



Adverse Water Quality Incident Response

A Review of the Risk Assessment and
Communication Practices in Oxford County

Research Report
Oxford County Public Health
December 2016

About Oxford County

Located in the heart of southwestern Ontario, Oxford County has a population of approximately 111,700 people across eight municipalities that are “growing stronger together” through a partnership-oriented, two-tier municipal government incorporated as the County of Oxford.

Oxford County is emerging as a leader in sustainable growth through the [Future Oxford Community Sustainability Plan](#) and County Council’s commitment to achieving [100% renewable energy](#) by 2050 and becoming a [zero waste](#) community. Situated in one of Ontario’s richest areas for farmland, agriculture forms a cornerstone of the County’s economy, which boasts 55,000 jobs in a rapidly expanding commercial and industrial sector bolstered by its location at the crossroads of Highways 401 and 403. The County offers a thriving local arts, culture and culinary community, as well as conservation parks, natural areas and more than 100 kilometres of scenic trails.

The Oxford County Administration Building is located in Woodstock. Visit www.oxfordcounty.ca or follow our social media sites at www.oxfordcounty.ca/social. Oxford County’s Strategic Plan is at www.oxfordcounty.ca/strategicplan.

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How to cite this document:

Oxford County. Adverse water quality incident response: a review of the risk assessment and communication practices in Oxford County. Woodstock, ON: Author; 2016.

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The author wishes to express sincere thanks to participating Oxford County Public Works staff members and key informants from the Township of Blandford-Blenheim, Oxford County Strategic Communication & Engagement, and Oxford County Public Health for providing their advice and insight in the focus groups and key informant interviews. The author would also like to thank the respondents from public health units for their participation and helpful responses in the online survey.

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Summary

Adverse water quality incidents (incidents) pose significant risk to the public's health due to the potential to cause widespread illness. Ontario public health units have a mandated responsibility to provide an appropriate response to reduce the public's exposure to unsafe drinking water. However, the approach to accomplish this may be tailored within each public health unit.

The purpose of this study was to document and review risk assessment procedures and communication practices when an adverse drinking water incident occurs, and to recommend key components of a risk assessment tool and related communication approaches for Oxford County Public Health (Public Health). An incident in Princeton, Ontario involving a loss of pressure in the municipal drinking water system in 2016 provided the case study and stimulus to more closely consider Public Health's response to incidents. The study consisted of four components including: a scoping review of the literature as well as specific government documents; a survey of public health units; a focus group of relevant Oxford County Public Works (Public Works) staff members; and key informant interviews with members from the Township of Blandford-Blenheim, Oxford County Strategic Communication & Engagement, and Oxford County Public Health.

Findings indicated that the best approach to risk assessment and communication of incidents should be tailored to reflect the size and characteristics of the affected community, as well as the urgency of the situation. Many improvements were suggested including seven key recommendations, specifically that Public Health:

1. Update the existing risk assessment tool to incorporate additional risk assessment components such as a review of historical water quality and a flow chart outlining the decision making process.
2. Determine the appropriateness of door-to-door delivery of notices in the communication approach based on the incident's scope and geography.
3. Explore the feasibility of a mass notification system and emergency warning system for Oxford County in collaboration with the Oxford County Emergency Management Supervisor.
4. Develop a memorandum of understanding within Oxford County between Public Health, Public Works and Strategic Communication & Engagement departments to define roles

and responsibilities during an incident, and create a flow chart as an appendix to provide an overview of each department's roles.

5. Adapt existing advisory categories (i.e., health information advisory, boil water, do not consume, do not use) to include a two-tiered approach for precautionary/emergency advisories where warranted (i.e., boil water, do not consume).
6. Develop an educational approach to inform the public of the different types of advisories released in response to incidents.
7. Refresh the existing *Safe Water Policy and Procedure Manual* and revise as necessary to include the templates for each type of advisory adapting recommended messaging from Health Canada.

Adverse Water Quality Incident Response

Introduction

Adverse water quality incidents (incidents) may be of significant public health concern as they can potentially cause serious and widespread illness. Drinking water systems that have not been properly treated or have been mechanically compromised have the potential to be a source of exposure to microbiological, chemical, physical, or radiological contaminants. Perhaps the most well-known case of a contaminated water supply occurred in Walkerton, Ontario in 2000.¹ This event led to an outbreak of *Escherichia coli* (*E. coli*) in the community that resulted in seven deaths and over 2000 people falling ill. It is important that Oxford County Public Health (Public Health) be prepared to provide an appropriate response to incidents concerning the quality of drinking water in order to mitigate the public's exposure to water-borne illness.²

In January of 2016, an incident occurred in the middle of the night which involved a loss of pressure in the Oxford County municipal drinking water distribution system operated by Public Works serving a section of residences in the north end of Princeton, Ontario. In response to this incident, a precautionary boil water advisory was issued and affected residences were notified by having written notices posted on their door in the middle of the night by an Oxford County public health inspector (inspector) or an Oxford County Public Works (Public Works) staff member. The notices advised residents to boil their drinking water or consume bottled water until laboratory sample results could confirm the safety of the municipal water. This incident did not result in any associated illness; however, in retrospect, it provided Public Health an opportunity to use the incident as a case study to review its *Safe Water Policy and Procedure Manual* and its response to future incidents.

In Ontario, the distribution and monitoring of safe drinking water is ensured through regulation. Ontario Regulation 170/03 (*Drinking Water Systems*) under the *Safe Drinking Water Act, 2002* provides regulatory requirements for municipal and non-municipal year-round residential water systems and systems that serve designated public facilities.^{3,4} Seasonal residential water systems (both municipal and non-municipal) and systems serving non-designated public facilities are regulated under Ontario's *Health Protection and Promotion Act, 1990*.⁵ In particular, the basic operational requirements are set out in Ontario Regulation 318/08 (*Transitional – Small Drinking Water Systems*), while site-specific requirements are established upon

inspection by an inspector in accordance with Ontario Regulation 319/08 (*Small Drinking Water Systems*).^{5,6,7}

All the above regulations place responsibility upon the owners/operators of drinking water systems to ensure operations are carried out in a manner that prevents exposure to unsafe drinking water. Under the *Health Protection and Promotion Act, 1990*, responsibility for community health protection has been assigned to local Medical Officers of Health and inspectors. The owner or operating authority responsible for any municipal drinking water system or regulated non-municipal drinking water system is required to report prescribed incidents to the local Medical Officer of Health and to Ontario's Ministry of the Environment and Climate Change (MOECC) immediately after the adverse result is obtained. In turn, under the Safe Water Program of the Ontario Public Health Standards (OPHS), boards of health have been entrusted with the responsibility to prevent and reduce water-borne illness related to drinking water.² As part of the OPHS requirements, boards of health must initiate a response to drinking water-related complaints within 24 hours of notification in order to determine the appropriate response. The Medical Officer of Health or an inspector must perform a risk assessment to evaluate the potential health impact of the incident on the users of the drinking water system. The owners/operators of the water system are then required, under the *Safe Drinking Water Act, 2002* and *Health Protection and Promotion Act, 1990*, to follow the steps as ordered by the Medical Officer of Health to mitigate the health risks that can affect the public. For regulated drinking water systems, the Medical Officer of Health or inspector should verify prescribed corrective actions are being carried out, and where necessary, may require additional action to mitigate health risks. Of note, if appropriate action is already being taken, additional steps may not be required.

In the event that the conditions of the drinking water pose a health risk to its consumers, the owner/operator of the system is obligated by the regulations to notify the users. Requirement #12 under the OPHS Safe Water Program area states "the board of health shall inform the public about unsafe drinking water conditions and provide the necessary information to respond appropriately..."^{2(p.64)} Supplementing the OPHS, the *Response to Adverse Drinking Water Quality Incidents Guidance Document (2009)* directs the board of health to "have an effective communication plan that involves all appropriate community partners in the process of disseminating correct information about adverse water quality incidents in a timely manner".^{8(p.4)} Furthermore, boards of health are directed to develop and maintain a plan of action for

responding to incidents and to “develop and maintain policies, procedures, and relevant information (e.g. draft media releases, notification letters) that may be necessary for effective management and timely response to an adverse water quality incident.”^{8(p.5)} The guidance document suggests communications and strong working relationships should be initiated and maintained between local boards of health and key partners, including owners/operators of all regulated drinking water systems, the MOECC, local government officials, neighbouring local boards of health, and local media.

Purpose of Review

The purpose of this report is to review the risk assessment procedures and communication practices used by Public Health in response to incidents in Oxford County (using the Princeton incident as a case study) and to provide recommendations that will enable Public Health to respond to incidents in a more timely and effective manner.

Methods

The review of the incident response was multi-faceted, consisting of:

- a literature review
- a survey of public health units in Ontario
- a focus group with staff members from Public Works
- key informant interviews with members from the Township of Blandford-Blenheim, Oxford County Strategic Communication & Engagement, and Oxford County Public Health

Literature Review

The literature review was conducted to become informed of best practice recommendations for performing risk assessments during incidents and for communicating with the public in response to drinking water concerns. The Public Health Ontario Hub Librarian available for consultation by Public Health was contacted to assist with the literature search. General and targeted internet searches were undertaken to find relevant grey literature including guidance documents, reports, and other technical documents released by the Ontario and Canadian

governments and by public health agencies. In addition, the literature review was supplemented with relevant findings from recent journal articles. Search terms included but were not limited to:

- 'risk assessment' AND 'drinking water'
- 'communication practices' AND 'drinking water'
- 'best practices' AND 'adverse water quality incidents'

Refer to Appendix A for a complete list of databases and search terms used. The review focused on retrieving documents written in English and published within the last 10 years.

Survey of Public Health Units

A survey of the public health units in Ontario was conducted to gather information about their risk assessment procedures and communication practices when responding to incidents. Each individual health unit (n=35) was added to an email distribution list and contacted to participate in the electronic survey hosted on FluidSurveys™. Data was collected from October 6, 2016 to November 15, 2016. In the survey, public health units were asked if they would be willing to share the risk assessment tools or communication protocol documents with Public Health for knowledge sharing purposes. Those agreeing were contacted by email in follow up. A copy of the survey can be found in Appendix B.

Descriptive statistics were performed using Microsoft Excel 2010 to analyze results from questions involving quantitative data. Thematic analysis was conducted to establish a pattern or theme of ideas for qualitative questions.

