

A TOTAL QUALITY WATER MANAGEMENT SYSTEM FOR ONTARIO:
The Model Water Utility

A paper prepared for the Walkerton Inquiry

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This paper has been prepared as a background document for the Walkerton Inquiry. It is intended to inform and generate discussion about the safety of drinking water among relevant experts, parties with standing, and the public. It does not represent the findings, views, or recommendations of the Commissioner. Written comments in response to the paper are welcome and will form part of the public record of the Inquiry. They should be submitted to:

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Diamond Management Institute provides customised management consulting and training services to both the private and public sectors. The Diamond Management team is comprised of dedicated and accomplished professional consultants and instructors, who are seasoned industry and subject-matter experts. This brings a diversity of experience and insight to every situation that helps our customers achieve superior performance.

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Acronyms

AMO	Association of Municipalities of Ontario
ACA	Apprenticeship and Certification Act
AWWA	American Water Works Association
AWWARF	American Association of Water Works Research Foundation
CCP	Critical Control Points
CCR	Consumer Confidence Report
CDWG	Canadian Drinking Water Guidelines
CEU	Certified Education Unit
CFIA	Canadian Food Inspection Agency
CofA	Certificate of Approval
CSC	Ofwat Customer Service Committees
Ct	Residual disinfectant Concentration x contact time
DBP	Disinfection By-Products
DFO	Department of Fisheries and Oceans
DWI	Drinking Water Inspectorate
EPA	Environmental Protection Agency
HACCP	Hazard Analysis Critical Control Points
LDP	Leadership Development Program
MAC	Maximum Acceptable Concentration
MNR	Ministry of Natural Resources
MOE	Ministry of the Environment
MTCU	Ministry of Training, Colleges and Universities
NSERC	National Science and Research Council
NTU	Nephelometric Turbidity Unit
OCWA	Ontario Clean Water Agency
ODWS	Ontario Drinking Water Standards
OMWA	Ontario Municipal Water Association
OMAFRA	Ontario Ministry of Agriculture, Food, and Rural Affairs
OSWCA	Ontario Sewer and Watermain Construction Association
OWWA	Ontario Water Works Association

Ofwat	Office of Water Services (England and Wales)
ONCC	Ofwat National Customer Council
OSWCA	Ontario Sewer and Watermain Construction Association
PWQO	Provincial Water Quality Objectives
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
TMDL	Total Maximum Daily Load
TQWMS	Total Quality Water Management System
UV	Ultra-Violet
WEF	Water Environment Federation
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

Part 1 – Executive Summary

Executive Summary

Ontario is blessed with abundant supplies of fresh water, more per capita than nearly anywhere on earth. The production of drinking water per capita is amongst the highest on the planet. Costs for water rank near the lowest in the world. There is, however, a crisis in the public's confidence in the safety of drinking water. The events at Walkerton and at North Battleford have served to publicise the ailments and failings of our drinking water systems.

There are water utilities in the province and elsewhere that have risen far above minimal expectations. These utilities adopt an approach of continuous quality improvement, establishing water quality goals that far exceed those of the provincial regulator. They maintain ties to other quality-driven drinking-water organisations to keep current on efficiency improvements. Buried infrastructure continuously is monitored and retrofitted, and water quality routinely is measured at the customer's tap, not just at the treatment plant discharge. Their customers are informed. These utilities do not rely on grant funding, yet their water rates are competitive and reasonable. How do they do it? – Leadership, culture, and the right people.

The goal of this Issue Paper is to examine these superior practices, both in Ontario and elsewhere, and to suggest a model water utility structure that will encourage a return of public confidence and support. Through the review of other jurisdictions and best practices, it is clear that many elements of this model are in place. No one jurisdiction, however, has pulled it all together in the comprehensive approach proposed here.

This Issue Paper is presented in several parts:

Part One is this Executive Summary.

Part Two, “What We Could Have: The Model Water Utility”, describes the model water utility for Ontario. The model water utility addresses the issue of public confidence by establishing a regime of transparency in everything that it does. This transparency underlies a culture that relentlessly pursues excellence and continuous improvement. The model water utility has technological infrastructure that is current and sustainable. It has Operators who are competent – they have been trained, examined and certified. The leadership and management expertise is self-evident, a result of careful recruiting and extensive training. It has established management systems, policies and practices that support the employees in achieving high performance.

The model water utility has a fully functioning **Total Quality Water Management System**. It has full cost-recovery, including operations and sustainable asset management. Its governance structure is exemplary and accountable. As water utilities evolve with this model, industry and professional associations create new partnership arrangements. Through all this, the public interest is served.

Part Three of the Issue Paper, “How We Get There: Transitional Issues and Strategies” identifies and analyses the barriers and issues that must be overcome to move from the current situation to “What We Could Have”. Both transitional and sustainable strategies are proposed to assist in travelling through this transition.

Appendix 1 refers to the Australian Framework in which the authors saw significant merit.

Appendix 2 provides templates for the Annual Report of the model water utility and the Annual Report for the Total Quality Water Management System.

Appendix 3 is a summary of the Literature Review.

Appendix 4, “A Matrix of Confusion” is a commentary of the multiple layers and varied roles of government, in general, and the Ministry of the Environment, in particular.

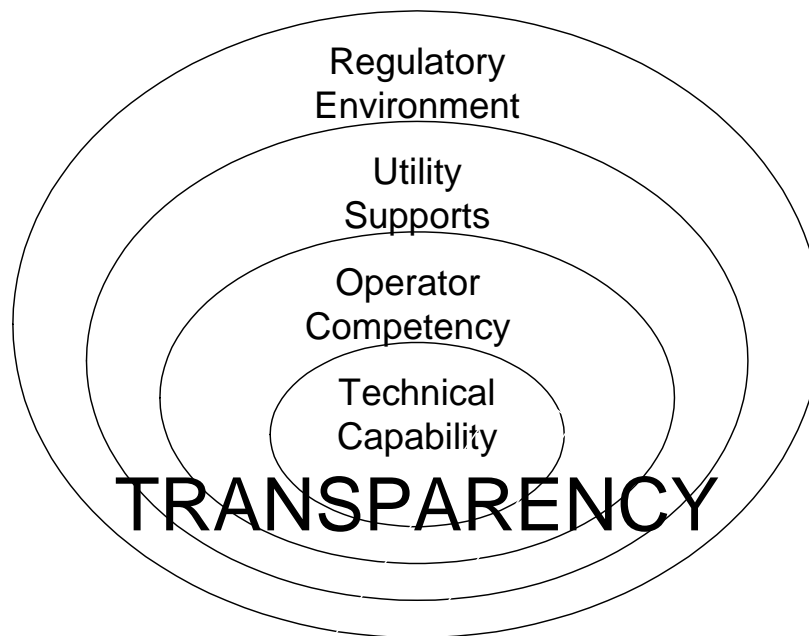
Although what is proposed in this Issue Paper is ambitious and challenging, it is *doable*. Furthermore, given current circumstances, this is the direction in which we must move and it is the commitment that we must pursue.

**Part 2 –
What We Could
Have:
The Model Water Utility**

1. Model Summary

The goal of this Issue Paper is to examine superior practices, both in Ontario and elsewhere, and to suggest a model water utility structure that will encourage a return of public confidence and support. The suggested drinking water utility model is shown pictorially in Figure 1.1, where the correctly applied process has resulted in a system that is capable of providing the required level of protection to the public (Technical Capability). The process is being operated, controlled and monitored by operators with the appropriate skills. An intricate set of supports for the operators (Utility Supports) is in place to facilitate the desired operation of the process. Finally, the system must operate within the laws, regulations and rules of the Province (Regulatory Environment). All components of the system have the common element of Transparency that is a requirement of all levels of the system.

Figure 1.1 – Model Water Utility Environment



The model water utility is summarised in brief detail in the following pages.

Transparency
See Section 3

Transparency is required for accountability and trust. The public must be able to trust that the water they are being supplied is safe. That trust has been eroded by recent events. The model incorporates transparency elements on every level, from the water utility to the Regulator. This transparency will ensure that the roles and responsibilities of each stakeholder are well understood by all stakeholders.

For the water utilities, transparency manifests itself by way of reporting and Customer Advisory Council participation and consultation. The Regulator must have a transparent assessment practice that ensures that the water utilities are aware of processes used to evaluate them. The standards setting body also is required to have a transparent process of implementing new standards.

Technology
See Section 4

At the heart of a water utility is the technology and the equipment used to treat and transport the water provided to the customer. The right technology must be used to provide the required level of treatment. Proper engineering must be applied to ensure that the treated water is supplied safely and consistently to the customer at all times. The feasibility of alternatives must be investigated to ensure that value is provided to the customer.

A multiple barrier approach is employed to achieve the maximum risk reduction of a contaminant reaching a customer. The barriers are selected to achieve redundancies and also to improve the efficiency of treatment in an area where another barrier is deficient.

A single technology or approach to determining the correct technology for water treatment is not prescribed in this Issue Paper. Rather, the application of the correct technology, with insightful and creative engineering, will be the natural consequence of the other elements of the model. The identification of a problem with the existing process will be the result of the Hazard Analysis Critical Control Points (HACCP) program. The selection of a specific process for the improvement of the utility will be selected following a research and development project. The identification of the need for pipe replacement will be the result of monitoring and the asset management plan.

Technical
Competence
See Section 5

Surrounding the equipment are competent Operators following the Triple-E process (Experience, Education, and Examination). The operators will be trained to ensure that the integrated systems are operating at the desired performance level. The Operators will be certified, under Ontario's Apprenticeship and Certification Act, to operate the equipment and empowered to continuously improve the water utility's operation. The employees of the utility are key to its success.

Operators possess a large amount of responsibility. With that

responsibility must come education about technical issues, quality management, standards, and customer needs. Operators are asked to perform increasingly difficult tasks that will challenge them and keep them interested. Within the Total Quality Water Management System (TQWMS), the employees will be authorised and required to alter the operation of the water utility to ensure that all water that reaches the customers meets the utility's objectives – objectives that may be more stringent than government regulated standards.

Utility
Management
See Section 6

Participation in the TQWMS will be a requirement of each and every employee of the water utility. At the forefront of the TQWMS is the concept of continuous improvement. A water utility is subject to many external forces (public pressure, legislative changes, environmental changes, etc.) and must have the ability to adapt to continue to thrive and grow.

A leader must provide the direction and vision to inspire the employees to meet these new challenges. Leadership, and the leader's impact on an organisation, is well understood. It is the obligation of the water industry to attract leaders and develop the leadership skills of individuals from within the industry. Leadership is particularly important in the time of transition to the TQWMS. The leader will empower all levels of the organisation to meet, and strive to improve upon, the new objectives. The leader will make success and achievement systemic.

Managers will be required to have the training to meet the demands of the TQWMS. Managers will be expected to have financial, technical, personnel, risk, and quality management skills at their disposal. Managers will be certified to ensure that they are familiar with these skills. The performance of the employees will be reviewed regularly in the context of the water utility under a Performance Management System to ensure that the employees have the appropriate skills and training to perform their prescribed duties.

A comprehensive quality management program by way of HACCP and the Standard Operating Procedures (SOPs) developed for each facility will provide the methodologies required to achieve and improve upon the performance objectives. HACCP is used to analyse the water utility's infrastructure one component at a time and multiple components as a system. The analysis results in a prioritised list that identifies the highest risk and highest hazards within the utility.

HACCP will ensure that the infrastructure is optimised with regards to risk reduction. The SOPs will make certain that the proper methodologies are in place to operate, monitor and verify the performance of the water utility. SOPs, which may have been viewed as bureaucracy by employees in today's environment, will provide the Operators and managers with the ability to improve the performance and efficiency of the system in which they work. The SOPs will be a living entity that will change and be continually updated as new challenges, ideas, and technologies are introduced to the water utility. To ensure that a water utility is achieving its best results, benchmarking

with other water utilities and other organisations will be used to compare performance.

TQWMS identifies and mitigates risk through its HACCP, ISO 9000, and SOPs programs. TQWMS does not eliminate risk. Risk management incorporates both of the mentioned programs, but it must account for the possibility of an emergency or a contamination incident that has the possibility of affecting the customers. Risk management will include emergency response protocols that notify the public and public agencies, communication programs that actively engage customers in the issues that affect the water utility, and public education programs that provide information to the public. The communication program is a key element of the Transparency concept that is fundamental to the accountability of water utilities.

The other elements of accountability to the customer and public perception of the water utility are external reports that detail the monitoring and verification programs, as well as TQWMS updates detailing operational improvements, financial performance, standards compliance, and the water utility's performance against objectives. These items are provided in either the quarterly or annual reports. The annual reports will be audited to ensure that the TQWMS is being followed and that the financial accounts are consistent with accepted practice. The Regulator will ensure that compliance with drinking water standards is met at a minimum.

A financial model will be followed to ensure the long-term stability of the water utility. The Regulator will include an assessment of the water utility's business plan in its review of licensure. The business plan will include costs for training of employees, the TQWMS plan, and a Sustainable Asset Management plan. The Regulator will review the costs and the rates of the water utility to ensure that the public receives water at a fair price.

Finally, the water utility must be governed by a board of directors that have appropriate skills and experiences, and have been provided the training to ensure that they are aware of the responsibilities and issues associated with a water utility.

Utility
Regulation
See Section 7

Standards will be set by a government agency employing the latest in analytical and epidemiological techniques. Health Canada will continue to set Maximum Acceptable Concentration (MAC) levels on parameters by way of its Canadian Drinking Water Guidelines (CDWG). The Province will set Ontario Drinking Water Standards (ODWS), using the CDWG as a baseline, with the ability to make individual standards more stringent. All new standards will be discussed with the industry to ensure that the water utilities have sufficient time to comply using a practical approach. The Regulator will enforce the ODWS.

The Regulator will be responsible for licensure of all water utilities in the Province. The Regulator is responsible for reviewing all aspects of a water utility, including its TQWMS (HACCP, SOPs, etc.), Financial

Plan, Governance, Personnel Management, Reporting and Communication programs, and Standards compliance. All of the above components must be approved by the Regulator, in order for the water utility to receive an operating licence.

The Regulator must operate in a transparent manner to ensure accountability to the water utilities and the public, as well as to ensure the accountability of the water utilities to the public.

As a further support system for individual water utilities, professional and industry associations can be utilised as a vehicle to exchange information, conduct peer review assessments, benchmark performance, co-ordinate research and development efforts, and promote best practices. Associations also can be used to co-ordinate lobbying efforts and education programs. In short, associations can be used to share resources that ordinarily are not available to any one water utility.

2. Introduction

After a review of the literature available from the Walkerton Inquiry and the authors' own literature search, a concept of a model water utility evolved. The structure of the model water utility is based largely on the Australian Framework (NHMRC, 2001) that presented a very strong foundation on which to build. The Australian Framework will be the basis from which the model Ontario water utility is built, with additional information and concepts where, in the authors' opinions, the Framework could be strengthened. The structure of the document puts the relevant sections from the Australian Framework into Appendix 1. Some adaptations to the text were required to make it applicable to Ontario. For example, the phrase "Ontario Drinking Water Standards" has been substituted for "Australian Drinking Water Guidelines", where applicable.

The virtues of either private or public ownership are not discussed in this document. The structure of the model water utility allows for either private or public ownership, in-house or contract employees, and a union or non-union environment. The model promotes the highest level of water quality for the public and this paper focuses on the organisational behaviour of model water utilities (see also Martin *et al.*, 2001). This should be the main goal of either a publicly or privately owned/operated water utility. The operator could be a private company, while the owner remains public (D'Ombrain, 2001).

Water utilities in Ontario will deliver their product (water) to consumers in a manner that is safe, and that is perceived to be reliable and assured. In order for water utilities to achieve this performance, processes and people need to be in alignment and need to be of the highest quality. The values of quality and accountability are embedded in the operating principles for governing the water utility. All employees must be competent in performing their jobs and committed to excellence and continuous improvement. What would such organisations look like?

The culture of an organisation may be understood as the collective behaviour of the employees. It can be lethargic, unfocused, unaccountable, unresponsive, and of poor quality. Or it can be the reverse!

There previously had been a regulatory regime in Ontario that endeavoured to achieve quality through enforcement. Although enforcement will continue to be an important element of the new system, it will not be sufficient to ensure that the water utilities achieve excellence. As has been observed in many other sectors, when industries or organisations choose to pursue a model of operation that relentlessly demands continuous improvement, the quality outputs exceed expectations. The model water utilities will embrace this operating philosophy and will reflect it through a seamless and open transparency to the Regulator and the public.

The new water utilities in Ontario will develop cultures that are high energy, professional, quality-oriented, collaborative, consumed with conversation (internally and externally), dedicated to problem-identification/solving and continuous improvement, accountable, and transparent.

Organisations don't just run themselves. Although at times it may appear that organisations seem to have a life of their own, in fact, they are being led, either actively or tacitly, by their leader. The leader stamps the organisation with his or her DNA, in the process creating apathy or enthusiasm, mediocrity or excellence, shallow performance

or high performance, uncertainty or confidence. The leader shapes direction and establishes the culture of the organisation.

In shaping the direction of the water utility, the leader will establish the strategic imperatives – those critical features that determine success. Managers, conversely, need to be trained properly to be managers. Operators need formalised training under Ontario's Apprenticeship Program, with re-testing and re-certification every 3 years.

The water utilities will need to develop systems and processes that will manage the risks associated with drinking water in a judicious manner. The public needs to be educated about the risks and how their water utility is managing those risks.

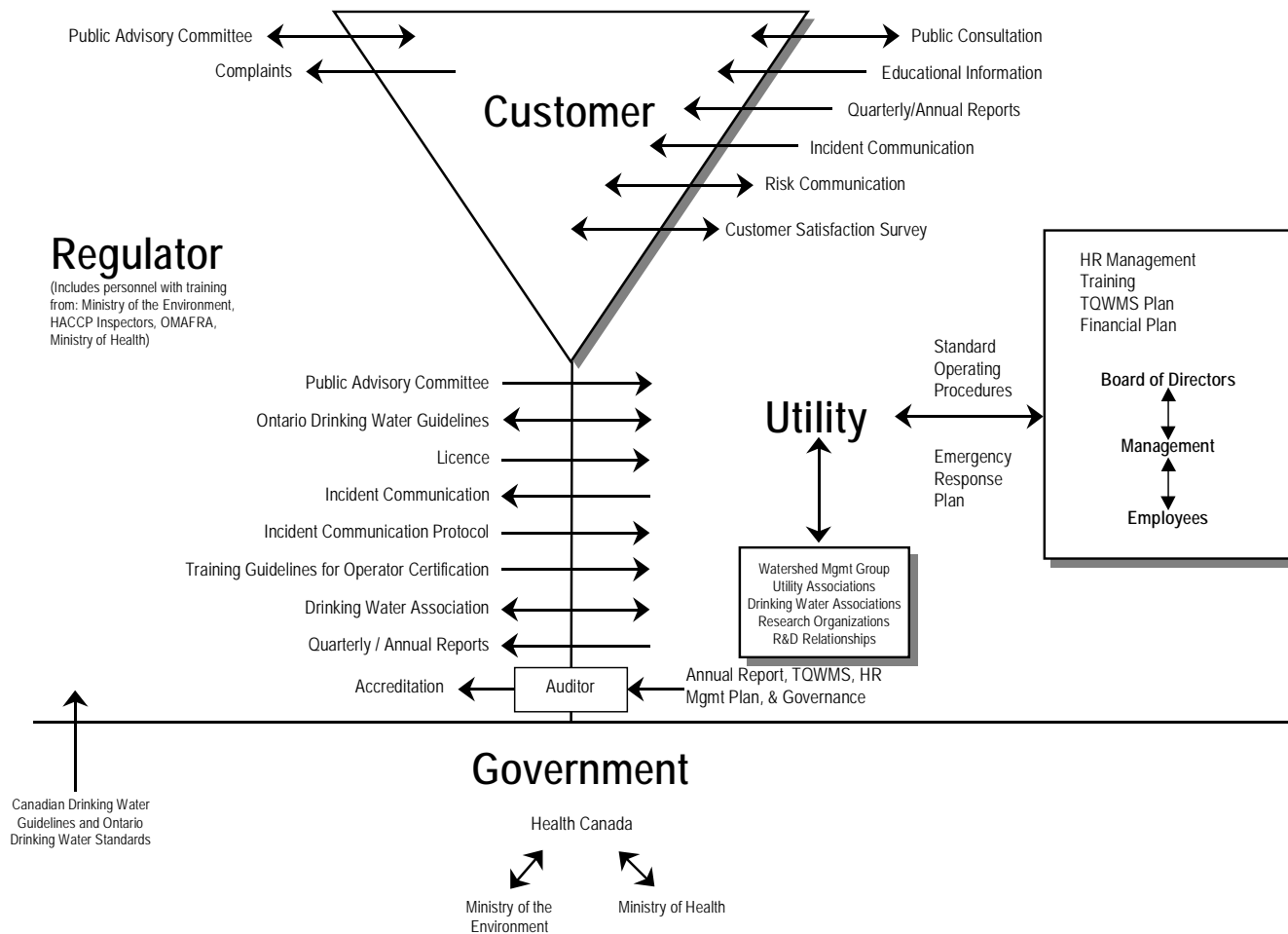
Proper finances and budgets will need to be developed that reflect the true cost of water, the actual operating requirements of the water utility and a sound plan for sustainable asset management.

The water utilities will need to be accountable and transparent. In order to achieve this type of drinking water utility, issues of scale will need to be considered. A governance structure, overarching the above, strategically will drive the process.

Many aspects of this description are to be found in the Australian model and that is why it is referenced extensively.

To help understand the interrelationships of the stakeholders, please see Figure 2-1 Model Utility Stakeholder Relationship Chart.

Figure 2-1 Model Utility Stakeholder Relationship Chart



3. Transparency

As the public becomes more aware and educated on the issues that effect their health, the level of accountability and transparency that is expected of the utilities that serve them also has increased. Transparency is a fairly recent concept in the water community. Many jurisdictions including the United States, the United Kingdom, Singapore, and Ontario have implemented elements of transparency.

The US Environmental Protection Agency (USEPA) has mandated that utilities publish an annual Customer Confidence Report (CCR) that provides information to the public about water quality, water quality standards and objectives, and health effects of drinking water contaminants. The USEPA also has a Public Notification Rule to provide a framework for water utilities on the procedures to be undertaken in the event of a non-compliance occurrence of the quality of water being supplied to the public. The CCR has been a requirement for utilities since 1998, while the Public Notification Rule was promulgated in 2000. Both items were mandated as part of the consumer right-to-know provisions in the 1996 Safe Drinking Water Act (SDWA) amendments.

In England and Wales, compliance reports must be made available to the public by water utilities. Benchmarking results of key parameters from the water utilities are made available to the public by way of Ofwat, the financial regulator of the water industry. Water rates are tracked and reported by Ofwat for review by the general public. Finally, Ofwat organises two councils that are comprised of members from the general public – at the national level by the Ofwat National Customer Council (ONCC) and at regional level by the ten Ofwat Customer Service Committees (CSCs). These councils provide a common voice for customers and ensure that the water suppliers are maintaining good customer relationship practices. These public information measures have been in place since the mid 1990s.

As can be seen from the examples of the above jurisdictions, transparency and accountability are requirements of water utilities that supply water to the public. As a fundamental tenet of any model water utility, regular reporting that is readily available to the public must be instituted (D’Ombrain, Pollution Probe). Regular reporting will form the foundation of the utility accountability to the customer. The individual elements of the customer involvement program are described in detail in Section 8 – The Customer. Water utility’s requirements are summarised below to highlight the transparency elements that are integral to the operation of the proposed model water utility.

A fully accountable water utility is one that demonstrates, in an open and transparent manner, that public expectations are being met, water quality can be assured, and good risk management and operational practices are in place. The water utility will need to report to the Regulator on compliance with preventive measures and any non-conformance. In addition, the water utility will report to the customer on the quality management of the water supply.

There will be a clear definition of roles and responsibilities for the Regulator and the utility.

There will be a clear designation of powers and regulatory reporting requirements outlined in legislation and regulation.

The mission statement for the individual water utility, including customer needs and expectations, will be available publicly. How the water utility is going about the implementation and operation of a Total Quality Water Management System will be captured in this mission statement.

The water utility will report on the progress of meeting the annual business and operational plan for the utility. Such an annual report will provide the full range of information to describe the effective operation of the water utility, including financial statements, progress measured against the plan, investments and improvements in the year, training undertaken as compared to planned, sustainable asset management, and technical compliance with standards.

Regular reporting can take a variety of forms, but will address the basic performance criteria for the Total Quality Water Management System. Ongoing monitoring of water quality will be available on a regular basis. Results of continuous improvement initiatives will be communicated to the customer and other stakeholders.

The progress reporting will provide customers with a “consumer confidence report”, so that any technical information on standards and implementation will be communicated effectively to the public.

The water utility, working with the industry associations, will work to develop performance benchmarks for the Total Quality Water Management System. The Regulator will establish standard procedures and forms for reporting that are clear and concise and that will facilitate benchmarking. Over time, these benchmarks will be reported to the public as an indication of how the water utility is managing improvements and change. In addition, these benchmarks will offer system-wide indicators to the regulator on performance, quality and effectiveness.

4. Technology – Utility Infrastructure

The core of any industrial production process must include the proper application of technology to provide an appropriate solution. In the water industry, the same holds true. Preventing contamination and managing risks at the source using technology and technical expertise provide the assurance of safe drinking water. Prevention is more effective at protecting public health than end-of-pipe compliance monitoring.

Prevention is a ubiquitous concept in the quality management field. The intent of implementing a quality management system is to prevent negative events from occurring by systematically reducing the risk of hazards. Risk analysis is fully described in Section 6.2.3 on Hazard Analysis Critical Control Points (HACCP). A general procedure for evaluating prevention strategies is discussed in the Australian Framework (NHMRC, 2001; please see Appendix 1 – Section 2.4 for the Australian Framework discussion of Prevention Strategies). The Australian Framework proposes a rational decision making approach that encourages the use a remediation measure that is proportional to the level of risk of the hazard.

Furthermore, prevention strategies are actively encouraged by many organisations including AWWA's QualServe and the EPA's Partnership for Safe Water program. Both of these organisations focus on evaluations (both self-assessment and peer review) of the water treatment facility. These evaluations are intended to lead the utility to modify existing procedures and practices in order to optimise performance with the goal of providing the highest possible quality of water to the customer. At the foundation of optimisation is the concept of prevention.

A standard prevention strategy in the drinking water community is the application of a concept known as the multiple barrier approach. The multiple barrier approach is outlined in the USEPA SDWA. The European Union includes source water protection and disinfection requirements in its Drinking Water Directive, thereby having an implied multiple barrier strategy to water treatment.

A multiple barrier approach is encouraged in meeting the 2000 Ontario Drinking Water Standards (ODWS). The ODWS uses the Ct concept to evaluate disinfection effectiveness and sets requirements for Ct levels. The Ct concept was modelled on the USEPA Ct requirements. Credit is provided to a treatment facility in meeting the Ct requirements by the addition of a disinfectant for a prescribed time and concentration. Substantial Ct credit can be awarded if effective physical removal of particulates is practised at a facility by way of filtration. This method of determining disinfection effectiveness encourages utilities to adopt a multiple barrier approach for water treatment.

4.1. Multiple Barrier Approach to Water Treatment

The multiple barrier approach employs several barriers in series to reduce the risk of pathogen transmission. If one barrier is performing less than optimally (or has failed), another barrier is in place to compensate for the suboptimal performance with the result that the complete system still provides the desired level of treatment. Furthermore, optimised barriers in series will reduce the dependency and improve the results from

each barrier, thereby providing superior water quality to the customer. Examples of barriers in water treatment include the watershed catchment area, settling tank, filter, disinfection, and the water distribution system. Appendix 1 includes information on how each barrier can be used and managed in a drinking water treatment system to effectively manage risk. Please see Appendix 1 – Section 2.4.1 for the Australian Framework discussion of Multiple Barrier.

4.2. Sustainable Asset Management

The heart of the water utility is its assets. It is critical that these assets be completely accounted for and judiciously managed and that a comprehensive computerised plan for preventive maintenance and renewal is developed and maintained. See Section 6.3.4 for further discussion.

5. Technical Competence–Utility Operations

The technical skills of the operators – those that have control of the switches, conduct the tests, monitor daily flows – are the key for assurance of water quality. Operators must be able to demonstrate their competence through certification. Operator certification is required in the United States under the 1996 SDWA amendments and is required in Ontario under O. Reg. 435/93 and its amendments. Others, including Delcan (2001) and the Australian Framework (NHMRC 2001), have reinforced that proper training of operators is required to ensure the reliable provision of safe water to the customer. Employees must be committed to continuous improvement, both from the perspective of their own skills, as well as the overall operation of the water utility. The ability to assure the public of the technical competence of operators is integral to building consumer confidence.

The knowledge, skills, motivation and commitment of a water supplier's employees and contractors ultimately determine its ability to successfully operate a water supply system. This element ensures that the level of awareness, understanding and commitment to performance optimisation and continuous improvement is developed and maintained within the organisation. (NHMRC, 2001)

5.1. Employee Awareness

Increasing awareness and understanding of drinking water quality management are essential elements in empowering and motivating employees to make effective decisions. All employees should be aware of the organisation's drinking water quality policy, the characteristics of the water supply system, what preventive strategies are in place throughout the system, regulatory and legislative requirements, roles and responsibilities of employees and departments, and how their actions can impact on public health. (NHMRC, 2001)

A water utility will increase employee awareness of the commitment to drinking water quality management throughout its organisation. An awareness program will include:

- the education element of the public information program
- newsletters, participation in operations manual maintenance
- notice boards
- seminars and videos
- briefings and meetings

The employees will also be encouraged to participate in community meetings to get first hand knowledge of customer concerns.

An employee rewards program will be developed to encourage suggestions to reduce operating cost or improve quality.

5.2. Operator Certification

The commitment and training of employees in issues relating to drinking water quality are essential to the provision of a safe and reliable drinking water supply (see Box 4.1). Employees and contractors must be appropriately skilled and trained in the management and operation of water supply systems as their actions have a major impact on drinking water quality (see Box 7.1).

A water supplier should identify employees' training needs and ensure that employees performing tasks that have a significant impact on drinking water quality are competent to perform those tasks. Employees assigned responsibilities for managing drinking water quality are required to be certified drinking water treatment plant operators.

Excerpt from Ministry of the Environment Fact Sheet, Published December 6, 2000 (<http://www.ene.gov.on.ca/envision/news/factdec6.htm>).

Anyone who operates a drinking water facility in Ontario must hold a valid operator's licence. Ontario's operator certification standards are consistent with the Association of Boards of Certification whose standards are followed by most U.S. states and Canadian provinces.

Licensing requirements are set out in Ontario Regulation 435/93 under the Ontario Water Resources Act. There are four classes of licence based on facility complexity. Licences are renewable every three years. All plant operators are required to undergo 40 hours of training each year in courses such as new or revised operating procedures, refresher courses in existing procedures, safety training and other related courses that improve operator knowledge and skills. It is the responsibility of facility owners to ensure training requirements are met.

On August 8, the Minister of the Environment announced the intention to require all operators to undergo an additional 36 hours of ministry approved training over three years to ensure they have the most current knowledge, skills and experience needed to sample water quality. In addition, a new licence will be created for water quality analysts. This licence will be required to perform a range of tests for operational parameters.

Currently, the Ministry of the Environment establishes the training standards for Operators and maintains the related certification system. This system does not appear to have the rigour and infrastructure support that is necessary to ensure that occupational standards are defined clearly and that the training is achieving those standards. Another ministry has the prime responsibility for organising skills training in Ontario.

The Ministry of Training, Colleges and Universities, under the Apprenticeship and Certification Act, has a workplace-based model to support all skills training. The model combines formalised classroom instruction, with performance-based on-the-job curricula. For many occupations, there also are formal examinations. This system incorporates the testing of knowledge and the demonstration of the on-the-job skills (competency or performance). It also has the potential to provide flexibility, in terms of defining and mapping competencies in a rationalised system, in relation to the diversity and variation of water treatment facilities in the province.

The Ministry of the Environment's role in setting occupational standards, attempting to manage an infrastructure for training, and maintaining a registration and certification system is a throw-back to the 1970s, when ministries tended to compete with one

another. Such competition amongst ministries results in duplication of effort, additional infrastructure costs, inconsistencies, fragmented outcomes, and confusion for the public. It makes eminent sense, therefore, to transfer the training and certification of Operators to the ministry that is best suited to manage this activity.

The MTCU has the experience, expertise, infrastructure, systems, certification, and visibility in this domain. Re-testing and re-certification also can be accommodated by MTCU. This model could create a hybrid to include both apprenticeship and post-secondary education, as requirements for operator certification. The program also can offer cross-Canada recognition under the Inter-Provincial Red Seal Program, thereby promoting harmonisation of occupational standards and labour mobility.

The Ministry of Training, Colleges and Universities should work with the industry to determine the adequacy of the current Operator training program and implement any necessary adjustments. In particular, under most apprenticeship programs, the formalised classroom instruction requires 720 hours over a three-year period. MTCU also arranges with training delivery agents (colleges and other approved agencies) to develop and deliver the formalised classroom instruction. Current arrangements by MOE are piecemeal and inadequate. Furthermore, through the Canada-Ontario Contribution Agreement, federal Employment Insurance funds also may be utilised to support the classroom instruction of qualified apprentices under the ACA.

Re-testing and re-certification, as in a number of other professions, would be required every three years to maintain an Operator licence of a drinking water treatment plant. *Grandfathering*, the concept of exempting some current water plant operators based only on the number of years of experience, must be discontinued by necessity to ensure that the operators are sufficiently qualified to ensure the public safety. “Education” must be further defined to be in the format of formalised classroom instruction with a Certified Education Unit (CEU) being provided at the completion of the training. The industry and professional associations, with the assistance of MTCU, will determine which training programs meet this requirement. “Training programs should utilise team-building exercises, where possible, and encourage employees to communicate and think critically about the operational aspects of their work.” (NHMRC, 2001)

Certification will include components of the following elements:

- Water and its effect on Public Health
- Safe operation of equipment
- Regulations and Standards
- Planned Emergency Response
- Customer awareness (sensitivity training)
- Implementation of TQWMS

Certification records of all employees who have received CEUs are to be maintained by the water utility and MTCU, as part of the TQWMS.

“Training is an ongoing process and a water supplier will regularly review the training requirements of employees and ensure that employees maintain the appropriate experience and qualifications” (NHMRC, 2001).

6. Support – Utility Management

All industries believe that they are unique and all organisations believe that they are unique. Each person believes that he or she is unique. Each of these beliefs is true and, yet, the patterns of accomplishment or shortfall all are very similar. When patterns are examined at an organisational level, the elements of leadership, management and culture can be seen to determine the overall performance. In technical environments, technical solutions tend to be sought out. Although it may seem somewhat counter-intuitive, it is through the social side of the work environment (i.e. achieving collaboration) that the discovery of the technical solutions will evolve.

This section discusses the elements critical to shaping the organisation that will create a work environment to support employees in achieving excellence in their performance. The presentation may appear generic and that is because the authors see nothing dramatically different in the drinking water supply industry. Like any other industry, there are processes, people and product. Here, we discuss people.

Management systems demonstrate a commitment to quality, strong leadership, competent management and a comprehensive approach to performance management. The TQWMS has the processes and procedures that provide a foundation for effective drinking water quality management.

Ongoing investment and strong accountability support technology and technical competence. Investment in people and quality are integral for achieving the TQWMS. The responsible management and financing of the product (quality water) and the asset (the utility) are necessary for a sustainable strategy of quality. Accountability to the public begins with the effective oversight of the direction and management of the water utility through good governance.

6.1. Personnel Management

6.1.1. Culture of Quality

Quality is the mantra of the late 20th Century and now the early 21st Century. Quality has been driven by customer expectations of improved durability, longer life and improved safety. In response to, or driven by, this requirement for quality there has arisen many institutions to support and further the quality endeavour. Of these institutions, the most prevalent are the International Standards Organisation (ISO)¹, American National Standards Institute (ANSI), and in Canada the Quality Management Institute (QMI). All standards institutions have as a core value the concept of improving quality by standardisation.

Quality methodologies developed for specific industries include HACCP in the food industry and Six Sigma in the manufacturing industry. Six Sigma mostly is applicable to the manufacturing environment and focuses on reducing the number of defective units produced in a given lot. This type of mentality and the steps to achieve Six Sigma standards are not applicable to a water utility environment.

Conversely, HACCP has the effect of being a quality management tool by way of its assessment and corrective action protocols. Although it is in its strictest sense a risk management tool, it reduces risk to the lowest reasonable level. In the case of drinking water, low risk means high quality. Risk in the case of drinking water is quantified by way of pathogen contamination and trace metal and chemical concentrations. HACCP identifies points where risk can be managed by improving processes that are under the control of the water utility personnel. For example, in a water treatment facility, adjustments to coagulant dose (a process - coagulation) could be used to remove pathogens (a risk).

In the water industry, associations such as AWWA's QualServe program and the EPA Partnership for Safe Water promote the use of best practises to improve treated water quality delivered to the customer. Other associations such as American Productivity and Quality Center (APQC – worked in conjunction with AWWA and Water Environment Federation to develop the QualServe program) and the Association for Quality and Participation (AQP) offer support for quality programs. In the UK water industry, a culture of continuous improvement is integral to the operation of the utilities due to the massive investment in infrastructure to make the water systems comply with European Union standards.

The Australian Framework emphasises commitment to quality across all levels of the water utility. The concepts of communication and continuous improvement also are established in the framework of the drinking water quality policy. Although the Australian Framework is not proven and will most likely require some modifications upon implementation, it is the most comprehensive quality system for the drinking water industry. The Australian Framework includes elements of HACCP and ISO 9000 & 14000 quality standards, all of which are recognised internationally. The quality standards have been adapted and applied in a drinking water treatment context allowing for a straightforward implementation by other drinking water organisations.

A sample generic mission statement is provided (please see Appendix 1 – Section 1) that any water utility could adopt and adapt. Of critical importance is that “each

¹ See Appendix 3 Section 10.1 for more information on ISO 9000.

employee should know how the mission statement applies specifically to the performance of his/her job.” (NHMRC, 2001). Each employee must understand that he/she is responsible for the quality of the water that a utility produces. The culture of quality must be instituted in an organisation by educating all employees about the benefits of a quality system.

Quality is about much more than just a system, forms and methodology. Quality is about attitude – and attitude resides in the gut. The system, forms and methodology will be established to support the attitude of continuous improvement. Water utilities will inculcate in all employees the belief and commitment to aspire to excellence and continuous improvement. There will be an obvious passion for quality. How will this passion be developed? It starts with the leader.

6.1.2. Leadership

Strong leadership is a requirement for implementation and maintenance of the Total Quality Water Management System (TQWMS). A large body of knowledge is available on developing leaders in organisations. The authors are attempting only to summarise and provide some general principles of leadership in the modern business environment.

There is both a technical side and a social side to managing. The social side is addressed in this section, while the technical issues are addressed in the next section.

It is through leadership that an idea, such as the Drinking Water Quality Policy, is implemented at a practical operational level. It is about getting people to do things in a certain way. Leading is not about telling, but rather relates to influencing the way in which employees interact and perform.

There are definitive attributes and strategies that culminate in effective leadership. A leader stands apart and above others through vision, commitment and communication.

- *Vision* is that element which interprets how the strategic business priorities will become transformational. It is a clear understanding and internalisation of how business will come to be conducted.
- *Commitment* is an unrelenting, consistent behaviour that advances the vision. It is demonstrated in everything that the Leader does.
- *Communication* is the process of explaining, influencing, engaging, supporting, and coaching employees in achieving their contribution to the vision.

Leaders believe that they can make a difference regardless of the prevailing environment, they will strive for excellence. Leadership is directional. It is the leader, therefore, that will establish and maintain the culture of excellence and continuous improvement in the water utility.

Leaders motivate others to achieve high performance. They are high impact players, who can help organisations become better-aligned and less imperfect. In fact, a leader can inspire not only an entire organisation, but suppliers and customers as well.

The leader can take the challenges of the move from the current system to the model water utility and create opportunities to effect improvement and achieve successes. The leader is the prime instrument in establishing and maintaining the organisation’s culture (see also Delcan, 2001 and Martin *et al.*, 2001), and creates within the staff the concept of challenge in job performance.

6.1.3. Management

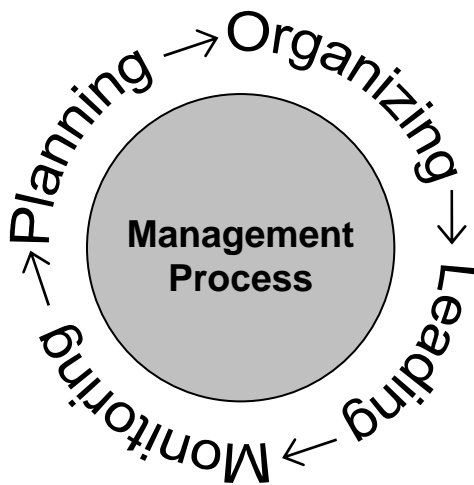
There are unlimited choices and managers make a variety of decisions every day. Each decision carries certain elements of risk. Fundamentally, the decisions are about how the manager will choose to participate in changing the world around him/her.

From the setting of goals through to execution, all organisations are challenged to perform to their maximum potential. There are a myriad of factors which may be constraining performance, including:

- conflicting priorities
- organisational misalignment
- underlying contradictions
- inconsistent culture
- inadequate leadership
- inappropriate skill sets
- constrained resources
- personality conflicts
- insufficient time

Given these organisational dynamics, what is it that managers need to do to achieve effective performance?

Managing is a process involving:



Planning, Organising and Monitoring essentially are technical activities, with methodologies, processes and measurements. The Total Quality Water Management System (see Section 6.2) expands on these elements. Leadership is an important element of management. It was dealt with in a previous section. The other processes in the Management Process are discussed further below.

Delegating

Successful management requires delegation. For the water utility, manager need to be confident that they can delegate to Operators and that the job will get done properly.

Delegating may be defined as, “commissioning a person as a representative with power to act for another”. Thus, delegating implies both responsibility and authority. What have

been omitted in this definition, however, are the required competencies to carry out the action in an effective manner.

If an employee has the required competencies, then:

- clearly define the assignment
- make available the necessary resources
- assign authority
- specify deliverables and timelines
- establish accountabilities and consequences

and let the employee carry out the assignment.

At The Task Level: A Four Step Process

In order for a manager to delegate with confidence, the employee first will need to be coached in how to perform a particular task. This coaching represents the on-the-job component of the Operator Apprenticeship Program. The complexity of the task will determine how in-depth the coaching will need to be. For tasks of a less complex nature, a four step process is used.

