Water conservation and efficiency performance measures and benchmarks within the municipal sector.

An identification of current practices and an assessment of the feasibility of expanding their use.

A Report Produced for the Ontario Ministry of Environment

By

The Canadian Water and Wastewater Association

And

The CWWA Water Efficiency Network

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Executive Summary

This report distinguishes between performance indicators, benchmarks and targets related to municipal water conservation and efficiency in respect to the production and consumption of water within the municipal context. Broader conservation indicators related to water source management and water system management have been excluded from this project.

There is a well-established methodology for developing performance indicators regarding water and wastewater services. This is summarized in the ISO Standards ISO 24510, 24511 and 24512. In addition the International Water Association has published two excellent reference books on performance indicators for water and wastewater services which provide a large number of examples of indicators and how to calculate them. Internationally, there has been a benchmarking initiative under the sponsorship of the World Bank. Within Canada, a National Water and Wastewater Benchmarking Initiative (NWWBI) has been underway for approximately 10 years involving the collaboration and participation of approximately 40 major water and wastewater utilities. Within Ontario, there has been an Ontario Municipal Benchmarking Initiative (OMBI) initiated by the Chief Administrative Officers of the major Ontario municipal and regional governments.

The variety of performance indicators that can be developed is virtually infinite and can reflect very precisely the needs or circumstances of individual utilities. Amongst this variety, there exists a smaller common set of performance indicators that would serve groups of utilities in general. To achieve the smaller common set of indicators for application at the provincial level or in the wider Canadian context, it would be necessary to identify and agree on a common set of core variables related to the services provided, to establish precise definitions for each of the variables, and to arrange for the participating utilities to collect the necessary data. (See comment below regarding the CSA initiative.) It is also necessary to have a full understanding of the [utility] context in which the indicator(s) is applied. Confidence grading systems can be developed to indicate the level of confidence that can be attached to the performance indicators and to the benchmarks that would be generated.

Performance indicators are recognized as means of assessing the state of an activity or service and are widely used in all fields of operation or management. The benefits of using them, providing they are accurately and appropriately defined, include the opportunity of comparing activities of a single organization from year to year, or of comparing achievements of similar organizations. It is important though to ensure that the indicators used for comparative purposes are in fact the same in terms of content and scope.

A wide range of performance indicators has been identified and illustrated in this report.

Benchmarks have been found for some of these indicators based on the survey undertaken or from bibliographic or internet searches. Generally, Canadian benchmarks indicate apparent low levels of conservation and efficiency when compared with international benchmarks, although there may be some questioning about this conclusion in particular situations. Targets for

Canadian water utilities could be set based on existing international benchmarks (providing the context is applicable), or from national discussion and debate.

An Ontario (and ideally a Canadian) set of indicators, benchmarks and targets could be established, but this will require the establishment of a guideline on how to do so, with definitions, and a means of public reporting and oversight.

A workshop of practitioners was held on February 9, 2009 to discuss and review the findings of the study. This report has been modified to reflect the outcomes of the Workshop.

The Canadian Standards Association is in the process of adopting the ISO Standards as Canadian Standards, and is developing a technical guidance document on the use of the standards within Canada. This will include the definition of the variables to be used in the construct of indicators relevant to the assessment of water and wastewater services. It is planned that a core set of indicators will be developed and fully documented that it is believed should be calculated by all utilities for the purposes of continuous improvement in the provision of water services to their customers. This core set will include indicators related to water conservation and efficiency.

It is recommended that this avenue of proceeding with the establishment of indicators and the calculation of benchmarks be followed as it will be based on well-established international practices that have already been integrated in several Canadian applications, and will include a multi-stakeholder consensus process.

While it is appropriate to have a harmonious and universally applied set of performance indicators (without numerical values applied), it should be left to individual utilities or possible government regulatory agencies to propose and determine targets (i.e., to set the numerical values for indicators) consistent with objectives and the context of the municipality.

Introduction

The purpose of this report is to present the results of the Canadian Water and Wastewater Association (CWWA) and its Water Efficiency Committee's analysis and findings on:

1. water conservation and efficiency **performance indicators** currently used in the municipal sector, including implementation issues;
2. water conservation and efficiency **benchmarks** for each performance indicator identified, including implementation issues; and
3. the feasibility of developing improved water conservation and efficiency performance indicators and benchmarks in the municipal sector in Ontario, and possibly Canada.

In the context of this report, conservation and efficiency has been limited to the production and consumption of water within the municipal context. Broader conservation indicators related to water source management and water system management have been excluded from this project.

Readers should note that **performance indicators** are combinations of variables that provide a means of measuring an attribute of a municipal water or wastewater service or a customer's water use, for example litres supplied per person per day. There is no numerical value attached to an indicator which is simply a generic measure.

When a numerical value is attached to an **indicator** it either becomes a **benchmark** (indicating a state of achievement in the past or currently) or it becomes a **target** if it indicates a state of achievement expected at some time in the future.

The project examined the feasibility of Canadian municipalities collecting the necessary data and calculating performance measures, including the costs, resources and tools that would be required.

CWWA notes that a requirement to practice water conservation is a feature of the **Ontario Design Guidelines for Drinking Water Treatment Systems –** the relevant text is excerpted and reproduced in Annex A.

The project was conducted at two levels: first a questionnaire was developed and sent to over 300 water utilities in Canada seeking information on water conservation and efficiency practices (see Annex B), and secondly, by conducting an international bibliographic and internet search for practices in other countries. The responses to the questionnaire are shown in Annex C and are summarized in the report (see the chapter: **Survey Results**).

Water conservation and efficiency performance indicators examined included, but were not limited to, **residential per capita water use**, **total water savings from conservation measures**, percentage **reduction of water use** from one specified year to another, and water loss through leakage. Additional performance indicators were identified through international searches and communications.

The report includes recommendations on the most appropriate set of performance indicators and benchmarks for the municipal sector in Ontario and how they should be implemented.

