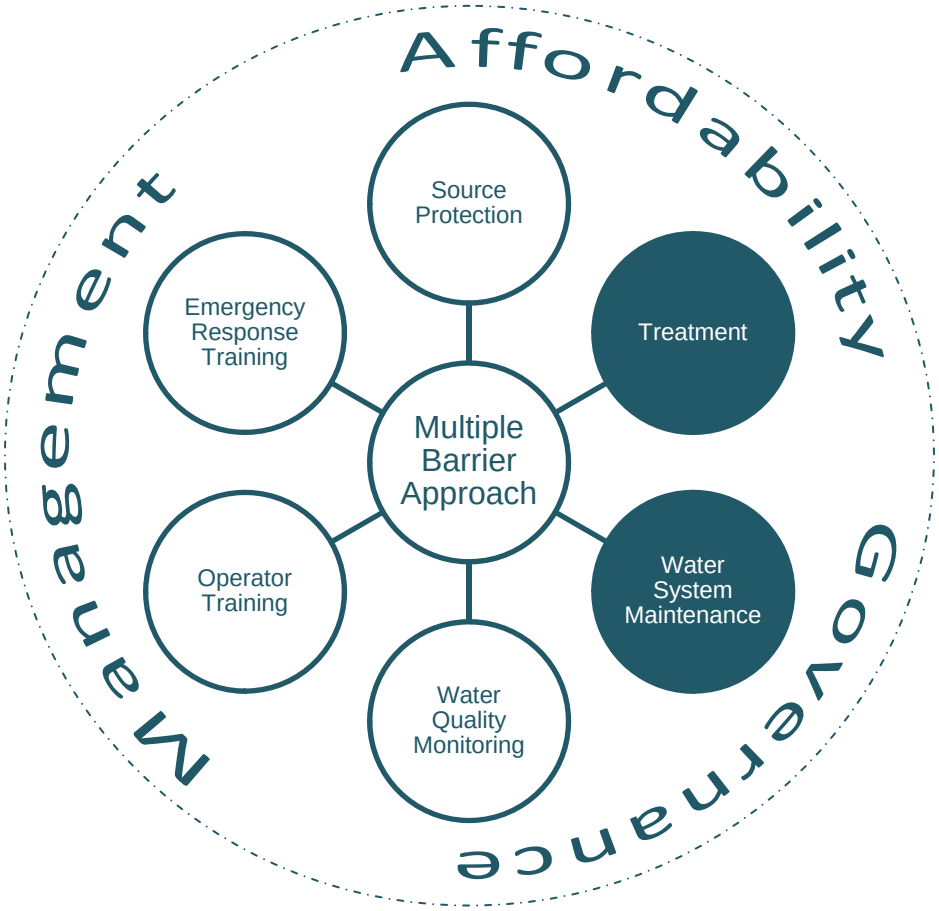
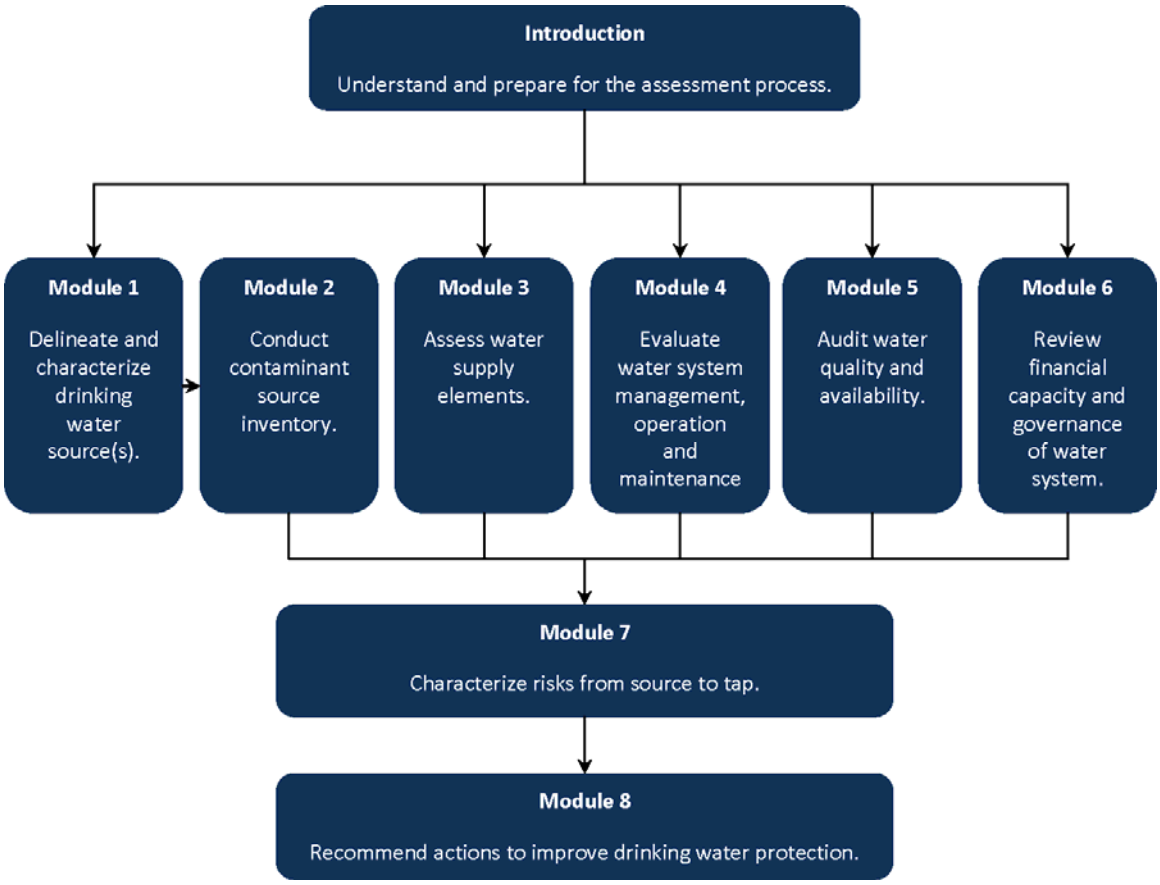
COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

