APPENDIX A - DETAILED REVIEW OF THE DELCAN REPORT

The following is a brief summary of some of the key points raised in Commission Issue Paper # 8 (Delcan) - Production and Distribution of Drinking Water. The bracketed information provides details regarding where the point may be found in the Issue # 8 report (i.e. page number, report section and paragraph number). Headings in this memo correspond to headings in the Issue # 8 report.

Purpose of Issue Paper # 8 (as defined by the Walkerton Inquiry Part 2 Study List)

A major paper - integration of treatment (including disinfection, and including standard and novel technological alternatives) and measurement. Big systems: best practices in bigger cities; case examples of Toronto and one or two other North American/European cities thought exemplary in the industry; effects of source quality on cost and risk. Smaller systems: best practices, costs and risks, source quality effects on costs. Private supplies: rural homes, cottages, farms; effects of source quality on costs/outcomes. Role of ISO standards, if any. Implications of non-real-time measurement. Establishes costs, capital and operating, in some detail as a function of system scale and scope, water source, and customer density. Assessment of various estimates of the costs to bring Ontario systems up to standard.

Summary Points From Issue Paper # 8

PART I ONTARIO TODAY: DRINKING WATER TREATMENT, STANDARDS, PRACTICES AND TECHNOLOGIES

SECTION 1 SURVEY OF ONTARIO DRINKING WATER TREATMENT

Section 1.2 Data Availability

1. Prior to introduction of the Drinking Water Protection Regulation in 2000, there were two main databases for drinking water: the SWIP (Sewage and Water Inspection Program) database, and the DWSP (Drinking Water Surveillance Program) database. The SWIP program started in 1989 and provided ongoing snapshots of sewage and water treatment plant status, based on physical inspection reports (Mahoney, 2000). During the 1990s plants were surveyed once every 2 to 4 years. However since 2000 the Ministry has undertaken to perform SWIP evaluations annually at all water treatment plants and once every 4 years at all sewage treatment plants. SWIP program data describe physical and operational parameters such as chemicals and treatment process used; they do not describe finished water quality. The data are used to measure delivery of Business Plan targets, and to help calculate infrastructure funding needs. SWIP data are not generally disseminated to the public, but are subject to Freedom of Information access (Mahoney, 2000). (Page 1, Paragraph 2)

   Comment: Why once every 4 years for sewage treatment plants? Wastewater discharges are a major source of nutrients, bacteria, viruses, parasites and chemical contamination. A well operated wastewater treatment plant is important to minimize degradation of water quality for downstream water treatment plants. This generally applies to river sources (i.e. the Grand River - Waterloo and

Brantford; Ottawa River - numerous communities) but some lake supplies may also be impacted.

AWWA's source water protection policy was submitted as part of the Issue 6 Response Paper.

2. The DWSP database, started in 1986, compiled data that were submitted on a voluntary basis. …. These data, collected routinely, assisted in setting standards and assessing treatment operation. By 1999, 162 treatment facilities were participating in the program, representing 88% of the population served by municipal drinking water plants (MOE 2000c). …. While DWSP monitoring was voluntary, it was standard practice for the Ministry to notify the operating authority and the Ministry district manager whenever a health objective was exceeded. The local operating authority was then responsible for notifying the local medical officer of health. (Page 1, Paragraph 3)

   Comment: I believe Ministry staff did indeed advise local operating authorities of health objective exceedances. However, this would not have been done in a timely fashion. Furthermore, this reporting may have caused some of the confusion regarding DWSP being a compliance program.

Section 1.3 Water Sources

3. According to the Ministry's SWIP database, approximately two-thirds (393) of municipal drinking water systems in the province obtain their water from ground sources, while the remaining one-third (217) use surface water (Figure 1.3.1). Nevertheless surface water serves almost 90% of the population (Figure 1.3.2). These data suggest that most facilities that use groundwater serve small populations, while major urban centres rely on surface water. The data shown in Figure 1.3.3, which divide the approximately 630 waterworks in Ontario by size (population served) and source corroborate this. The number of facilities, 630, is approximate, due to opening and closing of facilities over the timeframe of the database. Almost all of the 393 waterworks that use groundwater serve less than 10,000 people. The major waterworks, such as those serving Toronto and Ottawa, use surface water. (Page 2, Paragraph 2)

   Comment: Figure 1.3.1 notes that "18 plants are not reported" and that the information is based on SWIP 2000 data. As such, statistics are: ground water - 393 plants; surface water - 217 plants; not reported - 18 plants. Therefore, the total number of plants equals 628. This compares relatively well to the number of water treatment plants provided by the Ministry of the Environment in their December 21, 2000 news release (i.e. Environment ministry completes inspection of 645 water treatment plants).

   The number of small systems in the province is noteworthy. Approximately 240 of the above noted 393 ground water systems (i.e. 60%) actually serve populations of 1,000 or less. No water quality information is provided for these ground water systems nor is any comment made regarding treatment issues that may challenge these small systems (i.e. iron, manganese, nuisance organisms, etc.) or certification requirements (i.e. how many small systems are classified as Level 1, 2, 3, or 4).

4. An additional factor to consider when describing drinking water supply in Ontario is the impact of the Great Lakes. The Great Lakes provide water to more than one third of all drinking water treatment plants in the province (251 of 630). Approximately half of these are located along Lake Ontario (Table 1.3.1). Almost three-quarters (73%) of Ontario residents served by municipal water systems drink Great Lakes water. This water is typically low in turbidity, low in microbial contamination, and low in concentration of chemicals. As a result, the treatment facilities that serve most of the population are not constrained by poor source water quality. This is not to say that Great Lakes water is entirely pristine: one of the largest outbreaks of waterborne disease in the United States occurred in Milwaukee, where *Crytosporidium* was shown to have contaminated Lake Michigan, near the city's drinking water intake (Bruesch *et al*, 1998). Furthermore, algae blooms in Lake Ontario have caused taste and odour problems in recent years. Nevertheless when compared to many water supplies in Canada and elsewhere, the Great Lakes offer a stable, high-quality and abundant water supply. (Page 2, Paragraph 3)

   Comment: The SWIP 2000 data noted in this paragraph does not correspond to the information provided in the proceeding paragraph (i.e. 251 surface water treatment plants versus 217 surface water systems, respectively). What is the difference between the "systems" reported above and the "plants" reported here? Notwithstanding this confusion, the statistics provided in Table 1.3.1 are: Lake Ontario - 112 plants; Lake Huron - 83 plants; Lake Erie - 42 plants; Lake Superior - 14 plants; Total - 251 plants.

   Regarding Milwaukee, it should be noted that this event occurred during spring runoff. As such, *Crytosporidium* levels were elevated in the raw water source. In addition, the solids removal barrier was not operating at optimum efficiency and *Crytosporidium* broke through. This event, and the recent North Battleford event, highlight the importance of source water protection and the need for well operating treatment units, especially during periods of higher risk such as spring runoff.

Section 1.4 Treatment Plant Characteristics

5. **Section 1.4.1, Distribution of Plants in Ontario** - Distribution of drinking water treatment plants in Ontario generally follows population density. Most of the 630 plants are located in the south and east of the province. This is shown in Figure 1.4.1, which divides Ontario into the five regions administered by the Ministry of the Environment. The northern area, although geographically larger, has a small population and correspondingly few treatment plants. In contrast, the smaller southwestern area has the largest population and the majority of the treatment plants. (Page 4, Paragraph 1)

   Comment: Three corrections are necessary, namely: 1) Figure 1.4.1 should note that 53 plants are missing from the data; 2) the Northern Region has the smallest population but the third most plants; and 3) the smaller southwestern area has the second largest population but the majority of the treatment plants.

6. **Section 1.4.1, Distribution of Plants in Ontario** - The population in the southwest, while large, is quite dispersed. Many of the waterworks in this area are small; 157 facilities that serve less than 1,000 people are located here. While the trend in many parts of North America is to merge several treatment plant and distribution systems to improve quality and supply, a large number of small individual systems remain in southwestern Ontario. This may present greater challenges to monitoring and promotion of uniform water quality for the population. (Page 4, Paragraph 2)

   Comment: Reference AWWA's Regionalization Policy.

7. **Section 1.4.2, Size of Water Treatment Plants** - Many of Ontario's treatment plants are small; slightly more than half of all municipal waterworks serve less than 1,000 people each (Figure 1.4.2). Only about 15% of all facilities serve more than 10,000 people. Nevertheless, this 15% of facilities serves about 90% of the population, as shown in Figure 1.4.2. Drinking water treatment in Ontario is therefore quite heavily polarised; a large number of small treatment facilities serve a few people and a small number of large facilities serve many people. The positive aspect is that resources directed to the large treatment facilities will benefit the majority of Ontario's population. The negative aspect is that to provide the same quality to the remainder of the population, resources must be widely distributed among a large number of small facilities. (Page 4, Paragraph 2)

   Comment: While I agree with the above statement regarding the polarisation of water treatment in Ontario, it would be useful to know the size of the missing 53 plants to assess whether there are more or less small systems and how this could affect system regionalization.

   Also, many small systems are well operated and provide excellent water quality. As such, the number of facilities that require assistance may be quite small.

8. **Section 1.4.3, Treatment Technologies** - Overall approximately 87% of Ontario's population receives filtered water, which roughly corresponds to the percentage of the population receiving treated surface water (Figure 1.3.2). However, not all surface water treatment plants report using filtration, as shown in Figure 1.4.4. In particular, about 50% of very small surface water plants (fewer than 1,000 people served) do not filter. In mid-sized plants (servicing 1,000 to 100,000 people) filtration is more common, with only 20% to 30% without it. Only 5% of large plants (serving more than 100,000 people) do not filter. All of these facilities are now required to install chemically assisted filtration or the equivalent to comply with the Drinking Water Protection Regulation. (Page 4, Last Paragraph)

   Comment: The Operation Clean Water inspection program conducted by the Ministry of the Environment identified 50 plants as being deficient vis-à-vis water treatment requirements. The cost estimate to bring these systems up to standard is approximately $30 million, subject to the completion of the required Engineer's reports (see page 29). This estimate appears low.

9. **Section 1.4.3, Treatment Technologies** - ***Coagulation*** - It is common to add a coagulant to water to enhance particle removal during sedimentation and filtration. Coagulation is

normally used to treat surface waters, and it is rare in groundwater treatment. The SWIP database indicates that only about 1% of Ontario groundwater treatment facilities applies coagulants. Coagulation of surface waters is much more common. The reported use of coagulation in different size surface water plants follows the trend observed for filtration. Only about 45% of small plants (fewer than 1,000 served) used coagulant (Figure 1.4.6). Approximately 80% of mid-sized plants used it, while almost all large plants serving more 100,000 people coagulated their water. The Drinking Water Protection Regulation requires that surface water treatment facilities provide "chemically assisted" filtration or an equivalent (MOE, 2000b). Coagulation normally provides the chemical assistance. It may be anticipated that the number of facilities using coagulation will increase in response to the Regulation. (Page 5, Last Paragraph)

Comment: The Operation Clean Water inspection program conducted by the Ministry of the Environment identified 50 plants as being deficient vis-à-vis water treatment requirements. The cost estimate to bring these systems up to standard is approximately $30 million, subject to the completion of the required Engineer's reports (see page 29).

It would have been helpful to discuss the "flocculation" component of the coagulation process and the importance of chemically assisted filtration as an effective barrier to chlorine resistant organisms such as *Cryptosporidium* is not mentioned. Also, the sedimentation process has not been discussed. Many surface water plants in Ontario use sedimentation hence this process should be outlined.

This section appears to only discuss treatment technologies noted in the SWIP database (which may explain why sedimentation is not mentioned). The Walkerton Inquiry Part 2 Study List requested an "integration of treatment (including disinfection, and including standard and novel technological alternatives) and measurement". Treatment technologies are further discussed in Part I, Section 4 of the report (see Comment 46).

Section 1.6 Water Quality Considerations

10. The DWSP database provides a representative cross section of drinking water systems in Ontario. It includes large, small, urban and rural systems. It distinguishes between those that supply water from surface and groundwater sources. In 1998 and 1999, 162 of 627 systems (26%) provided water samples to the Ministry for analysis. The suite of parameters measured included those listed in the drinking water objectives, as well as many others. Over 300,000 individual measurements were made under the DWSP program during 1998 and 1999. Of these measurements, there were 91 instances when monitored parameters exceeded health-based objectives. The specific contaminants that exceeded the objectives and the number of occasions are shown in Table 1.6.1. (Page 10, Paragraph 2)

Comment: The exceedance data are summarized by parameter as follows: fluoride - 8; nitrate - 2; turbidity - 38; lead - 10; selenium - 4; NDMA - 4; chloramines - 2; THMs - 23. No details are provided regarding the source water (i.e. surface or ground water) or type of system (i.e. urban or rural).

The above indicates the high level of compliance in Ontario using a drinking water quality "guideline" approach. Also, it would be useful to know how many of the 229 water authorities in Ontario are voluntarily participating in the DWSP (i.e. 162 systems out of 229 authorities represents a 71% participation rate).

11. While the DWSP program monitored many potential chemical contaminants in drinking water, the only direct microbiological measurement routinely conducted was a standard plate count (MOE, 2000a). Such a measurement provides partial information concerning the microbiological quality of a water sample, but it is by no means definitive. It is possible, for example, for water to exhibit an acceptably low plate count while still containing harmful levels of pathogens such as protozoa or viruses, which cannot be measured using this technique. While the DWSP database indicates that the chemical quality of Ontario's drinking water is generally very good, the database should not be used to draw similar conclusions about the microbiological quality. This is not surprising. Microbiological sampling is much more time-sensitive and difficult to co-ordinante than chemical sampling. In the past, the overall microbiological quality of drinking water was monitored through surrogate parameters or indicators, such as standard plate count, or the concentration of residual chlorine in the water. It is only in recent years that the drinking water industry has begun to look more closely at how to detect harmful organisms. For example, in 1998 and 1999 the United States Environmental Protection Agency (USEPA) undertook a program called the Information Collection Rule (see Part II Section 1), in part to collect more extensive microbiological data from drinking water supplies across the country. The USEPA uses these data to assess regulations that target microbial contamination in drinking water. There is no equivalent to this program in Ontario at present. (Page 10, Paragraph 3)

Comment: It is important to note that the goals and objectives of the DWSP are:

- develop a database on water quality to support standard setting;
- trend analysis;
- identify emerging contaminants (and possibly develop an early warning system for same);
- evaluate treatment efficiency.

Particular systems were picked to be included in the DWSP based on their geographic location, population served, and potential for contamination. In this sense, DWSP is a trend monitoring tool and is not designed to be a regulatory compliance/public health regime. Timely microbiological compliance testing is conducted by the water authorities in accordance with the Ontario Drinking Water Objectives/Standards. The objectives/standards reflect low tolerance levels due to the acute health risks associated with microbiological contamination. As such, it is not surprising that the DWSP did not focus on microbiological testing.

Notwithstanding the above, the American Water Works Association (AWWA) and the AWWA Research Foundation (AWWARF) continue to sponsor extensive research regarding organisms that pose acute health risks to the public. Until monitoring methods improve, water utilities should continue to assume that these organisms are ubiquitous and their multiple treatment barriers should therefore be optimized.

