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Our File No. 20035
June 18, 2001

VIA ELECTRONIC MAIL

The Honourable Dennis R. O'Connor
Commissioner
The Walkerton Inquiry
180 Dundas Street West, 22nd Floor
Toronto, Ontario
M5G 1Z8

Dear Justice O'Connor:

Re: Walkerton Inquiry - Part II - Ontario Water Works Association ("OWWA") and Ontario Municipal Water Association ("OMWA") - Review of Report by Daniel Krewski, et al on Managing Health Risks from Drinking Water, etc. prepared by Michael Brodsky on behalf of OWWA/OMWA - Respecting Issue # 3 Matters - History of Drinking Water Pollution Outbreaks in Ontario

As you are aware I am counsel to the OWWA/OMWA, two organizations with Party status in Part II of the Inquiry. In this regard, I am attaching the above referred to review and recommendations prepared by Mr. Michael Brodsky for OWWA/OMWA. We would ask that this review be placed on the Commission website, and that Mr. Brodsky be given an opportunity to appear before you during the Public Hearings to speak to his review and recommendations.

This review is the first of ten submission documents to be filed by OWWA/OMWA in the Part II process. I would ask that if Mr. Brodsky is permitted to appear before you that I also be permitted to attend with Mr. Brodsky to assist the Commission, where necessary, in understanding the link between the above document and the other OWWA/OMWA submission documents to follow.

I trust the above is satisfactory.

Yours truly,

"Joseph Castrilli"

Joseph F. Castrilli

Encl.
c.c. James Van Loon
c.c. Michael Brodsky, consultant to OWWA/OMWA
c.c. Rod Holme, OWWA
c.c. Jim Craig, OMWA
c.c. Judy A. MacDonald, OWWA
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A Review of
Managing Health Risks from Drinking Water:
A Background Paper for the Walkerton Inquiry

by

Daniel Krewski, John Balbus, David Butler-Jones,
Charles Haas, Judith Isaac-Renton, Ken Roberts & Martha Sinclair

As it relates to the History of Drinking Water Pollution Outbreaks in Ontario

By

Michael H. Brodsky
Consultant

Review Prepared on Behalf of the Ontario Water Works Association and the Ontario Municipal Water Association

This review has been prepared at the request of the Ontario Water Works Association/Ontario Municipal Water Association. It does not represent the findings, views or recommendations of the Commissioner. In the preparation of this report, I reviewed Chapters 3,4,5, and 6 as they pertained to the History of Drinking Water Pollution Outbreaks in Ontario. In the interest of simplicity, I will refer to the document under review as the Krewski paper.

Table of Contents

Executive Summary

- Waterborne outbreaks probably occur with greater regularity than we are aware of, but reporting of such incidents is uncommon in Ontario
- Waterborne outbreaks are often not recognized or, if they are, are not traced as being due to the drinking water supply
- Lack of a coordinated effort at data collection on a national scale.
- From 1974-2000, there were only 39 published reports on waterborne outbreaks/incidents associated with drinking water in Ontario.
- 6/30 reported incidents (20.0%) associated with municipally treated distribution systems
- 16/30 (53.3%)of reported incidents associated with well water
  - 5/16 (31.2%) outbreaks associated with communal wells
  - Private wells involved with 11 of the 16 (68.8%) reported incidents
- 7/30 (23.3%) incidents associated with consumption of water from an unprotected source
- 1/30 (3.3%) of reported incidents associated with "trucked-in water."
- Scientific opinion suggests that majority of outbreaks tend to occur in water systems which serve small populations.
- Most of the pathogens that cause water-borne outbreaks have animal hosts and thus may be spread either directly or indirectly from animals to humans
- No correlation between the presence of any indicator organism and enteric pathogens
- Indicator organisms should be more appropriately interpreted as a reflection of both the susceptibility of a water source to environmental contamination and the source of such contamination
- Implementation of intensive microbiological monitoring schemes with emphasis on more frequent sampling of finished water may not be a cost-effective approach to improving microbiological safety
- A well-managed, adequately treated water treatment system should be effective in ensuring the removal or inactivation of such disease-causing organisms
- The type and effectiveness of the disinfectant and treatment to be used depends on the type of pathogen present and the physical characteristics of the water being treated
- Water utilities should engage in constant monitoring of performance parameters, such as turbidity, particle counting, free and residual chlorine and pH, as these measures offer a more preventative approach than intensive microbiological monitoring activities.
- Drinking water must be kept pathogen-free water by (a) selecting high-quality, uncontaminated source waters, (b) applying efficient treatment and disinfection measures to water, and (c) protecting water from contamination during distribution to the user.
- Public health protection requires a preventive approach to detect and correct problems before they affect the quality of the finished water supply. The development of a formal framework for water quality management incorporating preventive management principles and elements of internationally recognized risk management systems such as Hazard Analysis Critical Control Point (HACCP) is paramount.
- Consideration should be given to establishing "sentinel systems" to enhance microbiological monitoring in smaller communities and to complement DWSP.

