3.1 Corrective actions

Some or all of the following corrective actions (where applicable) should be implemented:

- Verify the integrity of the treatment process and distribution system.
- Verify that the required disinfectant residual is present throughout the distribution system.
- Increase chlorine dosage/shock chlorinate the well and plumbing system, flush the system, clean treated water storage tanks and domestic cisterns, and check for the presence of cross-connections and pressure losses. Water should be dechlorinated before being discharged to fish-bearing streams. The responsible authority should be consulted regarding the methods available, and the correct procedure, for carrying out dechlorination. Further information on this topic is available in Health Canada's *What's in Your Well? — A Guide to Well Water Treatment and Maintenance* (Health Canada, 2004).
- Look for dead zones (stagnant water) in mains and storage reservoirs.
- Conduct an investigation to identify the problem and prevent its recurrence, including a measure of raw water quality (e.g., bacteriological, colour, turbidity, conductivity) and variability.
- Continue selected sampling and testing of all identified sites during the investigative phase to confirm the extent of the problem and to verify the success of the corrective actions.

4.0 Significance of heterotrophic plate counts in drinking water

4.1 Description and sources

Heterotrophs are those microorganisms that use organic compounds for most or all of their carbon requirements (Singleton and Sainsbury, 2001). Most bacteria, including many of the bacteria associated with drinking water systems, are heterotrophs.

[2] For the purpose of this document, the use of the term 'boil water advisory' is taken to mean advice given to the public by the responsible authority to boil their water, regardless of whether this advice is precautionary or in response to an outbreak. Depending on the jurisdiction, the use of this term may vary. As well, the term 'boil water order' may be used in place of, or in conjunction with, 'boil water advisory'.

Heterotrophic plate count (HPC) is a microbial method that uses colony formation on culture media to approximate the levels of heterotrophic flora. HPC does not, however, give an indication of the types of organisms present or their sources. It should also be noted that the results obtained using an HPC test are not an accurate assessment of total heterotrophic concentrations but, instead, are indications of culturable organisms present. For example, it has been shown that only approximately 1% of the total bacteria found using direct microscopy are enumerated using HPC procedures (Wagner *et al.*, 1993). Possible explanations for this difference include the presence of some bacteria in a viable but non-culturable state and the fact that HPC media do not provide the complex nutritional requirements necessary for the growth of all heterotrophs.

The composition of species recovered using an HPC procedure and their concentrations will vary depending on many factors, including the physical and chemical characteristics of the water. Variations in the number and types of organisms recovered at the same sampling location also occur. Recovered microorganisms can include those naturally found in the water environment and others from diverse pollutant sources. This may include species within the genera *Pseudomonas*, *Aeromonas*, *Alcaligenes*, *Acinetobacter*, *Klebsiella*, *Flavobacterium*, *Chromobacterium*, and many others. HPC tests recover a broad range of bacterial species, some of which may be opportunistic bacterial pathogens. Further discussion on this topic can be found in section 4.2.

Unlike other indicators, such as *Escherichia coli* or total coliforms, low concentrations of HPC organisms will still be present after drinking water treatment. In general, water utilities can achieve heterotrophic bacteria concentrations of 10 colony-forming units (CFU) per millilitre or less in finished water (Fox and Reasoner, 1999). Within a distribution system, increases in the density of HPC bacteria are usually the result of bacterial regrowth. The density reached can be influenced by the bacterial quality of the finished water entering the system, temperature, residence time (i.e., stagnation), presence or absence of a disinfectant residual, construction materials, surface-to-volume ratio, flow conditions, the availability of nutrients for growth (Prévost *et al.*, 1997; Payment, 1999), and, in chloraminated systems, the chlorine/ammonia ratio and the activity of nitrifying bacteria.

4.2 Health effects

As mentioned above, the heterotrophic population in potable water may include a broad range of genera, including some opportunistic bacterial pathogens. In numerous studies, heterotrophic bacteria isolated from water have been shown to possess very few virulence factors (Lye and Dufour, 1991; Payment *et al.*, 1994; Edberg *et al.*, 1996, 1997) and are therefore of no human health consequence. At a recent expert meeting dealing with HPC in drinking water management, it was also concluded that HPC in drinking water are not a health concern to the general public (WHO, 2002).