Describe	In detail, the manager will describe the task in its entirety. The use of written Procedures, Work Instructions, Videos, and Checklists is highly recommended. The manager will provide relevant related information, so that the operator can understand the task in relation to other activities. For example, if the task relates to the measurement of a water quality parameter, discuss the testing equipment required to perform the test, the calibration procedures if any are required, the chemicals for the test, the forms and recording procedures, and sample locations.
Demonstrate	The manager will show the operator how to perform the task. The operator observes each step of the process and any critical actions and potential problems and their solutions are identified.
Observe	The manager will observe the operator performing the task.
De-Brief	The manager will provide immediate feedback to the operator, positively critiquing the performance. The manager will ensure that the operator has sufficient opportunity to ask questions and to confirm performance standards and operating procedures.

This cycle will need to be conducted several times, because competency is achieved through training and experience. Periodic performance reviews also are appropriate.

Complex Functions and Assignments

More complex functions and assignments have a number of additional features. Describing an assignment requires more detail and comprehensiveness. In fact, in some assignments or projects, all the details may not be known at the outset, but are

discovered through the process itself. The manager will need to be available for regular reviews and coaching sessions.

At the outset, the manager must determine the skills and knowledge required in order to perform the function. If the employee has skill gaps, formalised training may be appropriate. For instance, if the assignment is to lead a project team on continuous improvement related to a particular function of the water utility, a training program in Project Management and Team Leadership may be extremely beneficial.

Critical paths, timelines, deliverables, resource requirements, and strategies for overcoming constraints need to be identified. Potential problems must be highlighted and contingency planning conducted. Regular reviews during the life of the assignment need to be scheduled. In complex assignments, expect to spend significant time with the employee, coaching for higher performance.

Job Functions

Job functions are even more complex. Detailed Job Description are established for jobs, but major responsibilities may be re-cast as competency groupings. Practical exposure, testing and analysis will determine which training interventions are necessary and appropriate. Employees progressively will mature in their positions, through regular training, upgrading and coaching.

In situations that require judgement, wisdom often is the outcome of reflecting on previous mistakes. It is necessary, therefore, for the manager to create circumstances that allow the employee to take risks, with the implied recognition that there will be some failures. It is the manager's responsibility to manage this process in such a manner that the water utility's exposure is minimised, while the employee's growth potential is maximised.

Through a consistent and persistent system of coaching, employees will develop and demonstrate the required competencies to perform a task, project or job. The manager must have the commitment to invest the time to share his/her knowledge and experience.

Motivation of Employees

Every employer wants to know how to motivate her or his employees. A very simple and practical three-step approach for turbo-charging the workforce is described below.

Mutual Respect

Employees need and deserve respect.

Mutual respect is the fundamental premise for all positive human interactions. A culture characterised by weakened *mutual respect* will breed unhappiness, contempt, lethargy, and conflict. *Respect* is that condition where diversity of thought, character and individuality are acknowledged. In a culture built on respect, consideration is extended to each person in an equitable manner. This contributes to a happier, more dynamic environment, where employees feel that they are wanted and valued. In turn, they will want to achieve higher levels of performance, quality and service.

Open Communication

High performance environments have trusting, two-way communication. Information is shared openly and discussion replaces “*telling*”. The norm is to solicit employees’ opinions and insights. As employees become more involved, real collaboration begins to develop and there is increased conversation regarding how best to contribute to the organisation’s success.

Active Engagement

Participation must be integrated into the entire process. It is critical that processes be structured to actively engage all employees in:

- identifying issues, problems and opportunities
- conducting analysis
- solving problems
- developing alternatives
- implementing solutions

Asking employees to *buy-in* at the implementation stage just does not work. Quality solutions best come from those directly doing a particular job and they need to participate in designing answers to their problems. Having been *actively engaged* in developing the solutions, employees are highly motivated to deliver success with a “*Pride of Ownership*”.

It is the responsibility of the manager to create and maintain an environment that cultivates mutual respect, promotes open communication, and actively engages the workforce in developing solutions. This is how water utilities will achieve the goals of the TQWMS.

6.1.4. Human Resources Management

The authors’ view is that a sound Human Resources Management System applies equally to publicly or privately operated organisations, and to union or non-union environments. (A separate issue paper is being commissioned to deal with the issue of public versus private operated facilities.)

Water utilities will need to establish and maintain effective Human Resources Management Systems to support productivity and employee satisfaction. Legal requirements must be addressed, including Pay Equity, Health and Safety, WSIB, Employment Equity, the Labour Relations Act, the Human Rights Code, and the Employment Standards Act. This will help the water utilities to become “the employer of choice”, in a fiercely competitive labour market.

A new level of management sophistication needs to be embedded in the water utilities. The following elements will need to be established:

1. Set up a progressive, corporate Human Resources function.
2. Audit and adjust the current Human Resources practices.
3. Establish and maintain corporate compliance with legislative requirements.
4. Analyse staffing requirements and demographics to develop a succession plan.
5. Analyse job functions; develop job specifications, competencies, job descriptions, and Standard Operating Procedures (SOPs).
6. Institute a process to address human resource issues at a strategic level.
7. Develop an in-house resource for staff to communicate with, in order to increase employee satisfaction.
8. Create an Employee Handbook that consolidates the water utility's policies, procedures, values, corporate mission, and a summary of significant working conditions and benefits.
9. Develop an employee Performance Management System that is linked to the water utility's strategic plan.
10. Identify corporate training needs; and develop a training strategy, including a management Leadership Development Program (LDP) and an Operator Apprenticeship Program.
11. Handle grievances
12. Identify external resources required to assist in the above.

The following chart identifies the elements of an established human resources management system and the benefits derived from that.

Human Resources Activity		Deliverables	Benefits
A	Strategic Planning	<ul style="list-style-type: none"> • facilitate a planning process to identify goals, objectives and business priorities • document and communicate the results 	<ul style="list-style-type: none"> • identification of business goals to focus activity • increase the alignment of resources • clarify strengths and areas for development
B	Orientation	<ul style="list-style-type: none"> • create an orientation process to be followed for new staff • create an orientation document for guidance on the process, addressing organisational issues, employment benefits, introductions, and establishment of job duties. • review the process with the relevant staff 	<ul style="list-style-type: none"> • provides a professional welcome for new staff and sets the right “tone” • reduces errors and saves time • develops clear organisational and job expectations • supports rapid achievement of acceptable performance levels for new employees • increases organisational stability
C	Training	<ul style="list-style-type: none"> • review employee training database • conduct training needs analysis • profile training needs by position • develop a training calendar • co-ordination/facilitation of training events • follow up evaluations on course effectiveness and application of skills by employee 	<ul style="list-style-type: none"> • ensures employees are all moving towards the ideal competency for their position • data base provides valuable information of human resource strengths and weaknesses • provides data for organisational planning and development
D	Policies and Procedures	<ul style="list-style-type: none"> • review existing policies and procedures • revise or create all relevant Human Resources policies to meet statutory requirements and good business practices 	<ul style="list-style-type: none"> • establishes company structure, culture and norms • informs employees, assists in decision making • provides a basis for corrective and disciplinary action • demonstrates compliance to legislative requirements (hiring, working conditions, termination, etc)

Human Resources Activity		Deliverables	Benefits
E	Performance Management	<ul style="list-style-type: none"> • develop format for performance evaluation • document procedures and definition of terms • provide complete training of management staff • conduct staff information session on objectives and process • provide support for implementation 	<ul style="list-style-type: none"> • feedback system for supervisors and employees • provides basis for compensation adjustments, training activities, internal staffing, succession planning, job design review • focuses future activity of employee
F	Staffing Internal External	<ul style="list-style-type: none"> • formalise a general process for internal and external selection that meets provincial employment standards • design an application form approved by the Human Rights Commission • establish communication pieces for stages of process • establish evaluation grid for selection • reference check format • train the appropriate managers 	<ul style="list-style-type: none"> • provides a professional approach for staff and external candidates • expedites selection by providing a process • demonstrates company adherence to good business practices and statutory compliance
G	Team Building	<ul style="list-style-type: none"> • identification of employee work preferences • identification of characteristics of team members • identification of profiles of key positions • workshop to develop more effective team management skills 	<ul style="list-style-type: none"> • people can perform more effectively if working in the “right” job • greater understanding and respect of skills and contributions of team members
H	Job Analysis - Organisational Development	<ul style="list-style-type: none"> • examine the work of the organisation • identify competencies required by position • write job profiles 	<ul style="list-style-type: none"> • provides profile of the work of the organisation • ensures that grouping of work is effective • provides data for growth and development of company and staff
I	Job Evaluation	<ul style="list-style-type: none"> • ranking of positions based on Pay Equity principals of skill, effort, working conditions and responsibility 	<ul style="list-style-type: none"> • provides an objective process to value the work of a position and removes subjective assessment of worth that can lead to fairness and Human Rights concerns
J	Compensation Policy	<ul style="list-style-type: none"> • review current industry salary surveys • review merit pay and bonus practice • recommend compensation plan 	<ul style="list-style-type: none"> • improve company ability to attract and retain the staff that are required for success of the operation • ensure compensation practices are in line with business direction

Human Resources Activity		Deliverables	Benefits
K	Employee Benefits Package	<ul style="list-style-type: none"> Examine current health care benefits for employees and their families: <ul style="list-style-type: none"> assess the package for cost effectiveness examine use and suitability Ensure coverage is communicated in orientation, policy manual and employee handout, recruiting piece 	<ul style="list-style-type: none"> Ensure provision of coverage meets needs of employees Provides clear communication to employees regarding benefits coverage Ensures cost effectiveness of benefit premium costs
L	Health and Safety, WSIB, WHMIS	<ul style="list-style-type: none"> review of existing policy and procedures establishment of Health and Safety committee and practices 	<ul style="list-style-type: none"> ensure company and staff of safe work practices demonstrates compliance with legislative requirements
M	Reward and Recognition Program	<ul style="list-style-type: none"> assess existing program, industry standards, employee interest formalise a basic program 	<ul style="list-style-type: none"> provides increased job satisfaction motivation for performance mechanism to acknowledge good performance establish role models for all staff increased company loyalty
N	Employee Relations/ Communication	<ul style="list-style-type: none"> establish a mechanism for workplace communication and problem solving 	<ul style="list-style-type: none"> improves moral and productivity through information exchange, better understanding of the water utility's strategies provides an opportunity to resolves problems at an early stage employees have a mechanism to be involved in activity of the company

6.1.5. Performance Management

Formal job descriptions and employee performance interviews are required. The job description are not intended as a limit to the employee, rather it is intended as a tool for management to identify current gaps and needs within the organisation. An integrated system to provide the context for human resource functions and activities is required.

When business operations and systems are not properly co-ordinated or are functioning at cross-purposes in an organisation, performance and morale suffer. This has a profound, negative bottom-line effect. It makes eminent good business sense, therefore, for an organisation to take the time and effort to develop and implement the system described below.

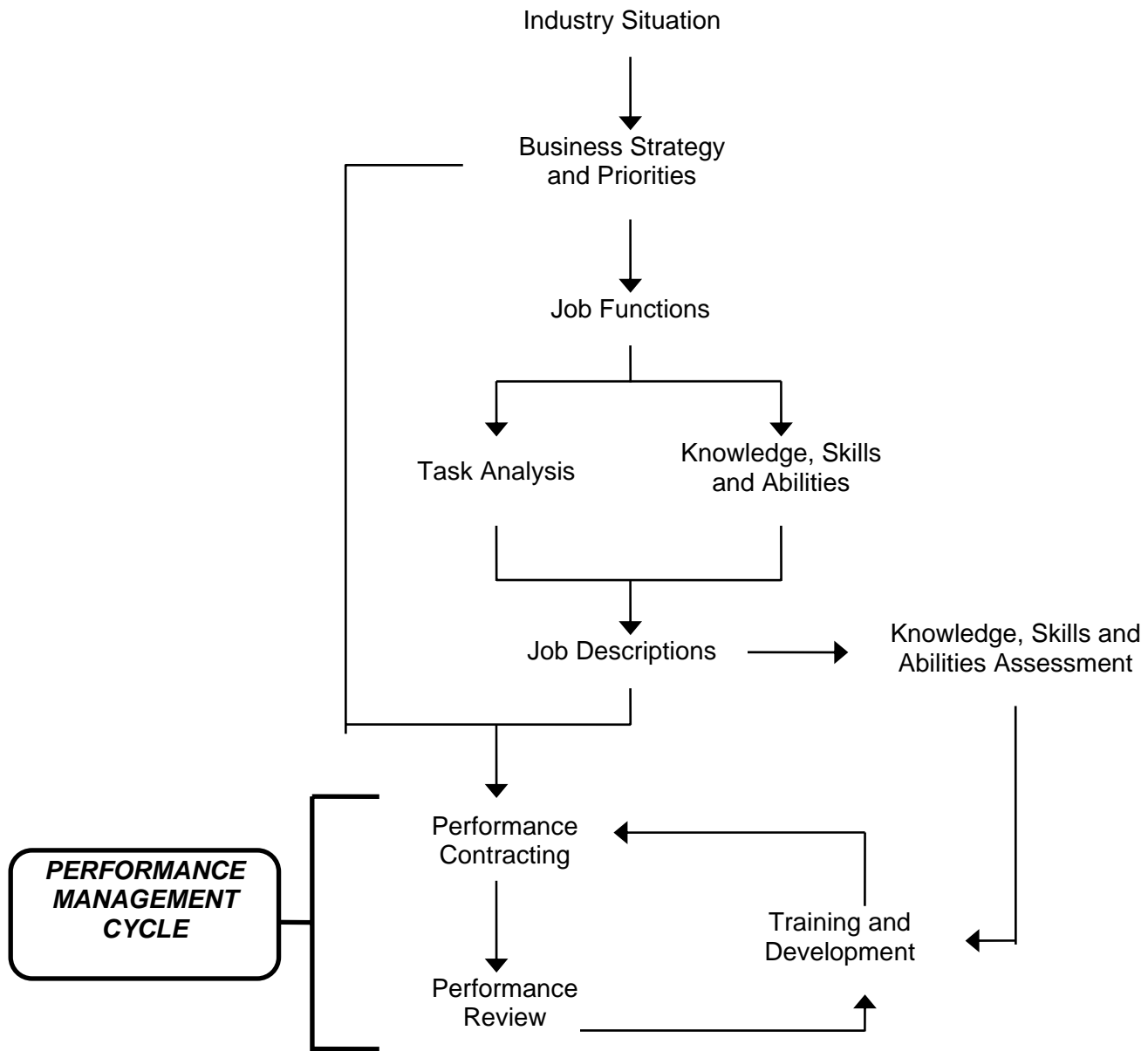
The Performance Management System

A Performance Management System is an intrinsic element of the business systems of every organisation. It is driven by the organisation's strategic business priorities and it functions at the critical juncture where strategy becomes translated into performance. This is the system that manages the people part of a business and it needs to be aligned with the others systems that support the water utility.

As a system, it is not overly complex. It does, however, require a certain level of attention and precision to manage it effectively. Organisations that establish and maintain good Performance Management Systems function better, and attract and retain high performing employees. Since it impacts on and involves every employee, it also provides early warnings that other systems may be out of alignment.

What It Is

The following flow-chart in Figure 6-1 illustrates the overall context of the Performance Management System. Note how it links the strategic business priorities to each employee.

Figure 6-1 Performance Management System

How It Works

Job Functions are driven by the business's strategy and priorities. As business conditions change, it is important to review the Job Functions, in order to ensure that they continue to be relevant and are in alignment with the organisation's strategies and priorities.

Once a Job Function has been defined, the Tasks which need to be performed and the related Knowledge, Skills and Abilities can be identified. These, in turn, lead to the development of a Job Description. The Job Description should include the attributes of both the technical and behavioural (performance) aspects required in the job.

Incumbents or job prospects can have their Knowledge, Skills and Abilities (both technical and behavioural) assessed against the Job Description. This will facilitate better recruitment practices, as well as identifying Training and Development needs.

Performance Contracting is the process of establishing individual goals with an employee. This should be a negotiated process between the employee and his/her supervisor, and the goals should include technical, behavioural and business objectives. It is critical that these goals be developed in a manner that makes them measurable, impartial, relevant, and attainable. Training managers in how to conduct these performance contracting sessions are part of the Leadership Development Program discussed below.

Performance Reviews (both formal and informal) should be conducted on a regular basis in order to assess progress toward achieving the goals, supports or interventions that may be appropriate to helping the employee achieve the performance standards, and Training and Development needs. These reviews also should be a negotiated process between the employee and his/her supervisor.

Employees, with their supervisors, then should develop priority-ranked Training and Development plans. These then can be rolled-up to create a utility-wide Training Plan. From this, training can be organised and delivered in a planned and rational manner, always in support of business priorities and individuals' needs.

This is a full Performance Management System. It should be applied to the entire organisation and to employees at all levels. Implementing such a system will bring cohesion, order and direction to the human resource activities of an the water utility, in support of its strategic business priorities.

6.1.6. Management/Leadership Training

The drinking water industry, like most other industries, has promoted technically-adept workers into management positions. Unfortunately, also like most other industries, many of these managers have never received the benefit of any management training.

In order to support and ensure excellence and quality, the water utilities will commit to a comprehensive Leadership Development Program for all employees in management positions. Water utilities will report on the successful completion of this program by their managers in their annual report. An abbreviated version of the training also should be considered for the other employees. Training managers in how to conduct these performance contracting sessions are part of the Leadership Development Program discussed below.

The elements of such a training program are identified below. Each of these elements would require a day of formalised training, extending over some period of time.

This training should be supplemented by participation in activities organised by the various professional and industry associations.

Topics Required for Leadership Development Program

- Vision
- Roles of the Manager, Supervisor and Employee
- Communication
- Understanding Behaviour
- Managing Difficult Employees
- Delegating and Following-Up
- Coaching For Performance
- Handling Conflict
- Human Resources Forum
- Labour Relations
- Employment Standards, Diversity
- Health and Safety
- Time Management
- Problem Solving and Decision Making
- Project Management
- Leadership
- Teamwork
- Investigating, Evaluating and Documenting Incidents
- Performance Management
- Interviewing and Recruiting
- Setting Goals and Priorities
- Grievance Handling and Collective Agreement Administration
- Workplace Harassment; Attendance Management
- Ethics
- Business Writing
- Report Writing
- Managing With A Customer Focus
- Strategy
- Finance for Non-Financial Managers
- Developing And Managing Budgets
- Effective Meetings

The elements described above – a Human Resources Management System, a Performance Management System and a Leadership Development Program – may seem to be somewhat unexciting. Taken together, however, they form an essential cornerstone in establishing and maintaining the model water utility. These are the processes and activities that often are overlooked or truncated by organisations, to their own detriment. Although not particularly glamorous, these elements are fundamental to the success or failure of an organisation and must be supported by the model water utility.

6.2. Total Quality Water Management System

6.2.1. Continuous Improvement

Continuous improvement is an element of the ISO 9000 and 14000 standards to ensure that an entity is continuously in search of ways to improve itself. This ongoing endeavour ensures that an entity changes with the environment in which it operates and takes advantage of its collective minds to define methodologies to improve efficiency and/or quality. Much of the concept of continuous improvement is based in quality management. Quality management is discussed in more detail in Section 6.1.1. For the same reasons that the Australian Framework was selected as the standard to be employed for quality management, it is again selected as the model to form the foundation of the proposed continuous improvement element of the of the Total Quality Water Management System (TQWMS). Please see Appendix 1 – Section 2.1 for the Australian Framework discussion of Continuous Improvement.

Continuous improvement requires commitment from senior management in the water utility to drive towards optimal performance and to keep track of changes within the industry that could have an effect on operations. The TQWMS Plan ensures that the TQWMS is being reviewed and regularly updated with new innovations and improvements. Senior management must review the TQWMS to monitor the implementation of the quality vision. The requirement for a short-term (1-year), intermediate-term (5-year), and long-term (20-year) TQWMS Plan is outlined.

Research and development is an important component of continuous improvement in the drinking water sector. Research and development projects could be ongoing by dedicated staff for plant optimisation, the projects may be better suited to be conducted by outside agencies such as universities, or the projects may be best suited for collaboration with universities, researchers, consultants, associations, and/or other utilities.

6.2.2. Benchmarking

Benchmarking is the process of comparing performance data with other water treatment plants' performance data. It is a process that is encouraged by associations such as QualServe in the US and Canada, in Australia by way of its Framework for Management of Drinking Water Quality, and in the UK. Performance parameters can be compared by utilities with similar capacities and source waters. Many water utilities in Ontario already have subscribed to the QualServe program.

Benchmarking also has been used by public advocacy groups such as Clean Water Action's "Measuring Up II" that rates all CCRs provided by California's water utilities. The power of benchmarking can be utilised by the public to rank the performance of water utilities and to identify what can be expected from a utility with regards to quality and efficiency.

Benchmarking is a quick way for managers to evaluate their treatment plant performance and should lead to discussion and exchange of information between water utility managers and operators on best practices. If one water utility has higher performance on a specific parameter, other utilities will want to emulate the practices resulting in the higher performance of the leading utility.

Several parameters can be used as a basis for benchmarking. Other parameters can be added as necessary or desired. Please see Table 6-1 Benchmarking Parameters for a basic list of benchmarking parameters.

Table 6-1 Benchmarking Parameters

PARAMETER	UNITS
Turbidity	NTU
Colour	TCU
Leakage	% of Total
Energy	kWh/m ³
Cost of Water Production and Supply	\$/m ³
Price of Supplied Water	\$/m ³

6.2.3. Hazard Analysis Critical Control Points (HACCP)

Hazard Analysis Critical Control Points (HACCP) was developed in the 1960s and has been adopted as the preferred quality control tool in the food industry since the early 1990s. It is internationally recognised as insurance that a food product has been packaged with proper quality control, much as ISO 9000 (and its variations) is the standard of quality control in manufacturing and other industries.

HACCP currently is being used extensively in the Canadian food industry. The full implementation manual for HACCP in the food industry can be found at (www.cfia-acia.agr.ca/english/ppc/psps/haccp/haccpe.shtml). In brief, the program consists of 7 basic principles (from CFIA):

1. identification of hazards that may be present from harvest through ultimate consumption and preventative measures for controlling them;
2. determination of critical control points (CCP) required to control the identified hazards;
3. establishment of critical limits that must be met at each critical control point;
4. appropriate monitoring procedures for CCP;
5. establishment of deviation procedures at critical control points;
6. procedures for verification that a HACCP plan is working; and,
7. documentation records concerning all procedures and records appropriate to principles (1) through (6).

Adoption of HACCP by water utilities would have a relatively low expense of adaptation and implementation. The expertise required to implement these programs is resident in our geographical area, there are many similarities between packaging food products and treatment and distribution of water, and the government already has the infrastructure to implement and regulate HACCP.

Inspectors from the Canadian Food Inspection Agency (CFIA) could be used to provide inspection services for water utilities. Inspectors would require some additional training and education, but their core values and skills are common with those in the water industry – concern with health and safety, appreciation for microbial contamination,

dedication to the protection of the public. Separate divisions for food and water would be required to ensure that specialised inspectors would be used in the water sector.

Finally, HACCP was included in the Australian Framework with rough protocols worked out on typical water treatment. Some of the groundwork for HACCP implementation in drinking water, therefore, already has been started.

Hazard Identification and Risk Assessment

A hazard is an agent or a situation with the potential for causing harm (e.g. Cryptosporidium is a water quality hazard, a potential danger to public health). Risk is the likelihood of identified hazards causing harm in exposed populations in a specified time frame, including the magnitude of that harm and/or the consequences (e.g. the likelihood that Cryptosporidium oocysts will breach water management system barriers with sufficient numbers to cause illness in consumers would constitute a risk).(NHMRC, 2001)

The Australian Framework details how hazard identification and risk assessment is applied in the drinking water treatment system. Potentially hazardous and/or contamination events are identified in Appendix 1 Table 2.2 for the different stages of the water system from the water catchment to the distribution system. A methodology for qualitative computation of risk is outlined in Appendix 1 – Section 2.2 to identify high and low risk hazards. Following the quantification of the risks, a prioritised list can be developed to identify the order in which the risks are to be addressed. Please see Appendix 1 – Section 2.2 for the Australian Framework for a thorough discussion of Hazard Identification and Risk Assessment.

Critical Control Points

“A Critical Control Point (CCP) is defined as a point, step or procedure at which control can be applied and is **essential** to prevent or eliminate a hazard or reduce it to an acceptable level” (Codex *Alimentarius*). In the drinking water system, the process can be most controlled at the drinking water treatment plant. Other CCPs include the watershed and the drinking water distribution system. Each of these general processes of the drinking water system can be subdivided into smaller processes to analyse specific strategies of control. Some characteristics of an ideal CCP are identified in Appendix 1.

Individual unit processes within a drinking water treatment plant are identified as CCPs. Strategies for managing the risk at each point are developed in Appendix 1 – Section 2.3. These strategies are general in nature and would require further development for implementation at each water treatment plant. Please see Appendix 1 – Section 2.3 for the Australian Framework discussion of Critical Control Points.

An additional CCP to those listed in Appendix 1 – Section 2.3 is described below.

Membranes

The use of membranes has been gaining wider acceptance in small and now in large plants (up to 150 ML/day). The cost of large membrane facilities is reducing constantly as a result of economies of scale and improvements in membrane manufacturing technologies. Membranes physically remove pathogens, can remove some dissolved compounds, and remove particulates.

6.2.4. Risk Management

Risk management is a continuous and iterative process. Risk management is a combination of reducing technical risk to reasonable levels as well as having open and frank discussions with the public about risk and its implications. Risk cannot be eliminated in drinking water. Risk, however, can be mitigated to levels that provide adequate protection. In the case of drinking water, a properly executed risk management program will result in higher quality and safer water.

The HACCP program is in its essence a risk management procedure for minimising technological risk. Please see Section 6.2.3 for more information on HACCP. The HACCP program will:

- identify chronic and acute risk within the treatment system
- mitigate chronic risk by the development of operational procedures to ensure the desired water quality is achieved on a consistent basis
- identify acute risks that need to be addressed with the development of procedures

Acute risks and the occurrence of an out of range parameter are the focus of the last two parts of this section.

Please see Appendix 1 – Section 2.5 for the Australian Framework discussion of Risk Management.

Risk Communication

The concept of risk minimisation needs to be transferred to the public. The public needs to be aware that there is always an element of risk when a food or beverage is ingested, whether that is tap water, bottled water, or any other food or beverage. The objectives of the treatment system are to reduce the risk to a reasonable level. When an incident occurs where standards are exceeded, the public then will be able to put the warning into context: a specific parameter has exceeded a prescribed risk level. The warning is not necessarily to let them know they are going to get sick if they drink the water (although it may). The warning is to let them know that the maximum risk level, as determined through epidemiological studies, has been exceeded.

Powell provides seven rules of risk communication.

- accept and involve the public as a legitimate partner
- plan carefully and evaluate performance
- listen to your audience
- be honest, frank, and open
- co-ordinate and collaborate with other credible sources
- meet the needs of the media
- speak clearly and with compassion

Powell also summarises detailed guidelines for risk communication. The foundation for risk communication is first to protect the public. A strong emphasis, however, is placed on maintaining the trust of the public in the water that is being supplied. This public trust is best maintained by following rules of communication like those provided above. Effective risk communication will ensure to the public that they have not been deceived so that at the end of the event, and the risk has been reduced to reasonable levels, the public then will have comfort and trust in the water that they are being provided.

Dobell extends risk assessment and characterisation to include the public. Dobell characterises the drift towards an “audit society” where we are increasingly moving towards quality systems and the resultant checking that is required. This puts increased pressure and expectations on public servants to have transparent processes that can be understood by others, including the public. Dobell has put together a recipe for “making decisions on behalf of individuals, but in a public interest”.

- A. *It must be principled – There is a core layer of individual human rights (requirements of natural justice) to be respected*
- B. *It must meet social tests of procedure*
- C. *Within these constraints, it must be substantively justifiable*
- D. *In a situation where there appear to be fundamental conflicts among these precepts it must meet a final test of personal responsibility*

and

- E. It must clear and understandable

It must be understood that Step B is in a continual state of flux. The public is demanding increasing access to information. Public servants also should remain cognisant of the fact that eventually, at some stage, the public will attain knowledge of a project. It is in the best interest of any decision maker to include the public in an early stage. If there is a strong resistance to the project, it is better to know early in a project life cycle when expectations and planning can be modified. A change late in a project costs more than a change early in a project. Because Step B requires more and more participation, a frank discussion with the stakeholders of the project on the risks and risk assessment procedure is a requirement of modern utilities. Because of the complexity of the issues surrounding this type of discussion with the public, it is recommended that experts be utilised for the communication program.

Please see Appendix 1 – Section 2.5.1 for the Australian Framework discussion of Incident and Emergency Response Protocols.

Incident and Emergency Response Protocols

A standard protocol must be established for reacting to an emergency situation. The protocol includes characterisation of the problem, correction of the problem, and communication with the required authorities. Of key importance is to have established protocols that have been effectively communicated across the organisation prior to an emergency situation. After the emergency has been brought under control, an evaluation process is required to analyse the cause(s) of the emergency, review the response to the emergency, and modify the emergency protocol if required. An example Water Incident Communication and Notification Protocol is presented at the end of Appendix 1 – Section 2.5.1.

Emergency Planning

Uncontrollable events with irregular cycles may have an impact on the operation of the drinking water treatment system. Examples of such events include natural disasters including the Ice Storm of 1998. The maintenance of consistent water supply is critical during these periods to ensure that the potable water is available to people in crisis and also to ensure adequate fire flow if the events result in fires. A good resource for

emergency planning is AWWA Manual M19 – “Emergency Planning for Water Utility Management”.

6.2.5. Standard Operating Procedures

The development of Standard Operating Procedures (SOPs) is a valuable process. This process results in the collection of information that forms the foundation of many TQWMS components including continuous improvement, identification of CCPs, and the SOPs themselves. Optimisation programs such as QualServe and Partnership for Safe Water would benefit by the use of SOPs to define current operating practices as a basis on which modifications would be made to improve the performance of a drinking water facility.

The effectiveness of preventive management strategies is highly dependent upon the design and implementation of associated process control programs. To consistently achieve a high quality water supply it is essential to have effective control over the processes and activities that govern drinking water quality and safety. This is particularly important for those activities that have been defined as Critical Control Points.

*Operations must be optimised and controlled on a continuous basis as even short periods of suboptimal performance can represent a serious risk to public health (see Box 4.1, Appendix 1 – Section 2.6.1). Therefore, continuous performance and ensuring that barriers are capable **at all times** are a critical requirement for the provision of a safe drinking water supply.*

A process control program supports the preventive strategies by detailing the specific operational factors that will ensure that all processes and activities are carried out effectively and efficiently. This includes a description of all preventive strategies and their functions together with:

- 1) Establishment and documentation of effective operational procedures.*
- 2) Use and maintenance of suitable equipment.*
- 3) Use of approved materials and chemicals in contact with drinking water.*
- 4) Establishment of a monitoring protocol for operational performance including selection of operational parameters and criteria and the routine review of data.*
- 5) Establishment of preventive and corrective actions to control excursions in operational parameters.*

Two additional requirements for effective process control are the skills and training of operations staff and the documentation of all procedures.(NHMRC, 2001)

Details of the methodology used to develop the SOPs are found in Appendix 1 – Section 2.6. The process of developing the SOPs will by necessity involve many or all of the water utility staff. This will give the staff a sense of ownership about the SOPs that ultimately will lead to higher participation in the ongoing TQWMS.

6.2.6. Verification of Drinking Water Quality

“Verification involves monitoring the quality of drinking water supplied to consumers to determine compliance with established criteria and requirements.” (NHMRC, 2001). Monitoring of drinking water parameters is required to ensure compliance with regulated standards and also for benchmarking of performance. As a bare minimum, the ODWSs are to be followed to ensure that the minimum number of samples are taken over a given period. Please see the following tables in the ODWS-2000 to get a comprehensive list of parameters to be monitored, frequency of monitoring, and the required reporting schedule:

- Table 5 - Sampling
- Table A – Microbiological Organisms
- Table B – Volatile Organics
- Table C – Inorganics
- Table D – Pesticides and PCB's

As important as verification is in TQWMS, it should always be remembered that meeting the requirements as detailed in standards such as the ODWS is not always sufficient to protect public health.

I hope we can all agree that a table of numbers – whether they are guidelines or strict standards – does not protect public health in and of itself. Meeting the numbers is just part of an effective program. More important to me is whether utilities have continuous quality improvement systems to verify that the entire process of delivering safe drinking water is working as it should.

Jack Hoffbuhr, Executive Director of the AWWA, 2001

Please see Appendix 1 – Section 2.7 for the Australian Framework discussion of Verification of Drinking Water Quality.

6.2.7. Documentation and Reporting

Documentation procedures and the forms used to standardise internal utility reports will form the foundation of the SOPs (discussed in Section 6.2.5). Beyond filling out a form, the information will have to be processed and analysed with the objective of identifying trends and modifying procedures to improve water quality. Periodically (every 3 months in Ontario), some of the pertinent information will be summarised and presented to the public in a Quarterly report.

As per Ontario Regulation 459/00, quarterly reports must be produced and available within 30 days after the end of each quarter. The specific parameters and sampling frequency of each parameter are listed in Ontario Regulation 459/00. Parameters that are only required to be sampled at a frequency greater than every 3 months should have the value that was last sampled along with the date it was measured. The criteria under which a public notice is required to be issued is clearly specified in Ontario Regulation 459/00 Section 8 – Notice to Medical Officer of Health and to Ministry. As an additional requirement of the TQWMS, annual reports also will be produced for audit and public reporting purposes.

Appendix 1 – Section 2.8 provides details about the types of activities that require documentation. The documentation system should be kept as simple as possible to ensure that the documents can be readily retrieved when needed. A system of updating

forms and documents should be in place to reflect the changes that occur within the organisation.

Please see Appendix 1 – Section 2.8 for the Australian Framework discussion of Documentation and Reporting.

6.2.8. Evaluation and Audit

To ensure that the staff adheres to the TQWMS, regular evaluations and audits are required. A system of internal evaluation and audit is required to identify areas that could be improved with the organisation, staff, and equipment. External evaluation and audit also can be utilised to provide analysis of specific issues. The process of evaluation and audit will provide the required information to implement improvements. Regular audits will be conducted by third parties who are recognised Registrars. Please see Section 7.1.3 for a description of the audit function. Please also see Appendix 1 – Section 2.9 for the Australian Framework discussion of Evaluation and Audit.

6.3. Financial

6.3.1. Value

Sometimes when purchasing external services, there is a tendency to make the selection solely on the basis of “lowest cost”. Water utilities need to review this practice and recognise that there is a *value proposition* – a certain correlation between *cost* and *value*.

The inclination to purchase services at the lowest cost, reduces other values to the lowest common denominator, that being cost. Making purchases on this basis ignores the intrinsic values being sought in the purchase of services and renders the purchaser with something less than the desired outcome.

For every purchase that is being contemplated, a set of screening criteria, and related standards and weighting, needs to be developed. This filter then can be applied to every proposal that is submitted and a transparent decision can be determined based on an inter-related series of factors.

This approach will help ensure that there is an appropriate balance between expenditures and deliverables. It is such a balance that brings true value to the purchases of the water utility.

Water utilities also need to explore innovative common purchasing arrangements that might reduce costs or bring greater value to purchases. For example, by forging linkages with other water utilities or other public sector organisations in the community (schools, hospitals, colleges, universities, other municipal departments), economies of scale in *purchasing power* can be achieved. This will have the effect of reducing costs or improving services. Innovative purchasing approaches will serve as another example of “best practices” that should be promoted by the industry and professional associations.

6.3.2. Investing in People

The model water utility being described in this paper is anchored in a culture that strives for excellence and continuous improvement. To achieve this end, the authors have identified that sound Human Resources Management Systems need to be developed and ongoing investments must be made in the employees.

In determining the costs related to the above, the following are critical considerations:

- The need for external resources to help build the Human Resources Management System and Performance Management System
- Determining appropriate pay bands and making provision for these costs
- The need for external resources to conduct a skills inventory and gap analysis
- Appropriate resources to support technical training of Operators through a formalised Apprenticeship Program
- Appropriate resources to support Leadership Development training of all managers
- Adequate provision to participate in industry and professional associations

The development and implementation of a Human Resources Management System and a Performance Management System is an intensive activity. The Ministerial Task Force

(See Section) may enable some collaboration in the high-level development of these systems. Each water utility, however, needs to budget sufficient time and resources to implement these systems in an effective manner, through a combination of external and internal resources to help fast-track these initiatives.

Attracting and retaining quality employees in a labour market that will continue to constrict over the next several decades will be a challenge for all industries and organisations. Compensation will be one important consideration. Establishing appropriate pay bands will be an immediate requirement. Furthermore, as water utilities move to shared services, consolidation or cross-boundary configurations, factors such as harmonisation of wages will need to be taken into account.

Employees of the new water utilities have a significant range of existing knowledge, skills and competencies. Not everyone will require all the training detailed in previous sections. Water utilities, therefore, will need to understand each employee's existing skills, in order to determine their required training. External resources can facilitate this process.

Training of Operators in an Apprenticeship Program and of managers in a Leadership Development Program are key to developing the competencies and culture embedded in the model water utility. These expenditures must be viewed as investments, not as costs. A multi-year plan, with supporting budget, will need to be established as part of the Human Resources Management System.

As the sector matures, the industry and professional associations will take a stronger leadership role in promoting best practices and lessons learned. Employees will need to be able to participate in these activities.

6.3.3. Investing In Quality

The model water utility is committed to developing and maintaining a TQWMS. Although we have identified some approaches where system-wide efficiencies could be realised, individual utilities need to budget for their quality initiatives.

This will include:

- The need for external resources to help establish the TQWMS
- The need for external resources to help customise SOPs, as required and appropriate
- The need for external resources to train all staff on the TQWMS and related documentation
- Adequate provision to support a third-party audit by a recognised Registrar

The Ministerial Task Force will review existing systems and approaches to quality management (ISO, HACCP, QualServe, etc.) and develop the framework for a Total Quality Management System that is customised to the needs of water suppliers in Ontario. Each water utility then will need to implement that TQWMS framework in their organisation. External resources will help fast-track this initiative.

The Ministerial Task Force will strike a Working Group to develop Standard Operating Procedures (SOPs) for similar type water facilities. Some customisation may be required for individual water utilities, and provision needs to be made for external resources to assist in this process.

All staff will require training in the TQWMS, its purpose and benefits, protocols, documentation, and appropriate levels of responsibility, authority and accountability.

Employees will need to be trained for the audit. External resources will assist in this process.

The Ministerial Task Force will share the TQWMS with the audit community of Registrars, who are recognised by the Standards Council of Canada. Each water utility will need to contract for audit services with a Registrar.

6.3.4. Sustainable Asset Management

Water utilities need to address all financial considerations from a strategic orientation. Life cycle considerations need to be imbedded in all elements of financial development and budgeting. Some items that previously may have been viewed as costs, in fact, need to be understood as investments. Financing must be developed using the *matching principle*, so that long-term capital activities (i.e.- infrastructure renewal) have long-term debt financing. Full cost recovery also must form the cornerstone of the new water utilities.

Strategically, budgets need to include ongoing commitments to expenditures that will ensure that staff and facilities consistently can deliver water that meets the required quality standards and minimise risk. Significant investments, particularly during the transitional phase, will be required for the technical and managerial training of staff. A multi-year training plan and supporting budget will need to be developed and implemented.

We need to re-fix the price of water in order to reflect its true cost and value, and to cultivate the types of behaviours (i.e. - less waste, infrastructure maintenance and renewal) that we desire.

“Canadians are charged, on average, significantly less for their municipal water supply and water services than other developed countries. Water prices in Germany and Denmark, for example, are about four times greater than Canada’s prices – and this is after Canada posted a 100% increase from 1987 to 1999.” Pollution Probe, 2001

The principle of *full cost accounting* was one of six principles of sustainable development endorsed by the Ontario Round Table on Environment and Economy. Full cost accounting demands that the “natural assets be fully valued to ensure proper use and allocation, and to make certain that the beneficiary of the activity pays the full price including the cost of any environmental damage and resource use”. Application of this principle should realise greater economic efficiencies and protection of the resource base (or system) for future generations. It should also lead to better use of existing water management infrastructure and provide a basis for rational assessment and informed decision-making about the need for new or expanded infrastructure.”

This view is echoed in the Ontario Sewer and Watermain Construction Association’s (OSWCA’s) submission.

The main reason why Ontario’s water rates are low is because municipalities are not billing consumers for the full cost of water treatment and supply. As well, water use is not universally metered, and where water charges are based on a “flat rate”, the rate may not cover the full cost of the service.

Full cost accounting is a method by which all monetary costs of resources used, committed, or required in the future, for water treatment and supply and sewage collection, treatment and disposal are taken into consideration.

At a minimum we would propose that full cost means adopting a method such as the following:

- *Determining total cash expenditures by adding together all direct and indirect overhead costs and operating costs of the works;*
- *Determining total debt repayment costs reasonably attributable to the works;*
- *Determining a total sustainability allowance for the works by adding together a reasonable total allowance for renewal and replacement and a reasonable total allowance for improvement; and*
- *Determining the total annual sustaining costs by adding together total cash expenditures; total debt repayment costs; and the total sustainability allowance; each as determined above. . (OSWCA, page 3)*

If the model water utilities are viewed as totally independent, stand-alone operations that are accountable to their boards and that are financially discreet and viable entities, then some further factors need to be considered in determining full-cost recovery. Obviously operating costs and sustainable asset management are the starting point. Cash reserves are another element. Provision for fire services forms part of the municipal tax base and some portion of that will need to be transferred back to the water utility. Support for ongoing industry research and maintaining the regulatory regime also might be appropriate considerations. In this way, consumers will be supporting the true and full costs of their water supply system. (See also “Financing Water Infrastructure”, Strategic Alternatives.)

The involvement of the federal and provincial governments in sporadically providing funding for infrastructure has created a number of distortions in the system.

...the politically inspired up and down provision of infrastructure funding from both federal and provincial governments during the past two decades has added to the difficulties of long-term financial planning by municipalities and to the uncertainty of funding availability for all competing municipal service sectors, including water services.

The current confusion of cross-subsidisation of drinking water, compounded by the inconsistent and unplanned federal and provincial infrastructure funding, has resulted in water utilities behaving in unintended ways. The water utilities routinely do not manage their assets in a renewable manner, because they hold out the expectation that infrastructure funds will flow to them in a *just-in-time* manner. Inadvertently, government effectively is rewarding bad behaviour and inadequate management, while actually penalising those water utilities that are managing their assets properly. The model water utilities will plan for their asset renewal and will budget, accordingly. If the federal and provincial governments continue to wish to fund infrastructure, it should be based on an analysis of the soundness of a water utility’s sustainable asset management plan. This will eradicate the current distortions.