These "sentinel systems" would require the collection of water potability data from various "high risk" locations (e.g. loops, end of line, etc.) throughout the distribution system on a more frequent basis. These samples would be analyzed for microbial parameters with results communicated accordingly.

A Review of
Managing Health Risks from Drinking Water:
A Background Paper for the Walkerton Inquiry
As it relates to the History of Drinking Water Pollution Outbreaks in Ontario

Introduction

The Krewski paper is very comprehensive. The authors have compiled considerable information on waterborne issues from many different sources. Chapters 3,4,5 and 6 of the Krewski paper make some reference to outbreaks and/or their prevention. This report, however, presents very little detail on outbreaks in Ontario. I have, therefore taken the liberty of appending information on waterborne outbreaks in Ontario attributed to drinking water.

Outbreak Reporting

One of the conclusions of the Krewski paper is that "Reporting of water-borne diseases continues to be a regular occurrence; however, most such occurrences are likely not reported." I would concur that water-borne outbreaks probably occur with greater regularity than we are aware of, but reporting of such incidents is uncommon. In Ontario, it is usually up to the local Health Units to voluntarily report the outcome of their investigations into suspected waterborne outbreaks to the Public Health Branch using the Reportable Disease Information System (RDIS). The RDIS was only started in 1990 and the system was not functioning as designed until 1993. The Public Health and Epidemiology Report Ontario (PHERO) summarizes articles on outbreaks. PHERO was previously known as Ontario Disease Surveillance Reports (ODSR). These reports are usually forwarded to Health Canada for publication in Canada Diseases Weekly Report (CDWR) and compiled into annual summaries of "Foodborne and Waterborne Disease in Canada". Such summaries are published at least 5 years after the fact. In some situations, however, laboratory investigations are published as research reports and not included in PHERO or CDWR. In addition, because reporting is voluntary, not all incidents/outbreaks are published, which exacerbates the problem of compiling accurate information on the frequency of waterborne occurrences. Furthermore, there is no standardized format for reporting details of the outcome of waterborne investigations, which makes comparative data compilation difficult.

Most of the articles in PHERO prior to 1996 focussed on food-borne diseases. The most recent PHERO presents data on Reported Enteric Disease Outbreaks in Ontario, 1994 to 1998, based on the RDIS. For this five year period there were 1628 enteric outbreaks; it is estimated that approximately six of the 16 water-borne disease outbreaks (1% of 1628) were associated with drinking water. There are, however, no details of any of these suspected outbreaks.

Appendix A presents a chronological summary of gastrointestinal outbreaks in Ontario, associated with drinking water between 1974 and 2000. I was unable to locate any published reports on outbreaks attributed to drinking water prior to 1974. From 1974-2000, there were 39 published reports on waterborne outbreaks/incidents associated with drinking water in Ontario. I have numbered the outbreaks in chronological order for

reference purposes and have attempted to summarize the information in a standardized format using the Canada Diseases Weekly Report (CDWR) Annual Summary as a guide for comparative purposes. Many reports, even those extracted from CDWR were missing significant details. This is a reflection of the lack of a coordinated effort at data collection on a national scale in waterborne outbreak investigations. Of the thirty incidents where the vehicle of transmission was reported, 16 (53.3%) were associated with well water (1,3,11,12,13,15,18,20,22,23,25,26,27,29,33,38), and only 6 (20.0%) were associated with municipally treated distribution systems (4, 14,19,36,37,39). Private wells were involved with 11 of the 16 (68.8%) reported incidents (11,12,13,18, 20, 22, 25, 26, 27, 33, 38); however, two of these incidents were outbreaks in which many people were exposed (20, 26). The other five of the 16 well water incidents were associated with communal wells (1, 3,15, 23, 29). There were seven incidents (23.3 %) in which the vehicle of transmission was associated with the consumption of water from a non-protected drinking water source, such as a spa, spring, river or lake (5, 7, 9, 28, 32, 34, 35). One incident of the 30 (3.3%) was attributed to "trucked-in water"(6).

