Potable Water

Methodology for Setting a Cross-Connection Control Program

This document is the tenth in a series of best practices related to the delivery of potable water to the public. For titles of other best practices in this and other series, please refer to ***<www.infraguide.ca>***.

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Methodology for Setting a Cross-Connection Control Program

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InfraGuide® – Innovations and Best Practices

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Canadian municipalities spend $12 to $15 billion annually on infrastructure but it never seems to be enough. Existing infrastructure is ageing while demand grows for more and better roads, and improved water and sewer systems responding both to higher standards of safety, health and environmental protection as well as population growth. The solution is to change the way we plan, design and manage infrastructure. Only by doing so can municipalities meet new demands within a fiscally responsible and environmentally sustainable framework, while preserving our quality of life.

This is what the National Guide to Sustainable Municipal Infrastructure (InfraGuide) seeks to accomplish.

In 2001, the federal government, through its Infrastructure Canada Program (IC) and the National Research Council (NRC), joined forces with the Federation of Canadian Municipalities (FCM) to create the National Guide to Sustainable Municipal Infrastructure (InfraGuide). InfraGuide is both a new, national network of people and a growing collection of published best practice documents for use by decision makers and technical personnel in the public and private sectors. Based on Canadian experience and research, the reports set out the best practices to support sustainable municipal infrastructure decisions and actions in six key areas: decision making and investment planning, potable water, storm and wastewater, municipal roads and sidewalks, environmental protocols, and transit. The best practices are available online and in hard copy.

A Knowledge Network of Excellence

InfraGuide's creation is made possible through $12.5 million from Infrastructure Canada, in-kind contributions from various facets of the industry, technical resources, the collaborative effort of municipal practitioners, researchers and other experts, and a host of volunteers throughout the country. By gathering and synthesizing the best Canadian experience and knowledge, InfraGuide helps municipalities get the maximum return on every dollar they spend on infrastructure—while being mindful of the social and environmental implications of their decisions.

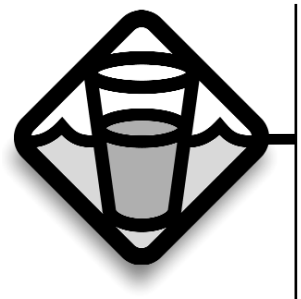
Volunteer technical committees and working groups—with the assistance of consultants and other stakeholders—are responsible for the research and publication of the best practices. This is a system of shared knowledge, shared responsibility and shared benefits. We urge you to become a part of the InfraGuide Network of Excellence. Whether you are a municipal plant operator, a planner or a municipal councillor, your input is critical to the quality of our work.

Please join us.

Contact InfraGuide toll-free at **1-866-330-3350** or visit our Web site at ***<www.infraguide.ca>*** for more information. We look forward to working with you.

1. Municipality (or municipalities) mentioned in InfraGuide best practices is intended to include all purveyors of public services as well as utilities.

The InfraGuide® Best Practices Focus



Potable Water

In keeping with the adage "out of sight, out of mind", the water distribution system has been neglected in many municipalities. Potable water best practices address various approaches to enhance a municipality's or water utility's ability to manage drinking water delivery in a way that ensures public health and safety at best value and on a sustainable basis. The up-to-date technical approaches and practices set out on key priority issues will assist municipalities and utilities in both decision making and best-in-class engineering and operational techniques. Issues such as water accountability, water use and loss, deterioration and inspection of distribution systems, renewal planning and technologies for rehabilitation of potable water systems and water quality in the distribution systems are examined.

Decision Making and Investment Planning

Elected officials and senior municipal administrators need a framework for articulating the value of infrastructure planning and maintenance, while balancing social, environmental and economic factors. Decision making and investment planning best practices transform complex and technical material into non-technical principles and guidelines for decision making, and facilitate the realization of adequate funding over the life cycle of the infrastructure. Examples include protocols for determining costs and benefits associated with desired levels of service; and strategic benchmarks, indicators or reference points for investment policy and planning decisions.

Environmental Protocols

Environmental protocols focus on the interaction of natural systems and their effects on human quality of life in relation to municipal infrastructure delivery. Environmental elements and systems include land (including flora), water, air (including noise and light) and soil. Example practices include how to factor in environmental considerations in establishing the desired level of municipal infrastructure service; and definition of local environmental conditions, challenges and opportunities with respect to municipal infrastructure.

Storm and Wastewater

Ageing buried infrastructure, diminishing financial resources, stricter legislation for effluents, increasing public awareness of environmental impacts due to wastewater and contaminated stormwater are challenges that municipalities have to deal with. Storm and wastewater best practices deal with buried linear infrastructure as well as end of pipe treatment and management issues. Examples include ways to control and reduce inflow and infiltration; how to secure relevant and consistent data sets; how to inspect and assess condition and performance of collections systems; treatment plant optimization; and management of biosolids.

Transit

Urbanization places pressure on an eroding, ageing infrastructure, and raises concerns about declining air and water quality. Transit systems contribute to reducing traffic gridlock and improving road safety. Transit best practices address the need to improve supply, influence demand and make operational improvements with the least environmental impact, while meeting social and business needs.

Municipal Roads and Sidewalks

Sound decision making and preventive maintenance are essential to managing municipal pavement infrastructure cost effectively. Municipal roads and sidewalks best practices address two priorities: front-end planning and decision making to identify and manage pavement infrastructures as a component of the infrastructure system; and a preventive approach to slow the deterioration of existing roadways. Example topics include timely preventative maintenance of municipal roads; construction and rehabilitation of utility boxes; and progressive improvement of asphalt and concrete pavement repair practices.