Under some circumstances, however, opportunistic pathogens within the heterotrophic flora can constitute a health risk for immunocompromised individuals, including the very young. For example, some species of *Pseudomonas* can become serious secondary pathogenic invaders in post-operative infections, in burn cases, and in the very young (Hunter and Ensign, 1947; Wilson *et al*., 1961; Fierer *et al*., 1967; Culp, 1969; Lowbury *et al*., 1970). Also, *Flavobacterium* has been reported as a primary pathogen for some surgical patients (Herman and Himelsback, 1965). Although these are serious health concerns, they do not result from the consumption of drinking water by the general public. In these circumstances, additional precautions should be taken to ensure the users' safety.

Other opportunistic heterotrophs have received attention based on their ability to grow within drinking water systems. For example, secondary pathogens such as *Legionella* and non-tuberculous mycobacteria are part of the heterotrophic flora (although they cannot be enumerated using standard HPC methods) and can multiply in water systems; however, there is no evidence that HPC levels have a direct relationship with their presence (WHO, 2002). *Aeromonas hydrophila*, an additional heterotrophic bacterium that is capable of growing in a distribution system, has been placed on the U.S. Environmental Protection Agency's Contaminant Candidate List . Microorganisms listed on the Contaminant Candidate List are those that are potential health risks through drinking water and need to be evaluated for possible regulation (Hilborn *et al.*, 2002). Further information on *Aeromonas*, *Legionella*, and non-tuberculous mycobacteria can be found in *Guidelines for Canadian Drinking Water Quality: Guideline Technical Document — Bacterial Waterborne Pathogens: Current and Emerging Organisms of Concern* (Health Canada, 2006). Overall, elevated HPC measurements in drinking water have not been responsible for outbreaks of waterborne illness, nor have they been epidemiologically linked to endemic illness in the general population. Exposure to general HPC microbiota is far greater through foodstuffs than through drinking water (WHO, 2002).

5.0 Role of HPC in maintaining drinking water quality

Rudimentary testing for heterotrophic organisms became possible with the advent of culture media in the late 1800s. By the end of the century, HPC tests were being used as indirect indicators of water safety by providing information on the treatment process — that is, they indicated the level of removal of bacteria by filtration. Based on observations of HPC levels and outbreaks of cholera, Robert Koch suggested that if drinking water contained less than 100 CFU of HPC organisms per millilitre, outbreaks (i.e., cholera and typhoid fever) would not be seen. The use of HPC as a safety indicator decreased in the 20th century with the advent of faecal-specific testing.

At present, measuring HPC levels in water during treatment and immediately upon leaving a treatment plant can be used by plant operators as a useful tool to monitor plant operation. Other useful tests include those for coliform bacteria, turbidity, and disinfectant residuals. HPC can also be used as a measure of quality deterioration in wells, distribution lines,

and reservoirs (Geldreich *et al*., 1972; Fiksdal *et al*., 1982; Reasoner and Geldreich, 1985). In distribution systems, HPC provides some indication of stagnation, tuberculation, residual disinfectant concentration, and availability of nutrients for bacterial growth; in addition, in chloraminated systems, it can reflect improper chlorine/ammonia ratios or a problem with nitrification. In 1989, the U.S. Environmental Protection Agency ruled that municipalities cannot have undetectable levels of disinfectant residual in more than 5% of their monthly samples for any two consecutive months. Where the HPC is 500/mL or less, that sample is deemed to have a detectable residual for compliance with this regulation (U.S. EPA, 1989). The Drinking Water Inspectorate of England and Wales, based on the European Union Council Directive on the quality of water for human consumption (Council of the European Union, 1998), has not set a numerical limit for HPC levels in drinking water, but has specified that HPC levels should show no abnormal changes at the consumer's tap or within treatment works or service reservoirs (DWI, 2000). A sudden rise in HPC measurements collected from a site that has traditionally had low counts should give rise to concern. Although high HPC measurements have not been found to correlate with illness incidence and no outbreaks have been directly linked to elevated concentrations of HPC flora in tap water, high HPC measurements do indicate favourable conditions for bacterial regrowth and should be remedied. Bacterial regrowth can promote or cause corrosion of pipes, be responsible for foul-tasting or discoloured water, and promote slime growth. As a result, HPC can be used as a marker for the underlying causes of some aesthetic problems (WHO, 2002). In addition, bacterial regrowth may harbour secondary respiratory pathogens, such as *Legionella* species, as well as increase the demand for disinfectant.

Historically, some jurisdictions used background colony counts on total coliform membrane filters as a convenient and inexpensive surrogate for HPC. Background colony counts should no longer be used as a surrogate for HPC testing, but they can be useful for determining if there is interference with coliform recovery when using standard lactose-based coliform media (Geldreich *et al*., 1972). It should be noted that inhibition of total coliform bacteria by HPC organisms does not occur with enzyme substrate tests that use defined substrate technology, so determining HPC or background colony counts to detect possible inhibition is not necessary.