MODULE 3
ASSESS WATER SUPPLY ELEMENTS



2010
Ministry of Healthy Living and Sport

Comprehensive Drinking Water Source-to-Tap Assessment Guideline Process



Here are the steps in the source-to-tap assessment process, through the Introduction and eight modules. Note that the Introduction should be read prior to undertaking any assessment.

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1. INTRODUCTION

In this module (Module 3) of the drinking water source-to-tap assessment, all the physical and operational components of the water system are assessed from source to tap for their condition, security and suitability for the water supply. This portion of the assessment addresses the physical characteristics of the water system, whereas Module 4 considers management, operation and maintenance issues.

Physical and operational components of a water system are called supply elements. Supply elements act together to determine the quantity and quality of the water received by the consumer (New Zealand Ministry of Health, 2002). Supply elements include components of the following broad categories (including backup components and electronic monitoring systems):

- Source.
- Intake/well.
- Treatment.
- Storage (raw and treated).
- Pumping facilities.
- Distribution system.
- Power source.

Supply elements include:

- Backup systems and components.
- Electronic monitoring equipment (for performance measurement and security monitoring).

Water sources are addressed in Modules 1 and 2. The remaining supply elements are assessed in Module 3 identifying the potential for degradation of water quality associated with the treatment, storage and conveyance systems. Each water supply system is unique, incorporating its own combination of supply elements based on a number of factors, including source water type, water quality and quantity, size of population served, and age of the system. The assessment methods presented here are generalized for application to a wide range of water system sizes and types. Not all supply elements discussed will be present in every water system.

This module requires an onsite inspection of the water system with operations and management staff available to provide information and documentation as needed. It is highly recommended that knowledgeable water system personnel accompany the assessor(s) throughout the onsite inspection. Reviewing past water system inspection reports, maintenance records, as-built drawings, or other documentation can also assist in identifying previous problems or concerns.

1.1. Hazard and Vulnerability Identification

Throughout the process of evaluating water supply elements in the source-to-tap system, assessors identify and describe hazards that pose a threat to drinking water safety or sustainability, and vulnerabilities in the multiple barrier (multibarrier) system or other protective systems (e.g., security).