The report could serve as a common base to enhance and promote the use and application of performance indicators and benchmarks for water conservation and efficiency in the municipal sector. It could also serve to provide more consistent interpretation and approaches to developing water conservation and efficiency performance indicators and methods of benchmarking for municipal water utilities.

This document is intended for use on a practical level by public-sector water utility managers. It is intended to help them make decisions on selecting appropriate water conservation and efficiency performance indicators that can be effectively implemented in Ontario, and possibly Canada and to establish benchmarks in respect to water conservation programs.

It is expected that the report will assist municipal, provincial and federal governments promote and measure the effectiveness of water conservation and efficiency initiatives within the municipal water production and consumption context.

The report builds on existing knowledge and work in use or available in Canadian jurisdictions and other countries on performance indicators and benchmarking. Where research gaps exist, these gaps have be clearly identified and described.

The report will be forwarded to the CSA Technical Committee S2029 which is in the process of adopting the ISO Standards 24510, 24511 and 24512 as Canadian National Standards and is producing a Technical Guideline for Water Utility Managers on the development and use of a core set of performance indicators (including conservation and efficiency) as a means of promoting continuous improvement in water utility services.

Definitions

The definitions used in this Document are drawn from two sources that are excerpted and included in Annex D.

Performance Indicator

A performance indicator is a parameter, or a value derived from parameters, which provides information about the achievements of an activity, a process or an organization with a significance extending beyond that directly associated with a parameter value.

An example of a performance indicator would be "The average number of litres [of water supplied] per person per day" – i.e., L/p/d; also more commonly referred to in North America as litres per capita per day or "Lcd".

The indicator may be treated as a "supply" or a "demand" side indicator of performance.

Performance indicators do not have numerical values associated with them. When a numerical value is associated with them, the indicator becomes either a benchmark (indicating a past level of achievement) or a target (indicating a future level of achievement to be obtained). Numerical values are determined by the responsible authority for the organization reporting the benchmark or establishing a target.

Benchmark

A benchmark is a numerical point of reference generally historical or current, and if used in a future sense would be understood to be a target.

An example of a supply-side benchmark for this indicator would be "In 2008, the average supply of water to residential customers was 350 Lcd."

Equally, a demand-side benchmark for this indicator would be: "In 2008, the average residential demand for water was 350 Lcd."

Target

A target in reference to a performance indicator will be a determined value for the indicator which is to be achieved over time through the conduct of a program.

An example demand-side target would be to reduce average demand to 300 Lcd by the year 2012.

In remote communities in Canada serviced by truck delivery, the current supply may be below health standards (80 Lcd) and a target might be “to increase water supply to 100 Lcd by the year 2012.”

Targets may be set by the utility management or by the responsible authority (e.g., the municipal council or a provincial or territorial regulatory body).

Targets should be set following consultation and progress towards achieving them should be transparent to all relevant stakeholders.

Characteristics of Performance Indicators

There are key characteristics of performance indicators which have been described in the ISO documents already referenced. Excerpts from those standards are provided in Annex E.

Performance indicators involve the measurement of **variables** generated by analysis of the service performed.

The **variables** selected should be easily understood, readily measured accurately, readily available, and relevant to the indicator to be developed. Careful and exhaustive definition of the **variables** used may in some cases be necessary to ensure reproducibility or comparability. For example, residential consumption of water should take into account differences between summer and winter demand, indoor and outdoor use, and whether the residential consumer is a single residence or in a multi-residential building – all of which factors and variables will affect the amount of consumption.

Each variable used should:

a) fit the definition of the performance indicator or context information it is used for;
b) refer to the same geographical area and the same period of time or reference date as the performance indicator or context information it will be used for;
c) be as reliable and accurate as the decisions made based on it, require.

Indicators are typically expressed as ratios between variables.

These ratios may be commensurate (e.g. %) or non-commensurate (e.g. $\$/m^3$).

In the case of non-commensurate ratios, the denominator should represent one dimension of the system (e.g. number of service connections; population served, total water main length; annual costs). This allows for comparisons through time, or between systems (although there may be other factors to take into account in inter-system comparisons which relate to the context in which the systems operate – e.g., small rural communities vs. suburban communities).

Water Conservation and Efficiency Performance Indicators Found

The following are selected examples of performance indicators that were found through an extensive national and international bibliographical and internet searches. It is considered that they meet the conditions set for the Guideline project; that is they:

1. are relevant and meaningful with respect to water use, conservation and efficiency,
2. are relevant and meaningful to virtually all municipalities or individual households in Ontario,
3. inform decision-making to improve the performance of the municipal drinking-water system or individual households,
4. recognize the inherent diversity of municipalities or households,
5. support benchmarking and monitoring over time,
6. have commonly accepted definitions and established methods for measurement and be transparent and verifiable, and
7. are understandable and meaningful to identified stakeholders.

The indicators listed below are considered to be most appropriate indicators to use and apply in the Canadian context in respect to production and consumption of water within the municipal context:

1. Percentage of customers who are metered – this would apply separately to all customer categories (residential, institutional, commercial, industrial and municipal).

2. Percentage of customers subject to increasing block tariffs.

3. Total water production per capita.

4. Infrastructure leakage index.

5. Indoor residential water consumption/household – calculated from winter water consumption patterns.

6. External residential water consumption/household – calculated by taking total summer residential water use and subtracting internal residential water consumption.

7. Multi-family residential water consumption/household.

8. ICI water consumption/consuming unit – note the principle of this indicator should be modified to apply to different types of ICI customers – for example
    a. for hotels, the indicator should be water consumption/room;
    b. for hospitals, the indicator should be water consumption/bed;
    c. for schools, the indicator should be water consumption/student;

   d. for restaurants, the indicator should be water consumption/number of licensed customers;
   e. for industrial customers the indicator should be water consumption/unit of output.

9. Use/type of municipal operation – for example:
   a. for parks the indicator should be water used/acre or water used/acre/month;
   b. for street washing, the indicator should be water used/km of road washed;
   c. for water treatment plant operations, the indicator should be water consumed for back-flushing operations/back-flush.