Section 1.7 Summary

12. According to the SWIP database, approximately 82% of Ontario residents receive water from a municipal drinking water system, with the remainder on private wells. There were about 630 such systems in the mid-1990s, the majority of which used groundwater and served fewer than 10,000 people. In contrast, a few large plants using surface water served most of the population. There is therefore a distinct polarisation of drinking water services in Ontario: most of the population is served by large surface water facilities, but the rest is served by a great number of small systems scattered throughout the province. This may influence efforts to ensure consistent water quality for the population as a whole. To address a similar issue, the United States has developed assistance programs to ensure that small systems have adequate access to resources aimed at facilitating regulatory compliance, as discussed in Part II Section 1. (Page 11, First Full Paragraph)

Comment: The OWWA/OMWA agree that capacity development programs (i.e. to develop the financial, technical and managerial capabilities of utilities) will be necessary for all water systems in Ontario, particularly the many small systems.

Section 1.8 Staff Training

13. Water Utility Staff Training is a legislated requirement for all Water Treatment Operators, Water Distribution Operators and Water Quality Analysts. The recent changes to Ontario Regulation 435/93, require that licensed Operators and Analysts have a minimum of 52 hours of training per year.

Comment: As of July 2001, this requirement remains a proposal (Samuel, 2001).

Section 1.9 Water Utility Operations, Maintenance and Management Practices

14. The operation, maintenance and management practices of water utilities across Ontario vary tremendously. This variation is based on numerous factors, such as size of the utility, type of operation (public or private), complexity of the facilities, source water type and quantity, location of the serviced community (Northern Ontario versus Southern Ontario), levels of governance involved (Region, City), type of community (urban, rural), etc. This variation is not unique to Ontario and in fact is found across the water industry worldwide.

Although these practices vary substantially, the push for efficient and effective practices has been a focus of the water industry over the past 10 years. This is principally due to large private water utilities seeing business opportunities arise where public utilities were either not meeting their customers' needs, or did not embrace new technologies and management trends to become more efficient. (Page 12, Paragraphs 1 and 2)

Comment: I do not agree that the push was primarily "due to private water utilities seeing business opportunities". I would tend to think it had more to do with the massive re-structuring that the industry has had to deal with since 1993. All utilities have had to struggle with doing "more with less".

15. **Section 1.10.4, Cost Recovery** - It is interesting to note that there is a greater reliance on property taxes for sewer system costs, at 12% of revenues. This is likely due to sewer costs historically being recovered from property taxes. A shift towards a sewer surcharge occurred in the 1970s when the regions were formed and they chose to move to a more "user pay" approach. It appears that the transition is still not complete. There is actually some justification for including some water costs on the property taxes. Many municipalities charge the water system costs for providing fire protection to property taxes, also a legitimate approach supported by the AWWA and allowed in provincial legislation. There is no parallel for sewers. (Page 19, Paragraph 2)

    Comment: The OWWA/OMWA strongly support the "user pay" approach.

16. **Section 1.10.4, Cost Recovery** - The analysis of 1997 revenue sources indicates that fully 96% of water revenues and 95% of sewer revenues are from local sources. Only $38 million or 4% of water revenues and $45 million of sewer revenues came in the form of grants from outside sources. Thus most of the costs are locally funded. Whether or not sufficient investment is currently being made in municipal water systems may be questioned. However, the recovery of current investment levels is very close to full cost recovery. (Page 19, Paragraph 3)

    Comment: Figure 1.10.5 indicates that the 96% of water costs recovered from local sources comprises: user rates - 80%; property taxes - 8%; other local sources - 8%. The remaining 4% comes in the form of grants from outside sources.

17. **Section 1.10.4, Cost Recovery** - The concept of recovering costs as much as possible through user rates is often promoted. Advantages include the promotion of conservation and clearly visible water and wastewater system costs.

    However, there are other revenue sources that are legitimate user pay methods of cost recovery. Capital costs are often recovered up-front for new servicing through frontage and connection charges, development charges and contributions by developers. Also, there are other fees and charge revenues reported that are levied based on services rendered. Thus it should not be assumed that the user rate should be carrying the total burden for water and wastewater costs. (Page 19, Paragraphs 3 and 4)

    Comment: The OWWA/OMWA support the "fee for service" approach. We also believe water revenues should be dedicated to the water system and not used to subsidize other services.

18. **Section 1.10.5, Large Water Systems Serve Most of Serviced Population** - Table 1.10.4 shows the number of municipalities served by municipal water systems, by category and estimated population. (Page 20, Paragraph 1)

    Comment: Table 1.10.4 indicates that there are 229 Water Supply Authorities in Ontario serving 309 municipalities (using 629 water plants per Section 1.3). As noted under Comment 7, there is no discussion on the number of plants each water authority operates to assess the benefits of system regionalization.

19. **Section 1.10.6, Average Per Capita Costs for Surface Water and Ground Water Systems** - The FIR Revenue Fund expenditure data have been analysed to determine unit costs. At the time of the analysis, water Capital Fund data were not available by municipality. The serviced population data were obtained from the MOE. The per capita water costs for different categories of municipality and for surface water source versus groundwater are provided in Table 1.10.5. Note that the analysis excludes municipalities where less than 90% of the supply came from either surface or groundwater sources. Note that "per capita" is used to bring costs to a common comparison basis. Flow data would have provided additional insight, but at the time the analysis was carried out, flow data were not available. (Page 20, Paragraph 1)

Comment: It would be very useful if the information was presented by MOE Region to assess how many of the "Town" systems are within the higher populated areas thereby allowing an evaluation of system "regionalization" benefits and a focussed review of the 70+ smaller "Village" systems. (Note: only 193 of 229 water authorities are included in the analysis).

20. **Section 1.10.8, Future Investment Requirements -** The following are summaries of studies carried out to estimated future investment levels needed in Ontario water and sanitary sewer systems. (Page 24-27)

a) ***Ontario Ministry of Environment & Energy (1996 Draft)*** - Water and wastewater treatment plant infrastructure needs from 1995 -2005 were identified as follows: deficiencies - $1,670 million; rehabilitation - $2,607 million; growth - $1,768 million; total - $6,045 million (over ten years). It was noted that costs should be recovered solely from user rates and that rates would have to increase by 73% to do so.

Comment: Water costs comprised $1,845 million of the above $6,045 million, as follows: deficiencies - $329 million; rehabilitation - $911 million; growth - $605 million. Since growth costs (i.e. one-third of the estimated costs) should be financed from development charges not rates, this would minimize the impacts to water rates. Increased wastewater charges, however, would affect serviced customers.

b) ***Canadian Water & Wastewater Association (CWWA) (1998)*** - This report estimated annual Canadian investments in municipal water and sewer systems at $1.84 billion for water and $4.09 billion for wastewater for a 15-year total of $27.6 billion and $61.4 billion, respectively. The estimates were based on extending water and sewer servicing to all urban residents, meeting Canadian Drinking Water Guidelines, separating storm and sanitary sewers and achieving wastewater treatment to Level III standards. The report estimated that an additional 3,862 km of watermain would be required to expand water supplies to the unserviced urban population. This is based on providing 193 km/capita. Water supply expansion costs were estimated at $2,000 per capita.

Comment: There must be a problem with the data as presented because: 1) it would not be sustainable to extend services to urban residents if you need to provide 193 km of watermain per capita - this should likely be 193 people per km; and 2) $2,000 per capita for water supply expansion (i.e. treatment capacity) is far too high.

c) ***Ontario Sewer & Watermain Construction Association (OSCWA) (2000)*** - This analysis found that a user rate increase of 31% would be required to put water and sewer financing on a sustainable footing using full cost pricing.

Comment: A review of the data indicates that the 31% increase was determined by combining water and wastewater revenues and costs. Splitting the revenues and costs by service results in a water rate increase of 7.5% versus a 55.7% increase in wastewater surcharges.

d) ***State of Ontario's Water Infrastructure (May 2000)*** - This paper prepared and presented by George Powell at the Joint OWWA/OMWA Annual Conference in May 2000, provided the following estimate of annual Ontario water and wastewater rehabilitation needs: renewal and rehabilitation - $0.895 billion; MOE needs - $0.267 billion (water) and $1.0 billion (wastewater); growth - $2.3 billion.

e) ***Association of Municipalities of Ontario (AMO)*** - Supporting material for a June 2000 document identifies a 5-year rehabilitation estimate of $9.1 billion for water/wastewater in Ontario.

Comment: The above two papers indicate that investment in the order of $2 billion per years would be necessary for renewal, rehabilitation and other upgrades (i.e. excluding growth costs). The 1997 capital investments for water and wastewater were $0.425 billion and $0.496 billion, respectively (see page 17). Based on the foregoing, it would appear that insufficient investment is currently being made in municipal water systems. This would concur with AWWA findings in the US that significantly more investment will be needed in the future to replace aging infrastructure.

21. **Section 1.10.9, Summary Comments on Cost Data - *Results of Infrastructure Deficiency Studies*** - The following comments on the results of the infrastructure studies are offered. (Page 29-31)

a) **Deficiencies** - During 2000 many MOE inspections and Engineers' Reports on water supply plants in Ontario have been completed. This information should provide a good basis on which to develop accurate estimates of scope and cost required to repair outstanding deficiencies. The recently completed inspection program of all 645 water treatment plants in the province reported that deficiencies exist in 357. A review of the public notices of infractions reveals the following frequencies and categories of deficiencies:

- Insufficient number of bacteriological or chemical samples being taken and analysed (205 plants).
- Inadequate disinfection equipment (74 plants).
- Plant operators not appropriately certified or inadequate training (59 plants).

- Failure to comply with minimum treatment guidelines. This included plants using groundwater that were not chlorinating the water, or plants using surface water that were not treating it with coagulation, flocculation and filtration (59 plants).

For the first three deficiency categories, the cost of remediation should not be significant. For example, the Region of Durham estimated additional costs of $800,000 for sampling and testing and other measures to meet new water treatment standards out of a total current water budget of $45 M. This is less that 2% of operating costs. The last category goes beyond training, sampling and chlorinator repair. The cost could be much more significant, but they have not yet been quantified. However, even at $500,000 per plant the total cost for 59 plants would only be about $30 million. This is not a lot if the province as a whole is considered, but it could be a burden for individual municipalities. This number should be able to be refined when the engineers' reports are analysed.

Comment: The OWWA/OMWA agree that this analysis should be conducted to refine the costs to upgrade the deficient systems - although other literature provided by the MOE indicates that 50 plants were deficient not 59 as noted above.

b) **Rehabilitation** - A more accurate assessment of rehabilitation costs is needed before the estimated impact can be provided with any confidence.

Comment: The OWWA/OMWA agree that this analysis should be conducted to refine the rehabilitation costs.

c) **Growth Costs Can be Recovered from New Customers** - Ontario legislation provides for recovery of costs expended on new infrastructure needed to satisfy system expansion (for growth and/or local improvements).

Comment: Existing customers should not subsidize system expansions - growth should pay for growth and benefiting residents should pay for local improvements unless there is a public health issue. This would ensure water is not under-valued.

d) **Further Refinement of Cost Estimates** - It is critical that investments in system rehabilitation be a normal part of water system expenditures. To determine whether current levels are sufficient or what the levels should be, more detailed information on water systems is needed. In the case of the above-ground facilities, the MOE has traditionally been well informed and the current reviews of every water supply facility in the province should provide a good review of current deficiencies and ongoing rehabilitation needs. In the case of below-ground facilities, a much better inventory of items such as length, size, construction material, age and condition is needed so that meaningful estimates of future rehabilitation needs can be derived. (Page 30, Second Last Paragraph)

Comment: The OWWA/OMWA agree that this analysis should be conducted to determine how much additional investment will be needed over the coming decades for infrastructure upgrades. These infrastructure needs should encompass both what is required to comply with Ontario Regulation 459/00 (Drinking Water Protection), as well as what will be needed to replace and rehabilitate aging water treatment and distribution facilities regardless of regulatory mandates.

e) **Depreciation** - The term is not applicable in the cash accounting basis used by municipalities is Ontario. In any case depreciation is not sufficient to generate the funds required to replace ageing equipment, since costs of replacement are frequently higher than the original costs being depreciated.

Comment: As noted above, it is critical that investments in system rehabilitation be a normal part of water system expenditures. The Prescott Water Treatment Plant case study presented in Part II, Section 5 appears to indicate that this is not occurring.

f) **Regional Systems** - It has been suggested that small municipalities should move towards area supply schemes. This may have technical advantages, but it should not be assumed that this approach would be cheaper. The unit cost analysis indicates that there are economies of scale, but they are most pronounced for large municipalities. The smaller municipalities do not show economies of scale.

Comment: A review should be conducted to assess whether a number of small systems can operate as a "larger" regional system and achieve some economies of scale.

SECTION 2 STANDARDS, GUIDELINES AND OBJECTIVES

Section 2.1 Guidelines for Canadian Drinking Water Quality

22. **Section 2.1.1, Guidelines for Microbiological Parameters** - In deriving the guideline values for microbiological quality, Health Canada observes that there is no acceptable lower limit on waterborne pathogen concentration, since some individuals may become ill after ingestion of no more than a single organism. Therefore the MAC is zero. In common with most microbiological standards and guidelines for drinking water quality worldwide, the Guidelines rely on measurement of indicator microorganisms to warn against pathogenic contamination. …. Since it may be neither practical nor possible to test for all potential pathogens, the supporting documentation to the Guidelines notes that effective filtration, disinfection and an adequate disinfectant residual in the distribution system provide the best overall protection. If possible, a watershed protection program should also be adopted since this helps to reduce the microbiological burden on the water treatment facility. The Guidelines also recommend that authorities responsible for water safety have policies in place for issuing and rescinding boil-water orders, and that they have a contingency plan in place to deal with a waterborne disease outbreak. (Page 33, Last Paragraph)

Comment: The OWWA/OMWA agree that source water protection, effective treatment and disinfection and an adequate disinfectant residual in the distribution system, complete with an effective system water quality monitoring program, provide the best overall protection. It is also critical that authorities responsible for water safety have policies in place for issuing and rescinding boil-water orders, and that they have a contingency plan in place to deal with a waterborne disease outbreak.

Section 2.2 Ontario Water Resources Act

23. The Ontario Water Resources Act (OWRA) addresses most aspects of water protection, abstraction, treatment, and control in the province. Its provisions have spawned regulations that govern: water works construction and classification; operator and analyst licensing, certification and training; operating standards; fees and fee payment; use and protection of water from any source; all aspects of well construction and operation; aspects of sewage works, treatment and discharge; and others.

    The OWRA applies generally to all municipalities or utilities that wish to abstract more than 50,000 litres of water per day from either surface or groundwater sources. The Act outlines the requirements for licensing to abstract water and the procedure that must be followed to construct works to abstract, treat, or distribute water. Is also outlines the administration of the Act, including the responsibilities of the Minister of Environment, Directors and Provincial Officers. Penalties for violating the provisions of the OWRA include fines of up to $200,000 per day and imprisonment. Detailed examination of the provisions of the OWRA and its daughter regulation is beyond the scope of this paper, however, major elements that control drinking water quality and safety are examined below. (Page 37, Paragraphs 1 and 2)

    Comment: We need to keep in mind what additional improvements, if any, can be implemented under the current regime.