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EXECUTIVE SUMMARY

This document outlines the best practice for setting a cross-connection control program. It is based on a review of existing literature, the responses to questionnaires sent to 17 Canadian municipalities and input from water quality and distribution system experts from across Canada.

Understanding Cross-Connections

A cross-connection is defined as "any actual or potential connection between a potable water system and any source of pollution or contamination" (CSA, 2003). Cross-connections are present in every water supply system, and depending on the size of the system, hundreds or thousands of potential cross-connections can exist.

Cross-connections that are not protected against backflow are potentially a dangerous source of contamination. When backflow occurs through an unprotected cross-connection, pollutants or contaminants can enter the municipal water system and be delivered to other consumers or locations. Based on the number of actual and potential cross-connections in a municipal water system, and the resulting health hazards, it is important for the municipality to have an effective cross-connection control program in place. While many Canadian municipalities have a comprehensive program, other municipalities have only a minimal program, or no program at all. This best practice addresses cross-connection control programs for all Canadian municipalities—those with a comprehensive program can review and update their program, and those with a minimal program or no program should develop and implement one.

Setting a cross-connection control program, as outlined in this best practice, involves meeting the following objectives.

- Establish authority and administrative responsibility.
- Establish policy.
- Establish budget and a source of funding.
- Review and conform to standards for backflow preventers.
- Establish a data management system.
- Develop a public relations and education program.
- Co-ordinate activities with local authorities.
- Develop a training program.
- Develop standard correspondence.
- Develop requirements for a cross-connection survey and hazard assessment.
- Establish inspection and testing protocols.
- Develop a backflow incident response plan.
- Address fire protection system issues.
- Establish enforcement strategies.
- Perform quality control and assurance.

Municipalities must obtain support and approval for a program, conduct detailed planning and policy work, and (most likely) implement the program using a phased approach.

Step 1: Investigate cross-connection control in general.
Step 2: Investigate the components of a program.
Step 3: Preliminary planning or brainstorming.
Step 4: Preliminary approval to proceed:
  (a) legal authority,
  (b) policy, and
  (c) budget figures.
Step 5: Co-ordinate and review steps 4a, 4b, 4c.
Step 6: Program approval.
Step 7: Detailed planning:
  (a) awareness,
  (b) resourcing requirements, and
  (c) enforcement strategies.
Step 8: Phased program implementation.
Step 9: Review and Continuous Improvement

While many Canadian municipalities have a comprehensive program, other municipalities have only a minimal program, or no program at all.

By following the methodology presented in this best practice and reviewing the recommended information sources, a municipality of any size can develop a comprehensive cross-connection control program to increase potable water protection, reduce risks to public health and the number of backflow incidences, demonstrate due diligence and regulatory compliance, and reduce liability.

1. General

1.1 Introduction

This is one of a number of best practices developed under the auspices of the *National Guide to Sustainable Municipal Infrastructure (InfraGuide)*.

InfraGuide best practices are defined as state-of-the-art methodologies and technologies for municipal infrastructure planning, design, construction, management, assessment, maintenance, and rehabilitation that consider local economic, environmental, and social factors. This document outlines the best practice for setting a water distribution system cross-connection control program. It is based on a review of existing literature, the responses to questionnaires sent to 17 Canadian municipalities, and input from water quality and distribution system experts from across Canada. The questionnaire included queries about practices related to cross-connection control programs, inspection and testing, record keeping, budget and source of funding, education, and backflow incidents. Municipalities responding to the questionnaire have water systems that serve populations from 6,000 to more than one million people.

Most of the information in this best practice is available through various existing documents, as referenced. As such, this is a summary of information tailored for municipalities wishing to develop or enhance their cross-connection control program.

1.2 Purpose and Scope

This document describes the methodology for setting a cross-connection control program. The elements of a comprehensive program are discussed, along with guidance for municipalities on how to obtain support and approval for a program, conduct detailed planning and policy work, and implement the program using a phased approach.

This best practice addresses cross-connections that may be present either on municipal or private property. Since contamination resulting from backflow incidents through cross-connections on municipal property, as well as private property, may enter the municipal water system and then be delivered to other consumers, the municipality has a responsibility to implement a program to eliminate or minimize the potential for contamination to occur. The hazards consumers can be exposed to from existing and potential cross-connections can create serious health risks, depending on the substance(s) that may backflow into the building or municipal water system.

1.3 Glossary[2]

Backflow — A flowing back or reversal of the normal direction of flow.

Backflow preventer — A device that prevents backflow.

Backflow prevention device tester — A person who is registered or licensed by the regulatory authority to test backflow prevention assemblies.

Back pressure — A pressure that is greater than the water system supply pressure.

Back siphonage — A form of backflow caused by a negative or sub-atmospheric pressure within a water system.

Cross-connection — Any actual or potential connection between a potable water system and any source of pollution or contamination.

Cross-connection control — The enforcement of an ordinance or other legal statement regulating cross-connections.

Cross-connection control program — A program initiated by a regulatory authority to administer and regulate the selection,

This best practice addresses cross-connections that may be present either on municipal or private property.

2. Definitions are taken from CSA (2003: 4–8), InfraGuide (2003: 2–4), WCS-AWWA (2001: VII–3, VII–5), and AWWA (2000).

installation, testing, and maintenance of backflow preventers.