More examples are provided in Annex F.

In each example, the indicator is followed by a comment regarding its serviceability. Please note, Annex F represents only a selection of examples of performance indicators that are used or could be developed

Survey Results

The responses received from the survey (see Annexes C and D) have been compiled and the following is the result of the analysis of the responses.

Metering practices

The following is a summary of the findings from the 39 returned survey questionnaires (a total of more than 300 surveys sent to CWWA member municipalities) regarding metering practices.

Residential Metering:

- 56% of respondents were fully metered (99% or better)
- 26% of respondents were not metered
- 10% of respondents were between 1% and 50% metered
- 10% of respondents were between 50% and 99% metered

Non-Residential Metering:

- 72% of respondents were fully metered (99% or better)
- 18% of respondents were not metered
- 5% of respondents were between 1% and 50% metered
- 5% of respondents were between 50% and 99% metered

Performance indicator generation

The following is the responses to the question: Are the performance indicators that you currently use:

1. always accurately calculated – 5 (12.8%)
2. calculated where possible based on available data – 19 (48.7%)
3. estimated based on available data and assumptions – 6 (15.4%)
4. more of an educated guess – 1 (2.6%)
5. other – 1 (2.6%)
6. did not answer – 7 (17.9%)

Implementation issues

What implementation issues have you encountered when developing you performance indicators? (***Note:*** some respondents provided multiple answers):

1. difficulty getting accurate data – 22 (56.4%)
2. difficulty getting support or buy-in from others – 7 (17.9%)
3. difficulty comparing results from year to year – 8 (20.5%)
4. difficulty comparing results with other jurisdictions – 9 (23.1%)
5. other – 13 (33.3%)
6. did not answer – 0 (0%)

An official water efficiency plan

Does your municipality have an official Water Efficiency Plan?

1. Yes – 14 (35.9%)
2. No – 23 (59.0)
3. did not answer – 2 (5.1%)

What is the gross average per capita demand

Respondents were asked to identify their gross Lcd demands (average annual day demand divided by population of municipality) –

- 21 municipalities provided a value (53.8%)
- 1 data point was not included in the analysis[1]
- results ranged from 340 to 1,790
- Average gross demand = 624 Lcd
- Median gross demand = 458 Lcd

Average Residential per capita demand

Respondents were asked to identify their residential Lcd demands (average day demand of residential customers divided by population of municipality) –

- 22 municipalities provided a value (56.4%)
- 2 of these data points were not included in the analysis[2]
- results ranged from 160 to 1,258
- Average residential demand = 413 Lcd
- Median residential demand = 279 Lcd
- Note: four respondents identified average residential demands of less than 200 Lcd, while five respondents identified average residential demands of greater than 500 Lcd.

Ratio between average per capita demands (gross demands) and residential per capita demands

Ratio between gross and residential demands (residential demand as a percentage of gross demand) –

- Ratio of average demands = 66.2% Lcd
- Ratio of median demands = 60.1 Lcd

Winter vs. Summer Residential (single-family & multi-family) Demands

Winter vs. Summer Residential (single-family & multi-family) Demands

- Only 7 municipalities provided data re: indoor vs. outdoor residential demands
- Only 3 of these municipalities provided a demand rate (e.g., Lcd), the other four municipalities provided just a volume (e.g., 0.17 m^3) which may or may not represent a demand rate (i.e., 170 Lcd) or they provided the data in another format (e.g., 234 m^3 per service winter demands and 120 m^3 per service summer demands).
- The following demand rates were provided by the 3 municipalities:
  - Winter demands – 171 Lcd, 189 Lcd, 214 Lcd (avg. 191 Lcd)
  - Summer demands – 193 Lcd, 227 Lcd, 230 Lcd (avg. 217 Lcd)

[1] One municipality identified their gross demand as 190,000 Lcd. It is assumed the question was misunderstood by the respondent and this value was not used in the analysis.
[2] One municipality identified residential demand as 83,000 Lcd and another as 3,500 Lcd. It is assumed the question was misunderstood by the respondents and these values were not used in the analysis.

- Difference in average summer vs. winter demands = 26 Lcd

Winter vs. Summer Single-Family Residential Demands

Winter vs. Summer Single-Family Residential Demands

- Only 1 municipality provided demand rates re: winter vs. summer for the single-family sector
- A small number of other municipalities provided data that was ambiguous and couldn't be used in the analysis
- The following demand rates were provided by the single responding municipality:
  - Winter demands – 226 Lcd
  - Summer demands – 229 Lcd
  - Difference in average summer vs. winter demands = 3 Lcd
  - Note that this municipality also provided an average annual demand rate of 232 Lcd for the single-family sector (i.e., the average demand is identified as greater than either of the summer or winter demands, a result that is not mathematically possible).

Types of Water Efficiency Programs being implemented by Municipalities

The following table sets out the number of responses indicating the implementation of different types of water efficiency programs.

Measure	No. of Responses
Structural programs	
Conservation Pricing	2
Customer Metering	8
Education and awareness programs	
Education Programs	17
Residential Indoor Audit	17
Indoor residential use programs	
6-L toilet rebates	14
Other toilet programs	2
Clothes Washer Programs	4
Outdoor residential use programs	
Landscape Audits	19
Provide Rain Gauges	2
Provide Rain Barrels	11
Irrigation bylaws	6
Watering Restrictions	4
Industrial/Commercial/Institutional programs	
Industrial/Commercial/Institutional Audits/Rebates	6
Municipal system programs	
Leak Detection Programs	13
Getting "Own House" in Order	1
Other programs	20

Note that some municipalities provided a great deal of information about their water efficiency programs while others provided only very brief or ambiguous descriptions (e.g., "leak reduction strategy", "school visits", "watering restrictions", "lawn watering bylaw", etc.).

Environment Canada, in its report on municipal water pricing in 2004 identified 17 types of conservation programs instituted by Municipalities. The list of programs and the reported implementation of them is shown in an excerpted table, in Annex F.