Hazards are recorded in the Hazard Identification Table (see Table 3-3) used to document hazards in a consistent way throughout the source-to-tap assessment process. Information on strengths and vulnerabilities in the drinking water supply system identified throughout the assessment is recorded, compiled from each module, and used to inform the multiple barrier system evaluation in Module 7.

1.2. Module 3 Assessment Team

A broad range of issues can exist in a water supply system from source to tap. As a result, comprehensive drinking water assessments require a multidisciplinary assessment team rather than a single assessor. Each module of the Comprehensive Drinking Water Source-to-Tap Assessment Guideline requires some specialized skills and a unique spectrum of knowledge related to water sources and systems.

Collectively, the assessment team for Module 3 should have knowledge and experience related to:

- Operation of drinking water collection, treatment, storage and distribution systems.
- Mechanical and electrical works.
- Assessing the appropriateness or "fitness for purpose" of equipment and procedures.
- Identifying cross-connections in the distribution system and cross-connection control programs.
- Influence of drinking water supply elements on water chemistry and microbiology.
- Public health issues related to drinking water.
- Legislation relating to drinking water, surface water and groundwater.
- Risk assessment and risk management.

2. ASSESSMENT COMPONENTS

2.1. Inventory Water Supply Elements

The first step in the assessment is to inventory the water system supply elements. Create a schematic diagram of the water system components by consulting water supply system drawings and through interviews with personnel (see Figure 3-1 for an example). Begin the assessment process by physically walking through and visually inspecting the supply elements, verifying and amending the schematic diagram when necessary.

Research the history of the water supply system infrastructure, when it was originally constructed, upgrades and other relevant information. Provide a brief history of the water system infrastructure including construction dates and major upgrades.

2.2. Describe and Evaluate the Condition, Suitability and Security of the Water Supply System from Source to Tap

Once all the supply elements have been identified, describe each element generally, with assessments of condition, suitability, adequacy, security and any other observations (see Table 3-1). Take photographs of notable observations to include in the report. If there are multiple intakes, treatment systems, storage structures or distribution pressure zones, each should be addressed separately. Similarly, all backup systems and components require the same level of scrutiny as their primary counterparts. Electronic monitoring equipment used for performance measurement or security monitoring should be assessed along with its associated water system components.

A useful approach to this step is to work through the water supply system from intake to the tap identifying all activities, processes or conditions that may influence water quality or volume. Review past water system inspection reports, maintenance records, as-built drawings or other documentation to assist in the evaluation process. Through the inventory and assessment process of the water system, professional judgment will be required to identify and record existing or potential drinking water hazards focusing on those with the greatest implications for public health.

Table 3-1. Assessment Elements for Describing Water Supply Elements

Water Supply Element	Description
All	• Type/design—approved by Public Health Engineer? • Size • Structural materials • Capacity • Other descriptive information • Backup components

Intake or Well	• Wells:
	  • Driller's well log
	  • Construction method
	  • Completed depth
	  • Casing diameter
	  • Pumping information
	  • Specific capacity

Treatment	• Process
	• Pathogen log inactivation
	• CT
	  o Disinfectant residual concentration at first customer
	  o Disinfectant contact time

Storage	• Retention times • Can reservoir be isolated from system for maintenance or in case of contamination? • Are overflow lines, vents, drain lines or cleanout pipes turned downward and screened?
Pumping Facilities	• Pump hours • Flows • Pressure
Distribution System	• Cross-connections • Location of dead ends, means of flushing • Horizontal separation from sewer mains • Fire protection features[1] • Frost protection
Power	• Automatic start-up?

[1] Fire protection standards are outlined in the most current version of the Fire Underwriters Survey publication entitled *Water Supply for Public Fire Protection* available from the Insurance Advisory Organization (604) 681-3113.