6.0 Role of disinfectant residuals in maintaining drinking water quality

The purpose of treating drinking water is to provide a product that is microbiologically and chemically safe for consumption. In all public and semi-public systems applying disinfection, a disinfectant residual should be maintained throughout the distribution system at all times. Maintenance and monitoring of a residual disinfectant offer two benefits. First, a disinfectant residual will limit the growth of organisms within the system and may afford some protection against contamination from without; second, the disappearance of the residual provides an immediate indication of the entry of oxidizable matter into the system or of a malfunction of the treatment process. It is therefore recommended that a disinfectant residual be maintained and monitored daily throughout the entire system. The minimum disinfectant residual

that needs to be maintained is determined by the responsible authority and may vary from jurisdiction to jurisdiction. It is recognized that excessive levels of disinfectant may result in taste and odour problems. If this occurs, the responsible authority may provide guidance as to the type and concentration of disinfectant residual to ensure that water remains microbiologically safe. When a residual concentration measured at a sampling point is less than that required by the responsible authority, another sample should be taken immediately. If this sample is also unsatisfactory, the line should be flushed and sampling continued until a satisfactory concentration is obtained. If the residual does not return to the allowable minimum, the disinfectant dosage should be increased. If increasing the dosage is ineffective or if excessive disinfection is required, a sanitary survey for potential sources of contamination should be made in cooperation with the responsible authority. Special samples should be taken for coliform analysis. Should all these measures prove inadequate, the responsible authority should be consulted for further advice, and action should be taken as appropriate.

7.0 Analytical methods for HPC

HPC tests are simple culture-based methods designed to recover a wide variety of organisms. Although no single growth medium, temperature, or incubation time will ensure the recovery of all organisms present in water, the 20th edition of *Standard Methods for the Examination of Water and Wastewater* (APHA *et al*., 1998) does specify requirements that will permit a meaningful estimate of selected members of the culturable population.

There are currently three methods — pour plates, spread plates, and membrane filtration — that are routinely used for HPC determinations (APHA *et al*., 1998). Depending on the method, different culture media are available, including plate count agar, m-HPC agar, R2A agar, and NWRI agar. All media, except m-HPC, can be used with the pour plate and spread plate methods. Membrane filtration, however, does not use plate count agar, but R2A, NWRI, and m-HPC agar are all used. In addition to the above methods, new enzyme-based methods have been developed and are commercially available. It should be noted that in order to make meaningful comparisons between HPC results, the same method, media, and incubation procedures should be used.

The sample should be analysed within 8 hours of collection. However, if it is stored at temperatures below 4°C but above freezing, analysis within 24 hours is considered acceptable (APHA *et al.*, 1998).

All analyses for HPC should be carried out as directed by the responsible authority. In many cases, the responsible authority will recommend or require the use of accredited laboratories. In some cases, to analyse samples in a timely manner, other means, such as the use of non-accredited laboratories or analyses using field kits, may be recommended. In these instances, validation samples should be sent to accredited laboratories for confirmation of test results. The requirements for validation sampling are determined by the responsible authority.

7.1 Pour plate method

The pour plate method involves adding a small volume of sample (0.1–2.0 mL) to melted agar (44–46°C) and then pouring the mixture into plates. The plates are then incubated for the required time. As detailed in *Standard Methods for the Examination of Water and Wastewater* (APHA *et al*., 1998), two incubation procedures are generally used. Plates can be stored at 35°C for 48 hours or at 20–28°C for 5–7 days. Using the pour plate method, colonies are generally small and compact and therefore easier to count. On the other hand, because the colonies are submerged, they are often slower growing and difficult to transfer (if necessary). Also, because the sample is being added to agar between 44 and 46°C, this could result in heat shock to the bacteria.

7.2 Spread plate method

The spread plate method has the advantage of using solidified agar, eliminating the possibility of heat shock. The sample is spread on the surface of the agar (0.1–0.5 mL), and the plates are incubated as required (as detailed above). Some media give better results under specific conditions (APHA *et al*., 1998). The resultant colonies can be easily transferred, and their colony morphology can be distinguished. Since the sample applied has to be absorbed into the agar surface, only a small sample volume can be used.

7.3 Membrane filtration method

Using the membrane filtration method, a water sample is passed through a 0.45-µm filter, and the heterotrophic organisms are retained on the filter surface. The filter is then placed onto culture media and incubated as required (as stated above). This method also eliminates the possibility of heat shock, but, because the colonies form only within the confines of the filter used, it limits the size of the viewing surface. There is also the possibility of damage to cells by excessive filtration pressures. The method does, however, permit larger volumes of low-turbidity water to be examined.

