The Walkerton Inquiry

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An Overview of Drinking Water Testing Laboratories in Ontario

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Abstract

The purpose of this paper is twofold: first, to provide an overview of the laboratories that test Ontario's drinking water, their current capacity, and the adequacy of accreditation programs; and second, to make recommendations for the role of the Ministry of the Environment's (MOE's) laboratory.

The findings and recommendations are based on interviews with key experts in public and private laboratories, and with not-for-profit organizations representing the private and public laboratory industry in Canada.

Capacity does not appear to be a problem with respect to analyzing drinking water. Private laboratories have the flexibility and agility to quickly respond to an increase in test load. With regard to the accreditation system in Canada, the interviewees were generally very positive about the ISO/IEC 17025 accreditation program provided by the Standards Council of Canada (SCC) and the Canadian Association for Environmental Analytical Laboratories (CAEAL). The program has developed with strong involvement and input from both private and public laboratories and is internationally regarded as a model for accreditation programs.

The overarching and generally undisputed role of the Laboratory Services Branch of the MOE is to support the standard setting, policy development, and regulatory functions of the ministry. This role includes developing new, non-routine, and more sensitive testing methods for drinking water contaminants. It also includes monitoring both the database on the quality of drinking water and the accreditation status of the private and municipal laboratories providing the test data. It should not, however, include providing high-volume routine testing services, which are capably handled by private laboratories. The reference centre activities carried out by the MOE need to be better focused and more relevant, and new methods must be practical and cost-effective. Public education and general outreach activities need to be strengthened and better staffed. Support for long-term research and trend analysis, publication in peer-reviewed technical literature, and presentations at both national and international conferences are essential if the MOE is to be truly effective as an internationally recognized reference centre for environmental

testing. The Ministry of Health and Long-Term Care should take an active lead in identifying new microbiological contaminants (such as *Cryptosporidium*) and developing new microbiological test methods.

About the Author

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1 Introduction

1.1 Background

The private environmental laboratory industry in North America has evolved rapidly over the last 10 to 15 years. In the 1970s, the public became increasingly aware of the presence of toxic chemicals and microbial contaminants in the environment. The political climate of the 1980s was conducive to a 'command and control' approach to environmental legislation. The result was the introduction of a number of regulatory programs that require significant analytical testing – for example, the Municipal-Industrial Strategy for Abatement (MISA) in Ontario. The environmental laboratory industry grew at a rate that reached about 25% per annum; it developed a 'commodity mentality' with respect to environmental analyses, with heavy emphasis on increased productivity and automation.

As the recession of the early 1990s slowed the regulatory drive, the resulting overcapacity, declining profitability, and vigorous competition among private laboratories led to price decreases of as much as 40% to 50%. The health of the environmental laboratory industry declined, causing numerous casualties as laboratories either closed or were swallowed in one of the many mergers.

In Canada, industry consolidation in the late 1990s created two major players in the general realm of environmental testing in Ontario: Philip Analytical Services Inc. and Maxxam Analytics Inc. As laboratories of all sizes struggled to stay in business, those who improved their quality and service survived; but many of the 'mom and pop' laboratories that were unable to meet the higher standards of quality went out of business.

The continuing evolution of the laboratory industry has been driven by liability issues and quality assurance of data. Today, successful laboratories in Ontario, both private and public, operate within internationally defined and accepted standards and guides that define quality management and technical competence. Private sector laboratories that also carry out analytical testing for U.S. clients are frequently subject to several different state and national accreditation regulations. Many of Ontario's laboratories analyze drinking water, often as one of many environmental matrices that include air, waste, soil, and biota.

This paper has been prepared for discussion purposes only and does not represent the findings or recommendations of the Commissioner.

Concern about the quality of Ontario's drinking water has increased dramatically since the tragedy in Walkerton in May 2000. In August 2000, the minister of the environment unveiled Operation Clean Water, a water quality strategy that included the introduction of the *Drinking Water Protection Regulation* (Regulation 459).[1] This regulation specifies that laboratories that perform drinking water analysis must be accredited to carry out the methods that cover the parameters cited in Regulation 459 and any additional parameters identified in Certificates of Approval or Director's Orders.

1.2 Objectives

The three primary and specific objectives of this paper are the following:

1. To provide an overview of the drinking water testing laboratory capacity in Ontario;

2. To report on the adequacy of the current accreditation processes for both public and private water testing laboratories; and

3. To recommend the functions that the Ministry of the Environment (and specifically its Laboratory Services Branch) should carry out to fulfill its public policy role in Ontario.

The following section describes the approach used to meet these objectives.

2 Approach

2.1 The Questions

The following questions were used as guidelines during interviews and data gathering, thus ensuring that the objectives of the study were met.

1. What is the existing capacity for testing drinking water in Ontario?

Information sought:

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[1] O. Reg. 459/00, under the *Ontario Water Resources Act*, RSO 1990, c. O-40.

- estimated number of private and public environmental laboratories conducting tests for a range of parameters (including drinking water analyses), and number of laboratories conducting solely drinking water testing; and

- the roles of private versus public laboratories, including those of the Ministry of the Environment (MOE), the Ministry of Health and Long-Term Care (MOH), and municipal laboratories.

2. What are the existing accreditation processes for drinking water laboratories and are they adequate?

Information sought:

- definition of accreditation;

- summary of roles and relationships of existing organizations that provide accreditation services to water testing laboratories in Ontario;

- assessment of the effectiveness of the current accreditation system; and

- examples of accreditation mechanisms and processes in other jurisdictions.

3. What are the appropriate in-house laboratory functions the MOE must undertake to fulfill its policy and regulatory role in respect of Ontario's drinking water?

Information sought:

- how the MOE can maintain sufficient scientific expertise;

- the MOE's role in problem solving, method development, education, and outreach;

- what research is being conducted on emerging contaminants; and

- the MOE's role with respect to accrediting organizations.

2.2 Information Gathering

The findings and observations outlined in section 3 are based on a series of interviews with key experts in public and private laboratories and with not-for-profit organizations representing or serving the laboratory industry in Canada. The opinions and anecdotal responses are supported wherever possible with online documents accessed from Web sites and with reports and papers analyzing this sector.