Section 2.3 Drinking Water Protection Regulation

24. In August 2000 the Government of Ontario amended the Ontario Water Resources Act to include the Ontario Drinking Water Protection Regulation (ODWPR) (MOE 2000a). The Regulation was fashioned to strengthen the provincial government's ability to oversee drinking water supply in Ontario and to detail the responsibilities of water suppliers, laboratories, and regulators in keeping water safe for human consumption. It also made the Ontario Drinking Water Standards enforceable by law. (Page 37-41)

a) ***Applicability (Section 2.3.1)*** - The Regulation applies to water systems that supply more than 50 cubic metres per day or are capable of providing greater than 250 cubic meters per cay, or that serve more than five private residences. The Regulation does not apply to systems that receive all their water from another supply system unless (a) they are owned or operated either by a municipality of by the Ontario Clean Water Agency (OCWA), (b) they re-supply water to OCWA or a municipality or (c) they disinfect or treat the water.

b) ***Minimum Treatment Requirements for Drinking Water (Section 2.3.2)*** - By December 31, 2002, no water, unless exempted by the MOE, can be supplied to a distribution system or to plumbing unless it has been disinfected, or subjected to an equivalent treatment. Owners or operators of water supplies that use surface water sources must in all cases use at least chemically assisted filtration (i.e. they must add chemicals that agglomerate particles in the water) and disinfection or an equivalent treatment. The Regulation allows no exceptions to this requirement. Requirements to receive an exemption to disinfection are outlined.

Comment: Groundwater under the direct influence (GUDI) of surface water is not mentioned in this section of the report. Guidance from the Ministry of the Environment regarding the definition of GUDI would be useful per our recommendation in the Issue 7 Response Paper (Hargesheimer, 2001).

c) ***Sampling, Analysis and Notification (Section 2.3.3)*** - The ODWPR requires frequent sampling, both in the distribution system and at the plant discharge, for microbiological parameters, turbidity, chlorine residual, fluoride, volatile organics, inorganics, and other parameters considered potentially threatening to helath. …. Only an accredited laboratory may analyse water samples for health-related parameters and water supply operators may only send samples to laboratories that are approved by the Ministry of Environment. If an owner or operator of a water supply chooses to change the laboratory he uses, he is required to inform the MOE of this change. This is to allow MOE to make the laboratory aware of its obligations under the provisions of the ODWPR. …. The ODWPR also specifies action to be taken if a sample exceeds the Ontario Drinking Water Standard MAC or IMAC for health-related parameters or if the sample shows adverse water quality.

d) ***Reporting (Section 2.3.4)*** - Water suppliers must complete several different forms of reporting required by the ODWPR. These reports are designed to inform consumers of the quality of their drinking water (i.e. two years of all laboratory reports, operational parameter records, MOE approvals or orders). …. Water suppliers are also required to produce Quarterly Reports. These reports must describe the water system, how it operates, and the sources used for treatment and supply. They must also profile the measures the supplier has taken to comply with the provisions of the Regulation and the Ontario Drinking Water Standards and they must summarise the analytical results for water quality for the previous three months. …. The Regulation also requires suppliers to post a public warning in cases where sampling or analysis for microbiological parameter measurement exceeds the ODWS values and corrective action has not been taken. If the supplier fails to comply with this provision of the Regulation, a public health inspector or a provincial officer may post the warning. Under the provisions of the Regulation, water suppliers are required to keep all laboratory reports, operational parameter records, MOE approvals or orders, quarterly water quality reports and engineers' reports for at least five years. These must be made available to the MOE when requested.

Comment: Regarding the quarterly reports, the MOE's Technical Brief on "Waterworks' quarterly reports for consumers" (August 2000) indicates that the water source section must also include information on the availability of source water assessments or protection plans and information on significant sources of contaminants, if applicable.

Regarding the need to post a public warning that corrective action has not been taken to address microbiological contamination, how will the Regulator know whether this has or has not been done? The Regulation currently does not require the owner to provide a copy of same to the MOE or Medical Officer of Health (although it does allow a public health inspector or a provincial officer to post the warning if the owner does not).

e) ***Engineers' Reports (Section 2.3.5)*** - To ensure that water facilities in Ontario continue to produce safe drinking water in the future, the ODWPR requires water suppliers to commission a Professional Engineer to complete an examination of the supply facilities and to make a report. This report must be updated at least every three years. The Engineer's Report must include:

- a description of the water supply facilities other than the distribution system;
- copies of Certificates of Approval for the facilities;
- an assessment of potential for microbiological contamination;
- a characterisation of the raw water source to confirm treatment necessary to meet the ODWS and the Regulation;
- an assessment of operational procedures including review of the Operations Manual;
- an assessment of physical works and their ability to meet the requirements of the Regulation, the ODWS and the recommendations of the Recommended Standards for Waterworks, 1997, also known as the "10 State Standards" (Committee of the Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers, 1997);
- a recommendation for a site-specific monitoring program for the facilities, including the distribution system, that indicates what parameters should be monitored, where and how often they should be monitored, and the type of sampling.

The MOE has published "Model Conditions for Certificates of Approval" that outlines monitoring program requirements for several types of water supply facilities, including groundwater supplies with treatment, groundwater supplies with chlorination only, surface water supplies, and supplies that re-chlorinate water received from another municipality's supply system (MOE, 2000).

Comment: Although not specifically noted above, the Engineer's Report also requires that the chlorination process be evaluated as part of the assessment of physical works to determine its ability to comply with the requirements the 'Chlorination Procedure'. The 'Chlorination Procedure' means "Procedure B13-3, Chlorination of Potable Water Supplies in Ontario" as issued August 2000.

Other improvements to the process have also been suggested in this report and the Issue 7 Response Paper (Hargesheimer, 2001).

Section 2.4 Ontario Drinking Water Standards

25. The Ontario Ministry of the Environment published the Ontario Drinking Water Standards (ODWS) in August 2000. (Page 41-44)

a) ***Standards, Objectives, and Guidelines (Section 2.4.1, Paragraph 3)*** - In common with the guidelines of other countries (e.g. Australia) the ODWS caution that the listed standard values represent the minimum acceptable quality level for water supply; supplies of higher quality cannot be allowed to degrade to the guideline levels. …. The standards do not set numerical limits for viruses or protozoa (e.g. *Giardia* or *Cryptosporidium*) but they do note that it is desirable not to have them present in drinking water. Accordingly, chlorination provisions are set to address *Giardia* and virus inactivation. The standards also note that to provide effective protection, a water supply system should be well-managed, should include chemically assisted filtration and disinfection, should provide an adequate disinfectant residual in the distribution system and should follow a comprehensive monitoring program for pathogens.

Comment: The ODWS do not require a comprehensive pathogen monitoring program.

b) ***Water Works (Section 2.4.2, Paragraph 2)*** - The ODWS reiterate the minimum standards of treatment specified by the Drinking Water Protection Regulation. They also stress the importance of public health and note items that can assist in its protection. These include:

- appropriate treatment processes;
- adequate capacity to meet demand;
- a careful choice of design and location of facilities to minimise pollution effects and source fluctuation problems, and;
- operators that hold licences in accordance with the provisions of Ontario Regulation 435/93 Water and Sewage Works, under the Ontario Water Resources Act.

Comment: Reference AWWA Standards, manual, policies.

c) ***Approval of Water Works (Section 2.4.3)*** - The Standards outline the approval conditions for new water works or modifications to existing supplies. They remind that approval must be obtained from MOE in accordance with Section 52 of the Ontario Water Resources Act. They note that generally the bases for approval is:

- sufficient quantity and good quality source water;
- adequate treatment facilities;
- adequate capacity to meet demands without developing low pressure in the distribution system;
- good engineering;
- compliance with the appropriate policies and guidelines, and;
- consideration of the public interest.

Examination of sources must be completed with sufficient sampling and over an appropriate time frame to demonstrate the necessary water quality.

Comment: Reference AWWA Standards, manual, policies.

d) ***Responsibility for Water Quality (Section 2.4.4)*** - The ODWS set out the responsibilities associated with water supply. They note that the municipality that distributes water is responsible for its quality. If the municipality contracts supply services to someone else it still remains responsible for water quality. Owners are also required to ensure that an appropriate protocol to deal with notification and corrective action is in place. The same provisions apply to private owners and operators who are covered by the provisions of the Ontario Water Resources Act.

Comment: The role of the local Medical Officer of Health and Regulator should be clear.

e) ***Parameter Information (Section 2.4.5)*** - In an appendix to the body of the document, the ODWS briefly examine each of the parameters for which standard values are given. This provides useful information as to the form the contaminant may take and where it may originate.

f) ***Procedure B13-3 Chlorination of Potable Water Supplies in Ontario (Section 2.4.6)*** - The ODWS present a major change to the requirements for water disinfection in the province. Procedure B13-3 of the ODWS outlines the requirements for chlorination in Ontario water supplies. This procedure follows closely the provisions of the United States Environmental Protections Agency's Surface Water Treatment Rule (SWTR) (EPA, 1991). Because viruses and *Giardia* cysts are relatively difficult to sample and measure, the USEPA, and now Ontario, base their disinfection requirements on the high probability that a properly operated treatment plant and a disinfection process that follows the specifications of the SWTR will remove or inactivate 99.9% of *Giardia* cysts and 99.99% of viruses. Thus the SWTR and Procedue B13-3 present an indirect assurance of pathogen control. …. E. coli would be extremely unlikely to survive the conditions established to give this level of virus and cyst kill (because it is easily inactivated by chlorine and other alternate disinfectants). …. In establishing conditions to assure the required removal of cysts and viruses, the SWTR and B13-3 rely on the "CT" concept. C is measured as the residual concentration in water and T is the effective time of contact. By listing known CT values, the ODWS allows water suppliers to calculate an appropriate chlorine dose to achieve a specified degree of inactivation. …. Because CT numbers vary with temperature, pH, disinfectant residual, and degree of inactivation required, the ODWS lists them according to various combinations of these factors. …. It should be noted that in adopting the SWTR provisions, MOE has adopted the first regulations specifically designed to address inactivation of *Giardia* cysts and viruses under the complete range of conditions normally experienced in water treatment plants in the province. It is interesting to note however that the provisions of the ODWS as they stand do not directly address the presence of *Cryptosporidium* in drinking water. This protozoan pathogen can also induce illness after ingestion of low doses and it is extremely difficult to inactivate using normal water treatment doses of chlorine. In its "Enhanced Surface Water Treatment Rule", an update of the original, the EPA adopted a requirement for less than 0.3 NTU (turbidity units) in the discharge from filters to assure removal of *Cryptosporidium*. MOE has not adopted similar provisions in the ODWS.

Comment: Although the report discusses the CT concept it does not note that the required reduction in pathogens is achieved by a combination of filtration and disinfection removal/inactivation credit. Since *Cryptosporidium* is a chlorine resistant pathogen, it is important that the coagulation/filtration processes be optimized to ensure removal of this protozoa - hence the USEPA turbidity requirement.

SECTION 3 WATER UTILITY BEST PRACTICES

Section 3.1 Introduction

26. Because best practices continuously evolve, due to ongoing changes in water treatment technology, equipment, materials, communication methods, regulations, detection

capabilities, etc., no single drinking water supplier can provide the best practices in all of its operations. Rather the water utility that has a complete, continuous improvement program to monitor, benchmark and implement best practices, is a best practice utility. (Page 46, Paragraph 3)

Comment: AWWA supports best management practices and has been a leader in preparing best management standards to ensure "continuous improvement".

Section 3.2 Water Operations

27. Water operations include all aspects of the source water, the water treatment processes, the maintenance of the water facilities and associated equipment, the water distribution system and water quality management programs. The best practices of water operations are address in the following sections: water resources; water treatment and maintenance; water distribution system; water quality management. (Page 46-50)

a) ***Water Resources (Section 3.2.1)*** - Best-in-class utilities have plans and measures in place to protect existing and future water sources. The utility will make certain that these plans are an integral part of the local/ regional zoning, land development planing, and watershed management. The utility will also protect its sources to make certain that water quality is maintained. This requires complete cooperation among multi-jurisdictional watershed management bodies including conservation authorities, neighbouring municipalities, and private and public landowners. …. The utility must determine whether existing water supply sources (groundwater or surface water) are adequate for the current service area, as well as forecasted regional economic development. Water withdrawal rate must be managed to sustain the resource and the utility must have a contingency/emergency plan in place to deal with drought, flood, or contamination. This plan should be updated regularly. …. Water utilities that follow best practices will also have a water efficiency and/or conservation program in place to properly manage the resource.

Comment: Reference the AWWA integrated resource planning policy and water conservation policy. Source water protection policy was submitted as part of the Issue 6 Response Paper.

b) ***Water Treatment and Maintenance (Section 3.2.2)*** - A key component to best practices in water treatment relates to human resources development programs used to train and develop operators and maintenance personnel. A best-in-class utility will have a formal operator training program to help employees become certified. The senior management of a best-in-class utility will have a good understanding of the complexities of a treatment system and the importance of investment in maintenance, repair, and retrofits. The utility will make certain its operators are appropriately trained on new equipment and new systems when they are being selected and put into operation. Any change in treatment process will be pilot-tested prior to implementation. Many best-in-class water utilities track advances in new treatment technologies through the use of pilot plants on their source water. These pilot plants are not only used for new technologies and treatment processes, but are also used on an ongoing basis to improve or optimise existing treatment. Both small and large utilities frequently partner on pilot testing and research of new treatment technologies with organisations such as the AWWA (American Water Works Association), the AWWA Research Foundation, the

CWWA (Canadian Water and Wastewater Association), and the NSERC (Natural Science and Engineering Research Council). They may also partner on other opportunities that arise on the local, provincial or federal level, as well as through the private sector. …. Compliance records must always be available to regulatory agencies or water customers. A best-in-class utility will have processes in place to find and correct exceptions in water quality before non-compliance issues arise. The operations of large and small water facilities, run by best-in-class water utilities, are computerised and automated as appropriate for the facility. Appropriate equipment redundancy must be available to ensure reliable operation at all times. Appropriate backup systems should be in place to avoid service interruptions during unplanned equipment outages. Control must be in place to address all microbiological quality concerns, including the presence of *Giardia* and *Cryptosporidium*. …. Most best-in-class utilities have computerised maintenance management systems that allow tracking of maintenance activities and provide the utility with a variety of strategies to maintain the equipment. A best-in-class utility will also have a formal energy management plan. …. A best-in-class utility will explore alternative energy efficiency methods such as self generation, co-generation, peak load shaving, hydro power, methane generator energy, and so on. … This allows the utility to benefit from lower energy costs; this benefit is in turn passed on to the customers. Storing water in reservoirs to reduce energy cost must be modelled and must consider impacts on water pressure provided to customers and availability of stored water for fire protection and emergency uses.

Comment: Storing water in reservoirs to reduce energy cost must also consider impacts to water quality - reference relevant AWWARF papers and other documents.