Internal isolation — Consists of fixture isolation, zone isolation, and area isolation. Fixture isolation involves installing an approved backflow preventer at the source of the potential contamination. Zone isolation involves confining the potential source of contamination within a specific area. Area isolation involves confining a section of a piping system with potable and non-potable water connections downstream of athe section.

Municipality/municipalities — A legally incorporated or duly authorized association of inhabitants of limited area for local governmental or other public purposes. The term is intended to include all purveyors of public services as well as utilities.

Premises isolation — The prevention of backflow into a public water system from a user's premises by the installation of a suitable backflow preventer at the entrance to the building or property.

Water service connection — A piping connection that conveys water from a public water main or private water source to the inside of a building.

Zone protection — Protection provided for sections of a piping system within a building or facility with no domestic or potable water connections downstream of a backflow preventer.

2. Rationale

2.1 Background

As described in the best practice, *Water Quality in Distribution Systems* (InfraGuide, 2003), water distribution systems are exposed to several sources of potential health risks, which include cross-connections and backflow. *Water Quality in Distribution Systems* recommended implementing a cross-connection control and backflow prevention program as one of the ways to minimize water quality degradation in the distribution system.

There are several ways to mitigate the potential for backflow:

- Provide physical separation between potable water and non-potable water systems.
- Install backflow prevention devices and assemblies. The choice depends on the health hazard of the actual or potential cross-connection and the plumbing hydraulics.
- Implement cross-connection control and backflow prevention programs.
- Maintain positive pressures in the distribution system.

Overall water distribution system operations including maintaining chlorine residuals, maintaining positive pressures, and performing appropriate levels of distribution system maintenance, should be covered under a municipality's total water quality management program. A cross-connection control program complements the other barriers of the multi-barrier approach to providing safe drinking water. Creating and implementing a cross-connection control program is the focus of this document.

2.2 Understanding Cross-Connections

A cross-connection is "any actual or potential connection between a potable water system and any source of pollution or contamination" (CSA, 2003). Cross-connections are present in every water supply system, and depending on the size of the system, there may exist hundreds or even thousands of potential cross-connections.

The *National Plumbing Code of Canada* (NRC, 1995b) requires that connections to potable water systems be designed and installed so non-potable water or substances that may make the water non-potable cannot enter the potable water system. This requirement to protect against backflow is also included in many municipal, territorial, and provincial regulations.

Backflow may occur under two conditions:

- Back siphonage occurs when negative or sub-atmospheric pressure exists within a water system (e.g., the water supply piping is shut down for repairs and drained).
- Back pressure occurs when the facility pressure is greater than the water system supply pressure (e.g., when pumps or boilers that operate at high pressure are connected to the potable water supply without a backflow preventer).

Appendix A of CAN/CSA B64.10–01 *Manual for the Selection and Installation of Backflow Prevention Devices* (CSA, 2003) contains detailed information and examples of conditions where back siphonage and back pressure may cause backflow. Cross-connections that are not protected against backflow are potentially a dangerous source of contamination. When backflow occurs through an unprotected cross-connection, pollutants or contaminants may enter the municipal water system and be delivered to other consumers or locations.

A cross-connection control program complements the other barriers of the multi-barrier approach to providing safe drinking water.

The source of pollution or contamination may create a minor, moderate, or severe hazard depending on the type of substance that could potentially backflow into the municipal water system. These hazard levels are defined in CAN/CSA B64.10-01 (CSA, 2003) as:

- **minor hazard**—any cross-connection or potential cross-connection that constitutes only a nuisance, with no possibility of any health hazard;
- **moderate hazard**—any minor hazard as defined in (a) that has a low probability of becoming a severe hazard; and
- **high or severe hazard**—any cross-connection or potential cross-connection involving any substance that could be a danger to health.

For example, a flexible shower head with a hose connection may be considered a minor hazard; swimming pools and laundry machines may be considered a moderate hazard; and many industries may be considered a severe hazard. The result of a backflow event may vary from a nuisance for minor hazards, to illness or death caused by severe hazards. There are different methods to prevent backflow, based on the level of hazard and hydraulics of the plumbing system.

There are numerous North American examples of cross-connections where backflow has occurred and caused illness or death. These include the backflow of pesticide chemicals through garden hose connections, the backflow of antifreeze from building cooling and heating systems through unprotected connections to the water supply, the backflow of steam from a heating plant due to excessive pressure buildup, and the backflow of blood and other body fluids through mortuary equipment. For more examples and specific dates and locations, consult the references included at the end of this document.

Based on the number of actual and potential cross-connections in a municipal water system and the resulting health hazards, it is important for the municipality to have an effective cross-connection control program in place. While many Canadian municipalities have a comprehensive program, other municipalities have only a minimal program, or no program at all. This best practice addresses cross-connection control programs for all Canadian municipalities. Those with comprehensive programs may review and update their program, and those with a minimal program or no program should develop and implement one.

With the many challenges and requirements faced by Canadian municipalities in the provision of potable water, it can sometimes be difficult to prioritize water quality programs and the associated funding and staff requirements to develop, implement, and maintain these programs. A phased approach to cross-connection control is appropriate for most municipalities. The phasing should address all severe risk connections and municipal facilities first. Severe risk connections should be addressed as a priority since they involve substances that could be an immediate danger to public health. Municipal facilities should be addressed since it is important for the municipality to "lead by example," which will make program implementation easier.