3 Findings and Observations

3.1 Capacity

There is little current quantitative published information on the capacity and capability of Ontario's analytical laboratories. Exact information on revenues, staffing, annual sample and test loads, and specialized equipment is generally considered competitive intelligence and kept confidential. However, the anecdotal information gathered from interviews with senior private and public sector laboratory experts seems to indicate general agreement on the following estimates of capacity:

- As of July 2001, there were 79 analytical testing Ontario-based laboratories carrying out drinking water analyses (this total includes three located outside Ontario that are part of a larger network headquartered in Ontario).
- Of the 79, there are 12 MOH laboratories and 1 hospital laboratory.
- A limited number of the laboratories are accredited for the full spectrum of chemical and microbiological analyses; many are small laboratories that conduct only microbiological analyses.
- The two major players in drinking water analyses are Maxxam Analytics Inc. and Lakefield Research Ltd., although Philip Analytical Services Inc. and Accutest Laboratories Ltd. also carry out a substantial amount of testing and are increasing their capacity for drinking water analysis.
- Total annual environmental laboratory revenues in Canada are approximately $150 million, of which Ontario generates $50 million annually.

- On the basis of an estimated $90,000 revenue per employee to cover full facility and overhead costs (estimates ranged from $80,000 to $100,000), there are 500 to 600 staff employed in private laboratories in the province.

- There are 11 significant municipal laboratories in Ontario, none of which perform the full spectrum of tests; most of their work is carried out for the respective region or municipality with little direct competition with private laboratories, although this was an issue when the municipal laboratories initially opened.

Capacity does not appear to be a concern with respect to drinking water analysis; in fact, there appears to be *more than adequate capacity in the private sector to handle the added drinking water workload*. In the case of one large private laboratory, for example, the number of samples analyzed increased by 50% from 1999 to 2000 and will likely almost double in 2001. As one interviewee pointed out, a free market economy moves fast, and private laboratories can gear up quickly. A large private laboratory can rapidly add capacity by purchasing or leasing equipment, adding space, and hiring and training staff. An additional $10-million worth of analytical work can thus be accommodated by a private laboratory in a two- to three-month time frame. By comparison, a government laboratory attempting to add capacity quickly would likely be encumbered by various purchasing approvals and hiring restrictions.

Interviewees estimated that the major sources of revenue for the private sector environmental laboratory industry are split among contractors and consulting engineering companies (50%), industry (30%), and government (20%.)

3.2 Accreditation

3.2.1 What Is Accreditation?

Generally, accreditation is a means of assessing the competence of a laboratory in a given field of testing. Accreditation is defined and thoroughly described in the backgrounder prepared for the Walkerton Inquiry by the Standards Council of Canada (SCC) and the Canadian Association for Environmental Analytical Laboratories (CAEAL), with input from the Canadian Council of Independent

Laboratories (CCIL).[2] It is defined as "the formal recognition of the competence of a laboratory to carry out specific tests." These tests are registered with SCC and posted on its Web site. To become accredited, a laboratory must demonstrate competence in its field of testing according to the internationally recognized standard, ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories*. (This document was published in 2000 to replace the previous ISO/IEC Guide 25 and is now the only accepted standards document for SCC accreditation applicants.)

Note that accreditation in Canada is voluntary unless regulators mandate accreditation to suit particular regulatory needs.

Accreditation is not the same as proficiency testing recognition.[3] Accreditation requires a full on-site inspection and ongoing demonstration of both performance and capability:

- Performance is evaluated through interlaboratory comparisons of test results on samples of each accredited parameter twice a year – also referred to as 'proficiency testing' (PT).
  - Successful performance results in the laboratory becoming 'recognized' and receiving a CAEAL Certificate of Proficiency.
  - Unsuccessful performance results in the suspension of the laboratory's recognition and/or accreditation.
- Capability is evaluated through inspection (site audits) of the laboratory every two years by the accreditation body.

Accreditation also entails taking corrective action, adopting a code of ethics, and conforming to publicity guidelines. The laboratory must demonstrate that it complies with an international standard in its record keeping practices, ensuring full traceability of data (full chain of custody).

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[2] Standards Council of Canada [SCC], Canadian Association for Environmental Analytical Laboratories [CAEAL], and the Canadian Council of Independent Laboratories [CCIL], 2001, "Accreditation of Laboratories in Canada with a Focus on Drinking Water Testing Laboratories," public submission, Walkerton Inquiry [online], [cited March 2001], <www.walkertoninquiry.com/part2info/publicsubmissions/pdf/SCC-CAEAL14mar.pdf>. See section 3.2.3 for a description of CCIL.
[3] This is described in more detail in section 3.2.3.

PT recognition, on the other hand, is a subset of accreditation, in that performance relative to other laboratories is evaluated through proficiency testing, but no on-site inspection takes place. As of July 2001, 112 laboratories in Canada were accredited through the SCC/CAEAL accreditation program, and most of these conducted testing of analytes in water. Another 30 applicants are in the process of becoming accredited.[4] About 265 laboratories in Canada are recognized by CAEAL for proficiency testing.

While accreditation has obvious benefits in terms of objective third-party analysis of a laboratory's operations, it does have its limits. *Accreditation cannot guarantee the accuracy of all test data* from accredited laboratories, no matter how thorough the assessors and the audit; but it does bring the laboratory closer to perfection. Data provided by SCC/CAEAL/CCIL show a comparison of 528 results between accredited and non-accredited laboratories, using five test parameters (including fecal coliform) over three years of proficiency testing. Accredited laboratories achieved higher test scores and a greater number of perfect scores in each parameter. These organizations conclude that "accredited laboratories produce more consistent and competent results than non-accredited laboratories."[5]

Accreditation is an important way of establishing credibility in many fields; hospitals, universities, nursing homes, and various other professions and institutions all have accreditation programs.

3.2.2 Accreditation on a Global Scale

Many countries have at least one organization responsible for the accreditation of their nation's laboratories. Most have been using the international guide ISO/IEC Guide 25 (and now the ISO/IEC standard 17025) as the basis for accreditation. This uniform approach enables countries to exchange test data on the basis of mutual recognition agreements. Such interchange facilitates the acceptance of imported goods, and supports international trade and development.

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[4] SCC, CAEAL, CCIL.

[5] Ibid.

In 1996, international cooperation was formalized with the signing of a Memorandum of Understanding (MOU) by 44 national accreditation bodies that agreed to the International Laboratory Accreditation Cooperation (ILAC).[6] This MOU was used to establish, after peer evaluation, a mutual recognition arrangement (MRA) among the ILAC members. Thirty-six accreditation bodies, including the SCC, signed the MRA in November 2000; the MRA is expected to further help eliminate technical barriers to trade. The signing of the MRA followed an extensive evaluation of the SCC's Program for Accreditation of Laboratories – Canada (PALCAN), including an evaluation of its principal partners, CAEAL and the National Research Council. A team made up of representatives from the SCC's international peers in the Asia Pacific Laboratory Accreditation Cooperation (APLAC) conducted the evaluation. The signing of the APLAC MRA set the stage for the SCC's signing of the ILAC MRA.