Reference AWWA's electric power reliability policy, drinking water quality policy, managing ground water policy.

c) ***Water Distribution System (Section 3.2.3)*** - Best-in-class utilities have a reliable water distribution system that provides customers with a continuous supply of potable water at adequate pressure. The fire suppression capabilities of the distribution system should provide homeowners and business with low fire insurance rates. …. The least amount of disruption to the buried watermain infrastructure will provide for a more reliable water system. Most best-in-class utilities now have a computerised geographic information system, which provides them with location, depth, pipe, material and repair records of the components of the water system directly on computers and/or maps. A reliable water distribution system will have reservoirs located appropriately through the system for pressure balancing, peak demands, fire protection, and emergency needs. The distribution system watermains will be appropriately looped to provide adequate pressure for daily peak and fire protection flows, as well as to reduce inconvenience to customers during planned and emergency repairs. …. Best-in-class utilities will have a continuous monitoring capability at reservoirs, pumping stations, and critical areas throughout the water distribution system. Continuous monitoring will include not only water quality aspects, but also pressures and flows, which are normally monitored through a SCADA (Supervisory Control and Data Acquisition) system. A best-in-class utility will also have a program to control potential cross connections within a water distribution system. Formal preventive maintenance programs include flushing of watermains, cleaning, inspection, and exercising watermains, valves and fire hydrants, as well as water service lines and water service posts. …. A best-in-class water utility will have a formal watermain rehabilitation and replacement program for improving water quality and maintaining the reliability of its systems. This formal program will be linked directly to a long-term capital and financial planning program to assure adequate funding. No-dig and trenchless technologies for rehabilitation of watermains are also very prominent in best-in-class water utilities. A best-in-class utility will also invest in computerised maintenance management systems and technologies to support its field maintenance operations. Bar code technology for valve maintenance, fire hydrant maintenance, and other types of appurtenances used in the water distribution system can be very efficient since data can be downloaded at the end of the day from hand-held computers used by maintenance staff. Large items such as water reservoirs, elevated tanks and other critical components of the water distribution system must also receive regular maintenance.

Comment: Reference the AWWA cross connection control policy and manual. Also, note the issue regarding the utility having limited authority in this regard (i.e. need for statutory position in municipality responsible for water similar to Fire Chief and Chief Building Official).

Reference distribution system goals which include: maintain positive pressure and fire flow; manage water age; maintain chlorine residual; keep the distribution system clean (i.e. flushing), provide treatment that does not allow water to degrade in the system (i.e. consider AOC); monitoring (including online results).

Also, the Issue 7 Response Paper highlighted the need for watermain break procedures to maintain distribution system water quality and other necessary standard operating procedures (Hargesheimer, 2001).

d) ***Water Quality Management (Section 3.2.4)*** - Quality of drinking water is the most critical component of any water system. A proactive utility will always consider the impact of drinking water quality standards on the water supplied to its customers. Should there be concerns, an appropriate process will be in place to address them. …. Water utilities must form partnerships to stay abreast of emerging issues. …. A best-in-class utility also participates in water quality optimisation programs to prevent or reduce taste, odour, and other aesthetic problems. The municipality will enact the necessary by-laws or water ordinances and standards to control improper activities in the water distribution system, e.g. cross-connections, which can cause back-flow into the water system. Whether the utility has its own laboratory or uses a private laboratory for water quality analysis, the utility must make certain that the laboratory is current and effective in its performance and that it is appropriately staffed with certified personnel. The utility will also make certain that it has a formal water quality monitoring program that covers the entire water distribution system.

Comment: Note the reference to utilities forming partnerships to stay abreast of emerging issues and highlight the benefits of this consolidated approach (i.e. AWWA Research Foundation).

Also, note the need for sanitary surveys to ensure representative sampling in the distribution system. Note other concerns that can compromise distribution water quality (i.e. dead ends, oversized watermains, etc.).

Section 3.3 Business Operations

28. Business operations of a water utility include the following functions: strategic planning; capital improvement programs; engineering; fiscal management; facilities management; information management systems; purchasing and inventory management. (Page 50-54)

a) ***Strategic Planning (Section 3.3.1)*** - The utility's strategic plan should be based upon its vision, mission and long range goals. The plan will define strategies to address the most difficult issues facing the utility. The leadership of the utility, as well as all supervisory levels, must support the plan and must be able to articulate it clearly to their staff and customers. A well thought out and strategic business plan will clearly define which groups or departments are responsible for which tasks. It will address the necessary resources available to meet the plan (people, money, etc.) and will attempt to foresee any future government regulations. The plan must be broad enough to consider social, economic and environmental issues associated with future development plans in the region or community. The plan will consider available water resources, treatment and distribution facilities and the customer base, both existing and future. A best-in-class utility also benchmarks its business and strategic planning process with other water utilities or similar types of industries. All relevant stakeholder groups (customer, governing bodies, employees, etc.) will be invited and should be involved in the strategic planning process. Employees in turn should feel a sense of ownership for the long-range plans to meet the needs of current and future customers and development.

Comment: Note the importance of "strategic planning" and "leadership" to entrench the continuous improvement culture in water system operations.

b) ***Capital Improvement Programs (Section 3.3.2)*** - To have a best-in-class capital improvement program, a utility must have a formal process to evaluate the condition of existing utility equipment and infrastructure and to determine its replacement and rehabilitation needs. …. A process must be in place to prioritise capital spending, with priorities determined through criteria that consider, in addition to regular operational issues, the consequences of customer and business disruptions, social costs, and the opportunities afforded by other infrastructure and public works projects. …. Best-in-class utilities will also employ value engineering and other methods to cross check the cost effectiveness of complex capital improvement programs.

Comment: Reference AWWA policy regarding long term fiscal planning.

c) ***Engineering (Section 3.3.3)*** - All utilities, regardless of size, appropriately use engineering consulting firms to perform selected services and projects in a way that makes economic and operational sense. …. The utility must have the means to monitor costs and quality control, both from the engineering component as well as the construction component of any capital improvement project.

Comment: AWWA policy regarding long term fiscal planning notes that decisions should be based on sound engineering.

d) ***Fiscal Management (Section 3.3.4)*** - Good financial management for water utilities requires a user pay system. A user pay system means that the users of the water system are the only ones that pay. This is normally based on two primary revenue sources: water consumption and fire protection. …. Best-in-class utilities have a completely metered water system, charging all customers on the basis on water quantity used. …. Regardless of the rate structure, full cost recovery must be implemented to operate and maintain current and long-term infrastructure. The fire supply charge component is used in many best-in-class water utilities to link received revenue to the infrastructure needs of various customers. …. A best-in-class utility will have a financial plan in place to ensure that the utility has the capital and cash it needs to meet its business plan. Most best-in-class water utilities have a sound financial performance and are financially strong. …. A best-in-class utility knows that its financial knowledge is limited; it will seek advice from outside experts when needed. The utility will also regularly conduct vigorous analysis of its rate structure, revenue generation, and capital needs to ensure that the rates are at the appropriate level and that adequate cash and capital are available. …. A best-in-class will also have a successful revenue collection system with complete control over its revenues and expenses. Best-in-class publicly owned utilities make certain that utility capital expenditures and utility operating expenses are managed separately from other local government department and authorities. They will also ensure that appropriate activity-based costing is identified for those activities that are shared at the municipal level. A key component to a best-in-class accounting system is to make certain that the information needed by staff is measurable, objective, and available for decision-making.

Comment: Reference AWWA policies regarding metering and water conservation.

e) ***Facilities Management (Section 3.3.5)*** - A best-in-class utility will have in place a geographic information system (GIS) mapping technology to map the complete infrastructure. This GIS system should be kept up to date and be accessible to all staff required to operate, maintain, or plan the infrastructure. The GIS mapping system must be accurate and must cover all utility properties, easements, rights of way, etc. …. Real estate and land acquisition must also be linked to future expansion plans and to customer/service area needs. The utility should have a long-range plan that includes a formal process to identify future real estate requirements. The utility should also participate in local and regional land planning. This will allow it to balance protection of resources with other legitimate land uses.

Comment: Technology advancements in the past decade have made this an affordable goal for all utilities.

f) ***Information Management Systems (Section 3.3.6)*** - Information management systems improve the quality and timeliness of information available to employees in a utility. …. Depending on the size and the needs of the utility, up to date computer applications must always be considered. …. Although many systems may be used (i.e. billing, hydraulic modelling, water quality tracking, maintenance management system, payroll, SCADA, GIS, LIMS, customer service tracking, etc.), depending on the size of the utility and its needs, these systems must be used appropriately to make the overall operation more efficient. …. Technical support is also critical to make certain that all these systems are up and running appropriately.

Comment: Technology advancements in the past decade have made this an affordable goal for all utilities.

g) ***Purchasing and Inventory Management (Section 3.3.7)*** - A best-in-class utility will solicit competitive bids for orders of all bulk chemicals, fuels, and other major equipment, materials, and supplies. The utilities will have authorised staff to make credit card purchases in cases of supply gaps or emergencies. …. A best-in-class utility will have a "just in time" chemical delivery system that minimises the inventory of hazardous chemicals on site and saves on stocking costs. …. The information management system used for purchasing and inventory must be automated so that stock items or other specialised items are automatically ordered, based on importance and delivery times, to make certain that parts are available for the operations and maintenance activities of the utility.

Comment: Technology advancements in the past decade have made this an affordable goal for all utilities.

Section 3.4 Organisational Operations

29. Organisational operations are the functions that normally include typical human resource and corporate activities of a utility and are broken down as follows: leadership; human resources management; continuous improvement; health and safety, and loss control management; emergency planning and response. (Page 54-57)

a) ***Leadership (Section 3.4.1)*** - Best practices in the leadership area of an organisation begin with a clear mission statement that includes a strong commitment to high quality service and continuous improvement. The utility's organisational structure must be well suited to implement its mission and to achieve its goals. This mission statement must be well communicated to all employees as well as to customers, the governance group, investors (if applicable), and all other stakeholders. …. The utility's leadership must have an open communication process that keeps employees informed about the future direction of the utility. Managers and supervisors must be aware that communication with their employees is a major requirement of their job. Communication channels must be open among the different levels in the organisation. Employees must feel comfortable discussing work-related issues with their immediate supervisor, their supervisor's boss, and the head of the utility. There should be a process in place to respond to questions or suggestions by employees. …. Employees must feel part of a team. They must work together to ensure that things get done correctly and on time. Team problem solving is a core competency of any best practice utility. …. The management of staff, and front line supervisors, requires that employees and supervisory skills be developed to deal with conflict between employees, other resources, and customer inquiries/complaints. Staff and supervisors must be offered the opportunity to improve these skills. All supervisory levels must have a clear understanding of the scope of their duties and responsibilities. This includes giving employees the responsibilities, tools and authority to get things done.

Comment: Leadership will be a key element in re-building consumer confidence. Also, note AWWA policy regarding sufficient time being allocated to skills development.

b) ***Human Resources Management (Section 3.4.2)*** - Training of all levels of staff is critical in any organisation. …. All training programs must be measured and compared to make certain that they are meeting the needs of the individuals being trained. …. Good leadership means that managers take and encourage professional development. Individual training and education plans should be developed for each employee. Management of the utility must have an understanding of the distribution of skills in its current workforce and guide these skills to the needs of the utility and the future distribution of staff. …. The level of diversity in a utility depends primarily on the community served, and good leadership will address diversity through community organisations to make certain that it is being properly addressed. …. Appropriate compensation for all levels of staff is also critical for a <u>best practice</u> utility. …. Recruitment and retention of staff at all levels is also critical for a <u>best practice</u> organisation. Re-training and other transitional assistance are required to retain or recruit the best staff possible. The <u>best practice</u> utility is one that is committed to equal opportunity and equal treatment of all employees regardless of age, sex, race, religion or other workforce diversity issues. A fair and impartial posting process for job and promotional opportunities must take place to meet the needs of all employees. …. A <u>best-in-class</u> utility will have good workplace policies and rules that are understandable by all the employees. …. The manner in which the leadership of the organisation enforces these policies and rules is critical to how the employees will follow them. The utility's management must meet and discuss policies and work procedures on a regular basis with labour representatives.

Comment: Reference AWWA compensation policy. The AWWA training policy was submitted as part of the Issue 10 Response Paper.

c) ***Continuous Improvement (Section 3.4.3)*** - Continuous improvement is one of the key best practices of all good utilities. A <u>best practice</u> utility will establish formal long-range improvement plans for water quality, operational efficiencies, operational productivity, and so on. These plans will establish realistic goals that will be prioritised and well communicated throughout the organisation. Communication of how goals have been reached and the benefits to the organisation and customers must be continually communicated. To meet these goals, a <u>best practice</u> utility will have ongoing metric benchmarking and process benchmarking. Metric benchmarking may be internal or external. Internal benchmarking includes reviews within the organisation e.g. comparisons of yearly maintenance cost for a piece of equipment. External benchmarking considers external comparisons e.g. comparison of water treatment cost with that of a comparable utility in another jurisdiction. Process benchmarking is based on priorities set by the organisation e.g. water quality parameters or operations efficiency in tasks such as repair of watermains. …. A <u>best practice</u> utility will have procedures in place that show how to review a specific process. These will include getting the appropriate levels of staff involved in a team approach, mapping out the activity, addressing the bottlenecks and issues, and implementing the team's suggestions. Once this process is complete, a review of the benchmarking numbers is again taken to see if the goals have been met. Process benchmarking by a <u>best practice</u> utility will be an ongoing activity for the numerous functions that take place. The ongoing improvement programs of a <u>best-in-class</u> utility promote a work environment that is conducive to change. This includes empowering employees to make decisions relating to improvement initiatives. This requires that employees be specifically trained in the applications of formal quality management and continuous improvement practices. This again means that senior management must allocate utility resources in a manner that empowers employees to achieve these improvement goals. These resources include training, financial investments, time, staff skills, etc.

Comment: Continuous improvement involves "empowering employees to make decisions relating to improvement initiatives" without the fear of reprisal (reference Martin paper) and as noted, it is one of the key best practices of good utilities. It asks four fundamental questions, namely: where are we, where do we want to go, how do we get there, and how did we do. Then the process starts again, hence the term "continuous improvement".

It is noteworthy that Quebec Section of AWWA received provincial funding to implement the "International Water Treatment Alliance" Program. The program has been adapted from the AWWA/USEPA "Partnership for Safe Water". It is a voluntary program where utilities adopt proven operational and administrative practices designed to improve treatment plant performance. The program has been a major success - within two years more than half of the Quebec population is served by plants that have joined the program. Ontario should consider supporting such an initiative.

d) ***Health and Safety, and Loss Control Management (Section 3.4.4)*** - A best-in-class health and safety program monitors safety on the job, investigates all accidents and near misses, and reviews all findings of these investigations to ensure staff have been appropriately instructed and trained. A good health and safety program includes a complete loss control program that does not simply address health and safety issues, but also all aspects of environmental codes. Employees should know exactly where to turn to find the information they need when they are faced with a safety risk or a safety question. A best practice utility also have special programs to manage short term disabilities of personnel and to provide assistance and physical therapy to get workers back to work as soon as possible and practicable. Confined space entry policies and procedures, as well as training, must be prominent due to the nature of the water facility. As well, due to the electrical and mechanical hazards of maintenance activities, lock-out and tag-out policies and procedures must be in place. The nature of work in the water distribution system means that safety requirements for trenching are also a key focus of any best practice utility. …. Due to the amounts and different types of chemicals being used in drinking water treatment, all staff working with or near these chemicals must be aware and well trained in their use and handling.