Although Ontario has an outbreak surveillance program, waterborne outbreaks are often not recognized or, if they are, are not traced as being due to the drinking water supply. Consequently, information on waterborne GI incidents/outbreaks in Ontario is difficult to obtain:

- The majority of these incidents involve only single cases or only a few individuals.
- Patients frequently do not visit a physician because symptoms are usually self-limiting.
- Physicians, unless they are seeing a cluster of patients with similar symptoms or etiology, are unlikely to notify the local Public Health agency.
- Patients are unlikely to notify the local Health Unit in the event of illness, unless there a number of related cases among family or friends.

There is an inherent difficulty of directly implicating a water source even in outbreak situations:

- water contamination is usually temporal rather than ongoing;
- distribution of the organisms in the water is heterogeneous;
- the etiological agents of waterborne disease are the same as those which cause foodborne illness and inevitably, in GI incidents, food is considered as the primary vehicle;
- the incubation period, i.e the time between exposure and symptoms onset, is often prolonged and notification of an incident or outbreak to a Medical Officer of Health is often well after the fact or does not occur at all;
- environmental methods for the isolation and identification of some etiological agents, particularly viruses, do not exist;
- environmental methods for the isolation and identification of some etiological agents, such as Cryptosporidium, lack sufficient sensitivity or specificity. Hence the etiological agent is rarely isolated. The Krewski paper states that "another important characteristic of protozoan parasites is that, unlike the other groups of microorganisms, they do not reproduce outside the host, i.e., in the environment or in the laboratory. This makes laboratory detection in water samples more difficult than that of bacterial or viral pathogens." Although some viruses can grow in tissue culture, virus detection in water samples is as inherently difficult as is the detection of protozoan parasites.

Therefore, as concluded in the Krewski paper, it would appear that the number of water-borne disease outbreaks and illnesses could be much greater than actually reported.

Endemic Illness

As presented in the Krewski paper, in recent years, questions have also been raised about the possible involvement of water-borne pathogens in endemic disease, particularly gastroenteritis, even in supplies that meet conventional microbiological water quality criteria. The pathogens that contribute to endemic gastroenteritis may potentially be transmitted by several routes including drinking water, recreational water, food and beverages, person-to-person contact, animal to person contact, and indirectly through contamination of the environment. Identification of the relative contribution of different factors is difficult and requires specific epidemiological studies. A number of approaches have been adopted in an attempt to answer this question by measuring the effect of water quality on human health. To date the studies have given conflicting results and it is not clear whether microorganisms in drinking water contribute to endemic gastroenteritis. It is possible, of course, that significant amount of endemic illness may exist in some water supplies but not others because of differences in microbiological water quality. Given the importance of the issue, there are ongoing, well designed, studies to provide a better understanding of the relationship between water quality and health.

Human Health Issues

Five primary factors influence the risk of illness to human health from water-borne pathogens:

- the concentration of the pathogen in the drinking water.
- the minimum dose capable of producing an infection (human infectious dose) of the pathogen.
- the virulence of the pathogen, i.e. its ability to overcome the body's defensive mechanisms
- the immune status of the host.
- the volume of water ingested. (Average daily intake is assumed to be 1.5 L).

From a human health protection perspective therefore there is no tolerable lower limit for the concentration of pathogens in drinking water supplies; this essentially means that the health-based guideline water-borne pathogens should be zero. The complete removal of pathogens from drinking water, however, is rarely feasible both from an economic and technological standpoint. Therefore, the approach used is to establish a practical limit taking into consideration the need to reduce the health risks to a level deemed "acceptable" in light of economic and practical factors.

Monitoring Water Potability

Although the source of contamination is not always identified, it would appear that most of the viruses, bacteria and parasites that cause water-borne outbreaks have animal hosts. Thus, these pathogens may be spread either directly or indirectly from animals to humans. It is, therefore, reasonable and traditional to assess water potability by looking for evidence of fecal contamination and by testing for indicator organisms rather than for pathogens. The Krewski report suggests that these indicators have been observed to be associated with the presence of potentially harmful microbial agents. Although water

microbiologists wish this were always true, there is no absolute correlation between the presence of any indicator organism and any enteric pathogen. I would suggest that indicator organisms should be used to reflect both the susceptibility of a water source to environmental contamination and the source of such contamination.