Focus Group and Key Informant Interviews

A focus group was held with staff members from Public Works. Participants for this focus group included the: Director, Manager of Water Services, and the Water/Wastewater Operations Coordinator. Key informant interviews were also held with several key stakeholders involved with incidents in Oxford County. Specifically, three separate interviews took place with the Chief Administrative Officer (CAO) of the Township of Blandford-Blenheim (in which Princeton is located), the Manager of Strategic Communication & Engagement for Oxford County, and the inspector from Public Health who was involved with the Princeton incident.

The purpose of the focus group and key informant interviews was to discuss the response to the Princeton incident, as it occurred within part of the municipal drinking water system operated by the Public Works department. Interview guides were created and used for the focus group and key informant interviews. Questions were asked in an open-ended manner to elicit responses relating to stakeholder responsibilities during incidents, and to review and assess Public Health's risk assessment and communication practices. Full copies of the interview guide questions used for the focus group and each key informant interview are included for reference in Appendices C, D, E, and F.

To ensure accuracy when reporting the findings, both the focus group and key informant interviews were recorded and subsequently transcribed. Thematic analysis was conducted to establish a pattern or theme of ideas regarding the response to the Princeton incident and regarding ways to improve response to incidents in general.

Results

Literature Review

Risk assessment

A number of government publications from both the federal and provincial levels provide helpful guidance for responding to incidents. In 2004, the Federal-Provincial-Territorial Committee on Drinking Water and the Canadian Council of Ministers of the Environment collaborated to produce a document that highlighted how the process of determining hazards within a drinking water system required consultation with a number of sources of information, including a detailed review of historical water quality data such as source water characteristics and system performance over time.⁹ However, data may not always be available to complete a detailed quantitative risk assessment; therefore, in these situations it is advised that qualitative or semi-qualitative approaches be used. The potential threat to the health of the public posed by exposure to the hazard and the potential duration of this exposure are key elements of the risk assessment.⁹ For instance, exposure to microbiological pathogens is an acute threat to the health of the public, even if the duration is short. If ingested, microbiological pathogens can lead to gastrointestinal illness within hours or days, permanent damage of organs, chronic health problems, or even death. Microbiological contamination would therefore be considered a high

risk event that would necessitate immediate action to remediate the situation. In other cases such as low-level chemical contamination, the hazard may only pose a threat if exposure occurs continuously over a long period of time. However, chemical contamination may still necessitate changes to the water treatment process.⁹

The Ministry of Health and Long-Term Care (MOHLTC) provides guidance for public health units on maintaining safe drinking water following incidents in the *Response to Adverse Drinking Water Quality Incident Guidance Document (2009)*.⁸ The document contains protocols for responding to specific types of incidents, including if there is:

- a link between drinking water and a specific disease outbreak
- presence of disease-causing microorganisms
- presence of *E. coli*
- presence of total coliforms
- presence of chemical or radiological contamination outside operating parameters
- low disinfectant level
- high post-filtration turbidity
- water main breaks or pressure loss

When a link between the drinking water system and a disease outbreak is probable, there is sufficient reason to provide directions to the users for its safe use, or to order the discontinuation of provision of drinking water from that system. The presence of disease-causing microorganisms (e.g., *E. coli* O157:H7, *Campylobacter*, *Salmonella*, *Giardia*, *Cryptosporidium*) in the water, as determined through laboratory testing, would warrant a similar response. Presence and quality of treatment at the time of testing, including operation of the filtration system, need to be considered when determining the best response in each situation. Presence of *E. coli* in testing samples indicates fecal contamination may have occurred. In these situations, it is important to review the history of the findings and compare current samples to other samples taken within a reasonable timeframe and physical proximity in order to determine background levels and spread of contamination. It must also be determined whether the disinfection systems are fully operational by identifying current disinfection residual and the residual at the time of sample testing. If information indicates the water system may have been compromised, users should be given directions on how to safely use the water or the provision of water may need to be discontinued.⁸

Detection of total coliforms in a sample does not necessarily indicate presence of disease-causing organisms. However, the finding does indicate the integrity of the water system may have been compromised. Following discovery of the presence of total coliforms in a sample, an immediate re-sample should be collected to confirm results. If resampling shows presence of total coliforms, a response similar to that used when addressing the presence of *E. coli* may be taken, with consideration of the significance of the total coliform count.⁸

Ontario Regulation 169/03 (*Ontario Drinking Water Quality Standards*) under the *Safe Drinking Water Act, 2002* and Ontario Regulation 319/08 (*Small Drinking Water Systems*) set out requirements for maximum acceptable microbiological, chemical and radiological parameters in drinking water, based on potential to cause adverse health effects.¹⁰ Issues to be considered in cases of chemical contamination include:

- level of contamination
- level of exposure (related to amount of water consumed or contacted)
- susceptibility of the users

For example, levels of nitrates above the Ontario Regulation 169/03 standards are not of significance to adult populations, but are of immediate concern to infants who are more susceptible to the harmful effects of the chemicals. In chemical contamination cases, there may be sufficient time to review the situation and take an informed approach to notifying users, unless there is direct contamination or a chemical spill near a water source. In situations where short-term exposure to a contaminant is a significant health threat or the actual level of contamination is unknown, there is sufficient reason to provide directions to users of the system on its safe use, or to order the discontinuation of provision of drinking water from that system.

In addition to cases where there has been detection of microbiological, chemical, or radiological contaminants, the health of the public may be at risk if the water treatment or distribution system is not operating properly. A number of metrics may indicate that there is equipment or process related issues or there is a breach in the system, including:

- low disinfectant level (<0.05 mg/L free chlorine or <0.25 mg/L combined chlorine)
- high post-filtration turbidity (>2.0 Nephelometric Turbidity Units)
- compromised mechanical integrity of the system (e.g., drop to pressure <20 PSI in the system)

An appropriate response in each of these situations would begin with a full review of system data with the owner/operator in order to determine corrective action. In cases where disinfectant levels were intermittently low with no potential of post-treatment contamination, it may not be necessary to notify the users of the drinking water system. However, if there is not an appropriate level of disinfectant to ensure water safety, it would be necessary to provide directions to the users or to discontinue the provision of drinking water from the system.

High post-filtration turbidity indicates that there may be inadequate filtration necessary for complete disinfection of the water supply. If there is a possibility that the source of turbidity is a contamination risk to the system, issuing directions to the users or discontinuation of the provision of drinking water from the system may be warranted.

A loss of pressure in the system may result from water main breaks, depleted reservoir storage, power failure, or other mechanical failure. Loss of pressure may lead to contamination through infiltration directly into the distribution system, or through back-siphonage or pressurized backflow. Systems with backflow protection or with high enough pressure to produce flow away from the distribution system may prevent contamination, reducing immediate risk to users. However, if contamination is suspected, users should either be notified or provision of the water supply should be discontinued.

Methods of communication

The *Drinking Water Protocol (2014)* released to support the OPHS Safe Water Program requires that boards of health use a risk management approach when addressing public health issues related to drinking water systems.¹¹ Following an incident, effective communication of risk is essential for ensuring the health and safety of the public. The *Response to Adverse Drinking Water Quality Incidents Guidance Document (2009)* contains recommended methods for effectively communicating adverse conditions to drinking water users.⁸ It is the responsibility of the owner/operator of a water system to provide notification in a timely manner; however, boards of health may provide support or, if necessary, take control of the notification if appropriate steps are not being taken.⁸ Some suggested means of communicating incidents with drinking water users include providing written notices to each user, notification by telephone, and/or notification through local media.⁸ A combination of options may be used as deemed necessary based on the size and characteristics of the affected community, and the urgency of the situation.⁸

Door-to-door delivery of written notices is often one of the timeliest, most effective means of communicating to users of drinking water systems servicing smaller geographical areas. Posting notifications on doors may help to ensure that the message is adhered to by water users until corrective measures have been taken to address the incident.⁸ However, this strategy may be too time consuming for larger systems that provide vast geographical coverage.⁸

If the telephone numbers of affected drinking water users are known, notification by telephone is often the fastest means of communicating adverse water quality conditions.⁸ Providing telephone notification is the preferred method of notification to facilities with populations particularly vulnerable to adverse water conditions (e.g., hospitals, nursing homes, long-term care facilities, daycares, schools, food premises), even if other means of communication are used.⁸ An automatic phone dialing system can help speed up the process with minimal staff resources required. Written notices may be used to complement messages sent by telephone to ensure the message is adhered to by water users until corrective measures have been taken.⁸

Notification through local media (e.g., radio, newspaper, or television) is also an important means of disseminating information regarding incidents, regardless of the other methods of communication being used. A combination of the above communication strategies may be used to ensure that intended messages are received by all affected. Following corrective action and verified remediation of the incident, communication strategies for rescinding a message should be the same as those used to issue the message.

Types of advisories

Following the risk assessment, there are specific types of advisories that may be most appropriate for notifying water users in response to each particular incident. Table 1 outlines the four main types of advisories recommended by Health Canada: precautionary boil water, emergency boil water, do not consume, and do not use.¹²

Table 1. Summary of types of drinking water advisories.