Comment: Reference the AWWA safety policy.

e) ***Emergency Planning and Response (Section 3.4.5)*** - A best practice utility will have very good success in responding to these emergencies with formal documented emergency preparedness procedures and staff who are trained in the use of these procedures. The training will be coordinated with the local emergency response network, such as fire, police, ambulance, etc. …. Emergency response includes a comprehensive emergency response plan than addresses equipment breakdowns, accidents, natural disasters, catastrophes, and any other circumstance that could disrupt normal utility operations. …. When emergencies do occur, a utility and the local emergency response groups must, where possible, have a formal corrective action plan to prevent a re-occurrence.

Comment: Issues related to a boil water advisory are not noted - should they be? Also, reference the AWWA emergency planning manual.

Section 3.5 Customer and Government Relations

30. Customer and government relations refer to those organisations or customers that the utility must respond to. They include local, provincial and federal government entities, drinking water organisations, and the utility's main base of residential, industrial, commercial and institutional customers. (Page 57-60)

a) ***Government Relations (Section 3.5.1)*** - A forward-thinking utility will regularly and effectively interact with local, provincial and federal government entities as well as other public and private organisations such as road authorities, natural gas organisations, telecommunications organisations, and sanitary and storm sewer organisations. …. Two other main organisations with which utilities must have ongoing contact are the local Health Authority and the local Fire Authority. Emergency response plans for both of these organisations must be linked with the water utility's emergency plans for water quality concerns, water pressure, and fire protection concerns. Regular meetings (minimum once per year) should be undertaken with the local health and fire authorities. …. The utility must also build good working relationships with the local regulators and other provincial jurisdictions. <u>Best-in-class</u> will also be aware of emerging issues within Health Canada or Environment Canada, the USEPA, and the World Health Organisation. Many of these relationships or handling of ongoing emerging issues cannot be realised solely by one utility. They are normally accomplished through partnerships with drinking water organisations such as the CWWA at the Canadian Federal level, the AWWA at the international level, the OWWA at the provincial level, and other local associations with the Province, for local issues.

Comment: It is important that regular communication occur between the water utility, Medical Officer of Health and the Fire Chief. A well operated water system is fundamental to protecting public health and providing fire protection.

The OWWA/OMWA has also recommended that: 1) we be consulted on matters affecting the water industry (see Issue 2 & 4 Response Paper); and 2) the Government of Ontario form a Professional Interest Advisory Forum (PIAF) to enhance communication between decision-makers from public health, regulatory/government officials, water utilities and other independent stakeholders with an interest in drinking water issues (see Issue 12 Response Paper).

b) ***Community Relations (Section 3.5.2)*** - A <u>best-in-class</u> utility will have formal programs to address potential odour, noise, safety, and traffic issues that may affect the community. Utilities should publish and widely distribute annual reports on all aspects of their operations. Community education programs should be available to address the utility and community needs. Utilities should work directly with the local school board on education programs to make certain that appropriate messages are understood by all age groups. The utility must inform the public about specific issues, such as the risk associated with disinfection by-products or the recreational use of surface waters. Under specific circumstances, communication with populations that may be at risk due to specific health concerns should also take place through the Health Authority. These could be groups such as the immuno-compromised population who have microbiological quality concerns, or those individuals who may have health issues associated with sodium diets if water softening is undertaken as a treatment process.

Comment: The AWWA has developed many educational videos to support programs at the utility level. Also, it has been suggested under Comment 25e above (see Engineer's Reports) that issues related to "utility planning" be subject to a public consultation process. This would complement what has been suggested above by the Commission's consultant.

c) ***Business Relations (Section 3.5.3)*** - A best-in-class utility will work with the community and the business leaders to make certain that new businesses are attracted to the service area. …. As such, utilities that provide high quality water, have a reliable water purveyance system, and have low fire insurance rates for business and residential customers, should promote themselves and their community as a prime area for future development.

Comment: It is also important to minimise disruptions to commercial customers due to the "business loss" that can result.

d) ***Customer Service (Section 3.5.4)*** - The customer service component of any water utility must be an essential part of that utility's mission statement. The utility's management must communicate the importance of customer service to all its employees. …. Utility personnel must realise the serving customers is their responsibility. …. Customer satisfaction surveys and follow-up to complaints will also be used by a best-in-class utility. The follow-up should be part of a service personnel work-order system that in turn should be linked to a quality assurance system. The quality assurance system should verify that work orders have been appropriately closed and that customer inquiries have been completely addressed. A follow-up call or written correspondence may be made to customers to assure satisfaction with various utility services. …. Customer service representatives should also be briefed on special situations that are occurring within the community due to utility works. Depending upon the size of the utility and the community, separate representatives may be assigned to commercial and industrial customer classes.

Comment: It is important to note that customers define satisfaction not only by the product, but by the services, and related information they receive. A 1993 survey of consumer attitudes commissioned by AWWA and the AWWA Research Foundation indicates that consumers want more information about their drinking water, and nearly nine of 10 respondents supported greater public input to water utility decisions. Reference the survey and the AWWA's consumer principles.

Section 3.6 Accreditation

31. Accreditation refers to a utility (or other organisation) being officially recognised as meeting criteria set out by a recognised accreditation organisation. Accreditation is used in many

industries, with the ISO (International Organisation for Standardisation) program playing a large role. The following sections will discuss ISO accreditation and other Water Utility programs. (Page 60-62)

a) ***ISO (International Organisation for Standardisation) (Section 3.6.1) -*** The objective of ISO is to promote development of world standards to facilitate international exchange of goods and services. The ISO 14001 program is the most appropriate for the water industry. It should be noted, however, that ISO 14001 does not establish absolute requirements for environmental performance beyond commitment to corporate policy, compliance with applicable legislation and regulations, and continual improvement. To determine compliance with ISO 14001, a registrar or auditor is required to look for evidence that procedures have been established or implemented, that they are being maintained through periodic reviews, and that there are revisions when a review process indicates that need for them. It is the utility management's responsibility, not the auditor's, to determine the effectiveness of the procedures and systems in place. ISO 14001 is an excellent tool that water utilities can use to review their environmental programs through a recognised process. Although having ISO 14001 does not recognise a utility to be a best-in-class organisation, having ISO 14001 designation is certainly considered a best practice.

Comment: It is my understanding that the ISO process is labour intensive and costly which may explain why relatively few utilities have implemented this approach to date. Regardless, accreditation is an emerging issue that warrants major consideration as it can help to re-build the public's trust in drinking water.

b) ***Water Industry Accreditation Programs (Section 3.6.2) -*** The AWWA is in the process of developing a water accreditation process. Best practice standards are being developed for all aspects of utility operation. The intent is to have accreditation available worldwide through affiliated professional and scientific organisations. The process would require audits to be conducted by recognised pre-qualified international firms that specialise in this type of service (i.e. CSA).

Comment: AWWA’s formal standards process has been used for more than ninety years to produce ANSI registered material standards that are used by the water utility industry. These standards are recognized worldwide and have been adopted by many utilities and organizations. Accreditation standards will be developed using the same formal process. Volunteer standards committees will establish standard practices in a uniform and appropriate format. Formal ballot procedures will be used to adopt recognized standards.

Accreditation pilots will be performed on each standard to refine and clarify the processes. Accreditation will be offered on each standard category as it becomes available. Full utility accreditation will not be available until 2004. A utility may be accredited in one or more standards or they may seek full utility accreditation, by conforming to all appropriate standards for their operation.

The standard categories relating to water and wastewater utility operation being developed by AWWA include:

- Distribution System Operation and Management
- Water Treatment Plant Operation and Management
- Source Water Management and Protection
- Business and Planning Practices Management
- Communications and Customer Relations Management
- Wastewater Collection Systems Management
- Wastewater Treatment Plant Operations and Management
- Biosolids Handling and Management
- Wastewater Pretreatment Management
- Water and Wastewater Conservation/Reclamation Program Management

c) ***Water Laboratory Accreditation (Section 3.6.3) -*** The Canadian accreditation program was revised in 1999 to meet the latest ISO/IEC 17025 requirement. And today there is a trend for both government and private sector contracting policies to specify laboratory accreditation. Since August 2000, all Ontario laboratories performing municipal water and wastewater samples have to be accredited by CAEAL/SCC.

Comment: The report indicates that the Standards Council of Canada (SCC) was established in 1970 to promote voluntary standardisation in Canada, to facilitate domestic and international trade, and to further international cooperation in relation to standards. The SCC represents Canada in international standards organisations such as the ISO and the International Laboratory Accreditation Cooperations (ILAC). In 1994, SCC and the Canadian Association for Environmental Analytical Laboratories (CAEAL) entered into an Accreditation Partnership Agreement for the accreditation of Canadian environmental testing laboratories. Under the terms of the agreement, CAEAL, a not for profit association, carries out assessments and operates the proficiency testing program. The program is recognised internationally by ISO. It provides formal recognition of the competence of a laboratory to manage and perform specific tests of types of tests listed on its accreditation certificate.

Section 3.7 Partnerships and Professional Associations

32. Regardless of the size of a water utility, partnerships are an essential part of being a best-in-class organisation. Partnerships take various forms and include local, provincial, federal and global components. They are formed to address specific or ongoing issues, and are intended to reduce costs while allowing the knowledge gained to be disseminated to all participants. …. Best practice utilities (large and small) join associations, partner with organisations, and disseminate the appropriate information throughout the organisation as well as to their customers and Board of Directors. …. Partnerships are a critical component of continuous improvement in the water industry. The leveraging of financial support for such items as research projects is most often accomplished through such partnerships. The knowledge gained through the research of a new chemical detection method, new treatment technology, new watermain rehabilitation technique, different training tool, etc. allows the partners to serve their customers more efficiently, and allows the water industry to continuously improve. (Page 62-63)

Comment: It is noteworthy that AWWARF has sponsored a significant amount of subscriber funded research in Canada. OWWA/OMWA recommends that the Government of Ontario and municipalities should participate in drinking water research and encourage participation in AWWARF. Any research activities must be coordinated to avoid duplication of effort while ensuring research relevant to local needs.

SECTION 4 WATER TREATMENT TECHNOLOGIES

Section 4.1 Introduction

33. Treatment of municipal drinking water, which only became widespread in the latter part of the 19th century, provided one of history's more significant advances in public health protection. Prior to routine treatment, waterborne diseases such as cholera and typhoid were common; today such outbreaks are rare in Canada (Health Canada 2000a). Nevertheless, the safety of our drinking water should not be taken for granted. (Page 65, Paragraph 1)

Comment: It took major developments in bacteriology during the 1870s and 1880s to demonstrate that microorganisms that exist in water supplies can cause human and animal diseases. The led to the realisation that water treatment could help prevent disease.

Section 4.2 Solids Removal

34. **Section 4.2.1, Coagulation, Flocculation, and Sedimentation** - For some waters, coagulation-flocculation is the only treatment step applied before filtration. Sedimentation is not used. In this process, called "direct filtration", coagulation and flocculation make particles bigger so that filtration is more effective, since larger particles are less likely to pass through the filter pores. Direct filtration is normally practised in waters that are relatively free of turbidityto begin with. Most of the drinking water treatment plants along the Great Lakes are direct filtration plants. (Page 67, First Full Paragraph)

Comment: The above is misleading. The coagulation and flocculation process causes small particles to attach to one another to form larger aggregates - this facilitates removal. Large "floc" is generally formed for conventional plants with sedimentation whereas smaller "pin" floc is formed for direct filtration plants.

a) ***Impact on health risks*** - The Ontario Drinking Water Standards for disinfection indicate that where coagulation, flocculation and sedimentation are operated correctly prior to filtration (as opposed to coagulation and filtration alone), subsequent disinfection need only provide 0.5-log (67%) of a total required 3-log (99.9%) *Giardia* inactivation, and 1-log (90%) of a total required 4-log (99.99%) virus inactivation (MOE, 2000). These more lenient requirements for disinfection reflect research results that show some pathogen removal occurring through sedimentation.

One further benefit of coagulation-flocculation-sedimentation is that it typically lowers the amount of organic matter in the water. Reduction varies, but can typically range from 10%

to 50% (USEPA 1998). Organic matter is a precursor to many of the chlorination by-products that are known or believed to be harmful, such as trihalomethanes and haloacetic acids. These by-products form when organic matter reacts with chlorine that is added as a disinfectant or oxidant. (Page 67, Paragraph 1 and 2)

Comment: Although primary disinfection is discussed on Page 75, the report does not make it clear that "primary disinfection" is part of the water treatment process to inactivate pathogens and "secondary disinfection" is required to maintain a disinfection residual in the distribution system.

35. **Section 4.2.2, Filtration** - There are many different types of filters, but the common types can be generally divided into the following categories: granular media filter (rapid and slow); diatomaceous earth filter (or, more generally a precoat filter); membranes. (Page 68-71)

a) ***Granular media filters*** - Water enters the basin and flows downward through the media into an underdrain collection system. The medium that is used (sand, anthracite, or other) is selected so that the pore sizes are small enough to collect much of the particulate material in the water, ideally allowing only clean water to pass through. …. The most common method to monitor filter discharge quality is to measure turbidity. Common guidelines or standards in Canada and the United States specify that filter discharge turbidity must remain below a certain limit, often 1.0 NTU (MOE 2000). Evidence over the last decade has shown, however, that a correlation does not necessarily exist between turbidity and the passage of pathogens through a filter (Schneider *et al*. 1998). Partly in response, many water treatment facilities have recently installed particle counters downstream of their filters. Particle counters provide a more accurate indication of filter performance than turbidimeters, allowing, for instance, measurement of the number of particles that fall within the size range of target pathogens.

b) ***Rapid Granular Filtration*** - Selected media are of difference sizes, with the largest medium, having the largest pore spaces between grains, placed on top, and the smallest medium (with the smallest pore spaces) on the bottom. This way, only the largest particles are removed in the top portion of the filter, while smaller particles can penetrate deeper before being removed by the smaller filter medium on the bottom. This lets the entire filter volume remove impurities. …. This process is called "rapid" filtration because by housing the filter in a relatively deep basin (often several meters), a deep-water column can be applied above the filter to "push" the water through the media, accelerating the overall purification process to rates more rapid than were possible in earlier "slow" sand filters. This is important for treatment facilities that must provide a high flow rate of water to a community. However, faster filtration rates come with a price; there is a greater risk that impurities, and more importantly pathogens, can break through the filter due to the higher flow rates and pressures. For this reason rapid granular filters must be more carefully operated and monitored than slow sand filters. The greater filtration flow rates (5-20 m/h for rapid filtration versus 0.1-0.2 m/h for slow sand filtration) also mean that the filters require more frequent cleaning, often in the order of once per day. All treatment systems contain several filters that are operated in parallel so that as individual filters are removed from service for cleaning, other filters continue to operate. Cleaning of rapid granular filters is accomplished by a procedure known as backwashing. A stored volume of clean water flows back (upwards) through the filter bed, fluidises the media and allows trapped impurities to be released. …. Studies that led to the U.S. Surface Water Treatment Rule indicated that properly operated rapid sand filtration can conservatively be estimated to remove 2-log (99%) of *Giardia* cysts, and 1-log (90%) of viruses (SWTR 1991). Filtration is therefore an important element in the multiple-barrier approach to making water safe to drink.

c) ***Slow Sand Filtration*** - Because they maintain a slow flow rate, the risk of particle breakthrough in slow sand filters is much lower. …. To clean a slow sand filter, the top layer of sand must be physically removed and replaced. Slow sand filters provide good pathogen control. The Ontario Drinking Water Standards assume that these filters can routinely remove 2-log (99%) of *Giardia* cysts, and 2-log (99%) of viruses (MOE 2000). Studies also suggest that 2-log (99%) of *Cryptosporidium* removal can also be routinely provided (Tanner 1997).

d) ***Granular Activated Carbon (GAC)*** - Many of the water treatment plants along Lake Ontario have responded to the recent increase in summer taste and odour events by adding a layer of GAC to existing filters.

e) ***Diatomaceous Earth Filter*** - Diatomeceous earth (DE) filters are very rare, and generally only used in very small systems. …. Drawbacks associated with DE filtration include a relatively complex operating cycle and a lower capability, relative to traditional granular media filters, to handle large variations in influent water quality (Montgomery, 1985).

f) ***Membrane Filters*** - Membrane filtration is a process by which a pressure gradient drives water through a semi-permeable membrane. While water can pass through the membrane material, impurities that are larger than the pore size of the membrane cannot. The advantage of membrane filtration over granular media filtration is that by manufacturing membranes with a fixed and predetermined pore size, a much higher level of control over the quality of the filtered water can be achieved.

g) ***Summary*** - Filtration is a process by which impurities are removed from the water either by straining, or by attachment to the filter media. Major types of filtration include granular media filtration (rapid or slow sand), diatomeceous earth filtration, and membranes. There are advantages and disadvantages to each, and the type of filter that is best for one community may not be best for another. The one factor that is common for all filters is that to be most effective, they must be properly operated and maintained. Filters are not simple devices, and knowledge of how operating conditions enhance or detract from filter performance is essential for good filtered water quality.