ILAC, as an umbrella group, also provides advice and assistance to countries that are developing their own accreditation systems. Regional bodies have been formed to provide in-region recognition of laboratory accreditation bodies, including the European Cooperation for Accreditation (EA), APLAC, and the Inter American Accreditation Cooperation (IAAC). The SCC, which has applied for recognition by EA, is a signatory to the APLAC MRA and joined IAAC in December 2000. The IAAC has begun work to establish a laboratory accreditation MRA.

Of the above-mentioned bodies, ILAC is considered the world's principal international forum for developing laboratory accreditation practices and procedures, promoting accreditation as a trade facilitation tool, and assisting with new accreditation systems and the recognition of competent test facilities around the globe. The goal of ILAC and its members is a harmonized worldwide system of laboratory accreditation that will eventually give the regulator or importer in any country an acceptable degree of comfort that a test report is reliable. The ultimate goal is "One test accepted everywhere."[7]

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[6] International Laboratory Accreditation Cooperation, 2001, About ILAC [online], [cited April 25, 2001], <www.ilac.org/about.htm>.

[7] Joseph O'Neil, 1999, Accreditation of Food Testing Laboratories, prepared as a white paper by the American Council of Independent Laboratories [ACIL] (Washington, D.C.: ACIL).

3.2.3 Accreditation in Canada

CAEAL was formed in Canada in 1989 through the initiative of a number of public and private sector laboratories and was incorporated as a not-for-profit association. Its principal objective is the promotion and maintenance of a strong environmental analytical service within Canada by "raising the level of competency, consistency, capability, and communication within environmental testing laboratories."[8] As of April 2001, CAEAL had about 278 institutional members and 99 individual members.

The SCC was established in 1970 by Parliament under the *Standards Council of Canada Act*.[9] Its role is to promote voluntary standardization in Canada, facilitate domestic and international trade, and further international cooperation in relation to standards.[10]

CAEAL and the SCC, which represent Canada in ILAC, jointly deliver accreditation services to environmental laboratories through a partnership agreement that was signed in 1994 and revised in January 2000. CAEAL programs are endorsed by the Canadian Council of Ministers of the Environment and supported by federal and provincial governments.

The SCC's accreditation program for all types of laboratories is known as the Program for Accreditation of Laboratories – Canada (PALCAN); it provides formal recognition of the competence of a laboratory to manage and perform specific tests or types of tests listed in the scope of accreditation approved by the SCC. This organization has been accrediting laboratories since 1981 and has developed a broad range of accreditation scopes in the 20 years that the program has been operating.

Environmental testing is assigned to one of a number of fields, depending on whether it is biological, chemical, or physical; but many other areas are covered, including ionizing radiation, thermal, and fire.[11] The accreditation program

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[8] Canadian Association for Environmental Analytical Laboratories, 2001, About CAEAL [online], [cited April 25, 2001], <www.caeal.ca/about.html>.

[9] RSC 1970, c. 41 (1st Supp.), as am. (latest amendment 1996, c. 24).

[10] Standards Council of Canada [SCC], Canadian Association for Environmental Analytical Laboratories [CAEAL], 2000, "Program description," SCC/CAEAL Laboratory Accreditation Program for Environmental Laboratories, CAEAL Proficiency Testing Program for Environmental Laboratories, revision 5.1, December [unpublished], p. 2.

[11] Ibid.

for environmental laboratories is jointly administered by the SCC and CAEAL; their responsibilities are divided as follows:

- CAEAL conducts site audits and evaluates each laboratory's performance at regular intervals.
- SCC grants accreditation to the laboratory on the basis of CAEAL's recommendation.[12]

To become accredited, a laboratory must go through numerous steps, which generally take six months to a year. These steps include the following:

- The laboratory submits a completed application form to CAEAL, confirms the availability of documents (such as a quality manual) and relevant test methods, and provides summary information on all tests for which accreditation is sought.
- One to four volunteer assessors conduct a site assessment over three to four days. The assessors are highly trained, with strong analytical backgrounds.
- The assessors leave a list of corrective actions to be completed within a specified time frame.
- The laboratory completes and documents corrective actions to the satisfaction of a scientific panel (CAEAL Advisory Panel).
- The final site evaluation report is issued by CAEAL.
- Applicant laboratories must also complete at least one proficiency study before accreditation will be granted.
- The CAEAL board approves the assessment or reassessment work and recommends to the SCC that the applicant be accredited.
- SCC approves the accreditation and issues the Certificate of Accreditation on the recommendation of CAEAL.

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[12] International guides require that the SCC not delegate the accreditation responsibility, and in this respect CAEAL may be considered a subcontractor carrying out accreditation assessments and reassessments. Note that in addition to the assessment and reassessment work, CAEAL also provides extensive PT services to its members.

Site assessments are carried out every two years, and reaccreditation of environmental laboratories is accepted by the SCC on the basis of an approval by the CAEAL board of directors. The SCC endorsement of the accreditation maintenance action is provided by the SCC's director of Conformity Assessment.

Plans for the future include expanding the array of environmental tests and making further efficiencies in the programs offered. Smaller facilities pay lower fees, but still find the costs associated with accreditation high; ultimately, broader participation will result in lower costs for all participating laboratories.

Another strong proponent of laboratory accreditation in Canada is CCIL (Canadian Council of Independent Laboratories), a federally incorporated non-profit organization representing independent consulting, testing, and inspection companies.[13] The role of CCIL, which was founded in 1993, is to educate the public, encourage good performance and reliability among member companies, and establish fair and just fee guidelines. Members must abide by a code of ethics. The CCIL also conducts surveys for members and lobbies government against government-controlled testing facilities where adequate independent facilities exist. In November 1999, the International Association of Environmental Testing Laboratories (IAETL) and Canada signed a merger agreement creating the Environmental Analytical Division of the CCIL.

3.2.4 Accreditation in Selected Countries

The accreditation model developed by the SCC/CAEAL can be compared with examples in a number of other countries. As discussed previously, the Canadian model is used as a template in several countries, and the SCC/CAEAL is active in seven countries, excluding the United States. Interestingly, the World Trade Organization and the European Union (EU) have both noted that the most significant non-tariff barrier to trade is the lack of acceptance of test results and certification.[14] Canada and South Africa are among nations with the strongest accreditation programs, which are quite similar to each other. Other nations with internationally credible accreditation bodies include the United Kingdom, France, Finland, and Australia. A brief description of

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[13] Canadian Council of Independent Laboratories, 2000, *About CCIL* [online], [cited April 11, 2001], <www.ccil.com/2e.html>.

[14] South African National Accreditation System, 2001, *Introduction* [online], [cited April 18, 2001], <www.sanas.co.za/Intro.html>.

accreditation programs and organizations in selected international jurisdictions follows.

