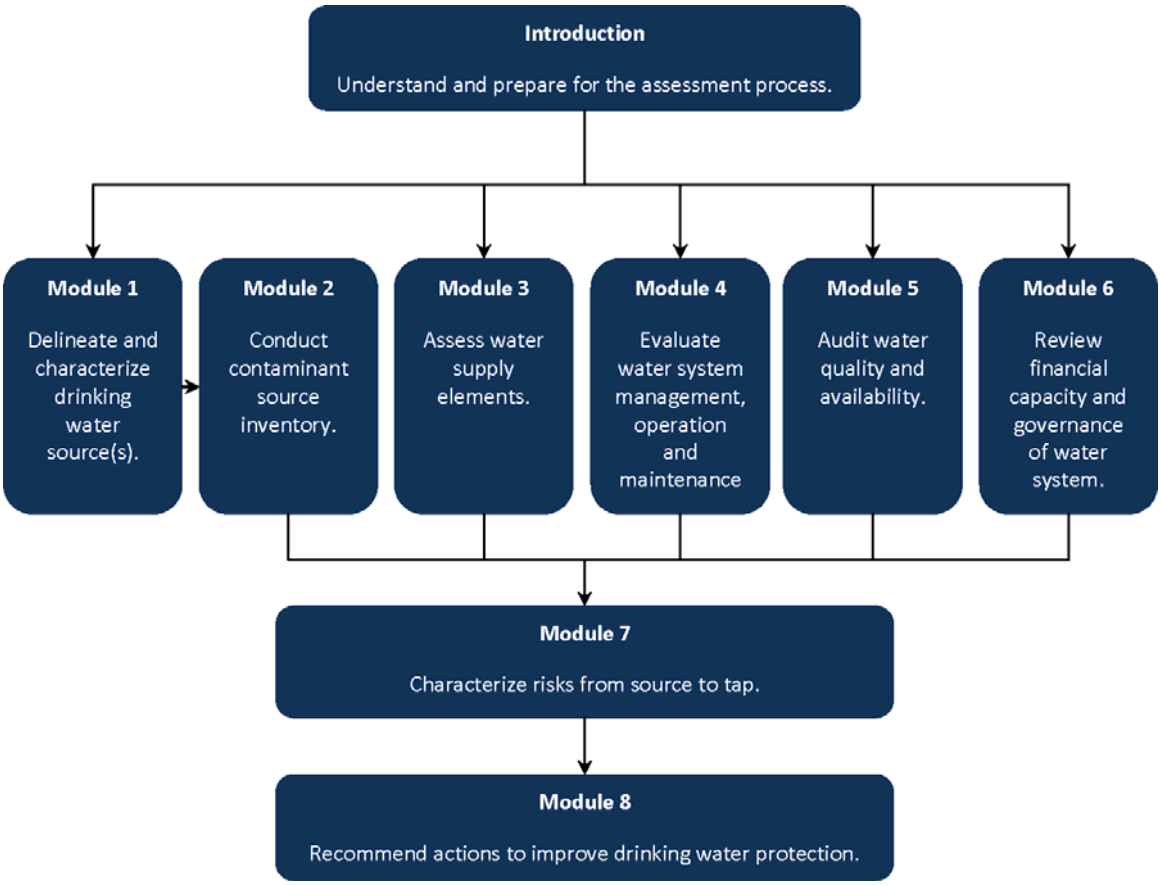
COMPREHENSIVE DRINKING WATER SOURCE-TO-TAP ASSESSMENT GUIDELINE

MODULE 4
EVALUATE WATER SYSTEM MANAGEMENT, OPERATION AND MAINTENANCE PRACTICES

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, the assessment focuses on how the water system functions to provide safe drinking water from a management, operations and maintenance perspective. Module 3 considers the physical aspects of the water supply system and Module 4 provides a systematic approach for investigating the human aspect of how the water system is run to adequately safeguard drinking water quality.