*“The provision of safe drinking water is an essential service that must be put on a steady, sustainable, long-term funding basis. Based on the principle of full-cost accounting, a **Sustainable Asset Management** model is proposed for the financing of drinking water systems in Ontario.*

This conceptual model provides a more systematic, long-term, anticipative and transparent approach to planning and decision-making.

... The Sustainable Infrastructure Investment Program walks through the evaluation of the full life-cycle of a water system by asking six basic questions:

- *What do we have?*
- *What is it worth?*
- *What condition is it in?*
- *What do we need to do to it?*
- *When do we need to do it?*
- *How much will it cost?*
- *an inventory of infrastructure assets, including the water*
- *total asset value (valuation and replacement value)*
- *relationship of asset condition to age*
- *maintenance/rehabilitation/replacement*
- *life expectancies of system assets*
- *sustainable funding levels*

(Pollution Probe, page 9)

This view is shared in the OSWCAs submission.

Prudent water and sewage system management begins with an inventory of assets and an assessment of the condition of each.

... An inventory provides municipalities with details (such as size) about individual water and sewage system components and where the components are located. Condition assessment takes the inventory one step further, providing municipalities with information about the integrity of each component, including its anticipated service life and expected replacement value. Information obtained during inventory development and condition assessment can provide a “snapshot” of strengths and weaknesses within water and sewage systems. Appropriate management strategies can then be adopted. (OSWCA, page 9)

6.4. Governance

Governance refers to the process and structure for overseeing the direction and management of a corporation so that it carries out its mandate and objectives effectively. (Report of the Auditor General, December 2000, p18-8)

In Canada and around the world, there has been a review and discussion of governance over the last decade. Moving beyond issues of control and financial accountability, the observance of good corporate governance principles and practices is a way of ensuring that potential problems can be discovered quickly and that risks can be reduced and managed. If the model water utilities are viewed as totally independent, stand-alone operations that are accountable to their boards and that are financially discreet and viable entities, then principles of good governance and effective practices become integral to assuring quality drinking water.

In Canada, the work of the Joint Committee on Corporate Governance, building on the Dey report in 1995, recommended principles for governance that focus on how boards should perform to ensure that Canadian corporate governance is among the best in the world. (Joint Committee, 2001) The review done by the Auditor General of Canada of crown corporations provided recommendations to improve accountability and board effectiveness. (Auditor General, 2000) In Ontario, a review of best practices conducted by the Haldimand-Norfolk Transition Board identified the terms of reference for a local board as a template for good governance and accountability. With the introduction of the *Public Sector Accountability Act*, there will be new accountability requirements on public organisations.

From around the world, reviews and studies in Australia, the United Kingdom and Europe affirm the principles of good governance and all offer suggestions and guidance on effective practices. In New South Wales, an audit of governance practices concluded that it was necessary to enhance these practices to ensure efficient and effective management of organisations. In the United Kingdom, the Chartered Institute of Public Finance and Accountancy (CIPFA) combined the foundation principles of good governance defined by Cadbury in 1992 with the responsibilities of public office and developed a framework for public service bodies (CIPFA, 1995). This framework was adapted for use by European countries by the Fédération des Experts Comptables Européens (FEE, 2000). Recent work by CIPFA and senior executives in local government provides guidance on how this framework can be used by local government. (CIPFA, SOLACE, 2001).

These reviews and studies conclude that there is no single structure for boards or a single prescriptive model for governance. Rather, the focus is on adopting demonstrated principles of good governance and effective best practices. Whether public or private, large or small, there are principles and practices of governance that can be applied to water utilities to ensure the responsible direction and management of the organisation. Adherence to these principles is essential for quality performance.

The basic principles of good governance are: **openness** in decision-making and actions; **integrity** based on honesty and objectivity; and **accountability** for stewardship and performance. In order to translate these principles into practice, there are fundamental elements for action:

1. Clear understanding of roles and responsibilities
2. Effective practices in place
3. Capacity to govern assured
4. Accountability and transparency

Currently in Ontario, the responsibility for governance can rest with different bodies, such as the municipal council, a public utility commission, the board of a public body (OCWA), or the board of a private utility. These principles can apply to all water utilities, whether they are small or large, private or public. In the following description of the principles, “the board” refers to that group of individuals with responsibility for overseeing the direction and management of a water utility so that it carries out its mandate and objectives effectively.

6.4.1. Clear understanding of roles and responsibilities

The role of the board is to provide stewardship to the organisation. These roles and responsibilities will be set out and shared with stakeholders in a statement that represents a code of corporate governance. The statement will address the board’s responsibility for:

- strategic planning
- budget approval
- internal controls and management information systems
- risk management systems
- recruitment of Chief Executive Officer, performance review and setting compensation
- human resources strategy
- Sustainable Asset Management strategy
- open communications with all stakeholders
- systematic nomination of new members
- assessing board effectiveness
- orientation of new members
- public reporting

The members of the board agree to commit the time and resources necessary to carry out their responsibilities effectively.

6.4.2. Effective Practices in Place

Strategic planning

The board will establish the mission statement for the utility. The Regulator may establish a general mission statement that describes basic expectations and purpose for the water utility. This general statement can be modified for use by each water utility. Working with management, the board will develop a strategic plan in support of that mission statement. The responsibility for implementation of the plan rests with management; the board, however, will ensure that there are mechanisms in place to monitor performance against the plan. The board also will be required to review, amend and/or approve the annual budget that supports the plan.

Internal Control and Management Information Systems

The board will ensure that the control and management information systems are in place to assess and evaluate whether the water utility is being properly managed and whether objectives are being met. These systems will flag issues that have an impact on the business and that are required for reporting on compliance. The board will ensure that necessary audit systems are in place (through the use of internal and external auditors).

Risk Management

The board will ensure that the implementation of appropriate systems to identify and manage risk are in place. The Risk Management System will be based on the Hazards Analysis Critical Control Point approach. The Australian Framework offers a modification of this approach for use with drinking water system.

Executive Recruitment and Compensation

There will be established processes for recruitment, performance review and compensation of the Senior Utility Manager /Chief Executive Officer.

Human Resource Strategy

The board will review and approve human resources plans and compensation strategies and will ensure that performance management approaches are aligned with the achievement of the strategic plan. The senior executive has responsibility for developing and implementing the human resources strategy.

Sustainable Asset Management

The board will ensure that there is an inventory of assets and an assessment of their condition. Key to their stewardship role, the board will ensure the implementation of appropriate management strategies for the physical assets.

Communications

The board will ensure that there is ongoing and effective communications with the customer, public stakeholders, and Regulator, and will establish a comment and feedback loop of communication with customers.

6.4.3. Capacity to Govern Assured

Board profiles

The board possesses the required skills, knowledge and experience to carry out their responsibilities effectively. Some board members will have knowledge and expertise in areas such as operations, public health and financial management. These skills will be described in profiles that reflect the requirements of the position of the board member, rather than the individual. All board members will demonstrate integrity and accountability in their decisions, informed and knowledgeable judgement based on experience in the water industry, a commitment to the public trust that they hold, and the ability to work as part of a team.

Recruitment of directors

Recruitment of new directors is based on the board profiles. Vacancies will be filled by an individual that brings the necessary skills to the boardroom table. In order to maintain

continuity and experience for the board overall, best practice suggests that appointment terms for individual members be staggered (Auditor General, 2000). The appointment term should be of sufficient length so that the individual members can exercise their responsibilities with knowledge and experience. The ability to re-appoint members also ensures a foundation of knowledge and experience on the board. The ability to re-appoint is balanced with the need for the board overall to have the required knowledge and skill sets around the table.

Orientation and training of directors

The board profile and the statement of responsibilities will set out the expectations for new members. The orientation program will include a briefing on the nature of the business and challenges, the legal framework governing their obligations as a director and the contribution expected from the new member. Ongoing training of directors will be done in conjunction with professional and industry associations.

Board assessment

Establish a formal and ongoing process of evaluation of board effectiveness.

6.4.4. Accountability and Transparency

The board ensures that regular reports on the operational and financial situation of the water utility are done, including reports on the progress of meeting the strategic plan and objectives for the water utility, on performance measures, and performance against industry benchmarks.

The board will document the mechanisms that they have adopted for citizen engagement and report on the activity and involvement of citizens.

The board, in some cases, will be required to adhere to the provisions of the *Public Sector Accountability Act*.

6.5. Partnership Agencies

Several aspects of drinking water quality management require commitment and involvement with other agencies. For example, where catchments and water sources are beyond the drinking water supplier's jurisdiction, collaboration with the appropriate agency is necessary. Consultation with the regulator also is necessary for establishing many elements of drinking water quality management (e.g. establishing monitoring and reporting requirements, emergency response plans and communication strategies).

The range of agencies involved in individual water supply systems will vary depending on local organisational and institutional arrangements. Aside from water suppliers, various other agencies that may be involved in drinking water quality management include Provincial Ministries (e.g. the Ministry of Health, the Ministry of Municipal Affairs, the Ministry of Natural Resources, the Ministry of Agriculture, Food and Rural Affairs, the Ministry of the Environment), other relevant provincial and local authorities, catchment boards and/or groups, local government, non-government organisations and community-based groups, industry associations, etc.

An integrated management approach with collaboration from all relevant agencies is essential for effective drinking water quality management. As a lead agency in the management of drinking water quality, a water supplier regularly should identify all major stakeholders who could affect (e.g. regulators, catchment boards, research organisations, drinking water organisations) or be affected by (e.g. consumers, industry, plumbers) decisions or activities of the water supplier.

Appropriate mechanisms and documentation should be established for stakeholder commitment and involvement. This may include establishing working groups, committees, and/or task forces with appropriate representatives and/or development of signed Memoranda of Understanding. The various agencies involved should define their accountabilities and responsibilities to support the water suppliers and where appropriate, co-ordinate their planning and management activities (see Box 1.2).

Professional and industry associations play a key role in continuous improvement of water suppliers. More than just providing information and access to expertise, the associations are a catalyst for change and improvement. For Ontario to be a leading jurisdiction in a TQWMS, the associations will play critical roles in leading research, promoting best practices including benchmarking, building the capacity of the sector and speaking on behalf of the sector.

6.5.1. Leading Research

Leveraging financial support for ongoing research and development is critical. The association can provide a focal point or be the contracting entity for Research and Development funding from the government. This research would be of benefit to water suppliers across the province. The research may focus on overall best practices and process improvements. As well, it may focus on the specific challenges faced by a few suppliers. Such research would have the potential to be shared and “showcased” around the world.

The American Association of Water Works Research Foundation (AWWARF) has conducted leading research in collaboration with water utilities, academic and other stakeholders. This research has generated innovative solutions to both unique and common issues.

The Canadian National Science and Research Council (NSERC) Chair in Water Treatment is located at the University of Waterloo. The membership contributing to this research program includes municipalities, OCWA, water suppliers and the universities. The NSERC Chair also trains students on drinking water issues, allowing a continuous trend of expertise to be developed and promoted in the industry (Delcan, p. 63)

6.5.2. Promoting Best Practice

Developing and documenting best practices in TQWMSs requires working with industry and government to provide the opportunity for best practices to be known and to be implemented in water utilities. Sharing this information can take many forms, such as web-based information, publications, workshops, roundtables, and conferences.

The promotion of best practices is a cascade of activity. The association can act as the co-ordinating organisation across the sector overall. One of the crucial “best practices” is how to disseminate this information and introduce the best practice throughout the organisations of the water suppliers. Another crucial “best practice” is how to effectively engage the customer in planning and decision making.

Peer review is to be integrated in the TQWMS as a method of providing third-party review with regard to activities including operations, water quality sampling practises, optimisation programs, and research and development programs. The peer reviewer can provide valuable information regarding techniques. The formal peer review process also provides a platform for information exchange.

The combination of research and best practices will enable the sector to develop benchmarks for effective operations that can be adopted by individual water utilities.

6.5.3. Building the Capacity of the Sector

Using the resources from across the industry, provide a focal point for learning, training and development activities. This lead role could be working with general management and business experts on developing and delivering programs for leadership development and management training in the water utility sector. In promoting the Triple-E approach to certification, the association can play a role in both the education and evaluation of Operators.

Box 9.1 Multi-Agency Partnership for Catchments and Aquifers (NHMRC, 2001 – Box 1.2)

The management of development within catchments or aquifer intake areas is normally the responsibility of local Conservation Authorities subject to consideration of planning regulations. These functions, if exercised without detailed knowledge of water quality issues, have the potential to undermine the drinking water supplier's catchment management activities. Developing a partnership with relevant authorities can ensure water quality issues are addressed within a more holistic framework.

Land use planning involves detailed evaluation of individual proposals for development and developing the strategic plans for future use of an area. At a strategic planning level, a drinking water supplier, together with water, environment and health authorities should work with the planning authority to develop joint public policy statements for catchment areas. These policies should include explicit formal planning objectives for catchment areas, management controls to be initiated, and detailed criteria for evaluation of development applications. The agreed planning policy needs to be translated into the relevant land use zones and regulations.

Development applications will be evaluated against the predetermined criteria and planning objectives. While the final decision rests with the planning authority, formal referral mechanisms can be established to enable a drinking water supplier and environment and health authorities to have input to the decision.

This arrangement makes the referral mechanism transparent and informs the developer of the need to consider the impact of water quality in project feasibility studies. These may include requirements to ensure ongoing management of water quality issues.

6.5.4. Watershed Management

Watershed management long has been recognised as an effective method of preventive practice for drinking water treatment. The sources of contamination in water supplies has been discussed in other Issue Papers for the Inquiry (see Goss et al., 2001, Johns, 2001, and Ritter et al., 2001). Watershed management is recognised in the Australian Framework, the USEPA SDWA, and the ODWS as an effective barrier for pathogen transmission prevention.

Increased emphasis on watershed protection has been gaining support in the US through the Total Maximum Daily Load (TMDL) program. A TMDL is the sum of the allowable loads that a waterbody can receive of a single pollutant from all contributing point and non-point sources. This is different from current Provincial regulations that only regulate the maximum concentration of a pollutant that can be discharged from a point source. Non-point pollutant sources, such as farms, and other sources such as septic beds, currently are not regulated in Ontario. A more holistic approach, such as the TMDL, needs to be applied in Ontario, if our water resource is to be maintained for current and future needs.

The Regulator and water utilities must co-ordinate with water shed management groups, such as the Conservation Authority, to ensure that watersheds are protected as much as possible.

- The watershed management group will regulate the volume, mass, and density of discharges from all stakeholders in the watershed. Entities that would fall under the umbrella of the watershed management groups include farms, factory farms, wastewater treatment plants (WWTPs), storm water outfalls, industrial discharges directly to the environment or through a WWTP, residential and commercial septic beds, and any other types of point and non-point discharges to the watershed that could have an impact on the raw water quality for a downstream water treatment plant (WTP). The watershed management groups could use a program similar to the TMDL approach developed by the USEPA.
- The watershed management group will review and summarise raw water reports from water utilities. The data will be analysed with the objective of identify trends in parameters and also one time occurrences of increased contaminant levels.
- The watershed management groups will co-ordinate with the Regulator on issues that impact the watershed such as residuals discharge from a WTP and Permits to Take Water.
- The watershed management group shall facilitate active watershed management stakeholder associations to encourage discussion and co-operation among the stakeholders.
- The watershed management group should be given the power to enforce laws with regards to emission violations into the watershed. Emphasis should be given to effluents that have pollutants that are detrimental to humans and are expensive to remove at the WTP.

Utilities in the same watershed will have a reporting mechanism to alert downstream utilities about sudden changes in raw water such as increased turbidity. This will give the downstream utility an opportunity to be proactive to a raw water change, instead of reacting after the event characteristics already have been identified in the downstream WTP. The process could follow the early warning flood program already established in most watersheds.

7. Control – Utility Regulation

Moving beyond the water utility, there are external players that have a role in providing the assurance of safe drinking water. The government sets the policy, legislative and regulatory environment within which water utilities operate. The professional and industry associations play a role in leading research, promoting best practices and building the capacity of the sector. The customer plays a role in ensuring the transparency of the production of drinking water – both in terms of cost and quality.

7.1. Policy Environment

The government has responsibility for setting the policy framework for safe drinking water in Ontario. This policy framework will affirm the standards-based approach as demonstrated in the Total Quality Water Management System and set out expectations for water utilities. The standard setter, the regulator and the audit function are separated and independent of each other.

A clear set of water quality standards, that are research based, will demonstrate the priorities of health protection and prevention of risk. The Regulator enforces the water quality standards, grants licenses, and reviews applications for rates. As discussed under the Total Quality Water Management System, internal evaluation is a key component. In addition, external third parties will conduct audits on the successful implementation of the TQWMS.

7.1.1. Water Quality Standards

Health Canada develops both health and aesthetic limits for drinking water. The individual parameter values are the result of fundamental research, review of existing data in the scientific community, epidemiology studies, and consultation with the provinces. The guideline numbers are the best estimate that the drinking water community has to determine acceptable levels of contamination and risk to the population. Under the TQWMS, the provincial government will work with national standards, which have been developed in an open manner with a scientific base, and prescribe water quality standards through regulation for Ontario water utilities. The Canadian Drinking Water Guidelines (CDWG - 1996 edition) should be the standard to which the Ontario Drinking Water Standards (ODWS – 2000 edition) must meet at a minimum. There is some latitude for compromise on adoption of the limits, if the Province can argue on a scientific or social basis for the relaxation of a specific parameter in the CDWG-1996 for the ODWS-2000. The relaxation of parameters cannot be made simply on a financial basis (i.e. the regulated limit on a parameter would require a capital expenditure to be met by utilities).

Health Canada is best suited to set water quality standards. They have the resources, the properly trained staff, and the infrastructure to continue with this work. Transparency of the standards setting process is required for co-operative effort in the water community. The structure of the process of setting water quality standards should be well understood by all stakeholders. Once a water quality standard is identified and scheduled for adoption into a revised CDWG, the utilities should be given sufficient time to comply with the standard. The time will be used by the utility to conduct engineering

studies, pilot scale testing of alternative operating procedures and alternative equipment, and implement procedural changes and/or procure and install new equipment.

This advanced notice of pending regulations is critical to maintain the co-operative environment by the standards setting body. For the most part, the standards will be prescriptive. The advanced notice is the most powerful tool that the standards body has to provide the instrument of participation by the utilities. The standards body should publish draft statements in respect to adding new parameters or changing the MACs of any existing parameter and invite comments from all stakeholders.

The standard setting body for Ontario will be part of the provincial government, but not part of the Regulator. The Regulator (to be discussed later) will be required to inspect and enforce the water quality standards.

The provincial standard setting body is responsible for providing information to the customer and utilities with regards to the procedures generally used in developing standards. If a new parameter is added to the list, the reasons for the addition will be explained, as well as a justification for the level at which the parameter value was set. This information is intended to increase the knowledge of how the values are set and increase the stakeholders' appreciation of the concept of risk. The information, therefore, should be provided in a format appropriate for the intended audience.

The focus of the water quality standards body should be on microbial risks since these are acute in nature versus chemical contamination that is generally more of a long term risk. The USEPA has initiated a process that would see the adoption of *Cryptosporidium* as the basis for microorganism related disinfection standards. This move by the USEPA is the result of monitoring programs that have identified the microbe in many surface waters, as well as its resistance to conventional disinfectants such as chlorine and chloramine. In Ontario utilities are required only to monitor for total Coliforms, E. Coli, and Bacteria. Requirements for microbial disinfection are represented only in the form of a theoretical disinfection calculation for *Giardia* – no monitoring or verification of *Giardia* disinfection is required. It should be noted that *Cryptosporidium* is far more resistant than *Giardia* to disinfection. It is because of this higher disinfection resistance that the USEPA has moved towards using *Cryptosporidium* as the basis for setting the disinfection. The regulations currently do not provide the public with adequate protection from microbial risk.

7.1.2. Regulator

There are clearly stated roles and responsibilities for the water quality standard setter, the regulator, the auditor, and the utility. Each of these roles is described in Section 7.1.1, Section 7.1.2, section 7.1.3, and Section 3, 4, 5, and 6 respectively.

At the provincial government level, there will be a single window on the regulation of water quality. It is not up to individual water utilities to co-ordinate the efforts and programs of various ministries of the provincial government. The Regulator will perform functions currently performed by the Ministry of the Environment (granting Certificates of Approval, enforcement of the Ontario Drinking Water Protection Regulation through the Ontario Drinking Water Standards, Operator Certification, etc.), the Canadian Food Inspection Agency (HACCP inspections), Ministry of Health, and any other agency that has a role to play in drinking water. The Regulator also will perform new functions including assessment of the utility financial and TQWMS plans. The Regulator can be set up with personnel only responsible to the Regulator, or it can be established as an entity with some core staff and then draw the necessary staff from the required existing

agencies with the necessary expertise. The provincial government will need to establish necessary co-ordinating mechanisms for internal operations and work with water utilities from a single point of service.

This issue paper does not make a recommendation on whether this single point of service is a regulatory arm's length crown agency or a provincial ministry. D'Ombrain makes the argument in his paper on the need for this regulatory role to remain in government and that it be taken on by a renewed Ministry of the Environment (p. 113). It is the assumption here that the Regulator is an arm of government in some way. The Regulator is **not** a kind of self-regulating industry body.

For the purposes of this issue paper, this single window in the provincial government will be referred to as the "Regulator". The Regulator will regulate drinking water utilities in Ontario. The Regulator will be established in statute with a clear legislative mandate.

The role of the Regulator is summarised below:

- Provide the focal point for a safe drinking water policy framework in Ontario
- The Regulator does not set technical or environmental standards, but works closely with the provincial water quality standards setting body and will oversee the development of requirements for accreditation and licensing .
- The Regulator will adopt a policy of facilitating communication with the water utilities and the water quality standards setter on expected changes to the water quality standards. Water utilities will be given sufficient lead time for the introduction of, or modifications to, certain standards.
- Water utilities would receive a license to operate when they demonstrate that they are capable of satisfying the requirements for the TQWMS. This license would be reviewed and renewed on a five-year basis. The Regulator would establish the licensing process and oversee its application to the water utilities.
- Water utilities would receive a renewable license from the provincial Regulator for extracting surface and/or groundwater.
- Ensure that expertise and operational services can be provided in case of an emergency (D'Ombrain p 115).
- Establish regulations that provide for a system of public reporting, evaluation and audit on all aspects of the drinking water policy including the performance of the regulator, the water utilities and testing laboratories (D'Ombrain p 118).
- The system of public reporting for the regulator will include quarterly reports as per the ODWS and annual reports as per the TQWMS requirements.

All reports to the Regulator are publicly available on the Regulator's web site.

The Regulator will set out in regulation the requirements for licensure to operate a facility including:

- Accreditation from an auditor, who is a recognised Registrar
- Compliance with monitoring and reporting as per the ODWS
- Compliance with required components of HACCP risk analysis program
- Employment of appropriate class operators for the facility
- Financial plan including Sustainable Asset Management
- Emergency Response Plan

There will be a fair process for review of any appeals to licensing decisions. This will be important particularly in the situation where the water utilities may not be of sufficient

size to meet the obligations for licensing and will need to explore ways of meeting the obligation of service to their community.

When reviewing applications for licenses to operate a facility, the Regulator will make a range of decisions:

1. Approve the application.
2. Approve the application, with conditions as per the requirements. Compliance with these conditions can be reviewed at the next inspection, audit or license renewal
3. In the case, where the applicant cannot or is not able to comply with the licensing requirements, the Regulator can:
 - a. Direct and facilitate discussions of water utilities to ensure that communities continue to be served with quality drinking water. These discussions can include exploration of shared services, promoting the establishment of “hubs” and “nodes” as demonstrated by OCWA, and/or examination of alternatives to address capacity issues associated with scale.
 - b. Assign a technical or financial review of the utility to determine whether the requirements for licensing can be met.
 - c. Direct water utilities to implement a solution. These solutions can include, mergers or amalgamations, adoption of a service delivery alternative that meets the needs of the community, and/or more appropriate financing plans.

It is important that the Regulator has the skills, resources and capacity to do the job expected. The proposed role for the Regulator is focussed with a priority on accountability. The Regulator will demonstrate, through reporting, its adherence to the general principles of a “good” regulator:

- Transparency of actions and decisions
- Accountability
- Targeting
- Consistency
- Proportionality
- A Clear legislative mandate
- Efficiency
- Expertise
- Reproducibility
- Non-prejudicial
- Non-retrospection
- Timeliness
- Flexibility

In addition to the review of applications for licenses to operate a facility, the Regulator also will conduct inspections of water utilities. Inspections will be done on the basis of priority and focussed on utilities where there are issues of higher risk. Compliance and inspection will be carried out in a manner consistent with the HACCP system with an emphasis on prevention. Inspection will be done in an effective way with resources directed at high-risk situations, depending on the product type, establishment

compliance or plant complexity. Inspection will include a review of the internal evaluations and third parties audits conducted by the utility and any other conditions that may be part of the approved license. The Regulator will develop a *Code of Enforcement* that encompasses the kind of standards set out by the Drinking Water Inspectorate in the government of the United Kingdom. Non-compliance as a result of inspection will be reported publicly and there will be the potential for fines and penalties. In the case where non-compliance indicates that the utility does have the capacity to meet the requirements of TQWMS, then the Regulator is not bound by the licensing cycle and can conduct the required reviews and make decisions as necessary.

The Regulator will establish Public Advisory Councils. These councils will be made up of members from the general public and other stakeholders and will provide a common voice for the customers and ensure that water utilities are maintaining good customer relationships across the province.

7.1.3. Audit Function

The evaluation and audit of drinking water quality management is required to ensure that preventive strategies are accurate, effective and implemented appropriately. A review of the monitoring data, reports and management processes provides assurance that the quality and safety are achieved. This kind of evaluation is a key element of planning for improvement. (NHRMC, 2001)

The need for internal processes for evaluation and audit is described in the preceding section on the Total Quality Water Management System. There also will be formal external audits. Combined, the internal and external audits demonstrate the commitment to achieving the highest standards possible and maintaining customer confidence.

The method and procedures for such audits will be developed in collaboration with the water industry, the audit community and the Regulator (including other provincial ministries as considered necessary). The audits will cover all aspects of the TQWMS – technical operations, management systems, compliance with testing and monitoring, performance audits and effectiveness of emergency response. The frequency and schedule of audits will be defined.

The external evaluation and audit will be conducted by approved independent third parties who are recognised Registrars, by the Standards Council of Canada.

Required items to be evaluated by the auditor for utility accreditation include:

- TQWMS Plan including implementation of HACCP risk analysis tools, continuous improvement programs and ISO 9000-like requirements
- Human Resources Management Plan
- Governance Structure and Statement on stewardship responsibilities

8. The Customer

The customer is the most critical element of the water industry.

The customer needs to have the opportunity to be involved in the utility at several points including:

- planning (both engineering and financial)
- operation of the water system including performance reports
- risk management
- regulation and enforcement

The water utility operation needs to be transparent to the public. The customer can be involved by way of the following communication mechanisms:

- consultation
- educational information
- Public Advisory Committees
- publishing of operations reports

The Australian Framework (NHMRC, 2001) lists the following items that could comprise a comprehensive **consultation** strategy:

- public hearings for major and controversial initiatives
- briefings targeted to specific groups with interests or responsibilities
- workshops or seminars on key issues, or for special groups
- focus groups and market research/surveys to determine community views, knowledge and attitudes

Education of the public on water treatment principles to develop an understanding to which they can put the published information into context is critical in the information transfer process. The information must be formatted in a way that non-water professionals can understand. The information communication can be implemented by way of the following:

- informative media programs targeting print media, radio and television
- Inclusion of information flyers with water billing
- community education/information exchange programs
- school programs
- preparation of technical issues papers
- newspaper advertising of activities and available papers

Public Advisory Committees to ensure a continuum of public involvement in the drinking water process will provide a constant voice in the operation of the water utility. The Public Advisory Committee will report through the regulatory regime. Utility involvement in the committee is recommended to proactively respond to the concerns of the public. The Public Advisory Committee reports directly to the regulator to ensure that the public voice is heard and that the public voice has bite. This has precedence with the Ofwat National Customer Council (ONCC) and Ofwat Customer Service Committees (CSCs) in England and Wales and with the National Drinking Water Advisory Council in the United States.

Finally, publishing of operations reports is necessary to preserve public confidence in the drinking water system. The performance of the system, by the numbers, will be there for all to see. Typical data format of the report will include the regulatory limits, operation objectives, average values, lowest values, and highest values during the reporting period. If the operational objectives are not met for a specific parameter, the conditions surrounding the non-compliance need to be explained with the report. It also would be beneficial to include revised protocols that have been enacted by the water utility to ensure that the non-compliance of that parameter is mitigated or eliminated in the future.

If it cannot be included in the report (depending on the complexity of the problem, the effort required to develop a strategy to deal with the problem may not allow for resolution in the timeframe required by the 30 day publishing period), then a subsequent news release will be required. Information is to be published in the local newspaper and an Internet site and sent out with the water bill. Originals will be available at the utility office for a small reproduction fee. Also included in this report will be the long-term infrastructure renewal requirements and corresponding expenditures. By the end of the transition period, these reports will include survey results and benchmarking results on many different parameters.

The goal of the public involvement program is to achieve transparency of the drinking water process to the public. Public involvement will increase the appreciation of risk assessment (to be discussed in a subsequent chapter) by the public, the security that their water is safe even in the event of an emergency/crisis/incident where the drinking water safety is compromised. The transparency will reduce or eliminate the stigmatisation of drinking water by the public after an emergency/crisis/incident.

Five step approach to customer involvement:

1. Public consultation at design/conceptual stage of project including allowance for public input to modify plans.
2. Public Advisory Committee – Reports aesthetic or health concerns to the regulator. Meets on a regular schedule to discuss local and provincial concerns that they would like to be addressed by the regulator and utilities.
3. Public education will include leaflets of basic information and water conservation ideas with the water bill, school education program and public service announcements on television, radio, and newsprint. Information transferred to the public will include topics such as risk, water resources and conservation, drinking water treatment processes, regulations and standards, and water quality parameters.
4. Regular quarterly and annual reports as per Ontario Regulation 459/00 will be made available as described in the legislation.
5. Customer surveys will be implemented and will include analysis with the objective of determining customer satisfaction and customer needs.

Part 3 – How We Get There: Transitional Issues and Strategies

9. Introduction

The Total Quality Water Management System (TQWMS) is an ideal model for assurance of safe water for our communities. This Action Plan, together with the accompanying Transition Plan, provides the pathway to achieve this ideal model. This is not an imposition of a new and untried ideal; rather this model can be built on existing good practices and strengthened practices. It also is possible to address some of the more difficult and challenging issues within the context of the TQWMS.

The TQWMS will be in full implementation within two years of the launch and subjected to a review before the end of five years. With a careful and planned transition all the necessary decisions can be made, planning done and financial arrangements established in the first year. All elements of the TQWMS for implementation will be well underway in the beginning of Year Two. Before the end of five years, the TQWMS will be fully operational. A review of the legislation will be conducted at the end of five years to determine if any changes need to be made in the policy, legislative and regulatory provisions.

THE ACTION PLAN

The Action Plan is an 11 point sequencing of the major activities that need to be undertaken, as detailed below. Actions 1-7 are sequential and are part of establishing the new responsibility infrastructure. Actions 8- 10 are the implementation of the TQWMS. Action 11 provides for reporting on results. Action 8 through 11 will be carried out concurrently.

	ACTIVITY
Building the Responsibility Infrastructure	
1.	The Minister creates the Ministerial Task Force, with a mandate and budget to carry out its responsibilities.
2.	The Minister establishes the legislative and regulatory framework. (Regulator, Standards Setter and Auditor)
3.	Convene regional information sessions, with round table discussions.
4.	ScoreCard on current water utility management and operations
5.	Regionally, examine the issue of scale and determine appropriate configurations.
6.	Establish the governance structure, recruit board members and deliver the required training to the new boards.
7.	Recruit the leaders of the new water utilities.
Implementation of the Total Quality Water Management System	
8.	Establish and implement the TQWMS.
9.	Deliver the Operator training and certification program.
10.	Deliver the Leadership Development Program.
Reporting on Results	
11.	Establish and implement the financial and other reporting systems that support the transparency.

The issues considered for the Transition Plan are the same as the major elements of the TQWMS. For the purpose of illustrating the timing and relationship of elements, the issues are organised around the general sequencing of events.

In order to provide a focal point for the launch and initial implementation of the TQWMS, a Ministerial Task Force will be established. This Ministerial Task Force will enable the Minister to develop the implementation plan, conduct research and consultation in a focused, direct and open manner. It is anticipated that the Ministry of the Environment will be undergoing restructuring as a result of the adoption of the strategy in *Managing the Environment* report. The Ministerial Task Force will allow the Minister to accomplish significant reforms in as efficient and effective a manner as possible.

This Ministerial Task Force will be made up of stakeholders and will have the responsibility of developing the implementation plan and setting into action many of the core elements of the TQWMS. It is anticipated that this Ministerial Task Force will be necessary for the first 6 –12 months and will be superseded by the Advisory Body to the Regulator.

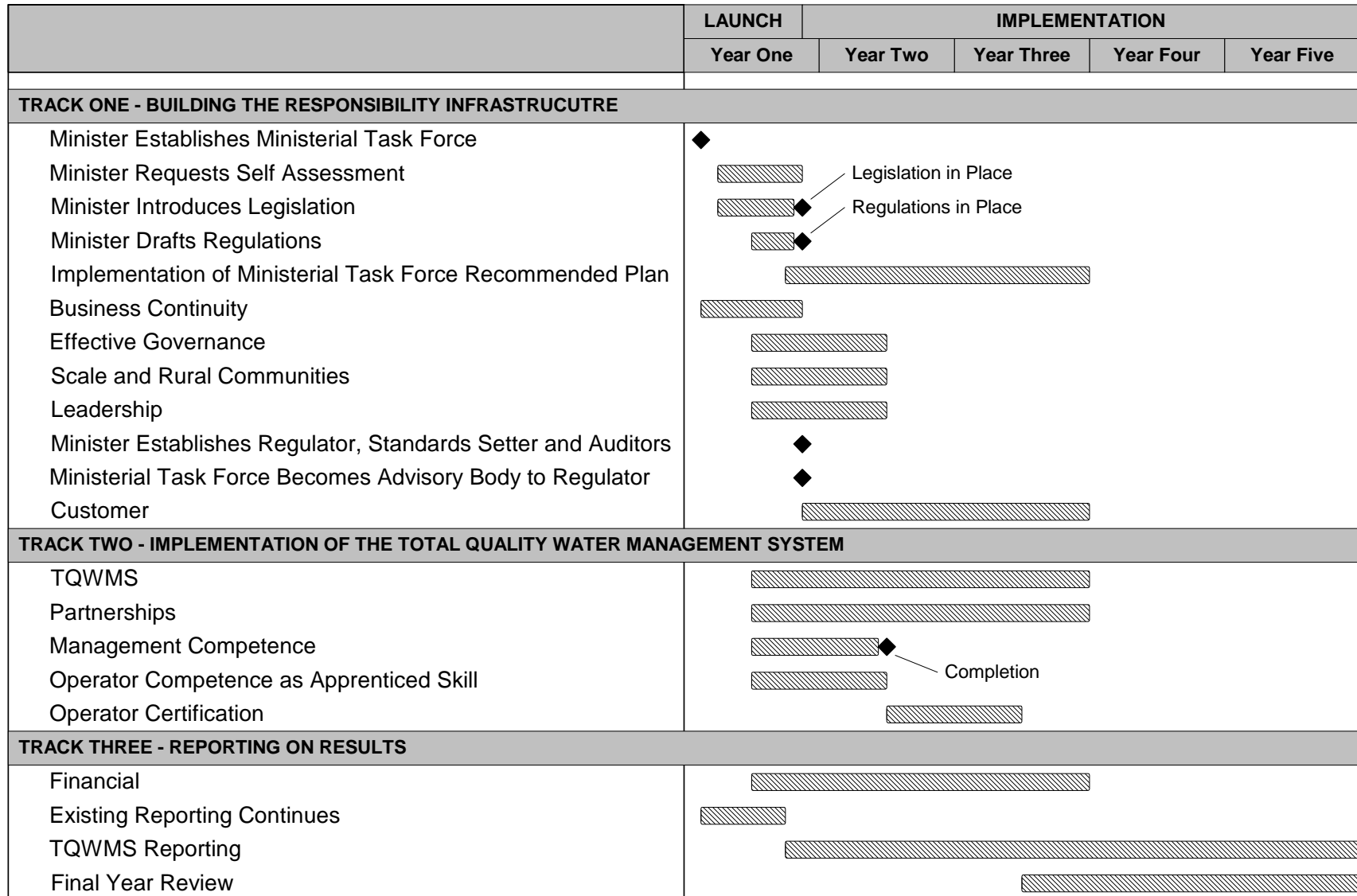
The first track of activities ensures that clear roles and responsibilities for those who have oversight of the water quality are developed and understood, and that all have the capability to act on their responsibilities. It begins with an assessment of the current situation (building on the work in the Engineers Report) and from that the scope of implementation will be determined. In addition, the question of scale will be addressed early on in order to plan for alternative arrangements and continue service to the community. Change in an organisation creates a distraction for the day-to-day work as operators, employees and the public consider what is in store. A focus on business continuity is critical.

The second track is the implementation of the management processes and requirements for the TQWMS, including the assurance of training and development of staff running water utilities.

The third track relates to the financing and reporting on the TQWMS. Financial management and financial information will be produced for common understanding and in such a way as to enable common benchmarks of sustainability. It also is at this stage that the public reporting will be matched to the expectations and results of the TQWMS. This final track also will include the assessment of the implementation of the TQWMS. Are there any gaps, has anything been overlooked and what issues still need resolution? This final year review will provide the road map for maintaining TQWMS.

Figure 9-1 Tracks for Transition demonstrates the relationship of these tracks over the planned transition.

Figure 9-1 Tracks for Transition



10. Track One – Building the Responsibility Infrastructure

10.1. The Legislative and Regulatory Framework

10.1.1. GOAL

To create the policy, legislative and regulatory framework that establishes the TQWMS and sets out the roles and responsibilities for the government, the Regulator and the water utility.

10.1.2. ISSUES AND BARRIERS

The development, introduction and passage of the legislation and regulations will be done expeditiously.

There will be activity during the period from the introduction of the legislation to its passage by the Ministerial Task Force. The development of the implementation plan, research and consultation will occur in this period.

10.1.3. TRANSITION STRATEGIES

- The Minister immediately will appoint the Ministerial Task Force (see following item)
- The Ministerial Task Force will work with the Minister in drafting the legislation and regulations.
- The Ministerial Task Force will advise the Minister on the information necessary for the self-assessment Score Card to be completed by all water utilities. This information will build on the work already done in the Engineers Reports and will provide input to the details and scope of the implementation required to be developed by the Ministerial Task Force.

10.1.4. SUSTAINABLE STRATEGIES

The Minister of the Environment will introduce legislation that clearly sets out the role of the government, the Regulator and the water utility.

The Minister has responsibility for setting the policy framework for safe drinking water in Ontario. This policy framework will affirm the standards-based approach as demonstrated in the TQWMS, provide for the powers and responsibilities of the Regulator, and set out expectations for water utilities, including the principles of good governance, technical competence, the principles of accountability, and the elements of transparent reporting and the role of the Advisory Body and the Consumer Advisory Councils.

The Regulator will have the responsibility to grant licenses to water utilities (including determination of appropriate scale), to require testing and monitoring, to require annual reporting, hear applications for rates, and intervene when public health may be at risk. An advisory body of stakeholders will work with the Regulator on an ongoing basis.

Consumer Advisory Councils will offer advice and input to the continuing implementation of the TWQMS.

The water utility will have the responsibility to fulfil the obligations of the TWQMS.

The Minister of the Environment will introduce regulations that offer specific requirements in key areas: standards for water quality; testing, monitoring and reporting requirements of test results; requirements for obtaining a license as a water utility; training and certification requirements for operators; requirements for reporting in a common format; and the requirements for the industry in conducting audit and third party reviews.

The legislation establishing the TWQMS Framework will include a provision for a review at the end of five years on the effectiveness of the Framework and consideration of modifications. This review will include an initial assessment of the implementation and any corrections and modifications necessary, as well as the provision for another review in five years after the assessment.

10.2. Ministerial Task Force

10.2.1. GOAL

To establish water utilities that will achieve the attributes of the model, as described in the previous section.

10.2.2. ISSUES AND BARRIERS

Municipalities may experience resistance and inertia in moving to the new model. Power, politics, “ownership”, and subterfuge may inhibit collaboration with adjacent municipalities in creating the scale of operations underpinning the new model.

The Ministerial Task Force will work collaboratively with the stakeholders in developing the implementation plan for the TWQMS.

10.2.3. TRANSITIONAL STRATEGIES

- The Minister will establish a Task Force of stakeholders who will be responsible for *kick starting* the process.
- The Ministerial Task Force will be comprised of 8-10 members representing stakeholders. Primary composition will be water utility managers, but also could include NGOs, professional/industry associations and experts.
- The Ministerial Task Force will maintain a close working relationship with the Deputy Minister of the Environment.
- This Ministerial Task Force will be in place for 6-12 months and will be superseded by the Advisory Body to the Regulator.
- The Ministerial Task Force will work in an open and collaborative manner to ensure the successful development of elements of the plan.
- The Minister will be responsible for the implementation of the plan.
- The Ministerial Task Force will develop the plan for implementing the model water utility – including the development of common elements of the model, conducting education and consultation, providing advice and expertise to the Minister, and facilitating expert resources for municipalities.

Common Elements of the Model:

- The Ministerial Task Force will develop the customised framework for the TQWMS in Ontario and share it with the audit community.
- The Ministerial Task Force will strike Working Groups to develop common high-level supports, such as Standard Operating Procedures (SOPs), Human Resources Management System, Performance Management System, etc.
- The Ministerial Task Force will develop a self-assessment Score Card for use by water utilities to determine areas of strength and weakness against the TWQMS. This self-assessment can build on the work already done in the Engineers Reports. The Minister will request that all water utilities complete this Score Card within the first six months.
- The results of this self-assessment will offer greater clarity to the implementation priorities, scope of work ahead and challenges. It also will provide an early report to the public on the state of water quality management overall in the province. This self-assessment will provide the basis for plans in individual water utilities.