South Africa

The South African National Accreditation System (SANAS) is the national accreditation body for South Africa. It is recognized by government through the Department of Trade and Industry. Like the SCC/CAEAL, it accredits laboratories to ISO/IEC 17025 and serves industry. It also provides services to various government departments.

SANAS accredits both laboratories and certification (registration) bodies. Industry requires SANAS accreditation to ensure the quality of products and other services. SANAS also provides training services and offers two regular courses pertaining to laboratory accreditation: a laboratory management system course (based on ISO/IEC Guide 25) and a Technical Assessors Course. In providing certification body accreditation, SANAS accredits the quality management systems (QMS) of organizations to ISO/IEC Guide 62, and environmental management systems (EMS) of organizations to ISO 14001.

Accreditation in South Africa started in 1980 with the formation of the National Calibration Service (NCS) and later the National Laboratory Accreditation Service (NLA). In 1994, the NLA became an independent company in line with international requirements pertaining to autonomy. Since 1995, the NLA has been accrediting testing laboratories that were previously accredited by the South African Bureau of Standards (SABS). During 1995, NLA contracted with the Department of Trade and Industry to manage the establishment of a single national accreditation system. The new accreditation body, SANAS, was officially launched in August 1996 and became fully operational in 1998. It has two divisions: one for handling accreditation of laboratories, the other handling the accreditation of all certification bodies.

SANAS is similar to the Canadian model in its governance structure and in the technical expertise of its auditors. It operates under the guidance of an elected board, with representatives of industry, government, utilities, and other state and public organizations. The auditors are generally analytical chemists trained by SANAS in its Technical Assessors Course.

Australia

The only government-recognized accreditation body for laboratories and testing centres in Australia is the National Association of Testing Authorities, Australia (NATA). NATA states that accreditation provides “an internationally recognised means of evaluating the competence of organisations to perform specific tests, calibrations, measurements and inspections.”[15] NATA has been operating since 1947 and provides accreditation services to both public and private laboratories that conduct any kind of testing, product or material evaluation, calibration, or measurement. Environmental testing is only one of more than a dozen different fields of testing covered.

The on-site assessment team, consisting of one to four technical assessors and a NATA staff officer, evaluates the elements of a laboratory that contribute to the production of accurate and reliable test data. These elements include staffing, training, supervision, quality control, equipment, the recording and reporting of test results, and the environment in which the laboratory operates. The laboratory may also be required to participate in proficiency testing between reassessments.

NATA also provides training courses in laboratory management, auditing, and quality control. It publishes a range of technical and information documents covering laboratory practice and evaluation, as well as an annual directory of accredited laboratories. NATA promotes its members through advertising, conferences, and other activities.

In 1990, NCSI (NCS International [Pty.] Ltd.) was formed as a wholly owned subsidiary of NATA to provide certification for independent recognition according to national and international management system standards such as ISO 9000 and ISO 14001.

On paper, the NATA system seems similar to both the SCC/CAEAL and the SANAS accreditation and certification systems, but according to at least one interviewee, the NATA system falls short in some areas. It is not as strongly performance-based, hires outside auditors without thorough assessment of their on-site expertise, and includes proficiency testing more as a formality than an entrenched part of the approach.

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[15] National Association of Testing Authorities, Australia, 2001, *What's NATA?: Benefits* [online], [cited October 9, 2001], <www.nata.asn.au/fs_services.htm>.

United Kingdom

The United Kingdom Accreditation Service (UKAS) is recognized by the U.K. government as the national body responsible for assessing and accrediting the competence of organizations in the fields of calibration and testing, inspection, and certification of systems, products, and personnel.[16]

A manual published on the UKAS Web site[17]entitled *The Conduct of UKAS Laboratory Assessments* provides general guidance on each step in the conduct of laboratory assessments. An appendix contains examples of the forms used during the assessment. The purpose of assessing the competence of the laboratory is to determine whether it complies with the requirements of the new standard, ISO/ IEC 17025. UKAS, which has its roots in the mining industry, uses its own staff as assessors as well as contracting with assessors from external sources. All the assessors are said to meet strictly defined criteria for technical expertise and experience, and are fully trained in UKAS assessment procedures. Confidentiality of the assessment results is stressed throughout the manual.

Using a system similar to the SCC/CAEAL post-assessment process, UKAS gives laboratories time to correct any non-conformances found, and requires evidence of the corrective action taken. Once the laboratory is accredited, the first surveillance visit normally takes place within six months of the date of accreditation, with subsequent yearly visits – which may be unannounced. The next full reassessment takes place three and a half years after the initial assessment.

Clearly, the U.K. system has strong similarities to the Canadian system; however, the former system is generally considered by Canadian experts to be a little stricter and more dogmatic.

United States

Given the number of states, it is perhaps not surprising that the U.S. system is not close to full reciprocity, as are the Canadian program and international programs conducted by SANAS and NATA. The United States has both state

[16] United Kingdom Accreditation Service, 2000, *The Conduct of UKAS Laboratory Assessments* (LAB, 3 ed. 1) [online], [cited December 2000], <www.ukas.com>.
[17] Ibid.

and national systems, including defence, environment, and energy agencies, with little reciprocity among them. There are more than 100 government and private sector accreditation bodies, many of them 20 years old or more.[18] The average commercial laboratory has 13 to 15 different accreditations if they work in different states or for different government agencies within the same state. Virtually all states have had some form of drinking water accreditation programs for many years.

The National Cooperation for Laboratory Accreditation (NACLA), a U.S. organization, is attempting to harmonize the country's accreditation programs. NACLA's mission is to "provide coordination, recognition and worldwide acceptance of competent laboratory accreditation in the United States."[19] NACLA is made up of members with any interest in laboratory accreditation; thus individual laboratories as well as government departments and agencies may be members. Thirteen accreditation bodies are members of NACLA, which has begun its own mutual recognition arrangement (MRA) to foster recognition between these bodies. As a means of improving the acceptance of laboratory test data across the Canada-United States border, the SCC and NACLA recently signed a bilateral MRA that will provide for reciprocity of test results between laboratories accredited by a NACLA-recognized accreditation body and laboratories accredited by the SCC.

The United States Environmental Protection Agency (EPA) has a *prescriptive, not performance-based,* approach to certification, and specifies exact and detailed procedures and equipment for sampling and testing. The National Environmental Laboratory Accreditation Program (NELAP) is funded by the EPA and has been endorsed by 11 states, with more likely to follow, according to interviewees. Certified, independent laboratories carry out almost all drinking water tests in the United States. The *Manual for the Certification of Laboratories Analyzing Drinking Water: Criteria and Procedures Quality Assurance* [20] applies to laboratories performing drinking water analyses for compliance with regulations pursuant to the *Safe Drinking Water Act*. These laboratories include EPA regional laboratories, certain federal laboratories, laboratories on Indian lands, principal state laboratories in "primacy" states, and drinking water laboratories in "non-primacy" states.[21] The EPA regulates the frequency of moni-

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[18] O'Neil.