Type	Use
Precautionary boil water advisory	<ul style="list-style-type: none"> • on case-by-case basis after site-specific risk assessment. Examples include: <ul style="list-style-type: none"> ○ pressure drop in distribution system ○ breach in integrity of the system (e.g., water main break) ○ persistent total coliform detection despite corrective action ○ equipment malfunction which may impact treatment efficacy
Emergency boil water advisory	<ul style="list-style-type: none"> • in response to confirmed <i>E. Coli</i> in drinking water • when there is significant treatment failure (e.g., loss of disinfection) • in situations where epidemiological evidence indicates the drinking water may be responsible for an illness outbreak
Do not consume advisory	<ul style="list-style-type: none"> • when there is significant exceedance of the guidelines for a chemical contaminant that when ingested can lead to acute health effects with short-term exposure • when there is suspected or confirmed chemical or radiological contamination events
Do not use advisory	<ul style="list-style-type: none"> • when there is significant exceedance of the guidelines for a chemical or radiological contaminant that when dermal (skin) contact or inhalation of the contaminant is of health concern

Boil water advisories are public health protection messages that boards of health may issue to advise the public to boil drinking water prior to its use to protect themselves from microbiological health risks related to their drinking water supply.¹² In 2015, 78% of boil water advisories in Canada were issued on a precautionary basis due to problems with drinking water equipment or processes, similar to the Princeton incident.¹³ By contrast, only 5% of boil water advisories were due to the detection of *E. coli* in drinking water samples and therefore issued as emergency advisories.¹³

Health Canada has advised that boil water advisories are typically to be issued in cases of confirmed or suspected microbiological contamination in order to protect the health of the public while source of water contamination is identified and the situation remediated.¹² Boil water advisories are not effective for addressing suspected or confirmed chemical or radiological contamination events.¹² Boiling water does not remove or reduce concentration of these contaminants; in certain cases, it may actually increase their concentration (as water is lost by steam generation) or lead to exposure through air (in the case of volatile chemicals). Do not consume advisories (advising the public to avoid using the water for drinking, preparing foods or beverages, dishwashing, and personal hygiene) or do not use advisories (advising the public to avoid the water for all domestic purposes, including showering and bathing) are more appropriate in these circumstances.¹²

Messaging for boil water advisories must be clear and easily understood.¹² Health Canada recommends that messaging should include:

- reasons for the advisory
- when the incident occurred
- precise geographical area and population affected
- potential adverse health effects from drinking water (e.g., diarrhea)
- precise and detailed actions required by consumers (e.g., how to boil water, alternative water supplies)
- where to seek additional, updated information or medical help
- actions taken by the water system authority to remediate the situation and when they expect it to be resolved

Advisories should only be rescinded when there is a complete resolution of the situation that prompted the advisory in the first place.¹² In the case of confirmed or potential microbiological contamination, the boil water advisory may be rescinded if there have been at least two consecutive samples collected 24 hours apart that produce negative results.¹² If improper operational conditions (e.g., treatment process) led to the advisory, the advisory may be rescinded once they have been corrected. When the advisory is released in response to a specific disease outbreak, it may be rescinded once surveillance data indicates the incidence of illness has returned to regular background levels.¹²

There must be consideration of the negative consequences of issuing advisories when making the decision to issue an advisory.¹² For example, boiling water advisories may have economic impacts (e.g., temporary restaurant closures leading to lost revenue), or may itself lead to injury of vulnerable populations (e.g., scalding). Risks mitigated by the advisory should outweigh the potential negative impact of the advisory.¹² Furthermore, the frequency and duration of advisories issued in a community has been shown to impact public compliance, as well as the public's perception of water quality.¹⁴ If an advisory is issued, specific or additional guidance may be necessary for sensitive subpopulations (e.g., pregnant women or formula-fed infants), and specific target groups (e.g., health care facilities, food premises, day cares, schools, hotels, pools), depending on the contaminant of concern.

Boards of health are required to report to the MOHLTC when an advisory has been issued to users of a drinking water system via the Drinking Water Advisory Reporting System (DWARS), a web-based data management system.¹⁵ In addition to the types of advisories recommended by Health Canada, the Ontario MOHLTC also has a reporting category for health information advisories. Health information advisories are notices that are issued to inform specific community users of an exceedance (such as fluoride and sodium) and the recommended measures to be taken to reduce exposure and mitigate the risk to human health (i.e., Public Health may notify dental or medical offices).¹⁵

Survey of Public Health Units

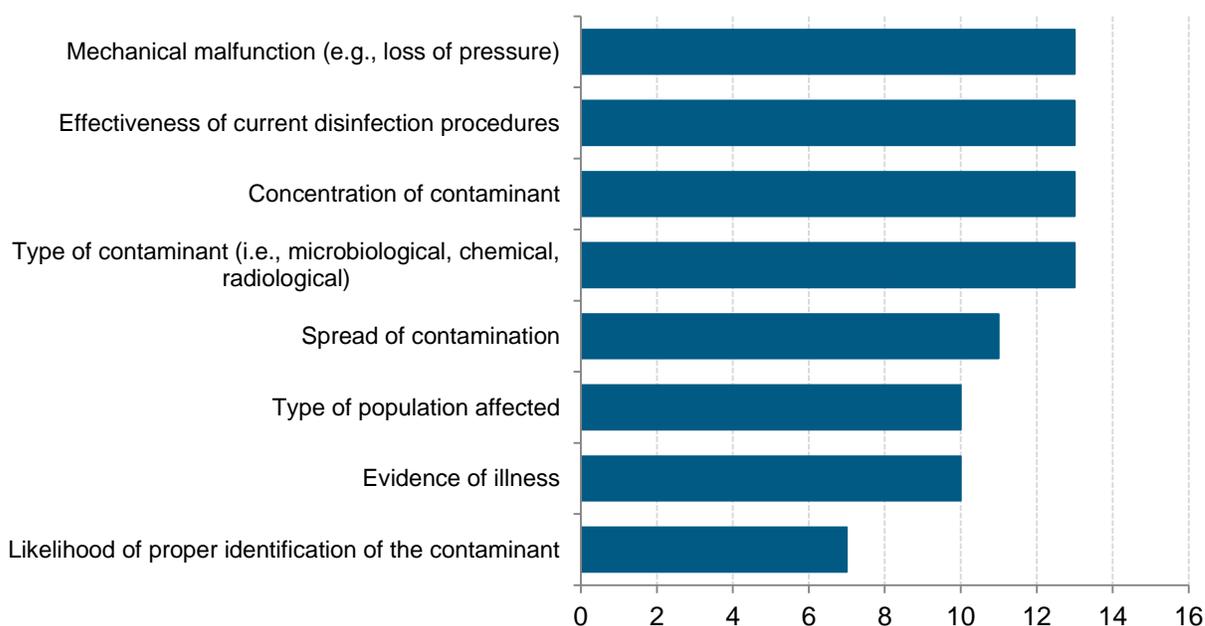
Sixty-nine per cent of public health units (24/35, excluding Oxford County) in Ontario responded to the survey. Of the 24 responding public health units, 19 (79%) completed the entire survey and five (21%) partially completed the survey. The term respondent will be used to describe

representatives of public health units that responded to the survey. The number of respondents and per cent of respondents answering each question will be indicated in the format of (n=X, Y%).

Risk assessment

Over half (n=13, 54%) of the respondents indicated that their public health unit had a formal risk assessment tool available for use when deciding whether issuing an advisory in response to an incident was necessary. The 13 respondents specified that their public health unit used the tool always (n=4, 31%), often (n=5, 38%), or sometimes (n=4, 31%) when responding to incidents. The risk assessment tools used by the public health units take into account a variety of factors surrounding the incident, as shown in Figure 1.

Figure 1. Factors taken into account in public health unit's risk assessment tools (note: multiple answer selections were possible).



Other identified factors taken into account in the risk assessment included:

- presence and level of disinfectant (e.g., chlorine residual)
- proportion of samples with the adverse parameter
- potential for sample error
- type of drinking water system (i.e., Ontario Regulation 170/03 vs. 319/08)

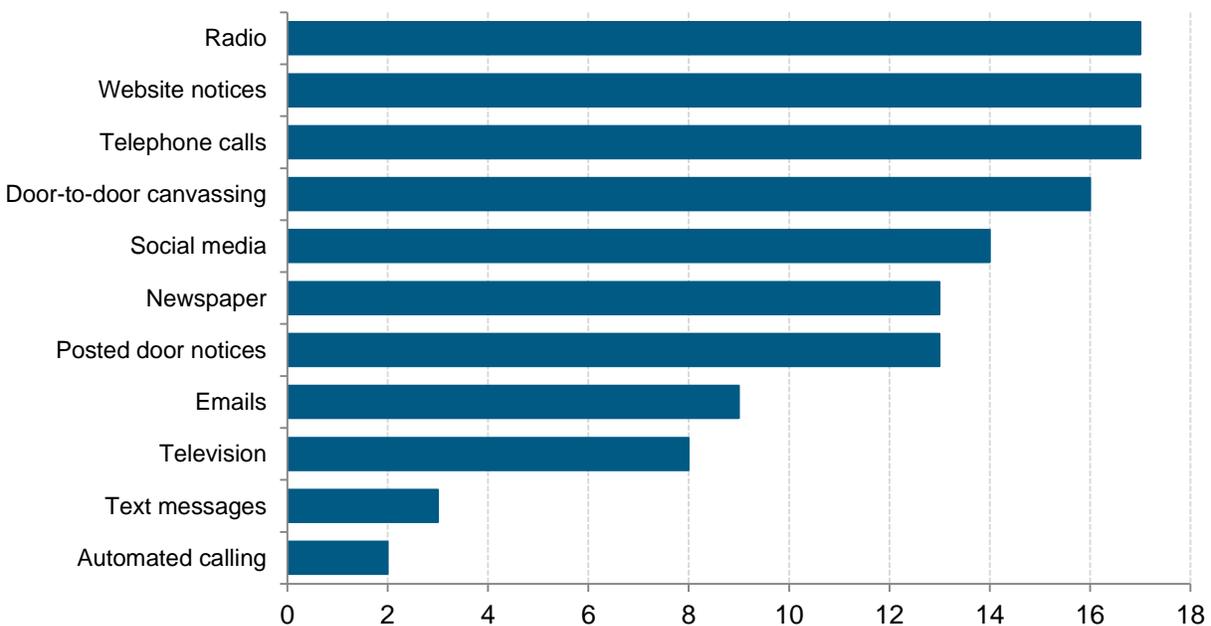
- water source and raw water characteristics
- history of the system and past corrective actions taken

In contrast, the other 11 respondents (46%) indicated that their public health unit did not have a formal risk assessment tool available for use in response to incidents.

Methods of communication

In regards to responding to incidents, 79% (n=19) of respondents indicated their public health unit had a formal written communications response plan in place. A variety of methods of communication are used to inform the public during such incidents, as show in Figure 2.

Figure 2. Communication methods used by public health units to inform the public during adverse water quality incidents (note: multiple answer selections were possible).



In addition to the methods of communication shown in Figure 2, one of the 19 respondents specified that advisories may be posted in public locations (e.g., recreation centers, post offices). Three respondents (16%) also highlighted their public health units' mass communication networks available for use during incidents. These communication networks use automated calling, emails, and text messages to notify the public. The notification system can be customized by the subscriber to use the communication methods of their choice.

A few of the respondents (n=5, 26%) referred to Ontario Regulation 170/03 (*Drinking Water Systems*) and Ontario Regulation 319/08 (*Small Drinking Water Systems*) when discussing methods of communication, which specify it is the responsibility of the owner/operator of the water system to notify the users of the incident.^{3,7} These respondents explained their public health unit may provide instructions prescribing the method of notification, and may support the operator to ensure affected users are properly notified. However, these respondents noted that it is ultimately up to the owner/operator to issue the advisory to the users. They indicated that the public health unit would monitor owner/operator communications, and take over if not enough was being done to reach users or if there was an imminent health hazard that necessitates immediate communication.