Issues addressed include water supply system management; operation and maintenance practices; operator training; backflow prevention and cross-connection control; documentation and reporting; and emergency response planning. Evaluation procedures used in this portion of the assessment include interviews with management, operations and maintenance staff; review of relevant documentation; and onsite inspection.

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 4-1), which is 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 that have been 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 4 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 about water sources and systems. Efficiencies may be gained by including the individuals involved in the screening tool in the Module 4 assessment team, although this may not be desirable if they need to be interviewed as a part of the assessment.

Collectively, the assessment team for Module 4 should have knowledge and experience related to:

- Assessing the effectiveness of drinking water management practice.
- Operation of drinking water collection, treatment, storage, and distribution systems.
- Mechanical and electrical works.
- Operator training and certification requirements.
- Identifying cross-connections in the distribution system and cross-connection control programs.

- Drinking water chemistry.
- Microbiology and microbes commonly found in drinking water.
- 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. Evaluate Water Supply System Management Standards and Practices

Management refers to the decision-making structure and processes used in a water supply system for setting standards and policies; complying with regulatory requirements; staffing and training; and financial planning and administration. Management is a major factor affecting a water supply system's performance. It influences all aspects of the system. The objective of this portion of the assessment is to determine the extent to which management practices contribute to the successful delivery of safe drinking water.

As an initial step, evaluate the management practices and standards for the water system through interviews with key staff, and a review of available policies and procedure manuals. It is important to interview all key players in the management of the water utility, including the water supplier or utility operator. Suggested interview questions to evaluate management practices include (but are not limited to):

Structure and Processes

- Is there a clear plan of organization and control among people responsible for the management and operation of the system?
- Are the functions of operations and management divisions clearly assigned?
- Lines of communication between operators and water system decision makers need to be clear and well used for effective water system functioning, and for budgeting purposes. This is to provide a realistic estimate of operating costs, an accurate inventory of assets, and anticipated capital costs, as well as to allocate funds appropriately (CCME, 2004). Is there a reporting relationship between the water operator and management? Is communication between field operators, supervisors and budget controllers effective?

Standards and Policies

- Where applicable, are best practices embedded in management practices (e.g., asset renewal and replacement, cross-connection control, distribution system monitoring)?
- Are there clear rules and standards for:
  - System modifications.
  - New hook-ups.

  - Main extensions.
  - Customer service.
- Is the water supply system assessed regularly? What type of assessment process is applied?
- Are water system personnel aware of the security risks associated with water system works? Is management proactive and supportive of security-enhancing expenditures?
- Are policies in place that address customer rights and responsibilities?

Compliance with Regulatory Requirements

- Does the water supplier have a system in place to stay abreast of the latest regulatory requirements? Is the water supplier aware of other complementary legislation that may be in place to regulate their water systems — for example, municipal bylaws on cross-connection control, and building and land development.
- Are all water licences and operating permits current?
- How effective is the relationship between the water supplier and local health authority?

Staffing and Training

Under Section 9 of the *Drinking Water Protection Act*, all drinking water system operators are required to be certified to the appropriate level, based on the water system classification by the Environmental Operators Certification Program (EOCP). Operator certification levels are based on the water system class. More information on EOCP can be found at: http://www.eocp.org/docs/guide.pdf.

- Does the water supplier have a staffing plan to compensate for planned and unplanned operator absences and staff changes?
- Are operators certified to an appropriate level, based on the water supply system classification?
- Is the level of training appropriate for each operator's actual role in the water supply system?
- What is the plan to have operators certified who are not meeting requirements?
- Are management and operators committed to ongoing training, continuing education and learning to determine if the system is keeping up with new and changing technologies and regulatory requirements? Training options include courses, workshops, seminars and conferences.

Financial Planning and Administration

- Does the water supply have a renewal and replacement plan in place?
- Does the water supply have a funding plan for training and certification?
- Does the water supply have funding plan for operating costs?

Identify key best management practices that contribute to a safe and sustainable water supply, and weaknesses that counteract that goal. This should be based on an analysis of the water system management structure and processes; standards and policies; compliance

with regulatory requirements; staffing and training; and financial planning and administration.