[19] As quoted by O'Neil.

[20] U.S., EPA, 1997, EPA 815-B-97-001, March, 4th ed. (Cincinnati, Ohio: Technical Support Center).

[21] Ibid.

toring, the analytical method to be used, and the protocol for reporting results. Interestingly, the states are *encouraged* to comply with the requirements specified in the manual, but *only elements in the drinking water regulations are mandatory.*

The manual is extensive, comprising almost 200 pages, which are divided into six chapters and eight appendices. The chapter on microbiology (chapter 5), for example, is 45 pages, and specifies details such as

- education requirements for laboratory staff and supervisors;
- equipment and calibration of equipment such as pH meters, balance, autoclaves for sterilizing bacterial growth media, and ovens;
- glassware washing methods;
- analytical methods for tests such as total coliforms, E. coli, and heterotrophic bacteria; and
- sample collection, handling, and preservation.

While this prescriptive approach may appear to guarantee correct results, it has a major drawback. The manual lists numerous authors and reviewers; changes and methodology improvements are generally very difficult to make, with updates in some instances taking years to incorporate – the 1990 version, for example, took several years to update. In one example cited by an interviewee, the need for a change in an analytical method was demonstrated in the United States, adopted in Canadian laboratories five years later, and then took another five years to become a standard method in the United States.

The American Council of Commercial Laboratories (ACIL), which was founded in 1937 (and later incorporated in the state of New York as the American Council of Independent Laboratories), is the national U.S. trade association representing independent, commercial, and professional service firms. ACIL's 350 members operate more than 1,500 facilities across the United States and abroad, and are engaged in a broad range of disciplines, including environmental sciences. They carry out testing, product certification, consulting, and research and development,[22] serving government, manufacturers, builders,

[22] American Council of Independent Laboratories, 2001, *About ACIL* [online], [cited April 11, 2001], <www.acil.org/about/index.html>.

and the general public. ACIL is a counterpart of CCIL in Canada and has been a strong advocate for accreditation in the United States for the past 30 years.

The 1999 white paper on accreditation previously cited, *Accreditation of Food Testing Laboratories*, was prepared by the former executive director of ACIL, Joseph O'Neil, who is now the executive administrator of NACLA. While the white paper is generally geared toward accreditation criteria for food chemistry and food microbiology laboratories, rather than drinking water laboratories, the underlying objectives and most of the principles of accreditation are the same. International trade and the increasing concern about public health and safety are two factors cited as prominent in making the 1990s "the age of laboratory accreditation."[23]

3.3 The Role of Government Laboratories

3.3.1 The MOE's Laboratory Services Branch

The overarching and generally undisputed role of the Laboratory Services Branch, which administers the MOE's testing laboratory, is to support the standard setting, policy development, and regulatory functions of the ministry. This role includes conducting research into new, non-routine, and more sensitive testing methods for drinking water contaminants. It also includes monitoring both the database on the quality of drinking water and the accreditation status of the private and municipal laboratories providing the test data. The role of the branch *does not, however, include providing routine testing services* – the word 'routine' implying analyzing a high volume of samples using 'fool-proof' methods.

The MOE laboratory conducts most of its testing for internal MOE programs and branches, and for enforcement-related or legal samples. Its focus in the case of drinking water analysis is more on the ultra-trace, complex analyses, and less on routine testing. According to interviews and a MOE report,[24] laboratory staff at MOE also provide a number of 'reference centre' activities, including

[23] O'Neil, p. 3.

[24] Ray Clement, 2001, *2000 Annual Report: Research and Reference Activities*, prepared for the Ministry of the Environment (Toronto: Queen's Printer for Ontario).

- testing new applications of technology and evaluating new instruments;
- developing methods;
- reviewing quality of private laboratory data;
- developing certified 'real-matrix' reference materials;
- acting as honest broker in resolving data conflicts and quality issues between private laboratories and industry;
- raising the awareness of and promoting quality systems;
- administering research and development projects in addition to method development;
- conducting international round robin studies (including studies at laboratories in the United Kingdom, Norway, and Italy in 2000); and
- providing staff as assessors for CAEAL.

In addition, laboratory staff provide a number of general outreach and educational services, including a seminar series, method advice to international laboratories (e.g., in the state of California and in Japan in 2000), and a Mass Spectrometry Discussion Group.

A 1993 review of Ontario government laboratories described reference capabilities as the core competencies of many government laboratory operations.[25] The term 'reference centre' was defined by the Analytical Laboratory Council as a "discipline-specific facility that provides impartial, authoritative consultation, service, and/or materials in a given field of testing. It may also maintain and enhance analytical methodologies from a scientific or technological perspective."[26]

Clearly, the preceding list of reference centre activities fits this definition; however, interviewees from private laboratories generally believed that these

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[25] David Balsillie, 1993, Report of the 1993 Review of the Organization of Ontario Government Laboratories, prepared for the Management Board Secretariat.
[26] Ibid., p. 9.

functions could be better focused. Furthermore, it can be argued that certain tasks such as developing new methodologies and reference materials and testing new instruments, as well as specific research and development projects, could be contracted out and performed equally well by private sector laboratories. According to several of the interviewees, new methods are developed for highly obscure compounds, and sometimes the methods developed are not sufficiently rugged or cost-effective to easily become routine tests. In some cases, changes are made to methods, or detection limits are unrealistically lowered (herbicides were cited as an example) without sufficient consultation with appropriate private laboratories. The activities – which one interviewee described as "drifting" and another as "not sufficiently relevant" – tend to be more reactive and less strategic. Certainly, the events of 2000 have made it difficult to be anything but reactive. With the highly positive relationship between the MOE and private and municipal laboratories already well established, a less isolated and more consultative approach to focusing the existing set of reference activities would produce more relevant results.

3.3.2 The MOH Laboratories

The laboratories of the Ministry of Health and Long-Term Care provide free well-water analyses for private citizens. Although many people may think that their water samples are tested for chemical contamination as well as a full range of microbes, no chemistry analyses are provided, and only two microbiological tests are generally performed, for total coliforms and *E. coli.* The laboratories provide testing services for large waterworks when samples are referred to them by a medical officer of health, for waterworks in remote locations where lengthy transport times may affect microbiological results, or in cases where the source of the sample is unknown.

The major issues the interviewees cited with respect to the role of the MOH laboratories were reporting problems, lack of integrated data, poor relations between the two ministries in the area of drinking water testing, as well as jurisdictional overlap with the MOE in that area of testing. Jurisdictional overlaps and the relationship with the MOE are covered in more detail in section 4.4, below. Interestingly, many of the private laboratory interviewees had the perception that the MOH and the MOE used different microbiological methods for drinking water analysis. In discussions with the MOE staff, they indicated that the methods and media used by both ministries are now the same.