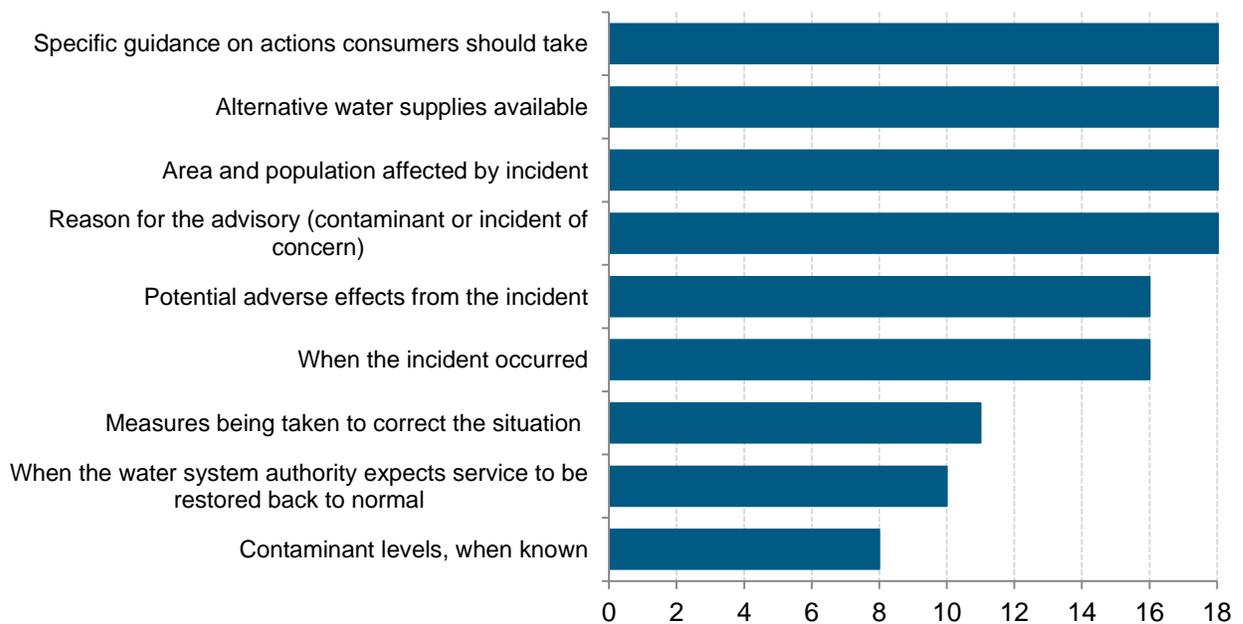
One respondent explained that their public health unit developed a written memorandum of understanding with their local public works division that scopes out each department's responsibilities during an incident, and provides a protocol for the communications between all stakeholders during the entirety of the response. In summary, it specifies that the public health unit's requests for information from the public works division should be made in relation to Schedule 17 and 18 of Ontario Regulation 170/03, which directs owner/operators to "take such other steps as are directed by the Medical Officer of Health." The public works division is responsible for distributing advisories after permission has been given by the Medical Officer of Health, but the public health unit staff may assist with distribution of the advisory if necessary. The two departments collaborate on media releases and public statements—the public health unit is responsible for providing information and answering questions regarding health issues, whereas the public works division covers the operational issues including who the affected users are and what is being done to correct the problem to ensure the water is safe for use. It is the responsibility of the public health unit to communicate additional public health information and guidelines to significant public health establishments including hospitals, nursing homes, daycare centers, schools.

Respondents indicated that the results of the risk assessment informs the method of communication used during incidents either always (n=3, 1%), often (n=3, 1%), sometimes (n=5, 21%), rarely (n=5, 21%), or never (n=3, 1%). Five respondents (21%) did not answer the question. Many of the respondents (n=10, 42%) specified that the risk assessment would help to identify how widespread or focused the advisory would need to be, and that method of communication is influenced by the location of the incident and number of people affected. A

specific example provided by a respondent was that rural areas and areas with seasonal cottages and homeowners would be notified through door-to-door canvassing instead of methods such as social media. Another respondent stated that if the affected water system served fewer than 20 residences, written materials would be provided to each owner rather than using traditional media channels (e.g., newspaper, radio, television). On the other hand, this respondent explained that traditional media would be used if the affected area was too large for door-to-door notification. Another respondent explained traditional media would be used if the situation was severe enough for it to be warranted, such as if there was an *E. coli* contamination in a large municipal system (similar to the Walkerton incident in 2000). In comparison, if there was high total coliform in a small municipal system, the respondent stated door-to-door notices would likely be the method used to issue the advisory. Those public health units with mass communication systems stated they would send out an email if a large population was affected. See Appendix H for an example of one public health unit’s response to a widespread chemical contamination that involved the municipal water supply.

Figure 3 shows the type of information public health units include in their advisory messages.

Figure 3. Type of information included in public health unit’s advisory messages (note: multiple selections were possible).



Nine respondents (37%) indicated their public health unit had customized their incident communications to reach specific audiences (e.g., people with limited English proficiency, young children, elderly). Ten other respondents' public health units (42%) had not customized their incident communications, and five respondents (21%) did not answer the question. Four respondents (44%) from those public health units with customized communications explained they use variations of the advisories depending on the language and the literacy of the community affected. Simple language and universal symbols were used to make the message understandable to the lay audience. One respondent specified that if the affected area contained facilities with populations particularly vulnerable to adverse water, then representatives from the public health unit would visit each site to provide instructions on how to continue operations, or for closing operations.

Respondents described their public health unit's working relationship with communication partners (e.g., communication division, local radio, local television, local newspaper) as strong partnerships with regular, frequent contact (n=14, 58%); casual relationships with occasional contact (n=4, 17%); and casual relationship with infrequent contact (n=1, <1%). Six respondents (25%) did not answer the question.

Most respondents (n=14, 58%) indicated responsibility for coordinating communications at their health unit is shared between a number of individuals, whereas the other respondents (n=5, 21%) listed only one individual as responsible. Five respondents (21%) did not answer the question. Most frequent responses for responsible individuals included the managers or supervisors of environmental health or health protection programs (n=14, 58%), and the communication specialist at the health unit (n=14, 58%) (multiple selections were possible). Of note, the five public health units that indicated one person coordinated their communications stated that it was the communication specialist who was responsible for such duties. Other individuals responsible listed included the public health inspector responding to the incident (n=9, 38%), the Medical Officer of Health (n=5, 21%), or the health unit director (n=4, 17%).

Fourteen public health units (58%) make use of two-way communication channels to receive input from the public regarding the response to incidents; four (17%) do not. Six respondents (25%) did not answer the question. Respondents from fourteen public health units specified that recipients are directed to contact the health unit with any questions or concerns. Furthermore, five public health units (21%) monitor social media accounts (e.g., Facebook, Twitter) for responses from the public and one public health unit utilizes Canada 211 (telephone service for

information on government and community based health and social services) to receive inquiries.

Types of advisories

Six respondents (25%) indicated their public health unit used a tiered approach to issuing water advisories similar to the four types of advisories identified earlier by the literature with slight variations. Twelve other respondents' health units (50%) did not use a tiered approach, and six respondents (25%) did not answer the question.

There were slight variations in the tiered advisory approaches utilized by the public health units specifying they had a tiered advisory system. Three of the six respondents (50%) specified their public health unit used a three tiered approach including precautionary advisory, advisory, and order. They explained precautionary advisories are used in lower risk situations where it is unknown if contamination has occurred, or if there is no evidence of contamination but the incident has the possibility to lead to a contamination (e.g., water main break or following loss of pressure). In these situations, the precautionary advisories are issued while conducting further investigation such as water testing. An advisory is issued if there is evidence of water contamination (e.g., water samples test positive for *E. coli*). An order is issued when the operator has not taken all necessary action.

One of the six respondents indicating their public health unit used a tiered approach explained that in addition to precautionary advisories, advisories and orders, their public health unit released health information advisories. These are issued to inform specific community users of an exceedance in levels of certain chemicals, such as fluoride and sodium, and to provide recommended measures to be taken to reduce exposure.

Another respondent indicated their public health unit used four types of advisories:

- precautionary boil water advisory
- urgent boil water advisory
- precautionary drinking water advisory
- urgent drinking water advisory

Noted factors taken into account when determining the type of advisory included:

- type of contaminant
- degree of contamination
- likelihood of false positive
- presence or absence of operational problems

Respondents specified that a number of factors are taken into account when determining when to remove an advisory. These included:

- identification of the cause of the water contamination
- clear water samples showing no more contamination
- demonstrated adequate treatment of the water (e.g., chlorine residual)
- repair of any mechanical damage to the system
- satisfactory water pressure

One respondent concluded that advisories are removed only when whatever led to the advisory has been rectified and samples are all within operating parameters (e.g., microbiology, chlorine, turbidity).

The most common types of incidents responded to by public health units each year are biological contamination or mechanical issues (which includes loss of pressure or a main line break); chemical or radiological contaminations occur less frequently. Figure 4 shows the average number of incidents of each type that are responded to by public health units each year. Figure 5 shows the average number of advisories of each type that are released by public health units following incidents each year.

Figure 4. Average number of adverse water quality incidents of each type responded to by public health units each year.