8.0 Treatment technology

As mentioned previously, the heterotrophic flora includes all microorganisms that require nutrients from their surrounding environments for survival and growth. This includes most bacteria naturally present in waters as well as the majority of bacteria from other sources, including from faecal contamination.

Unlike *E. coli* and total coliforms, it is not feasible or necessary to reduce the level of heterotrophic organisms to zero in drinking water. However, water utilities should aim to minimize HPC levels by implementing appropriate and effective treatment, including. Overall, physical removal methods (including coagulation, flocculation, sedimentation, slow or rapid sand filtration, and direct filtration with or without filtration aid) can remove 90–99.9% (1–3 logs) of heterotrophic bacteria. Disinfection can achieve an additional 99–99.99% removal (2–4 logs), to

give a total removal of 99.999–99.99999% (5–7 logs) (Fox and Reasoner, 1999). With this level of removal, it is possible to achieve HPC bacteria concentrations of 10 CFU/mL or less in finished water (Fox and Reasoner, 1999). HPC levels can also be minimized in a distribution system by supplying water containing low levels of assimilable organic carbon and a disinfectant residual and exercising best practices to ensure proper distribution system maintenance.

9.0 Conclusions and recommendations

9.1 Potable water quality

HPC tests can be used as one of several methods available for monitoring overall water quality. They do not, however, indicate water safety and therefore do not indicate the possible presence of human pathogens. Boil water advisories should not be based solely on HPC measurements.

No guideline value has been established for HPC levels in drinking water, but effective treatment including disinfection can yield water with a concentration of HPC bacteria as low as 10 CFU/mL. Significant increases in HPC values above normal levels suggest changes in raw water quality, treatment, or disinfection, as well as regrowth or poor design and/or maintenance in the distribution system.

9.2 Relationship with pathogenic microorganisms

Some specific heterotrophic bacteria present in water have been shown to be opportunistic pathogens in immunocompromised individuals or through routes of exposure other than consumption. There is no evidence, either from epidemiological studies or from correlations with the occurrence of opportunistic pathogens, that HPC values alone directly relate to health risk (WHO, 2002). Consequently, the presence of HPC organisms in drinking water is not a health concern for the general public.

9.3 Considerations for the treatment of raw supplies

Since modern water treatment technologies can produce high-quality drinking water from even heavily contaminated sources, numerical limits for the microbiological quality of raw supplies are not proposed. Nevertheless, the microbiological quality of raw water should be considered when selecting sites for new treatment plants or before performing major upgrades to existing plants. Similarly, close monitoring of the raw water quality is required so that existing treatment processes can be adjusted accordingly. In addition, measures to protect raw supplies from contamination should be implemented where feasible.

When assessing the bacteriological safety of source water, the *E. coli* test is preferred, because it gives a good indication of faecal contamination. Total coliform bacteria and/or HPC levels are used as monitors of water quality during treatment and distribution.

Barring system-specific exemptions, all drinking water supplies should be disinfected to produce microbiologically safe water. In all public systems and semi-public systems applying disinfection, a disinfectant residual should be maintained throughout the distribution system at all times. Maintenance and monitoring of a residual disinfectant offer two benefits. First, a disinfectant residual will limit the growth of organisms within the system and may afford some protection against contamination from without; second, the disappearance of the residual provides an immediate indication of the entry of oxidizable matter into the system or of a malfunction of the treatment process. It is therefore recommended that a disinfectant residual be maintained and monitored daily throughout the entire system. It is recognized, however, that excessive levels of disinfectant may result in taste and odour problems. In these cases, the responsible authority may provide guidance as to the type and concentration of disinfectant residual to ensure that water remains microbiologically safe.

In addition to disinfection, all public supplies derived from surface water sources and groundwater under the direct influence of surface water should be treated in accordance with the guideline technical document for turbidity (Health Canada, 2003). Semi-public and private supplies using similar sources should include adequate filtration (or use technologies achieving equivalent quality) and disinfection. Drinking water taken from pristine surface water sources may be exempt from the filtration requirements (Health Canada, 2003).

It should not be inferred that these guidelines will guarantee the production of drinking water of adequate quality from every raw water source. For example, protection of the supply or partial treatment may be necessary to reduce turbidity even when the coliform counts are low. In addition, satisfaction of other water quality criteria may dictate the use of unit processes not mentioned in the above scheme.

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Appendix A: List of acronyms

CFU colony-forming unit
HPC heterotrophic plate count
MAC maximum acceptable concentration