Conclusions regarding the survey results

Although the questionnaire was intended to be very clear regarding the information requested, it was clear from the responses that many municipalities were either unclear about what was being asked or they were unable to access the information. What's more, some of the values provided on the surveys were questionable. For example, residential water demands varied from 160 to 1,258 Lcd. While average residential demands of only 160 Lcd are far lower than some studies have identified even for new homes fitted with efficient toilets, showers, aerators, etc., average residential demands of 1,258 Lcd are far greater than can be explained even if all of the homes in the municipality are fitted with inefficient toilets, showers, clothes washers, etc.

The range in results may indicate that municipalities are calculating values in a different fashion, i.e., that either not all municipalities view the term "residential water demands" in the same way or that not all municipalities are able to accurately calculate these values. This may be true even though more than 75% of the municipalities that responded said their performance indicators were either "always accurately calculated" or "calculated where possible based on available data". Perhaps more guidance is required regarding exactly how certain performance indicators should be calculated.

It is interesting to note that while the average values for gross and residential water demands appear to be too high, the median values are very close to what would be considered expected values.

It appears, based on analyzing the data provided by the 39 respondents, that there is no true consensus concerning what certain performance indicators entail or how to determine these values. Ambiguity surrounding performance indicators can make it much more difficult for municipalities to accurately determine their existing level of efficiency, to set realistic savings targets, or to compare results from one municipality to another.

It may be beneficial to not only define what is meant by certain performance indicators and to explain how to calculate these values; it may also be beneficial to provide expected ranges for these values.

Benchmarks found for Water Conservation and Efficiency Performance Indicators

The following Table indicates numerical data that could be considered as benchmarks (i.e., recent or current achievements) for some of the performance indicators identified in this report.

Selected national and international research reports providing information on current benchmarks are contained in Annex F.

Table 1: Indicators and benchmarks found

Indicator	Benchmark	Source
CWWA Survey findings		
Average winter residential demand *(Indoor (winter) residential water use) or (Average Daily Base Residential Demand)*	191 Lcd	3 responding municipalities
Average summer residential demand *(Average summer residential water use)*	217 Lcd	3 responding municipalities
Average residential demand (*Average per capita residential consumption)*	413 Lcd	20 responding municipalities
Median residential demand *(Average per capita residential consumption)*	279 Lcd	20 responding municipalities
Average gross demand *(Average per capita demand)*	624 Lcd	20 responding municipalities
Median gross demand *(Average per capita demand)*	458 Lcd	20 responding municipalities
Ratio of average demands *(Residential water use ratio)*	66.2%	20 responding municipalities
Ratio of median demands *(Residential water use ratio)*	60.1%	20 responding municipalities
Environment Canada's 2004 Survey		
Average gross demand/person *(Average per capita demand)*	609 Lcd	"2008 Municipal Water Pricing Report"
Average residential demand/person *(Average per capita residential consumption)*	329 Lcd	"2008 Municipal Water Pricing Report"
Percentage of Metered Residential Clients	63.3	"2008 Municipal Water Pricing Report"
Percentage of Metered Business Clients	83.0	"2008 Municipal Water Pricing Report"

Indicator	Benchmark	Source
International Benchmarks		
Australian projected residential indoor use/household	225 Lcd	"Not Down the Drain"
Residential average use/person	227 Lcd	Seattle Public Utilities - 2007
Non-residential average use/employee	170 Lcd	Seattle Public Utilities - 2007
Average single family use/household	628 Lcd	Seattle Public Utilities - 2007
Average multi-family use/household	378 Lcd	Seattle Public Utilities - 2007
Total water consumption/person/day	378 Lcd	South Australia Water Corporation - 1998
Residential water consumption/person/day	231 Lcd	South Australia Water Corporation - 1998
Ratio of average night flow to average daily flow	25%	National Environmental Services Center, West Virginia University
Infrastructure Leakage Index rating	3.5	Median value of a report by the AWWA Water Loss Control Committee

Because of the intrinsic variability in the contexts of municipal water services, extreme caution should be used in obtaining and reporting benchmark data, and in particular in making any comparisons between water utilities, unless the definition of the indicator is explicit and unambiguous and the contextual information is similar.

Potential Targets for Ontario (Canadian) Water Utilities

It is not considered appropriate to propose targets for water conservation and efficiency for Ontario or Canadian water utilities through this report due to the very significant variability of individual utility situations and circumstances and the presence of institutional or infrastructural barriers (for example, plumbing code requirements and the availability of water efficient devices and appliances).

There are two aspects to establishing targets for water utilities.

Internal or individual water utility targets

This is a policy decision to be made by the water utility management based on an assessment of needs and capabilities and commitment to an appropriate investment or operating expenditure program. Many utilities will and do establish these types of targets and will have conducted a benefit-cost assessment of instituting a program to reduce water consumption or to promote efficiency in the use of water supplied. Many utilities have established targets[3], for example, to reduce peak day water consumption through programs such as irrigation bans, or to reduce base water demands by the introduction of toilet retrofit programs.

Setting time frames for the achievement of targets is also something that needs to be considered carefully.

Province or Canada-wide targets

Establishing potential mandatory targets for all Ontario or all Canadian water utilities is something that a senior level government might do and would reflect a policy decision to achieve specific provincial or Canada-wide goals. Such targets should be made in consultation not only with stakeholders in general, but specifically with water utility managements and their technical staff to ensure reasonableness and achievability.

In cases of severe drought, targets have been established for broad indicators of water use such as total water production per customer. While these would be general in nature, it would be up to the water utility itself to determine specific applications.