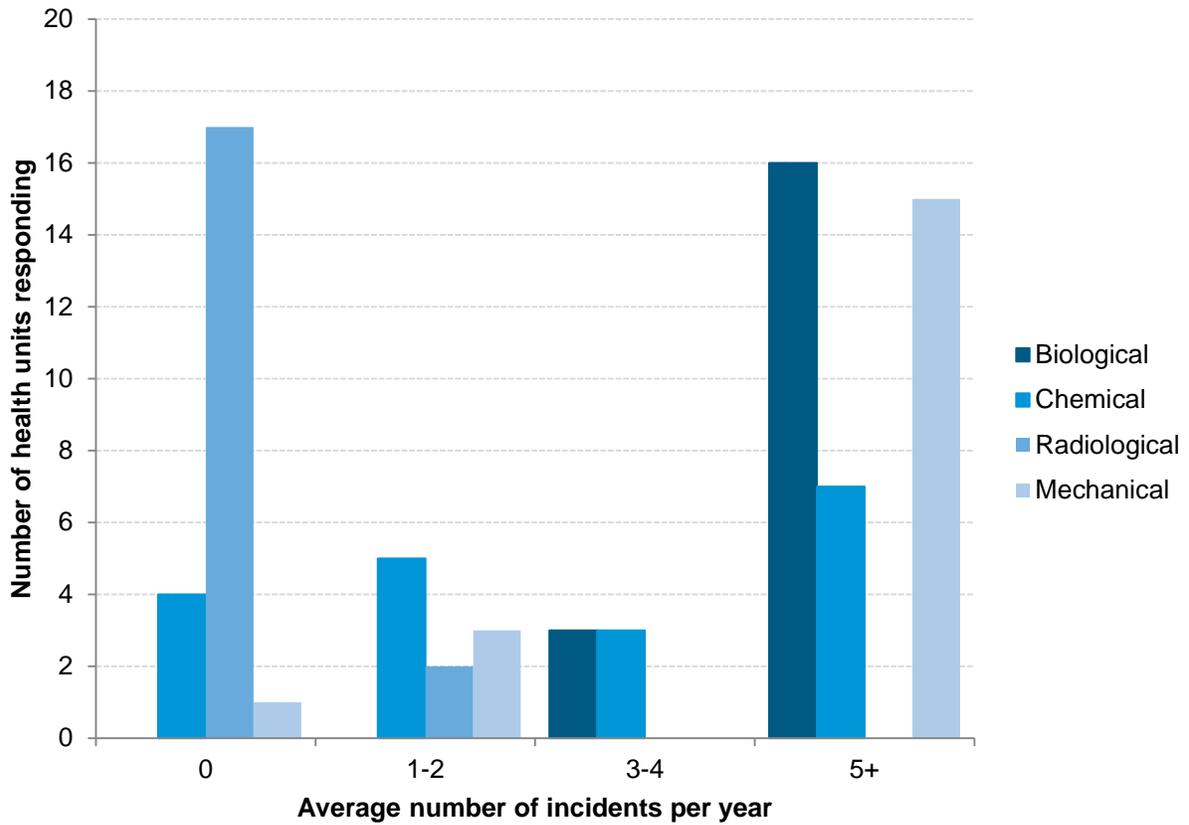
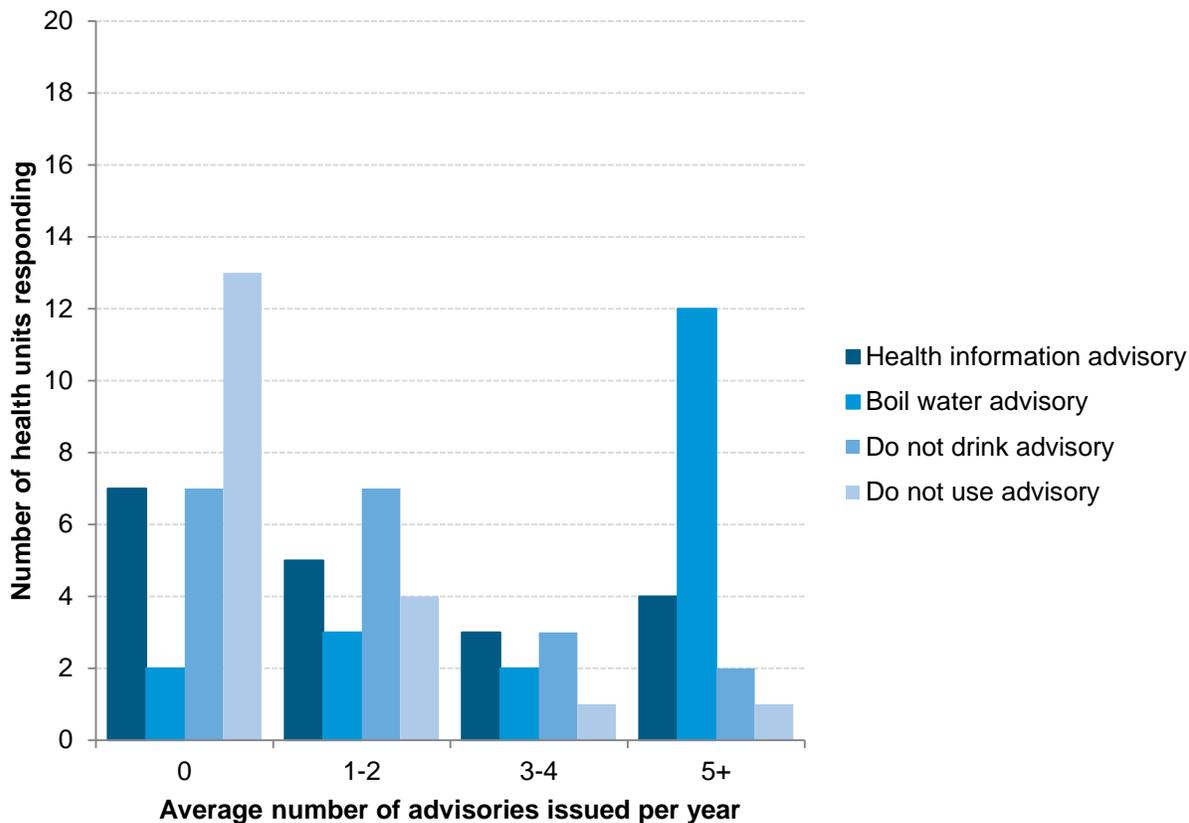


Figure 5. Average number of advisories of each type released following incidents by public health units each year.



Focus Group

A focus group was held in October 2016 with three members of the Public Works department: the Public Works Director, the Manager of Water Services, and the Water/Wastewater Operations Coordinator. As the department responsible for operation of the municipal water system in Oxford County, this focus group was particularly important for informing Public Health’s approach to responding to incidents affecting municipal systems.

Interviewees began by explaining how municipal water treatment and distribution in the province of Ontario is highly regulated as Ontario Regulation 169/03 (*Ontario Drinking Water Quality Standards*) sets out very specific parameter limits and descriptions for the way water must be maintained. Interviewees explained that what defines an incident is prescribed in this regulation and that there are reporting requirements associated with the parameters for what must be reported to Public Health and the Ministry of the Environment and Climate Change’s Spill Action

Centre (Spill Action Centre). This may involve laboratory test results that do not meet drinking water standards (e.g., *E. coli* levels greater than 0), or may include output from monitoring equipment that does not meet minimal standards (e.g., chlorine residual).

Interviewees noted that the Princeton incident—involving a loss of pressure in the system—was actually one of only a few types of incidents (power outages being another) where response is not as strictly prescribed in the regulations. They explained that there are no “hard and fast rules” for responding to pressure loss because it may occur due to a wide variety of reasons. They explained that in these situations, a risk assessment process is necessary and that it would need to involve consideration of:

- the length of time there was a loss of pressure
- the location in the system where there was pressure loss
- the scope of the pressure loss (how widespread)
- the likelihood of contamination in the system as a result of pressure loss
- the likelihood of complete pressure loss as opposed to partial or lower pressure in parts of the distribution system

Interviewees explained that management staff at Public Works would assess all these factors when deciding whether or not to consider an event as an incident that requires further action. It was explained that further steps would involve a discussion between Public Works, Public Health and the Spill Action Centre to evaluate all factors using the technological data available to determine the potential adverse effects. Interviewees stated that Public Works informs Public Health of incidents as per the regulatory requirements, and often informs them of abnormal events that would not necessarily be considered an incident to make them aware in case there are questions from the public.

Interviewees clarified that the response to potential adverse conditions may be different than what is actually defined as an adverse water quality incident strictly by the Ontario Regulation 169/03 parameters. They explained that there may be an incident as defined by regulations, but it may have absolutely no impact on the general public. An example provided was that if there is inadequate disinfection and drop in chemical levels, it would be considered an incident.

However, because of on-site storage and reservoirs, the water can be dealt with before entering the distribution system. For example, if an alarm indicates the chlorinator has failed, it can actually shut down pumps—the water can be mitigated or re-directed to chlorinate it prior to

reaching the public. Interviewees explained this would still be discussed with Public Health and MOECC SAC, and a decision would be made collaboratively about whether or not to issue an advisory.

Interviewees voiced concern with the approach taken during the Princeton loss of pressure incident. They pointed out that because notices were posted on the doors overnight, people did not see them until leaving the house in the morning. By this point, they stated that residents may have used water for bathing and preparing breakfast. Interviewees reflected that responding to incidents occurring during the day are much simpler because residents can be notified immediately without being as likely to disturb them. It was noted a complicating factor with pressure loss is that Public Works can be notified of it in the middle of the night, whereas other adverse results (e.g., lab results) are received during working hours.

Interviewees described that the biggest concern during low pressure incidents would typically be infiltration of contaminants through joints or cracks in the pipes that are not completely impermeable. They explained that because Princeton's water distribution system was so new and constructed with such high quality materials (high density polyethylene with welded joints), it is considered a "very tight system" that is well protected from infiltration by external contaminants. Therefore, the interviewees suggested back-siphonage from water use end points would have likely been the only source of contamination and should have been the main consideration during this event.

Interviewees suggested that Public Health's communication efforts should correlate with the level of danger to the health of the public. Thus, the interviewees stated that if there is little to no risk, then public notification may not even be necessary because it could cause people unnecessary concern. They explained that the risk assessment process needs to balance the benefits and risks associated with informing the public. The interviewees noted that when assessing the nature of a response from adverse microbiological samples, one needs to consider if water tested would have already been consumed. The interviewees reasoned that because the Princeton pressure loss incident lasted a short length of time (45 minutes), they did not think it warranted an advisory. They stated that if Public Health felt that there was a high level of risk to the health of the public, then it would have been more appropriate to issue a do not drink advisory rather than a boil water advisory. According to the interviewees, the potential contamination could have been chemical in nature rather than microbiological, in which case boiling the water would cause the contamination to become more concentrated rather than

treated with boiling. Interviewees explained that boil water advisories are only useful when the suspected contaminant is microbiological in nature. Furthermore, interviewees explained that if Public Health thought it was a serious threat to the health of the public, they would have recommended knocking on the doors and ensuring water users were notified, even if it was in the middle of the night.