Municipal facilities should be addressed since it is important for the municipality to "lead by example," which will make program implementation easier.

A cross-connection control program requires co-operation between the municipality and its water consumers, since most of the cross-connections that exist are located on private property.

2.3 Benefits

With an effective cross-connection control program, a municipality may:

- increase potable water protection, which reduces risks to public health;
- reduce the number of backflow incidents;
- reduce system shut down time and cleanup costs due to backflow incidents;
- increase consumer confidence and heighten cross-connection control awareness;
- demonstrate due diligence and regulatory compliance; and
- reduce liability.

Without an effective program, backflow incidents may occur that result in human illness or death. The Decision Making and Investment Planning technical committee will soon publish *Managing Risk*. This new best practice will highlight that, as part of an overall asset management strategy, risk management can minimize costs associated with the delivery of a healthy, safe, affordable, and publicly acceptable service.

The costs and staff requirements associated with developing, implementing, and maintaining a cross-connection control program can include:

- operational costs for staff redeployment to implement, maintain, and update the program;
- the need for additional staff;
- additional staff training;
- more data to manage and report; and
- additional skill to monitor backflow prevention assembly test results and qualifications for tester registration.

It is important to note that these additional costs and staff requirements are more than offset by the financial savings due to the avoidance of a water quality incident as a result of backflow occurrences through cross-connections.

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3. Methodology

The methodology for setting a cross-connection control program outlined in this best practice includes the following steps.

1) Establish authority and administrative responsibility.
2) Establish policy.
3) Establish budget and a source of funding.
4) Review and conform to standards for backflow preventers.
5) Establish a data management system.
6) Develop a public relations and education program.
7) Co-ordinate activities with local authorities.
8) Develop a training program.
9) Develop standard correspondence.
10) Develop requirements for a cross-connection survey and hazard assessment.
11) Establish inspection and testing protocols.
12) Develop a backflow incident response plan.
13) Address fire protection system issues.
14) Establish enforcement strategies.
15) Perform quality control and assurance.

3.1 Authority and Administrative Responsibility

Establishing authority and administrative responsibility for the cross-connection control program is necessary to ensure that the program is enforceable and properly administered. This includes creating appropriate bylaws/ordinances/regulations that allow the municipality to define its responsibilities as well as the consumers' responsibilities. The municipality is ultimately responsible for enforcing the program. For the program to be enforceable, the municipality must ensure that municipal, provincial, and federal requirements are fulfilled, and that they have the required resources to carry out enforcement actions (e.g., sending notices, reviewing test results, registering or licensing testers, etc.). Bylaws should be registered with the provincial/territorial authority to allow for enforcement of the bylaw to occur.

Based on the results of the municipal questionnaire conducted during the development of this best practice, common elements of bylaws are in place in various Canadian municipalities. Based on this collected information, a bylaw might include the following points.

- Unprotected cross-connections that could allow a substance to backflow into the potable water system are prohibited; the type of backflow preventers that are installed for these connections must be approved by the municipality.
- Determine installation standards (e.g., municipal, provincial, or federal standards/codes, CAN/CSA–B64 Series–01 standards (CSA, 2001a, etc. including updates).
- Possibly require premise isolation in addition to internal isolation at the source of the hazard and zone protection.
- Include the required frequency of inspection and testing of equipment, submission of inspection and testing reports, and the display of information card(s) on the backflow preventer.
- Spell out the enforceable consequences of not complying with inspection and testing requirements, in terms of notification and suspension of water service, and fines.
- Identify actions to be taken if a backflow preventer does not pass testing, including repair/replacement and retesting, within a required time period. Give the consequences of not complying with the requirements, including notification, fines, and suspension of water service.

For the program to be enforceable, the municipality must ensure that municipal, provincial, and federal requirements are fulfilled, and that they have the required resources to carry out enforcement actions (e.g., sending notices, reviewing test results, registering or licensing testers, etc.).

- Confirm the municipality's right to access a building to conduct a cross-connection survey and hazard assessment, and inspect premises for backflow preventers.
- Require testers to be registered or licensed by the municipality to conduct inspections and testing. Criteria for registration or licensing may, or may not, be included in the bylaw.
- Be able to revoke a testers' registration or licence if the tester falsifies test report(s) or submits incorrect reports.
- Require inspections of newly constructed, renovated, or reconstructed premises, before providing water service, to check for the presence of cross-connections.
- Identify the responsibility of the municipality and consumer regarding installation, maintenance, and costs related to cross-connection control activities.
- Give the municipality the ability to issue a written corrective order to consumers in contravention of the bylaw.
- Authorize the municipality to suspend water service in the event of non-compliance with any of the provisions of the cross-connection control bylaw.
- Make provision for additional definitions relating to cross-connection control.

Example bylaws are included in the Cross-Connection Control manual published by the Western Canada Section of the American Water Works Association (WCS AWWA, 2001, **Appendix 5**). Many other easily accessible sources of example bylaws exist on municipal Web sites. For example:

- City of Calgary, Alberta ***<www.calgary.ca>***
- City of Fredericton, New Brunswick ***<www.city.fredericton.nb.ca>***
- City of London, Ontario ***<www.london.ca>***
- City of Medicine Hat, Alberta ***<www.medicine-hat.ca>***
- City of Penticton, British Columbia ***<www.penticton.ca>***
- City of Red Deer, Alberta ***<www.city.red-deer.ab.ca>***
- City of Vancouver, British Columbia ***<www.city.vancouver.bc.ca>***
- City of Yellowknife, Northwest Territories ***<www.city.yellowknife.nt.ca>***

While many groups will be involved with the cross-connection control program, including the water quality, plumbing inspection, and health departments, it is important that one staff position have administrative responsibility. Depending on the size of the program, one or more staff members may also be required as assistants. The municipality should decide on the appropriate group to administer the program; for most municipalities, it will be the group with overall responsibility for water quality.