Section 4.3 Disinfection

36. **Section 4.3.1, Disinfection Basics** - Experience has shown that most natural water sources contain pathogens, either continuously or intermittently, due to contamination by human or animal waste (Abbaszadegan *et al*. 1998, LeChevallier and Norton 1995). …. It is common practice to disinfect drinking water to control pathogens. Common disinfectants used in drinking water treatment are chlorine, chloramines, chlorine dioxide and ozone. These are strong chemicals that act either by destroying important constituents in the cell or by disrupting essential metabolic activities (Montgomery 1985). …. Disinfectants react with

impurities and with pathogens. As a result, disinfectant concentration decreases with time. The difference between the applied disinfectant dose and the remaining concentration at any time is called the "disinfectant demand". Waters containing a high concentration of impurities often exert a high disinfectant demand, with the result that high doses of disinfectant must be added to ensure that an adequate amount remains to control pathogens. While this disinfectant demand has a financial cost, perhaps a more serious consequence is the formation of disinfection by-products (DBPs). …. Engineers and water treatment professionals therefore face the challenge of providing enough disinfectant to control pathogens, while at the same time minimising DBP formation. A properly designed disinfection process must address both of these issues simultaneously. (Page 73-74)

37. **Section 4.3.2, Disinfection By-Products (DBPs)** - It is important to be aware that DBPs include species beyond those few that are regulated. Ideally, DBP minimisation strategies should attempt to focus on all DBPs, and not just only those that are regulated. To control DBP concentrations, there are a few steps that can be taken: 1) remove DBP percursors (impurities in the water) prior to disinfection; 2) avoid overdosing with disinfectant; 3) selection of the appropriate disinfectant; and 4) pH control. (Page 74-75)

38. **Section 4.3.3, Other Uses for Disinfectants** - The common chemical disinfectants act by oxidising and disrupting cellular activities. The strong oxidising property that makes these chemicals such effective disinfectants also may be used for other beneficial purposes, such as: 1) taste and odour control; 2) oxidising colour compounds; 3) oxidising iron and manganese. (Page 75)

39. **Section 4.3.4, Primary Disinfection** - Waters at risk of contamination (surface waters or groundwater under the influence of surface water) must be disinfected to sufficiently control *Giardia* cysts and certain viruses. This would be achieved by providing an appropriate concentration of disinfectant (C) for an adequate length of contact time (T). This is called the CT approach and it has now been adopted in the new Ontario Drinking Water Standards (MOE 2000). …. The new Ontario disinfection standard (MOE, 2000) was adapted from the U.S. Surface Water Treatment Rule, which when written involved an analysis of the measured concentration of pathogens in waters, based on historical surveys and the susceptibility and tolerance of the population to illness (SWTR 1991). It was concluded that as a general rule, treatment facilities at risk of source water contamination should ensure that their treatment processes were capable of providing a minimum of 3-log (99.9%) *Giardia* removal/inactivation and a 4-log (99.99%) virus removal/inactivation. Higher levels may be required, based on historical influent concentrations. Depending on the treatment process, a substantial portion of these requirements could be achieved through filtration, often leaving a remaining disinfection requirement of 0.5-log *Giardia* inactivation and 2-log virus inactivation. Systems would then determine the CT required to achieve these inactivation targets, using tables provided in the regulatory literature that correlate CT values to different levels of *Giardia* and virus inactivation. In practice, CT is calculated using allowable simplifying assumptions. …. The important implication of these simplifying assumptions for C and T is that while they provide a conservation underestimation of *Giardia* and virus inactivation, they consequently tend to promote addition of more disinfectant than may in fact be necessary. This increases DBP formation. It is therefore perhaps not in the best interests of public health to be too conservative in calculating CT. Arguably, a better approach would be to make as accurate an assessment of the true CT as possible, so that the

disinfectant does required to provide the desired level of pathogen control is known precisely, thereby avoiding overdosing. While the Ontario Drinking Water Standards make no mention of more sophisticated and accurate methods to calculate CT, the equivalent American regulation encourages such approaches to be taken, recommending the simplistic T_{10} and "C effluent" approach for only those treatment facilities without the means to employ the better methods (SWTR 1991). (Page 75-77)

Comment: Agree.

40. **Section 4.3.5, Description of Disinfectants** - Chlorine is extremely capable of controlling bacteria and most viruses, however it has difficulty inactivating certain protozoa. It is also noteworthy that chlorine is ineffective at controlling *Cryptosporidium*. A treatment system that chlorinates must therefore rely exclusively on filtration to remove *Cryptosporidium*. Chloramines are useful for secondary disinfection because they are very stable and can often last in water for weeks. Chloramines also do not form high concentrations of DBPs, an important property given the long periods of time that water may spend in distribution systems (Symons et al. 1998). As a result, many facilities in the United States are responding to tougher DBP limits by switching from free chlorine to chloramines for secondary disinfection. While chloramines may by appropriate for secondary disinfection, they are weak disinfectants and do not provide adequate primary disinfection. Chlorine dioxide, ozone and ultraviolet (UV) radiation are also discussed. (Page 77-80)

Comment: It may be worth noting that the Calgon patent on the UV process for the inactivation of *Cryptosporidium* continues to hang over installation of UV treatment. A patent (for medium pressure UV) has been granted in the US and Canada and Calgon has requested an extension of the patent to cover *Giardia* and other applications down to 1 millijoule. The licence fee will be 1 1/2 cents per 1,000 gallons through the UV system.

41. **Section 4.3.6, Summary** - Disinfection is now considered to be one of the more important processes in drinking water treatment. As such it should be designed to meet treatment objectives that take into account the range of pathogens that may be present in natural water sources, including those that are known to be very resistant. Providing a sufficient CT, calculated to achieve adequate *Giardia* and virus inactivation, is used to achieve regulatory compliance.

42. **Section 4, General Comment -** I felt the discussion fell short of the Commission's study request (i.e. a major paper - integration of treatment, including disinfection, standard and novel technological alternatives, and measurement). A discussion starting with the components of the multiple barrier approach would have been useful. This would have allowed the authors to:

- identify the benefits of source water quality management;
- describe conventional water treatment processes (i.e. pre-disinfection, coagulation and flocculation, sedimentation, filtration, post-disinfection, fluoridation, residuals management);

- describe other treatment processes and innovative technologies (i.e. air stripping and aeration, flotation, membranes, chlorine dioxide, ozone, ultraviolet light, granular activated carbon, powdered activated carbon, particle counters, etc.);
- describe the need for process optimization (i.e. to maximize the efficiency of the multiple barriers to ensure effective removal of contaminants, particularly for organisms such as *Cryptosporidium* that are chlorine resistant);
- describe the need for effective disinfection;
- describe the need for distribution system maintenance (i.e. maintain positive pressures and fire flows, manage water age, maintain a chlorine residual, keep the distribution system clean);
- outline the need for appropriate monitoring and sanitary surveys;
- summarize the need for operator certification and training.

PART II DRINKING WATER IN OTHER JURISDICTIONS

SECTION 1 UNITED STATES OF AMERICA

43. The experience in the United States was discussed extensively in the OWWA/OMWA Issue 2 and 4 Response Paper. In addition, the Issue 12 Response Paper discussed issues related to Consumer Confidence Reporting and issues related to the U. S. Clean Water Act will be discussed in the OWWA/OMWA Issue 6 Response Paper. Other noteworthy points include:

- ***Sanitary Surveys***: The total coliform rule requires an on-site inspection (referred to as a sanitary survey) every 5 years for each system that collects fewer than five samples per month. These sanitary surveys allow the regulator (and utility) to establish representative sampling locations in the distribution system for water quality monitoring purposes.
- ***Variance Provisions***: Variances to SDWA requirements can be granted provided the terms of the variance ensure adequate protection of human health.
- ***Cryptosporidium Monitoring***: Large utilities will have to monitor for *Cryptosporidium* for two years, and depending on the mean concentrations measured, actions could vary from nothing to source water protection to UV/ozone treatment.
- ***Immuno-Compromised***: Studies are to be conducted to identify groups with the general population that may be at greater risk than the general population of adverse health effects from exposure to contaminants in drinking water.
- ***Training and Education***: A "health care provider" training program and a public education campaign is required to inform both the professional health care community and the general public about waterborne disease and the symptoms that may be caused by infectious agents, including microbial contaminants.

Comment: Differences between the Ontario and US approaches as summarised in the Delcan report include: 1) drinking water standards are determined at the federal level whereas individual provinces set standards in Canada (although it is my understanding that the standard setting process in Canada is based on Health Canada research that is presented to the Federal-Provincial Sub-Committee); 2) the existence of the U.S. Safe Drinking Water Act that unified almost all issues pertaining to drinking water; 3) the American commitment to research (although the Issue 2 and 4 Response Paper noted in the appendices that the level of research being done was nowhere near what was required).

SECTION 2 EUROPEAN UNION

44. Noteworthy points include:

- ***Integrated Water Quality Management***: This unified approach integrates legislation designed to protect consumers with legislation designed to protect and manage source waters. Consumers are protected through The Bathing Water and Drinking Water Directives, which deal with water for consumption. Standards and obligations in the Drinking Water Directive apply to waters supplied from a distribution network, from a tanker or in bottles or containers. Source Management divides into two focus areas: protection of raw water quality (to ensure good water quality and good habitat for fish life) and control of emissions (to limit discharges of wastes and potentially harmful substances to surface and groundwater).
- ***River Basin Districts***: The Water Management Framework is based on river basins. Groundwater and coastal waters must be assigned to the nearest or most appropriate river basin. Where water bodies cross national boundaries, an International River Basin District must be formed. Member states must then assess the characteristics of each river basin, establish a Programme of Measures to be enacted and produce a River Basin Management Plan for each district. The Directive gives particular emphasis to protection of water bodies used or intended for use as drinking water. The River Basin Management Plan must be published with nine years, updated within fifteen years and every six years thereafter.
- ***Public Consultation***: Public input into the implementation of the Water Framework is considered vital. Interested parties have a six-month period for submitting written comments.
- ***Exemptions and Derogations***: Member states may exempt an individual supply that provides less that 10 m3/d on average or serves fewer than 50 persons but the served population must be informed of this exemption. Also, member states are alllowed to provide derogations to some provisions of the Directive as long as this does not constitute a potential danger to human health.
- ***Monitoring and Variances***: The monitoring program must include check monitoring unless it can be demonstrated that a parameter is unlikely to be found in the water at a significant concentration (i.e. a variance). Additional monitoring, however, is required for parameters for which no standard is provided but which must be adopted if they present a significant risk to human health (i.e. *Giardia* and *Cryptosporidium*).
- ***Reporting***: Member states must publish a report on the quality of water for human consumption every three years. Member states are also required to provide a second report to the Commission that describes measures taken or planned to (a) inform and advise consumers in circumstances where supplied water may not meet standards (i.e. derogations) due to suspect distribution, even when the distribution system is not under the control of the supplier, and (b) ensure that total trihalomethanes concentration in supplied water is at most 150 ug/L five years after implementation of the Directive and at most 100 ug/L ten years after implementation of the Directive.

Comment: Differences between the Ontario and EU approaches as summarised in the Delcan report include: 1) regulations in Ontario apply to water utilities whereas in the EU they are aimed at the governments of member states; 2) exemptions in Ontario are not readily achieved whereas the EU allows "derogations"; 3) the different approach for *Giardia* and *Cryptosporidium* in Ontario and the EU is noted.

SECTION 3 ENGLAND AND WALES

45. In addition to the requirements set by the EU, noteworthy points include:

- ***Wholesomeness***: Conditions under which water supplied for drinking, washing, or cooking may be considered "wholesome: are defined.
- ***Monitoring***: The required number of samples may be reduced in situations where analysis over the previous three years had shown values of less than 50% of the prescribed value for the parameter tested, except for pH, which must remain between 6.5 and 8.5, and hardness or alkalinity, which must have been no less than 90 mg Ca/L or 45 mg bicarbonate/L, respectively. The regulations also require suppliers to take samples if they consider that parameters may have or are likely to exceed the regulated values.
- ***Reporting***: Suppliers are required to prepare and maintain a record that presents details of the water supply. This must include the name of the supply zone, the name of the treatment works, the population of the zone, details of any relaxation granted in respect of the required parameter values, analytical results, and the number and extent of water quality exceedences. This record must be updated at least yearly and the information must be made available to the public. The supplier must make the public aware that such records are available for inspection.
- ***Cryptosporidium***: Water suppliers must examine their systems and determine the risk of circulating waterborne *Cryptosporidium* oocysts from the treatment works. If a significant risk exists, suppliers must install treatment that ensures the average number of oocysts per 10 litres of treated water is less than one. The supplier must also install on-line sampling equipment that samples a flow of no less than 40 litres per hour on average. Treatment works capable of continuously removing or retaining particles greater than one micron in diameter, and which are continuously monitored and have the capability of shut-down on failure, do not need to continuous monitor for oocysts.