The interviewees discussed a boil water advisory that was released in Norwich, Ontario in June of 2000 after three consecutive testing samples at a single residence tested positive for microbiological contamination. They explained how staff from Public Works, Public Health, the Township of Norwich and Norwich Public Utilities Commission worked together to notify the public with door-to-door notices. Duties were shared as Public Health notified vulnerable institutions (such as retirement homes, restaurants, and schools) and took microbiological samples from around the town, while Public Works added chlorine to the system and flushed the main lines in the area of the adverse sample. It was later determined that the cause of the positive test samples was due to “crud” build-up in the frost-free tap of the single residence. Following the event, a highly attended public meeting was held at the Norwich arena at which the public expressed satisfaction with the actions taken by Public Health and Public Works. Almost everyone was happy (with a few exceptions) that a boil water advisory was called as a precaution and that prompt action was taken, even though the system was proven to be safe. Interviewees explained that door-to-door notices were well received by the public, and the local media was cooperative in sending out appropriate, accurate messaging. The interviewees noted, however, that the Norwich incident occurred under different circumstances than the Princeton incident, because it happened just after the Walkerton *E. coli* outbreak, so heavy precautions were undertaken.

Key Informant Interviews

Three separate key informant interviews were held in October 2016 to gather information about the incident in Princeton. Specifically, information was sought about:

- Public Health’s response to the Princeton incident.
- Ways in which Public Health can improve its risk assessment procedures and communication practices when responding to future incidents.

The three interviewees participating in the interviews included the Chief Administrative Officer (CAO) of the Township of Blandford-Blenheim, Oxford County's Manager of Strategic Communication & Engagement, and an inspector who was directly involved with the handling of this incident.

CAO of the Township of Blandford-Blenheim

The interview with the CAO of the Township of Blandford-Blenheim took place at the Township head office in Drumbo, Ontario. Overall, the CAO was very satisfied with the response taken by Public Health to address the Princeton incident, stating that he felt it went "pretty much without a hitch."

Regarding the method of communication, the CAO stated that the door-to-door delivery of the notices was the most effective option when taking into consideration the size of the population affected (<200 homes), and the time the event took place (2:00 AM). The CAO expressed that leaving the notice posted on the door was the appropriate approach, and felt that knocking on the door or ringing the doorbell would have upset people. He felt that using a broader reaching channel of communication would unnecessarily alarm people that were not affected by the incident. He noted that some unaffected home owners in the community heard from others about the notices and had questioned the Township office about whether or not their water supply was affected, even those with a private well.

The CAO stated that the concern with posting the notice on the door is that people may use the water when they wake up to bath, brush their teeth, or make breakfast before going out the door to receive the notice. The CAO shared that he did receive some comments from people who had not seen the notices stuck to their front door until a few weeks after the incident. He explained that because the incident took place in the winter, people were not necessarily using the front door of their residences, but rather entering in the back door. To err on the side of caution, he recommended posting the notices in a few different locations at the same residence. No other comments were received by the Township office from members of the public regarding the incident.

If the event were to have been more widespread, the CAO suggested that notifying people by telephone could have been another option. However, he stated that this would be labour intensive and would require having a roster of the phone numbers of all affected residences.

According to the CAO, other potential issues of telephone notification includes: contacting people who do not have landlines, notifying tenants who do not own the property, or having the call go to voicemail. In light of this, he suggested it would likely be easier to just deliver the notice to the affected residences. If the incident were widespread in the Township, he suggested using every method of communication available, including a website notice, email and social media. At the time of this interview, the CAO mentioned that the Blandford-Blenheim Emergency Services was looking into getting a township-wide alert system to use for mass communication.

The CAO explained that the Township does not have two-way communication channels in place for receiving feedback from the public, and that inquiries about water issues would go to Public Works. The CAO felt that the contents of the notice were clear to residents, and that if residents had health-related questions, they would be referred to Public Health to get that information. He advised to always get as much information out as early as possible, because in his opinion, “it is better to over inform than under inform the public.” He further suggested, one is “never criticized for giving out too much information[...]the harm comes when you don’t tell them or you assume everybody knows [but some] actually don’t [know].”

The CAO expressed that he was pleased with the way Public Health handled the situation, and was satisfied with the collaboration between Public Health and the Township when responding to incidents. He requested that Public Health continues to involve the Township office early in the response as they may have ideas to help in delivery of the message.

Manager of Strategic Communication & Engagement

The Manager of Strategic Communication & Engagement for Oxford County was satisfied with the way Public Health collaborates with the Communications Department (Communications) in general. To improve response to incidents, she suggested that Communications should be informed earlier in the process, even while Public Works and Public Health are investigating and performing a risk assessment, so that they can be better prepared to respond in a rapid manner. When describing her perspective on the role of Communications in response to incidents, she stated that her team seems to be somewhat removed from the response in comparison to other types of communications from Public Health. For example, during heat warnings and cold weather alerts, she stated that Communications has a very well established system and process

for how to communicate alerts rapidly; there is a standard tip sheet that is made available on the website every time a notice is posted.

In contrast, during previous incidents, the Manager felt as though Communications had to be reactive to the messages that had already been issued by Public Health or Public Works. She noted that Communications does not fully understand the relationship between Public Health and Public Works in responding to incidents, which she explained makes it more difficult to understand their role in the communication response. She noted that Communications is responsible for releasing media advisories on behalf of Public Health. Therefore, bringing in the Communications closer to the time of initial assessment would be beneficial to improve the response.

Since Communications is responsible for updating the Oxford County website, it was suggested to have the information made available in the online newsroom and on the website homepage as quickly as possible so the public can find the information right away. Communications also uses social media, which she indicated would probably be one of the fastest ways to get out messaging. It was also suggested that creation of a standard boil water advisory social media graphic to post on Facebook and Twitter could be useful. She explained that a series of educational social media graphics are available for use during heat warnings and cold alerts, and that in the past, they have been widely shared on social media. She stressed that having an advisory template available during risk communications to the public is important because it ensures a consistent and reliable process that everyone, including the public, knows.

In reflection of the communication response to the Princeton incident, she stated that posting door notices was probably the best option for conveying the boil water advisory given the circumstances. She suggested that in the future, it may be helpful to post the advisory on social media, because residents would likely get these notices before leaving their homes. Furthermore, it was suggested that social media announcements, such as Facebook advertisements, can be targeted to the affected community and since social media platforms allow for two-way communications, she indicated it would allow for questions to be addressed in a timely manner. She also suggested that an emergency phone call system would work well for responding to incidents, but this capability is not yet in place for mass communication in Oxford County. Currently, there is an E-alert system used through the Oxford County website that allows subscribers to receive certain notifications by email, and a category was recently added for emergency notifications. Developing the Oxford County E-alert system to allow for public

health notifications to be sent by email and telephone could be a useful strategy when communicating incidents. However, she mentioned that since the E-alert system requires the user to sign up initially, this system would need to be promoted throughout Oxford County to ensure the public is aware of this service.

Public Health Inspector

The last key informant interview was held with the inspector who was on call during the incident in Princeton. Overall, he thought Public Health and Public Works responded to the incident in the most appropriate manner possible. Given the limited information about the risk to the health of the public available at the time of the incident, he felt that Public Health was responsible for taking a precautionary approach to public safety and that issuing the boil water advisory was the most appropriate course of action. The inspector noted that following the incident, there was a conversation between Public Health and Public Works as to whether posting notices on the door was the best method of communication, and whether it was necessary to issue any advisory at all. Since it was a low pressure incident, Public Health was concerned with the potential risk of back-siphonage of contaminants into the system. The inspector explained that in the absence of test results, he felt the public should be advised, and that posting the notice on the door was the best course of action given the situation. He indicated that if the incident would have posed a higher risk to residents, then awakening residents would have been the most appropriate to ensure they were immediately notified. The inspector concluded that he was pleased with the collaboration between Public Health and Public Works during the incident.

Discussion and Recommendations

To eliminate or reduce the potential risk to health caused by adverse water conditions, Public Health must be prepared to respond in a rapid, appropriate manner. The review of the literature, survey of public health units in Ontario, focus group discussion with members of Oxford County Public Works, and key informant interviews all provided valuable information about how Public Health's risk assessment and communication response to incidents can be improved to ensure the safety of drinking water for the public.

Risk management during incidents is a process that involves identifying existing and potential hazards in a drinking water system and assessing their potential impact on water quality.⁹

Having effective hazard identification and risk assessment tools are valuable for understanding the vulnerability of the drinking water supply and for planning effective strategies aimed at minimizing the risk to the public's health. In the survey of public health units in Ontario, respondents specified the five key components to include in a risk assessment including identifying:

- the likelihood of proper identification of the contaminant
- evidence of illness
- type of population affected
- type of contaminant
- concentration of contaminant
- effectiveness of current disinfection procedures

In addition, the *Response to Adverse Water Quality Guidance Document (2009)* emphasized including a detailed review of historical water quality data to assist in understanding the characteristics of the water and system performance over time. By incorporating this review in the risk assessment, aspects of the drinking water system that could be improved may be brought to the attention of the owner/operator.

The focus group with members of Public Works highlighted components of a risk assessment that would be pertinent for the response to an incident involving low pressure in the municipal water system. These components included:

- the length of time there was a loss of pressure
- the location in the system where there was pressure loss
- the scope of the pressure loss (how widespread)
- the likelihood of contamination in the system as a result of pressure loss
- the likelihood of complete pressure loss as opposed to partial or lower pressure in parts of the distribution system.

In order to improve the response to low pressure incidents, Public Health's risk assessment tool could be updated to incorporate the suggestions made by Public Works. It is recommended that Public Health:

1. Update the existing risk assessment tool to incorporate additional risk assessment components such as a review of historical water quality and a flow chart outlining the decision making process.

Effective communication with the public is an essential and important part of the incident response, necessary for ensuring the health of users of drinking water systems. There will always be uncertainty associated with conducting risk assessments; however, an appreciation of the uncertainty is necessary and important when taking a precautionary approach to managing risks and informing the public. As highlighted by the *Response to Adverse Drinking Water Quality Incident Guidance Document (2009)*, multiple methods of communication should be utilized in situations where an incident is deemed to be of high risk in order to ensure the message is received in a manner that is timely and effective. The survey of public health units provided helpful explanation for how the scope of an incident can influence method of communication. Particularly, it is recommended that Public Health:

2. Determine the appropriateness of door-to-door delivery of notices in the communication approach based on the incident's scope and geography.

Findings relayed by Public Works from the previous Norwich incident provides evidence to the effectiveness and public acceptability of delivering door-to-door notices in circumstances where the risk to health is uncertain. Ultimately, it is the responsibility of the owner/operator to notify water users of adverse water conditions. However, Public Health should be prepared to help facilitate the process and provide guidance to owner/operators to ensure notification of the public is timely and effective.