The cross-connection control policy should be readily accessible to consumers and municipal staff, and be written in plain language that can be understood by laypersons.

3.2 Policy

While the legal authority for the program is contained in the municipality's bylaw, the cross-connection control policy is a much more elaborate document that contains detailed information about the program. The legal authority should not be burdened by detailed program information, since it is much more cumbersome to affect changes to the legal authority than it is to update the policy.

The cross-connection control policy should be readily accessible to consumers and municipal staff, and be written in plain language that can be understood by laypersons. The cross-connection control policy may be a stand-alone document, or be included in other water service or utility policy documents.

The elements of the cross-connection control policy may include, but are not limited to:

- references to the authority for the program (bylaws, regulations) and applicable standards and codes, such as CAN/CSA–B64 Series–01 (CSA, 2001a), and plumbing and building codes;
- responsibilities of the municipality[3] and the consumer/building owner;

3 As noted previously, reference to municipality (or municipalities) throughout this document is also intended to include utility (or utilities) or other purveyors of water. Where the municipality is not the water purveyor, responsibilities for both the municipality and the water purveyor should be clearly defined in the policy.

- how the program will be implemented, and maintained;
- qualification of hazards and why backflow preventers are used;
- responsibility for performing the cross-connection survey and hazard assessment, and regular inspection and testing;
- type of backflow prevention that will be included in the program (e.g., premise isolation, internal isolation), options available when determining the location of the backflow protection (CAN/CSA–B64.10–01, Appendix B1), and which devices will be monitored by the program's regular testing program;
- procedures for access to consumer premises;
- ownership of backflow preventers (In most cases, the consumer will retain ownership of devices installed on private property. The owner should refer to the manufacturer's literature for testing and maintenance requirements. For cases where the municipality supplies a water meter set and a backflow preventer, the municipality will retain ownership and the consumer will rent the meter and backflow preventer.);
- procedures for issuing notices and fines to consumers and suspending water service for non-compliance;
- procedures for temporary connections to municipal fire hydrants (if allowed), and use of portable backflow preventers;
- procedures for registration or licensing of testers; and
- contact information for inquiries about the program.

For overall public health, the municipality's cross-connection control program may concentrate on premise isolation, as opposed to internal isolation, to limit the possibility of backflow events into the municipal water system. Plumbing and building code requirements for internal isolation, as well as premise isolation, will complement the municipality's cross-connection control program.

The many excellent references to consult when developing the policy and program elements, include:

- CAN/CSA–B64.10–01/CAN/CSA–B64.10.1–01 Manual for the S*election and Installation of Backflow Prevention Devices/Manual for the Maintenance and Field Testing of Backflow Prevention Devices* (CSA, 2003).
- WCS of AWWA (2003) Cross-Connection Control manual.
- AWWA (2004) Manual M14 R*ecommended Practice for Backflow Prevention and Cross-Connection Control*.

Although many municipalities have established cross-connection control policies, the City of Penticton, British Columbia has developed a comprehensive policy that is available on its Web site ***<www.penticton.ca>***, which includes many of the elements listed above, as well as definitions and bulletins to provide additional technical updates to the program.

3.3 Budget and Source of Funding

Gaining municipal staff support for a cross-connection control program includes securing budget approval. Therefore, it is important to identify all the costs associated with developing, implementing, and maintaining the program. A large part of the cost associated with the program will be the requirements for conducting the cross-connection survey and hazard assessments (on-site inspections), and the administration of the regular testing program. Other considerations are the costs associated with data management, public relations, and education.

The cost of implementing a successful cross-connection control program can vary depending on the type of program the municipality decides to implement. A municipality's historical cost for water quality incident responses could be applied to the implementation costs of a cross-connection control program, since hazards are now being assessed, controlled, and reduced (assuming the municipality can tabulate these historical costs).

For overall public health, the municipality's cross-connection control program may concentrate on premise isolation, as opposed to internal isolation, to limit the possibility of backflow events into the municipal water system.

An effective way to implement a program is to phase it in over time. As described in Section 2.1, concentrate on severe hazard connections first, which are typically found in commercial, industrial, and agricultural applications. To demonstrate the importance of protecting the municipal water system, the municipality should budget for cross-connection control implementation at all municipal facilities at the same time, regardless of whether they are minor, moderate, or severe hazards. This will help the municipality understand the costs associated with retrofitting backflow prevention within an existing facility, processing inspection and testing reports, and providing follow-up inspection.

If the municipality uses a phased approach to implement the program, education programs should try to re-assure consumers that even though the process will take some time, the end result is obtainable and in their best interests.

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Most cross-connection control programs require that the consumer bear the cost of the cross-connection survey and hazard assessment, purchase and installation of backflow preventers, and regular inspection and testing (i.e., user-pay system). Some municipalities provide staff to conduct the initial cross-connection survey and hazard assessment. Other municipalities help residential consumers by offering a garden hose connection backflow preventer free of charge to each household, and take advantage of bulk pricing due to the large number purchased from suppliers.

