

# Best Management Practices

## Chlorine Disinfection and Monitoring

Developed by



BCWWA

for



BRITISH  
COLUMBIA

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# Chlorine Disinfection and Monitoring

B.C.'s *Drinking Water Protection Act* requires all surface water sources intended for drinking to be disinfected.

## What is disinfection?

Disinfection can be broken down into two categories: primary disinfection and secondary disinfection. **Primary disinfection**, typically undertaken at a treatment facility, inactivates pathogens in source water. Common technologies for primary disinfection include chlorination, ultra-violet (UV) treatment, and ozonation. **Secondary disinfection**, which occurs throughout the distribution system, prevents bacterial regrowth and reduces the risk of accidental contamination. Common technologies include chlorination and chloramination.

Most water suppliers use chlorine for primary and secondary disinfection. As defined in the *National Guide to Sustainable Municipal Infrastructure*, **chlorination** is the process of adding chlorine to water to kill disease-causing organisms (e.g. bacteria, viruses) or to act as an oxidizing agent. Chlorine monitoring is a method of measuring free chlorine residual to ensure effective secondary disinfection in the distribution system. Monitoring can be manual and sporadic or automatic and continuous. In some jurisdictions, continuous monitoring is a requirement of their operating permits.

## Why should BMPs be applied to chlorine disinfection and monitoring?

As part of a multi-barrier approach, chlorine disinfection and monitoring provides many benefits. A chlorine disinfection and monitoring program that reflects BMPs:

- reduces risk to public health;
- increases protection of potable water supply;
- increases customer confidence;
- reduces liability;
- ensure compliance with regulatory requirements;
- demonstrates due diligence;
- provides a proven and simple technology;
- ensures reasonable capital and operation costs; and
- provides an easily detectable/monitorable indicator of water safety.

A chlorine disinfection and monitoring program that reflects BMPs also helps build consistency throughout the province.

## Information Links

[Chlorination Materials](#)  
(PDF file, 545 KB)

[Water Chlorination Principles](#)  
(PDF file, 842 KB)

[Chlorination Practices](#)  
(PDF file, 1.6 MB)

[Distribution System Chlorination](#)  
(PDF file, 459 KB)

[Chlorination Control](#)  
(PDF file, 738 KB)

[Chlorination: Safe Handling Practices](#)  
PDF file, 1.4 MB)

[Chlorination Equipment](#)  
(PDF file, 3.4 MB)

[Chlorination: Glossary of Terms](#)  
(PDF file, 616 KB)

[Best Practices for Utility-Based Data: National Guide to Sustainable Infrastructure](#)

## What BMPs should be applied to small water systems?

This BMP has been prepared for systems that have completed a disinfection feasibility study. For small systems (e.g. those servicing a trailer park or subdivision) that have not completed a study, the following are recommended steps.

1. Contact the Drinking Water Officer (DWO) to determine if primary and/or secondary disinfection are required.
2. Research successful chlorine disinfection and monitoring programs implemented by other small systems.
3. Gather background water quality information, flow or pump hour records, and water system as-built records.
4. Review the background information with your DWO to identify information gaps.
5. Complete a disinfection feasibility study in keeping with recommendations from your DWO (e.g. determine chlorine contact time).
  - Consider safety and handling in choosing specific method of chlorination.
6. Provide your water users with information about the disinfection study.
7. If chlorination is determined to be appropriate for your system, please proceed to the rest of this BMP.

### *If you need help...*

#### **Small Systems**

- **Coastal Water Suppliers Association**  
Pauline Berkman  
250-338-7796  
pauline@rid.bc.ca
- **Small Water Users Association**  
Denny Ross-Smith  
250-229-2262  
smallwaterusers@shaw.ca
- **Water Supply Association of BC**  
Bruce Wilson  
250-765-5218  
bruce@rutlandwaterworks.com

## What BMPs should be applied to larger water systems?

### **1. Build Program Framework**

- Identify objectives and targets
- Identify manpower requirements and resources
- Identify equipment needs
- Develop program framework (e.g. chlorination and monitoring approach) based on regulatory requirements
- Develop budget
- Set schedule
- Prepare business plan
- Evaluate and refine plan (ongoing)

### **2. Garner Support and Funding**

- Present business plan to senior staff and council or board (include regulatory requirements, liability considerations, recommended approach, and funding requirements)
- Provide frequent updates (ongoing)