The MOH data on private well analyses may represent an enormous untapped long-term database on groundwater resources and their recharge zones.[27] However, the data collection and reporting system is said to be antiquated, with handwritten reports apparently provided by some MOH laboratories and no electronic integration or analysis of the data collected over many years.

3.3.3 Municipal Laboratories

Municipalities such as the City of Toronto, Ottawa, Waterloo, Hamilton, York, Durham, Peel, and Halton have their own in-house laboratories that provide drinking water analyses. Some municipal laboratories also provide a range of other tests such as waste analysis, but none are accredited for the full range of parameters.

When these laboratories first opened, some in the early 1990s, they competed with private sector laboratories. This was a heated issue because municipal laboratories tended to be located in tax-subsidized, well-equipped facilities, with incomplete accounting for their overhead costs. Initially, municipal laboratories reportedly attempted to become low-cost providers in competition with private laboratories but without becoming accredited. This feud appears to have resolved itself because municipal laboratories now serve primarily their own municipalities and, since August 2000, are required to be accredited for parameters cited in Regulation 459.

Municipal laboratories are the newest participants in the SCC/CAEAL accreditation program, and they are likely to continue to improve in quality as they undergo additional site assessments and proficiency tests.

4 Conclusions and Recommendations

4.1 Overview

A number of conclusions can be drawn from the findings and observations described in the previous pages. In each of the three areas (capacity, accredi-

[27] Issues related to water quality data and the role of government laboratories were described in a presentation by Russ Calow to the Walkerton Inquiry, Peterborough, Ontario, April 10, 2001: The Role of Private and Public Sector Laboratories in Protecting the Quality of Ontario's Drinking Water and the Health of the Public.

tation, and the role of government laboratories) recommendations are made to deal with the issues and challenges identified. A reality that is not generally understood by those outside the laboratory and that underlies the continuing drive by stakeholders to improve the quality of environmental data and laboratories is that *environmental testing is a highly complex field* – whether the laboratory is testing drinking water or other matrices. It is not as straightforward as, for example, medical testing of blood or urine samples. Environmental test results, especially for microbial analyses, can be influenced or drastically affected by minor variations in

- sampling method, sample transport, and storage temperature;
- sample matrices, which are not always homogeneous and can contain suspended matter with high concentrations of contaminants and small pockets of bacteria;
- preparation of dilutions;
- level of personnel experience or change in personnel; and
- data transfer and reporting.

As methods and equipment evolve and become more sophisticated, as detection limits are pushed below the level that reviewers can interpret, and as analyses become more sensitive, it becomes easier, in fact, to be measuring artifacts introduced during sampling, storage, or analysis.

Accreditation is undoubtedly improving the competence of testing laboratories, but critical factors in testing are

- the role and experience of the chemist or microbiologist,
- the application of human thought and decision making, and
- the ability to recognize a result that does not make sense.

4.2 Capacity

Interviewees from both private laboratories and the MOE laboratory agreed that capacity for drinking water analyses is not an issue in Ontario. Private laboratories have the flexibility and agility to quickly respond to an increase in test load. For example, in one laboratory, 43,000 samples were analyzed in 1999, 60,000 in 2000, and 118,000 are anticipated to be analyzed in 2001. Another laboratory added an additional $10-million worth of testing capacity over a three-month period. An increase of this magnitude requires key personnel to be hired and trained, and equipment and laboratory space to be acquired. One senior laboratory expert estimated that it takes two to three months to double capacity.

There are, however, instances where the MOE can play a role in distributing the analytical workload more evenly and thus avoid potential capacity problems. For example, the MOE now requires engineering reports on the drinking water parameters in its Ontario Drinking Water Standards, as listed in Tables 1 through 4 of test parameters and their associated standards and objectives.[28] These reports on raw water tests by the large waterworks are now required every three years, all at the same time. This will result in laboratories developing overcapacity to handle the test load – capacity that will not be used until the engineering reports are required again three years later. This requirement will also drive up costs for the municipalities and could potentially affect the quality of results as laboratories are pushed to deliver an enormously increased number of test results on time.

When the decision is made to require small waterworks to report on the same basis, this problem will be even more extreme since there are approximately five times as many small waterworks as large.

4.2.1 Recommendations

1. Stagger the reporting required by large waterworks over three years, starting with those that have a higher incidence of non-compliance.

2. Stagger the reporting by small waterworks, when it becomes required, using a logical system such as postal or area codes.

4.3 Accreditation

4.3.1 Is the Accreditation Process Working?

Interviewees from both private and public laboratories were generally very positive about the current ISO/IEC 17025 accreditation program provided by SCC/CAEAL. The program has developed with strong involvement and input

[28] Ontario, Ministry of the Environment, 2001, *Ontario Drinking Water Standards* [online], [cited October 9, 2001], <www.ene.gov.on.ca/envision/WaterReg/Pibs4065.pdf>.

from both private and public laboratories. Internationally, it is regarded as a model for accreditation programs. In 2001, for example, an agreement was signed between Canada and the Pan American Health Organization to help set up accreditation programs in South and Central America. Canada's program compares favourably with those of the other jurisdictions described earlier in this report. Its joint-governance model encourages better public-private cooperation, broader buy-in for accreditation, and more effective decision making. The assessors are thoroughly trained, technically proficient, and, as volunteers, unlikely to have any conflict of interest. Site visits are constructive, and newcomers who initially resisted the accreditation process find that each audit is more favourable.

These positive aspects have developed over the last six or seven years. Initially, government and some private sector laboratories resisted becoming accredited. In 1994, only Quebec had a laboratory accreditation program; now, all provinces except P.E.I. have a program in place. Full harmonization across Canada does not yet exist, however. For example, only Quebec requires specific staff credentials for on-site inspection. The ISO/IEC 17025 program requires only that staff be "appropriately trained" for the work they do. Interviewees did not generally see this as a quality issue or indicative of a tolerance for lower staff competence.

More serious is the fact that Ontario has lagged behind most other provinces in requiring the use of accredited laboratories. The *Drinking Water Protection Regulation* (Regulation 459) specifies that accredited laboratories must be used to perform drinking water analysis for parameters cited in the regulation. For a number of years, environmental testing laboratories have been encouraged by the MOE to seek accreditation, but only in 2000 were they required to do so by regulation. Several other provinces and the federal government (through Environment Canada) require that any regulated environmental testing parameters – not just those cited for drinking water – be analyzed by accredited laboratories. Since the analysis of air samples or almost any other type of environmental testing involves health and data quality issues, it makes sense that accredited laboratories be required for this task. This was one of the most frequent issues raised by the interviewees. Mandatory use of accredited laboratories for any testing required by regulation is generally seen as inevitable.