SECTION 4 AUSTRALIA

46. Noteworthy points include:

- ***Multiple Barrier System of Protection and Water Supply System Management***: The Australian Drinking Water Guidelines recognise the importance of the multiple barrier system of protection and present the concept of "quality systems" as an effective and efficient way of managing a water supply system. The "Australian Framework" recommends a 12 step "watershed to tap" approach to ensure the production of good quality water.

- ***Disinfection By-Products***: The guidelines strongly point out the relative risks posed by disinfection by-products versus waterborne pathogens. The guideline summary states "while the presence of these compounds in drinking water should be minimised any such action must not compromise disinfection. It must be emphasised that water which has not been disinfected poses a far greater risk to health than disinfection by-products".
- ***Reporting***: Water authorities should provide annual reports of their performance against the guidelines and agreed levels of service.
- ***Public Consultation***: The above noted levels of service are subject to public review and comment. Public consultation is an important component of the Australian Framework.
- ***Small Systems***: The guidelines note that in conditions of economic constraint some small systems may only be able to supply water with no or minimal treatment. This water may be subject to a minimum of monitoring. Noting the potential danger to human health, the guidelines depend on regular sanitary inspections of the supply, and on the use of a good quality supply source. If severe problems occur that may require better treatment or use of an alternative source, the estimated cost required should be presented to the community, along with the relative advantages and disadvantages. The community must then decide on the action to be taken.
- ***Waters and Rivers Commission***: A State agency whose function it is to manage the State's water resources in a manner compatible with sustainable development and conservation of the environment by: 1) guiding planning, development and catchment management to protect water resources; 2) responding to pollution complaints; 3) cleaning up spills that threaten to pollute wetlands, water ways or groundwater; assessing groundwater contamination; 4) monitoring water quality in wetlands, waterways and groundwater; 5) regulating land use in Public Drinking Water Source Areas, including permits for business to operate.
- ***Office of Water Regulation***: A State agency whose function it is to issue licences to water suppliers, as well as: 1) develop policy and advise the Minister for Water Resources, particularly on (water) price levels and development; 2) provide customer service (through investigation and arbitration of complaints); 3) manage the Farm Water Grant Scheme which provides assistance to farmers located in areas with insufficient water supply.
- ***Health Department***: Water providers are required to meet specific quality levels included as conditions of their operating licences. Monitoring and enforcement of these conditions generally falls to the Health Department.

Comment: Seems like a complicated process.

SECTION 5 CASE STUDIES

47. This section was included to examine the effects of regulations and other influencing factors on several operating water treatment facilities in Canada and abroad. The questions to be answered included:

- how regulations influence water supply?
- do different regulatory approaches result in a significantly different quality of drinking water?
- what are the critical influences on production of good and safe water?

The following case studies were discussed:

Regulatory Regime	Facility Type	Name and Location	Rated Capacity (m^3/d)
Guidelines (to August 2000)	Large Scale - Ontario	F. J. Horgan WTP - Toronto, Ontario	459,000
Regulations	Large Scale - Canada	E. L. Smith WTP - Edmonton, Alberta	235,000
Regulations	Large Scale - US	McCarron WTP - St. Paul, Minnesota	545,000
Guidelines (to August 2000)	Small Scale - Ontario	Prescott WTP - Prescott, Ontario	8,200
Regulations	Small Scale - US	Camptonville WTP - California	547
Guidelines	Large Scale - Australia	Serpentine Pipehead Dam WTP Perth, W. A.	500,000
Guidelines	Large Scale - Australia	Wanneroo WTP Perth, W. A.	130,000

The level of treatment provided by each of the above noted facilities varies as follows:

Facility	Type	No. of Operators	Filtration		
			No. of Filters	Type	Rate[2] (m/hr)
F. J. Horgan WTP	Direct Filtration	13	8	Dual Media	11.7
E. L. Smith WTP	Conventional	16	12	Dual Media	5.2
McCarron WTP	Conventional	10	18	Dual Media	?
Prescott WTP	Direct Filtration	2	3	Dual Media	10
Camptonville WTP	Slow Sand Filtration	?	?	Slow Sand	0.024 to 0.1
Serpentine WTP	Disinfection Only	1.2 [1]	N/A	N/A	N/A
Wanneroo WTP	Conventional	?	12	Rapid Sand	12.5

Notes:

1) The information provided in the report notes that three (3) operators are available 40% of the time. This equates to approximately 1.2 operators.
2) The filtration rate noted in the above table is per the report. Values provided generally refer to the "plant design rate" - that is the filtration rate that the plant would experience at its design capacity. The only exception is the Camptonville information. Average filtration rates for winter (0.024 m/hr) and summer (0.1 m/hr) were provided for this plant.

It is noteworthy that the range in filtration rates observed at the Camptonville WTP for winter and summer flows was provided. The other plants would obviously also experience a range in filtration rates for winter and summer flows. Although the actual range in filtration rates experienced by the other plants has not been provided by Delcan, the range in flows experienced at each of the facility was provided. Winter and summer flows are generally represented by the average day and maximum day production values, respectively. The range in flows observed at each of the facilities is as follows:

Facility	Serviced Population	Production (m^3/d)		Peaking Factor	Usage Rate[1] (Lpcd)
		Average Day	Maximum Day		
F. J. Horgan WTP	780,000 [2]	382,000	531,000	1.39	489
Edmonton (total)	830,000	334,000	435,000	1.30	402
McCarron WTP	395,000	191,527	321,726	1.68	485
Prescott WTP	4,500	3,000	7,100	2.37	667
Camptonville WTP	260	216	432	2.00	831
Serpentine WTP	560,000 [2]	220,000	450,000	2.05	390
Wanneroo WTP	330,000 [2]	130,000	230,000	1.77	390

Notes:

1) The usage rate has been calculated for all communities except Toronto, Ontario and Perth, Australia. The usage rate is calculated by dividing the average day production by the serviced population. Please note that this is what we call a "loaded" rate as it includes residential and non-residential uses.
2) For the Toronto, Ontario and Perth, Australia case studies, the usage rate was given and the serviced population was estimated by Delcan using same.

The Prescott usage rate is noted as being high in the Delcan report due to the higher than normal industrial consumption in that community. No comment, however, is provided on the high Camptonville rate (although it could be high owing to its location).

The range in raw water quality, and associated use of chemicals, also varies by facility as outlined in Table 1. Notwithstanding the differences in raw water turbidity, the plants produce comparable finished water quality with the exception of the Australian plants, which have notably higher turbidity values.

The concerns with the financial information and the lack of comparable financial data, call into question any conclusions drawn from comparing these plants. Futhermore, the lack of an identified "transfer to capital" for infrastructure renewal for the Prescott case study raises a "big" red flag. This could have major impacts to user rates for communities that have not made provisions for same.

A further breakdown of the costs for the two Ontario plants for which details have been provided, excluding any capital financing stabilisation fund allowances, indicates that the top three expenses for Toronto - a large system - include: 1) debt repayment; 2) electrical power; and 3) direct labour. For Prescott - a small system - the top three expenses include: 1) labour; 2) electrical power; and 3) other (for which no details are provided). It is noteworthy that currently sampling and analysis costs represent in the order of 2.1% and 3.0% of the expenditures for the large and small systems evaluated as part of the Delcan report, respectively. If these costs were to double or triple, due to enhanced monitoring requirements, they would represent in the order of 6% to 10% of the costs.

Notwithstanding the impacts that increased sampling and analysis cost may have to systems across Ontario, the lack of "capital transfers" to reserves for future infrastructure renewal may have a far greater impact.

Comment: It is interesting to note the purpose of this section, because no opinion regarding the effects of regulation is provided. The two plants in Ontario, that up to August 2000 operated under the guideline scenario, provide water quality as good as the regulated plants in Alberta and the US and better than the plants in Australia. Is this due to good operations? I believe so, but the inclusion of river based supplies in Ontario that see similar fluctuations to Edmonton (i.e. Brantford, Ottawa) would have confirmed same.

Furthermore, there is obviously something wrong with the cost analysis which calls into question the material presented in this section.

PART III MAKING ONTARIO WATER TREATMENT A WORLD-LEADER

SECTION 1 CONSIDERATIONS FOR ONTARIO WATER SUPPLY

Section 1.1 Standards

48. **Section 1.1.1, Standards in General** - A distinction should be made between standards and the implementation of these standards. Frequently an early reaction to adverse water supply incidents is a call for tougher standards and more regulation. An assumption that existing standards are deficient is implicit in such demands. Generally they are not. Most water supply incidents result from a lack of knowledge of correct procedure or a lack of knowledge of the consequences of incorrect procedure. Thus the problem more often lies in compliance with the standards and not with the standards themselves. Conversely, no matter how high standards of water quality, treatment, or training are set, they do not guarantee that supply will be error-free unless they are followed rigorously at all times. (Page 172, Paragraph 2)

Comment: This comment confirms the need for the appropriate "organisational behaviour" in a water utility.

49. **Section 1.1.2, The Ontario Drinking Water Standards** - In many respects the ODWS put Ontario to the forefront of drinking water regulation. They deal not only with the quality of drinking water in the province but also regulate water utility infrastructure, testing and analysis, and provision of information to the public. (Page 172, Paragraph 1, Sentence 2)

Comment: This comment confirms that Ontario's standards "compare favourably with those in the rest of Canada and are on a reasonable par with international regulations" (Gammie, 2001).

TABLE 1 - RAW WATER QUALITY AND CHEMICAL USE FOR THE CASE STUDIES

Facility	Raw Water Turbidity (NTU)			Alum Dose (mg/L)			Pre-Chlorine Dose[1] (mg/L)			Post-Chlorine Dose (mg/L)			Treated Turbidity (NTU)		
	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.
F. J. Horgan WTP	0.40	0.10	30.0	5.8	5.0	9.0	0.9		1.5	1.4		4.6	0.05	0.02	0.18
E. L. Smith WTP	54	25	500	49	25	300	2.75	2.5	3.2				0.04	<0.02	0.11
McCarron WTP	?	?	?	18	15	19	5.0		6.0				0.04	0.02	.29
Prescott WTP[2]	0.30	0.19	0.59	12	12	12	0.32	0.30	0.34	1.0	0.8	1.2	0.06	0.03	0.05
Camptonville WTP	?	?	?	Not required with slow sand filtration.			?	?	?	?	?	?	?	?	?
Serpentine WTP	0.8	0.6	2.4	N/A	N/A	N/A	N/A	N/A	N/A	2.0	1.5	2.5	0.8	0.6	2.4
Wanneroo WTP	16	10	22	65	50	110				5.5	0.7	9.0	1.1	0.79	1.8

Notes:

1) Represents the total chlorine dose provided if no value is noted under the post-chlorine dose column.
2) Chlorine dioxide is used at the Prescott WTP for pre-chlorination.

50. **Section 1.1.3, Areas of Contrast with Standards and Regulations in Other Jurisdictions *(Microbiological Standards)*** - A much greater challenge to safe water is presented by microbial pathogens that are considerably more resistant to common disinfectants. These include viruses and protozoa such as *Giardia* and *Cryptosporidium*. These microbes have been responsible for many outbreaks of illness worldwide and are considered a health threat, particularly to immuno-compromised populations. The ODWS have adopted the CT approach (see Part I, Section 4.3.4) and some of the EPA Surface Water Treatment Rule provisions for inactivation of Giardia and viruses. Standards have not been included for inactivation of *Cryptosporidium*. (Page 172, Paragraph 1, Last 6 Lines)

Comment: It is unlikely that a standard for *Cryptosporidium* would be useful until monitoring methods for same improve. In the interim, it is imperative that the treatment barriers that remove *Cryptosporidium* (i.e. coagulation and filtration) be optimized and well operated. Research must continue on alternate disinfectants that appear to inactivate *Cryptosporidium* (i.e. UV/ozone).

a) ***Giardia and viruses*** - The ODWS include tables of CT values for inactivation of *Giardia* cysts and viruses under various conditions of temperature, pH, and disinfectant residual. These tables, which are reproduced from the EPA Surface Water Treatment Rule (USEPA 1989), are applicable only for chlorine disinfection. Even though the OWDS note that "the use of disinfectants such as ozone, chloramines, chlorine dioxide and ultraviolet radiation is increasing in Ontario", they do not provide CT tables for these disinfectants. Such tables are available and form part of the Surface Water Treatment Rule (AWWA 1991). Given that ozone and chlorine dioxide are effective in the control of *Giardia* and viruses and have also shown promise for inactivation of *Cryptosporidium* it is likely that these powerful disinfectants will receive greater attention in the province. It is therefore surprising that the ODWS did not provide greater guidance for their application to control at least *Giardia* and viruses. (Page 173, Paragraph 1)

Comment: Agree (Gammie - Recommendation 3.7).

b) ***Cryptosporidium*** - The ODWS do note that "it is desirable that no virus or protozoa (e.g. *Giardia*, *Cryptosporidium*) be present in drinking water", nevertheless they do not provide guidelines or directions that specifically address *Cryptosporidium* removal. Because control of *Cryptosporidium* is probably the most challenging task that faces water treatment facilities in the province it will be necessary to follow the lead of other jurisdictions and address methods for its inactivation. It is likely that Ontario will have to implement strict standards to ensure that the potential for disease caused by this parasite is minimised and that the safest possible drinking water is available to the public. (Page 173, Paragraph 5)

Comment: As noted above, large utilities in the US will have to monitor for *Cryptosporidium* for two years, and depending on the monitoring results, actions could vary from nothing, to source water protection to UV/ozone treatment. The action levels are associated with a "toolbox" of options, each with a "credit" attached. The UK approach was to assume it exists and to regulate treated water. The analytical uncertainties render this a dubious approach in AWWA's opinion. In addition, the UK approach was not recommended in Australia by the Sydney Inquiry. The US approach is to monitor raw water then take action according to need. The US approach will likely result in a "process" standard as opposed to the traditional numerical standard.

c) ***Groundwater Under the Influence of Surface Water*** - The ODWS also note that, "Groundwater under the direct influence of surface water is considered to be surface water." They stipulate that treatment of such water must achieve a minimum of 3-log removal of *Giardia* and a minimum of 4-log removal of viruses. However unlike the Surface Water Treatment Rule, the ODWS do not outline the conditions under which groundwater should be considered groundwater under the influence of surface water.