Education and Consultation:

- The Ministerial Task Force will convene a roundtable of international experts with experience in implementing parts of the TQWMS approach in other jurisdictions. The results of this roundtable discussion will inform and guide the implementation plan.
- The Ministerial Task Force will convene information sessions through AMO, OMWA and OWWA to discuss related issues. The information sessions will include round-table discussions, grouped geographically, that will be facilitated by external experts. The information sessions also will include lessons learned from electrical de-regulation, and other relevant undertakings and jurisdictions.

Advice and Expertise:

- Expert external facilitation also will be available to municipalities to help them negotiate new utilities or shared services with neighbouring municipalities.

10.2.4. SUSTAINABLE STRATEGIES

Once new water utilities or shared services are established, they will be maintained through the governance structure and the annual reporting requirements, as described in the section on “What We Could Have” in a model utility.

The Advisory Body to the Regulator will offer expert advice to the Regulator and provide an oversight of the regulatory function.

10.3. Business Continuity

10.3.1. GOAL

To ensure the safe supply of drinking water to the public during the transition to the TQWMS.

10.3.2. ISSUES AND BARRIERS

The move to a TQWMS is to ensure the safe supply of drinking water to the people of Ontario. It may be perceived incorrectly as a power struggle between levels of government or between the public and private sectors.

During a time of change, employees often are distracted from their work, as they worry about the future organisation and their role in it.

There will be new roles and responsibilities, and all the players need time to learn and develop the necessary skills.

10.3.3. TRANSITIONAL STRATEGIES

- The Ministerial Task Force will play a strong leadership role in the communication of the purpose and intent of the TQWMS.
 - The purpose of the transition is to meet public expectations for safe supply of drinking water, not to test new technical standards.
 - There is no single solution for how water utilities are organised, but there are expectations for how they perform.
- Those responsible for governance play a critical role in affirming the purpose and intent of the TQWMS. They play that role through:
 - Ongoing and effective communication with the public
 - Clear expectations for the leadership of the water utility
 - Ensuring that the operational capacity meets the requirements of TQWMS
 - Taking responsibility for plans to ensure that they can fulfil their responsibility for the supply of safe water to their community.
- Expert resources will be available to the governance board and to the leadership of water utilities to ensure that they can move to becoming a TQWMS entity effectively and quickly.
- TQWMS is about assurance for safe supply of drinking water. It is expected as part of the plan for each water utility that training and development of existing staff will be a first priority.
- The implementation of the TQWMS will require all water utilities to develop a preparedness plan in the event of any emergency.
- Financial resources will be available to the professional and industry associations to take on the leadership and co-ordinating role during the development of the processes, standards and best practices.

10.3.4. SUSTAINABLE STRATEGIES

Once water utilities address the issue of scale and move in consolidation to implement a TQWMS, the concern regarding business continuity will be overcome by the new utility.

10.4. Effective Governance

10.4.1. GOAL

To ensure that the mandate and the objectives of the water utility are carried out effectively, and that the process and structure for overseeing the direction and management are in place.

10.4.2. ISSUES AND BARRIERS

The TWQMS provides for a water utility that is a distinct organisation for financial and management responsibilities. Accordingly, there will be a governing body with specific responsibility for overseeing the direction and management of the water utility.

There are bodies already in place with responsibility for governance of the water utilities. The framework does not propose one single structure for these bodies, but ensures their effectiveness in practice.

There is the potential for an entire change of members of the board at the time of municipal election in the circumstances where the governing structure for the water utility is the local council. This possibility is a challenge for long term planning.

Among the governing bodies that exist, the understanding of roles and responsibilities varies. The skills, knowledge and capability to carry out the roles and responsibilities are mixed and, in some cases, are insufficient. The use of effective practices in the ongoing governance needs to be sustained.

10.4.3. TRANSITIONAL STRATEGIES

- General orientation sessions through AMO, OMWA and OWWA
 - These sessions will provide a general orientation to “boards” of water utilities on their roles and responsibilities, and the legal framework within which they operate.
- The Self-Assessment Tool will include a checklist or boards to use to determine how well they meet the principles of good governance
 - Based on this self-assessment, boards will develop plans for improvement.
 - Expert resources will be available to boards throughout this process from self-assessment to developing a plan for continuing improvement to implementing that plan.
- The Ministerial Task Force will conduct a comprehensive review of best practices in governance, generally, and water utilities, specifically. These practices will be shared with all water utilities.
 - Best practices will include the obligations and responsibilities that come with the provision of a life necessity such as quality drinking water.
 - Best practices will include areas of public engagement and participation, internal control and management information systems, senior executive recruitment and compensation, human resource strategies, recruitment and appointment of members, and board assessment methods.
 - The best practice for the board’s role in risk management will be developed specifically for the TQWMS.
- On a case by case basis, expert resources will be available to advise on the appropriate governance structures for new utilities or shared services.

10.4.4.SUSTAINABLE STRATEGIES

All boards of water utilities will include a report on the board effectiveness and their plans for continuing improvement in their annual report.

10.5. Leadership

10.5.1. GOAL

To recruit and retain high quality leaders to establish the organisation and culture desired in the new water utilities.

10.5.2. ISSUES AND BARRIERS

There is a general scarcity of leadership in organisations, which is exacerbated in the water industry. It will be a challenge to identify sufficient numbers of “leaders” in the industry or to attract such talent from other industries. The required compensation level may be problematic.

10.5.3. TRANSITIONAL STRATEGIES

- The board of each water utility will be responsible for identifying the competencies and attributes of the leader.
- The board of each water utility will determine the appropriate compensation level.
- The board of each water utility will be responsible for executive recruitment and may need to consider innovative approaches to fill these positions.
- Compensation levels probably will exceed current rates, but there is likely to be a significant offset through consolidations or shared services.
- The Ministerial Task Force will commission a compensation review for the sector that will be available to all water utilities.

10.5.4. SUSTAINABLE STRATEGIES

The executive’s performance will be reviewed annually by the board of the water utility.

The professional and/or industry association can continue updating the compensation review periodically.

10.6. Scale

10.6.1. GOAL

To ensure that the water utility has sufficient capacity – human resources, financial and future investments – to be licensed as a TQWMS.

10.6.2. ISSUES AND BARRIERS

Scale is determined by the balance among three key factors: the desired quality of the water, the quality of the source of the water and the density of the population being served. Size alone is not a determinant of scale.

Some water utilities will not be able to achieve licensing accreditation, because of limits on their capacity (human resources, financial and future investment).

Partnerships over political boundaries are a challenge to achieve.

The ability to make collaborative and partnering arrangements is dependent on the ability of leadership to orchestrate this. The scarcity of leaders puts a limitation on successful collaboration.

In the past, financial subsidy and grants from governments masked the real challenge communities faced in infrastructure management.

There has not been a sustainable way for ensuring that the human resources (skills, knowledge and expertise) were up to the job. There is a challenge for some utilities to attract the leadership needed for TQWMS.

Local Service Realignment did not address the capacity issue.

10.6.3. TRANSITIONAL STRATEGIES

- The Ministerial Task Force will take a leadership role on developing strategies for addressing the capacity issue. These strategies will include:
 - Single utility owned by one municipality that offers its services to other communities.
 - Shared services among neighbouring communities where the existing resources are applied to ensure that the TQWMS can be implemented for each community
 - Operational co-ventures among water utilities
 - A single utility owned by several municipalities
 - Combined electrical, water and waste water utility corporation as the local management group
 - Introduction of point-of-use systems
- The Ministerial Task Force will involve those with responsibility for the Rural Economic Development Strategy to ensure that alternative strategies for the provision of safe drinking water are consistent and supported by economic development plans. Access to expert resources can be obtained under the Rural Economic Development Strategy.
- The Ministerial Task Force will work with the stakeholders in determining what indicators in the licensing process trigger a discussion of these strategies for addressing the capacity issues. The results of the initial self-assessment Score Cards will be used in this consultation.

- The Ministerial Task Force will conduct a consultation with the insurance industry to examine the implications of scale, accreditation and compliance with the TQWMS, and insurance coverage and rates.

10.6.4. SUSTAINABLE STRATEGIES

The available strategies for addressing capacity issues are documented, including costs and benefits, and communicated to all water utilities.

The licensing process includes a step for considering these strategies.

The public reporting will indicate how well the utility is doing in realising the benefits of scale. The Regulator may put a utility “on watch” based on the on its report, if the indicators demonstrate that the utility is disadvantaged because of scale.

10.7. Rural Communities

10.7.1.GOAL

To maintain the quality attributes of the TQWMS in water utilities regardless of location in the province

10.7.2.ISSUES AND BARRIERS

Rural communities in Ontario are small in population and often are separated by large distances. As a result, it is difficult for these communities to realise the benefits of scale that other communities will achieve. In the south, this can be accommodated through consolidation or shared services.

In the north, distances pose a challenge to shared services and infrastructure. Although there are technology solutions, the water utility itself may not have sufficient capacity – human resources, financial and future investments – to fully implement the TWQMS.

The circumstances of size and distance may require alternative technology, and alternative operational and management solutions. The need to manage risk and provide assurance of water quality to the public, however, still exists.

10.7.3.TRANSITIONAL STRATEGIES

- The Ministerial Task Force will establish a Working Group to develop technology, operational and management approaches that are appropriate for Northern Ontario.
- Technology solutions can include alternatives, such as:
 - point-of-use,
 - drip feed systems and
 - truck delivery.
- Operational alternatives will include the use of information technology and automation to enable control hubs or shared services over wide geographic areas. In addition, the assurance of water quality in certain systems will require a different kind of monitoring, testing and reporting (especially for in-home systems).
- Management solutions to achieve the quality attributes of TWQMS will need to be structured to the technical and operational design of the water supplier.
- A comprehensive education program will need to be developed and delivered to the public.
- The Ministerial Task Force also will develop the methodology and approach that can be used by rural communities in assessing risk against cost.

10.7.4.SUSTAINABLE STRATEGIES

All water utilities still will need to report on performance, test results and incidence rates to the public. Ongoing education will be required.

10.8. Regulator

10.8.1. GOAL

To ensure that the Regulator demonstrates, in practice, the skills, resources and capacity to do the job in addition to adherence to the principles of “good” regulation (as outlined in Section 7.1.2) the Regulator’s performance will be monitored through public reporting.

10.8.2. ISSUES AND BARRIERS

There still is uncertainty of the structure of the Regulator (provincial ministries, single window for provincial ministries or arm’s length agency). There still is uncertainty of the organisation and behaviour of the Regulator (sufficient expert staff and adequate resources to carry out the role effectively).

Although the structure of the Regulator was not discussed in this Issue Paper, the authors maintain that it is not appropriate to consider a kind of self-regulated industry body in an area of such significant health and public safety.

The Regulator is a representative of the provincial government and there is potential for government policy and direction, as it affects water utilities, to change from time to time.

The Regulator will need to be unencumbered in carrying out its responsibility and will need to be seen to be fair, reasonable and free from conflict. The Regulator needs to be able to command the skills, resources and capacity necessary to carry out its responsibilities.

The water utilities, as regulated organisations, do not have a coherent manner for interacting with the Regulator, communicating issues, and participating in ongoing development of regulatory practices and protocols.

There are questions over the nature of interventions and penalties for failure to comply.

Once the Regulator is established and operational, the Ministerial Task Force becomes the first Advisory Body to the Regulator.

10.8.3. TRANSITIONAL STRATEGIES

- The general principles of a good Regulator will be reviewed and endorsed by the sector. The Regulator will work with the water utilities in the development of licensing requirements, the public reporting system and role and functioning of the Advisory Board and Consumer Advisory Councils.
- The Regulator will work with the Advisory Body (the former Ministerial Task Force) on the development of the appropriate intervention mechanisms for any non-compliance. As with the TQWMS, these mechanisms will be matched to the risk presented by the non-compliance.
- The Regulator will work with the Advisory Body to determine the information for reporting that indicates the performance of the Regulator. The indicators will relate to the principles of a “good” Regulator and how closely matched the performance of the Regulator is to the principles.
- The Regulator will work with the Advisory Body to determine the process for nomination to the Consumer Advisory Councils and the two-way flow of information from these councils.

10.8.4. SUSTAINABLE STRATEGIES

Affirm existing provincial government policy that any public financial support for community infrastructure will be done on a priority basis. Water, sewage and road developments take precedent over community buildings or recreation facilities.

Affirm financing policy that any financial assistance, if available, is directed to utilities licensed as TWQMS and who have demonstrated their efficiencies and effectiveness.

Fair process for review of decisions of the Regulator.

The Regulator will provide an annual report of their performance in implementing an ensuring the ongoing effective operation of TQWMS. If the Regulator is a public body, such as a crown agency, then it will be subject to the Public Sector Accountability Act. If the Regulator is part of the government, then it will be required to prepare business plans and report on performance, as with all other ministry departments.

The Environmental Commissioner will report on the effectiveness of the Regulator on the basis of how performance matches to the principles of a “good” Regulator.

10.9. Water Quality Standard Setter

10.9.1. GOAL

To establish a clear set of water quality standards that are research-based and that demonstrate that the protection of health and the prevention of risk are adopted.

10.9.2. ISSUES AND BARRIERS

Existing parameters of the current guidelines sometimes “relaxed” on the basis of financial considerations, rather than health protection.

The current guidelines have been developed and reviewed by committees of bureaucrats at the provincial and federal level of governments with little transparency. The processes for the research, development and introduction of new standards is slow and not necessarily in pace with international standards and trends.

Traditional methods to remove or inactivate pathogens may not be effective (such as chlorine resistant parasitic strains). Traditional tests to ensure that treated drinking water is safe take time and money. Thus, the focus of drinking water treatment has shifted towards risk reduction in treatment and protection of source water.

In Ontario, there are no treatment requirements from *Cryptosporidium* or requirements to analyse source water for its presence or the presence of *Giardia*.

Standards have tended to be defined by what the available technology can measure in a timely and cost effective manner, rather than tracking those risks that pose a threat to public health.

Changes in regulations have been introduced without notice and without lead-time for compliance.

The standards adopted must be defensible based on evidence and research.

10.9.3. TRANSITIONAL STRATEGIES

- Existing standards under the Ontario Drinking Water Standards (2000) will continue to apply as a minimum for all water utilities across the province.
- The water quality standards as expressed in the “Canadian Drinking Water Guidelines” (CDWG - 1996 edition) should be the required standard to which the Ontario Drinking Water Standards (ODWS – 2000 edition) must meet at a minimum. There is some latitude for compromise on adoption of the limits, if the Province can argue on a scientific or social basis for the relaxation of a specific parameter in the CDWG-1996 for the ODWS-2000. The relaxation of parameters cannot be made simply on a financial basis (i.e. the regulated limit on a parameter would require a capital expenditure to be met by utilities).

10.9.4. SUSTAINABLE STRATEGIES

As the TQWMS is phased in, any new water quality standards will be developed through Health Canada and adopted by the provincial standards setting body as the minimum standard for all water utilities across the province. Any relaxation of the new parameters will be done on a scientific or social basis.

The provincial standard setting body will provide for notice and sufficient time for compliance when new standards are identified and scheduled for adoption.

10.10. Audit

10.10.1. GOAL

To ensure that regular evaluations and audits are completed by the water utilities in order to plan for continuous improvement and for public reporting.

10.10.2. ISSUES AND BARRIERS

The few water utilities that have received quality management certification (ISO, TQM) have internal evaluation and external audit processes in place. Very few water utilities, however, have received such certification.

The TQWMS will require processes of internal evaluation and external verification and audit. The water utilities' internal resources and expertise will not be sufficient to implement the TQWMS. External expertise will be required during the implementation stage.

The Engineers' Reports recently completed by all water utilities provide an initial indication of the current operations and technical capacity of utilities.

The Regulator/ministry will oversee the development of management standards and methodology for use in the TQWMS.

10.10.3. TRANSITIONAL STRATEGIES

- External expertise will need to be utilised to assist the water utilities in establishing the TQWMS.
- The requirements for internal expertise for on-going management and evaluation of the TQWMS will be addressed in training at the water utility.
- The framework for the TQWMS will be developed by the Ministerial Task Force and will be shared with the audit community. The external evaluation and audit will be conducted by credible third parties that are Registrars, recognized by the Standards Council of Canada.

10.10.4. SUSTAINABLE STRATEGIES

A standard methodology for audit with defined audit standards will be developed.

Third parties to conduct such audits will be by a recognised Registrar.

The Regulator/ministry will provide for the methodology and the third party evaluation and audit in regulation.

10.11. Customer

10.11.1. GOAL

To achieve transparency of the drinking water process to the public and to engage the public effectively in the TQWMS.

10.11.2. ISSUES AND BARRIERS

There is not a strong track record of involvement of the public in the planning, operation and regulation of water utilities.

The involvement of customers and the public has been largely ad hoc with each individual water utility developing its own means and ways of communicating and engaging their customers.

The Operation Clean Water Program establishes regular reporting to the public on the treatment of water and how the quality compares to provincial standards.

10.11.3. TRANSITIONAL STRATEGIES

- The Ministerial Task Force will create a Working Group of stakeholders who will develop the five-step approach for customer involvement identified in Section 8.
- This five-step approach will be available to utilities to adopt, modify and use as appropriate for their community.
- The Ministerial Task Force will develop a public education and communication program as part of their mandate.
- Reporting and communication of information to the community will be described in more detail under the Transparency item of this Transition Plan.
- Customer Advisory Councils will be described in more detail under the Regulator item of this Transition Plan.

10.11.4. SUSTAINABLE STRATEGIES

The Regulator will establish Customer Advisory Councils.

Each water utility will communicate with their community through the public reports.

Public education and communications are elements of the TQWMS.

All reports of the water utilities will be posted to the web site of the Regulator.

11. Track Two – Implementation Of The Total Quality Water Management System

11.1. Total Quality Water Management System

11.1.1. GOAL

To establish and maintain a Total Quality Water Management System (TQWMS) that includes risk management, accountability and education.

11.1.2. ISSUES AND BARRIERS

A comprehensive and consistent system does not exist that will assure the public that risks are being managed in a deliberate and thoughtful manner. There is not an effective means of communicating with the public so that they can see and understand the nature of risk management.

11.1.3. TRANSITIONAL STRATEGIES

- The Canadian Drinking Water Guidelines set by Health Canada will be used as the baseline reference for all standards regulated in Ontario.
- The Ministerial Task Force will develop the framework for the TQWMS. This framework will be a customised “made-in-Ontario” version and will be based on the ISO methodology, with enhancements from HACCP, QualServe, EPA Partnership, etc. The TQWMS will be shared with the audit community.
- A Working Group of Operators will develop Standard Operating Procedures (SOPs) for varying types of facilities.
- The functions of Regulator, Standards Setter and Auditor will be separated, and roles and responsibilities will be defined clearly.
- Water utility staff will need to be trained in the TQWMS.

11.1.4. SUSTAINABLE STRATEGIES

The TQWMS’ achievements and non-conformances will be reported in the Annual Report. Ongoing training requirements will be identified in the Performance Management System (as described in section 3.6 of Part Two, the Model Water Utility) The professional and industry associations will inform this discussion, on an on-going basis.

11.2. Partnerships

11.2.1. GOAL

To build the capacity of the Ontario water supply system through effective partnerships and leadership of professional and industry associations.

11.2.2. ISSUES AND BARRIERS

There are many agencies currently involved in water supply management. There is no integrated approach and a limited track record of collaboration. Protection of source waters will require a watershed management group.

There is a track record of leadership provided by industry and professional associations in supporting the sector and advancing knowledge and information. There maybe resistance, however, from some water utilities to using the utilities as a resource. To do so, the utility must acknowledge that there is a problem and they may believe that it will appear as if they cannot do their job.

11.2.3. TRANSITIONAL STRATEGIES

- An integrated watershed management role is essential. The Ministerial Task Force will develop a model approach for water utilities and agencies in working together to ensure the safe supply of drinking water.
- The associations play a key role in promoting best practices.
 - The Ministerial Task Force, with a Working Group of industry and professional associations, will identify the priority areas for determining best practices and which group most appropriately can take a lead.
- The Ministerial Task Force will provide funding for the initial research and development of information on best practices, building on existing resources, wherever possible.
- The associations play a key role in the Triple-E approach to certification
 - The learning, training and development activities of the associations will be enhanced and aligned with the TQWMS.
 - Initial funding will be provided for this start up activity. Fees will support ongoing costs.

11.2.4. SUSTAINABLE STRATEGIES

The model approach for integrated watershed management will be adopted by water utilities and the Regulator.

There will be a province-wide clearinghouse for research and sharing information on best practice.

The role for associations in learning, training and development will be recognised by the Regulator.

11.3. Management Competence

11.3.1. GOAL

To embed in the new water utilities managers who demonstrate exemplary competence.

11.3.2. ISSUES AND BARRIERS

As with most other industries, the water industry has not provided sufficient training to its managers and, as a result, the existing competence level may not meet the requirements of the model.

The requirements and demands on managers as envisioned under the TQWMS are new and different from past expectations. For the most part, managers are facing new demands and expectations.

11.3.3. TRANSITIONAL STRATEGIES

- The Ministerial Task Force will develop a comprehensive *Leadership Development Program*, with the assistance of an external expert and in consultation with industry and professional associations.
- Water utilities will commit to support the *Leadership Development Program*.
- Financial resources will be budgeted for the *Leadership Development Program*.

11.3.4. SUSTAINABLE STRATEGIES

Performance assessments and ongoing training requirements are incorporated in the Performance Management System. Deliverables, progress and expenditures will be detailed in the Annual Report.

Industry and professional associations will provide ongoing leadership in defining and refining the *Leadership Development Program*.

11.4. Operator Competence

11.4.1. GOAL

To develop and maintain a workforce that is competent in performing their jobs and committed to high quality and continuous improvement.

11.4.2. ISSUES AND BARRIERS

Training Standards have been developed for the Operators. When implemented in the 1990s, however, all existing Operators who had sufficient work experience were *Grandfathered* and certified. As indicated in the previous section, all Operators will need to be re-examined and re-certified every three years. This will include *Grandfathered* Operators.

There could be encumbrances in the collective agreements that will have to be sorted out, such as access to training and compensation levels. Any issues covered under a collective agreement will be dealt with between employer and employee.

11.4.3. TRANSITIONAL STRATEGIES

- The Training Standards for Operators should become a formalised *Apprenticeship Program*, with restricted skill sets, under the Ministry of Training, Colleges and Universities' *Apprenticeship and Certification Act*.
- The Ministerial Task Force will establish a Working Group that will consult with the Ministry of Training Colleges and Universities to review and revise the Operator Training Program to be consistent with the provincial apprenticeship program and to ensure that it fully meets the current occupational requirements for an Operator.
- Water utilities (perhaps using external expertise) will need to conduct a gap analysis on all Operators to determine what training is required and for whom.
- Water utilities will commit to support the *Apprenticeship Program*.
- Financial resources will be budgeted for the *Apprenticeship Program*.

11.4.4. SUSTAINABLE STRATEGIES

Performance assessments and ongoing training requirements are incorporated in the Performance Management System. Deliverables, progress and expenditures will be detailed in the Annual Report. There will be re-testing and re-certification every three years.

12. Track Three – Transparency

12.1. Financial

12.1.1. GOAL

This model is based on a move to full-cost recovery. Water utilities need to develop and manage budgets that reflect the true costs of their operations and that support the attributes of the new model.

12.1.2. ISSUES AND BARRIERS

Currently, most customers in Ontario are not paying the true cost for their water.

Operational budgets do not match the true costs. They do not accommodate sustainable asset management. They do not accommodate for future investment and deferred maintenance. The water utility's contribution to fire services is not re-imbursed to the utility. Support for research and the regulatory regime are not part of the current cost of water. There has been a reliance on special government sponsored infrastructure programs for major works. In other instances, water revenues may be in excess of costs and are applied to other purposes within the community.

The current structure of grants does not support the fiscal responsibility of water utilities and are inconsistent with the move to full cost recovery.

12.1.3. TRANSITIONAL STRATEGIES

- A metered, user-pay system will need to be developed by each water utility, with a phased-in implementation plan.
- The Ministerial Task Force will develop a common financial accounting system for use by each water utility.
- Budgets will need to be developed to support fully the requirements of the new water utilities, including operations, sustainable asset management, conducting a gap analysis, providing training, establishing and maintaining the TQWMS, and establishing and maintaining a Human Resources Management System.
- A sustainable asset management system will need to be implemented, including an inventory of all assets, evaluation of their life cycle, a prioritised replacement plan, and a corresponding budget allocation.
- The federal and provincial governments either should withdraw from funding water infrastructure or set forth a multi-year commitment to enable proper budgeting.

12.1.4. SUSTAINABLE STRATEGIES

The Regulator will have responsibility for rate reviews of all water utilities. All financial aspects of actual expenditures and achievements against plan will be in the Annual Report, including asset management. This transparency will keep a positive, healthy tension and accountability in the system. The common accounting system will facilitate comparison assessments and benchmarking.

12.2. Transparency

12.2.1. GOAL

To establish an open and transparent accountability system for water utilities.

12.2.2. ISSUES AND BARRIERS

The changing organisations in the Provincial Government and the new responsibilities for municipalities have occurred at such a pace, that a clear definition of roles and responsibilities reflecting the new organisations and responsibilities has not been done.

Public reporting required by TQWMS builds on the water quality reporting which has been introduced under the Operation Clean Water Program. The public reporting required by TWQMS is also consistent with the requirements under the Public Sector Accountability Act.

The development of a reasonable and relevant reporting regime will need an investment of time, effort and resources.

12.2.3. TRANSITIONAL STRATEGIES

- The Ministerial Task Force will develop a template for the mission statement that provides the direction for the implementation of the TQWMS.
- The Ministerial Task Force, with a Working Group of stakeholders, will develop the information required as a basis for the annual report.
 - This information will build on commonly used practices for annual reporting, including financial statements and progress against plans and future developments.
 - There will be additional information relating specifically to the implementation and continuing improvement of the TQWMS.
 - These annual reports will provide, at a minimum, the information as required under the Public Sector Accountability Act or as required by publicly traded companies.
- The Ministerial Task Force, with a Working Group of stakeholders, will develop the requirements for regular reporting as a result of the ongoing monitoring of standards and performance.
- The Ministerial Task Force will identify the kind of information and the variety of means most appropriate for communicating with the public.
- Existing reporting will continue and will be enhanced over time to reflect the implementation of TQWMS.

12.2.4. SUSTAINABLE STRATEGIES

The Ministerial Task Force will establish a mechanism for the water utilities, working with industry and professional associations to identify best practices in reporting and communication with the public. Please see Appendix 3 for an annual report template.

Water Utilities that are owned by municipalities (as part of the municipalities, a commission or corporations with share capital held by the municipality) will be required to report under the Public Sector Accountability Act.

Develop system wide indicators for reporting performance, quality and effectiveness.

12.3. Five Year Assessment of the Legislation

12.3.1. GOAL

To assess the implementation of the TQWMS as provided for under legislation.

12.3.2. ISSUES AND BARRIERS

It is difficult for the Ministerial Task Force and Regulator to assess their own work.

An assessment will identify necessary adjustment to the TQWMS and corrections.

An assessment will determine whether the purpose and objectives of the legislation have been met, whether the regulatory requirements are sufficient or duplicative, and whether the Minister needs to make changes to the policy context.

12.3.3. TRANSITION STRATEGIES

- A third party will lead an assessment, with the involvement of the Advisory body to the Regulator and the Regulator.
- The report of this assessment is available to the public and decision-makers – the water utilities, the Regulator and the government.

12.3.4. SUSTAINABLE STRATEGIES

The TQWMS will be modified and improved based on the findings of the assessment.

Improvements will be done on a prioritised basis.

Any policy changes, legislative amendments or regulatory changes will reflect the results of the assessment.

13. Financing the Transition

There will be costs associated with the transition to the new model for water management in Ontario. Over and above the demands of ongoing operations and needed investments, the transition will need to be financed.

The transition costs include, at a general level:

- The work of the Ministerial Task Force,
- Development of communications,
- Regional information sessions,
- Provision of expert resources,
- Introduction of new training and development for utility staff, including operators and managers,
- Priority based research to establish best practices,
- Development and implementation of the elements of the TQWMS,
- Development work for the Standard Operating Procedures, indicators, methodology on assessment of risk and protocols for integrated management
- Launching any new service delivery arrangements
- Introduction of new reporting information

There will be change as a result of the Walkerton Inquiry. The Minister of the Environment has committed to a plan to “refocus” the ministry, and through regulatory and non-regulatory initiatives adopt an approach of continuous improvement. In particular, the Minister has committed to a multidisciplinary approach to water management. There are commitments to Rural Economic Development, infrastructure development and improvements to processes. The government has introduced the Public Sector Accountability Act. These changes have been anticipated, announced and are being planned. The TQWMS complements these initiatives. All that is needed is the commitment to ensure that existing resources and related new resources are directed at achieving the goal of quality water management.

Many municipalities currently are having difficulties meeting the new standards for drinking water quality. Failure to comply with the standards is not an option. The province cannot allow systems to fail and health to be threatened. There are demands for new investment and skills now. The Transition Plan provides a focal point for that investment. Rather than expect each individual water utility to try to develop the core elements of the TQWMS on their own, the common information and commonly used practices can be developed once through the work of the Ministerial Task Force. Such information and practices include the standard operating procedures, performance indicators, compensation review, methodology for risk assessment, financial accounting, training, and audit standards.

References

References

A Model for Governance, the Final Report of the Project Team on Governance, The Haldimand Norfolk Transition Board, August 2000.

A Nine Step CPR Plan For Ontario's Water and Sewage Systems, The Ontario Sewer and Watermain Construction Association.

Approaches to Corporate Governance in the Public Sector, Fédération des Experts Comptables Européens, 2001.

Best Communication Practices in Communicating a Drinking-Water-Related Public Health Emergency. Powell, Douglas A. Katija Blaine, Liz Gomes, Sarah E. Grant, Bonnie LaCroix and Shane Morris. 2001. Walkerton Inquiry Draft Issue Paper.

Beyond Compliance: Building a Governance Culture, Interim Report of the Joint Committee on Corporate Governance, Toronto Stock Exchange, Chartered Accountants of Canada, Canadian Venture Exchange, March 2001.

Corporate Governance in Local Government: A Keystone for Community Governance – Framework, Chartered Institute of Public Finance and Accountancy and Society of local authority Chief Executives and Senior Managers, 2001.

Corporate Governance in Local Government: A Keystone for Community Governance – Guidance Note (English Authorities), Chartered Institute of Public Finance and Accountancy and Society of local authority Chief Executives and Senior Managers, 2001.

Corporate Governance in Practice, Performance Audit Report, Government of New South Wales, Audit Office, 1997.

Corporate Governance: A Framework for Public Service Bodies, Chartered Institute of Public Finance and Accountancy, 1995.

Emergency Planning for Water Utility Management. 3rd Edition. AWWA Manual M19, 1994.

Financing Water Infrastructure. Fortin, Michael, Mike Loudon, Harry Kitchen. 2001. Walkerton Inquiry Draft Issue Paper.

Framework for Management of Drinking Water Quality – A Preventive Strategy from Catchment to Consumer. NHMRC/ARMCANZ Coordinating Group. 2001. Draft.

Getting Organized – The Performance Management System, “The Business Owner”, Fields, Bill. November 1998. Publishing Alliance Inc.

Human Resources Management, Fields, Bill and Maureen O’Leary-Pickard. January 2001. Unpublished

ISO 9000 – Are You Ready?, “The Business Owner”, Fields, Bill. April 1998. Publishing Alliance Inc.

Machinery of Government for Safe Drinking Water in Ontario, D’Ombain, Nicholas. 2001. Walkerton Inquiry Draft Issue Paper.

Managing Health Risks from Drinking Water: A Background Paper for the Walkerton Inquiry. Krewski, Daniel, *et al.* 2001. Walkerton Inquiry Draft Issue Paper.

Measuring Up II – An evaluation of water quality information provided to drinking water consumers in California. Clean Water Action, Clean Water Fund and CALPIRG Charitable Trust. April 2001.

Motivating Employees – The Secret Pill, “The Business Owner”, Fields, Bill. February 2000. Publishing Alliance Inc.

Ontario Drinking Water Standards, Ontario Regulation 459/00, Ontario Water Resources Act, 2000.

Production and Distribution of Drinking Water. Doyle et al., Delcan. 2001. Walkerton Inquiry Draft Issue Paper.

Provincial-Local Relations and Drinking Water in Ontario, Sancton, Andrew. 2001. Walkerton Inquiry Draft Issue Paper.

Report of the Auditor General of Canada, December 2000.

Social Risk, Political Rationality and Official Responsibility: Risk Management in Context. Dobell, Rod. 2001. Walkerton Inquiry Draft Issue Paper.

Structure Follows Vision – Eliminating Organizational Drift, “The Business Owner”, Fields, Bill. March 1999. Publishing Alliance Inc.

The Art Of Delegating – Achieving Employee Responsibility And Accountability, “The Business Owner”, Fields, Bill. November 1999. Publishing Alliance Inc.

The Management and Financing of Drinking Water Systems: Sustainable Asset Management. Pollution Probe. 2001.

The Management of Manure in Ontario with Respect to Water Quality. Goss, Michael J., Kimberley S. Rollins, Kenneth McEwan, J. Ralph Shaw, Helen Lammers-Helps. 2001. Walkerton Inquiry Draft Issue Paper.

The Regulatory Paradox. Hoffbuhr, Jack W., Journal AWWA, Vol. 93, No. 5 (May 2001).

The Role Of Leadership In An Imperfect World, Presentation To: The Association For Services Management International, Toronto Chapter. Fields, Bill. January 1998.

Water Works and Sewage Works Regulation, Ontario Regulation 435/93, Ontario Water Resources Act

Why do People and Organizations Produce the Opposite of What they Intend? Martin, Roger L., Mary Ann Archer and Loretta Brill. 2001. Walkerton Inquiry Draft Issue Paper.

Your Employees – Asset Or Liability?, “The Business Owner”, Fields, Bill. September 2000. Publishing Alliance Inc.

Internet Web-Site Addresses for Additional Information

American Productivity & Quality Center www.apqc.org/

CFIA HACCP Information Site www.cfia-acia.agr.ca/english/ppc/psps/haccp/haccpe.shtml

Chartered Institute of Public Finance and Accountancy www.cipfa.org.uk

Drinking Water Inspectorate, Department of the Environment, Transport and the Regions (United Kingdom) www.detr.gov.uk/dwi/index.htm Health Canada (English Site) www.hc-sc.gc.ca/english/index.htm

iSixSigma - Quality and Management Resources Including Six Sigma Quality Total Quality Management Quality Assurance and ISO9000 www.isixsigma.com

ISO 9000 & ISO 14000 www.iso.ch/9000e/9k14ke.htm

Ministry of Environment (Ontario) www.ene.gov.on.ca

Ofwat (Office of Water Services -UK) www.ofwat.gov.uk

Ontario Drinking Water Protection Regulation
www.ene.gov.on.ca/envision/waterreg/Reg-final.pdf

Partnership for Safe Water www.epa.gov/safewater/psw/psw.html

Singapore Public Utility Board (PUB) www.pub.gov.sg/pub_main.php

QualServe www.awwa.org/qualserve

The Association for Quality & Participation www.aqp.org

United States Environmental Protection Agency www.epa.gov/safewater

Water UK www.water.org.uk

American Water Works Association www.awwa.org

Ontario Water Works Association www.owwa.on.ca

Appendix 1 – Draft Australian Framework

1.(Section 1, NHMRC) Commitment to Drinking Water Quality Management

Commitment to continually improve performance is the foundation to effective management of drinking water quality. This commitment should be based on the awareness and understanding of the importance of drinking water quality management and how decisions affect the protection of public health.

Leadership from a drinking water supplier's senior management is essential to the development of a management philosophy within the organisation that fosters commitment to continuous improvement and cultivates employee responsibility and motivation. The ongoing and active involvement of senior management is a key factor in maintaining and reinforcing the importance of drinking water quality management to all employees, as well as to those outside the organisation.

Senior management should ensure that its actions and policies support the effective management of drinking water quality (e.g. appropriate staffing, training of employees, provision of adequate financial resources, active participation, reporting to the Board/Chief Executive). Establishment of a water quality policy, review of requirements, and involvement of relevant agencies demonstrate a water supplier's commitment to drinking water quality management and provide a means for communication of this commitment throughout the organisation and to the public.

1.1. Drinking Water Quality Policy

Development of an organisational drinking water quality policy is an important step in increasing focus on water quality management throughout the organisation and in formalising the level of service to which the water supplier is committed. The drinking water quality policy should define the commitments and priorities of a water supplier relating to drinking water quality and provide the basis for which all subsequent actions can be judged.

The drinking water quality policy is intended to provide a framework from which more detailed policies and implementation strategies can be developed. As such, it should be clear, succinct and address broad issues and requirements of drinking water quality management. The policy may consider, for example:

- commitment to drinking water quality management
- the level of service provided
- involvement of employees
- compliance with relevant regulations and other criteria
- liaison with relevant agencies
- communication with employees and the public
- intention to adopt best practice management and multiple barriers
- continual improvement in the management of drinking water quality

In developing the drinking water quality policy, the opinions/requirements of employees, consumers and other stakeholders should be considered.

It is the responsibility of all employees to maintain this commitment. Employees must be assured that senior management is committed to achieving the goals of the drinking water quality policy, particularly given the pace of change within the industry in recent years. Management should ensure that this policy is highly visible and continually communicated and understood at all levels of the organisation. Each employee should know how the mission statement applies specifically to the performance of his/her job.

An example of a generic drinking water quality policy is provided in Box 1.1.

Box 1.1 Generic Drinking Water Quality Policy

The organisation is committed to managing its water supply effectively to provide a safe, high quality drinking water that consistently meets or exceeds the Ontario Drinking Water Standards, customer and other regulatory requirements.

To achieve this, in partnerships with stakeholders and relevant agencies, the organisation will:

- Manage water quality at all points along the delivery chain from source water to the consumer.
- Integrate the needs and expectations of our customers, stakeholders, regulators and employees into our planning.
- Establish regular monitoring of the quality of drinking water and effective reporting mechanisms to provide relevant and timely information and promote confidence in the water supply and its management.
- Develop appropriate contingency planning and incident response capability.
- Participate in appropriate research and development activities to ensure continued understanding of drinking water quality issues and performance.
- Continually improve our practices by assessing performance against corporate commitments and stakeholder expectations.

Consistent with the Ontario Drinking Water Standards approach, detailed plans that support the management of drinking water quality will:

- Utilise a risk-based approach in which potential risks associated with water quality are identified and balanced, and
- Provide the most economical community solutions to maintain an acceptable cost of supply.

The organisation will establish a good working relationship with public health agencies to ensure it contributes to the debate on setting industry regulations and guidelines, and other standards relevant to public health and the water cycle.

The organisation will implement and maintain a Total Quality Water Management System consistent with the Ontario Drinking Water Standards to adequately manage the risks to drinking water quality.

All managers and employees involved in the supply of drinking water are responsible for understanding, implementing, maintaining and continuously improving the Total Quality Water Management System.

Dated

Signed by Responsible Officer

2. Total Quality Water Management System

2.1. (Section 12, NHMRC) Continuous Improvement

Senior management support, commitment and ongoing involvement are essential to the continual improvement of the organisation's activities relating to drinking water quality. Management regularly should review its approach to drinking water quality management, develop action plans and commit the resources necessary to improve its operational processes and overall drinking water quality performance. This review will be apart of the annual report.

2.1.1. (Section 12.1, NHMRC) Senior Management Review

In order to ensure continual improvement, senior management should assess the extent to which the drinking water quality management system remains suitable and effective. This provides the necessary mechanism to ensure that the drinking water quality management system is maintained and reviewed on an ongoing basis.

Senior management should take the opportunity to critically assess the effectiveness of drinking water quality management activities and evaluate the need for any changes to be made. The scope of the review should be comprehensive, though not all elements of the drinking water quality management system need to be reviewed at once. A systematic review schedule is a requirement of the Total Quality Water Management System (TQWMS) Plan.

The process will include review of audit results and drinking water quality performance, evaluation of any previous management reviews, any concerns of consumers, regulators and other stakeholders, plus an evaluation of the suitability of the drinking water quality policy, objectives and preventive strategies in relation to changing internal and external conditions such as:

- changing legislation
- changing expectations and requirements
- changes in the activities of the organisation
- advances in science and technology
- outcomes of drinking water quality incidents and emergencies
- reporting and communication

Observations, conclusions and recommendations from the senior management review should be documented.

2.1.2. (Section 12.2, NHMRC) Total Quality Water Management System Plan

A Total Quality Water Management System (TQWMS) Plan is required to address the recommendations for improvements defined by the management review. Improvement plans should include short-term (1-year), intermediate term (5-year), and long-term (20-

year) programs which address the resolution of any existing or potential drinking water quality problems.

Examples of actions that could be included in improvement plans include long-term capital works projects such as the covering of water storages, the introduction of filtration, or short-term operational improvements such as the development of pesticide programs, increasing staffing, the development of community awareness programs, etc.

Implementation of TQWMS Plans often will have significant budgetary implications and may require detailed cost-benefit analysis and careful prioritisation.

TQWMS Plans will include the objectives, actions to be taken, accountability, timelines and reporting. A water supplier should ensure that the improvement plan is communicated throughout the organisation and to the community, regulators and other stakeholders by the prescribed methods. Implementation of improvements should be monitored to confirm they have been made and are effective.

2.1.3. (Section 9, NHMRC) Research and Development

Applied research and development should be directed toward increasing the understanding of a water supply system and potential impacts, and investigating improvements and new processes. Investigations will necessarily include validation of operational effectiveness of new products and processes such as coagulation and filtration.

A corporate commitment to conduct and participate in research and development activities aimed at advancing knowledge of drinking water quality issues is important to ensure continual improvement and to support the ongoing capability to meet drinking water quality requirements.

Ongoing research at a local level increases understanding of the specific characteristics of individual water supply systems. Local research could include examination of specific characteristics of individual water systems and detailed analysis of temporal and spatial variations in source water quality parameters. Research and development activities also should investigate mechanisms to improve/optimize plant performance, evaluation of treatment processes including the validation of critical limits and targets, and the design of new equipment. These activities should be carried out under controlled conditions by qualified staff and all protocols and results should be documented and recorded.

Additionally, participation in research and development activities through partnerships and industry-wide co-operation can be a cost-effective approach for addressing the broader issues associated with water quality and treatment including the development and evaluation of new technologies. A water supplier should identify opportunities for collaboration and seek to initiate joint research and development projects.

2.2. (Section 2.3, NHMRC) Hazard Identification and Risk Assessment

Adoption of a risk-based approach that enables the identification of hazards from catchment to consumer and the assessment of their potential impact on water quality is essential to efficient system management. Hazard identification and risk assessment are valuable tools for understanding the vulnerability of a drinking water supply and planning effective risk management strategies to assure drinking water quality and safety.