Testing for indicator organisms is used worldwide. I do not support the statement that faecal coliform bacteria remain the most useful indicator bacteria. The faecal coliform group includes several types of bacteria, but *Escherichia coli* is the most specific indicator of faecal contamination. The detection of *E. coli* in a potable water sample indicates that the source of the supply may be subject to contamination from a sewage or faecal source and hence the probability of faecal pathogens also being present is increased. The presence of coliforms in finished water suggests that the supply may be subject to environmental contamination i.e. a breach in the system. However, they could also arise from the sloughing of biofilms, or occur as the result of the decay of organic material, particularly in loops or the ends of lines in distribution systems. Persistent detection of coliform contamination should be investigated, including a sanitary survey. According to the Krewski paper, the Ontario Ministry of the Environment has been only been keeping a record of adverse microbiological water quality data since July 2000. However, the MOE Drinking Water Surveillance Program (DWSP) has been in effect for many years. In 1997, 145 municipal water works, representing 88% of the population served by municipal water, were being monitored by DWSP, including microbiological sampling**.** Included in these municipalities are the major water sources as well as supplies considered more vulnerable to contamination events**.** In Ontario, small systems (currently defined by the United States Environmental Protection Agency as serving populations <3,300) are generally not included in DWSP (because the goals and objectives of DWSP were designed to support standard setting not regulatory compliance). Notwithstanding the goals and objectives of DWSP, of specific interest is Craun's observation that the majority of outbreaks tend to occur in small systems. As reflected by the Walkerton outbreak, smaller communities could be at a higher risk for waterborne disease in Ontario. I would therefore recommend that consideration be given to establishing "sentinel systems" to enhance microbiological monitoring in smaller communities and to complement DWSP. These "sentinel systems" would require the collection of water potability data from various "high risk" locations (e.g. loops, end of line, etc.) throughout the distribution system on a more frequent basis. These samples would be analyzed for microbial parameters with results communicated accordingly.

The Ontario Ministry of Health and Long-Term Care has only been keeping records of Boil Water Advisories in a new database since January of 2000. From 1982-1999, however, the Environmental Microbiology Section of the Laboratory Services Branch of the Ontario Ministry of Health and Long Term Care was compiling data on the frequency of adverse bacteriological results for indicator organisms in drinking water. This data was gathered on a the regional laboratory basis related to where the analyses were conducted, compiled monthly, summarized quarterly and annually, circulated internally and shared with the Public Health Branch. Unfortunately, this data has never been formally published. The data does indicate the potential for waterborne outbreaks in potable water samples tested by the MOH laboratories from municipally treated water supplies, community wells and private residential wells. The data indicated that although there was seasonal variation, on average between 25-40% of samples from private wells had

significant coliform counts, with about 20% having *E. coli* contamination. Similarly about 10-15 % of samples from communal wells had coliform contamination and about 5% of these had *E. coli*. The contamination frequency of municipally treated systems was in the order of 1-2 % for coliforms and <1% for *E. coli.* There is no information on the significance of these observations relative to waterborne incidents or outbreaks.

Conclusions and Recommendations

A well managed, adequately treated (e.g., filtered, effective disinfection and maintenance of a free chlorine residual) water treatment system should be effective in ensuring the removal or inactivation of such disease-causing organisms. The type and effectiveness of the disinfectant and treatment to be used depends on the type of pathogen present and the physical characteristics of the water being treated. Reliance on microbiological testing for assessing water potability is totally inadequate. Microbiological parameters are useful to validate the effectiveness of the treatment and disinfection, particularly in the distribution system. In this regard, I agree with the conclusion of the Krewski paper that the implementation of intensive microbiological monitoring schemes with emphasis on more frequent sampling of finished water may not be a cost-effective approach to improving microbiological safety. Constant monitoring of other performance parameters, such as turbidity, particle counting, free and residual chlorine and pH offer a better preventative approach. In this regard, we both concur with the WHO statement that pathogen-free water "is attainable by selection of high-quality uncontaminated sources of water, by efficient treatment and disinfection of water known to be contaminated with human or animal faeces, and by ensuring that such water remains free from contamination during distribution to the user."

As pointed out in the Krewski report, public health protection requires a preventive approach to detect and correct problems before they affect the quality of the finished water supply. The development of a formal framework for water quality management incorporating preventive management principles and elements of internationally recognized risk management systems such as Hazard Analysis Critical Control Point (HACCP) is paramount. Although developed for the food industry, HACCP principles are applicable to any process that has health risks associated with it. Certainly the production of potable water falls into this category and is amenable to the HACCP philosophy.

In Summary:

1. Water utilities should engage in constant monitoring of performance parameters, such as turbidity, particle counting, free and residual chlorine and pH, as these measures offer a more preventative approach than intensive microbiological monitoring activities.

2. Drinking water must be kept pathogen-free water by (a) selecting high-quality, uncontaminated source waters, (b) applying efficient treatment and disinfection measures to water, and (c) protecting water from contamination during distribution to the user.