Australia for example established in 2004 target percent reductions in water production / consumption for the major water utilities. These ranged from 15 to 40% reductions over time

[3] Please note: setting targets is also implicit in the determination of the level of service to be provided to customers. In the current discussions on sustainable asset management, it has been necessary to link asset management to the level of service provided. For example, assets will be managed (sized and operated) so as to provide a maximum of X Lcd.

periods extending from 2011 to 2020[4] and were specific to the different utilities and reflected both their present consumption levels and potential for reduction. Similar broad targets for the reduction in water demand have been established more recently in the arid States of the USA. Alberta[5] and British Columbia[6] are examples of Canadian provinces that have found it appropriate to establish such broad target reductions, which are also applicable to all water using sectors of the economy, not just the municipal sector.

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4 www.iclei.org/fileadmin/user_upload/documents/ANZ/WhatWeDo/Water/CPNationalConsReport04.pdf
5 http://www.auma.ca/live/MuniLink/Communications/Member+Notices?contentId=7145
6 http://www.livingwatersmart.ca/business/becoming_efficient.html
7 At the senior government level, the targets set may also relate directly to the broader aspects of conservation and efficiency not specifically covered in this report. These broader aspects can related to indicators of water rights and access to them, or discharge requirements of treated wastewater to preserve environmental conditions in receiving bodies of water.

Feasibility collecting the necessary data and calculating performance indicators

There is no doubt that the data necessary for the calculation of a core set of performance measures already exists in many, if not all, water utilities. This core set of indicators would however be relatively superficial – for example, total water production per person per day (Lcd), as demonstrated by the data collected by Environment Canada in its Municipal Water Pricing Survey, or the recently conducted survey of water utilities by Statistics Canada[8]. The reason for this is the fact that less than 65% of residences are metered and only 85% of ICI customers are metered. Techniques are available where zone metering systems are in place to refine gross estimates of water consumption, but this would still have some level of inaccuracy.

The Ontario, National and International water and wastewater benchmarking activities (see Annex G) have found that it is essential that the variables to be measured and reported are explicitly and unambiguously defined. They have also found that only the larger of the utilities have the ability to approach the level of definitional refinement and accuracy necessary for reasonable levels of confidence[9].

The feasibility could be improved over time with infrastructural investments in metering and ideally would require automated data collection and entry information systems.

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[8] This survey was conducted of all water utilities in Canada during the latter half of 2008, but the results of the survey have not yet been published.

[9] For example, larger utilities dispute the findings for the average consumption of water as published by Environment Canada, believing that the average reflects inaccurate date reported by smaller utilities. Similarly, OECD reports of per capita water consumption by countries in Europe at the 120Lcd are not considered reliable.

Conclusions

The following conclusions can be drawn from this project:

1. There is both general and specific knowledge of performance indicator methodologies and systems and the conduct of benchmarking practices within Ontario and Canada.

2. Indicator and benchmark reports do exist to demonstrate this. These indicator and benchmarking practices relate to achievement of, for example, water quality goals, and to the complex area of asset management. There is a continuing effort to improve and expand knowledge of these activities and to make the results more reliable and, in particular, comparable.

3. Current efforts to produce indicators and benchmarks for comparative purposes, are often hindered by the inability to obtain explicitly defined data or to obtain the necessary data from current management information systems – for example, financial systems may report on system-wide situations rather than on specific operations; billing data may not reflect consumption in unmetered services; or they may be no-submetering of multiple family buildings. In addition, as has been mentioned, indicators and benchmarks used for comparative purposes between systems, must be based on a full understanding of the context of the service being provided.

4. There is a reluctance at this time to share (publish) much of the individual benchmarking data by those who participate in the current benchmarking exercises due to the fear of misunderstanding or misinterpretation the significance of individual utility benchmarks calculated[10].

5. There has not been to date a focussed effort to establish a performance indicator system that would apply comprehensively to water conservation and efficiency issues at the municipal level. Current indicator and benchmarking activities address broader aspects of utility management and operation.

6. It would be possible to establish at least a core performance indicator system for water conservation and efficiency issues, although this would require further work.

7. Having developed the core indicator system, time would be required to commence and then expand implementation and reporting.

[10] See for example the Canadian National Water and Wastewater Benchmarking website, which limits access to data only to blinded reports.

Recommendations

Indicators, benchmarks, and targets

An agreed upon core set of indicators should be developed reflecting the areas of greatest interest: for example, residential water use, ICI water use, municipal water use. The core set of indicators could be expanded over time as experience is gained in their use[11].

The variables needed for the set of indicators should be identified and defined unambiguously to ensure uniformity of use and comparability of the benchmark or targets when numerical values are attached to the indicators, and assessed from the point of view of accessibility.

These should be plain language guidance materials and documents, supplemented by a series of practitioner workshops to encourage adoption and use of the indicators.

If province-wide or Canada-wide benchmark reporting[12] or targets are to be imposed or developed, consultation with the water services sector should take place regarding the targets, their application, and their time-frame, in order to reflect achievability and reasonableness.

Next Steps

It is recommended that the first step should be to assemble a core team of utility and other representatives with knowledge of performance indicator design and definition and of water conservation and efficiency practices and needs, to prepare a guideline document fully and unambiguously describing the indicators to be recommended for use in this area. While international guidance can be used for this, the guideline has to reflect commonly used terminology and abbreviations used in Canada.

This step should be linked to the activity being undertaken through or at least in conjunction with the CSA S2029 Committee and the National Water and Wastewater Benchmarking Initiative.

A parallel step would be the development of training and educational materials related to the development and use of indicators, benchmarks, and targets.

[11] Note: larger utilities may already be using indicators beyond the core set that might be developed for use by small to mid-size utilities.
[12] It is noted that water quality benchmarking reports are already required in most provinces.

Annex A - Ontario Design Guidelines

Excerpt from the ***Ontario Design Guidelines for Drinking Water Treatment - 2008*:**
Source: www.ene.gov.on.ca/publications/6881e.pdf
Section 3.5 on page 3-10.
Published: December 2008.

3.5 WATER CONSERVATION

Water conservation and efficiency measures to reduce domestic, industrial, commercial and institutional use of water should be considered along with efforts to estimate and reduce distribution system leakage. Simple estimates for excessive leakage in the distribution system can be obtained by measuring the outflow from storage. The best conditions are after rainfall, when irrigation systems would not be operated, and between the hours of 2:00 and 4:00 a.m. when domestic water use would be at a minimum.