A hazard is an agent or a situation with the potential for causing harm (e.g. *Cryptosporidium* is a water quality hazard, a potential danger to public health). Risk is the likelihood of identified hazards causing harm in exposed populations in a specified time frame, including the magnitude of that harm and/or the consequences (e.g. the likelihood that *Cryptosporidium oocysts* will breach water management system barriers with sufficient numbers to cause illness in consumers would constitute a risk).

A structured approach to identify areas of greatest risk is important in ensuring that significant issues are not overlooked. A water supplier first may choose to carry out a screening level risk assessment to identify broad issues and then determine where to focus efforts on a more detailed risk assessment. An example of a hazard identification and risk assessment methodology is provided in Box 2.1.

Realistic expectations for hazard identification and risk assessment are important. Hazard identification and risk assessment are predictive activities that will inevitably be based on less evidence than is desirable for definitive calculation. These inherent limitations must be recognised by viewing the predictions as no more than reasonable and practical judgements and not as scientifically derived determinations of the “real” risk. Such perspectives are necessary to maintain flexibility to read events as they unfold and respond effectively when events differ from predictions. Likewise, when dealing with the public, a realistic perspective on the limitations of the predictions is essential so that dialogue can focus on improving the evidence rather than engaging in unproductive debate about “real” versus “perceived” risk.

Box 2.1 Hazard Identification and Risk Assessment

A structured approach to identify areas of greatest risk is important in ensuring that significant issues are not overlooked. While there can be wrong ways to conduct the analysis (i.e. if erroneous characterisations are relied upon), there is no single right way to perform these activities. The process must evolve from a comprehensive and rigorous evaluation of the system under study. Steps involved in the process should logically include:

Structure and Scope of Analysis

- Define the structure of the analysis by dividing the system and the assessment into logical elements, e.g. catchment, treatment plant, distribution system, consumers, etc.
- Define the approaches and methodology used to identify hazards and hazardous events (tools and techniques, appropriate representatives).
- Define the scope of analysis, i.e. the range of conditions that correspond to unacceptable water quality (hazards and events) and the nature of the risks being considered (e.g. impacts on human health, aesthetics, public relations and company image, legal liability).

Hazard Identification

- Identify and document all potential hazards from catchment to consumer regardless of whether or not they are under the control of the drinking water supplier.
- Identify and document the hazardous events, causes and scenarios that might affect the drinking water quality (what can happen and how).
- The initial hazard identification process should not be constrained by practical considerations that might stifle the creativity of the assessors in foreseeing obscure hazards. After acquiring a full list of hazards, those that are judged to be too improbable to warrant an assessment of risk may be simply listed without any required follow-up action.

Risk Assessment

- Estimate the level of risk for each hazard/scenario (a function of likelihood and severity of the consequences). This will be at best a semi-quantitative exercise that must rely on an agreed scoring system that is transparent to scrutiny and reconsideration by others once the risk scoring and ranking has been completed.
- Establish and document priorities for risk management action based on assessment of risk. The sensitivity of the risk ranking to the scoring system used must be open to scrutiny. This system must be viewed as distinguishing very big risks from very small risks and will not be likely to achieve on strictly objective grounds any fine distinctions among a number of moderate risks.

Source: Adapted from AS/NZS 4360:1999 Risk Management

Hazard Identification

“A hazard is an agent or situation with the potential for causing harm”

The 2000 ODWS provides a comprehensive list of potential hazardous agents in drinking water. These include physical, microbiological, chemical, and radiological agents. Events, scenarios and causes that might give rise to exposure to these hazards and affect drinking water quality (what can happen and how) should be identified and documented for each water supply system component and their risk assessed so that appropriate strategies can be planned for their prevention.

All potential hazards and hazardous events should be included regardless of whether or not they are under the direct control of the water supplier. This includes identification of point sources of pollution such as human and industrial waste discharge as well as diffuse sources of pollution such as those arising from agricultural and animal husbandry activities, etc. Potential continuous, intermittent or seasonal pollution patterns also should be considered as well as extreme and infrequent events such as droughts or floods.

The information provided by the Water Supply System Analysis and Review of Water Quality Data should be used to ensure that hazards and hazardous events are not overlooked. It is important that the hazard identification and risk assessment be reviewed and updated on a periodic basis. This is essential to ensure that staff is involved in and familiar with the judgements that are inherent in the hazard identification and risk assessment. Likewise, changing conditions may introduce important new hazards or modify risks associated with identified hazards.

Table 2.2 includes examples of some typical hazardous events and causes. Box 2.2 provides an example of various pollution sources and the potential hazards they produce.

Box 2.2 Examples of Sources and Potential Hazards

Human and animal waste represent the largest sources of potential hazards in drinking water. Both can include high numbers of enteric pathogens and large amounts of nutrients. Due to the scale of primary production in Australia the total amount of livestock waste would greatly exceed the amount of human waste.

Septic tanks:	<i>pathogens*, nitrates/nitrites</i>
Sewage treatment plants:	<i>pathogens, nutrients</i>
Animal husbandry:	<i>pathogens, nutrients, turbidity, colour</i>
Horticulture:	<i>pesticides, fertiliser nutrients, turbidity and colour</i>
Rural stormwater:	<i>pathogens, high turbidity and colour</i>
Forestry:	<i>pesticides</i>
Industry:	<i>heavy metals, organic chemicals including halogenated organics. Specific industries can be associated with specific types of contaminants, e.g. arsenic and copper associated with wood preserving, cadmium and chromium with electroplating, chromium with leather tanning, etc.</i>
Mining:	<i>acid mine wastes from pyrites tailings can release and transport metals such as aluminium, iron and manganese, other naturally occurring metals such as cadmium and copper can also be leached, arsenic can be associated with old goldfield areas</i>
Urban Stormwater:	<i>lead and zinc from roads, colour, turbidity, microorganisms from pets (lower range of pathogens than from humans or livestock waste)</i>
overflows:	<i>pathogens, high colour and turbidity</i>

* The potential range of pathogens present will vary according to the type of waste involved. Many enteric pathogens and in particular viruses and protozoa exhibit species specificity. Human enteric viruses are only carried and excreted by humans. Similarly livestock have been shown to be sources of human infectious *Cryptosporidium parvum* but the species that infect birds do not infect humans.

Table 2.2 Examples of Potential Hazardous/Contamination Events

Catchments and Groundwater Systems	Storage Reservoirs and Intake	Treatment System	Service Reservoir and Distribution System	Service Reservoir and Distribution System (cont'd)
<ul style="list-style-type: none"> ▪ Rapid variations in raw water quality ▪ Sewage discharges/septic systems ▪ Industrial discharges ▪ Chemical use in catchment areas (eg use of fertilisers and agricultural pesticides) ▪ Major spills / accidental spillage ▪ Public roads ▪ Human access (recreational activity) ▪ Wildlife (native and feral) ▪ Unrestricted livestock ▪ Inadequate buffer zones ▪ Surrounding land use (eg animal husbandry, agriculture, forestry, industrial area, waste disposal, mining) ▪ Changes in surrounding land use ▪ Poorly vegetated riparian zones and failure of sediment traps / soil erosion ▪ Stormwater flows and discharges ▪ Existing or historical waste-disposal or mining sites / contaminated sites / hazardous wastes ▪ Unconfined and shallow aquifer ▪ Groundwater under direct influence of surface water ▪ Inadequate well-head protection and unhygienic practices ▪ Uncased or inadequately cased bores ▪ Saline intrusion of coastal aquifers ▪ Contaminated aquifer ▪ Climatic and seasonal variations (e.g. heavy rainfalls, droughts) ▪ Bush fires, natural disasters, sabotage 	<ul style="list-style-type: none"> ▪ Open reservoirs and aqueducts/ uncovered storages ▪ Human access / absence of exclusion areas around shorelines ▪ Animal access including birds and vermin ▪ Short-circuiting of reservoir ▪ Depletion of reservoir storage ▪ No selective withdrawal ▪ No alternative water sources ▪ Unsuitable intake location ▪ Algal blooms ▪ Stratification ▪ Soil erosion ▪ Inadequate buffer zones and vegetation ▪ Climatic and seasonal variations (e.g. heavy rainfalls, droughts) ▪ Public roads / accidental spillage ▪ Failure of alarms and monitoring equipment ▪ Bush fires and natural disasters ▪ Sabotage 	<ul style="list-style-type: none"> ▪ Significant flow variations through water treatment system ▪ Incapable equipment/ unit processes ▪ Inadequate backup ▪ Inappropriate treatment processes ▪ Process control incapability / operational flexibility ▪ Use of unapproved or contaminated water treatment chemicals and materials ▪ Chemical dosing failures ▪ Inadequate mixing ▪ Failure of dosing equipment ▪ Inadequate filter operation and backwash recycling ▪ Ineffective disinfection ▪ Equipment malfunctions ▪ Poor reliability of processes ▪ Failure of alarms and monitoring equipment ▪ Power failures ▪ Sabotage and natural disasters 	<ul style="list-style-type: none"> ▪ Open reservoirs and aqueducts/ uncovered storages and unprotected pipe system ▪ Human access / absence of exclusion areas around shorelines ▪ Animal, bird and vermin access ▪ Short-circuiting of reservoir / stagnation zones ▪ Build up of sediments and slimes ▪ Inappropriate materials and coatings or material failure ▪ Aged pipes, infrastructure ▪ Corrosion of reservoirs and pipe system ▪ Mixing of different source waters ▪ Infiltration and ingress of contamination from cross connections, backflow (soil and groundwater) ▪ Biofilms, sloughing and resuspension / regrowth ▪ Pipe bursts / leaks ▪ Inadequate repair and maintenance / inadequate system flushing and reservoir cleaning 	<ul style="list-style-type: none"> ▪ Commissioning new mains ▪ Inadequate disinfection after construction, repairs ▪ Flow variability / inadequate pressures ▪ Treatment dosing failure ▪ Inadequate maintenance of chlorine residual ▪ Formation of disinfection byproducts ▪ Failure of alarms and monitoring equipment ▪ Sabotage and natural disasters <p>Consumers</p> <ul style="list-style-type: none"> ▪ Potential consumer misuse ▪ Inappropriate plumbing and construction materials ▪ Leaching of metals

Note: This list provides examples of some typical hazardous events and scenarios. It is not intended to be exhaustive. Inadequate staffing and training, inadequate operating procedures, poor communication, lack of community involvement, etc. should also be considered as potential hazardous scenarios. These issues are discussed in subsequent elements.

Risk Assessment

“Risk is the likelihood of a hazard causing harm in exposed populations in a specified time frame, including the magnitude of that harm and/or consequences”

Once potential hazards and their causes have been identified, the level of risk associated with each hazard/scenario must be estimated so that priorities for risk management action can be established and documented. It is important to recognise that there are countless contaminants that can compromise drinking water quality but that not every potential hazard may require the same degree of attention. The distinction between hazard and risk needs to be made so that attention and resources can be directed to actions based primarily on the degree of the risk rather than just the existence of a hazard.

The level of risk for each hazard/scenario can be estimated by identifying the likelihood of occurrence (e.g. certain, possible, rare) and evaluating the severity of consequences if the hazard occurred (e.g. insignificant, major, catastrophic). Rarely will enough knowledge be available to complete a detailed quantitative risk assessment; and in most cases it will be more appropriate to adopt qualitative or semi-quantitative approaches that are transparent and fully understood by involved parties.

An example of risk definition and classification for estimating the level of risk of each hazard is provided in Table 2.3, 2.4 and 2.5 (as adapted from AS/NZS 4360:1999 Risk Management). These tables can be adapted to meet the needs of an individual organisation.

Using these tables to guide a risk assessment exercise will quickly reveal the need to reach a consensus on the level of detail and format to be used for specifying events that will be listed in the assessment. The approach to designating events determine how they will be ranked because events may arise along a continuum from commonly recurring events of minor consequence to rarer manifestations of the same event with more serious consequences. Take, for example, the failure to maintain specified disinfectant residual in the reticulation system. Whereas slight deficiencies may be common with limited consequences, a total disinfection failure should be rare and could raise potentially severe consequences. There is no absolute set of rules to be followed in using these tables; rather they are offered as a general guide for the development of a consistent approach that will make sense for the water system under study.

The foregoing risk assessment process is different in scope and purpose from other environmental health risk assessments that may be used to develop environmental quality guidelines (including health-based drinking water quality guideline levels) or to assess specific developments or activities. The latter usually involve a wide range of detailed environmental, toxicological and epidemiological information about individual contaminants or mixtures. Typically, after formulating the problem to be assessed in its full context, the process will involve a hazard assessment, dose-response assessment, exposure assessment and a risk characterisation (see EnHealth Council in Further Reading).

Risk Assessment as described in the Framework is designed to be part of a management process which establishes priorities and evaluates the effectiveness of preventive strategies in minimising risk. Risk can be assessed at two levels:

- maximum risk in the absence of preventive strategies

- residual risk assuming that existing preventive strategies are operating effectively (see Appendix 1, Section 2.4 Prevention Strategies)

Assessing maximum risk is useful in preparing for emergencies while residual risk provides an indication of the need for additional preventive strategies. Determining each provides valuable information on both high priority risks and the preventive strategies that are critical for ensuring the delivery of safe drinking water (see Appendix 1, Section 2.3 Critical Control Points).

Table 2.3 **Qualitative Measures of Likelihood**

<i>Level</i>	<i>Descriptor</i>	<i>Example Description</i>
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur at some time/the event should occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

Table 2.4 **Qualitative Measures of Consequence or Impact**

<i>Level</i>	<i>Descriptor</i>	<i>Example Description</i>
1	Insignificant	insignificant impact, little disruption to normal operation, low increase in normal operation costs
2	Minor	minor impact for small population, some manageable operation disruption, some increase in operating costs
3	Moderate	minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring
4	Major	major impact for small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required
5	Catastrophic	major impact for large population, complete failure of systems

Table 2.5 **Qualitative Risk Analysis Matrix – Level of Risk**

<i>Likelihood</i>	<i>Consequences</i>				
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A (almost certain)	moderate	high	very high	very high	very high
B (likely)	moderate	high	high	very high	very high
C (moderate)	low	moderate	high	very high	very high
D (unlikely)	low	low	moderate	high	very high
E (rare)	low	low	moderate	high	high

Rare Events

When systems are operated well, problems will be rare, making them more challenging to anticipate and possibly to respond to creating a more difficult response. This reality highlights the need for collaboration with other water suppliers within the country and internationally to maximise opportunities to learn constructive lessons from the difficult experiences of others. There are a number of notable examples where rare events have had severe consequences (e.g. see Box 4.1).

Uncertainty

The predictive nature of hazard identification and risk assessment dictate that there will always be substantial uncertainty associated with these activities. An appreciation of the types of uncertainty can be helpful in dealing with it. Uncertainty may be broadly classified into: 1. Variability and 2. Knowledge Uncertainty.

Variability represents the true differences that can exist in the specific values of parameters that contribute to a risk such as contaminant concentrations over time and space, flows, number of people exposed, etc.

These characteristics contribute to uncertainty because they vary and we usually cannot describe them completely because we have incomplete monitoring data and there is no single correct answer that will cover all circumstances. For example, what is the correct representation of water temperature over some time period? The mean temperature will not represent the high and low extremes which may be more important depending on what we are seeking to know. Because there is variability in temperature, we must decide which value is correct to use among the data we have, and this choice will carry with it some uncertainty.

Knowledge uncertainty, however, represents our inadequate state of knowledge that exists in the values of parameters measured. Knowledge uncertainty may be reflected in a lack of assurance that methods are accurately measuring what we intend them to or in a lack of understanding of how a process works. For example, in using methods to count *Cryptosporidium oocysts*, there may be a degree of uncertainty that the particles being counted are truly *Cryptosporidium oocysts*. Alternatively, while there may be confidence that the method for counting oocysts is accurate, further uncertainty exists about what the measurement means because it is not known if the oocysts are viable and infective.

There is value in being able to distinguish the relative impacts of variability and knowledge uncertainty. Variability cannot be reduced by measuring it more accurately. However, by better characterising variability, the nature of a hazard and thereby, the dimensions of the risk, can be better understood. Understanding the role of variability in contributing to uncertainty may lead to actions to change a system to reduce its variability, e.g. increase reservoir storage times to minimise fluctuations in water quality.

In contrast, knowledge uncertainty can be reduced by additional measurement and research. The increased understanding from reducing knowledge uncertainty can provide greater assurance that the preventive measures being considered will achieve their intended purpose. This requirement supports the need for a research capability within the water industry (see Appendix 1, Section 2.1.3 Research and Development).

Hazard identification and risk assessment need to explicitly consider the sources and types of uncertainty. By documenting the major sources of variability and knowledge

uncertainty that arise for all risks, insights can be gained into the appropriate actions for reducing the role of uncertainty.

Risk Prioritisation

Based on the assessment of risks, priorities for risk management and application of preventive strategies can be established and documented. Generally risk assessment will be at best semi-quantitative and will often include subjective judgements. The aim should be to at least distinguish between very high risks and low risk. Very high risks require implementation of preventive strategies whereas low risks might be tolerated.

Investigative studies and research monitoring can be used to provide further information to input into the risk assessment and priority setting process.

2.3. (Section 3.2, NHMRC) Critical Control Points

In addition to the placing of multiple barriers (discussed in Appendix 1, Section 2.4 Prevention Strategies) that reduce exposure to hazards, a crucial requirement is the selection/identification of the critical activities and processes which are essential for the control of water quality (i.e. Critical Control Points), and establishing the mechanisms to control these processes, including methods that will verify effective performance and which will trigger immediate corrective actions to operational processes where required.

A Critical Control Point (CCP) is defined as a point, step or procedure at which control can be applied and is **essential** to prevent or eliminate a hazard or reduce it to an acceptable level (*Codex Alimentarius*). In determining whether a step or process should be considered a CCP, a practical explanation is whether loss of control at that point will lead to an unacceptable health risk. If an activity or step can not be adequately controlled, it is more difficult to use it as a Critical Control Point.

In determining critical control points there are several characteristics of an ideal CCP (Tompkin 1992):

- operational parameters and criteria are specific, quantifiable and provide a yes/no response
- operational parameters and criteria are validated through research and technical literature
- the technology for controlling the CCP is readily available at reasonable cost
- monitoring of criteria is continuous and real time and the operation can be automatically adjusted to maintain control
- there is a favourable history of control
- the potential hazard is prevented or eliminated

It is recognised however that ideal CCPs are often not achievable and measurable parameters and clearly defined criteria may not be available. Thus parameters and criteria are sometimes more subjective, based on judgement and operational experience, e.g. compliance with procedures, inspection, auditing, etc. Also, in many cases it may not be possible to prevent a hazard but rather minimise it to an acceptable level (Tompkin 1992).

Major efforts in process control for a water supply system will be directed toward the activities selected as Critical Control Points. The appropriate selection of CCPs is an

important consideration as too many CCPs may make the system unwieldy and too few may not provide adequate assurance of drinking water quality and safety.

The selection of CCPs will be different for each water supply system depending on the nature of the system, the range of hazards, the number of barriers and the treatment processes used. Examples of potential CCPs which can be controlled effectively and which can prevent, eliminate or reduce a hazard to acceptable levels are listed in Box 3.3 and are briefly described below.

CCPs are not limited solely to the following examples and alternate treatment methods can make effective CCPs provided that appropriate operational criteria are developed (see Element 9.2 Validation of Processes). Additional CCPs and criteria may need to be defined as water systems adopt advanced technologies such as dissolved air flotation, activated carbon, membrane systems and alternative disinfection and treatment processes.

Operational parameters and criteria for CCPs, a monitoring system including corrective actions and verification procedures, record-keeping and documentation are discussed in subsequent steps of the framework.

Box 3.3 Potential Critical Control Points

CCPs will be different for each water supply system depending on the levels of barriers and the treatment processes used. Some common examples of potential Critical Control Points that can be used include:

1. Groundwater / Wellhead Protection
2. Selective Use of Water Sources
(Alternate Sources / Source Water Type)
3. Selective Withdrawal / Reservoir Drawoff
4. Coagulation, Flocculation and/or Sedimentation
5. Filtration
6. Disinfection
7. Protection of Distribution System

Groundwater / Wellhead Protection

In a groundwater supply, location, design, construction and maintenance of bores, and protection from localised contamination, undesirable surface water or shallow groundwater could be considered a CCP. The essential requirements are protection of the wellhead including sealing and casing of bores, and the local aquifer infiltration area from agricultural, industrial and septic discharges.

Monitoring can include regular inspections of protection areas, integrity of bore casings and seals and by testing groundwater for the ingress of faecal microorganisms.

Selective Use of Water Sources (Alternate Sources / Source Water Type)

Where this is available and feasible, a potential critical control point for surface water sources could be in the selection of source water. When water quality parameters vary (e.g. seasonal variations, after heavy rainfall, algal blooms, etc), an effective approach may involve changing the source of raw water.

Avoiding poor water quality by employing alternative sources (e.g. groundwater, alternate surface water or the use of available storage) can minimise the number of contaminants entering the treatment system.

Continuous monitoring of raw water quality parameters such as turbidity, pH, stream/river flow and climatic conditions could be used to indicate periods of poor raw water quality and trigger control by the selection of alternative source water.

Selective Withdrawal / Reservoir Drawoff

Reservoir drawoff can serve as an effective critical control point for a water supply system. Understanding water quality profiles and utilising multiple take-off points can assist in selecting good quality drinking water.

Specific operational criteria based on temperature, pH, turbidity and depth profiles of algal numbers can be developed but may rely more on operational experience and understanding of the reservoir and which is likely to be unique to the specific reservoir.

Coagulation / Flocculation and/or Sedimentation

Coagulation/flocculation and sedimentation (where used) are key activities in a water treatment plant. These processes are well-established and provide an effective means for the removal of particles including microorganisms. It is important that operations are optimised and controlled so that the subsequent barriers of filtration and disinfection are not overloaded and can achieve consistent and reliable performance.

Optimising coagulation and coagulant dose is dependent on a number of raw water conditions such as colour, the size, surface charge, shape and composition of particles, pH and alkalinity. The use of streaming current detectors is increasingly being used for optimising coagulant dosage. Effective flocculation depends on the temperature, mixing conditions and the rate of treatment. Key parameters in sedimentation are the surface loading rate and regular maintenance and cleaning of sedimentation basins. High effluent turbidities in water after sedimentation are usually indicative of poor performance.

Using turbidity or particle counts as indicators for the effectiveness of these steps can provide the desired control over these processes and provide an early indication of limitations in the system. Monitoring turbidity can be continuous and real time and operational criteria have been studied extensively and are well established in the scientific and technical literature.

Filtration

Filtration is becoming an increasingly important barrier for removal of contaminants particularly for viruses and pathogens that are more resistant to disinfection. Extensive research has been conducted on the effectiveness of filtration in eliminating or reducing potential hazards to an acceptable level. Filtration is conducive as a CCP because specific operational criteria have been developed and online continuous monitoring is possible to provide rapid response to poor performance.

For optimal performance of media based filtration, particular attention should be given to monitoring turbidity from each filter, appropriate handling of backwash water to avoid

recycling pathogens, minimising turbidity increases during filter start ups and operation of filters to avoid sudden flow surges.

Filtration should be monitored continuously and treated water of a constant quality should be produced irrespective of the quality of the raw water. The most established indicator of filtration performance is turbidity monitoring with operational criteria limits placed on upper levels and acceptable variations. Particle counters after each individual filter could also serve as an effective indicator providing the appropriate operational criteria are developed. Another key characteristic to be monitored is headloss on filters.

Disinfection

Disinfection of surface water supplies to prevent waterborne disease is an essential activity in the treatment process. Disinfection is capable of inactivating bacterial and viral pathogens and may have some effect against protozoa. The most common methods of disinfection are chlorination, ozonation, UV irradiation, chlorine dioxide addition, and chloramination.

Disinfection lends itself very effectively as a CCP. It is supported by extensive research and technical literature on effectiveness of various methods to eliminate potentially harmful microorganisms. In addition, the technology for process control including online continuous monitoring, feedback on dose control, alarm systems, automatic backup systems, etc. is readily available.

Effective disinfection is dependent on contact time, dose, pH, temperature and disinfectant demand. Assessment of disinfection should consider all four parameters; this is normally done by calculating Ct values (Ct = concentration or dose x time) to determine whether effective residual concentrations of disinfectant are achieved for adequate contact times to attain target levels of pathogen inactivation at specified temperatures and pH. (Tables of Ct values for inactivation of *Giardia* and viruses by free chlorine and other disinfectants have been published by the U.S. EPA).

Protection of Distribution System

Protection of the distribution system from any ingress of contamination is important in maintaining the quality of water leaving the treatment plant and ensuring a safe water supply to consumers. Although not an ideal CCP, control of activities in the distribution system is necessary to prevent any recontamination from occurring.

Integrity of construction, the use of approved materials, use of appropriate maintenance and repair procedures, and maintenance of backflow prevention should be monitored and adequately controlled including appropriate documentation. In addition, operational parameters that can be readily measured include disinfectant residual, thermotolerant coliforms (or *E. coli*) and hydrostatic pressure. For activities that require adherence to operational procedures, appropriate training of staff responsible for the distribution system, including contractors, is essential.

2.4. (Section 3, NHMRC) Prevention Strategies

Prevention is a critical component for effective drinking water quality management and it is far more efficient and effective for the protection of public health than reactive approaches based on compliance monitoring.

The comprehensive assessment of the drinking water supply system enables the identification of effective risk management strategies from catchment to consumer. When a situation that can give rise to a significant hazard has been identified, preventive strategies can be identified to prevent or control the hazard, thereby minimising its risk.

Preventive strategies are those actions and activities that are required to eliminate hazards or reduce their impact to acceptable levels. Preventive strategies should be comprehensive from catchment to the consumer and should be based on validated science and best practice management. Many preventive measures cover a broad spectrum and may control more than one hazard.

For each significant hazard/cause identified, the identification and planning of preventive strategies includes:

- evaluating the effectiveness of existing management strategies including the methods used to verify that these strategies are carried out properly
- evaluating alternate and additional management strategies considering factors such as level of risk, benefits, feasibility, costs, etc.
- identifying the critical activities and processes which are essential for preventing, eliminating or reducing the hazards to acceptable levels and at which control can be applied

Preventive strategies often require considerable expenditure and decisions about water quality improvements can not be taken in isolation from other aspects of water supply that compete for limited financial resources. Priorities will need to be established and many improvements will have to be phased in over a period of time. The degree of preventive action planned to control a hazard should be proportional to the associated risk (see Appendix 1, Section 2.2 Hazard Identification and Risk Assessment). Other considerations will include:

- effectiveness of the strategy
- potential benefits
- cost
- negative impacts on other stakeholders (particularly for catchment management)

If large reductions in risk can be achieved at low-moderate expenditure, then the case for implementation is strong. On the other hand, it may be difficult to justify high expenditure on strategies where the risk and the potential benefits are low.

In planning and selecting preventive strategies, it is important to consider community expectation and possibly the willingness of consumers to pay for water quality improvement.

Once strategies dealing with each significant risk have been identified, the strategies should be documented into a plan, e.g. a Risk Management Plan, Drinking Water Quality Management Plan or an Agenda for Improvement, etc. Long-term preventive strategies such as covering of water storages, introduction of filtration or alternative treatment, should be incorporated into the Total Quality Water Management System (TQWMS).

Where responsibility for improvement strategies lies outside the direct control of the water supplier (i.e. with external agencies), mechanisms for communication to ensure co-operation and development of action plans should be established.

2.4.1. (Section 3.1, NHMRC) Multiple Barriers

In assessing the effectiveness of existing management strategies from catchment to consumer and evaluating alternate and additional management strategies, it is essential

to consider the important principles of multiple barriers, prevention at source rather than downstream control, and the validation of suggested preventive strategies.

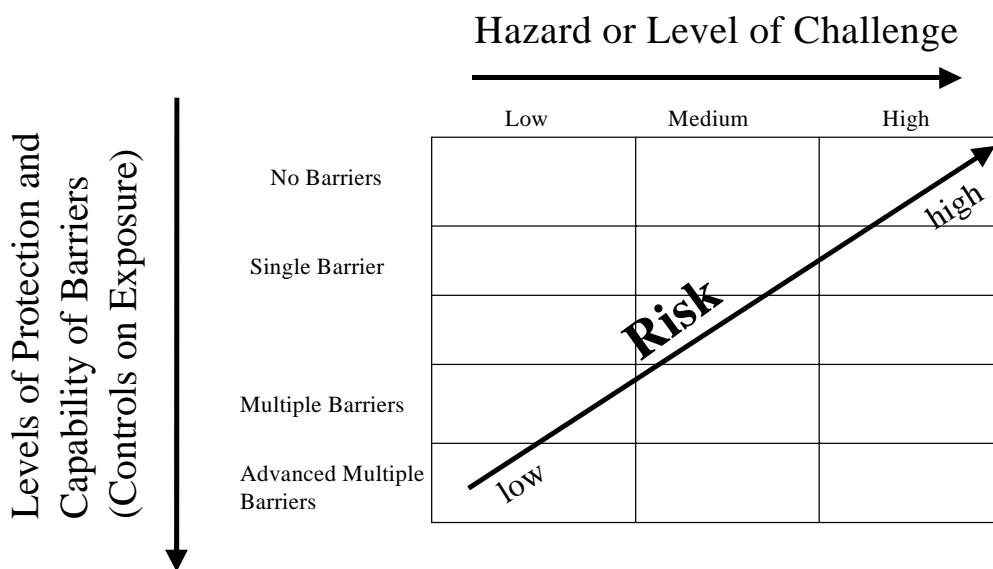
Application of multiple barriers to prevent contaminants from entering the water supply system and/or to control transmission through the system is universally recognised as a critical and fundamental tenet for effective drinking water quality management and for ensuring the supply of safe drinking water.

The strength of multiple barrier systems is that a failure of one barrier may be compensated for by effective operation of the remaining barriers; thus minimising the likelihood of contaminants passing through the entire treatment system and being present in sufficient amounts to cause harm to consumers.

The level of protection planned to control a hazard should be proportional to the associated risk and each barrier should provide an additional margin of safety. As Figure 3.1 (Hrudey 2001) demonstrates, the multiple barrier approach is one in which the overall risk of an incident occurring is significantly reduced by implementing and optimising several barriers throughout the entire water supply system from catchment to consumer.

Figure 3.1 Reduction of Risk Through Multiple Barriers

Ensuring the safety of a water supply entails a wide-ranging program of protection,



treatment and monitoring with barriers to the entry and transmission of contaminants (particularly microorganisms) throughout the system. Traditional barriers include:

- Catchment management and source water protection
- Detention in protected reservoirs/storages
- Extraction management
- Coagulation, flocculation, sedimentation and filtration
- Disinfection including an adequate disinfection residual
- Protection of the distribution system / reticulation maintenance

Water can be affected at each of these points but they are all interrelated and, therefore require integrated management. The security provided by the multiple barrier approach

is reliant on each individual barrier being maintained at all times with any failures or faults being rectified as soon as possible.

The level of protection and types of barriers required will be different for each water supply system. While there is some flexibility in choosing barriers, they often are dictated by the characteristics and quality of the raw water source (see Box 3.1).

Each of the barriers is discussed briefly below.

Box 3.1 **Selection of Multiple Barriers**

Large parts of Melbourne are supplied with high quality source water from a highly protected catchment. Melbourne Water focuses much of its attention and resources on maintaining prevention of contamination at the source. The series of barriers for the majority of the system include:

- protected forested catchments for harvesting of water with no human or livestock access
- large catchment reservoirs with long detention times
- additional retention time in seasonal storage systems
- disinfection of water prior to it entering the distribution system
- closed distribution systems

In contrast, Adelaide is supplied with surface water derived from multi-use catchments and the River Murray where there is limited control over activities with potential impacts on water quality. As a result, the barriers applied are heavily weighted towards water treatment and downstream control to remove turbidity and microorganisms. These include use of multiple reservoir storages, coagulation, flocculation, sedimentation, filtration, disinfection with long contact times before supply, provision of residual disinfectant through large parts of distribution systems and effective maintenance in the distribution system.

Catchment Management and Source Water Protection

Catchment management and source water protection provide the first barrier for the protection of water quality. Catchment management usually involves a co-ordinated approach to develop short-term and long-term plans to enhance water quality and eliminate or control any potential sources of pollution.

In addition to minimising risks from contamination, effective catchment management offers several additional advantages including reducing the degree of treatment required, the quantity of chemicals used in treatment, minimising costs of water treatment and reducing the creation of treatment byproducts.

Intelligent management of land use and water resources in catchments is essential to a safe water supply. The extent to which catchment pollution can be controlled or remediated, however, is often limited in practical terms wherever there are competing water uses and pressure for increased development in the catchment.

Whether water is drawn from surface catchments or underground sources, it is important that the characteristics of the local catchment or aquifer be understood and the activities that could lead to water pollution be identified and managed. Hazard identification and

risk assessment should include threats to both the quality and quantity of water (having regard to both point and diffuse sources of pollution) and future land use activities.

Surface and groundwater sources should be protected from contamination. Possible sources of contamination include:

- animal (livestock) waste from farming, feedlots, dairies
- human waste from urban development and septic tanks
- recreational activity on reservoirs
- agricultural and forestry use of fertilisers and pesticides
- industry
- mining and quarrying runoff
- disposal of hazardous wastes
- accidental spills

Any such activities, or others which may pollute, should be identified and controlled or where feasible excluded from the catchment. Clearing of vegetation should be carefully controlled as this can result in soil erosion and increased water salinity and turbidity.

Diffuse sources of pollution arising from agricultural and animal husbandry activities are more difficult to manage than point sources of pollution, but their effect on water quality can be minimised by the use of best agricultural practices such as fencing of streams, use of riparian zones and off-stream watering of stock. Co-operation with landowners and agricultural advisers in the development of joint land and water management programs is therefore essential.

For large river systems protection may be possible only over limited reaches in the vicinity of the raw water offtake or reservoir inlet.

Many Australian surface waters typically carry large amounts of particulate matter, mainly dispersive clays, and plant and algal debris. This presents a problem because:

- suspended matter is aesthetically undesirable
- micro-organisms readily attach themselves to particles, and can utilise adsorbed nutrients, thus enabling them to survive longer than unattached micro-organisms
- it can be a vehicle for the adsorption and transport of many pollutants, including some pesticides and heavy metals
- it can interfere with disinfection processes by exercising a high demand for the disinfectant and screening pathogenic microorganisms from disinfectant action

Water sources with high loadings of suspended solids usually require coagulation, sedimentation and filtration before disinfection. Turbidities of 1.0 Nephelometric Turbidity Unit (NTU) is the maximum acceptable concentration (MAC) at the time that the water enters the distribution system (ODWS-2000).

Groundwater in deep or confined aquifers usually is protected from local sources of contamination, microbiological quality tends to be high and chemical quality remains reasonably stable over long periods of time. Providing that chemical quality is suitable and the water is extracted through well constructed and maintained bores, it is usually safe for drinking without treatment. In longer reticulation systems, disinfection may be used to provide protection against contamination introduced during distribution.

However, groundwater supplies may contain high concentrations of naturally occurring elements with health or aesthetic impacts. Groundwater containing high salinity may be unpalatable while high levels of nitrates, arsenic, boron, fluoride and radionuclides may make water unfit for use. Anoxic groundwaters with high loadings of reduced iron and

manganese can be associated with dirty water and severe staining problems. Water with high levels of carbon dioxide or hydrogen sulphide is extremely corrosive and may require aeration and buffering.

While groundwater from depth is generally microbiologically safe and chemically stable, shallow or unconfined aquifers can be subject to contamination from discharges or seepages associated with agricultural practices (pathogens, nitrates and pesticides), septic tank discharges (pathogens and nitrates) and industrial wastes.

Where groundwater is at risk from pollution, the highest standards of protection are needed, from the wellhead out to the aquifer infiltration area. The prime objective should be prevention as most forms of groundwater pollution are difficult to reverse and remediation is often a lengthy and expensive exercise.

A water supplier should ensure that a comprehensive Catchment Management Plan (see Box 3.2) based on mitigating any existing and potential future risks is developed and implemented. This must include an emergency response plan for responding to major pollution events such as spillages or contamination. Where practical, catchment management plans should have elements that aim to enhance the quality of water harvested over time.

Catchment Management Plans should be developed in consultation with the community and relevant agencies such as planning authorities, catchment boards, environmental and water resource regulators, road authorities and emergency services. It may be useful or necessary to divide large catchments into smaller more manageable units, e.g. subcatchments. Where this is done, it is important to ensure that in combination, the various plans provide an integrated approach across the entire catchment.

Box 3.2 Management of Catchments and Aquifer Intake Areas**Catchment Management Plan**

A Catchment Management Plan should be developed and maintained. This should include, where appropriate, the following elements:

- 1) Preparation and review of land use planning controls jointly with the planning authority.
- 2) Establishment of agreed processes and criteria for managing development applications.
- 3) A clear statement of responsibilities of different agencies and agreed co-ordination processes.
- 4) A Catchment Management Policy to guide employees, the community and other agencies.
- 5) Identification of water quality hazards, estimation of risks and relevant management strategies.
- 6) A monitoring program to identify pollution sources, maintain quality control, provide support for on ground works, and collect long-term data to determine trends.
- 7) Regular inspections with documented results to monitor catchment conditions and land use changes.
- 8) Strategies for working with landowners to establish good relationships, optimise water quality and maintain their viability.
- 9) A community awareness program to support the Catchment Management Plan.
- 10) Agreed and tested emergency response plans for a range of incidents with the relevant emergency services.

Best Practices

Planning regulations should prohibit high risk development in catchments and/or aquifer intake areas (e.g. intensive animal feedlots). Planning policy should set the protection of water quality as an explicit objective of local legislation with formal referral of development applications that may create a water quality risk to the drinking water supplier. Policy also should address the issue of long-term incremental development (see also Box 1.2).

Urban development, agraindustry and general industry should be scrutinised carefully to ensure that they will not impact on water resources. On site wastewater disposal systems should be permitted only where the applicant has satisfied the relevant authorities that the site is suitable and the process sustainable with minimal risk to the water supply. Disposal systems should be designed, installed and maintained correctly, and inspected regularly. Defects should be reported and rectified.

Where appropriate, formal agreements should be required to ensure approval conditions are complied with and recorded on land titles to alert potential purchasers of the obligations associated with the property. Streams should be fenced off to prevent stock access and buffer strips provided to minimise nutrient runoff. Off stream watering points should be provided for stock.

Community Awareness

Landowners can be encouraged to protect stream banks and provide buffer strips through community awareness programs and by subsidising tree planting and fencing works. Management of point sources such as dairy effluent and stockyard runoff is essential and requires Co-operation of local landowners as well as close collaboration with agricultural agencies. Demonstration projects that aim to show the benefits of collecting and using this material are useful. Support for local landcare groups is a low cost opportunity to develop community awareness and reduce pollution risks.

Detention in Protected Reservoirs/Storages

Storage of water in protected reservoirs can improve water quality by reducing numbers of faecal microorganisms through settling and inactivation including solar (UV) disinfection. Most pathogenic microorganisms of faecal origin do not survive indefinitely in the environment. Substantial die-off of enteric bacteria will occur if water can be stored for at least 3 to 4 weeks before being used for drinking water supplies. Enteric viruses and protozoa will survive for longer periods (weeks – months).

In addition to die-off, storages also allow suspended material in the raw water to settle. As well as improving clarity, this also can reduce the numbers of enteric microorganisms. A combination of die-off and settling during long storage (1-6 months) can provide over 2 log removal of *E. coli*, *Giardia* and viruses and 1-2 log removal of *Cryptosporidium*. Improved water clarity makes subsequent disinfection more effective and efficient while reducing the formation of disinfection byproducts.

Removal of suspended solids and microorganisms is dependent on hydrological and limnological characteristics and can be reduced substantially by short-circuiting of the storage. Hydraulic residence times and potential for short-circuiting need to be determined.

Storages also can provide a buffer against the impacts of short-term peaks of turbidity and contamination associated with events such as heavy rainfall. In some cases it may be possible to avoid transferring water from rivers and streams when water quality is poor (e.g. immediately following heavy rainfall).

Reservoirs should be managed to minimise deterioration related to stratification and growth of algae. Cyanobacteria are generally most problematic for producing taste and odour problems and for producing dangerous toxins. Reservoir mixing is often essential to prevent cyanobacteria from gaining a competitive advantage leading to cyanobacterial blooms.

Unless storages are protected from public access, there is an increased risk that the supply may become contaminated. For example, faecal material from human waste can be washed into the storage and pass quickly into the distribution system, bypassing or short-circuiting the normal protective detention time of the storage. Other problems such as malicious or accidental contamination of storages with toxic material, and vandalism of plant and equipment, occasionally have been reported where public access is uncontrolled.

Extraction Management

The withdrawal of water at an extraction point may be from a bore, lake, reservoir or river. Careful design and management of the extraction process, avoiding poor quality water, can greatly minimise risk and prevent potential problems in subsequent treatment processes.

Where there are a number of water sources available there may be flexibility to enable the best quality of water to be selected for treatment and supply. In reservoirs and lakes, contaminants such as algal blooms can concentrate in layers or pockets associated with temperature gradients. Extraction Management through the use of multiple take-off points can provide protection against localised contamination either horizontally or vertically through the water column.

Coagulation, Flocculation, Sedimentation and Filtration

Coagulation, flocculation, sedimentation and media-based filtration are key steps in conventional water treatment and provide removal of particles including bacteria, viruses and protozoa. The degree of removal depends on optimal operation, avoidance of flow surges and turbidity spikes and monitoring of each of the processes. Water of a constant quality should be produced irrespective of the quality of raw water. These processes can be expected to achieve at least a 2 log reduction of viruses, Giardia and Cryptosporidium. For microorganisms that are highly resistant to disinfection (e.g. Cryptosporidium), filtration may be the final barrier to their transmission.

Treatment may range from simple direct sand filtration to the standard practice of coagulation with a flocculant (such as alum, iron compounds, polyelectrolytes, and other organic flocculants), followed by sedimentation and filtration through graded sand or a combination of anthracite and sand.

In contrast to conventional media-based processes, membrane filtration (micro-, ultra- or nano-) provides a direct physical barrier and generally achieves a greater removal of microorganisms. However, this level of removal may not be required and this type of treatment is relatively expensive.

Treatment plants should be operated by trained and skilled personnel. Failure of water treatment processes should be regarded as representing a potential failure to remove microbial contaminants.

Disinfection

Disinfection of drinking water to prevent waterborne disease has been practiced for most of this century and remains the single most important activity in system management for providing a safe supply, particularly from surface water sources.