2.2. Evaluate Water Supply System Operation and Maintenance Procedures and Practices

Operation and maintenance encompass the procedures and practices applied in running the water supply system. These include inspection, monitoring, testing, calibrating, maintaining and repairing water supply elements — such as backup components and backflow prevention, and cross-connection control features.

This portion of the assessment is a structured method for evaluating the operation and maintenance of the water supply system by:

- Comparing current practices with the requirements set out in the operating permit.
- Reviewing the adequacy of operating standards and procedures; testing, inspection, and maintenance schedules; and system monitoring processes.
- Evaluating the backflow prevention and cross-connection control program.

2.2.1. Compare Current Practices with the Requirements Set Out in the Operating Permit

Operation and maintenance practices should first be evaluated against the operating permit, which authorizes a water system to operate. The permit also specifies performance standards for the treatment system, operator requirements, and monitoring and reporting protocols. Evaluate whether the water supplier is meeting the requirements set out in the operating permit. If no permit exists for the water supply system, identify this as an issue in the assessment report. Also, evaluate the system against the requirements of the *Drinking Water Protection Act,* Drinking Water Protection Regulation and *Water Act*.

2.2.2. Review the Adequacy of Operation and Maintenance Standards, Procedures and Practices

Water supply system operation and maintenance standards, procedures and actual practices have a tremendous influence on the quality of water between the intake and the tap. Evaluate operation and maintenance practices considering the following criteria (including any others relevant to the water supply system being assessed):

- Frequency and seasonal timing.
- Adequacy of processes for the unique needs of the water supply system.
- Planning.
- Communications within the organization and with customers.

Information on operation and maintenance can be obtained by interviewing water operators and reviewing relevant documentation. Some suggested interview questions are:

Operating Standards and Procedures

- What are the regular operations/maintenance activities for the water system?
- Are operation and maintenance manuals, standard operating procedures, and standard maintenance procedures available to operators for the water supply system?
- Are positive water pressures maintained at all times?
- Are treatment chemicals stored and handled safely?
- Are sanitary wastes and filter backwash disposed of according to Material Safety Data Sheets?
- Is a tamper policy in place (who can work on and access the water system) to ensure that standards are met and to reduce the risk of cross-contamination?

Testing, Inspection and Maintenance Schedules

- Is a there a system in place for scheduling routine preventative maintenance, including (but not limited to):
  - Distribution system flushing/swabbing/pigging?
  - Reservoir management: aeration, artificial circulation, precipitation, sediment control, flushing and recycling?
  - Sanitation/maintenance of equipment/structures?
  - Structural repair/replacement/inspection?
  - Testing and maintaining: fire hydrants, pumps, meters, pressure regulating valves, shutoff valves, altitude valves, blowoffs and other components?
- Do water system maps show valve locations accurately?
- Are regular inspections performed?
- How is the need for repairs identified? How are the repairs subsequently carried out?
- Is equipment calibrated according to manufacturers" instructions?
- Is there an adequate supply of essential spare parts and backup components
- Are backup equipment and controls tested? How often and under what conditions?
- Is backup power tested and operated regularly, both with and without load?
- Leaks in water distribution pipes can impair water quality due to cross-contamination and result in increase costs due to loss of water and property damage. A leak detection program can minimize risks to public health and property, and reduce costs if leaks are detected early. Is a leak detection program in place?
- Of the water supplied, what proportion is lost?

System Monitoring Processes

- Are water supply system processes and components monitored adequately?
- Are source water levels regularly monitored?
- Is pressure testing undertaken in the distribution system?
- Are automated supervisory control and data acquisition (SCADA) systems installed, operated, calibrated and maintained according to the manufacturers' instructions?

- Are trained operators available to respond to SCADA alarms, perform regular checks and calibrations on sensing equipment, and restore proper function to the system in the event of a power failure?