Where flow records or estimates for an existing distribution system suggest that unaccounted-for-water exceeds 15% of average daily demand, then, in consultation with the municipality/owner, an average value within the range of 270 to 450 L/(cap/d) should be considered and the cause of the unaccounted-for-water determined and reduced/eliminated as much as is practical. Metering of water service connections has been found to be effective in controlling excessive water demand, and is therefore recommended by the ministry.

The designer is reminded that, when a *Permit to Take Water* (PTTW) is required, the *Water Taking and Transfer Regulation* (O. Reg. 387/04) made under Section 34 of the OWRA requires that the application for the permit document all water efficiency measures and practices that have been undertaken or will be undertaken for the duration of the PTTW.

Annex B - Questionnaire

Municipal Water Demand Management Performance Indicator & Benchmarking Questionnaire

There is a growing movement in Ontario and throughout North America regarding the need for environmental stewardship. Both individuals and government agencies are becoming more aware of the significant impact their actions have on the environment. Growing populations generally mean growing demands for clean water and, as water demands increase, so does the demand for energy required to draw the water from the natural system, to treat and distribute the water to the growing number of customers, and to collect and treat the resulting wastewater and return it to the environment, i.e., as a municipality grows, so does its environmental footprint.

Using water more efficiently is not only fiscally responsible but environmentally responsible as well. While there is a growing need and desire to improve the efficiency of our water and wastewater systems – from the water treatment & distribution systems, to customer end uses, to the wastewater collection & treatment systems – it is not always easy to determine how efficient a system currently is or what level of efficiency can be practically achieved from year to year. Similarly, because each municipality is somewhat unique, it is difficult to make an 'apples to apples' comparison between water systems in different municipalities.

Some municipal systems have a larger percentage of single-family homes, some have a high industrial component, some systems are relatively new, some are quite old, etc. What's more, municipalities do not all tend to collect and analyze water production and demand data in the same way. With all of the inherent differences between water systems and how they are operated, making direct comparisons can be complicated or even misleading.

The Canadian Water and Wastewater Association, with funding support from the Ontario Ministry of Environment, is undertaking a study to identify and analyze:

1. water conservation and efficiency performance indicators and benchmarks currently used in the municipal sector, including related implementation measures; and
2. the feasibility of developing improved water conservation and efficiency performance indicators and benchmarks in the municipal sector.

An ideal performance indicator would provide a true reflection of how efficient a particular *component* of a system is, but may not reflect the efficiency of the system as a whole. For instance, while a system leakage indicator (e.g., the Infrastructure Leakage Index or ILI) may reflect how "tight" a distribution system is, it does not provide any indication of per capita demands, variations in seasonal demand patterns, etc. Performance indicators are useful because they relate only to specific, well defined aspects of a system and, as such, they can be directly compared year to year within a municipality as well as from municipality to municipality.

A benchmark can be seen as a "target". Benchmarks are established based on results achieved in other jurisdictions and what is practically possible using available technology. For example, a municipality may establish a benchmark for indoor water demand of 150 litres per capita per day for new home construction and 200 litres per capita per day for existing homes.

It is recognized that a study to establish suitable performance indicators and benchmark values would be of interest to municipalities outside Ontario. Thus, as a first step, CWWA is distributing the following questionnaire to a large number of Canadian municipalities to identify which performance indicators and benchmarks are currently being used and any related implementation issues. CWWA appreciates your response - all who respond will be kept informed of the progress of the enquiry and the results.

Please answer the questions and complete the table on the following pages (circle or highlight correct answer where applicable) and forward your response to:

Kara Parisien
Manager, Policy and Legislation
Canadian Water and Wastewater Association
(613) 747-0524 ext. 4
kparisien@cwwa.ca

Are the performance indicators that you currently use:

1. always accurately calculated based on complete data
2. calculated where possible based on available data
3. estimated based on available data and assumptions
4. more of an educated guess
5. other (please explain): ____

What implementation issues have you encountered when developing your performance indicators?

1. difficulty getting accurate data
2. difficulty getting support or buy-in from others
3. difficulty comparing results from year to year
4. difficulty comparing results with results from other jurisdictions
5. other (please explain): ____

What percentage of you customers are metered?

1. residential ____________% Billed every _________ mths
2. commercial ___________% Billed every _________ mths

Does your municipality currently have an official Water Efficiency Plan? If yes, please indicate year that Plan was developed or approved.

1. yes ___________ year ______________
2. no ___________

If your municipality has a Water Efficiency Plan, what is the savings target? Please include units and target years, etc., such as – “10% reduction in average annual day demand by 2015”

____

____

____

If your municipality has a Water Efficiency Plan, what measures are included? For example: $50 toilet rebates, free showerheads, landscape audits, industrial audits, system leakage reduction, school visits, etc.

____

____

____

QUESTIONNAIRE

Indicator	Use? Yes /No	If yes – what is your most recent Benchmark Value? And year?		If yes - have you set a Target Benchmark Value? And year?	
		Value (include units)	Year	Value (include units)	Year
System demands					
Average annual day[1]					
Peak day[2]					
Average Base (winter) day[3]					
Average Summer day[4]					
Average per capita[5]					
Peak day demand ratio (design)[6]					
Percentage water loss[7]					
Infrastructure Leakage Index (ILI)[8]					
Customer demands					
Average Residential per capita[9]					
Single-Family Residential[10]					
Multi-Family Residential[11]					
Indoor (winter) Residential[12]					
Average summer residential[13]					
Average summer single-family residential[14]					
Average winter single-family residential[15]					
Daily non-residential[16]					
Percentage non-residential[17]					
Average per non-residential customer[18]					
Total municipal[19]					
Wastewater flows					
Average daily[20]					
Average dry weather[21]					
Average wet weather[22]					
Peak day[23]					