The municipality may wish to investigate alternate sources of funding, including provincial and federal programs, to help with the implementation costs of the program. A "partner-municipality" of a similar size and demographic that already has a successful cross-connection control program may be able to provide information on its budgeting costs, program successes and failures, and goodwill support. If possible, several municipalities could be contacted for a more comprehensive analysis of the type of program that could be implemented, along with the actual budgeting costs.

Appendix A contains some examples of the staff requirements of various municipalities' cross-connection control programs.

Although the municipality may acquire some contracted services to administer the program, ultimately, the municipality should retain overall responsibility for the program.

3.4 Standards for Backflow Preventers

The municipality shall require that the selection, installation, maintenance, and field testing of backflow preventers follow the CAN/CSA B64.10–01/B64.10.1–01 standard (CSA, 2001a). All approved backflow preventers must conform to the following CSA standards, and shall be certified by the CSA or a certification body recognized by the Standards Council of Canada:

- CAN/CSA–B64 SERIES–01 Backflow Preventers and Vacuum Breakers which comprises B64.0, B64.1.1, B64.1.2, B64.2, B64.2.1, B64.2.1.1, B64.2.2, B64.3, B64.3.1, B64.4, B64.4.1, B64.5, B64.5.1, B64.6, B64.6.1, B64.7, B64.8, and B64.9.
- CAN/CSA–B125–01 *Plumbing Fittings*

3.5 Data Management

A good data management system keeps and maintains the records associated with the cross-connection control program, which include:

- a record of cross-connection survey and hazard assessment;
- inventory of backflow preventers (type, size, make, model, serial number, and location) installed in the municipality;
- inspection and testing reports;
- backflow incident reports;
- correspondence with consumers and authorities;
- a list of registered or licensed testers; and
- a list of approved testing equipment.

Appendix B contains further information on these data management components.

The data management system provides access to records for program administrators, and program enforcement, and gives a chronology of events in case of legal actions and fines arising from a water quality or non-compliance incident.

Many data management systems are available, including standard database and spreadsheet software, commercially available packaged water quality management systems that include cross-connection control modules, and custom-built management systems. Many systems will accommodate an automatic link to the water maintenance management system, and will automatically issue notices of upcoming inspection and testing requirements.

While many components of the program may be submitted as a paper record (e.g., inspection and testing results, correspondence with consumers, etc.), transferring and keeping as much information as possible in electronic format, is recommended, with appropriate backup measures and procedures in place.

Where paper records need to be retained for legal purposes, the municipality's legal department should be consulted to determine the required data retention time. For both paper records and electronic format data management, it is important that adequate records be retained and available that can demonstrate the history and performance of backflow preventers and testers. These records may be necessary to determine liability for water quality incidents.

3.6 Public Relations and Education

The public relations and education component of a cross-connection control program is essential to ensure success. Many groups should be targeted, including municipal staff, councillors, the mayor, and administrators; residential, commercial, and industrial consumers; and stakeholders such as professional, trade, and technical groups including private house/business inspection firms.

Municipal staff, councillors, the mayor, and administrators must be educated about the program so they can communicate effectively with consumers and the public. Another important, upfront component will be gaining support and funding for the cross-connection control program.

Brochures and water bill inserts are effective and can reach a large number of consumers, as well as information presented on the municipality's Web site, radio and television announcements, and newspaper articles. Information should be easy to understand and include photos or illustrations where possible. Some municipalities host public meetings, open house sessions and prepare presentations that explain the components of the program and consumer responsibilities. Web sites and commercially available presentations and videos explain cross-connection control, most notably the AWWA video, "Backflow Prevention and Cross-Connection Control" (AWWA, 2003), which presents the concepts of how backflow can occur, methods to prevent backflow, and elements of a cross-connection control program. It should be noted that this video uses American terminology, which in some cases is different than Canadian terminology.

Consumers should be educated about the hazards of cross-connections and backflow conditions, and about their responsibilities to comply with the program. Materials distributed to commercial and industrial consumers will have a different focus than residential consumers. For example, a brochure to residential consumers may cover the hazards associated with garden hose connections and irrigation systems, while a commercial and industrial brochure may cover the hazards associated with industrial fluid systems and compressors, laboratory equipment, and fire sprinkler systems, as well as the requirement to assess the plumbing system and apply backflow preventers where necessary.

Stakeholders are an important part of a successful program, since they are directly involved with the piping systems where

Consumers should be educated about the hazards of cross-connections and backflow conditions, and about their responsibilities to comply with the program. Materials distributed to commercial and industrial consumers will have a different focus than residential consumers.

cross-connections can occur. Contractors for irrigation and sprinkler systems, fire protection systems, homebuilders, and plumbers should all be educated about the municipality's requirements for cross-connection control. Trade associations can be an effective venue through which to educate these groups.

Establishing a cross-connection control committee and having stakeholders as members of the committee will increase awareness of the program and enable more groups to be reached. Representatives for the cross-connection control committee could include a municipality's cross-connection control staff, building/plumbing inspectors, bylaw/legal, and health department representatives, plumbing contractors, cross-connection control instructors from local accredited schools, and other interested parties.

Many tasks associated with cross-connection control require training. These include program administration, survey and hazard assessment, backflow preventer installation, inspection, testing, and repair, and bylaw enforcement.