2.2.3. Evaluate the Backflow Prevention/Cross-Connection Control Program

Cross-connections within a water distribution system are a key public health hazard that could result in backflow where nonpotable water or contaminants flow back into the potable water conveyance system. Backflow results either from a pressure reduction in the water distribution pipes (back-siphonage) or from excess pressure in a consumer's pipes that forces water to flow against its intended direction (backpressure)(CCME, 2004). Backflow prevention devices can be installed to stop the flow of water from a connection back into the distribution system.

To minimize the risk they pose, cross-connections and their controls require management and maintenance. Additionally, water system staff and consumers need to be educated about cross-connections.

In the assessment, identify whether a cross-connection control bylaw is in place or planned. Does the water supply system have an adequate cross-connection control program in place, considering its size and type of possible cross-connections? A comprehensive inventory of backflow prevention devices in the distribution system is the foundation of a successful cross-connection control program. Verify the locations and status of backflow preventers in the system.

Some water systems have policies requiring backflow prevention devices only on connections of highest risk, such as industrial operations, whereas others require all connections to have these devices. Backflow prevention devices should be appropriate to the particular hydraulic conditions and degree of risk (CCME, 2004).

As a part of the program, backflow prevention devices should be inspected, tested and maintained on a regular basis by a trained person. Are checks and balances in place to ensure the program is effective?

Consumer education is another critical aspect of reducing risk from cross-connections. Industrial customers need to be informed about backflow and its causes, and the importance of installing backflow prevention devices. Even individual households can create cross-connections from hoses attached to taps and left in swimming pools, laundry sinks or other nonpotable sources of water, or through direct connections to other water sources such as a well on the property.

Most people are not aware of the risks to drinking water that these situations pose. Water suppliers should be educating their customers. Determine if a cross-connection education program is in place for the water system, either through bill inserts, media campaigns or other methods. Throughout the evaluation process, identify where there are shortfalls in the backflow prevention and cross-connection control program.

2.3. Evaluate Documentation and Reporting Practices

Documentation and reporting are critical aspects of the proper management and operation of a water system. Water system documentation includes records of activities; operational procedures; process control; preventative strategies; monitoring; maintenance; and corrective actions (see Box 4-1). An established documentation and reporting system is important for (NHMRC/ARMCANZ, 2001):

- Demonstrating that a systematic approach to drinking water quality management is employed.
- Facilitating review and audits by providing written evidence of the system.
- Enabling development and protection of the organization's knowledge base.
- Enhancing communication within the organization and with stakeholders.
- Serving as a mechanism for accountability.
- Establishing due diligence and credibility.
- Ensuring documentation is visible and accessible.

Each water supply system will have a unique suite of useful documents. Box 4-1 provides a listing of some of the more common types of water system records. Using its professional experience and judgment, the assessment team should identify what the documentation requirements are for the water supply system for regulatory compliance, management, operation, maintenance and consumer reporting. Once the set of necessary documents are identified, answer the following questions:

- Does the water supplier maintain the required documentation?
- How are records used?
- How and where are records stored?,
- Are backup copies of records stored offsite and in a safe place?
- How up to date are the records?
- Are records reviewed and reported on periodically?

On the flip side of documentation is reporting. The following questions can be used to evaluate reporting processes:

- Is the water supply system meeting compliance reporting requirements?

Box 4-1. Examples of Water Supply System Records (Adapted from CCME, 2004)

- Operating permit
- Water licence
- Driller's well log
- Water quality analysis results
- Records of flow meter readings and reservoir levels
- Records of continuous monitors
- Flow meter, pump records
- Laboratory analysis reports
- Operation, maintenance and repair logs
- Inventory records
- Source/systems assessments
- Source protection plans
- Engineering reports, inspections, drawings, approvals
- Water system maps
- Records of water treatment chemicals used (type and quantity)
- Inventory of MSDS sheets
- Standard operating procedures
- Operation and maintenance manuals
- Customer complaints

- Does the water supply system publicly report the results of water quality measurements and other important water system information?