Although this is a relatively minor issue that would likely be addressed during approval, allowing the water supplier to make this determination beforehand and avoid the work and cost associated with the application process would be useful. Suppliers from existing sources should also be able to determine whether their sources require treatment equivalent to the minimum specified for surface water. (Page 174, Paragraphs 1 and 2)

Comment: The OWWA/OMWA believe MOE staff thought the addition of the word "direct" would clarify matters versus simply stating "groundwater under the influence of surface water". Regardless, the drinking water community is looking for guidance on this issue. The USEPA definition of "groundwater under the influence of surface water" notes that "direct influence of surface water may be indicated by rapid shifts in water quality indicators such as turbidity or conductivity, the presence of diatoms, plant debris, rotifers, insect parts, larvae, Coccidia or Giardia cysts in the source water" (Gammie, 2001).

d) ***Water Resources Management*** - Eventually the difficulty and cost required to remove contaminants become greater than those required to limit initial contamination of the source. In recognition of this, both the United States and the European Union have incorporated watershed protection requirements directly into their drinking water regulations and standards. (Page 174, Paragraph 1, Last 2 Sentences)

Although a number of watershed management projects are currently underway in Ontario, the ODWS do not formalise any requirements for a watershed management plan beyond noting that "water supply should be obtained from a source that is most likely to produce drinking water of a quality meeting the Ontario Drinking Water Standards and Policies". They do states that the "owner of the water works should conduce frequent surveys of impacts of pollution on the water source" however the frequency or extent of these surveys are not specified. Ontario practice contrasts with the approach taken by the European Union which has made River Basin Management and generation of a "Programme of Measures" central to its Integrated Water Quality Management (see Part II, Section 2). Similarly the EPA's Surface Water Treatment Rule outlines watershed protection provisions that are mandatory for supplies that do not filter and are recommended for those that do. The focus of these provisions is to control "detrimental activities" that can lead to increased concentrations of contaminants, particularly microbial, in water abstracted for drinking (AWWA 1991). (Page 174, Paragraph 3)

Comment: A Technical Brief prepared by the Ministry of the Environment entitled "Waterworks' quarterly reports for consumers" (August 2000) indicates that the following information must be included in the quarterly report required under Section 12 of Ontario Regulation 459/00 (Drinking Water Protection):

- a description of the waterworks, the operation of the waterworks, and the water source;
- availability of source water assessments or protection plans;
- information on significant sources of contaminants, if applicable;
- an outline of the measures taken to comply with the Regulation and the Ontario Drinking Water Standards (ODWS);
- a summary of the analytical results taken during the quarter.

In addition, Section 13 of Ontario Regulation 459/00 (Drinking Water Protection) now requires the owner of a water treatment or distribution system to prepare a report in accordance with the MOE publication entitled "Terms of Reference for Engineers' Reports for Water Works". The principal objectives of the Engineers' review and Report are to assess the potential for microbiological contamination of the water works (i.e. source water characterisation) and to identify operational and physical improvements necessary to mitigate this potential utilizing multiple barrier concepts. A monitoring regime for the entire system must also be identified to ensure compliance with the Ontario Drinking Water Standards and Regulation (MOE, August 2000 and Revised January 2001).

The Engineers' Report is a comprehensive process that includes components similar to the source water assessment process included in the 1996 USEPA Safe Drinking Water Act (SDWA) Amendments and many parts of the Australian "Framework for Management of Drinking Water Quality". As such, the completion of the Engineer's Report will be necessary to allow utilities to present their "source water assessments or protection plans" to the public in the quarterly reports.

The OWWA/OMWA recommend the process evolve to include source water assessments and protection plans for presentation to the public.

e) ***Conclusion*** - The Ontario Drinking Water Standards are comprehensive and represent a significant improvement to provincial regulation. They are also well written and easy to understand. The limitations noted above are not insurmountable. Nevertheless in the interest of providing clear direction to Ontario water suppliers they should be addressed. (Page 174, Paragraph 1)

Comment: Gammie paper highlights other issues as well as these noted above.

Section 1.2 Operations and Quality Management

51. **Section 1.2.1, General** - Part I, Section 3 presented the elements and practices that constitute a best-in-class utility or define best management practices. These are targets for which all Ontario water suppliers must aim. …. It must also be recognised that a true definition of what constitutes a world-leader is difficult to capture. It depends on the criteria applied. For example, which is a world leader: a facility that produces drinking water whose characteristics are orders of magnitude better than the required standards, but at an exorbitant price, or a plant whose water just meets the standards but also minimises consumer cost? (Page 174-175, Paragraphs 1 and 2)

Comment: This raises the "level of service" issue that the Australian Framework has attempted to deal with via public consultation. The Australian Framework suggests that the public consultation plan address the following:

> *"discussions should include the establishment of levels of service, costs, existing water quality problems, and the options for protection and improvement of drinking water quality including land use constraints, changes in treatment or infrastructure. Consumers should also be consulted on monitoring requirements and mechanisms for public reporting of system performance. Decisions and agreed levels of service should be based primarily on estimates of risk and cost, together with local knowledge of the source water (including the degree of catchment protection), treatment processes employed, history of the distribution system and the quality of the management program exercised over its operation. Consumer needs and expectations will influence the extent to which each community will adopt guideline values." (page 51)*

The establishment of "levels of service" noted above should not be construed as "standards" for regulatory purposes. Rather, they are intended to establish the needs and expectations of consumers on which the utility can be evaluated.

52. **Section 1.2.2, Large Scale Water Supply Facilities *(Water Resources Management)*** - Water suppliers should also establish and report benchmark characteristics of the source, particularly its flow and its quality. (The new Ontario regulations require a characterisation of the source water as part of the Engineer's Report). These will establish the current status of the water source. The supplier should then follow a defined schedule of follow-up examination and reporting to measure and note subsequent changes to the water resource. This examination should go beyond a simple chemical analysis of the raw water; it should include observations of flow changes, land use modifications, and industrial or agricultural development, as a minimum. The Ministry of the Environment should stipulate the frequency and extent of the follow-up testing. Both of the initial status report and subsequent examination reports should be made freely available to the public. This approach serves a two-fold purpose: protection of the source and protection of the abstractor. The latter is important in cases where degradation of water supply is not due to the activity of the supplier. Similar to European Union practice the Ministry of Environment should then establish a registry of protected water sources in the province (see Part II, Section 2). (Page 175, Paragraph 2)

Comment: This is an excellent objective. The MOE's roles and responsibilities will need to be clearly defined, as will those of the water utilities. Furthermore, program oversight needs to be assigned to ensure that provincial trends and emerging issues are being monitored appropriately. Lastly, public consultation should be a formal requirement of the process.

53. **Section 1.2.2, Large Scale Water Supply Facilities** ***(Water Treatment)*** - Each water treatment facility in the province must be able to meet the current needs of its community. …. Treatment facilities must be controlled by operators who are appropriately trained on the equipment and processes used. …. In addition to holding the appropriate licence, operators must also undergo continual training, especially on new or upgraded equipment. (Page 175-176)

    Comment: Enforcement will be key to ensuring appropriately certified operators are in place and receiving the minimum required training (Samuel, 2001).

54. **Section 1.2.2, Large Scale Water Supply Facilities** ***(Water Distribution)*** - To achieve world-leader status, Ontario water distribution systems must provide a continuous supply at adequate pressure. …. Maintaining quality of water in the distribution system is critical. Steps to ensure this will include the provision of an adequate disinfectant residual, as required by the Ontario Drinking Water Standards, comprehensive sampling and analysis, and monitoring of flows and pressures. Inadequate disinfectant residual in the distribution system can allow contamination of treated water by pathogens resident on the pipe walls or through infiltration of poorly sealed joints. (Page 176, Paragraphs 1 and 2)

    Comment: Given that more waterborne disease outbreaks result from problems in distribution systems than from breakdowns in treatment processes, I would have expected a whole section dedicated to "maintaining water quality in the distribution system". The issues noted under Comment 31c above should be discussed, as well as other best management practices for distribution systems.

55. **Section 1.2.2, Large Scale Water Supply Facilities** ***(Other Recommended Practices)*** - Part I, Section 3 gives a comprehensive examination of other best practices that should be adopted in Ontario water supply. These will not be repeated here, however, achieving the aim of being a world leader will require adoption of as many as possible of these practices. (Page 176, Paragraph 1)

    Comment: Part I, Section 3 is a well written section that essentially provides the Government of Ontario with a checklist of requirements.

56. **Section 1.2.3, Small Scale Water Supply Facilities** ***(Problems Facing Small Scale Systems)*** - In the U.S., between 1992 and 1994, systems servicing fewer than 500 people exceeded Maximum Contaminant Levels more than twice as often as those serving populations over 10,000. (Page 177, Paragraph 2)

    Comment: Although this information made by correct, the source is not provided to confirm same.

57. **Section 1.2.3, Small Scale Water Supply Facilities *(Recommendations)*** - Any effort to address the problems facing small systems should focus on ensuring sustainable high quality service. An effective system must have the technical, financial and managerial capabilities to address long-term public health and safety requirements.

    Depending on a small systems proximity to other systems, physical interconnection with a larger system may be a restructuring alternative. This may involve the wholesale purchase of water from another facility or ownership consolidation. Another alternative often referred to as satellite management involves the co-operation of two or more systems with respect to sharing of some services.

    An important aspect for improving the operation of many small scale systems is adequate operator training, which will require improvements in current training and certification methods for small system operators. Training and certification programs must be made accessible to those operators in remote areas and must focus on the skills that are important for these individuals to properly manage their facility. (Page 177, Paragraphs 1, 2 and 3)

    Comment: Small system issues noted above include: 1) capacity development; 2) regionalisation; and 3) training and certification. Adequate funding/financing of infrastructure rehabilitation/renewal with also be a major issue.

58. **Section 1.3, Training** - It is during circumstances of unexpected or unnoticed change that many treatment failures occur. These are also the circumstances under which it is crucial to have well-trained personnel in charge. (Page 178, Paragraph 4, Sentences 2 and 3)

    Comment: Samuel report (Issue 10) recommendations.

59. **Section 1.4, Technology** - The Ontario case studies examined in Part II, Section 5 showed that careful operation of established technologies produces very high quality drinking water. (Page 179, Paragraph 3, Line 4)

    In general the technologies that will help establish or maintain Ontario facilities as world leaders will include increased automation, improved control and data acquisition and optimised process operation. (Page 179, Last Paragraph)

    Comment: It would have been useful if the Ontario case studies included an evaluation of a groundwater and river supply system. Also, the evaluation of one or more systems serving less that 1,000 people would have helped identify specific concerns related to the small system problem in Ontario.

60. **Section 1.5, Research and Development** - Research and development of drinking water technologies is becoming increasingly important for water utilities. …. In the past, the Ontario Ministry of the Environment (MOE), and also to some degree Health Canada, funded research dedicated to specific treatment issues or to problems associated with raw water sources. As a result of financial restraint both of these agencies now provide only minimal funding, if any, to applied research conducted by Universities and other parties. …. In

contrast, larger organisations such as the Environmental Protection Agency (EPA) and the American Water Works Association Research Foundation (AWWARF) fund drinking water research in the United States. These organisations typically fund multi-year projects and teams of academics from various universities. In addition, many of these projects link directly to issues associated with specific water treatment facilities. It should be noted that although AWWARF is a US-based organisation, Canadian researchers may also apply for research funds. In summary, both the Ontario Ministry of the Environment and Health Canada should be re-established as funding sources for drinking water treatment research. MOE funding of projects would ensure that specific treatment issues were addressed when they were most required in the province. It would also assist in the implementation of new drinking water standards and in the preparation of future standards. Health Canada funding would ensure a strong health focus in drinking water research, as well as allowing this information to be readily disseminated at both regional and national levels. (Page 179-180)

Comment: Although the AWWARF headquarters are located in Denver, Colorado, it is a North American, if not global, organisation. The mission of the AWWARF is to advance the science of water to promote quality of life. The AWWARF serves a planning and management function and awards research contracts to other institutions such as water utilities, universities, and engineering firms. The funding of this research effort comes primarily from the Subscription Program. Water utilities subscribe to the research program and make an annual payment proportionate to the volume of water they produce. Consultants and manufacturers subscribe based on their annual billings. Canadian utilities that are members of AWWARF include but are not limited to: Halifax, Fredericton, Charlottetown, Windsor, Brantford, Waterloo, Toronto, Peterborough, Kingston, Ottawa, Winnipeg, Regina, Edmonton, Calgary, Vancouver, Victoria. Moosehead Breweries is also a member!

The foundation's research agenda addresses a broad spectrum of water supply issues: resources, treatment and operations, distribution and storage, water quality and analysis, toxicology, economics and management. The ultimate purpose of the coordinated effort is to assist water suppliers in providing the highest possible quality of water economically and reliably. Since 1986, the foundation has supported nearly 450 research projects valued at more than $100 million (US). Many of these projects have been or are being conducted by Canadian researchers.

Lastly, the EPA does sponsor research but our Response Paper for Issues 2 & 4 highlighted that the amount of research conducted is not nearly enough. It is important to have a coordinated drinking water quality research effort and not duplicate research being done elsewhere.

61. **Section 1.6, Utility Structure -** One of the obvious questions relating to water operations, is "When is small too small?" The case studies in Part II highlighted differences between small and large systems through the quality and depth of the responses to the questionnaires used to gather information. Operators of large systems seem to be well supported by knowledgeable scientific and engineering staff. Large utilities also support several levels of technically

aware management and thus decisions that affect water supply are in the hands of knowledgeable managers. Operators of small systems by comparison, tend to answer directly to managerial or engineering staff who are not water or wastewater specialists.

Although there is little evidence to suggest that small systems are poorly operated, MOE's move from technical and scientific support to a more regulatory role over the past ten to twenty years has brought about change. In simple terms, the result has been that advice and guidance once freely offered to small communities is no longer available. Although, in theory, this service could be obtained from the private sector, it is reasonable to suggest that much of the help provided by MOE in the past was given in situations where operators were not even aware that advice was necessary.

Availability of funding is also a problem for smaller communities. While small municipalities might support a minor increase to water rates to spread costs over a year, they often cannot afford the cost of on-site consulting. …. Lack of funding can also be a barrier to continued training of operators. …. Often small communities cannot afford to invest in the training necessary to bring staff to this level of understanding. Small utilities may also argue the sense in employing Class IV level operators, or an equivalent, when general water duties are minimal.

Regionalisation is sometimes presented as a solution to the problems of small system operation. …. The best approach to water supply in small communities must therefore acknowledge the potential difficulties while also ensuring the appropriate level of help is available when required. A specialised District Water Supply Officer, supported by one or two technicians, could operate within a district that incorporated a number of small communities. The main function of the position would be to act as a resource to facility operators and small communities, during normal water supply conditions and especially during emergencies. Because the position would be an annual rather than an immediate cost, such as incurred every time an outside consultant is hired, it is likely that small communities would make more use of the resource. …. A second function of the Water Supply Officer would be to perform ongoing inspections of water facilities in the district and to require corrections in the event that standards were not met. This would provide inspection continuity between updates to the Engineers' Reports. …. The position would therefore require a qualified specialist in water supply who could advise on treatment strategies, chemical dosing, regulatory requirements, general operating procedures, etc.

Comment: I would like to make the following points regarding the above text:

- I do not know how the Delcan report can draw any conclusions from the case studies in Part II given the problems with the data and given that only one small systems in Ontario - with a very stable source water - was considered.
- The key is to have well trained operators that can response to appropriate emergency situations - this does not necessitate the need for a Class IV operator to run a Class II system.
- Notwithstanding the need to have technical assistance available to small systems, it is not appropriate to have an individual provide assistance and

also "regulate" the water authority. The AWWA does provide a "Small Systems Hotline" and there are a number of operator association throughout Ontario. The key is to ensure the operator recognises when he or she has a problem (i.e. training and education) and is not afraid to ask a question when they are uncertain (i.e. organization behaviour).

- In addition, the National Research Council document entitled "Safe Water From Every Tap" is an excellent resource aimed at improving water service in small communities. The document reviews the risk of violating drinking water standards and discusses options for improving water service in small communities. A wide range of technologies appropriate for treating drinking water in small communities are reviewed. A number of institutional options for improving the management efficiency and financial stability of small community water systems are also presented.