3. Public health protection requires a preventive approach to detect and correct problems before they affect the quality of the finished water supply. The development of a formal framework for water quality management incorporating preventive management principles and elements of internationally recognized risk management systems such as Hazard Analysis Critical Control Point (HACCP) is paramount.
4. Consideration should be given to establishing "sentinel systems" to enhance microbiological monitoring in smaller communities and to complement DWSP. These "sentinel systems" would require the collection of water potability data from various "high risk" locations (e.g. loops, end of line, etc.) throughout the distribution system on a more frequent basis. These samples would be analyzed for microbial parameters with results communicated accordingly.

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APPENDIX A

SUMMARY OF GASTROINTESTINAL DISEASE IN ONTARIO ASSOCIATED WITH DRINKING WATER
1974-2000

1974- no outbreaks or incidents reported

1975- 1 outbreak reported

1. Locale: Kingston
   - Etiology: *Salmonella typhi*
   - Date of Occurrence: July 29-August 18
   - Location: Summer Camp
   - Vehicle: Well water
   - Number ill: 42
   - Number at Risk: 987
   - Incubation period: 10-30 days (mean, 19 days)
   - Duration: unknown
   - Symptoms: nausea, vomiting, diarrhea, cramps, headache, fever
   - Source of Contamination: Well water epidemiologically implicated
   - Underlying cause:
     - Sewage system connected to well
     - Chlorination not working properly

1976- 3 outbreaks reported:

2. Locale: Napanee
   - Etiology: *Giardia lamblia*
   - Date of Occurrence: October
   - Location:?
   - Vehicle: ?
   - Number ill:1
   - Number at risk: 3
   - Incubation Period: not defined
   - Duration: 3 weeks
   - Symptoms: stools with bloody mucus
   - Source: Not defined, drinking water epidemiologically implicated
   - Underlying Cause: Not identified

3. Locale: Grey County
   - Etiology:*?*
   - Date of Occurrence: September 2-3
   - Location: Ski Resort
   - Vehicle: Well water
   - Number ill: 19
   - Number at Risk: 37

- Incubation period: 6-24 hours
- Duration:?
- Symptoms: nausea, vomiting, diarrhea, cramps, fever
- Source of Contamination: ?
- Underlying cause: water contained >80 fecal coliforms/100 mL

4. Locale: Kitchener
   - Etiology:?
   - Date of Occurrence: September 26
   - Location: Restaurant
   - Vehicle: Municipal water
   - Number ill: 41
   - Number at Risk: 203
   - Incubation period: 24 hours
   - Duration: ?
   - Symptoms: ?
   - Source of Contamination: ?
   - Underlying cause: Chlorinator malfunctioned

1977- 2 outbreaks reported:

5. Locale: Napanee
   - Etiology: *Salmonella paratyphi B*
   - Date of Occurrence: July 19
   - Location: Private Spa
   - Vehicle: Spa water
   - Number ill: 1
   - Number at Risk: 6
   - Incubation period:?
   - Duration: 15 hours
   - Symptoms: diarrhea, fever
   - Source of Contamination:?
   - Underlying cause:?

6. Locale: Kingston
   - Etiology: *Giardia lamblia*
   - Date of Occurrence: April 8
   - Location: Work camp
   - Vehicle: Trucked-in water
   - Number ill: 2
   - Number at Risk: 4
   - Incubation period:?
   - Duration: 3 weeks
   - Symptoms:?
   - Source of Contamination:?
   - Underlying cause:?

1978- No outbreaks reported

1979- 1 outbreak reported

7. Locale: St.Catherines
    - Etiology:?
    - Date of Occurrence: June
    - Location: Private home
    - Vehicle: Spring water
    - Number ill: 4
    - Number at Risk:?
    - Incubation period: 24 hours
    - Duration:?
    - Symptoms: vomiting, diarrhea, fever
    - Source of Contamination:?
    - Underlying cause:? 4cats and 2 dogs also ill

1980 – 1 outbreak reported

8. Locale: Hamilton
    - Etiology: *Campylobacter jejuni*
    - Date of Occurrence: January 7-March 9
    - Location: Trailer camp
    - Vehicle: ?
    - Number ill: 220
    - Number at Risk: 224
    - Incubation period:?
    - Duration: 2 weeks
    - Symptoms: vomiting, diarrhea, rash
    - Source of Contamination: *C. jejuni* isolated from the drinking water source
    - Underlying cause:? Water had undesirable odour

1981- 1 outbreak reported:

9. Locale: Kapuskasing
    - Etiology: *Giardia lamblia*
    - Date of Occurrence: July
    - Location: Scout wilderness camp
    - Vehicle: river water
    - Number ill: 3
    - Number at Risk: 14
    - Incubation period: up to 2 weeks
    - Duration:?
    - Symptoms:?
    - Source of Contamination: Untreated river water
    - Underlying cause:?