[1] Total annual water production divided by 365 days/year.[13]
[2] Highest single day demand in any calendar year.
[3] Average daily water demand during non-irrigation months divided by residential population.
[4]Average daily water demand during irrigation months divided by residential population
[5] Average daily water production divided by residential population.
[6]Ratio of “peak day to average annual day demand” used when designing new infrastructure.
[7] Mathematically: (total annual production – total annual sales) ÷ (total annual production)
[8] Developed by the IWA Water Losses Task Force to more accurately assess system leakage.
[9]Average daily volume of water sold to residential customers divided by residential population.
[10] Average daily volume of water sold to single-family residential customers divided by single-family residential population
[11] Average daily volume of water sold to multi-family residential customers divided by multi-family residential population
[12] Average daily volume of water sold to residential customers during non-irrigation (winter) months divided by residential population

[13] Average daily volume of water sold to residential customers during irrigation (summer) months divided by residential population
[14] Average daily volume of water sold to single-family residential customers during irrigation (summer) months divided by single-family residential population
[15] Average daily volume of water sold to single-family residential customers during non-irrigation (winter) months divided by single-family residential population
[16]Total volume of water sold to non-residential customers divided by 365 days/year.
[17]Total volume of water sold to non-residential customers divided by total water produced on an annual basis.
[18]Average daily volume of water sold to non-residential customers divided by number of non-residential customers.
[19]Total volume of water used by municipality (e.g., for fire fighting, mains flushing, etc.) on an annual basis.
[20]Total annual wastewater flows divided by 365 days/year.
[21] Average daily wastewater flows during periods of dry weather.
[22] Average daily wastewater flows during periods of wet weather.
[23] Highest wastewater flow during 24-hour period in a calendar year.

Do you use/propose other indicators (e.g., annual demands, weekly demands, etc.)? Please list below or on separate sheet?

Does your municipality implement any water efficiency measures (e.g., toilet rebates, system leakage reduction strategies, landscape audits, subsidize use of rain barrels or rain gauges, showerheads, etc.)? Please identify.

If yes, do you track (or attempt to track) savings related from the implementation of these measures? Y N

Do you track changes in water demands from year to year? Y N

If yes, do you track changes in demands on a:

- system-wide basis
- season-to-season basis
- customer sector basis

Response Contact	
Name	
Organization	Title:
Phone :	Fax :
Email	
Would you like someone to contact you? Y N	

Annex C - Responses

The following table sets out the names of the organization responding and the population served.

Organization	Population
Alberta	
City of Calgary	768,082
City of Edmonton	616,306
Town of Edson	7,399
Village of Heisler	
Village of Foremost	556
Village of Linden	565
City of Medicine Hat	46,783
Northern Sunrise County Utilities Dept.	2,264
City of Red Deer	60,075
Subtotal Alberta	**9**
British Columbia	
City of Nanaimo	76,000
City of Abbotsford	222,397
City of Burnaby	202,799
District of Elkford	2,729
Regional District of East Kootenay	16,094
City of Grand Forks	3,994
City of Penticton	30,987
City of Port Alberni	18,468
City of Surrey	394,976
City of Vancouver	1,831,665
Village of Cumberland	2,548
Subtotal British Columbia	11
Manitoba	
City of Winnipeg	618477
Subtotal Manitoba	**1**
New Brunswick	
Municipality of Kedgwick	1,221
Subtotal New Brunswick	**1**
Ontario	
City of Guelph	95,821
City of Hamilton	450,000
Township of Huron Kinloss	5,972
City of Kawartha Lakes	74,561
Norfolk County	61,400
City of Orillia	27,882
City of Ottawa	721,136
City of Owen Sound	20,380

Organization	Population
Region of Peel	1,200,000
City of Thunder Bay	116,965
Town of Collingwood	15,745
Ontario First Nations Technical Services Corporation	
Town of Cochrane	7,424
Subtotal Ontario	**15**
Prince Edward Island	
Community of Miltonvale Park	1,242
Subtotal Prince Edward Island	**1**
Saskatchewan	
City of Prince Albert	39,000
Subtotal Saskatchewan	**1**
Total all provinces	**39**

Annex D - Definitional References

The following definitions are referenced:

ISO Standards 24510/24511/24512

The ***ISO Standards 24510/24511/24512*** which provide a methodology for assessing the performance of water services provides the following definitions of relevance:

> **2.16 indicator**
>
> A parameter or a value derived from parameters, which provides information about a subject matter with a significance extending beyond that directly associated with a parameter value.
>
> NOTE 1 Adapted from OECD works on “Core sets of indicators for environmental performance reviews”[9].
>
> NOTE 2 Indicators can refer to context, conditions, means, activities or **performances** (2.24).
>
> **2.24 performance**
>
> achievements of an activity, a **process** (2.31) or an organization

Combining these ISO definitions,

> A performance indicator is a parameter, or a value derived from parameters, which provides information about the achievements of an activity, a process or an organization with a significance extending beyond that directly associated with a parameter value.

InfraGuide

The ***National Guide on Sustainable Municipal Infrastructure’s Best Practice for Developing Indicators and Benchmarks*** also provides additional guidance and several of these terms.

Indicator
At its simplest, an indicator is data that identifies the condition or state of something being measured.

Performance measures
A performance measure is an attempt to quantify the success of a best practice, program or policy in achieving its intended goals or objectives. In the context of municipal decision-making support, a performance measure assesses the condition and quality of infrastructure or the achievement of a policy or program goal. It can also assess the effectiveness of a particular decision-making process.

Indicators
Indicators may be aggregated and massaged, and can combine with related data to form higher levels of indicators, moving from the specific (operational) to more abstract (strategic).

The InfraGuide also goes on to characterize indicators as follows:

Operational indicators
An operational indicator is generally raw data collected about an infrastructure asset by road or work crews while performing their duties or as part of an asset inventory process. In the case of roads, it will be what is often referred to as "counting cracks." Operational indicators are often expressed by municipalities as survey results or scorecards. Some indicators can also be a dollar value, expressed as the cost of an individual asset repair.