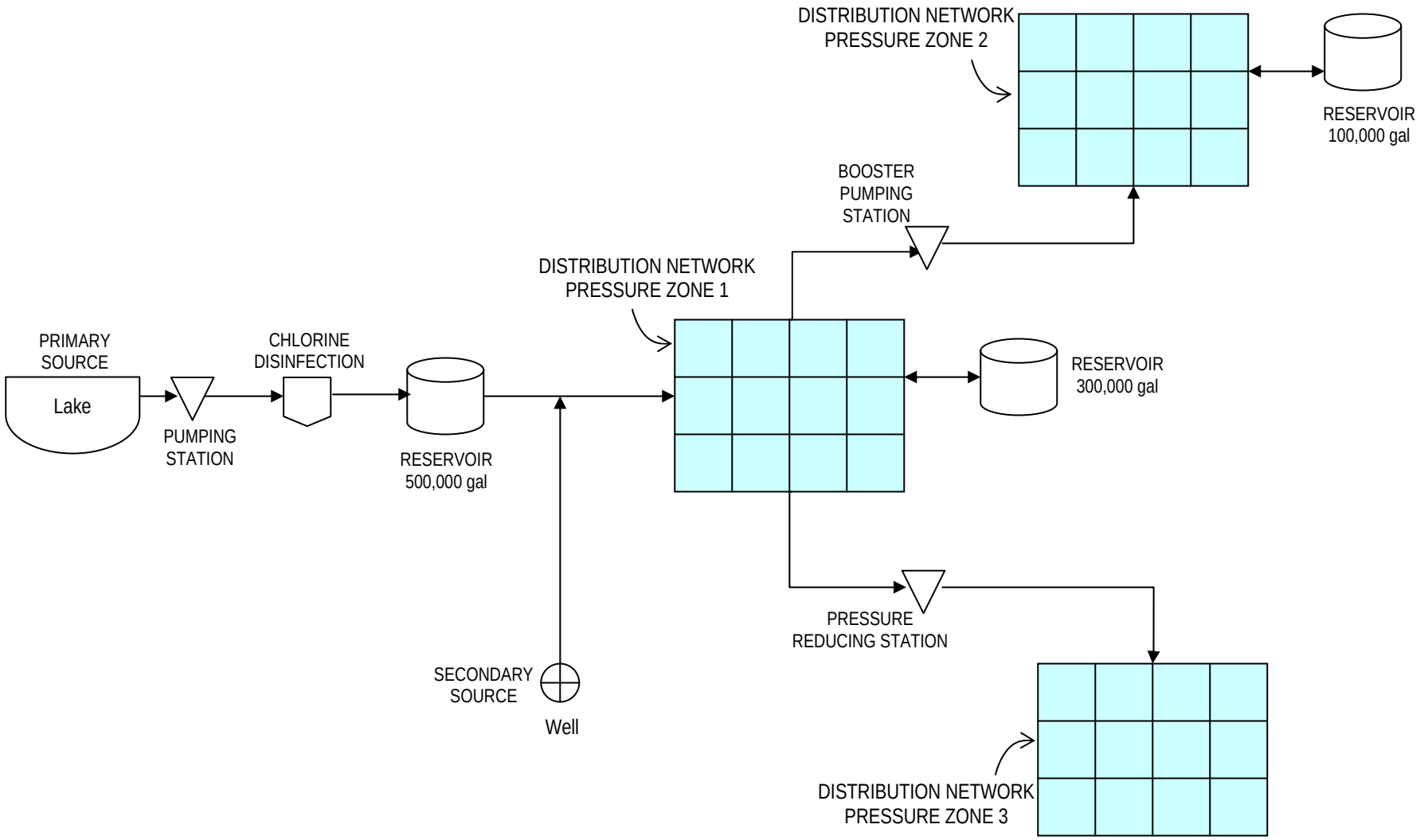

Figure 3-1. Example of Water Supply System Schematic Diagram

2.2.1. Description

Describe water system components with details such as type, size, structural materials, process(es), capacity and any other relevant descriptive information (see Table 3-1).

When assessing water distribution, it is important to identify where distribution lines are serving connections previously supplied by individual wells. These wells could pose a cross-connection hazard if they have not been properly disconnected. Likewise, where a water supply system has separate water distribution systems for domestic and irrigation purposes, potential cross-connections between the two systems need to be identified and assessed.

In addition to describing the disinfection and treatment processes applied, determine log inactivation for pathogens, both for individual treatment components and collectively where multiple methods are used. Conduct an analysis of disinfectant contact time before the first customer and residual concentrations within the water system.

Through the process of inventory and description of water supply elements, record the existence of and assess redundant or backup systems for all components affecting health, including stand-by emergency power.