1982- 1 outbreak reported

10. Locale: Windsor
    - Etiology:?
    - Date of Occurrence: May 23-24
    - Location: Trailer camp
    - Vehicle: ?
    - Number ill: >5
    - Number at Risk:?
    - Incubation period:?
    - Duration:?
    - Symptoms: diarrhea, cramps
    - Source of Contamination: Drinking water
    - Underlying cause:?

1983- No outbreaks reported

1984- 3 outbreaks reported:

11. Locale: Kingston
    - Etiology: *Campylobacter jejuni*
    - Date of Occurrence: June 13
    - Location: Private home
    - Vehicle: Well water
    - Number ill: 1
    - Number at Risk:?
    - Incubation period:?
    - Duration:?
    - Symptoms:?
    - Source of Contamination: ?
    - Underlying cause: *C. jejuni* isolated from well water

12. Locale: Central East
    - Etiology: *Yersinia enterocolitica*
    - Date of Occurrence: ?
    - Location: Private home
    - Vehicle: Well water
    - Number ill: 3
    - Number at Risk:?
    - Incubation period:?
    - Duration:?
    - Symptoms:?
    - Source of Contamination: ?
    - Underlying cause: *Y. enterocolitica* isolated from well water

13. Locale: Lakefield
    - Etiology:?
    - Date of Occurrence: March 10
    - Location: Private home
    - Vehicle: Well water
    - Number ill: 3
    - Number at Risk:?
    - Incubation period:?
    - Duration:?
    - Symptoms: diarrhea
    - Source of Contamination: Private well
    - Underlying cause: Suspected contamination of well water

1985- 6 outbreaks reported:

14. Locale: Orangeville
    - Etiology: *Camplyobacter jejuni*
    - Date of Occurrence: April 17
    - Location: Private homes and businesses
    - Vehicle: Unchlorinated municipal well water
    - Number ill: >250
    - Number at Risk: 15,000
    - Incubation period:?
    - Duration: <2->7 days (majority ill for 3-7 days)
    - Symptoms: vomiting, diarrhea, bloody diarrhea, fever, chills, weight loss
    - Source of Contamination: Farm ditch water, possible frozen animal wastes in the watershed
    - Underlying cause: Heavy rain and spring thaw combined to cause ditch to overflow into well. Chlorination only instituted after bacterial counts rose and boil water advisory issued.

15. Locale: Orillia
    - Etiology: *Campylobacter sp.*
    - Date of Occurrence: May 19-20
    - Location: Resort
    - Vehicle: Well water
    - Number ill: 29
    - Number at Risk: 120
    - Incubation period:?
    - Duration:?
    - Symptoms: vomiting, diarrhea, cramps, fever, headache, chills
    - Source of Contamination:?
    - Underlying cause: Chlorinator malfunction

16. Locale: Long Sault
    - Etiology: *Salmonella sp.*
    - Date of Occurrence: April 9-10

- Location: Restaurant
- Vehicle: ?
- Number ill: 13
- Number at Risk: 21
- Incubation period: 8-37 ½ hours (Mean 19 ½ hours)
- Duration:?
- Symptoms: nausea, vomiting, diarrhea, cramps, headache
- Source of Contamination:? Drinking water tests indicated coliforms >160/100 mL and Fecal coliforms 4/100 mL
- Underlying cause:?

17. Locale: Cornwall
    - Etiology: *Salmonella sp.*
    - Date of Occurrence: April12
    - Location: Restaurant
    - Vehicle: ?
    - Number ill: 11
    - Number at Risk: 40
    - Incubation period: 5-17 hours (Mean 8 hours)
    - Duration:?
    - Symptoms: nausea, vomiting, diarrhea, cramps, headache, chills, weakness
    - Source of Contamination: Drinking water
    - Underlying cause: Chlorination equipment failure

18. Locale: Cambridge
    - Etiology: *Salmonella sp.*
    - Date of Occurrence: June 27
    - Location: Private home
    - Vehicle: Well water
    - Number ill: 2
    - Number at Risk: 6
    - Incubation period:?
    - Duration: 1 week
    - Symptoms: nausea, vomiting, diarrhea, cramps, headache, chills
    - Source of Contamination:?
    - Underlying cause:?

19. Locale: Pickering
    - Etiology: *Salmonella hadar, Sal. Haardt, Campylobacter jejuni, C. laridis*
    - Date of Occurrence: March 6-29
    - Location: Nuclear plant
    - Vehicle: Municipal drinking water
    - Number ill: 162
    - Number at Risk: 1000
    - Incubation period:?