Plans are in place to *expand the scope of services and proficiency testing* offered by SCC/CAEAL. As of July 2001, 77 drinking water parameters were listed in Table 1 of the Ontario Drinking Water Standards, yet only 20 have performance evaluations ('check' samples) available; in the United States almost all of these are available. Check samples not available in Canada include pesticides such as paraquat and diquat, and other drinking water test parameters such as nitrosodimethylamine (NDMA) and dioxin/furan. Of some concern is the fact that proficiency testing is required by CAEAL only for those parameters for which they provide check samples. Both public and private laboratories are demanding that more check samples be offered by CAEAL and that single-blind check samples (artificially contaminated samples whose contaminant the laboratory is not made aware of) be required on all tests. Additional matrices and more real samples were also suggested as improvements.

The sale of check samples is a source of revenue for CAEAL, but it considers that offering additional parameters is not statistically viable unless more than 20 laboratories require this service. As of July 2001, about 12 to 14 laboratories were estimated to be carrying out pesticide analyses. The U.S. National Institute for Standards and Technology (NIST) has, under the National Voluntary Laboratory Accreditation Program (NVLAP), accredited about 11 laboratories to provide PT samples according to the specific requirements of the NELAC laboratory accreditation program. The use of private providers, as in the United States, may be the solution for Canada. Alternatively, the provision of additional check samples may be a potential role to explore with the MOE laboratory on an interim basis until there are private companies offering this service. Currently, the federal government prepares most of the performance evaluation samples.

Finally, several interviewees suggested that the MOE Laboratory Services Branch should make recommendations on the appropriateness of the test method for drinking water analyses. For example, depending on the detection level required, analysis by ICP/MS may be more appropriate than the less sensitive and less costly ICP method. Currently, a laboratory has the choice and can reduce costs by using the less sensitive method with a higher detection level, making results close to this level difficult to interpret. The prescriptive approach of recommending and verifying the appropriateness of methods was used under the MISA program, but is counter to the performance-based approach now generally used by the Ontario government.

In summary, the following are the key positive features of the accreditation process in Ontario:

- international respect as a successful model for accreditation;

- inclusion of both proficiency testing and site inspection;

- joint governance of the CAEAL board (half the members are from the public sector and half from the private sector), which is non-confrontational and cooperative, and described as a successful partnership by most of the interviewees;

- international recognition of SCC-accredited laboratories and associated business opportunities; and

- the system of technically competent and trained volunteer assessors.

The SCC/CAEAL accreditation program continues to evolve, but the following suggestions were made for several areas that need improvement:

- The appropriateness of test methods is not evaluated by the MOE or dealt with during accreditation.

- Accreditation is not fully harmonized across Canada.

- Reciprocity with the United States needs to be improved.

- Certified reference materials are not available for a sufficient number of parameters.

4.3.2 Recommendations

1. Make reciprocity with other accreditation programs both within Canada and internationally a continuing priority.

2. Phase in mandatory use of accredited laboratories for all parameters, as is now the case in many other provinces; a phased-in approach would allow smaller laboratories sufficient time to become accredited.

3. Expand the number of performance-evaluation samples to include additional regulated parameters. Additional certified reference materials for CAEAL proficiency testing (including pesticides, NDMA, and dioxin) could be available through CAEAL by using either

- outside private providers or, if unavailable,
- check samples provided on a cost-recovery basis by the MOE or other laboratories.

4.4 The MOE and MOH Laboratories

4.4.1 The Role of the MOE Laboratory

In general, from discussions with both private and public sector laboratory staff, the relationship between the MOE laboratory and private sector laboratories appears to be collaborative and positive. As laboratories in both sectors have worked at improving their quality systems and have grappled with accreditation as a "worldwide phenomenon,"[29] mutual respect and appreciation have grown. Dialogue is open, and scientists usually exchange ideas and information freely. The MOE laboratory now holds very broad accreditation for more than 140 analytical methods and is seen as a leader among provincial laboratories in the quality of its analyses and staff in certain areas such as ultra-trace analysis of organics in water.

The laboratories in each sector have appropriate – but significantly different – roles. Reference centre activities carried out at the MOE have been listed earlier in this paper (section 3.3.1) and most are functions that should fall within the mandate of a government laboratory. Certain tasks, such as development of new methodologies and reference materials, the testing of new instruments, and specific research and development projects, could be contracted out and managed by the MOE staff – and carried out equally well by private sector laboratories. The reference centre activities need to be focused and relevant, and new methods must be practical and cost-effective. Public education and general outreach activities need to be strengthened and better staffed.

The MOE staff carry out some routine testing, almost entirely for Ontario government programs. Whether the MOE laboratory should be carrying out any routine testing is still a debated issue between government staff and the private laboratories. The latter depend on a high volume of routine tests to stay in business and have the quality and production systems set up to do this very well. The MOE staff argue that they need to perform routine tests to maintain

[29] O'Neil, p. 3.

the technical expertise required for the laboratory's quality monitoring and public policy roles. Interviewees from private laboratories point out that EPA laboratories develop and validate methods that are recognized worldwide, but do not carry out any routine testing in their own laboratories. The EPA uses private laboratories to beta test new methods and to help write protocols.

The issue of routine testing can be argued from both perspectives, and the opposing sides seem to have reached the stage of agreeing to disagree. The level of testing by the MOE laboratory does not appear to be generating a high level of competition with the private sector, and government staff are more comfortable with a supervisory role on methods that they have in-house technical expertise to perform.

In the case of legal or enforcement-related samples, other fields certainly offer precedents of private laboratories providing these analyses without conflict of interest being an issue. One example cited during the interviews was the RCMP's use of private laboratories to carry out casework sample analysis. Full chain of custody procedures and blind samples are standard operating processes in many private laboratories. The proportion of routine analyses and, in particular, enforcement or legal sample analysis by MOE should be reexamined in a year or two.