2.4. Evaluate Emergency Response and Contingency Planning Practices

Emergency response plans are required under Section 13 of the Drinking Water Protection Regulation. Emergency response plans are important to prevent worsening of problems, protect consumers from harm, and reduce costs by preventing complications (CCME, 2004). The primary objectives in the assessment of an emergency response plan are to determine if it is adequate in scope and depth, reasonable to implement, up to date, easily accessible, and familiar and understandable to staff in an emergency.

An emergency response plan should address all possible situations that could pose a risk to drinking water, and outline specific directives for action when an incident occurs. For emergency response plans to be effective, they need to be current, so any changes in the water system require corresponding changes in the plan. Likewise, it is critical that contact names and numbers for water system management and staff, health authorities, service companies, and media for consumer notification are accurate and up to date in the notification list. Protocols and templates for public notice should be included for incidents in which an immediate reporting standard is not met.

The emergency response plan should also contain detailed procedures that the responder can follow to accomplish tasks. Assess whether the emergency response plan contains clear, specific step-by-step procedures that can be effectively used by water operators to safeguard drinking water in potentially high-stress, emergency situations. Current and comprehensive content of an emergency response plan is essential to its effectiveness. The plan must also be accessible to the water system personnel who respond to incidents. Multiple locations should be established for copies of the emergency response plan, so that action can be taken immediately once an incident is apparent.

Coupled with emergency response planning is contingency planning, in which alternative options are available when key aspects of a water system are not functioning. Contingency planning includes keeping backup equipment (such as a chlorinator or pump) or parts on hand in the event of a breakdown; establishing an alternative water source in the event of catastrophic contamination or water shortages; and providing an alternative electricity source (such as a generator) in the event of a power failure.

Identify whether or not the emergency response/contingency plans are adequate and thorough in scope, reasonable, current, accessible and understandable so they can be effective tools when potentially hazardous situations occur.

The Drinking Water Protection Regulation requires that water suppliers make available a summary of emergency response plans to their customers to increase consumer confidence while ensuring that sensitive information is not released. Note in the assessment report if emergency response plan summaries are available to water customers.

3. ASSESSMENT DOCUMENTATION AND REPORTING

3.1. Assessment Report

The assessment report should include the following as a minimum for Module 4:

- List of key best practices in the management, operation and maintenance of the water supply system, and identification of important weaknesses.
- Description of documentation and record-keeping procedures.
- Reporting requirements and practices (including list of records maintained).
- Discussion of whether emergency response and contingency plans are adequate, thorough in scope, reasonable, current, accessible and understandable.
- Supporting documentation.
- Completed hazard identification table for Module 4 (see Table 4-1 for an example).

3.2. Hazard Identification Table

Drinking water hazards identified in Module 4 should be entered into the hazard identification table. See Table 4-1 for an example.

Table 4-1. Sample Module 4 Hazard Identification Table

Hazard No.	Drinking Water Hazard	Possible Effects	Existing Preventative Measures	Associated Barrier(s)
4-1	No cross-connection control program	Cross-connections can allow nonpotable water into the distribution system.	None identified	System maintenance
4-2	Emergency response plan not updated for five years	Emergency response plans function as the last barrier in emergency or abnormal operating situations. Contact phone numbers and information must be current for the plan to be effective.	None identified	Emergency response planning
4-3	No formal system of handling or recording customer complaints	Customer satisfaction is a key indicator of finished water quality and can provide a warning sign for problems.	None identified	Management

APPENDIX 4A:
MODULE 4 ASSESSMENT AT A GLANCE

Components	Recommended Methods	Scope	Documentation and Reporting
1. Evaluate water supply system manage-ment standards and practices.	• Evaluate the management practices and standards for the water system through interviews with key staff and a review of available policies and procedure manuals.	• Structure and processes • Standards and policies • Compliance with regulatory requirements • Staffing and training • Financial planning and administration	• Discuss key best management practices and important weaknesses. • Identify as a hazard in the Hazard ID table any practice, process, situation (or absence of one) that could put the safety of water at risk.
2. Evaluate water supply system operation and mainten-ance procedures and practices.	• Compare current practices with the requirements set out in the operating permit. • Review adequacy of: o Operating standards and procedures o Monitoring processes o Testing, inspection, and maintenance schedule • Evaluate the backflow prevention and cross-connection control program.	• Criteria for evaluating operations and maintenance processes: o Frequency and seasonal timing o Adequacy of processes for the unique needs of the water supply system o Planning o Communications within the organization and with customers	• Discuss key best operation and maintenance practices and important weaknesses. • Identify as a hazard in the Hazard ID table any practice, process, situation (or absence of one) that could put the safety of water at risk.