Social media is a method of communication that has not been previously used during incidents that could be added to the communication toolkit for improving response to incidents in Oxford County. Discussion with the Manager of Strategic Communication & Engagement for Oxford County provided insight into how creation of an informative graphic with a clear message would be useful during incidents, similar to those used during heat and cold alerts, as they can be widely viewed and shared amongst the public. Consideration can also be given into how to further develop the mass communication system in Oxford County. The Oxford County website currently contains an E-alert function whereby subscribers can chose to receive certain notifications by email. To improve mass communications during incidents, an option could be added for the public to be able to subscribe to receive important public health notices. The

addition of this feature would have to be advertised to ensure the public is aware of its existence. It is recommended that Public Health:

3. Explore the feasibility of a mass notification system and emergency warning system for Oxford County in collaboration with the Oxford County Emergency Management Supervisor.

Effective information exchange and co-operation between Public Health and key partners and stakeholders is essential when responding to incidents. It is typically the municipal public works department that is responsible for operation of municipal water systems. In cases where the public health unit falls under the same regional government as the public works department, as is the case in Oxford County, the two departments may collaborate and share responsibility during incidents to ensure a timely and effective response is carried out. From the survey of public health units, it was determined that one public health unit has developed a written memorandum of understanding to provide a protocol for the communication pathways with key partners, and to scope out each department's responsibilities during an incident. Adopting a memorandum of understanding to define roles and responsibilities in Oxford County would be beneficial for ensuring response to incidents is as well-coordinated as possible. A key finding from the key informant interview with the Manager of Strategic Communications & Engagement for Oxford County was that the Communications team is not clear on their role in incident communications. Therefore, incorporating the role of Communications in this memorandum would be helpful in ensuring they are involved early in the process. It is recommended that Public Health:

4. Develop a memorandum of understanding within Oxford County between Public Health, Public Works and Strategic Communications & Engagement departments to define roles and responsibilities during an incident, and create a flow chart as an appendix to provide an overview of each department's roles.

In the response to incidents, it is essential that the type of advisory released by Public Health provides appropriate instruction for mitigating the risk to the health of the public. The approach to issuing advisories outlined in Public Health's *Safe Water Policy and Procedure Manual* aligns with the recommendations from Health Canada and the MOHLTC. The manual outlines the use of health information advisories, boil water advisories, do not consume advisories and do not use advisories, allowing for specific types of incidents to be responded to in a manner that most

appropriately addresses the risks at hand. Furthermore, it allows for increased clarity of the message to the public when providing instruction for the actions they must take. However, the manual does not currently differentiate between a precautionary advisory and an emergency advisory. It is recommended that Public Health:

5. Adapt existing advisory categories (i.e., health information advisory, boil water, do not consume, do not use) to include a two-tiered approach for precautionary/emergency advisories where warranted (i.e., boil water, do not consume).

Adopting a two-tiered approach (precautionary/emergency) as recommended by Health Canada would allow for increased clarity to the public regarding the type of incident and the urgency of the situation. However, this would require that the public understands the differentiation between the types of advisories. It is recommended that Public Health:

6. Develop an educational approach to inform the public of the different types of advisories released in response to incidents.

Factors that should be taken into account when determining the type of advisory to issue include the potential for contamination or degree of contamination, type of contaminant and presence or absence of operational problems. Precautionary boil water advisories may be issued if there is potential or suspected microbiological contamination, which may occur when there is failure of treatment process or breach in mechanical integrity of the system. Emergency boil water advisories are best suited for cases where there have been samples that test positive for microbiological contamination. In the case of potential or detected chemical or radiological contamination, boil water advisories are not appropriate because it may actually cause an increase in contaminant concentration. Do not consume or do not use advisories are more appropriate for mitigating risk when there is potential or detected chemical or radiological contamination. Determining which of these two advisories to issue would depend on the severity of exposure. If ingestion of the contaminant is the primary threat to health, issuing a do not consume advisory would be appropriate. If the threat comes with any type of contact (e.g., dermal or inhalation), issuing a do not use advisory would be more appropriate. The advisories should only be removed once whatever led to the advisory has been rectified and consecutive testing samples are all within operating parameters (e.g., microbiology, chlorine, turbidity). To ensure timely issuance of an advisory during an incident, it is recommended that Public Health:

7. Refresh the existing *Safe Water Policy and Procedure Manual* and revise as necessary to include the templates for each type of advisory adapting recommended messaging from Health Canada.

The focus group and key informant interviews provided opportunity to evaluate the method of communication and type of advisory released during the Princeton incident. Public Health is responsible for taking a precautionary approach to managing risk to the health of the public. In this regard, Public Health felt as though issuing a precautionary boil water advisory was the appropriate response during the Princeton incident given the uncertainty of the safety of the water. However, as Public Works interviewees noted, the possibility of chemical contamination could not be ruled out. Therefore, they felt a do not consume advisory would have better ensured that the risk from the potential contamination was mitigated. The response to the Princeton incident was particularly complicated as it occurred in the middle of the night and the loss of pressure only lasted for a relatively short period of time. An additional factor of consideration was that the water distribution system was relatively new and well-built with high grade materials and tight joints. These factors provide reason to speculate that contamination would have been unlikely. Ultimately, Public Health decided to release a precautionary boil water advisory by posting notices on the doors of residences. This response was well received by the public and there were no illnesses resulting from the incident.

Conclusion

Public Health has a responsibility to eliminate or reduce the potential risk to the health of the public resulting from incidents. In reaching this end, it is necessary for Public Health to have effective risk assessment procedures and communication practices in place for responding to incidents. This report gathered findings from a literature review, a survey of public health units in Ontario, a focus group discussion with members of Oxford County Public Works, and key informant interviews to identify key components to include in a risk assessment tool, and to provide guidance on the selection of the appropriate methods of communication and type of advisory to use in response to incidents.

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Appendix A: Search Strategy

Databases Searched: Medline Ovid, CINAHL Plus, PubMed

Search Strategy:

1	water supply/ or water wells/	30515	Advanced
2	Water Microbiology/	29890	Advanced
3	Water Purification/	23503	Advanced
4	water pollution/ or water pollution, chemical/ or water pollution, radioactive/ or water quality/	22406	Advanced
5	Waterborne Diseases/	34	Advanced
6	wastewater/ or groundwater/	10302	Advanced
7	sewage/	24984	Advanced
8	exp fresh water/ or exp saline waters/ or exp Water Pollutants/	140690	Advanced
9	Drinking Water/	4548	Advanced
10	Communication/	70847	Advanced
11	(communication* adj3 (plan or plans or planning or toolkit* or strateg* or policy or policies or risk or risks)).mp.	5790	Advanced
12	access to information/ or advertising as topic/ or answering services/ or exp communication barriers/ or computer literacy/ or cybernetics/ or exp "diffusion of innovation"/ or disclosure/ or health communication/ or hotlines/ or information dissemination/ or exp information literacy/ or information seeking behavior/ or interdisciplinary communication/ or literacy/ or exp nonverbal	177685	Advanced

	communication/ or persuasive communication/ or propaganda/ or public service announcements as topic/ or social media/ or mass media/ or communications media/ or exp mass media/ or telecommunications/ or electronic mail/ or exp telephone/		
13	or/1-9	212907	Advanced
14	or/10-12	242577	Advanced
15	13 and 14	453	Advanced
16	limit 15 to (english language and yr="2000 -Current")	370	Advanced
17	meta analysis.mp.pt.	102605	Advanced
18	cochrane database*.jn.	15818	Advanced
19	(search or "systematic review*" or medline).tw.	256905	Advanced
20	practice guideline*.mp.	122614	Advanced
21	guideline.pt.	15968	Advanced
22	exp "review"/	2112663	Advanced
23	"best practice*".mp.	12893	Advanced
24	best practise*.mp.	52	Advanced
25	or/17-24	2373830	Advanced
26	16 and 25	28	Advanced
27	16 not 26	342	Advanced

Appendix B: Survey of Public Health Units

Purpose of this Survey

The purpose of this survey is to become informed of the risk assessment procedures and communications practices used by other Ontario public health units in response to adverse water quality incidents.

Privacy and Confidentiality

It is important to note that any information that you provide will be collated and stripped of public health unit identifiers. Please note, however, that while in transmission on the internet, confidentiality of data cannot be guaranteed.

Possible Risks and Harms

There are no known or anticipated risks from participating in this survey as the information that is collected will be combined, and thus individual responses will not be singled out. Participation is voluntary and you are free to withdraw at any time.

Possible Benefits

There are no known personal benefits to participating in this survey. However, by completing this survey your experiences will help inform the adverse water quality incident response plan in Oxford County.

Contacts for Further Information

Should you have any questions about the study, please contact either Tim Duivesteyn at (519) 539-9800 ext. 3527 or via email at tduivesteyn@oxfordcounty.ca, or Rob Haile at (519) 539-9800 ext. 3429 or via email at rhaile@oxfordcounty.ca. Further, if you would like to receive a copy of the results of this study, please contact either investigator.

Consent to Participant

I have read the above Letter of Information. I have had the opportunity to ask questions, and all questions have been answered to my satisfaction.

- I agree to participate
- I do not wish to participate

Name of health unit:

Does your public health unit have a written communications response plan in place for responding to adverse water quality incidents?

- Yes
- No

Does your public health unit use a risk assessment tool to determine whether or not to issue an advisory in response to adverse water quality incidents?

- Yes
- No

How often does your public health unit use the risk assessment tool to determine whether or not to issue an advisory in response to adverse water quality incidents?

- Always
- Often
- Sometimes
- Rarely
- Never

What factors are considered in the risk assessment tool utilized by your public health unit when determining the type of advisory to issue? (Check all that apply)

- Type of contaminant (microbiological, chemical, radiological)

- Concentration of contaminant
- Likelihood of proper identification of the contaminant
- Spread of contamination
- Effectiveness of current disinfection procedures
- Mechanical malfunction (e.g., loss of pressure)
- Evidence of illness
- Type of population affected
- Other, please specify... _____

What method(s) of communication does your public health unit use when issuing advisories in response to adverse water quality incidents? (Check all that apply)

- Phone calls
- Automated calling
- Text messages
- Door-to-door canvassing
- Posted door notices
- Website notices
- Emails
- Social media
- Newspaper
- Radio
- Television

Other, please specify... _____

Does the risk assessment inform the method(s) of communication used to issue the advisory?

- Always
- Often
- Sometimes
- Rarely
- Never

Please explain how the risk assessment informs the method of communication utilized in response to adverse water quality incidents.