3.7 Co-ordination with Local Authorities

The development, implementation, and maintenance of a cross-connection control program requires co-ordination with many local authorities.

- Building, plumbing, public works, engineering, planning, and health officials should be involved in the development of the program, bylaw, and policy.
- The building/plumbing department and building/plumbing inspectors should require that inspection results and test records be submitted for newly constructed, renovated, or reconstructed premises.
- The building permit department should be involved so during the plan review for new construction it can identify potential cross-connections.
- Many departments may be involved to identify facilities that have been renovated, or had a change of occupancy or type of industry, because the cross-connection hazards may also change (e.g., planning or business licensing department).
- Other departments (i.e., utility billing information or tax and assessment) may also be involved to provide current mailing information.
- The bylaw department, legal department, and bylaw enforcement officers will be involved with enforcement actions.
- The fire department should be involved when water service is suspended due to consumer non-compliance, and for a previous fire service that has been disconnected.
- Call centres that receive customer inquiries should be trained to recognize possible backflow events and involve the cross-connection control group.
- Provincial authorities, including the ministries or departments responsible for the environment, health, and plumbing inspection, and the local health department must be involved where there is a water quality incident resulting from backflow events.

In addition, the municipality will have to decide which department is best suited to administer the cross-connection control program. As described in Section 3.1, for most municipalities, it will be the water quality group.

3.8 Training

Many tasks associated with cross-connection control require training. These include program administration, survey and hazard assessment, backflow preventer installation, inspection, testing, and repair, and bylaw enforcement.

While a municipality may wish to conduct its own in-house training for some elements, especially for administration of its program, accredited schools and colleges offer cross-connection control courses, and backflow prevention device tester certification and re-certification courses.

Backflow preventer testers can obtain certification through an accredited school or college, and will have to attend a re-certification course periodically. In addition to certification, a municipality registering or

licensing the tester should require a calibration certificate for its testing equipment, another trade or professional qualification (e.g., plumbing certificate), and current liability insurance coverage (CSA, 2003). In addition, the municipality should require testing of a certain number and type of backflow preventers within a certain time period.

Currently, there is no Canadian-based training available to obtain certification for conducting cross-connection survey and hazard assessments. It is hoped that future updates of the CAN/CSA B64.10 standard will list the qualifications required to perform these tasks.

Municipal staff involved with a cross-connection survey and hazard assessment, inspection, and testing should also be trained in safety procedures, including access issues to private buildings, dealing with possible irate customers, use of special tools to inspect and test backflow preventers, and access to hazardous locations for both municipal and private property applications. They should also be familiar with other local bylaws related to cross-connection control and relevant occupational health and safety acts.

3.9 Correspondence

The correspondence associated with a cross-connection control program may include:

- service agreement;
- letter of introduction to the cross-connection control program;
- notice of requirement to install backflow preventer(s);
- notice of inspection and testing requirements for existing backflow preventers;
- follow-up letters for non-compliance relating to installation, inspection and testing requirements including possible fines or penalties;
- notice of fines or penalties;
- final notice before suspending water service; and
- notice of requirement for testers to renew their licence or registration.

To simplify the process for program administrators, standard letters should be used where possible. Sample letters are included in the WCS of AWWA manual (WCS– AWWA, 2001). Correspondence should be sent well in advance of upcoming testing and renewal dates. Prior to fines or suspension of water service, it is important to demonstrate that the consumer was contacted more than once. The municipality may wish to follow up correspondence with a telephone call to investigate the issue further before suspending water service.

The program administrators should consult with the municipality's legal department to determine whether a copy of the actual correspondence must be kept or just information in the data management system about the date, recipient, and type of letter. For example, some municipalities keep almost no copies of correspondence, but enter into the data management system the date the letter was sent, who it was addressed to, and whether it was the first, second, etc. notice of inspection and testing requirements.

3.10 Cross-Connection Survey and Hazard Assessment

The cross-connection survey and hazard assessment is used to identify any actual or potential cross-connections, the potential risk of contamination, the probability that backflow could occur, and to determine the appropriate backflow preventer to use. For the hazard assessment, Clause 4.1.4 of CAN/CSA B64.10 –01 (CSA, 2003) requires identification of:

- the probability that back siphonage will cause backflow;
- the probability that back pressure will cause backflow;
- the severity of any hazard; and
- the type of building.

Assessment of the probability of backflow and severity of the hazard is a very subjective task, since there is no simple formula to apply. The municipality may wish to conduct the initial cross-connection survey and hazard assessment to ensure appropriate backflow

Assessment of the probability of backflow and severity of the hazard is a very subjective task, since there is no simple formula to apply.

preventers are identified, and to satisfy itself that adequate protection of the municipal water system has been provided. The CAN/CSA B64.10–01 Standard, WCS of AWWA manual, and AWWA Manual M14 all provide guidance on the type of backflow preventer and level of hazard protected against (i.e., minor, moderate, or severe), and the type of cross-connection and level of hazard (e.g., Appendix B of CAN/CSA B64.10–01 where photo lab sinks are considered a severe hazard).

It should be noted that these standards and manuals use different terminology for some aspects. As well, AWWA Manual M14 uses the classification of health hazard, or non-health hazard, while the Canadian publications use a three-tiered classification of minor, moderate, or severe.

Cross-connection control courses, offered by accredited schools or colleges, also provide guidance on hazard assessment. The AWWA Manual M14 provides guidance on the "recommended protection for water purveyor's hazards," which covers the distribution system, treatment plants, offices, and work areas.