Components	Recommended Methods	Scope	Documentation and Reporting
3. Evaluate emergency response and contingency planning practices.	• Review water system emergency response and contingency plans to determine if they are: o Comprehensive. o Up to date. o Reasonable. o Accessible. o Clear/understandable. o Familiar to staff.	• Any possible situation or scenario that could put the safety of water at risk	• Discuss whether or not emergency response and contingency plans are adequate, thorough in scope, reasonable, current, accessible and understandable. • Identify deficiencies in emergency response and contingency plans that could put the safety of water at risk as a hazard in the hazard ID table.

APPENDIX 4B: RECOMMENDED RESOURCES

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.
**Lists many other helpful resources, guidance, best practices etc.

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.

Cross-Connections

British Columbia Water and Waste Association (BCWWA). 2004. *Best Management Practices: Cross connection control*. http://www.bcwwa.org/BMP/index.php

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

Emergency Response Planning

British Columbia Water and Waste Association (BCWWA). 2004. *Best Management Practices: Emergency Response Planning*. http://www.bcwwa.org/BMP/bmp_04_emergresp/Emergency_Response_Planning_BMP_Draft_Version_1.pdf

Health Canada. 2009. *Guidance for Issuing and Rescinding Boil Water Advisories*. http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/boil_water-eau_ebullition/index-eng.php

Province of British Columbia. Ministry of Health and Ministry Responsible for Seniors. 1994. *Emergency Response Planning for Small Waterworks Systems*. Victoria, B.C.: Ministry of Health and Ministry Responsible for Seniors. http://www.health.gov.bc.ca/library/publications/year/2000/PHI061.pdf

Provincial Emergency Program (PEP). 2002. British Columbia Emergency Response Management System (BCERMS). http://www.pep.bc.ca/bcerms/bcerms.html.

Environmental Operator Certification Program

Environmental Operator Certification Program. 2001. *Environmental Operator Certification Program Guide*. http://www.eocp.org/docs/guide.pdf.

Renewal Planning

National Guide to Sustainable Municipal Infrastructure (InfraGuide). 2003. *Developing a Water Distribution System Renewal Plan.* http://gmf.fcm.ca/files/Infraguide/Potable_Water/Develop_water_distr_syst_renewal_plan.pdf

Maintenance

British Columbia Water and Waste Association (BCWWA). 2004. *Best Management Practices: Reducing Water Distribution Losses*. http://www.bcwwa.org/BMP/index.php

British Columbia Water and Waste Association (BCWWA). 2004. *Best Management Practices: Distribution System Cleaning/Unidirectional Flushing*. http://www.bcwwa.org/BMP/index.php

National Guide to Sustainable Municipal Infrastructure (InfraGuide). 2004. *Small System Operation and Maintenance Practices (*Under Review*).* http://gmf.fcm.ca/files/Infraguide/Potable_Water/small_syst_operation_maint_practices.pdf

National Guide to Sustainable Municipal Infrastructure (InfraGuide). 2004. *Speed and Quality of Linear System Repairs.* http://gmf.fcm.ca/files/Infraguide/Potable_Water/Speed_quality_linear_syst_repairs.pdf

National Guide to Sustainable Municipal Infrastructure (InfraGuide). 2003. *Water Quality in Distribution Systems*. http://gmf.fcm.ca/files/Infraguide/Potable_Water/Monitor_water_quality_distr_syst_727k.pdf

Security

US Environmental Protection Agency. 2004. Water Security: Vulnerability Assessments. http://cfpub.epa.gov/safewater/watersecurity/home.cfm?program_id=11