A range of processes is available for disinfection including ozone, ultraviolet irradiation and chlorine dioxide; however chlorination and chloramination are the most common. These methods are very effective in killing bacteria, can be reasonably effective in inactivating viruses (depending on type) and Giardia. Cryptosporidium is not inactivated by the concentrations of chlorine and chloramines that can be safely used in drinking water while the effectiveness of ozone and chlorine dioxide is limited. However, results indicate that UV light might be effective in inactivating infectivity of Cryptosporidium.

An adequate disinfectant residual should also be maintained throughout the distribution system to provide protection against the ingress of contamination through faults in the system. A persistent residual (such as that provided by chloramination) in remote sections of the supply will guard against recontamination and prevent colonisation. Chloramination has proved successful in eliminating Naegleria fowleri from water and sediments in long pipelines.

Maintaining a residual throughout reticulation systems will optimise disinfection and limit regrowth problems and is recommended, but in practice this may be extremely difficult to achieve at all points of a hydraulically complex system. In addition, while maintaining microbiological control is the highest priority, there is also a need to consider the issue of minimising the production of disinfection byproducts.

Alternative Treatment Options

Alternative processes such as dissolved air flotation, activated carbon, membrane filtration, ozone/BAC, combined oxidants, etc. may provide effective barriers. The need for, and utility of, such processes should be assessed on a case-by-case basis. Pilot scale evaluation should be pursued before committing to full scale implementation of these newer alternative technologies.

Protection of the Distribution System / Reticulation Maintenance

The structural integrity and cleanliness of reticulation systems must be maintained in order to minimise any decline in water quality after treatment and to prevent external contamination. This can be influenced by:

- plumbing regulations
- construction specifications
- maintenance practices

Water distribution systems should be fully enclosed to prevent ingress of contamination. This also will assist in maintaining a disinfectant residual. Storages and tanks should be securely roofed with external drainage. Backflow prevention policies should be applied and monitored and there should be effective procedures to repair faults and burst mains in a manner that will prevent ingress of contamination. Adequate positive pressure should be maintained throughout the distribution system. Appropriate security needs to be put in place to prevent unauthorised access and/or interference with water storages.

Corrosion of pipes can affect both public health and the aesthetic quality of water, and will increase the cost of providing safe water. Cadmium and lead, both potentially toxic metals, occur in tap water almost entirely as a result of leaching caused by corrosion. The following metals, if present, can also be the product of corrosion:

- copper (causing blue stains on fixtures and metallic taste)
- iron (causing red-brown stains on fixtures and metallic taste)
- zinc (causing metallic taste)

Corrosion in the distribution system can support and/or promote the development of biofilms which can protect bacteria and other microorganisms from disinfection as well as providing an environment for growth. Non-pathogenic coliforms can grow in biofilms. In addition, biofilms can cause aesthetic problems including off-tastes, odours and staining. Growths of microorganisms can also cause additional corrosion.

Proper training of maintenance workers, including contractors, responsible for the distribution system is essential because of the potential for contamination during repairs and recommissioning.

An indication of removals of enteric pathogens using the multiple barrier approach is provided in Table 3.1. Further examples of management strategies and preventive measures are outlined in Table 3.2.

Table 3.1 Estimated Removals of Enteric Pathogens using the Multiple Barrier Approach

Enteric Organisms	Estimated Reduction in numbers of enteric pathogens				Estimated Overall Removal**
	Watershed Protection	Reservoir Detention	Filtration	Disinfection*	
<i>Bacteria</i>	0.5 – 1 log	~ 1 log per 10 days storage. Retention for over 60 days will provide almost complete removal.	0.5 – 1 log	Complete inactivation can be achieved by a range of disinfectants including chlorine, chloramines, UV providing sufficient doses and contact times are provided.	Complete removal achievable.
<i>Giardia</i>	0.5 – 1 log	1.5 - 2.5 log Long-term detention (1-6 months)	Conventional 2.5 log Direct 2 log Membrane > 4 log	Chlorine 1 - 2 log Ozone and chlorine dioxide 2 log	Removal of 5.5 - 8 log achievable.
<i>Cryptosporidium</i>	0.5 – 1 log	1 – 2 log Long-term detention (1-6 months).	Conventional 2 log DAFF 2 log Membrane > 4 log	Ozone 0.5 – 2 log Chlorine dioxide 0.5 - 1 log UV light 3 log Chlorine and chloramines ineffective.	Removal of 3.5 - 7 log removal achievable.
<i>Viruses</i>	Complete removal of human enteric viruses if human waste excluded.	1 - 2 log Long-term detention (1-6 months).	Conventional 2 log Direct 1 log Membrane (depending on pore size) > 4 log	Chlorine, UV light, ozone and chlorine dioxide 3 log	Removal of 5 log achievable

* log reductions based on standard doses and minimum contact times of 30 minutes

** using standard technology (catchment control, detention, conventional filtration, chlorination)

Table 3.2 Examples of Preventive Strategies – Catchment to Consumer

<u>Source Water</u>	<u>Water Extraction and Storage Systems</u>	<u>Water Treatment System</u>
<ul style="list-style-type: none"> • Use of an appropriate source water 	<ul style="list-style-type: none"> • Control of water extraction • Alternate selection of water source • Use of available water storage for periods of heavy rainfall • Appropriate location and protection of intake • Proper well construction including casing, sealing and wellhead security • Proper location of wells in aquifer • Water storage systems to maximise detention times • Infiltration wells • Enclosed water storages • Prevention of unauthorised access • Destratification of water storage • Diversion of stormwater downstream from intake • Roofed storages and reservoirs with appropriate stormwater collection and drainage • Securing tanks from access by animals • System maintenance • reservoir cleaning/scouring • pipeline flushing • fittings maintenance 	<ul style="list-style-type: none"> • Coagulation/flocculation and sedimentation • Alternative treatment • Use of approved water treatment chemicals and materials • Control of water treatment chemicals • Regular assessment of hazards and risks • Use of skilled and trained operators • Process controllability of equipment • Availability of backup systems • Water treatment process optimisation including chemical dosing • filter backwashing • flow rate • minor infrastructure modifications • Use of tank storage in periods of poor quality raw water
<p><u>Catchments</u></p> <ul style="list-style-type: none"> • Ownership and control of catchment area • Registration of chemicals used in catchments • Control of human activities within catchment boundaries • Control of wastewater effluents • Involvement in land use planning procedures • Participation of community and landowners within the catchment area • Regular inspections of catchment areas • Protection of waterways (fencing out livestock, buffer zones, riparian zones) • Runoff interception • Use of planning regulations to regulate potential water polluting developments 	<p><u>Monitoring</u></p> <ul style="list-style-type: none"> • Quality assurance and validation procedures for sampling and testing • Calibration and maintenance of equipment • Appropriate monitoring strategies for periods of heavy rainfall and high winds 	<p><u>Consumers</u></p> <ul style="list-style-type: none"> • Information dissemination: • drinking water quality • plumbing and appliances • best practice agricultural methods • backflow prevention • point of use devices
<p><u>Distribution Systems</u></p> <ul style="list-style-type: none"> • Regular maintenance of equipment • Availability of backup systems (power supply) • Maintaining an adequate disinfectant residual • Cross connection and backflow prevention devices implemented • Fully enclosed distribution system and storages • Secondary disinfection • Appropriate repair procedures including subsequent disinfection of water mains • Maintaining adequate system pressure 		

2.5. (Section 6, NHMRC) Risk Management

Considered and controlled responses to incidents or emergencies that can compromise the safety of water quality are essential for protecting public health, as well as maintaining customer confidence and company reputation. While preventive strategies including redundant equipment and facilities are intended to prevent incidents and emergency situations from occurring, some events can not be anticipated or controlled, or have such a low probability that providing backup systems would be too costly. For these incidents, there must be an adaptive capability to respond to the unforeseen circumstances in a constructive and efficient manner.

Wherever possible, emergency scenarios should be identified and incident and emergency protocols, including communication and notification procedures, should be planned and documented. It is vital that protocols are developed prior to the occurrence of any incident or emergency to enable efficient, effective and rapid responses which will minimise the impacts on the community. Establishing procedures “on the run” is a recipe for disaster and the potential loss of public confidence.

Actions and protocols should be developed in consultation with relevant regulatory agencies and other stakeholders. In an emergency situation there will not be time to establish confidence and good will if these have not been established during normal operation. An investment in advance for building trust and understanding with parties who will be partners in responding to an emergency will pay important benefits for more effective action when an emergency arises.

Incident and emergency response protocols must be communicated to all relevant personnel and copies of documented procedures should be available to all personnel.

2.5.1. (Section 6.2, NHMRC) Incident and Emergency Response Protocols

A water supplier should regard incident and emergency response as a priority and commit the necessary resources to developing emergency response plans. The development of an appropriate incident and emergency response plan involves a review of the hazards and events that can lead to emergency situations. These include events such as:

- non-compliance with regulatory criteria
- accidents which increase levels of contaminants (e.g. spills in catchment, incorrect dosing of chemicals)
- equipment breakdown and mechanical failure
- prolonged power outages
- extreme weather events (e.g. flash flooding, cyclones, etc)
- natural disasters (e.g. fire, earthquakes, lightning damage to electrical equipment, etc)
- human actions (e.g. serious error, sabotage, strikes, etc)

Potential incidents and emergencies should be defined and incident and emergency response plans should be developed and documented in advance to respond to these events. Plans should involve consultation with relevant regulatory agencies and stakeholders and should be consistent with existing government emergency response arrangements. Key areas to be addressed in incident and emergency response plans include clearly specified:

- response actions including increased monitoring;
- responsibilities and authorities internal and external to the organisation;
- plans for emergency water supplies;
- communication protocols and strategy including notification procedures (internal, regulatory body, media and public); and
- mechanisms for increased health surveillance.

Training in emergency response is important to ensure that employees have the skills and knowledge to manage effectively any potential incidents and/or emergencies. Incident and emergency response plans, particularly communication protocols, should be reviewed regularly and practised to improve preparedness. Furthermore, testing the effectiveness of incident and emergency response allows the necessary modifications to be made to make the plan more effective and efficient before an emergency occurs.

Following any incident and/or emergency situation, an investigation of the incident and/or emergency should be undertaken and a debriefing with all involved staff should be conducted to discuss performance and address any issues or concerns. The investigation should consider factors such as:

- what was the initiating cause of the problem?
- how was the problem first identified or recognised?
- what were the most critical actions required?
- what communication problems arose and how were they dealt with?
- what were the immediate and longer-term consequences?
- how well did the protocol function?

Appropriate documentation and reporting of the incident and/or emergency should also be established. The organisation should learn as much as possible from the incident to improve preparedness and planning for future incidents. Review of the incident may indicate necessary amendments to existing protocols.

Community consultation and communication is essential for restoring consumer confidence and water supplier credibility after an incident and/or emergency situation. All employees should be kept informed during any incident as they provide informal points of contact for the community. Notifications advising the end of an incident/emergency and information regarding the cause on the incident and the actions taken to minimise future occurrences are necessary activities for allaying community concerns. Interviews and surveys of a representative portion of the community are also valuable for establishing consumer perceptions..

Box 6.1 provides an example of an emergency response protocol.

Box 6.1 Water Incident Communication and Notification Protocol

In South Australia a protocol has been established between the Department of Human Services (Health), SA Water, the EPA and the Department of Water Resources to ensure effective communication between government agencies in the event of incidents associated with reticulated water supplies. The protocol also includes notification to other relevant bodies such as catchment water management boards and local authorities.

Incidents are classified as:

- Type 1 –potentially serious with either human health or environmental risks, or
- Type 2 – lesser incidents representing a low risk to human health or possible low impact and localised environmental harm.

The protocol includes agreed criteria for both raw water (cyanobacterial blooms, high numbers of *Cryptosporidium*, unacceptable concentrations of health related chemicals, detection of pesticides, etc.) and treated drinking water (high turbidity in filtered water; chlorinator failure; detection of high concentrations of health related chemicals, pesticides, *Cryptosporidium*, *Naegleria fowleri*, persistent *E.coli* coliform bacteria, etc).

The protocol defines the role of a Water Incident Coordinator placed in the Department of Human Services and specifies which Minister/agency will take the lead in dealing with and communicating incidents (incidents with health concerns are led by Department of Human Services, those with environmental concerns led by the EPA and those with operational concerns by SA Water).

Reporting requirements for individual agencies are defined as well as communication requirements and protocols for the agencies, the Water Incident Coordinator, offices of the Ministers and the lead Minister.

The testing agency (SA Water for drinking water) is required to report all Type 1 incidents immediately to the Water Incident Coordinator and provide confirmation in writing within 24 hrs by email or fax. The Coordinator ensures that all appropriate agencies have been notified and that relevant Ministers are notified by their agencies as soon as possible and in any event within 24 hrs.

Type 2 incidents are normally only notified to relevant agencies and generally do not require ministerial advice.

The protocol includes a list of 24 hour contacts for all agencies. Copies of the protocol are provided to all emergency contacts and relevant officers. The protocol is updated and reissued every 6 months.

2.5.2. (Section 6.1, NHMRC) Incident and Emergency Response Communication

Effective communication is critical to managing incidents and emergencies. Clearly defined protocols for both internal and external communications should be established in advance with involvement of relevant agencies including health and regulatory agencies. These protocols should include a contact list of key people, agencies and businesses, detailed notification forms and procedures for internal and external notification, and a reporting and decision making structure both within and outside the organisation (definition of responsibilities and authorities). These contact lists should be updated regularly (e.g. 6-monthly) to ensure that they are accurate.

Maintaining customer confidence and trust during and after an incident or emergency is essential and this largely can be affected by how a water supplier responds to such events. A public and media communication strategy should be given careful consideration in advance of any incident or emergency situation occurring. Draft public and media notifications should be prepared in advance with care taken to ensure that any written statements are clear, accurate, easily understood and formatted for the target audience. An appropriately trained and authoritative contact should be designated to handle all communications in the event of an incident or emergency.

2.6. (Section 4, NHMRC) Standard Operating Procedures

The effectiveness of preventive management strategies is highly dependent upon the design and implementation of associated process control programs. To consistently achieve a high quality water supply it is essential to have effective control over the processes and activities that govern drinking water quality and safety. This is particularly important for those activities that have been defined as Critical Control Points (see Appendix 1, Section 2.4 Prevention Strategies).

Operations must be optimised and controlled on a continuous basis as even short periods of suboptimal performance can represent a serious risk to public health (see Box 4.1). Therefore, continuous performance and ensuring that barriers are capable **at all times** are a critical requirement for the provision of a safe drinking water supply.

A process control program supports the preventive strategies by detailing the specific operational factors that will ensure that all processes and activities are carried out effectively and efficiently. This includes a description of all preventive strategies and their functions together with:

- 6) Establishment and documentation of effective operational procedures.
- 7) Use and maintenance of suitable equipment.
- 8) Use of approved materials and chemicals in contact with drinking water.
- 9) Establishment of a monitoring protocol for operational performance including selection of operational parameters and criteria and the routine review of data.
- 10) Establishment of preventive and corrective actions to control excursions in operational parameters.

Two additional requirements for effective process control are the skills and training of operations staff and the documentation of all procedures. Operators should be proficient and have the ability to interpret water treatment and water quality changes and to respond appropriately in accord with established procedures (see Part 2, Section 3.4 Technical Skills).

All components of a process control program should be documented with controlled copies readily accessible to all appropriate personnel. Documentation should include:

- description of all preventive strategies and their purpose
- operational procedures for all activities
- resource requirements
- responsibilities and authorities
- schedules and timelines
- data and records management requirements
- maintenance procedures

- operational parameters and criteria
- operational monitoring protocols and procedures for review of data
- preventive and corrective actions to be implemented
- internal and external communication and reporting requirements

Documentation should be collated into an operations manual. This manual can take several forms with examples including Operations Guidelines, an Operations and Maintenance Manual, a Water Quality Control Program, Process Control Program, etc. One option could be to organise the manual into programs dealing with the various elements of the water supply system. Drinking water quality management programs will vary with each water supply system but could, for example, include the following:

- Catchment Management Program for the protection and management of the catchment and source waters
- Intake/Reservoir Management Program for the protection and management of storage reservoirs, dams, borefields and/or river intakes
- Treatment Plant Operations Program for the operation and management of treatments plants
- Service Reservoir and Distribution System Program for the operation and management of service reservoirs and the protection and management of distribution systems
- Maintenance Program for the regular inspection and maintenance of the water supply from catchment to consumer.

2.6.1. Operational Procedures

Managing a water supply system to continuously deliver safe drinking water is dependent on attention to detail of operational procedures. Operational procedures formalise the activities that are essential to ensure consistent water quality. All activities and processes should be described in detail including functions and performance requirements for each component from catchment to consumer. Defined procedures are required for the operation of all of the processes and activities (both ongoing and periodic) and will necessarily incorporate control measures, verification procedures and maintenance requirements.

Operational procedures are particularly important for those measures established as Critical Control Points.

Appropriate training and adherence to documented operational procedures are important considerations in maintaining controlled operations. Procedures are most effective when operations staff are involved in their development, documentation and verification. This participation will help ensure that all relevant activities are included, and will enhance operator training and awareness in addition to creating commitment to operational and process control.

Operational procedures documentation should be visible and readily available to employees. As a suggestion, documents should be assembled in a manner that will enable any required modifications to be made more easily. Having the Operations Manual reside on computers, rather than in binders, can create significant efficiencies.

Box 4.1 Examples of Outbreaks Resulting from Suboptimal Performance**Walkerton Outbreak (Canada, 2000)**

Over 2000 cases of illness reported including 26 cases of haemolytic uremic syndrome and 6 deaths. Public health investigations confirmed that the most severe illnesses were caused by *E.coli* 0157 and *Campylobacter* strains that matched strains found in cattle on farms in the vicinity of two of the bores serving the community. Contamination of the shallow groundwater supply following heavy rains and localised flooding appears to have come from cattle waste. A large number of faults have been proposed as potential contributing factors to the outbreak including:

- reliance on bores subject to direct influence of surface runoff with only chlorination for treatment;
- operation and monitoring on the assumption that the bores were secure, deep groundwater sources;
- inadequate protection of surface catchments near the water supply bores;
- deficient chlorination practice;
- inadequate regulatory oversight;
- unreliable chlorine residual monitoring;
- failure to respond to detection of contamination and to communicate results to regulatory authorities; and
- inadequate operator training and corporate commitment.

A judicial inquiry into the outbreak and its implications for the safety of drinking water elsewhere in Ontario will be ongoing throughout 2001 (www.walkertoninquiry.com).

Milwaukee Outbreak (USA, 1993)

Assessments indicate that over 400,000 illnesses were caused including 4,400 hospitalised. Premature deaths of at least 69 immunocompromised persons (most HIV positive) were recorded. The source of the contamination was not identified but it is considered that increased flows in rivers supplying Lake Michigan could have carried oocysts from livestock wastes or human sewage. Turbidity of the water taken from the Lake deteriorated in the weeks preceding the outbreak.

Operation of one of the treatment plants supplying Milwaukee was not under optimal control. Although coagulant doses were adjusted this did not prevent turbidity fluctuations in filtered water produced at one filtration plant (0.1 - 2.7 NTU). Inexperience with the use of polyaluminium chloride, which had been a recent introduction, could have been a contributing factor. In addition monitors intended to optimise coagulant doses during changes in water quality were not being used due to improper installation and filtered water turbidimeters were not being used. Turbidity measurements were being taken every 8 hours.

Recycling of backwash water through the filtration process could also have had an impact on the numbers of oocysts passing through the plant. Other water treatment deficiencies associated with outbreaks of cryptosporidiosis have included:

- failure to respond to deterioration in source water quality;
- poor coagulation;
- poor monitoring of chemical dosing;
- inadequate flocculation; and
- filters brought on-line without backwashing.

2.6.2. Equipment Capability

The capability of equipment is an important consideration in maintaining process control. Where treatment processes exist, a water supplier should ensure that the equipment and infrastructure associated with flocculation, sedimentation, filtration and/or disinfection, etc are adequately designed and provide the necessary capacity (size, volume, detention times) to handle peak flow rates and not limit performance. Unit processes should not be hydraulically overloaded or subjected to rapid changes in hydraulic loading as these conditions compromise their effectiveness.

Equipment and infrastructure also must be capable of providing process flexibility and controllability. Requirements include:

- the availability and use of online measuring devices which monitor operational parameters continuously;
- automation where possible to rapidly respond to any changes in water quality;
- instrumentation with 24 hour monitored alarms to indicate when critical limits have been exceeded;
- backup equipment if failure of processes occurs and backup generators in the event of a power failure;
- the capability to control various plant flow rates including filtration rates and backwash rates;
- the capability to control the addition of chemicals at various dosages and application points, and feed the various types of chemicals required;
- effective mixing facilities;
- adequate inlet and outlet configurations and placement; and
- appropriate filter media (or membrane porosity) and adequate surface wash/backwash capability.

When performance limiting factors are design related, major capital improvements are not always warranted and in many cases with minor modifications and improved process control, many of the limitations can be corrected. References for evaluating the state of existing equipment and operation are provided in Further Reading. Design of new equipment and processes should undergo validation through appropriate research and development (see Part 1, Section 7 Process Capability and Appendix 1, Section 2.4 Prevention Strategies).

The use and maintenance of suitable monitoring equipment are also important aspects to providing accurate process control information. Such equipment needs to be sufficiently accurate and sensitive enough to perform at the levels required. For example, turbidimeters need to be accurate within the required operating range, i.e. if filtered water turbidities are to be between 0.1 and 0.5 NTU, the turbidity meter should accurately measure values within this range to be able to quickly detect changes in turbidity. Control of monitoring equipment, including its regular calibration and maintenance, must be performed to ensure that data collected is representative and accurate. Operations personnel should understand how monitoring equipment works so that causes of spurious results can be recognised and rectified.

Monitoring equipment must be capable of detecting loss of control of processes. It is desirable wherever possible that monitoring be online and continuous and alarms be provided to indicate when operational criteria have been exceeded. Additionally, failure

of monitoring equipment should not compromise the system. Particularly at CCPs, a system should be in place to detect failure and provide backup of monitoring equipment.

All equipment, including measuring and monitoring equipment, requires suitable calibration and maintenance to ensure continuing process capability. Procedures and records for calibration and maintenance of equipment should be established and documented.

2.6.3. Materials and Chemicals

Materials and chemicals used in water treatment have the potential to affect drinking water quality. The choice and use of water treatment chemicals and the materials that come into contact with water are important process control considerations.

Examples of chemicals that are purposely added to water for specific operational processes include disinfection and oxidation chemicals, coagulants and flocculants, softening chemicals, neutralisation and scale prevention chemicals, algicides, antioxidants, fluoridation chemicals, etc. Other contaminants may occur indirectly when water comes into contact with materials such as filter media, protective coatings, linings and liners, joining and sealing materials, pipes and fittings, valves, meters, etc.

Only appropriate chemicals and materials should be used in water treatment. Materials should comply with the NSF Standard for potable water. Water treatment chemicals and materials should be evaluated for potential contamination. General considerations include data on impurities, chemical and physical properties, maximum dosages, behaviour in water, migration and concentration buildup from materials used, etc. References for material and chemical use are provided in Further reading.

The products used in water systems should be subjected to a system of continuous quality control. Chemical suppliers should be evaluated and selected based on their ability to supply product in accordance with required specifications. Documented procedures for control of chemicals include the purchasing, verification, handling, storage and maintenance of chemicals should be established to assure their quality at the point of application. Responsibilities for testing and quality assurance of chemicals (supplier, purchaser or both) should be clearly defined in the purchase contracts.

2.6.4. Operational Monitoring

Operational monitoring includes the planned sequence of measurements and observations to assess and verify the performance of preventive strategies. Although compliance requirements may be included, e.g. turbidity of filtered water, the general intent of operational monitoring is different from compliance monitoring. Effective operational monitoring is critical for confirming that the barriers for controlling hazards are functioning properly and effectively. Data from operational monitoring are used as triggers for immediate short-term preventive and corrective actions to operational processes to improve drinking water quality.

Operational monitoring of water quality should be considered for all aspects of the water supply system from catchment to consumer and can include both measurement and observation. Observational monitoring may include, for example, the regular inspections of the catchment for integrity of fences, inspections of plant equipment, inspection of wellhead protection areas/bore construction, etc. Measurement monitoring involves the use of suitable operational parameters to ensure that operational processes are

functioning effectively. Monitoring generally should be concentrated at Critical Control Points where control can be applied to immediately mitigate any potential hazards that arise.

Key elements of operational monitoring are:

1. Development of Operational Monitoring Plans from catchment to consumer detailing strategies and procedures.
2. Identification of the operational parameters and criteria that will be used to control processes and, where necessary, trigger immediate short-term preventive and corrective actions.
3. Review and interpretation of results to evaluate the need for preventive and corrective actions.

Operational Monitoring Plan

An operational monitoring plan should be developed and documented to monitor control of CCPs and other preventive strategies from catchment to consumer by scheduled measurement or observation. An operational monitoring plan details the strategies and procedures to follow and considers:

- operational parameters to be monitored
- sampling location and frequency
- sampling methods and equipment
- establishing schedules for systematic, non-random sampling
- requirements for checking and interpreting results
- clearly defined responsibilities and use of qualified staff
- documentation and records management including how monitoring results are recorded and stored
- reporting and communication requirements

The use and maintenance of suitable equipment, including its regular calibration and maintenance, are equally important aspects to providing accurate and representative data.

Operational Parameters and Criteria

Parameters should be selected to reflect operational effectiveness and to indicate failure of barriers and/or provide an indication of potential contamination. Where possible, parameters that can be used to predict ultimate output quality should be chosen so that there is lead time for action if necessary.

Operational monitoring should focus on those parameters that can be readily measured and responded to rapidly. Online and continuous monitoring of operational parameters should be pursued or developed wherever possible to provide an immediate indication of performance. At Critical Control Points (see Element 3 Planning – Preventive Strategies for Drinking Water Quality Management), continuous monitoring is considered necessary and is recommended to allow rapid response to problems. For example, where filtration is used, continuous monitoring of turbidity from each individual filter and from the product water outlet of the plant in addition to disinfectant residual are considered important to ensuring the effectiveness of treatment. For operational parameters that are deemed less critical or for parameters that are more stable, grab samples may be used.

Examples of some parameters that can be used for operational monitoring from catchment to consumer are listed in Table 4.1.

Table 4.1 Examples of Operational Parameters

Operational Parameter	Treatment Step/Process/Critical Control Point					
	Raw Water	Coagulation	Sedimentation	Filtration	Disinfection	Distribution System
pH	✓	✓	✓		✓	✓
Turbidity (or Particle Count)	✓	✓	✓	✓	✓	✓
Temperature	✓		✓		✓	✓
Dissolved Oxygen	✓					
Stream/river Flow	✓					
Rainfall	✓					
Thermotolerant Coliforms	✓				✓	✓
Total Coliforms	✓				✓	✓
Heterotrophic Bacterial Count					✓	✓
Colour	✓					
Conductivity (TDS)	✓					
Alkalinity	✓	✓	✓			
Organic Carbon	✓		✓			
Algae	✓					
Chemical Dosage		✓			✓	
Flow Rate		✓	✓	✓	✓	
Net Charge		✓				
Streaming Current Value		✓				
Headloss				✓		
Ct					✓	
Disinfectant Residual					✓	✓
Disinfection Byproducts					✓	✓
Pressure						✓

Once parameters that will control performance of operational processes have been identified, target criteria (performance goals) should be established for each preventive

measure. Target criteria can be quantitative (numerical) or qualitative (descriptive). Any deviation of operational performance from established targets should result in appropriate actions taken to remediate potential problems.

For operational monitoring of Critical Control Points, critical limits also must be defined which ensure the CCP is under control (see Box 4.2). A critical limit is defined as a prescribed tolerance that must be met to ensure that a CCP effectively controls a potential health hazard. When critical limits have been exceeded or deviated from, a potential health hazard may exist or could develop and should automatically result in a corrective action being instituted to resume control of the process.

Critical limits should not be confused with target criteria. Targets are something that a water supplier attempts to meet whereas critical limits are not. Critical limits on CCPs represent absolute boundaries for safety. They are set so that when exceeded or deviated from they represent an out-of-control hazard. Ideally critical limits are numerical limits set in terms of maxima, minima or ranges; however, where numerical data is not available, critical limits may be more subjective and rely on the appropriate skills and experience of operations staff.

Validation of critical limits is necessary (see Appendix 1, Section 2.1.3). Various resources can provide information on critical limits. Literature, collaborative research findings, local experimental data, historical data and findings, etc should be used to define critical limits. Critical limits are individual and site-specific and will depend on raw water sources and water quality variations, management strategies, treatment processes used and distribution system complexity. Critical limits for some CCPs have been defined by numerical values prescribed in various drinking water guidelines and standards (e.g. filtered water turbidity criteria, disinfection Ct values, numbers of thermotolerant coliforms in drinking water, etc). For other CCPs however system-specific experimental data may need to be collected before the critical limit can be defined.

Adoption of stringent targets (performance goals) will focus staff on optimum plant performance and also will reduce the chances of exceeding critical limits and numerical guideline values. Standard practice is to use turbidity goals lower than required limits. For example, to ensure that an upper limit of 0.5 NTU is achieved in filtered water, a water treatment plant could be operated to produce filtered water at 0.3 NTU.

Results Analysis

Operational monitoring results must be documented appropriately and results reviewed and interpreted frequently to verify operational performance. Results analysis should confirm that records are complete and accurate and that critical limits have not been exceeded. Results indicating loss of process control should result in appropriate corrective actions and process adjustments being instituted to maintain quality. Those responsible for interpreting and recording operational results should clearly understand how they should be assessed.

A system of regular reporting of results to relevant staff and departments also should be implemented. Graph or trend charts can be used to enhance the interpretation of operational monitoring results. Comparison of current results with past trends may be valuable in identifying any site-specific patterns associated with poor performance.

Box 4.2	Special Considerations for Monitoring at Critical Control Points
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Operational monitoring at CCPs requires special attention to several factors. Some of the key considerations are:

- 1) Identification of appropriate parameters that will be used to control operational processes. Parameters should focus on those that can be readily measured and responded to rapidly, e.g. temperature, pH, turbidity, particle count, disinfectant residual, flow and pressure.
- 2) Defining critical limits which represent boundaries for safety. Critical limits should be validated.
- 3) Sampling points must be representative of the water being sampled.
- 4) Frequency of sampling must be adequate. Online and continuous monitoring of key parameters (e.g. turbidity, disinfectant residual) should be used wherever possible.
- 5) Use of appropriate equipment and ensuring that equipment is well maintained and calibrated.
- 6) A well-designed monitoring program to monitor the critical limits and ongoing review of monitoring results.
- 7) Appropriate preventive and corrective actions documented for when parameters have deviated from critical limits. Ideally, 24 hour monitored alarms should be provided to indicate when critical limits have been exceeded.
- 8) Use of skilled and qualified staff to monitor parameters and make appropriate adjustments to operational processes. The use of automation where possible can ensure rapid responses.
- 9) Documentation of all elements of operational procedures including operational monitoring, responsibilities and authorities, schedules and timelines, recording and interpretation of results, corrective actions taken, etc.

2.6.5. Operational Preventive and Corrective Action

Preventive and corrective action includes planning of appropriate procedures in advance for immediate preventive and corrective action to reestablish process control when operational monitoring indicates that target criteria or critical limits have not been met for a particular operational activity or CCP. These operating procedures should be documented and include instructions on required adjustments and process control changes and should clearly define responsibilities and authorities including communication and notification requirements.

Procedures (protocols) should include the range of actions to be taken in response to exceedance of criteria. Where appropriate these actions may include resampling, additional monitoring and/or checking other operational monitoring. Where required, a preventive or corrective action should be implemented to reestablish process control and then verified to ensure its effectiveness. The effect of the preventive or corrective action, and what adjustments or action may be needed further along in the supply system, also should be considered. Incident and emergency responses should be prepared in the event that normal preventive and corrective actions can not reestablish operational performance in an appropriate time to prevent unacceptable drinking water quality from reaching consumers.

Although it is not possible to anticipate and document procedures for every possible event, it is suggested that planning be undertaken for the types of events that can be identified. For other events, systems incorporating rapid communication should be

developed. Some typical examples of corrective actions for which operational procedures should be documented include:

- selection of alternate raw water source if available;
- altering plant flow rate (e.g. reduce loading);
- jar testing for coagulant control and optimisation;
- altering mixing intensity;
- instituting additional sampling;
- changing treatment chemicals;
- use auxiliary chemicals such as coagulant aids, flocculant aids, filtration aids;
- adjusting pH;
- varying chemical feed rates and feed points;
- adjusting filtration loading rate and/or operation;
- increasing disinfectant dose;
- secondary/booster disinfection;
- mains flushing and localised disinfection; and
- notification of the health authority and provision of details of the problem and remedial action taken.

Where possible, the underlying cause of the problem should be identified and measures implemented to prevent future occurrences. An analysis of the causes may define some solutions such as modifying an operating procedure, treatment plant adjustments, training, etc. Finally, details of the incident should be recorded and reported (internal and external as necessary).

2.7. (Section 5, NHMRC) Verification of Drinking Water Quality

Verification involves monitoring the quality of drinking water supplied to consumers to determine compliance with established criteria and requirements. Monitoring can incorporate testing of drinking water quality (system performance monitoring) as well as assessment of consumer satisfaction.

In addition to providing essential information on the ultimate quality of water being supplied to consumers, verification also serves as a useful indication of problems within the water supply system (particularly the distribution system) and the necessity for any immediate short-term corrective actions and/or incident and emergency response.

2.7.1. Drinking Water Quality Monitoring

Drinking water quality monitoring is a wide-ranging assessment of the quality of water in the distribution system and as supplied to the consumer. It includes the regular testing performed for assessing conformance with guideline levels and compliance with regulatory criteria and/or agreed levels of service. The 2000 ODWS is the definitive reference in Ontario on standard values for water quality parameters.

Monitoring of drinking water quality constitutes the final check that the barriers and preventive measures implemented are working effectively (see Box 5.1). Demonstrating compliance will provide regulators and consumers with confidence about the safety of the water.

Drinking water quality monitoring differs from operational monitoring not only in purpose but also in terms of the water quality characteristics to be measured, sampling locations

and frequency of sampling. As it is neither physically nor economically feasible to test for all drinking water quality parameters on an equal and frequent basis, monitoring effort and resources should be planned carefully and directed at significant or key characteristics and monitored with appropriate frequency.

Please see the following tables in the ODWS-2000 to get a comprehensive list of parameters to be monitored, frequency of monitoring, and the required reporting schedule:

- Table 5 - Sampling
- Table A – Microbiological Organisms
- Table B – Volatile Organics
- Table C – Inorganics
- Table D – Pesticides and PCB's

Frequent exceedance of such parameters (e.g. taste and odour) is likely to be indicative of problems that may require further investigation to determine their health significance.

Box 5.1 Limitations of Drinking Water Quality Monitoring

Monitoring of drinking water quality does not guarantee the safety of water supplies. Rather, it should be regarded as a check that the barriers and preventive measures which protect public health are implemented and working effectively. Monitoring for drinking water quality should never be used as a replacement for any of the barriers or as a reason for removing them.

Reliance on monitoring of drinking water for the protection of public health has important limitations that should be recognised. Firstly, monitoring is limited in scope. There exists a wide range of parameters that could be monitored; however it is neither technically feasible nor economically desirable to monitor for every possible parameter. Monitoring is also irregular and infrequent and only represents single points in time (i.e., only a very small proportion of water is sampled). It is quite possible that contamination can occur between sampling events and can go missed by the monitoring program.

Additionally, reliance on monitoring of treated water assumes that the numerical guideline values are, by themselves, a sufficient measure of drinking water quality. In reality, there remain substantial limitations in our knowledge of the relationship between those parameters and public health outcomes. Furthermore, it is not an effective response to contamination of drinking water by any known or unknown contaminant that does not have a prescribed guideline value (e.g. *Cryptosporidium*).

The most significant limitation of drinking water quality monitoring, however, is that corrective actions are initiated only after monitoring reveals that guideline values have been exceeded. Therefore this type of monitoring promotes a reactive rather than preventive approach.

Where sampling is performed depends on the water quality characteristic being sampled. For characteristics where the concentration does not change greatly within the distribution system, sampling the water at the treatment plant may be sufficient. For characteristics that vary in concentration during distribution, however, sampling throughout the distribution system including the point of supply to the consumer should be undertaken. It should be noted that the behaviour of some parameters (e.g. DBPs, chlorine residual, microbial quality) during distribution may vary from one system to another and is likely to require system-specific investigation.

Drinking water quality monitoring procedures should be developed and documented for the regular testing of water in the distribution system and as supplied to the consumer. Monitoring data should be representative, reliable and fully validated (see Box 5.2). Careful consideration should be given to the water quality characteristics to be analysed, sampling locations, frequency, analytical tests and methods, recording and maintenance of results, as well as evaluation and reporting of results. Guidance on developing drinking water quality monitoring is provided in the 2000 ODWS.

Box 5.2 *Reliability of Data*

As monitoring is only as good as the data collected, every effort should be made to ensure that data collected are representative, reliable and fully validated. Appropriate procedures should be in place and the following need to be considered:

Sampling Plan:

- parameters measured, sampling locations, sampling frequency
- qualifications and training of personnel
- approved sampling methods and techniques
- quality assurance and validation procedures for sampling
- statistical validity

Analytical Testing:

- qualifications and training of personnel
- suitable equipment
- approved test methods and laboratories
- quality assurance and validation procedures, e.g. positive and negative control samples, interlaboratory comparisons
- Laboratory to be accredited by the Standards Control Council for analysis of ODWS parameters

Monitoring Equipment:

- calibration and inspection procedures to ensure control of monitoring equipment

2.7.2. Short-term Evaluation of Results

Drinking water quality performance evaluation entails the daily reviewing of compliance monitoring to assess the day-to-day management of the drinking supply. It is an important element for verifying that the quality of water supplied to consumers is in compliance with relevant requirements.

Monitoring results should be reviewed within appropriate time frames, and compared with previous results and drinking water quality criteria. Procedures for performance evaluation and how results should be recorded and interpreted should be established and documented. Responsibilities and reporting mechanisms should be identified. Compliance criteria should be established and communicated so that those responsible for interpreting and recording results clearly understand how they should be assessed and if required, how and where results should be communicated. In some cases this could involve reporting to health/water quality regulators.

2.7.3. Corrective Action

Corrective action includes the documentation and training of staff in appropriate procedures, including clearly defined responsibilities and authorities, in advance for immediate corrective action when monitoring of drinking water quality indicates non-compliance or provides early warning of potential problems.

If the short-term evaluation of drinking water quality performance indicates that compliance requirements have been violated, an investigation should be initiated and, if

necessary, a corrective action implemented. Corrective actions should be implemented as quickly as possible. Failure to do so or failure of the action may lead to the development of a more serious situation, that depending on the issue, could require incident and emergency response protocols to be instituted. Implementation of corrective action could also be required in response to consumer feedback.

Corrective actions for non-compliance should be developed in consultation with relevant regulatory authorities and other stakeholders. Examples of corrective actions in response to non-compliance include:

- disinfection of tanks
- flushing and maintenance of the distribution system
- temporarily shutting down the plant if adequate storage is available
- increased or booster/secondary disinfection
- enhanced filtration
- investigative/sanitary surveys of distribution systems

Significant system failures which pose a health risk or which adversely affect water quality for an extended period should be immediately reported to the relevant health authority (see Appendix 1, Section 2.5 Risk Management).

2.8. (Section 10, NHMRC) Documentation and Reporting

Appropriate documentation provides the foundation for the establishment and maintenance of effective drinking water quality management systems. Documentation should:

- demonstrate that a systematic approach is established and is implemented effectively
- develop and protect the organisation's knowledge base
- provide an accountability mechanism and tool
- facilitate review and audits by providing written evidence of the system
- establish due diligence and credibility

Documentation also provides a basis for effective communication within the organisation as well as with the community and various stakeholders. A system of regular reporting, both internal and external, is important to ensure that the relevant people receive information needed to make informed decisions about the management or regulation of drinking water quality.

2.8.1. Documentation and Records Management

Appropriate documentation is required for all aspects of drinking water quality management. Documents should describe how procedures are performed and should include detailed information on process control. A water supplier should ensure that all relevant documentation is read, understood and adhered to by employees.

The documented system should include process documentation including specific operational procedures and criteria, monitoring procedures and forms, corrective actions, etc as well as preventive strategies and information related to CCPs, incident and emergency response plans, details of training programs, procedures for evaluating results and reporting, communication protocols, and the drinking water quality policy.

Operation of systems and processes necessarily leads to the generation of data that needs to be recorded. Efficient record keeping is an essential tool for indicating and

forewarning of potential problems and providing evidence that the system is implemented effectively.

Activities that generate records include operational and drinking water quality monitoring, preventive and corrective actions, incident and emergency response, training, research and development, drinking water quality performance evaluations, assessment of the water supply system (flow diagrams, potential hazards, etc), community consultation, audits and reviews.

Documentation and records systems should be kept as simple and focused as possible. It should be ensured that a system is in place to control all documents and records. Mechanisms should be established to periodically review and where necessary revise documents to reflect changing circumstances. Documents need to be controlled to ensure current versions are in use and obsolete documents are discarded.

Records of all activities pertaining to the performance of drinking water quality management should be stored so that they can be easily accessed and reviewed and are protected against damage, deterioration or loss. A system must be in place to assure that employees are properly trained to fill out records and that records are regularly reviewed by a supervisor, signed and dated.

Documents and records can be stored in a variety of forms, e.g. written documents, electronic files and databases, video and audiotapes, visual specifications (flow charts, posters, etc). Computer based documentation should be considered to allow for faster and easier access as well as to facilitate updating and keeping information current.

2.8.2. Reporting

Reporting includes both the internal and external reporting of the organisational activities pertinent to the implementation and performance of drinking water quality management. Internal reporting is to enable effective decision making at the various levels of the organisation including operations staff and management, senior management, Board of Directors, etc. Internal reporting is also required to communicate information on decisions to employees throughout the organisation.

A water supplier should define internal reporting requirements and establish an internal reporting system for communication between the various levels and functions of the organisation. Documented procedures (including definition of responsibilities and authorities) should be established for periodic operational reporting (daily, weekly, monthly, etc). These should include summaries of monitoring data, performance assessment and significant operational problems for the period. Results from audit and management reviews should also be communicated to those within the organisation responsible for performance.

External reporting ensures that drinking water quality management is open and transparent and includes reporting to regulatory bodies, consumers and other stakeholders in accordance with requirements.