Cross-connection control courses, offered by accredited schools or colleges, also provide guidance on hazard assessment.

Typically, the municipality would identify the type of building to determine all the industrial and commercial uses, and focus the cross-connection survey and hazard assessment on the type of use with the highest potential for contamination first.

Consumers should be notified of the result of the cross-connection survey and hazard assessment, and the required backflow preventer, along with the required time period to have the backflow preventer installed and successfully tested.

If existing backflow preventers are found during the survey and assessment, for which the municipality has no historical records, they should be tested immediately and entered into the data management system. If these devices do not meet the municipality's requirements, they must be replaced.

3.11 Inspection and Testing

An important element of a cross-connection control program is regular inspection and testing, since a backflow preventer that is not functioning properly will be of little use to protect against backflow.

The bylaw and policy will outline the requirements for inspection and testing. In most cases, the owner will retain a registered or licensed tester who meets the municipality's requirements. Inspection and testing should be carried out according to recognized industry standards, including CAN/CSA B64.10.1-–01 Manual for the Maintenance and Field Testing of Backflow Prevention Devices (CSA, 2003). There are many other sources for inspection and testing standards, including the WCS of AWWA manual; as well, the municipality may have special testing requirements included in the bylaw.

Generally, annual testing is required as a minimum. However, this should be evaluated on a case-by-case basis depending on the risks to the drinking water system.

3.12 Backflow Incident Response Plan

The municipality should already have a plan in place to respond to water quality incidents. This would include appropriate and expedient communication to the customers in the affected area, and between the different personnel involved in sampling, flushing, lab analysis, and on-site inspections. This plan should be expanded to incorporate information specific to backflow incidents. This would include procedures municipal staff should follow to isolate and sample the affected area. Staff should also perform an on-site cross-connection survey and hazard assessment of the facilities to determine the source of contamination, and by isolating and flushing so the contaminant, it can be quickly removeding by isolating and flushingit the contaminant from the system.

The plan should provide for collection of as much information as possible, including laboratory results to determine the type of contamination and the required measures

based on health impacts (e.g., boil water advisory, etc.). A data management system can be used to identify the addresses where existing backflow preventers are installed. This will help reduce or narrow the facilities that may require an on-site inspection for determination of the origin of the contaminant. While the contaminants can come from facilities with unknown cross-connections that are not protected by backflow preventers, they can also come from malfunctioning backflow preventers. In these cases, it is important for the municipality to have the proper authority to require immediate testing during a water quality incident to check if a backflow preventer is malfunctioning.

As a follow-up to a backflow incident, the municipality should promptly ensure that unprotected facilities have proper backflow preventers installed and tested, and that malfunctioning backflow preventers are repaired or replaced, and re-tested, all in a manner consistent with the bylaw and policy.

3.13 Fire Protection Systems

When implementing a cross-connection control program, the municipality should be aware of requirements for backflow preventers on certain types of fire protection systems. These are outlined in CAN/CSA B64.10–01 and CAN/CSA B64.10.1–01. However, retrofitting older fire protection systems to apply backflow preventers should be done only with a comprehensive evaluation of each system by a qualified, competent person (such as a professional engineer), to ensure adequate flow and pressure through the device(s) to meet fire protection needs, and to address the thermal expansion issues associated with installing backflow prevention devices on sections of the fire protection system that include anti-freeze. AWWA Research Foundation (AwwaRF), *Impact of Wet-Pipe Fire Sprinkler Systems on Drinking Water Quality* (AwwaRF, 1998) provides more information on the application of backflow preventers to new fire protection systems, as well as possible hydraulic problems associated with retrofitting existing wet-pipe fire sprinkler systems.

3.14 Enforcement

The municipality should consider the strategies that will be used to enforce the cross-connection control program. Enforcement may be required for inspection and testing, submission of reports, installation of devices, access to premises, etc. While the legal authority allows the enforcement to occur, a strategy is required to minimize the need for enforcement. For example, if the fine for not complying with testing requirements is much more costly than the actual test, consumers are more likely to arrange for testing.

Enforcement strategies may include notification, fines, and suspension of water services. These should be clearly indicated in the bylaw and policy, and communicated in the education program. Where consumers are notified of ensuing enforcement, the municipality may wish to issue a first notice, followed by a second notice, etc., dependent on the infraction. As noted previously, fines should be set high enough to make sure that paying the fine is considered unattractive compared with complying with the program. For cases where the water service may be suspended, the municipality should make sure to co-ordinate with the health, fire, and legal departments to ensure the consequences of suspending the water have been considered.

3.15 Quality Control and Assurance

The cross-connection control program should include quality control and assurance checks where the municipality will review backflow preventer testers' performance and device test results. This can consist of a review of testers' performance, follow-up inspections where the tester performs the test in front of municipal staff, and verification of device test results including statistical analysis of test results.

The cross-connection control program should include quality control and assurance checks where the municipality will review backflow preventer testers' performance and device test results.

The municipality should retain historical records of test results and individual testers' performance. As part of the tester's licensing or registration agreement, the municipality should have the capability to verify the tester's skills. As listed in Section 3.1, the municipality's bylaw should include a provision to enable revocation of a testers' licence or registration if the tester falsified test report(s) or submitted incorrect reports.

Another component of quality assurance is to verify the impact of the local water quality on the performance of backflow preventers.