2.2.2. Condition

The assessment of the condition or state of the supply elements in a water system is done during the onsite inspection. It addresses age (including consideration for upgrades), structural integrity, apparent maintenance condition, reliability, cleanliness and overall appearance.

Visual inspections of every part of a water system will not be possible, especially the distribution system, and alternative methods of determining condition should be used where needed. For example, indicators can be used to evaluate the condition of the distribution system (see Box 3-1). These indicators can be evaluated interviews with staff or by reviewing system monitoring results. In the course of assessing the condition of parts of the water system, identify any need for repairs or upgrades.

Box 3-1. Indicators of Water System Deterioration (InfraGuide: *Deterioration and Inspection of Water Distribution Systems*, 2003)

- Impaired water quality, due to:
  - Internal corrosion of unlined metallic components
  - Poor maintenance practices
- Reduced hydraulic capacity, due to internal corrosion and tuberculation of unlined metallic components
- High leakage rate, due to:
  - Corrosion
  - Deteriorating joints
- Frequent breaks, due to:
  - Corrosion
  - Material degradation
  - Poor installation practices
  - Manufacturing defects
  - Operating conditions

2.2.3. Suitability

Assessing the suitability of water supply elements is subjective and requires the use of professional engineering expertise and judgement. Suitability refers to the appropriateness of the type, design, size, materials and adequacy of the component in the context of the water system. Factors to consider when assessing suitability of water supply elements are presented in Table 3-2.

Table 3-2. Assessment Elements for Evaluating Suitability of Water Supply Elements

Water Supply Element	Suitability
All	• Suitability of type, size, materials or use of component in the context of the other aspects of the water system. o Is the component designed/constructed correctly to promote the water system's ability to protect water quality? • Is the component compatible with water quality (e.g., turbidity, pH, alkalinity and temperature)? • Is the component adequate for its intended use? o Is the component sized correctly for the water demand? o Do fluctuations in demand have the potential to have an impact on the function of the component? • Are standards for sizing, materials, layout and siting met? • Interaction with water and other water system components. • Can backup systems be relied on for an adequate supply of safe drinking water in unplanned events and emergencies? • Are there system parts/components absent that could improve water quality or the function of the other components in the system (e.g., addition of a chlorine booster station to maintain adequate disinfectant residual in the distribution system)?
Intake or Well	• Protection from elements: o Wave action. o Boats/anchors. o Sediments.
Treatment	• Does source water quality hamper the effectiveness of the treatment process (e.g., use of ultraviolet (UV) disinfection without prefiltration when the source water has high turbidity)? • Is treatment effective against the primary contaminants of concern?
Storage	• Is storage capacity adequate to meet system needs? (see CCME, 2004, p.131 for an empirical formula)
Pumping Facilities	• Ability to manage the full range of anticipated flows. • Appropriate number and locations.

2.2.4. Security

Adequate security measures to restrict access are necessary for all water systems to avoid fecal contamination from humans, canines and wildlife; malicious or accidental contamination; and vandalism. Concerns over acts of terrorism or vandalism can be addressed through a water system security program. Assess the level of security in each water system component taking into consideration:

- Level of security considered appropriate considering the probability that an unplanned event would occur.
- Ease of unintended/unauthorized access to water system components.
- Existence of protective easements, rights-of-way or other tenures for water supply elements.
- Use and types of locks, gates, fences and lighting.
- Use of alarms, video surveillance and/or periodic security checks.

3. ASSESSMENT DOCUMENTATION AND REPORTING

3.1. Assessment Report

The assessment report for Module 3 should include the following elements at a minimum:

- **Description of the water supply system**, its components, processes, number of connections, and history—including its age and dates of component upgrades.
- **Schematic diagram of water supply system** and its elements.
- **Descriptions of all supply elements** including condition, suitability, security and any other comments or observations. Where possible, drawings and photographs to corroborate observations.
- **Supporting documentation** such as well logs, equipment specifications, or drawings should be referenced or included in an appendix to the report.
- **Completed hazard identification table for Module 3** (see Table 3-2 for an example).

3.2. Hazard Identification Table

Drinking water hazards identified in Module 3 should be entered into the Hazard Identification Table as shown in Table 3-3.