### **3. Develop Capital Plan**

#### *Evaluate Information*

- Reevaluate information to determine if pretreatment is required

#### *Research/Select Equipment*

- Identify water quality objectives (e.g.

max/min residuals, locations, disinfection byproduct potential

- Identify operational objectives (simplicity, safety, frequency of attendance, automation, alarming)
- Assess facility characteristics/requirements
- Identify treatment equipment options:
  - o chlorination technology (e.g. gas, solution, generation)
  - o dosing point(s), contact time
  - o dosing control (e.g. automatic, manual)
- Identify monitoring equipment options:
  - o online monitor(s)
  - o handheld test kits
  - o alarming
- Compare equipment options (e.g. capital costs, operating costs, consumables, safety, simplicity, proven performance, “approvability”)
- Select equipment
- Prepare cost estimates
- Identify BMPs for operation and maintenance of chlorine equipment (e.g. repairs, recalibration, emergency response)
- Obtain approval from council/board and senior staff to proceed.

### ***Meet Design/Approval Requirements***

- Confirm system classification
- Identify specifications
- Prepare drawings
- Obtain construction permit from Health Authority

### ***Procure/Install/Commission Equipment***

- Procure equipment
  - construction tender
  - equipment supply contract
  - performance specification
- Construct/install equipment
- Commission equipment
- Conduct vendor training
- Conduct inspections

## **4. Develop Operations and Maintenance Plan**

- Develop and implement a plan to suit your specific needs
  - For chlorination equipment
    - ◆ daily
    - ◆ weekly
    - ◆ monthly
    - ◆ annual
    - ◆ renewal of consumables
    - ◆ ordering of consumables
    - ◆ scheduled maintenance
    - ◆ vendor documentation
  - For online monitors
    - ◆ calibration
    - ◆ renewal of consumables
    - ◆ ordering of consumables
    - ◆ vendor documentation
- Conduct staff training leading to certification
- Commence plan

## **5. Develop Monitoring Plan**

- Develop plan according to your selected approach
  - Dosing/injection monitoring
    - ◆ online monitoring
    - ◆ dosage/consumption monitoring
    - ◆ record keeping
    - ◆ notification of variances
      1. who/how
      2. response protocol
  - First customer monitoring
    - ◆ frequency
    - ◆ parameters
    - ◆ record keeping
    - ◆ notification of variances
      1. who/how
      2. response protocol

## ***Recommended Reading...***

**\*All manuals published by the Pacific Northwest Section of the AWWA are available from the BCWWA at 604-433-4389 or [www.bcwwa.org](http://www.bcwwa.org)**

### ***Water Chlorination Principles and Practices, AWWA M20***

Pacific Northwest Section, AWWA  
(503-246-5845) [www.pnws-awwa.org](http://www.pnws-awwa.org)

### ***AWWA Standard for Hypochlorites: AWWA B300-64 (1964)***

American Water Works Association  
(303-794-7711) [www.awwa.org](http://www.awwa.org)

### ***AWWA Standard for Deep Wells: AWWA A100-66 (1966)***

American Water Works Association  
(303-794-7711) [www.awwa.org](http://www.awwa.org)

### ***Chlorine Manual (4<sup>th</sup> ed., 1969)***

Chlorine Institute  
(703-741-5670) [www.cl2.com](http://www.cl2.com)

### ***Proceedings of the National Specialty Conference on Disinfection***

American Society of Civil Engineers (1970)

### ***Standard Methods for the Examination of Water and Wastewater***

AWWA, APHA, & WPCF. New York (1971)  
American Water Works Association  
(303-794-7711) [www.awwa.org](http://www.awwa.org)

### ***Water Quality and Treatment***

AWWA. McGraw-Hill, New York (1971)

### ***Water Treatment Plan Design***

AWWA, ASCE & CSSE, New York (1972)  
American Water Works Association  
(303-794-7711) [www.awwa.org](http://www.awwa.org)

### ***Handbook of Chlorination by G.C. White***

Van Nostrand Reinhold, New York (1972)

### ***Hypochlorites: Materials and Handling***

Laubusch, *Water and Sewage Works*, 107:6  
(June 1960)

### ***Distribution Systems Operation and Management***

AWWA Standard  
(303-794-7711) [www.awwa.org](http://www.awwa.org)