On the issue of staffing, with approximately 130 staff, the MOE has a relatively large laboratory with a number of pockets of specialized expertise. Experts interviewed from private laboratories offered high praise for the helpfulness and competence of the MOE experts. However, several years of downsizing and more attractive salaries in other sectors such as the pharmaceutical industry have made it difficult for the MOE to attract and retain senior research scientists and technicians. Furthermore, support for long-term research and trend analysis, publication in peer-reviewed technical literature, and presentations at both national and international conferences are essential if the MOE is to be truly effective as an internationally recognized reference centre for environmental testing. This observation is also made in *Managing the Environment Report: A Review of Best Practices* (also known as the Gibbons Report), which indicates that the MOE is aware of the need to "broaden and deepen the base of scientific and technical expertise."[30] The report also suggests that the MOE's research needs to be more "strategic" – that is, to look further into the future,

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[30] Executive Resource Group, 2001, *Managing the Environment Report: A Review of Best Practices* (Toronto: Queen's Printer for Ontario), p. 17.

away from solving day-to-day problems, and aim more at anticipating problems before they arise; the report further suggests that external expertise and advice need to be incorporated.[31]

4.4.2 The Relationship between the MOE and MOH Laboratories

The relationship between the MOE and MOH laboratories has often been strained over the last ten or more years, particularly with respect to drinking water analyses. Jurisdictional overlaps, controversy over different analytical methods, and the use of a different accreditation program for MOH laboratories strained the fragile relationship. During the Walkerton crisis, the associated high level of tension further exacerbated this situation, particularly with the regional MOH laboratories. Both private and public laboratory interviewees commented on this.[32] The issues can be summarized as follows:

- The MOH laboratories do not have the staff or data handling systems necessary to alert individual home owners as soon as bacterial results exceed the regulated limit.

- Consultation and communication between the two ministries is poor, and they do not appear to consult each other with regard to new regulations.

- The MOH laboratories are not accredited by the same system as other laboratories that carry out drinking water analyses.

On the last issue, MOH laboratories employ certified medical laboratory technologists and are exempt from Regulation 459's requirement for accreditation by SCC/CAEAL; however, they are deemed proficient by the College of Medical Laboratory Technologists of Ontario (CMTLO). The interviewees did not elaborate on the similarities or differences between the two, but frequently commented that there should not be two different quality systems for the same tests, whether on samples from private wells or from waterworks. There could be value in opening dialogue between the MOH and the SCC and CAEAL about the possibility of closer collaboration and a more integrated laboratory assessment arrangement.

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[31] Ibid., p. 18.
[32] Calow.

Another complex issue is that of jurisdiction over water testing. The MOH, with far greater depth of microbiological expertise, is the logical choice to take the lead in identifying new microbiological contaminants (such as *Cryptosporidium*) and developing new test methods. Similarly, once a test method has become routine and relatively straightforward (such as that for total coliforms and *E. coli*), this testing could be handled by private laboratories, meeting clear reporting requirements and equipped to handle large volumes of samples with rapid data reporting systems. The quality supervisory function for routine tests could be carried out by a core group at the MOE.

4.4.3 Recommendations

1. In consultation with representative private sector and municipal laboratories and CAEAL, the MOE should review the existing reference centre activities to determine their relevance, practicality, cost-effectiveness, and potential for out-sourcing or public-private partnerships.

2. Establish a joint public-private research and development committee that includes the MOH staff to (a) discuss at a high level analytical methods, detection limits, and reporting issues, and (b) advise on strategic priorities for new work that would improve the analysis of drinking water and other environmental samples in Ontario.

3. On the basis of the results of the review of reference centre functions, and any new strategic research priorities identified by the research and development committee, identify additional resources needed, including senior scientific researchers and analytical equipment.

4. Establish a small senior level MOE-MOH task force to (a) recommend a workable solution to the jurisdictional overlap of drinking water testing, (b) resolve the conflict over the different accreditation programs, and (c) recommend ways to strengthen the level of communication and cooperation between the laboratories.

4.5 Closing Comments and Questions

This report is intended as an overview on laboratories and not an analysis of related public policy issues; however, during the interviews, a number of high-level policy questions were raised.

Private well-water analysis. Should the public be entitled to free private well-water analysis? Should the cost be added to property or municipal taxes or constitute the fee for an annual licence? or should this service be treated the way medicare is treated? Is bacteriological analysis sufficient, or should the analysis include contaminants such as pesticides or heavy metals, particularly in rural areas that are known to have aquifer problems?

First Nations. First Nations communities may be among the most vulnerable populations in terms of the quality of their drinking water. Is sufficient effort being made to analyze contaminants and is there commitment to make the water treatment improvements needed in areas inhabited by First Nations peoples?

Emerging contaminants. Who is investigating emerging microbial contaminants in drinking water – the *Cryptosporidium* of the future – or water-borne viruses, bacteria, or protozoa?

These broader public policy questions are beyond the scope of this paper but need to be dealt with.

Appendix 1: List of Interviewees

Russ Calow, vice-president, Lakefield Research Ltd.

Trent Gow, president, Thompson Gow and Associates, and executive director, CCIL

Peter Haulena, analytical services manager, Accutest Laboratories Ltd.

Barry Loescher, vice-president, Philip Analytical Services Inc.

Cammy Mack, drinking water regulation coordinator, Laboratory Services Branch, Ontario Ministry of the Environment

John Martin, chief executive officer, Maxxam Analytics Inc.

Andrew Masters, vice-president, Environment Division, Maxxam Analytics Inc.

Allan Maynard, managing director, Analytical Service Laboratories Ltd. (now with ALS Environmental)

Chris Riddle, assistant deputy minister (acting), Ontario Ministry of Energy, Science and Technology

Peter Sadlier-Brown, executive vice-president, Thompson Gow and Associates

Dan Toner, assistant director, Laboratory Services Branch, Ontario Ministry of the Environment

Don Wilson, director, Conformity Assessment, Standards Council of Canada

Rick Wilson, executive director and secretary, Canadian Association for Environmental Analytical Laboratories

Appendix 2: List of Abbreviations

ACIL	American Council of Independent Laboratories
APLAC	Asia Pacific Laboratory Accreditation Cooperation
CAEAL	Canadian Association for Environmental Analytical Laboratories
CCIL	Canadian Council of Independent Laboratories
EMS	Environmental Management Systems
EA	European Cooperation for Accreditation
EU	European Union
IAAC	Inter American Accreditation Cooperation
IAETL	International Association of Environmental Testing Laboratories
IEC	International Electrotechnical Committee
ILAC	International Laboratory Accreditation Cooperation
ISO	International Standards Organization
MISA	Municipal-Industrial Strategy for Abatement
MOE	Ministry of the Environment
MOH	Ministry of Health and Long-Term Care
MRA	Mutual Recognition Arrangement
NACLA	National Cooperation for Laboratory Accreditation
NATA	National Association of Testing Laboratories
NCS	National Calibration Service
NDMA	nitrosodimethylamine
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute for Standards and Technology
NLA	National Laboratory Accreditation Service
NVLA	National Voluntary Laboratory Accreditation Program
PALCAN	Program for Accreditation of Laboratories – Canada
PT	Proficiency Testing
QMS	Quality Management Systems
SABS	South African Bureau of Standards
SANAS	South African National Accreditation System
SCC	Standards Council of Canada
UKAS	United Kingdom Accreditation Service

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