What other related factors influence the channels of communication utilized during an adverse water quality incident? (Check all that apply)

- Cost to use the channel
- Budget restrictions
- Reach of the media
- Deadline to use the media
- Other, please specify... _____

Which of the following types of information do you provide in your advisory messaging? (Check all that apply)

- Reason for the advisory (contaminant or incident of concern)
- Contamination level (if applicable)

- When the incident occurred
- Potential adverse effects from the incident
- Area and population affected by incident
- Alternative water supplies
- Specific guidance on actions consumer should take
- What measures are being taken to correct the situation
- When water system authority expects service to be restored back to normal
- Other, please specify... _____

Does your public health unit use a tiered approach to issuing advisories? (e.g., precautionary advisory, advisory, order)

- Yes
- No

Please explain the circumstances considered when determining whether to issue a precautionary advisory, an advisory, or an order (e.g., severity of incident, type of contaminant/incident).

Approximately how many adverse water quality incidents from each of the following categories does your public health unit respond to each year on average?

	0	1-2	3-4	5+
Biological contaminant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chemical contaminant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Radiological contaminant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Mechanical issue (e.g., loss of pressure, water main break)

Approximately how many times are the following types of water quality incident advisories utilized at your public health unit each year on average?

0 1-2 3-4 5+

Health information advisory

Boil water advisory

Do not drink advisory

Do not use advisory

What factors do you consider when determining when to remove an advisory following an adverse water quality incident? (Check all that apply)

- Clear water samples
- Adequate treatment (e.g., chlorine residual)
- Repair of mechanical damage
- Water pressure satisfactory
- Other, please specify... _____

How do you communicate the conclusion of an advisory following the adverse water incident? (Check all that apply)

- Phone calls
- Automated calling
- Text messages
- Door-to-door canvassing
- Posted door notices

- Website notices
- Emails
- Social media
- Newspaper
- Radio
- Television
- Other, please specify... _____

How would you describe the working relationship between your public health unit and other communication partners (e.g., communication division, local radio, local television, local newspaper, etc.) when responding to adverse water quality events?

- Strong partnership with regular, frequent contact
- Casual relationship with occasional contact
- Acquainted with little contact
- No working relationship
- Other, please specify... _____

Who is responsible for coordinating communications during adverse water quality incidents at your public health unit? (Check all that apply)

- Medical Officer of Health
- Health Unit Director
- Manager of Environmental Health
- Public Health Inspector
- Communication Specialist

Other, please specify... _____

How would you describe the working relationship between your public health unit and the drinking water utilities in your jurisdiction?

Strong partnership with regular, frequent contact

Casual relationship with occasional contact

Acquainted with little contact

No working relationship

Other, please specify... _____

Have you customized your incident communications to reach different audiences? (e.g. people with limited English proficiency, young children, elderly)

Yes

No

How have you customized your incident communication to reach different audiences?

Do you have two-way communication channels to receive input from the public regarding response to adverse water quality incidents?

Yes

No

Which two-way communication channels do you use to receive input from the public regarding response to adverse water quality incidents?

Would you be willing to share your health unit's written communication response plan?

- Yes
- Not at this time

Thank you for agreeing to share your communications response plan! We greatly appreciate it! Please upload here or contact tduivesteyn@oxfordcounty.ca.

Would you be willing to share your health unit's risk assessment tool?

- Yes
- Not at this time

Thank you for agreeing to share your risk assessment tool! We greatly appreciate it! Please upload here or contact tduivesteyn@oxfordcounty.ca.

Do you have any additional feedback that you would like to share?

Appendix C: Public Works Focus Group Interview Guide

- 1) Could you briefly explain how Public Works approaches an adverse water quality incident?
 - a. Is there a risk assessment tool you use?
 - b. From your perspective, what factors should be considered when determining level of risk to the health of the public? (e.g. type of contaminant, concentration of contaminant, likelihood of proper identification, spread of contamination, effectiveness of current disinfection procedures, mechanical malfunction (loss of pressure), evidence of illness, type of population affected)
 - c. In general, when do you think Public Health should be notified about an adverse water incident? What are the triggers to communicate to Public Health?

- 2) In your perspective, what do you think are the best communication strategies during adverse water quality incidents? What would be the best way of distributing information to the public affected?
 - a. What are the best channels of communication? (phone calls, automated calling, text messages, door-to-door canvassing, posted door notices, website notices, emails, social media, newspaper, radio, television)
 - b. How should the risk assessment influence the way public health communicates the message to the public?

My next questions are related to the boil water advisory issued in Princeton, last January, following a loss of water pressure.

- 3) Do you think Public Health's assessment of the risk was appropriate in this particular case?

- 4) Was the communication strategy appropriate?
 - a. Was the method of communicating appropriate?
 - b. Was the message clear?

- 5) Was the response to the adverse water quality incident appropriate and timely considering the context?
 - a. Could the response have been improved in any way? If so, how?

My next questions are designed to learn more about your interaction with the public on water quality incidents.

- 6) Do you have two-way communication channels in place for receiving feedback from the public regarding response to adverse water quality incidents?
 - a. Which two-way communication channels do you use?
 - b. Have you received feedback from the public, or have there been concerns expressed about the way the adverse water quality incident was dealt with in January?

That is the end of my formal questions. Is there anything else you would like to share with us that might be helpful to us to improve Public Health's response to adverse water quality incidents?

Thank you for your time – we really appreciate you sharing your thoughts and ideas with us.

Appendix D: CAO of the Township of Blandford-Blenheim Key Informant Interview Guide

My first questions are related to the boil water advisory issued in Princeton, last January, following a loss of water pressure.

- 1) To begin, what are your impressions of the way adverse water quality incident was communicated in Princeton during the loss of pressure incident?
 - a. Was the method of communicating appropriate?
 - b. Was the message clear?
 - c. Was the response of Public Health and Public Works appropriate and timely considering the context?
 - d. Could the response have been improved in any way? If so, how?

My next questions are designed to learn more about your interaction with the public on water quality incidents.

- 2) Do you have two-way communication channels in place for receiving feedback from the public regarding response to adverse water quality incidents?
 - a. Which two-way communication channels do you use?
 - b. Have you received feedback from the public, or have there been concerns expressed about the way the adverse water quality incident was dealt with in January?
- 3) In your opinion, would it be worth holding a focus group with members of the public to discuss Public Health's communications during adverse water quality incidents?
 - a. If yes, what do you think is the best method of recruiting people?
 - a. Is there an alert system within the township that could be used to alert the residents of the community? Would you be able to send out a notice to the residents of the community that were affected by the loss or pressure incident?
- 4) In your perspective, what do you think are the best communication strategies during adverse water quality incidents?
 - a. From your perspective, what are the best channels of communication? (by channel, I mean things like phone calls, automated calling, text messages, door-to-door canvassing, posted door notices, website notices, emails, social media, newspaper, radio, television)

That is the end of my formal questions. Is there anything else you would like to share with us that might be helpful to us to improve our response to adverse water quality incidents?

Thank you for your time – we really appreciate you sharing your thoughts and ideas with us.

Appendix E: Manager of Strategic Communication & Engagement Key Informant Interview Guide

- 1) Could you briefly explain your perspective on the role of the Communications team in responding to adverse water quality incidents?
 - a. Could you briefly explain how the Communications team approaches communications during an adverse water quality incident?

- 2) In your perspective, what do you think are the best communication strategies during adverse water quality incidents? What would be the best way of distributing information to the public affected?
 - a. What are the best channels of communication? (phone calls, automated calling, text messages, door-to-door canvassing, posted door notices, website notices, emails, social media, newspaper, radio, television)
 - b. How should the risk assessment influence the way Public Health communicates the message to the public? Are there any particularly important principles to follow during risk communications?

My next questions are related to the boil water advisory issued in Princeton, last January, following a loss of water pressure.

- 3) Was the communication strategy appropriate?
 - a. Was the method of communicating appropriate?
 - b. Was the message clear?
 - c. Was the response to the adverse water quality incident appropriate and timely considering the context?
 - d. Could the response have been improved in any way? If so, how?

- 4) Do you have two-way communication channels in place for receiving feedback from the public regarding response to adverse water quality incidents?
 - a. Which two-way communication channels do you use?
 - b. Have you received feedback from the public, or have there been concerns expressed about the way the adverse water quality incident was communicated in January?

That is the end of my formal questions. Is there anything else you would like to share with us that might be helpful to us to improve Public Health's communication response to adverse water quality incidents?

Thank you for your time – we really appreciate you sharing your thoughts and ideas with us.

Appendix F: Public Health Inspector Key Informant Interview Guide

- 1) Do you think Public Health's assessment of the risk was appropriate in this particular case?
- 2) What are your impressions of the way adverse water quality incident was communicated in Princeton during the loss of pressure incident?
 - a. Was the method of communicating appropriate?
 - b. Was the message clear?
 - c. Was the response of the Public Health Unit and Public Works appropriate and timely considering the context?
 - a. Could the response have been improved in any way? If so, how?
- 3) In your opinion, would it be worth holding a focus group with members of the public to discuss public health's communications during adverse water quality incidents?
 - a. If yes, what do you think is the best method of recruiting people?
 - a. Is there an alert system within the township that could be used to alert the residents of the community? Would you be able to send out a notice to the residents of the community that were affected by the loss or pressure incident?
- 4) In your perspective, what do you think are the best communication strategies during adverse water quality incidents?
 - a. From your perspective, what are the best channels of communication? (by channel, I mean things like phone calls, automated calling, text messages, door-to-door canvassing, posted door notices, website notices, emails, social media, newspaper, radio, television)

That is the end of my formal questions. Is there anything else you would like to share with us that might be helpful to us to improve our response to adverse water quality incidents?

Thank you for your time – we really appreciate you sharing your thoughts and ideas with us.

Appendix H: An Example of an Advisory Released by a Public Health Unit

In the survey of public health unit's, one respondent highlighted an example of a water advisory that was released as a result of a car wash spilling 19 litres of “pink water” containing detergent into the municipal water supply. The water contained traces of 2-Butoxyethanol, an industrial solvent which can cause irritation of the eyes and nose. It can also cause breathing problems and low blood pressure if ingested. During this event, there was an initial ban for water usage for drinking and bathing, even if boiled first. The ban was later downgraded to a boil water advisory before being rescinded. Due to the widespread impact and potential for significant harm to health, the communication response was rapid and consisted of door-to-door, radio, newspaper, website, and social media platforms.



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