- o Distribution system monitoring
  - ◆ locations
  - ◆ frequency
  - ◆ parameters
  - ◆ record keeping
  - ◆ notification of variances
    1. who/how
    2. response protocol
- Conduct staff training
- Commence plan

## 6. Create Communication Plan and Materials

- Identify internal and external audiences' specific communication needs
- Prepare a written plan, including emergency response procedures
- Educate all appropriate staff about chlorine disinfection and monitoring including specialized training for handling chlorine gas
- Access/prepare information and education materials for external audiences, if appropriate
- Educate external audiences, if appropriate
- Evaluate and refine plan (ongoing)

## 7. Conduct Reporting

- Provide monthly residual summaries to council, senior staff, and DWO, as requested
- Provide yearly residual summaries to council, senior staff, health authority, and customers
- Plan to address related concerns (e.g. THMs)
- Notify your DWO when distribution chlorine residuals do not meet minimums

## *If you need help...*

### Large Systems

- **Dipak Dattani**  
City of Burnaby  
604-294-7390  
dipak.dattani@city.burnaby.bc.ca
- **Judi Ekkert**  
Fraser Health  
604-702-4950  
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- **Robin Gear**  
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- **Don Miller**  
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604-572-2600  
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- **Toby Pike**  
South East Kelowna Irrigation District  
250-861-4200  
toby.pike@shawbiz.ca
- **Dave Swanson**  
City of Vancouver  
604-326-4801  
dave\_swanson@city.vancouver.bc.ca
- **Adrian Weaden**  
City of Kelowna  
250-862-5510 (244)  
aweaden@city.kelowna.bc.ca
- **Michael Wu**  
Northern Health  
250-286-5748  
Michael.wu@northernhealth.ca

# Online Chlorine Analyzers

There are two ways to continuously monitor chlorine residuals in your drinking water system.

## 1. Amperometric titration/polarographic membrane sensor method

The polarographic membrane sensor consists of a pair of electrodes immersed in a conductive electrolyte and isolated from the sample by a chlorine-permeable membrane. Chlorine migrates through the membrane and is reduced to chloride on the surface of the working electrode. This process causes electrons to flow through an external measuring circuit, with the current flow being linearly proportional to chlorine concentration. This method requires a constant flow across the membrane and gives a continuous reading for the chlorine. Analyzing range is 0-2 mg/l.

Installation will require about three feet of wall space, 120 VAC, a water supply, and a drain. This type of unit will consist of an electronic monitor, chlorine sensor, and a flow cell. The flow cell has an overflow built into it so a constant pressure on the membrane can be maintained. A flow of about seven gallons/hour will be required. This unit will have a 4-20 mA output that may be connected to a SCADA system or a local chart recorder. Alarms can be set on this unit as well.

Before the unit can be put in service, electrolyte and a membrane must be added to the chlorine sensor. It must be zeroed. This is accomplished by placing the chlorine sensor in water that has no chlorine in it. The unit should be left over night to allow for zeroing. Once the unit has zeroed it can be placed into the flow cell. On initial setup after the unit has run for about 24 hours, it may require some fine adjustments for final setup.

Over time, the analyzer can start to drift on the chlorine readings. The analyzer should be checked

weekly with a grab sample. The membrane and electrolyte should be changed every four to six months depending upon your water conditions. Every time the electrolyte and membrane are changed the unit will need to be zeroed again.

## 2. Colorimetric monitoring method

The DPD colorimetric method requires a continuous flow of water through the flow cell. Every 2.5 minutes a sample is retained in the flow cell to measure blank absorbance (colour intensity) before reagents are added. This compensates for turbidity in the sample and provides an automatic zero reference point. Reagents are then added to the flow cell and a magnetic stirring motor mixes the sample. After colour development the colour intensity is measured and compared to the reference. The difference between the two readings is used to calculate the chlorine concentration. Analyzing range is 0-5mg/l.

This unit also requires about three feet of wall space, 120 VAC, water supply and drain. The analyzer will need to be assembled according to instructions.

Once the unit is assembled and installed the buffer and reagent will need to be installed following instructions in the manual. The system will prime itself and be ready for service. High and low chlorine alarms may be set as well. These alarms can be used to take pumps off line, if there is a problem with the chlorination equipment. A 4-20 mA is available for SCADA or chart recorder outputs.

Depending on water conditions, the flow cell will need to be cleaned weekly. The buffer and reagent must be replaced once a month. The tubing will need to be changed annually.