The regulator should be notified of spills in catchments, interruptions to supply, process failures, failure to meet agreed levels of service, detection of significant contaminant concentrations, the persistent presence of microbiological indicators, etc. The health authority can then ensure that any health concerns are reported to the community. Protocols for public notification and issuing health advisories should be developed jointly between the health authority and water supplier.

Annual reports should be produced for consumers, regulatory authorities and stakeholders that summarise drinking water quality performance over the preceding year against numerical guideline values and/or agreed levels of service, and identify water quality trends and problems. Reports should also provide a summary of system failures and the action taken to resolve them. Reporting publicly on a water supplier's performance ensures a high level of transparency and public accountability.

The annual report should specify to whom the water supplier reports and is accountable, statutory or legislative requirements, and minimum reporting requirements. It should also include the statement that monitoring has been carried out in accordance with the ODWS, standards set by the regulator and/or to the requirements outlined in agreed levels of service. Annual reports also provide a mechanism for feedback and encourage consumers and stakeholders to provide comment. The reports should contain sufficient information to enable individuals or groups to make informed judgements about the quality of drinking water and contribute to the priorities that will be given to improving drinking water quality.

2.9. (Section 11, NHMRC) Evaluation and Audit

The evaluation and audit of drinking water quality (long-term) and management by a water supplier is required to ensure that preventive strategies are accurate, effective and implemented appropriately. A review of long-term drinking water quality data and management procedures provides assurance that the planned objectives of drinking water quality and safety are being achieved, and also identifies opportunities for improving operational processes and overall drinking water quality performance.

2.9.1. Long-term Evaluation of Results

Operational and water quality monitoring data can not provide insight into performance unless it is systematically reviewed. Consumer confidence in performance will also depend on being able to provide assurance that performance data are reviewed on a regular basis and improvements planned in response to problems identified.

The long-term evaluation of results is intended to use the results of a planned monitoring program to assess water quality data collected over an extended period of time (typically the preceding 12 months). There will inevitably be occasions when operational criteria or numerical guideline values are exceeded; however each incident must be assessed and dealt with immediately on a case-by-case basis.

Assessing the performance of a water supply system from the source to the consumer over an adequate period of time enables assessment of general performance against the numerical guideline values and agreed levels of service, to identify emerging problems and trends, and to determine what priority will be given to improving drinking water quality.

Operational and drinking water quality data collected over time should be collated to allow observation and trending of data. In addition to an effective monitoring program, performance evaluation of the water supply system from catchment to consumer requires a statistical evaluation of results. Graphs and trend charts using a “control chart” format are useful tools to enhance the interpretation of results.

Appropriate procedures should be established for the evaluation of operational and water quality monitoring results to assess performance over time. Mechanisms for

evaluation should be documented and responsibilities, accountabilities and reporting requirements defined.

Evaluation of results should be reported internally to senior management, and externally to consumers and regulatory authorities in accordance with requirements (see Appendix 2.8.2 Reporting).

2.9.2. Drinking Water Quality Management Audit

Auditing is the systematic evaluation to determine if activities are performing well and producing the required outcomes. It also includes an assessment of whether the management system is suitable to achieve planned objectives, and that it is being implemented effectively. Auditing provides valuable information on those aspects of the system that are effective as well as identifying opportunities for improvement of the management system, its implementation and resulting drinking water quality performance.

Periodic internal and external auditing of all aspects of the drinking water quality management system is required to confirm the performance of a water supplier with respect to its implementation, i.e. that the management system is accurate, that it is being implemented properly, and that its performance is effective. Auditing is necessary to ensure that errors or systematic poor operational practices are revealed.

A water supplier should establish and document procedures for internal audits of the management of drinking water quality. This involves a review of the system, plans, operational procedures, monitoring programs, and the records generated to ensure that the system is being correctly implemented and is effective at achieving the desired objectives. Internal audits identify areas for improvement and facilitate external audits.

The frequency and schedule of audits, as well as the responsibilities and requirements associated with conducting audits and communication of audit results should be defined. The audit and review process can take place over time but it should be comprehensive.

Drinking water agencies should also seek to establish and formalise external auditing mechanisms and procedures for their management of drinking water quality. In addition to demonstrating the commitment to the highest standards possible, external auditing by independent agencies is necessary for establishing credibility and maintaining customer confidence.

External audits may include evaluation of the entire system or specific aspects of drinking water quality management, e.g. operational audits, management system audits, performance audits, compliance of drinking water quality monitoring, effectiveness of incident and emergency response, etc. External auditing could be achieved by peer-review or be undertaken by an approved independent third party.

Audit results should be appropriately documented and communicated to management and personnel responsible for the department or function being audited. Results of audits should also be presented as part of senior management review.

3. FURTHER READING/REFERENCES

Anon 1999. Getting It Together: Integrated Management Systems. *Waste Management and Environment*. 10(5): 19-20.

Agriculture and Resource Management Council of Australia and New Zealand/Australian and New Zealand Environment and Conservation Council. 1994. *National Water Quality Management Strategy: Water Quality Management - An Outline of Policies*. Available at: www.affa.gov.au/docs/nrm/water/water_reform/nwqms/publist.html

Agriculture and Resource Management Council of Australia and New Zealand/Australian and New Zealand Environment and Conservation Council. 1994. *National Water Quality Management Strategy: Policies and Principles – A Reference Document*.

Agriculture and Resource Management Council of Australia and New Zealand/Australian and New Zealand Environment and Conservation Council. 1995. *National Water Quality Management Strategy: Guidelines for Groundwater Protection in Australia*.

Agriculture and Resource Management Council of Australia and New Zealand/Australian and New Zealand Environment and Conservation Council. 1998. *National Water Quality Management Strategy: Implementation Guidelines*. Available at: www.affa.gov.au/docs/nrm/water/water_reform/nwqms/publist.html

Allen M.J, Clancy J.L, Rice E.W. 2000. The Plain Hard Truth About Pathogen Monitoring. *Journal of the American Water Works Association*. 92(9): 64-76.

American Water Works Association. 1999. *Water Quality and Treatment : A Handbook of Community Water Supplies*. 5th Ed. ed. R.D. Letterman. McGraw-Hill.

American Water Works Association Research Foundation/International Water Supply Association. 1998. *Treatment Process Selection for Particle Removal*. ed. J. Brock McEwen. AWWARF/IWSA.

AS/NZS 3931:1998. *Risk Analysis of Technological Systems – Application Guide*. Standards Australia/Standards New Zealand.

AS/NZS 4360:1999. *Risk Management*. Standards Australia/ Standards New Zealand.

AS/NZS 4581:1999. *Management System Integration – Guidance to Business, Government and Community Organizations*. Standards Australia/Standards New Zealand.

AS/NZS 8402:1994. *Quality Management and Quality Assurance – Vocabulary*. Standards Australia/Standards New Zealand.

AS/NZS ISO 9000.2:1998. *Quality Management and Quality Assurance Standards. Part 2: Generic Guidelines for the Application of ISO 9001, ISO 9002 and ISO 9003.* Standards Australia/Standards New Zealand.

AS/NZS ISO 9001:1994. *Quality Systems: Model for Quality Assurance in Design, Development, Production, Installation and Servicing.* Standards Australia/Standards New Zealand.

AS/NZS ISO 9001(Int):2000. *Quality Management Systems – Requirements.* Standards Australia/Standards New Zealand.

AS/NZS ISO 9002:1994. *Quality Systems – Model for Quality Assurance in Production, Installation and Servicing.* Standards Australia/Standards New Zealand.

AS/NZS ISO 9004(Int):2000. *Quality Management Systems – Guidelines for Performance Improvement.* Standards Australia/Standards New Zealand.

AS/NZS ISO 10013:1996. *Guidelines for Developing Quality Manuals.* Standards Australia/Standards New Zealand.

AS/NZS ISO 14001:1996. *Environmental Management Systems – Specification with Guidance for Use.* Standards Australia/Standards New Zealand.

AS/NZS ISO 14004:1996. *Environmental Management Systems – General Guidelines on Principles, Systems and Supporting Techniques.* Standards Australia/Standards New Zealand.

Australian Water and Wastewater Association. 1999. *Catchment Management Workshop Proceedings.* Adelaide.

Bannister R, O'Connor N, Stivers C. 2000. Managing Water Quality Risks from Catchment to Tap. *Water.* March/April: 46-50.

Clancy J.L. 2000. Sydney's 1998 Water Quality Crisis. *Journal of the American Water Works Association.* 92(3): 55-66.

Clancy J.L. 2001. Lessons from the 1998 Sydney Water Crisis. *Water.* 28(1): 33-36.

Clancy J, Hargy T, Marshall M, Dyksen J. 1998. UV Light Inactivation of *Cryptosporidium* Oocysts. *Journal of the American Water Works Association.* September: 92-102

Cleasby J.L, Dharmarajah A.H, Sindt G.L, Baumann E.R. 1989. *Design and Operation Guidelines for Optimization of the High-Rate Filtration Process: Plant Survey Results.* American Water Works Association Research Foundation/American Water Works Association.

Cleasby J.L, Sindt G.L, Watson D.A, Baumann E.R. 1992. *Design and Operation Guidelines for Optimization of the High-Rate Filtration Process: Plant Demonstration Studies.* American Water Works Association Research Foundation/American Water Works Association.

Cleasby J.L., Williamson M.M, Baumann E.R. 1963. Effect of Filtration Rate Changes on Quality. *Journal of the American Water Works Association*. 55(7): 869-878

Codex Alimentarius Commission (CAC). 1997. Hazard Analysis and Critical Control Point (HACCP) Systems and Guidelines for Its Application. Annex to CAC/RCP 1-1969, Rev 3. Available at: ftp://ftp.fao.org/codex/standard/fh_basic.pdf

Cohen Y.K. 1999. Water Quality Program Defines Operations. *Opflow*. 25(10): 1,4-5. American Water Works Association.

Colwell M, Mosse P.R.L. 2000. Optimisation of Filter Function Using Particle Counting. *Water* . November/December: 33-35.

Consumers Health Forum of Australia Inc. *Government Consultation with Consumer Groups – Common Pitfalls and Oversights*.

Cornwell D.A, Lee R.G. 1993. *Recycle Stream Effects on Water Treatment* . American Water Works Association Research Foundation/American Water Works Association.

Cromwell J, Owen D, Dysken J, Means E. 1997. *Managerial Assessment of Water Quality and System Reliability*. American Water Works Association Research Foundation / American Water Works Association.

Davison A, Deere D. 1999. Safety on Tap. *Microbiology Australia* May: 28-31

Deere D, Davison A. 1998. Safe Drinking Water: Are Food Guidelines the Answer. *Water*. November/December: 21-24.

Deere D, Davison A. 1999. Assuring Water Quality. *Water* 21 July/August: 8-9.

DeNileon G.P. 2000. Certification Ensures System Integrity, Process Control. *Opflow*. 26(3): 7,8,14.

Department of Land and Water Conservation, New South Wales. 1999. *The Management of Giardia and Cryptosporidium in Town Water Supplies: Protocols for Local Government Councils*

Dickinson G. 1997. *HACCP (Hazard Analysis Critical Control Point): A Food Safety Plan*. Royal Melbourne Institute of Technology, Department of Applied and Environmental Sciences.

EnHealth Council 2000. *Environmental Health Risk Assessment*. Public Consultation Draft. Available at: www.health.gov.au/pubhlth/strateg/envhlth/risk/risk_draft.pdf

Fairley C.K, Sinclair M.I, Rizak S. 1999. Monitoring Drinking Water: The Receding Zero. *Medical Journal of Australia*. 171: 397-398.

Fairley C.K, Sinclair M.I, Rizak S. 1999. Monitoring Not the Answer to Cryptosporidium in Water. *The Lancet*. 354(9183): 967-969.

Government of British Columbia. Drinking Water Protection Plan – A Discussion Document. Available at: www.env.gov.bc.ca/wat/wq/dw/

Government of Western Australia. 2000. *State Water Quality Management Strategy*. Available at: www.wrc.wa.gov.au/protect/SWQMS_final.pdf

Fairley C.K, Sinclair M.I, Rizak S. 1999. Monitoring Drinking Water: The Receding Zero. *Medical Journal of Australia*. 171: 397-398.

Fairley C.K, Sinclair M.I, Rizak S. 1999. Monitoring Not the Answer to Cryptosporidium in Water. *The Lancet*. 354(9183): 967-969.

Government of British Columbia. Drinking Water Protection Plan – A Discussion Document. Available at: www.env.gov.bc.ca/wat/wq/dw/

Government of Western Australia. 2000. *State Water Quality Management Strategy*. Available at: www.wrc.wa.gov.au/protect/SWQMS_final.pdf

Gray R, Morain M. 2000. HACCP Application to Brisbane Water. *Water*. January/February: 41-42.

Havelaar A.H. 1994. Application of HACCP to Drinking Water. *Food Control*. 5(3): 145-152.

HB 90.5-2000. *Correlation Between ISO 9001:2000 and the HACCP Principles*. Standards Australia.

Health and Welfare Canada. 1993. *Water Treatment Principles and Applications: A Manual for the Production of Drinking Water*. (Guidelines for Canadian Drinking Water Quality).

Hellard M.E, Sinclair M.I, Forbes A.B, Fairley C.K. In Press. A Randomized Blinded Controlled Trial Investigating The Gastrointestinal Health Effects Of Drinking Water Quality. *Environmental Health Perspectives*.

Hill M, Deere D, Hansen G. 2000. Excellence Through Continuous Improvement: Connectaflow. *Water*. January/February: 43-44.

Hrudey S.E. 2001. Drinking Water Quality: A Risk Management Approach. *Water*. 28(1): 29-32.

Hudson H.E, Singley J.E. 1974. Jar Testing and Utilization of Jar Testing Data. In *Upgrading Existing Water Treatment Plant*. American Water Works Association Seminar Proceedings. AWWA.

Jay J.M. 2000. The Haccp System And Food Safety. In *Modern Food Microbiology* 6th Ed. Chapter 21: 407-422. Aspen Publishers.

Jordan C.G. 1998. Water Quality Reports Boost Consumer Confidence. *Journal Of The American Water Works Association*. 90(1): 40-43.

Mackenzie W.R. Et Al. 1994. A Massive Outbreak In Milwaukee Of Cryptosporidium Infection Transmitted Through The Public Water Supply. *New England Journal Of Medicine*. 331(3): 161-167.

Maywald S. 1989. *Consulting with your Community: A Guide to Effective and Equitable Community Consultation Techniques for Local Government and Associated Organisations*. Local Government Community Services Association.

Murray B.A. 1995. Particle Counting in Water Treatment. *Water*. 22(2).

Nadebaum P.R, Adlem L.M, Baker A.J, Chapman M.R, Rizak S. 2000. Improved Management of Drinking Water Quality. *Water*. July/August: 12-16

Nadebaum P, Chapman M, Baker A. Rizak, S. 2001. Application of HACCP to Drinking Water Supply Systems. Paper presented at the Annual Conference of the Australian Water Association, Canberra 1-5 April.

National Advisory Committee on Microbiological Criteria for Foods. 1992. *Hazard Analysis and Critical Control Point System*. NACMCF. Washington DC:

National Advisory Committee on Microbiological Criteria for Foods. 1997. *Hazard Analysis and Critical Control Point Principles and Application Guidelines*. Washington DC.

National Health and Medical Research Council/Agriculture and Resource Management Council of Australia and New Zealand. 1996. *Australian Drinking Water Guidelines*. NHMRC/ARMCANZ. Available at:

www.nhmrc.health.gov.au/publicat/synopses/eh19syn.htm

National Water Quality Management Strategy. Information available at:

www.affa.gov.au/docs/nrm/water/water_reform/nwgms/nwgms_toc.html

Nestel G, et al. 1997. *Guidance for Self- Assessment and Peer Review for the AWWA QualServe Program*. American Water Works Association Research Foundation/ American Water Works Association.

New Zealand Ministry of Health. 2000. Draft Model Public Health Risk Management Plans for Drinking Water Supplies. Available at:

www.moh.govt.nz/moh.nsf/wpg_Index/Publications-Index

New Zealand Ministry of Health. 2000. *Drinking Water Standards for New Zealand 2000*. Available at: www.moh.govt.nz/moh.nsf/wpg_Index/Publications-Index

New Zealand Ministry of Health. 1995. *Guidelines for Drinking-Water Quality Management for New Zealand*.

Partnership for Safe Water Program. American Water Works Association. Information available at: www.awwa.org/partner/partner1.htm and www.epa.gov/oqwdw000/psw/psw.html

Pearson T.R. 2000. Embracing Total Quality Management. *Journal of the American Water Works Association*. 92(1): 52-53.

Peterson T. 2000. Process Optimization and the O&M Manual. *Opflow*. June: 17-19.

Pizzi N. 1996. Optimizing Your Plant's Filter Performance. *Opflow*. 22(5): 1,4,5.

Renner R.C, Hegg B.A. 1997. *Self-Assessment Guide for Surface Water Treatment Plant Optimization*. American Water Works Association Research Foundation/American Water Works Association.

Renner R.C, Hegg B.A, Bender J.H, Bissonette E.M. 1993. Composite Correction Program Optimizes Performance at Water Plants. *Journal of the American Water Works Association*. June: 67-74.

Responsible Care report. Available at: www.ccpa.ca/english/

SAA/SNZ HB78:1998. *Correlation Between AS/NZS ISO 9002:1994 and the HACCP Principles*. Standards Australia/Standards New Zealand.

Source Water Protection. Further references available at

www.awwa.org/unitdocs/referenc.htm#ground and www.epa.gov/safewater/protect.html

South Australian Health and Social Welfare Councils. 1991. *Consultation Principles and Consultation Protocol*.

Taylor M.E.U. 2000. Drinking-Water Management in New Zealand. *Water*. 27(6): 36-40.

Tompkin R.B. 1992. Corrective Action Procedures for Deviations from the Critical Control Point Critical Limits. In *HACCP – Principles and Applications*, eds. M.D. Pierson and D.A. Corlett, Jr: 72-82. Chapman & Hall.

Truss Jr. C.L. 2000. The Future of Operator Training. *Journal of the American Water Works Association*. 92(1): 80-81.

Trussell R.R. 1999. Safeguarding Distribution System Integrity. *Journal of the American Water Works Association*. January: 46-54.

United States Environmental Protection Authority. 1989. *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources*. U.S. EPA. Washington DC.

United States Environmental Protection Authority. 1999. *Protecting Sources of Drinking Water: Selected Case Studies in Watershed Management*. U.S. EPA. Washington DC. Available at: www.epa.gov/safewater

United States Environmental Protection Authority. Source Water Assessment Program. Information available at: www.epa.gov/safewater/protect/swap.html

United States Environmental Protection Authority. 1999. *Guidance Manual for Conducting Sanitary Surveys of Public Water Supply Systems; Surface Water and Groundwater Under the Direct Influence (GWUDI)*. Available at

www.epa.gov/safewater/mdbp/pdf/sansurv/sansurv.pdf

United States Environmental Protection Authority. 1999. Alternative Disinfectants and Oxidants Guidance Manual. Available at:

www.epa.gov/safewater/mdbp/pdf/alter/cover_al.pdf

Walkerton, Canada Outbreak available at: www.walkertoninquiry.com

Water Services Association of Australia (WSAA). 1995. Environmental Management Guidelines for the Australian Water Industry.

Whately R. *Community Communication Programs – A Seven Step Guide*. Major Urban Water Authorities of Australia.

World Health Organisation. 1993. *Guidelines for Drinking-Water Quality*. WHO.

World Health Organisation. 1997. HACCP – Introducing the Hazard Analysis and Critical Control Point System (WHO/FSF/FOS/97.2). Available at:

www.who.int/fsf/Codex/IntroducingHACCP.pdf

World Health Organisation. 1999. *Toxic Cyanobacteria in Water: A Guide to Their Public Health Consequences, Monitoring and Management*. eds. I. Chorus and J. Bartram. E & FN Spon.

Reference Web Sites:

www.nhmrc.health.gov.au

www.awwa.org

www.awwarf.com

www.moh.govt.nz

www.epa.gov/safewater/

www.awa.asn.au/

www.wrc.wa.gov.au/

www.iawq.org.uk

Appendix 2 – Annual Report Template

Template for the Annual Report for the Total Quality Water Management System

Mission Statement for Water Utility

- Drinking Water Quality Policy commitment
- Overview of the utility's strategic plan in support of that mission statement
- Performance against plan as detailed in sections below.

Total Quality Water Management System in Operation

- Performance indicators for service levels and water quality as developed by the Task Force to be Ontario-specific including
 - Hazard identification and critical control points in that water utility
 - Prevention strategies in place at the water utility
 - Risk Management and incident communications in place
 - Sustainable Asset Management Plan for that water utility
 - Drinking Water Quality monitoring and reports
 - Total Quality Water Management System Plan for improvement identified
 - Results of any third party evaluations and audits

Performance Management System

- Deliverables, progress and expenditures identified for:
 - Training and certification and/or re-certification
 - Leadership development completion
- Report on the safety of the workplace and any infractions under health and safety legislation
- Report on human resource development initiatives, such as recognition and reward programs

Financial

- All financial aspects of actual expenditures and achievements against plan as developed by the Task Force to be Ontario-specific
- User- pay phased in implementation plan

Customer

- Description of the approach adopted for customer involvement from five-step approach developed by the Task Force for use by the water utilities.
- Report on public education and communication activities in the year
- Summary of consumer reports as provided for under the Operation Clean Water Program

Partnerships

- Describe contribution to industry research, education and development work on benchmarks

Effective Governance

- Profile members
- Time committed to offer the oversight (meetings, special sessions, consultation)
- Vacancies and new appointments orientation
- Assessment of effectiveness

Appendix 3 – Literature Review Summary

1. Introduction

A literature review was conducted to investigate the types of systems in place across the world in the water industry and in other industries. Of specific interest were the following topics:

- Quality Systems
- Financial Models
- Management and Leadership Fundamentals
- Governance Structure
- Regulatory Bodies
- Communication Techniques
- Training and Certification

The goal of the literature review was to evaluate existing best practices with the objective of determining which, if any, system had elements that could be applicable to the water industry for the proposed Model Water Utility (see Part 4). No single model incorporated, at least explicitly, all of the elements that the authors believe are necessary for the Total Quality Water Management System (TQWMS).

This Appendix summarises the findings of the literature review focusing on both the best models available and also on the most prevalent. The Appendix is intended to provide the reader with some background on the roots of the TQWMS proposed in this paper. The Appendix is not intended to provide an exhaustive review of all models nor is it intended to provide a complete summation of the reviewed models. Only the elements that the authors determined to be pertinent or of interest are included in the Appendix, however, all elements in the Appendix are not necessarily incorporated in the model.

2. The Customer

The customer is always implicitly at the top of the supply chain, but the concerns and rights of the customer are not always explicitly at the top of the agenda. The awareness of customer needs – education, communication, satisfaction, and participation – has improved in many private and public sectors. The customers and how they are regarded are discussed.

2.1. Canadian Blood Services

The Canadian Blood Services (CBS) is an entity created to own and operate the blood supply system across the country. As part of its mandate, it must “establish public and professional educational programs directed at appropriate utilisation of blood products”.

The CBS also requires that its Board of Directors have “two Directors elected from the general public on the basis of their relevant knowledge or experience with organisations representing persons who are consumers of blood and blood products”. Despite the fact that the wording of the above directive limits the involvement in the CBS to individuals involved in the health care or (bio-) pharmaceutical industries, the involvement of the public directly in the operation of the entity is more participatory than most institutions involved with the general public as the end customer. The structure of a Board of Directors ultimately responsible to the public and with direct public involvement in the Board of Directors is a model that could be applied to a structure in the water industry.

2.2. Privatised England and Wales Water Model

2.2.1. The Utilities

The regulated water utilities in England and Wales have a commitment to customer service that includes:

- Customer Communication & Education
- Customer Satisfaction Surveys
- Customer categorisation to better understand the needs of their individual customers
- Special consideration for customers with unique needs

Customer communication and education is transmitted in many forms. Water utilities offer information on their web sites, they have booths at local exhibitions to meet customers one-on-one, and they supply informational leaflets.

The implementation of the customer satisfaction surveys indicates a mature quality program that has not been realised in many other models in the water industry.

The industry as a whole has the objective of recognising special circumstances. They promote the delaying of bill payments by customers who were directly and indirectly effected by natural disasters (e.g., flooding, drought) and circumstances outside of their control (e.g. foot-and-mouth disease). The industry wants to promote the image that they are compassionate.

2.2.2. The Regulator – Ofwat

Ofwat (Office of Water Services) is the economic regulator in England and Wales. Ofwat has two councils that are comprised of members from the general public – at the national level by the Ofwat National Customer Council (ONCC) and at regional level by the ten Ofwat Customer Service Committees (CSCs). These councils provide a common voice for customers and ensure that the water suppliers are maintaining good customer relationship practices through Ofwat.

2.2.3. Drinking Water Inspectorate – DWI

The Drinking Water Inspectorate, of the Department of the Environment, Transport and the Regions, is responsible for inspection of water suppliers in England and Wales. Every three years, the DWI conducts a consumer survey to understand consumers' perception, information needs and trends in relation to drinking water quality. As a result of these surveys, the DWI has produced information material on water standards and provides easily understood explanations of testing and what the results mean. This information is available as fact sheets on their web site or in paper.

2.3. The Australian Framework

A proposed management framework being piloted in Australia (NHMRC/ARMCANZ, 2001) provides wide range of vehicles that enable the customer to participate in all levels of the water industry. The customer needs and expectations are listed in a proposed general mission statement that could be adopted by individual water utilities. The framework also details how the public should be involved by way of consultation and communication. The programs that are listed are comprehensive and should satisfy the needs of most public advocacy groups.

2.4. QualServe

The first goal listed by QualServe is to “Increase customer satisfaction”. QualServe also has the objective of implementing customer surveys. The surveys will provide customer feedback to the utility to provide direction as to what the customer perceives to be issues of greatest importance with regard to quality, typically aesthetic quality.

2.5. Dobell Paper

The Dobell paper addresses the question of the level of participation that is acceptable to the public while allowing an organisation to proceed with business in an orderly and timely manner. Dobell proposes a recipe for public involvement in the risk assessment process that ultimately leads to the adoption of policy or implementation of a course of action that results in the public accepting a course of action with known elements of risk.

Dobell is also aware that public servants have the unwieldy task of identifying and regulating the level of risk that is justifiably imposed on the public. A process of including the public in that risk assessment is to have a “two-way flow of evidence, beliefs and perceptions, with public servants expected to listen and learn in public hearings as well as in expert panels.” Dobell believes that the public, once informed, has the ability to act in a manner so as to ensure long-term net benefit to the community.

2.6. Citizens First Survey

A survey of citizens, called Citizens First, is sponsored by all levels of Canadian governments. This survey invites citizens' views of the quality of service they receive from municipal, provincial and federal governments in a variety of service areas. It also assesses the effectiveness of communication and access to information using the telephone and internet.

It is directed by the Senior Service Delivery Officials Forum and the Institute for Public Administration of Canada, who have commissioned Erin Research to conduct the study. The first survey, done in 1998, was repeated with a larger sample size in 2000 and the next is scheduled for 2002. Citizen households are chosen at random and sent a mail-in questionnaire. Overall survey results are available publicly. This allows governments to measure priorities and satisfaction over time. Comparisons are possible to other levels of government and to other similar governments.

1.7. Summary

All models that identify clients include some or all of these elements:

- Participation
- Consultation
- Communication
- Education

The extent of customer interaction varies widely in the above models. The most extensive involvement by the customer is the framework proposed in the Australian model. The UK model has active participation by the customer by way of a national council and regional committees with input to the industry regulator. As well, proactive communications with the customer by the water utilities ensure that the public input is taken into account when making operational decisions. The Canadian Blood Services model offers the interesting example of ultimate public participation by allowing members of the public to direct the operations of the owner/operator entity by being elected to the Board of Directors. The Citizens' First survey allows for involvement of a large, representative sample of the population to comment on service areas of priority and perceived quality. The DWI surveys identify the priority areas for public education.

3. Scale

There are no explicit limits (either lower or upper) on the size of a water utility. The scale of the operation will be determined by the structure that the drinking water sector.

The do nothing scenario, allow the current mode of operation to continue, has the current structure in place. There is no lower limit or upper limit on the size of the water utility. The current mode of operation in Ontario is not expected to continue and is therefore not a reasonable criterion on which to base a scale estimate.

There are however some general rules and some critical mass issues that can be assessed if a Total Water Quality Management System (TWQMS) is adopted. In general, it is suggested that a minimum of 20 staff dedicate 10% of their time to administer an ISO 9000 program. Alternatively, 2 full time staff could be utilised to administer the program. The later is not recommended since the ISO program is intended to promote quality and continual improvement by encouraging employee participation. Typically the employees performing the work will be expected to maintain and improve their portion of the ISO 9000 manual. In the case where each individual operating utility is required to develop and maintain their own set of standards (as per ISO 9000 or any other), the minimum staffing level should probably be in the order of 20 core people with support staff.

An alternative is for a general standard to be developed by the Province (similar to the Australian Framework) from which prescriptive operating procedures are determined for the majority of conventional systems in Ontario. The unit processes and overall objectives of each plant can be categorised for similar operations. This takes some of the burden off of the individual plants to develop the standard operating procedures and quality programs (a labour intensive task). Operations utilising unique processes would still be required to develop their own standards. Each plant's staff would still be required to review and adapt any deviations that their specific operation had from the general procedures developed by the Province. This would ensure participation by the operators, a key success element in any TQWMS. This structure would allow smaller utilities than with an ISO 9000-type structure imposed at the operational level.

Another possible model for scale guidelines is to form an utility to manage a particular watershed. For example, the 39 Watershed Conservation Authorities formed from 1956 in Southern Ontario were established to integrate land and water management including the control of water quantity and quality. The utility may be formed to manage a watershed such as the Grand River, the Ottawa River, or Hudson's Bay. These utilities would follow geographical lines that are well established. This structure becomes challenging to manage when trying to manage the great distances and small populations that would have to covered by the utility formed to manage the Hudson's Bay area.

4. Leadership

4.1. Australian Framework

Leadership by senior management is addressed as a requirement to drinking water quality management. Without buy-in by senior management and the trickle-down of this philosophy to the entire organisation, the employees of the organisation will not engender the quality management mentality.

Establishes a general mission statement to be adopted by an organisation. This provides the framework, but leadership on the implementation of the concepts is required.

4.2. England and Wales

Individual utilities are encouraged to take a leadership role in improving their water quality, their customer relations, and all aspects of their operation. They do not wait for the regulator to identify a problem and react to it.

4.3. Partnership for Safe water

The foundation on which the Partnership was formed was that the management of a water utility would take the initiative to take a leadership role. The main objective is to have water utilities assess individual plants to look at ways providing optimum water quality with the existing infrastructure. Optimum performance may go beyond simply meeting regulations.

A requirement for admission to the program is for senior management to buy-in to the concept of improvement for sake of quality, not regulatory conformance. This requires leadership.

4.4. QualServe

Leadership is not explicitly addressed by the QualServe literature. However, the participating utilities have to have the initiative to join and participate in the program which substantially depends on motivating employees and managers to perform functions outside of their normal operation. Strong leadership is certainly a tenant of the program.

Buy-in to the concept of improvement by senior management is required for participation in the program.

Benchmarking, both metric and process, will be added in future evolutions of the program. The reason for benchmarking is to have a comparison to industry standard and industry best operating performance. The comparison should then encourage improvement on the initiative of the individual water utility. This again requires strong leadership.

4.5. The Association for Quality and Participation

The Association for Quality and Participation (AQP) has developed a curriculum to teach managers the skill of leading during the time of change towards a quality system. The changes that are highlighted by the AQP include creating “new structures for measurement, accountability, teamwork, service and product consistency, communication and process improvements”. These objectives are inline with many of the objectives from the other models under review. AQP provides an association that could aid in the transition from the current system (whatever that is) to the new quality based and self-critical system.

4.6. Summary

All models recognise the importance of having senior management buy-in for successfully implementation. The importance of senior management buy-in implies that leadership is fundamental for the mindset shift that may be required to move to a new operating strategy.

Very little attention is paid to the concept of leadership or the need to develop leadership within organisations other than through the AQP. Leadership, as well as other general management principles, is assumed to be a fundamental requirement for the success of any program. More attention on building leadership skills in the water community would be beneficial.

5. Management Competence

Very little is discussed about the training and evaluation of the level of competence of management's managerial skills with regards to management principles such as resource allocation, communication skills within and outside of the organisation, motivational skills, and financial skills. Management skills are only addressed with regards to public relations management and engineering systems management. Strong general management skills are a requirement for any successful competitive business.

The models that have been reviewed for this paper focus on assessing the systems and the hands-on operators. However, nothing is said about assessing, improving or changing the management skills of the people with the most control over the direction of the water utility.

General management skill is an area that requires attention in the water industry. In an industry where most managers have been promoted to management positions because of their good organisational and engineering skills, it is imperative to ensure that these managers also have a complement of general management skills, including a sound financial foundation.

6. Culture and Continuous Improvement

6.1. Australian Framework

The Australian Framework puts a strong emphasis on continuous improvement of water quality through Research and Development. Small R&D projects (optimisation of coagulant dosage) can be conducted by the utility alone. On a large scale R&D projects, the utilities should share resources with other utilities, government agencies and universities to combined knowledge and spread out the cost.

The use and involvement of industry associations is encouraged as a mode of information transfer. Associations can be used to implement programs such as data collection, analysis, and ultimately benchmarking.

Finally, R&D should be used assess new equipment to identify possible improvements in the current operation.

6.2. ISO 9000 & ISO 14000

A fundamental tenant of ISO 9000 and ISO 14000 is continual improvement. Continual improvement is achieved by systematically analysing and documenting each process and then finding ways on which the process can be improved. ISO 14000 focuses on reducing the impact on the environment of a water utility. This includes reducing waste discharges and reducing energy consumption

6.3. England and Wales

The water utilities in England and Wales report to put a strong emphasis on improvements to exceed existing EC and UK drinking water quality regulations. The philosophy of improvement is firmly entrenched in the utilities since they were formed with the mandate to improve the drinking water treatment and supply infrastructure. Continuous improvement is a requirement of their business plan.

The English and Welsh system is unique in the drinking water industry. They have a mature methodology of improvement including a few years of industry benchmarking data, customer surveys and reactions to the surveys. This is a step above most other quality management based systems in the drinking water industry across the world.

6.4. QualServe

The basis for formation of QualServe is to improve the operation of drinking water treatment plants to optimise performance and delivered water quality.

QualServe provide a systematic approach to optimisation including a methodology to achieve the objective including self-assessment, peer review, benchmarking (future, in progress), accreditation (planned), and customer satisfaction surveys (planned).

QualServe is in its infancy and does not have the full cycle of continuous improvement concepts implemented. In addition, there is no explicit statement about an ongoing program of improvement but self-assessment and/or peer review could be conducted on a recurring basis.

6.5. Partnership for Safe Water

The Partnership for Safe Water has a unique feature. Joining the Partnership provides a utility with a detailed self-assessment framework for participating utilities to fill out. The self-assessment will result in recommendations (self generated) for improvement of the current plant. It does not have the framework to actually recommend new processes or equipment, only optimisation of the existing system. Peer review is available at an additional cost.

The Partnership falls short of many other programs in that there is no statement about ongoing improvements or implementation of new management principles such as quality programs. It seems to have a mandate of turbidity data collection and exchanges that information with a optimisation procedure for the utilities.

6.6. Summary

The concept of continuous improvement is ubiquitous in drinking water, manufacturing, and service literature. It is an accepted concept in today's competitive business environment. The goal of continuous improvement is to improve quality of the product or service and reduce costs. The methodologies used to achieve continuous improvement range from self-assessment reviews to peer reviews, all with the goal of identifying inefficiencies or high risk practices. Following assessment, revised operations protocols or changes in planning are instituted to improve efficiency or reduce risks.

7. Technical

7.1. Australian Framework

Awareness of a commitment to quality is highlighted in the Australian Framework. The mechanisms of education are informal by way of “development of employee education/induction programs, newsletters, guidelines and manuals, notice boards, seminars, briefings and meetings.”

The Framework ensures that the fundamentals of drinking water treatment and associated systems are well understood by employees. Formal education and training programs are required to ensure that the highest quality of drinking water is provided to the customer. The Framework recommends the use of accredited training programs with certification of employees and also contractors.

The Framework highlights that training should be ongoing. The drinking water systems will evolve over time, as may the equipment, the source water quality, and the delivered water quality standards.

The development of emergency response and incident reporting protocols are critical to ensure that the public’s trust in municipal drinking water is maintained during and after a crisis. A solid plan must be backed up with appropriate training of the personnel involved in the reaction to an incident.

The operators need to be trained to recognise that an incident has occurred (i.e. what constitutes an incident and what action is required once an incident has been recognised and characterised). The actions of the operators may include, but is not limited to:

- notifying the public about an incident and the recommended course of action to be taken by the public to protect themselves
- documenting the causes of the incident
- documenting the incident characteristics as it is in progress
- developing a report of the incident including actions to take in the future to prevent or mitigate the incident

7.2. England and Wales

The authors have found no indication of certification of operators or operator education in either the Ofwat literature or in the literature available by the water utilities. This only indicates that neither party is interested in promoting this idea in the public and does not indicate an absence of a certification or training program by the England and Wales utilities.

Emergency plans have been developed by the utilities in England and Wales. The utilities review the response to emergencies, make modifications to their plans and make recommendations to external agencies with which they must co-ordinate during the execution of an emergency plan.

7.3. Ontario Clean Water Agency (OCWA)

The Ontario Clean Water Agency (OCWA) currently operates and maintains more than 400 facilities in more than 200 municipalities. OCWA provides “highly trained, fully certified” staff to perform this service.

D’Ombra argues that a central agency such as OCWA is best able to provide emergency response services to the water industry, especially to smaller utilities. This also would imply that knowledge for crisis management also would be held by the central agency. Therefore, only one group of specialists would have to be trained in emergency response.

7.4. Summary

The drinking water system is not static. The education and training of the employees is required to evolve with the system. Some of the basic skills highlighted in the Australian Framework include:

- coagulant control testing
- proper filtration operation
- disinfection system operation
- reticulation management
- monitoring and analysis
- interpretation and recording of results
- maintenance of equipment

These basic skills also could be supplemented with quality control and quality system training.

Emergency response plans need to be implemented by the trained personnel. The training of these personnel is essential for effective crisis management and reduction of stigmatisation of the water industry by the public after a crisis. The personnel either can be from within the utility or from an external organisation specialised in crisis management.

8. Process Capability

8.1. Australian Framework

A water supply system analysis phase is included in the implementation of the Australian Framework. The proposed scope of systems to be assessed is comprehensive with provisions for source water, reservoirs, treatment plant systems, distribution systems, and customer characterisation. It is up to the water utility to determine how to conduct the assessment. The objectives and goals of the assessment and the resulting improvement implementation are also in the domain of the water utility. No guidance or guidelines are provided to the water utility on how the assessment should be conducted and what level of competency the assessors are required to have. The water utilities are expected to confer with other utilities to develop best operating strategies.

8.2. Partnership for Safe Water & QualServe

The goal the Partnership for Safe Water and QualServe is to improve the operation of the existing drinking water system with the objective of improving the quality of the water delivered to the consumer. The first step in each of these programs is to perform a self-assessment. Each process is analysed to determine its operation capability (limits and normal operation) and its current operation. The deficiencies of the processes are analysed and the necessary remediation steps are determined and performed.

Both associations offer peer review for further refinement of the processes in a utility's drinking water system. A peer review would consist of the same elements of a self-assessment. External expertise and experience, however, would then be accessed for additional innovative solutions for process and operational improvements.

8.3. Summary

Although not explicitly stated in many of the systems that were investigated, the basis of any competent or "best-of-class" drinking water system must employ equipment that has been properly selected for the purpose. The self-assessment and peer review generally promoted by the discussed systems must first address the basic concept of whether the installed equipment can provide the desired level of water treatment. Once the applicability of the individual and combined technologies is determined, the system then can be optimised to provide the highest possible quality of water.

9. Risk Management

This section is concerned with risk management at an operational level. The risk assessments used to develop MACs for chemicals and disinfection by-products, as well as acceptable microbial counts or removals, are outside of the scope of this paper and have been discussed in other Walkerton Inquiry Issue Papers.

9.1. HACCP

The Hazards Analysis Critical Control Points (HACCP) offers a proven systematic approach to assessing problem areas in the water supply chain from watershed to consumer. HACCP is discussed in the Australian Framework as it directly relates to the drinking water system. A Critical Control Points (CCP) is defined in the Australian Framework as a “point, step or procedure at which control can be applied and is **essential** to prevent or eliminate a hazard or reduce it to an acceptable level”. The HACCP has 7 basic principals (from Canadian Food Inspection Agency – CFIA)

8. identification of hazards that may be present from harvest through ultimate consumption and preventative measures for controlling them;
9. determination of critical control points (CCP) required to control the identified hazards;
10. establishment of critical limits that must be met at each critical control point;
11. appropriate monitoring procedures for CCP;
12. establishment of deviation procedures at critical control points;
13. procedures for verification that a HACCP plan is working; and,
14. documentation records concerning all procedures and records appropriate to principles (1) through (6).

There is an extensive knowledge base about the application HACCP in the Canadian food industry. The HACCP is audited by the CFIA’s Food Safety Enhancement Program (FSEP). The FSEP encourages the adoption of the HACCP methodology by manufacturers of all commodity groups to ensure the highest level of safety to the consumer. Adoption of HACCP also ensures that the product is accepted for international sale, since HACCP is an internationally recognised food safety program.

HACCP adoption by the water industry would require some adaptations from the food program. The process of water production, however, is not dissimilar from the process food production: a base product is required, the product requires some processing to be made acceptable and/or marketable for public consumption, and the product is required to be distributed to the public. FSEP is principally concerned with HACCP in the processing plant. However, HACCP can be applied from watershed to customer tap in the water industry.

9.2. Risk Communication

Powell provides seven rules of risk communication.

- accept and involve the public as a legitimate partner
- plan carefully and evaluate performance
- listen to your audience
- be honest, frank, and open
- co-ordinate and collaborate with other credible sources
- meet the needs of the media
- speak clearly and with compassion

Powell also summarises detailed guidelines for risk communication. The foundation for risk communication is first to protect the public. A strong emphasis is placed on maintaining the trust of the public in the water that is being supplied. This public trust is best maintained by following rules of communication like those provided above. Effective risk communication will ensure to the public that they have not been deceived so that at the end of the event, and the risk has been minimised to reasonable levels, the public then will have comfort and trust in the water that they are being provided.