- Duration: 3 days
- Symptoms: nausea, vomiting, diarrhea, cramps, fever, dizziness, muscle aches
- Source of Contamination: Lake water
- Underlying cause: Poor system design and human error. Cross contamination between municipal distribution system and nuclear plants' high pressure cooling water system with no backflow prevention device; gate valve left in an open position; raw lake water drawn into cooling water system and then into distribution system.

1986- 2 outbreaks reported:

20. Locale: Eastern Ontario
    - Etiology: *Campylobacter jejuni*
    - Date of Occurrence: June 10-16
    - Location: Farm
    - Vehicle: Well water
    - Number ill: 35
    - Number at Risk: 41
    - Incubation period: 72-96 hours
    - Duration:?
    - Symptoms:?
    - Source of Contamination: Surface water
    - Underlying cause: Visiting children drank contaminated well water (Fecal coliform >60/100 mL) from a hose. Well had loose sanitary seal allowing surface water to enter.

21. Locale: Brampton
    - Etiology:?
    - Date of Occurrence: August 18
    - Location: Camp ground
    - Vehicle: ?
    - Number ill: 14
    - Number at Risk:?
    - Incubation period:?
    - Duration:?
    - Symptoms: nausea, vomiting, cramps, fever, headache
    - Source of Contamination: Drinking water
    - Underlying cause:?

1987- 2 outbreaks reported

22. Locale: Guelph
    - Etiology: Yersinia enterocolitica
    - Date of Occurrence: August 31
    - Location: Home
    - Vehicle: Well water

- Number ill: >2
- Number at Risk:?
- Incubation period:?
- Duration:?
- Symptoms:?
- Source of Contamination: Yersinia enterocolitica isolated from Private well.
- Underlying cause:?

23. Locale: Mindemoya
    - Etiology: Norwalk-like, Picorna and Rota-like viruses
    - Date of Occurrence: March 10
    - Location: Hockey arena
    - Vehicle: Well water
    - Number ill: 68
    - Number at Risk: 114
    - Incubation period: 36 hours
    - Duration: 48 hours
    - Symptoms: nausea, vomiting, diarrhea, cramps
    - Source of Contamination: Communal well
    - Underlying cause: Chlorinator turned off during hockey tournament

1988- No outbreaks reported

1989- 1 outbreak reported

24. Locale: Williamstown
    - Etiology:?
    - Date of Occurrence: May 26
    - Location: Church
    - Vehicle: ?
    - Number ill: 35
    - Number at Risk: 49
    - Incubation period: 4-67 hours
    - Duration: 5-7 hours
    - Symptoms: nausea, vomiting, diarrhea, cramps, fever, headache
    - Source of Contamination: Drinking water
    - Underlying cause: ?

1990- No outbreaks reported

1991- 1 outbreak reported

25. Locale: Arthur
    - Etiology: Giardia lamblia
    - Date of Occurrence: September 10
    - Location: Home
    - Vehicle: Well water

- Number ill: 4
- Number at Risk: 5
- Incubation period: 2-10 days
- Duration: 4 days
- Symptoms: diarrhea, cramps
- Source of Contamination: Drinking water
- Underlying cause:?

1992- 3 outbreaks reported

26. Locale: Toronto
    - Etiology: Shigella sonnei
    - Date of Occurrence: November 24
    - Location: Private Home
    - Vehicle: Well water
    - Number ill: 16
    - Number at Risk:?
    - Incubation period:?
    - Duration:?
    - Symptoms:?
    - Source of Contamination: Private well
    - Underlying cause:?

27. Locale: York Region
    - Etiology: Giardia lamblia
    - Date of Occurrence: March 3
    - Location: Private Home
    - Vehicle: Well water
    - Number ill: 4
    - Number at Risk: 5
    - Incubation period:?
    - Duration:?
    - Symptoms:?
    - Source of Contamination: Private well
    - Underlying cause:?

28. Locale: Peterborough
    - Etiology: Giardia lamblia
    - Date of Occurrence: June 9
    - Location: Camp
    - Vehicle: Lake water
    - Number ill: 4
    - Number at Risk: 55
    - Incubation period: ?
    - Duration:?
    - Symptoms:?
    - Source of Contamination: Lake water

- Underlying cause:?