Table 3-3. Sample Module 3 Hazard Identification Table

Hazard No.	Drinking Water Hazard	Possible Effects	Existing Preventative Measures	Associated Barrier
3-1	Aging distribution pipes	Deterioration can lead to increased leaks, breakages, and corrosion, possibly impairing water quality following treatment.	None identified	System maintenance
3-2	No backup treatment system	If the primary treatment system fails, no backup is in place and consumers will be supplied with raw water without treatment.	None identified	Treatment
3-3	Security at reservoir inadequate	The exterior of the reservoir has been vandalized in the past and continues to be vulnerable. The lock on the hatch could be easily broken.	A locked hatch prevents access to reservoir	System maintenance

APPENDIX 3A:
MODULE 3 ASSESSMENT AT A GLANCE

Components	Recommended Methods	Scope	Documentation and Reporting
1. Inventory water supply elements.	• Review existing plans and drawings. • Interview water supplier and staff. • Do a physical walk through with the water supplier to verify and amend the schematic drawing.	• Intake(s)/well(s) • Treatment • Storage (raw and treated) • Pumping facilities • Distribution system • Power source • Electronic monitoring equipment (performance measurement and security monitoring) • Backup systems and components	• Schematic diagram of the source-to-tap system • Description of water system as a whole: o Components that make up the system o Processes o Number and type of connections • Water system history: o Age o Dates of component upgrades
2. Describe and evaluate the condition, suitability and security of the water supply system from source to tap.	• Inspect each applicable water system component (see Scope), then evaluate and describe as indicated in Section 2.2. • Review past water system inspection reports, maintenance records, as-built drawings or other documentation to assist in the evaluation process.	• Intake(s)/well(s) • Treatment • Storage (raw and treated) • Pumping facilities • Distribution system • Power source • Electronic monitoring equipment (performance measurement and security monitoring) • Backup systems and components	• Description and evaluation of the condition, suitability and security of each water supply element • Supporting documents. • Identification of hazards (including cross-connections) and vulnerabilities in the Hazard Identification Table

APPENDIX 3B: RECOMMENDED RESOURCES

Water Supply System Assessment

Canadian Council of Ministers of the Environment (CCME). 2004. *From source to tap: Guidance on the multi-barrier approach to safe drinking water*. Produced jointly by the Federal-Provincial-Territorial Committee on Drinking Water and the CCME Water Quality Task Group. http://www.ccme.ca/sourcetotap/mba.html.

Hellier, K. 2000. *Hazard Analysis and Critical Control Points for Water Supplies*. Paper presented to the 63rd Annual Water Industry Engineers and Operators' Conference, Brauer College—Warrnambool, September 6-7, 2000. http://www.wioa.org.au/conference_papers/2000/pdf/paper13.pdf

New Zealand Ministry of Health. 2002. *Public Health Risk Management*. Wellington: Ministry of Health. http://www.moh.govt.nz/moh.nsf/ea6005dc347e7bd44c2566a40079ae6f/9c57904f727879eacc256bb100143184/$FILE/publichealthriskmanagementversion4.pdf

New Zealand Ministry of Health. 2005. *A Framework on How to Prepare and Develop Public Health Risk Management Plans for Drinking-water Supplies*. Wellington: Ministry of Health. http://www.moh.govt.nz/moh.nsf/0/CCA65C18B2E29251CC256A7900082B9C/$File/aframeworkfordevelopingaphrmp.pdf

National Guide to Sustainable Municipal Infrastructure (InfraGuide). 2003. *Deterioration and Inspection of Water Distribution System.* http://gmf.fcm.ca/files/Infraguide/Potable_Water/Deterior_Inspect_water_distrib_syst.pdf

US Environmental Protection Agency. 1999. *Guidance Manual for Conducting Sanitary Surveys of Public Water Systems; Surface Water and Ground Water Under the Direct Influence (GWUDI)*. http://www.epa.gov/safewater/mdbp/pdf/sansurv/sansurv.pdf.

Water System Security

US Environmental Protection Agency. 2002*. Security Vulnerability Self-Assessment for Small Drinking Water Systems*. http://www.erwow.org/documents/VulnerabilityssessmentMediumSystemsNew.pdf.

Cross-Connections

US Environmental Protection Agency. 2003. *Cross-Connection Control Manual*. http://www.epa.gov/safewater/crossconnectioncontrol/pdfs/crossconnection.pdf.