Dobell extends the risk assessment and characterisation to include the public. Dobell characterises the drift towards an “audit society” where we are increasingly moving towards quality systems and the resultant checking that is required. This puts increased pressure and expectations on public servants to have transparent processes that can be understood by others, including the public. Dobell has put together a recipe for “making decisions on behalf of individuals, but in a public interest”.

- A. *It must be principled – There is a core layer of individual human rights (requirements of natural justice) to be respected*
- B. *It must meet social tests of procedure*
- C. *Within these constraints, it must be substantively justifiable*
- D. *In a situation where there appears to be fundamental conflicts among these precepts, it must meet a final test of personal responsibility*

It must be understood that Step B is in a continual state of flux. The public is demanding increasing access to information. Eventually, at some stage, the public will attain knowledge of a project. It is in the best interest of any decision maker to include the public from the beginning. If there is a strong resistance to the project, it is better to know early in a project life cycle when expectations and planning can be modified. A change late in a project costs more than a change early in a project. Because Step B requires more and more participation, a frank discussion with the public on the risks and risk assessment procedure is a requirement of modern utilities.

9.3. Summary

Risk management is a combination of reducing technical risk to reasonable levels, as well as having open frank discussions with the public about risk and its implications. Risk cannot be eliminated in drinking water. It, however, can be mitigated to levels that provide adequate protection. The above models provide methodologies for addressing both aspects of risk management.

10. Quality Management System

Quality management systems are well established in many other industries and services across the globe. Quality is the mantra of the late 20th century. The most universally recognised quality system is the ISO 9000 system. More specific systems to drinking water include the HACCP management systems developed for food processing and the Australian Framework that incorporates the ISO 9000 and HACCP system and applies these systems directly to the drinking water industry.

10.1. ISO 9000

An extensive body of knowledge has been accumulated on ISO 9000 and its implementation. ISO 9000 can be applied to any company that produces standard and/or custom products and/or services. Documents and manuals about the ISO 9000 standards and its implementation are available in Canada through CSA, bookstores, library, and consultants. It can be summarised in the following:

“Say what you do and do what you say.”

ISO 9000 puts the emphasis on the company to develop its own quality system to ensure that the product or service that they say they want to produce is produced in the way and to the level of quality that they have set.

An ISO 9000 system does not ensure a good product. An ISO 9000 program is developed internally or with the help of external consultants. The company documents its process including filing structures, account practices, core business activities (e.g. producing drinking water, manufacturing ball bearings, providing accounting consulting services), review processes, etc. In short, everything a company does needs to be documented.

The gaps between the current operations and the requirements to meet the quality levels set by ISO 9000 then need to be addressed. Training programs, standardisation of processes and paper work, and certification of personnel are a few of the programs that may constitute an ISO 9000 program.

It should be noted that a certified ISO 9000 program does not guarantee a good product. If the initial product or process was flawed, the ISO 9000 program will ensure that the flawed process is followed every time or that the flawed product is produced with the same flaw every time. The ISO 9000 program is intended to ensure that once a good product or process is developed that the same high standard is achieved in every iteration. ISO 9000 programs also enable integration of new/additional staff easier, since protocols are documented and are in place to aid in training.

Finally, because the business is completely documented, improvements can be more easily identified and implemented. This is essential for continued evolution and improvement of the business.

10.2. HACCP

HACCP has the effect of being a quality management tool by way of its assessment and corrective action protocols. Although it is in its strictest sense a risk management tool, it reduces risk to the lowest level possible. Risk in the case of drinking water is quantified by way of pathogen contamination and trace metal and chemical concentrations. HACCP identifies points where risk can be managed by improving processes that are under the control of the plant personnel. For drinking water, adjustments to coagulant (a process - coagulation) could be used to remove pathogens (a risk).

10.3. Australian Framework

As stated earlier, the Australian Framework has elements of many different quality programs incorporated into it including ISO 9000, HACCP, and ISO 14000. It also incorporates (or resembles) specific elements of Partnership for Safe Water and QualServe including self-assessment and peer reviews from employees in other utilities with the ultimate goal of accreditation of water treatment plants.

10.4. Six Sigma

The Six Sigma concept has been *en vogue* in recent years in the manufacturing industry, popularised by General Electric. Six Sigma strives for only 3.4 defects per one million opportunities. This is practically perfection. Its applicability to the drinking water industry is difficult to assess since the defining criteria of Six Sigma is difficult to apply in drinking water. However, the quality improvement process may have legitimacy and has common elements to other quality programs.

There are two Six Sigma sub-methodologies: DMAIC (define, measure, analyse, improve, control) and DMADV (define, measure, analyse, design, verify). DMAIC is used to improve processes that do not meet the prescribed level of quality and DMADV is used when introducing new products. The concepts and protocols used in each of these methodologies could be applied to drinking water systems.

10.5. Others

American Productivity and Quality Centre (APQC) and the Association for Quality and Participation (AQP) provide information, resources, and forums for information exchange to help manage the transition to quality based systems for management and employees.

10.6. Summary

There is a smorgasbord of quality systems available. The most relevant system seems to be the Australian Framework. Although it is not proven and will most likely require some modifications upon implementation, it is the most comprehensive quality system for the drinking water industry. The Australian Framework includes elements of HACCP and ISO 9000 & 14000 quality standards, all of which are recognised internationally. The quality standards have been

adapted and applied in a drinking water treatment context allowing for a straightforward implementation by other drinking water organisations.

11. Standards

The development of standards is based on epidemiology and assessing a level of acceptable risk to a population or sub-population. The determination of acceptable operational levels of contaminants is outside of the scope of this paper. Krewski *et al.* (2001) provides a good summary of methodologies used to set pathogen concentrations with associate levels of acceptable risk.

There are many drinking water quality standards setting organisations around the world. A short list of the more relevant organisations include:

- World Health Organisation
- Health Canada by way of its Canadian Drinking Water Quality Guidelines
- Ministry of Environment (Ontario) by way of its Ontario Drinking Water Protection Regulation
- USEPA by way of its Safe Drinking Water Act (SDWA)
- European Union by way of its Drinking Water Directive

Summaries of the acceptable contaminant levels from each of these organisations is available elsewhere (Delcan, 2001).

An analysis shows most, if not all, of the contaminants that are regulated by an individual organisation have maximum concentrations with multiples of 2 or 3 times of the maximum levels set by all other standards organisations. This indicates that either the science of epidemiology is fairly precise, the levels are set using the same or similar data, or the assumptions used by each organisation's researchers are similar.

The assessment of appropriate standards for implementation in drinking water is well studied by epidemiologists. It is a body of knowledge constantly changing and under continuous review. It appears that Canadian Drinking Water Guidelines provide adequate representation of contaminants and maximum contaminant levels in comparison to international standards.

12. Financial

12.1. D'Ombrain

D'Ombrain states that the current relationship between what the water costs to deliver to the customer and the price that the customer pays for the water has compromised the safety of the drinking water in the province. The system of loans and grants has distorted the actual cost of drinking water in this province. The province has experimented with many different financial funding models over the years including those under the umbrella of the Ontario Water Resources Commission, the Ontario Clean Water Agency, the Ministry of the Environment, and the Ontario SuperBuild Corporation.

D'Ombrain states that funding does not necessarily need to be separated from policy and that one regulator (as per Ofwat in England and Wales) could administer both duties.

D'Ombrain states that the province has an obligation to finance municipal water and sewage facilities regardless of size. He concludes by stating that “As long as users do not pay real costs, facilities will be substandard” and that “the current arrangement is a threat to public health”.

12.2. Sustainable Asset Management

Pollution Probe has proposed the Sustainable Asset Management concept as a logical model for drinking water financial management. It simply proposes a model that has full cost accounting of what it costs to produce, administer and deliver (and improve ed.) drinking water and maintain and expand the drinking water infrastructure. The full cost must be determined so that the full cost can be recovered from the customer. This cost must be recovered to ensure future safety and continuity of drinking water in the province.

12.3. Asset Management Plan (AMP)

Ofwat, the all-powerful water regulator in England and Wales, is also responsible for approving a five year recurring Asset Management Plan (AMP) by the water utilities. The AMP is developed by the utilities and approved by Ofwat as part of the procedure to get a certificate to operate the drinking water system. The intent is to ensure that the utilities are not overstating their costs that would result in higher revenue requirements and ultimately to increased rates for the customers.

12.4. Summary

Full cost billing for drinking water is consistently supported in the drinking water industry. Models for full cost billing already are in place in many jurisdictions. The drinking water infrastructure must be self-supporting to sustain high quality service and the ability to meet the future demands on the system.

13. Governance

Governance is defined as the process and structure for overseeing the direction and management of an organisation so that it carries out its mandate and objectives effectively.

This section is comprised of three parts. The first part offers a summary of reviews of governance principles and practices drawn from both the public and private sector, as well as Canadian and international sources. The second part relates to the elements of the Australian Framework and the English and Wales systems that provide for citizen participation in the governance of the water supply operations. The third part provides a brief overview of the governance of the Canadian Blood Service. This new public organisation was created in response to a significant public health dilemma and serves as a relevant example for the safe supply of drinking water.

13.1. Governance Principles and Practices

Governance is not addressed specifically in the ISO models, the Partnership for Safe Drinking Water, or QualServe and, therefore, these models will not be discussed in this section.

13.1.1.13.1.2 Chartered Institute of Public Finance and Accountancy (CIPFA)

In the United Kingdom, the Cadbury Committee on Financial Aspects of Corporate Governance established the foundation definitions and principles of corporate governance in 1992. Building on this work, as well as the work of the Nolan Committee on Standards in Public Life in 1995, the CIPFA has developed *Corporate Governance: A Framework for Public Service Bodies* (1995). This framework sets out the principles and standards of good corporate governance as: organisational structure and processes, including roles and responsibilities, communication with stakeholders and financial accountability; external reporting and internal controls, including annual reporting, audit, risk management; and, standards of behaviour, including a code of conduct.

This framework is intended as a best practice example that is not prescriptive but offers guidance on how to translate the principles and practices of good governance into action. The Fédération des Experts Comptables Européens (FEE), furthered this framework in *Approaches to Corporate Governance in the Public Sector* (2000) for use in European countries. With the aim to achieve better quality decision making and performance, this work recognised that corporate governance in a risk-based environment is about more than control and accountability, it is also about service improvement and innovation. Most recently, the framework has been modified and adapted for use by local authorities in the United Kingdom in *Corporate Governance in Local Government – Framework and Guidance Notes* (CIPFA, Society of local authority Chief Executives and Senior Managers 2001).

13.1.2. Sancton paper

Sancton identified in his issue paper, "Provincial-Local Relations and Drinking Water in Ontario", the trends in organisation for water supply and some of the changing locus of responsibility. The effect of municipal amalgamations has been to move the water-supply function from the public

utility commission to the direct control of municipal councils. The effect of the policy on electricity providers has been to force municipalities to establish new companies under the *Business Corporations Act* to operate the local electricity assets.

These trends pose a new challenge and new responsibility for elected Councils, particularly in Ontario's smaller municipalities, in that they must have the skills, knowledge and experience to determine what is in the best interest of the community. Sancton offers two possible solutions. Smaller municipalities can find another means of providing water to their community (such as contracting with OCWA or approved company) and larger municipalities can establish their own companies. Both of these suggested solutions raise the question of governance and accountability

13.1.3. New South Wales, Australia

In 1997, the Audit Office of the New South Wales government conducted an audit on the governance practices of public boards, including water corporations. Their findings identified the need for transparent and consistent processes for appointment to boards and that the skills, knowledge and expertise required for the operation of that organisation are obtained. There needed to be a rigorous approach to reporting on practices and transparent accountability for decision making. They concluded that it was necessary to enhance governance practices to ensure efficient and effective management of public organisations.

The recommendations include: clearly understood and stated roles and responsibility; strong processes for appointment to ensure the proper skills and qualifications; a program for induction and training of new board members; establishment of transparent decision making processes, including a code of conduct; an annual report on the organisation, including an assessment of board effectiveness; and, that the board should recruit and conduct the performance evaluation of the CEO.

13.1.4. Auditor General of Canada

In the December 2000 report of the Auditor General, there was an examination of the effectiveness of governance of federal crown corporations. The focus of this examination was on the appointment process, the relationship of the corporation to government and the roles and effectiveness of the audit committee of the board. The findings of the Auditor's review included the need for board members to have the necessary skills and capabilities in order to carry out their responsibilities, the need for a strategic plan and that effective governance practice will maximise performance, prevent financial loss and achieve the mandate.

The Auditor General recommended that the process for appointing board members needed to be strengthened to ensure the necessary skills and capability and that the timing of appointments be done in such a way to ensure that there is always a "nucleus of seasoned directors" in place, the board leads in the recruitment and review of performance of the CEO and that the corporate strategic plan as the cornerstone of operations be in place.

13.1.5. Haldimand Norfolk Transition Board

During the transition process in Haldimand Norfolk (2000), a project team examined the governance structures in place elsewhere in the province and made recommendations to the Transition Board on effective governance for council, committees and boards. Parts of their recommendations were for an accountability framework for local boards. The recommended

approach was based on the review of practices elsewhere and the experience of a local board in the former township of Delhi.

The accountability framework included, the board's responsibility to establish a mission statement and conduct planning; a definition of the scope of authority of the board, the criteria for selection of members to the board; roles and responsibilities for committees of the board; the process to ensure financial planning and reporting against the plan in an annual budget presented to the Council; and, the standards for service that the board is committed to in their service area. This framework is available on the Transition Board web site www.haldimand-norfolk.on.ca

13.1.6. Joint Committee on Corporate Governance

The Joint Committee was established in July 2000 to review the current state of corporate governance in Canada, compare Canadian and international best practices and make recommendations for changes. In March 2001, the committee released for consultation an interim report of their findings with proposed recommendations.

Their findings and recommendations included the need for clearly stated roles and responsibilities for boards in a Board Charter; the need for board members to understand the practices for good governance (such as, planning, risk management and CEO selection and review); the capacity of boards to operate effectively must be openly addressed in ways such as recruitment, orientation and training processes for board members; the importance of the leadership role provided by the chair; a clear understanding of the legal framework in which decisions are made; and clear accountability through effective audit committees, risk management, reporting, disclosure and communications.

13.2. Citizen Participation in Governance

13.2.1. Australian Framework

The Australian framework allows for extensive public participation. The mechanisms to ensure participation by the public include:

- Education of technical issues and risks of new policy, new procedures, new infrastructure, new management techniques etc.
- Consultation with the public by the water utilities
- Communication in the event of an emergency situation

The implication of the above series of public consultations is to incorporate the feedback resulting from the above proceedings into the decision-making process. The Framework does not go so far as to include any direct power by the public in the decision to be made. In theory, all of the consultation and education could be used just as a charade to provide the public with a perception of involvement.

13.2.2. England and Wales

The privately operated water companies are focused in customer responsiveness, either directly or through the regulator. There is no instrument in place to include the public in decisions about

the operation or planning of the operation of the water treatment systems or resource management. Public consultation exists to the extent that they want active participation from the public on how the water utility is perceived and the level of satisfaction with the water service being provided.

13.3. Canadian Blood Services

As Section 1 – Customer, the Canadian Blood Services (CBS) includes the public at the highest level by including public representation in the Board of Directors.

Responsibilities and Functions

Provincial and Territorial Health Ministers, "as Ministers"

Notwithstanding their involvement in the new Canadian blood services, Ministers remain accountable for their ongoing powers and responsibilities as Ministers of Health, in accordance with existing health legislation.

Ministers are responsible for:

- *the effectiveness of the blood supply system as an integral component of the Provincial/Territorial health care delivery systems*
- *funding requirements of the new blood authority as approved by its members*
- *recommending to the Minister of Health (Canada) any proposed changes to the new authority's legislation.*

Provincial and Territorial Health Ministers, "as members" of the new Canadian blood services

Participating provincial and territorial Ministers, serving as "Members" will establish and will remain responsible for the mission and mandate of the authority.

Members will have the authority to approve, upon the submission by the new blood services Board of Directors, the three-year corporate business plan, which includes its annual global budget and performance objectives, and a plan to allow for a contingency fund for emergencies, and, where necessary, to provide guidance to the Board on the contents of the plans.

While participating Ministers "as members" will not have the power to direct operational decisions of the authority's Board of Directors or staff, the members will be responsible for:

- *overall expenditure of public funds by the authority in delivering the blood program, and*
- *selecting a Board of Directors.*

1. *Participating provincial and territorial Ministers will be known as "members", similar to shareholders in other corporations. As members, they have the authority to appoint a Board of Directors.*

The Board of Directors will consist of a minimum of 7 and a maximum of 13 comprising a Chair, four Directors elected on the basis of nominations from members representing the regions of (1) British Columbia & Yukon, (2) Alberta, Saskatchewan, Manitoba and the Northwest Territories, (3) Ontario, and (4) New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland; two Directors elected from the general public on the basis of their relevant knowledge or experience with organisations representing persons who are consumers of blood and blood products; and up to six other directors elected on the basis of their relevant knowledge or expertise in business, scientific, medical, technical or public health matters. New members can join the new authority with the unanimous consent of existing members.

Employees of the federal, provincial or territorial governments will not be eligible for appointment to the Board.

Members will have the authority to require direct, external, comprehensive management audits and targeted special audits at their discretion. Should objectives for the blood program not be met satisfactorily, members will hold the Board accountable to take corrective action.

Members will retain the power to remove some or all of the Board.

Members will publish an annual report, including its audited financial statements.

Responsibilities of the new Canadian blood services Board of Directors

The Board of Directors is responsible for the overall direction of the affairs, operational activities and budget of the authority, including the appointment of the Chief Executive Officer.

The Board of Directors is responsible for translating the approved business plan into blood system operations.

Within the framework established by the participating Ministers "as members," the Board of Directors:

- *exercises broad discretion in establishing corporate and operational policies of the authority, including setting and enforcing standards;*
- *is responsible to the members for achieving the goals of the approved business plan, which includes its annual global budget and performance objectives for the authority;*
- *is accountable for reporting on the authority's performance to Ministers "as members."*

The Board is responsible for the development and implementation of Canadian blood services standards supplementary to any regulatory standards of the federal, provincial or territorial governments.

The Board is expected to develop corporate and operational policies reflective of the principles contained in provincial and territorial statutes dealing with public access to information about the affairs of the authority, protection of personal information controlled by the authority, and the provision of service to the public where appropriate, in the official language of their choice.

The Board will be required to create a Finance Committee and will have the authority to appoint committees as they deem necessary to advise and assist them in carrying out their duties.

Although Ministers will remain accountable for the use of public funds, the internal Finance Committee will be responsible for preparing authority budgets for the approval of the Board of Directors.

Responsibilities of the Chief Executive Officer of the new Canadian blood services

The Chief Executive Officer is:

- *responsible for the management and day-to-day operation of the authority's programs and activities, including the supervision of the authority's staff.*
- *responsible to the Canadian blood services Board of Directors for implementing corporate and operational policies as directed by the Board.*
- *responsible for ensuring all executive decisions are made within an analytical framework of health risk management.*

The Chief Executive Officer will be required to create Consumer Advisory, Scientific Advisory and Research and Development Committees and will have authority to appoint committees as he or she deems necessary to advise and assist in carrying out his or her duties.

The Board of Directors may also, at their discretion, appoint consumer advisory, scientific advisory, and research and development committees, or may require the CEO's committees to provide advice directly to the Board.

13.4. Summary

There has been a great deal of review and examination of governance and accountability in both the public and private sectors. Although few relate specifically to water utilities, there are issues of quality, customer confidence, public accountability, and sustainability of valued assets that have application to water utilities.

Whether public or private, large or small, there are principles and practices of governance that can be applied to water utilities to ensure the responsible direction and management of the

organisation. These principles are: clearly understood and defined roles and responsibilities for the board; effective practices; the assured capacity to govern; and accountability and transparency.

Citizen participation is important for continuous improvement and building an understanding of the Total Quality Water Management System.

The example of the Canadian Blood Services agency is important for the involvement of the public in its governance, the governance principles and practices adopted to ensure the safe supply of its product and the combination of both to achieve public confidence.

14. Accountability

Accountability is a natural by-product of instituting a Total Quality Water Management System (TQWMS). A TQWMS would clearly identify the responsibilities and roles of employees, managers, government, regulators, and the public. A level of standards to which the utility must perform will also be defined. In the event of a failure of one of the sub-systems or sub-processes, a clearly defined path can be drawn back to the responsible party. Accountability does not necessarily mean reprisal. It does allow for analysis and rectification of whatever the flaw was, either mechanical failure, process related failure, or human error.

14.1. England and Wales

The water utilities in England and Wales are privately owned and operated. All matters relating to the business, pricing and service offered by the utilities are regulated by Ofwat (Office of Water Services). Ofwat also regulates environmental concerns and watershed management of the water utilities. Ofwat licenses water utilities and has the power to revoke licences in the event of non-compliance of one of the tenants of the licence. Ofwat is an all-powerful regulator.

Customer advisory groups also report back through the Ofwat. Ofwat has two councils that are comprised of members from the general public – at the national level by the Ofwat National Customer Council (ONCC) and at regional level by the ten Ofwat Customer Service Committees (CSCs). These councils provide a common voice for customers and ensure that the water suppliers are maintaining good customer relationship practices through Ofwat.

The utilities are directly accountable to their customers directly, their customers via Ofwat, and Ofwat itself.

The Drinking Water Inspectorate (DWI) conducts an annual assessment of the quality of drinking water supplied by each of the water companies. DWI ensures that each company complies with the UK drinking water standards, set by the Environmental Agency, which must be at least as stringent as the European Union drinking water standards. This assessment is based on information that is supplied regularly by the water companies and includes the results of compliance tests. The DWI also will carry out inspections if the information provided or a complaint/incident warrants. The DWI prepares an annual public report in layperson's language to describe the performance of each water company against the water quality standards.

All water companies are required to have copies of their record of compliance to standards in their office where customer service staff is to be available to explain the meaning of test results. In addition, these records are submitted to the local government about the quality of water supply in their area. These reports are posted on the DWI web site and are available in paper copy from that office.

The DWI, based on their periodic consumer surveys, have developed information material explaining the standards for bacteria, chemicals (nitrate and pesticides), metals (lead) and the way water looks and tastes. This information material is available in leaflet form and from their web site.

14.2. Canadian Food Inspection Agency (CFIA) - HACCP

The Canadian Food Inspection Agency (CFIA) administers its HACCP program by way of its Food Safety Enhancement Program (FSEP). Canadian food manufacturers are accountable to CFIA for quality programs and HACCP. Depending on the specific type of food being processed, the manufacturer also may be accountable to standards and regulations that fall under other government departments including Fisheries and Oceans, Agriculture Canada, Environment Canada, and others. The CFIA has made agreements with other government agencies to prevent inspection overlap and avoid duplication.

14.3. Summary

Accountability can be achieved only with transparency. A problem must be identifiable and reportable to ensure a proper chain of responsibility and ultimately accountability. Regular reporting readily available to the public must be instituted (D'Ombra, Pollution Probe).

Public reporting must be preceded by public education. Reports showing any level of suspected carcinogens may be alarming to many members of the public. The meaning of the numbers would have to be explained to ensure that the public does not react adversely to the reports when the results are "normal".

15. Water Supplier Associations

Water supplier associations are excellent vehicles for information transfer amongst utilities, vendors, and consultants. Examples of existing associations include American Water Works Association (AWWA), Ontario Water Works Association (OWWA) a section of the AWWA, AWWA Research Foundation (AWWARF), QualServe, Partnership for Safe Water, and Water UK. Speciality associations with focused objectives and concerns are also available to utilities.

Associations are widely promoted as the vehicle to increase knowledge exchange between professionals and reduce R&D costs on common problems. They also can serve as a platform for friendly competition by way of performance benchmarking.

16. Regulations (and Regulators)

16.1. Ofwat - England and Wales

Ofwat (Office of Water Services) is the regulator for drinking water utilities in England and Wales. The role of the regulator (as defined by Ofwat) is summarised below.

The Director's Primary duties

He must ensure that:

- *the functions of a water and sewerage company, as specified in the Act, are properly carried out;*
- *companies are able to finance their functions, in particular by securing a reasonable rate of return on their capital*

Lenders and shareholders should be able to receive a return that is sufficient, but no more than sufficient, to induce them to make loans and hold shares, if the company operates efficiently.

The Director's Secondary duties

Protecting customers

Promoting economy and efficiency - *The Director must encourage companies to operate efficiently. The companies' price limits contain tough efficiency targets. Ofwat compares company performance. Comparisons are made between companies; against each company's targets; and with other sectors. Where necessary improvements are sought.*

Competition - *The Director has a duty to facilitate competition between suppliers and potential suppliers, ensuring that a framework exists in which competition can develop.*

General Environmental Duty - *The Director is also required under Section 3 of the Act to exercise his powers subject to the requirement (among other things) "to further the conservation, enhancement of flora, fauna and geological or physiographical (landscape) features of special interest". He should also have regard to the preservation of public amenities, such as freedom of access to the countryside and seaside, so far as they are consistent with his primary duties.*

Limiting charges - *The Director sets price caps which allow the companies to finance their functions. This gives companies incentives to make efficiencies. The Director does not control profits or dividends. Companies are allowed scope to increase efficiency and hence profitability and to share these rewards with shareholders and customers.*

Enforcing company licences - *Companies operate under Licences granted by the Secretaries of State for the Environment, Transport and the Regions and for Wales to provide water and sewerage services in England and Wales. The*

Licences impose conditions on the companies which the Director is required to enforce.

Handling other disputes - *The Director also has enforcement powers in respect of claims and complaints, **including:** Guaranteed Standards, Connection Charges, Drainage, Pipeline powers on private land, Public interest and monopoly power, Appointment of the Director, Relations with CSCs and ONCC, and Other water regulators.*

The Director does not set environmental standards but works closely with:

- *the Environment Agency which regulates and enforces water quality standards in inland, estuarial and coastal waters;*
- *the Secretaries of State who set standards concerning the quality of drinking water which are regulated by the Drinking Water Inspectorate.*

Ofwat, has the power to control the market – access to supply, managed competition and rate structures. The water utilities have formed an association known as Water UK. Water UK promotes the views of water utilities as whole. Water UK has put together the following list of what they believe constitutes a good regulator.

General Principles of a Good Regulator

1. *Transparency*
2. *Accountability*
3. *Targeting*
4. *Consistency*
5. *Proportionality*
6. *A clear legislative mandate*
7. *Efficiency*
8. *Expertise*

Additional Principles of a Good Regulator as per Water UK

9. *Reproducibility*
10. *Non-prejudicial*
11. *Non-retrospection*
12. *Timeliness*
13. *Flexibility*

16.2. DWI – England and Wales

DWI (Drinking Water Inspectorate) enforces the Water Quality Regulations. They operate under a public *Code for Enforcement*. The Code sets out the levels of service that water companies and members of the public can expect to receive from the Inspectorate. This code reflects the principles of good enforcement set out by the Better Regulation Unit in the Cabinet Office of the government of the United Kingdom.

The Role of the Inspectorate

The Drinking Water Inspectorate's main task is to check that water companies supply water that is wholesome and complies with statutory requirements of the Water Supply Regulation.

The Inspectorate carries out this function by technical audits of water companies. Technical audits consist of three parts:

- *An annual assessment based on information provided by companies, of the quality of water supplied, compliance with sampling and other statutory requirements, and the progress made on improvement programmes;*
- *Inspection of individual companies, covering not only a general check on the matters above but also checks that the sampling and analysis carried out by the companies is accurate and that it provides a reliable measure of drinking water quality;*
- *Interim checks made on particular aspects of compliance with the Regulations based on information provided periodically by the companies.*

If a company is found in breach of the statutory requirements, the Inspectorate notifies the company that enforcement action is under consideration. If effective remedial action is not demonstrated then legally the company must accept binding undertakings. As a final step, an enforcement order with specific rates and deliverables is served on the company.

In their *Code for Enforcement*, the DWI has established clear standards setting out the level of service and performance the public and business can expect to receive. The DWI publishes details of their performance against these standards in their Annual Reports. The *Code* covers areas such as:

- The conduct of technical audits
- Undertakings
- Relaxation of standards on a case by case basis
- Drinking Water Quality Incidents
- Openness
- Provision of Information and Advice
- Consumer Market research
- Helpfulness
- Consultation and Communications
- Enquiries
- Handling of Complaints
- Proportionality
- Value for Money
- Consistency
- Good working Relations with Water Companies and the Public

Transparency is a concept that is supported and promoted (Dobell, D'Ombrain) for all levels in the water sector including the standard setting bodies (government), the regulator (usually government or government-owned), and the water utility. The regulator should be logical, methodical, and scientific with accountability to the public directly and through the government.

16.3. Canadian Food Inspection Agency (CFIA) - HACCP

The HACCP system is a preventative system. The regulator, the Canadian Food Inspection Agency (CFIA), is only involved to ensure that the individual manufacturers are meeting the quality control program as prescribed in the Food Safety Enhancement Program (FSEP) Implementation Manual.

The HACCP system does impose increased controls on the individual manufacturers and also increased inspection requirements with regards to those controls. The intention, however, is not to increase the number of inspectors (regulators) required to police the HACCP system in the food industry. Instead, the CFIA is co-operating with other government agencies to reduce the amount of duplication with regards to inspections and government regulations.

The CFIA also has the objective to utilise its resources effectively. The CFIA will “direct its resources in a sequential fashion, from high risk to low risk, depending on product type, establishment compliance, or plant complexity”.

16.4. Other

D’Ombrain argues that “The regulatory regime must include provision for enforcement, but to the extent possible the operating principle should be reliance on prevention.” The regulator should be a safety net, where for the most part the utilities are performing at or near optimum levels to ensure the highest quality of water is delivered to the customer.

The regulator and the government agency directing the policy of the regulator also would need to be subject to regular auditing to ensure that they are performing as per their mandate.

16.5. Summary

Ofwat and DWI in England and Wales have developed their roles and responsibilities in a complementary fashion where each has a clearly stated role. Their role is measured by their consumers and themselves against principles and standards. The England and Wales structure enables an efficient reporting and accountability process.

CFIA has made important steps in the right direction of reducing government bureaucracy with regards to compliance and inspection issues.

Water UK has provided a good outline as to the characteristics that a regulator should possess. An appropriate level of the scope of powers available to the regulator must be determined prior to determining which functions it will perform. The DWI’s *Code of Enforcement* provides clear standards against which the performance of the regulator can be measured and judged.

Appendix 4 – Matrix of Confusion

A Matrix of Confusion

The following commentary demonstrates that there are multiple layers of confusion in the myriad roles of the Ministry of the Environment, in particular, and governments, in general. This commentary serves as a useful backdrop to understand many of the solutions proposed in the model water utility. The authors recommend that the Ministry of the Environment's role be one of a singular focus – that being the Regulator.

The Drinking Water Regulatory Role in Ontario

The provincial Ministry of the Environment (MOE) has been the dominant influence in Ontario's drinking water since its inception in the early 1970s:

- The MOE established Ontario Drinking Water Objectives (ODWO), based on Health Canada's Canadian Drinking Water Guidelines. ODWO recommends the Maximum Allowable Concentration (MAC) of a contaminant and the water quality testing required. (The ODWOs were superseded in August, 2000 by the Ontario Drinking Water Standards (ODWSs) that were largely based on the ODWOs.)
- The MOE requires that any additions to or modifications to a water treatment works, reservoirs or watermains, etc. be subjected to an approvals process and receive a "Certificate of Approval" (CofA) prior to construction. A CofA is permanent until conditions of the CofA are exceeded, usually on the basis of exceeding capacity requirements due to community growth.
- The MOE developed the Operator certification program and determines the certification level required to operate plants and distribution systems.
- Grant funding by senior levels of government for water works historically has been administered by the MOE.
- Extraction permits (the Permit to take Water) are issued by the MOE. These permits are issued in perpetuity.
- The MOE is responsible for ensuring that drinking water in the province is safe to drink.
- The MOE (and its successor Ontario Clean Water Agency - OCWA) operates hundreds of water and wastewater treatment plants throughout the province on behalf of municipalities.
- The MOE establishes design criteria for treatment facilities and distribution systems through its published design guidelines and the approvals process. The design guidelines for water systems were last updated in 1982.

Commentary on the MOE as Drinking Water Standards Setter

Most drinking water in Ontario originates as surface water, from lakes and rivers that are subjected to various treatment processes designed to improve the aesthetic quality and to eliminate pathogens. It was believed that chlorination was capable of inactivating pathogens,

until the detection of chlorine-resistant parasitic cysts such as *Giardia* and *Cryptosporidium*. A major outbreak of Cryptosporidiosis, infecting over 300,000 in Milwaukee, Wisconsin in 1994 prompted revisions to US drinking water regulations, as the water had been filtered and chlorinated to then-acceptable standards throughout the incident. The source of contamination was linked to runoff from an animal feedlot. Subsequent outbreaks of this disease occurred in Waterloo and Collingwood, ON, and more recently in North Battleford, SK. These also were linked to pollution discharges.

Drinking water research has shown that there may be a wide variety of pathogens in our source waters, and that traditional methods used to remove or inactivate these pathogens may not be as effective as once believed. Perhaps of even greater concern is that the tests used to confirm that the water is safe to drink are time-consuming, often costly, and may be specific to only one pathogen. Thus the focus of drinking water treatment has been shifting towards risk reduction in the treatment process and protection of the source water, both surface and underground.

Ontario's drinking water quality requirements do not appear to have kept pace with health risk despite the introduction of new drinking water regulations in August 2000:

- There are still no requirements for treatment techniques to control *Cryptosporidium*. There are no requirements to analyse source waters to determine the presence of *Cryptosporidium* or *Giardia*. Requirements to treat for *Giardia* have been in the USEPA Safe Drinking Water Act (SDWA) regulations since 1991. Proposed requirements to treat for *Cryptosporidium* are to be implemented by 2006.
- Low turbidity of treated water is one of the most basic indicators of proper surface water treatment. The provincial turbidity goal of 1 NTU for particulates in filtered surface water is applicable to only 95% of production, and is based on the blended plant effluent. From a health risk perspective the goal should be closer to 0.1NTU; with 100% compliance by each process unit. Halifax, NS required this level of performance in a public-private partnership project as early as 1995. Leading Ontario utilities operate consistently at this performance level.
- The regulations still require only coliform bacteria analyses as indication that water is free of pathogens. To quote a presentation at the OWWA/OMWA 2001 annual conference: "Regulatory agencies need to accept the fact that pathogen monitoring is not a practical option for ensuring wholesome drinking water" (AWWARF/CEC/USEPA presentation)

Perhaps a summary on the state of weak Canadian drinking water guidelines can be found in the design criteria used for drinking water treatment plants provided for First Nations communities in British Columbia. Funded (both capital and O&M) by federal taxes, all plants are designed for full compliance with USEPA drinking water requirements.

Commentary on the MOE Approvals and Permitting Processes

The MOE 's approvals and permit process has inherent weaknesses in that the permits have been granted in perpetuity. This stifles the ability to require upgrades to treatment processes or modifications to extraction volumes based on evolution of understanding and experience. An additional concern has been the practice of CofAs for treatment facilities documenting physical facilities, rather than the quality of drinking water to be produced. It should be noted that subsequent to the Walkerton incident, the MOE is proposing to modify its approval process by issuing "consolidated CofAs" for 3-year terms which will have drinking water quality regulations

attached as conditions. Although none of these new CofAs have been issued, they appear to be a renewable license to operate a drinking water system. A final concern is the implied responsibility of the MOE for satisfactory performance of designs receiving approval. This places the MOE in a vulnerable position should "approved" facilities have performance shortcomings.

Commentary on the Grant Funding Programs

Grant funding programs historically have provided significant capital assistance for treatment facilities for small communities and for regional schemes with rapid growth rates. Unfortunately, these grants rarely have been applicable to rehabilitation of the buried infrastructure and the funding formulae for treatment facilities have had no attached conditions to require that leakage rates be controlled or that water revenues be sufficient to maintain the value of the grant funded asset. Thus, treatment plants have been provided to municipalities whose unaccounted-for-water can be over 50%. There is no assurance that the increased cost of maintaining these oversized assets will be borne by local water revenues.

Commentary on the Training and Certification Programs

The MOE, in 1993 enacted a "Triple E" (Education/Experience/Examination) program for certification of water treatment and distribution system Operators. All existing Operators, who had worked as Operators for the required time, automatically were *Grandfathered*, obtaining certification without meeting any educational or examination requirements. While many *Grandfathered* Operators were, and still are, extremely competent, the risk to public health suggests that the *Grandfathering* approach be corrected.

Commentary on the Structure and Scope of the MOE

The provincial MOE has a broad mandate in Ontario's drinking water: It has been designer, funding agent, approver, operator, standards setter, investigator, and enforcer. There has been considerable discussion over the lack of funding for the MOE. A higher priority, however, should be about the structure, responsibilities and potential for conflicts of interest:

- Can the Standards Setter and the Regulator (inspector/enforcer) be one and the same? Models from other jurisdictions suggest that these two functions should be kept separate. Drinking water quality standards should be established on the basis of health risk and not linked to the enforcement process. As a parallel, we ask the OPP to enforce the speed limit on highways, not to set the limit.
- Can the regulatory function be linked to the design of treatment facilities? As mentioned earlier, this linkage can place the Regulator in a compromising position. In addition, maintaining design guidelines is an expensive proposition in light of today's rapidly changing technologies. Models from other jurisdictions rely on industry associations (for example CSA, AWWA, WEF) to continuously publish up-to-date research directions and design guides.
- Can the regulatory function be seen to have any linkage to specific plant operating authorities? The MOE no longer owns or operates any drinking water treatment plants. The Province, however, operates hundreds through its OCWA organization. OCWA competes against public and private utilities for operations contracts in Ontario. The issue here is the perception that the provincial regulatory function is compromised by the provincial operational function.

The Watershed and Groundwater Management Roles in Ontario

The delivery of safe drinking water to the public starts with source water protected from pathogenic waste discharges. The management of surface and groundwater in Ontario falls into a multi-jurisdictional structure:

- The federal government, through the Department of Fisheries and Oceans (DFO), has the responsibility for “fisheries” throughout Canada via The Fisheries Act. Fisheries in this context refer to aquatic life, rather than commercial harvesting. In effect, DFO is responsible for ensuring that all surface waters in Ontario are capable of sustaining the type of fish life that was present before contamination by humans. DFO assesses surface waters with various designations, such as “warm water fishery”, “cold water fishery”, etc. and establishes water quality requirements for each designation. DFO is federally-funded.
- The provincial Ministry of Natural Resources (MNR) has responsibility to work with DFO and Conservation Authorities to restore waterways in Ontario to support fisheries. MNR is provincially-funded.
- Conservation Authorities fall under the MNR and cover most of Ontario, organised on a watershed basis. Their role includes management of surface waters. Conservation Authorities are funded by constituent municipalities and by MNR.
- The MOE has responsibility for regulating point-source discharges (such as wastewater treatment plants, combined sewer overflows, industrial lagoons, etc.) to waterways through its CofA process. Discharge impacts on receiving waters are compared with the Provincial Water Quality Objectives (PWQO) for the receiving water. If the receiving water quality is still higher than the PWQO, the discharge is permitted. For receivers that do not already meet the PWQO (called Policy 2 receivers), the discharge of the problematic constituents will be restricted so as not to worsen the condition of the water. Additional treatment or better dispersion/dilution may be required to meet the provincial objectives. CofAs are issued in perpetuity until the conditions are exceeded.
- The MOE has responsibility for regulating sub-surface discharges to the ground/groundwater, through its CofA process. These discharges include landfills, spray irrigation, exfiltration lagoons, etc.
- Septic tank/exfiltration bed systems must be installed to meet Ontario Ministry of Municipal Affairs and Housing design guidelines. Construction is inspected by the local health unit, who issues an approval certificate as part of the Building Permit process. Once the certificate is received, there are no inspection/compliance responsibilities to ensure that the tank has been pumped or the field bed is still working. Recently, municipalities have had the option to take on this responsibility.
- Biosolids (from wastewater treatment plants) and septage wastes can be disposed of on agricultural land that has received a CofA from the MOE.
- Liquid discharges from agricultural land are considered non-point discharges and are not regulated. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) publishes guidelines to good practice for distribution to farmers.

- Liquid discharges from waste produced by farms and factory farm complexes are considered non-point discharges and are not regulated. OMAFRA distributes guidelines to good practice for handling these wastes.
- Groundwater monitoring for quality is not the responsibility of the province. Private well owners can obtain testing of their water for coliform bacteria from the Ministry of Health at no charge. The Ministry records all sample results on their database.

Commentary on the Regulatory Structure

The regulatory structure appears to be confusing and inconsistent. For point-source discharges, there may be several regulators who have jurisdiction. The jurisdictions have different emphases in different parts of the province, depending on the proximity to, and funding of, the local office. In some areas, there appears to be duplication of services; in other situations there is a lack of services. In any case, it would appear that there are opportunities to simplify and level the regulatory structure.

While the permitting side of the regulatory function appears strong, there seems to be a lack of enforcement at both the federal and provincial levels.

For non-point discharges, there is a lack of monitoring, regulation, permitting, and (understandably) enforcement. In some areas of the province, this has contributed to ridiculous situations. The South Nation River watershed, for example, is a policy 2 receiver from a phosphorous loading standpoint. The point-source discharges from municipal and industrial pipes into the river contribute <1% of the total phosphorous loading, yet municipalities are required to reduce their phosphorous discharges, if they wish to expand their communities. Over 99% of the phosphorous discharge to the watershed is derived from non-point sources, predominantly agricultural in origin.

Other jurisdictions consider the impact of all pollution sources on a watershed basis and do not allow exemptions.

Commentary on the Approach to Managing Surface Water Quality

The approach of establishing PWQO was intended to be a goal to steadily improve the province's most polluted waterways and result ultimately in all waterways reaching at least a minimum level of quality. Communities on smaller waterways construct advanced wastewater treatment facilities, while those adjacent to large waterways, such as the Great Lakes usually have simpler, cheaper processes simply by virtue of the dilution volume available. Thus, the policy inadvertently may be contributing to the "dilution as a solution to pollution" scenario.

Given the advances in technology and "clean manufacturing", it might be appropriate to establish water quality standards that steadily improve and to replace the CofAs with licenses to operate for fixed term periods.

Commentary on the Scope of the MOE

The MOE carries out a somewhat similar role in wastewater and associated areas as it does in the drinking water arena. The MOE sets standards, provides design guides, approves designs, manages grant funding programs, and is responsible for ensuring that the waste emitters are compliant with MOE requirements. The province's OCWA group (formerly the MOE operations group) operates hundreds of wastewater treatment plants under contract with municipalities. The issue here is the same as on the drinking water side: does the clustering of all these roles

compromise the responsibility of the regulatory function and contribute to the perception that waste discharges will not be treated equally.