1993- 8 outbreaks reported

29. Locale: Ottawa
    - Etiology: Rotavirus
    - Date of Occurrence: March 18
    - Location: Day Care Centre
    - Vehicle: Well water
    - Number ill: 11
    - Number at Risk: 60
    - Incubation period:?
    - Duration:?
    - Symptoms:?
    - Source of Contamination: Communal well
    - Underlying cause: Possible sewage contamination

30. Locale: Toronto
    - Etiology: Giardia lamblia
    - Date of Occurrence: January 29
    - Location: Church
    - Vehicle: ?
    - Number ill: 20
    - Number at Risk: 20
    - Incubation period:?
    - Duration:?
    - Symptoms:?
    - Source of Contamination: Drinking water
    - Underlying cause:?

31. Locale: Toronto
    - Etiology: Giardia lamblia
    - Date of Occurrence: July 28
    - Location: Travel
    - Vehicle: ?
    - Number ill: 4
    - Number at Risk: 5
    - Incubation period:?
    - Duration:?
    - Symptoms:?
    - Source of Contamination: Drinking water
    - Underlying cause:?

32. Locale: Swift Current
    - Etiology: Giardia lamblia
    - Date of Occurrence: August

- Location:?
- Vehicle: River water
- Number ill: 3
- Number at Risk:?
- Incubation period:?
- Duration: 336 hours
- Symptoms: diarrhea
- Source of Contamination:?
- Underlying cause:?

33. Locale: Simcoe County
    - Etiology: Giardia
    - Date of Occurrence: August 15
    - Location: Private home
    - Vehicle: Well water
    - Number ill: 3
    - Number at Risk: 4
    - Incubation period:?
    - Duration:?
    - Symptoms:?
    - Source of Contamination: Private well
    - Underlying cause:?

34. Locale: Guelph
    - Etiology: Giardia lamblia
    - Date of Occurrence: September 3
    - Location: Camp
    - Vehicle: Lake water
    - Number ill: 8
    - Number at Risk: 200
    - Incubation period:?
    - Duration:?
    - Symptoms:?
    - Source of Contamination:?
    - Underlying cause:?

35. Locale: Toronto
    - Etiology: Giardia lamblia
    - Date of Occurrence: September 14
    - Location: Home
    - Vehicle: Lake water
    - Number ill: 2
    - Number at Risk: 4
    - Incubation period:?
    - Duration:?
    - Symptoms:?

- Source of Contamination:?
- Underlying cause:?

36. Locale: Kitchener-Waterloo
    - Etiology: Cryptosporidium parvum
    - Date of Occurrence: March-April
    - Location: Municipality
    - Vehicle: Municipal water
    - Number ill: ~100,000
    - Number at Risk: 390,000
    - Incubation period:?
    - Duration:?
    - Symptoms: nausea, vomiting, diarrhea, cramps, fever
    - Source of Contamination: Contaminated source water (Grand River)
    - Underlying cause: Improper backflushing of filters?

37. Locale: Collingwood
    - Etiology: Cryptosporidium parvum
    - Date of Occurrence: February-March
    - Location: Municipality
    - Vehicle: Municipal water
    - Number ill: 20 laboratory confirmed cases
    - Number at Risk: 2500-8750
    - Incubation period:?
    - Duration:?
    - Symptoms: diarrhea, cramps
    - Source of Contamination: Unfiltered drinking from Nottawasaga Bay
    - Underlying cause: Runoff from farmland and sewage effluent into source water. Only chlorination.

1994 (No summaries currently available)

1995 (No summaries currently available)

1996 (No summaries currently available)

1997 (No summaries currently available)

38. Locale: South Western Ontario
    - Etiology: *Escherichia coli O157:H7*
    - Date of Occurrence: July
    - Location: Farm
    - Vehicle: Well water
    - Number ill: 1
    - Number at Risk: 5000
    - Incubation period: 3-8 days

- Duration: 1-3 weeks
- Symptoms: bloody diarrhea
- Source of Contamination: Farm runoff
- Underlying cause: Integrity of well was compromised; Possibly contaminated by cattle-manure runoff into surface water

1998 (No summaries currently available)

1999 (No summaries currently available)

2000 (No summaries currently available)

39. Locale: Walkerton
    - Etiology: *Escherichia coli O157:H7, C. jejuni & Salmonella sp.*
    - Date of Occurrence: May
    - Location: Municipality
    - Vehicle: Municipal water
    - Number ill: 2300, 7 deaths
    - Number at Risk: 5000
    - Incubation period: 3-8 days
    - Duration: 1-3 weeks
    - Symptoms: diarrhea, bloody diarrhea, HUS,
    - Source of Contamination: Farm runoff
    - Underlying cause:
        - Heavy rains accompanied by flooding;
        - E. coli O157:H7 and Campylobacter in the environment;
        - well subject to surface water contamination
        - inadequate treatment system
        - Deteriorating distribution system