Functional indicators
Functional indicators result from analyzing different but related operational indicators to obtain an overview of an infrastructure asset's condition. For example, a number of operational indicators, such as number and types of cracks, smoothness, etc., can be combined to produce an overall pavement quality index (PQI). A functional indicator provides managerial-level municipal decision makers (e.g., city engineer, public works manager) with an overview of an infrastructure asset's condition, state or value.

Strategic indicators
Strategic indicators are the highest and most abstract type of indicators. They are set and reviewed by the highest level of municipal decision makers. Examples include a measurement of a municipality's quality of life or meeting an annual infrastructure budget.

Benchmark
A benchmark is a point of reference generally historical or current, and if used in a future sense, would be understood to be a target.

The quantitative aspect of the benchmark and its units has to be defined and understood. An example of a water-related benchmark is the number of litres of water delivered / person-occupant / day. This can be modified by mathematical conditions such as the **average**, **median**, or the **minimum** or the **maximum** number of litres of water delivered / person-occupant / day.

The current Canadian benchmark for residential water consumption according to Environment Canada is approximately 350Lcd. Europeans generally claim a benchmark of 120Lcd to 180Lcd.

Benchmarking
"Benchmarking" can be defined as a systematic process for securing continual improvement through comparison with relevant and achievable internal and external norms and standards. Benchmarking implies comparison, which may be internal comparisons with previous performance or future targets, or external comparisons of performance against similar municipalities or households.

"Benchmarking" simply stated is measuring performance against a standard of quality (industry sector or technical standard).

Annex E – Characteristics of Indicators

The ISO Documents point out that there are three key components of a performance indicator system:

1. performance indicators,
2. context information, and
3. variables.

They also recommend that specific targets for each indicator chosen to assess the performance of the water service should be established and routinely monitored, tracked and adjusted as needed.

Performance indicators
Individual performance indicators should be unique and collectively appropriate for representing the relevant aspects of the service in a true and unbiased way.

Each performance indicator should:

1. be clearly defined, with a concise and unequivocal interpretation;
2. be assessed from variables that are easily and reliably measured at a reasonable cost;
3. contribute to the expression of the level of actual performance achieved in a certain area;
4. be related to a specified geographical area (and, in the case of comparison analysis, it should be for the same geographical area);
5. be related to a specific time period (e.g. annual, quarterly);
6. allow for a clear comparison with targeted objectives and simplify an otherwise complex analysis;
7. be verifiable;
8. be simple and easy to understand;
9. be objective and avoid any personal or subjective appraisal.

Performance indicators are typically expressed as ratios between variables. These ratios may be commensurate (e.g. %) or non-commensurate (e.g. $/m^3). In the case of non-commensurate ratios, the denominator should represent one dimension of the system (e.g. number of service connections; total water main length; annual costs). This allows for comparisons through time, or between systems. Variables that may vary substantially in time (e.g. annual extraction/discharge volumes), particularly if not under the control of the utility, should be avoided as denominators in the indicator ratios. An exception can be made when the numerator varies in the same proportion as the denominator.

A clear processing rule should be defined for calculating each indicator. The rule should specify all the variables required and their algebraic combination. The **variables** may be data generated and managed within the utility (utility data) or externally (external data). In either case, the **quality** of the data should be assessed (see below) and verified. The interpretation of the performance indicators should not be carried out without taking into account the **context** (see below), particularly if it is based on comparisons with other cases. Therefore, complementary to the performance indicators, the context information should consider also the characteristics of the system and the region in which the services are provided.

Variables

Each variable used should:

d) fit the definition of the performance indicator or context information it is used for;
e) refer to the same geographical area and the same period of time or reference date as the performance indicator or context information it will be used for;
f) be as reliable and accurate as the decisions made based on it, require.

Some of the variables are external data and mainly informative, and their availability, accuracy, reference dates and limits of the corresponding geographical area is generally out of the control of the utility. In this case, variables should also whenever possible:

g) be collected from official sources, which include information on the accuracy and reliability of the variable(s);
h) be essential for the performance indicator assessment or interpretation.

Context information

Context information defines inherent characteristics of a system that are relevant for the interpretation of the performance indicators. There are two possible types of context information:

- information describing pure context and external factors that are not under the control of the utility (e.g. demographics, topography, climate), and
- characteristics that can only be influenced by management decisions in the long term (e.g. age of the infrastructures).

Quality of the information

The quality of the data should reflect the importance of the assessment being conducted.

A scheme providing information on data quality is needed so that users of the performance indicators and context information are aware of the reliability of the information available. The value of the performance indicators can be questionable without such a scheme.

The confidence grade of a performance indicator can be assessed in terms of its accuracy and reliability. The accuracy accounts for measurement errors in the acquisition of input data. The reliability accounts for uncertainties in evaluating the reliability of the source of the data.

Such a scheme might simply grade the variables ordinally for both accuracy and reliability – e.g. 1 – highly accurate or reliable, 2 – normally accurate or reliable, 3 – poor accurate or reliability, and 4 – accurate or reliability not known.

Annex F – More Examples of Performance Indicators Found

Indicators of system meterage

Indicator: *Percentage of residential customers who are metered*
Definition: Number of metered residential connections as a percentage of total residential connections.
Comment: This is an essential indicator of the ability of the utility to implement pricing policies as a conservation mechanism and to indicate the reliability of other consumption indicators.

Indicator: *Percentage of ICI customers who are metered*
Definition: Number of metered ICI connections as a percentage of total ICI connections.
Comment: This is an essential indicator of the ability of the utility to implement pricing policies as a conservation mechanism and to indicate the reliability of other consumption indicators in the ICI section. Note: some municipalities have not metered some institutional clients.

Indicator: *Density of zone metering*
Definition: Number of zone meters per 1000 connections.
Comment: This is an essential indicator of the ability of the utility to verify consumption patterns in un-metered areas.

Indicators of system demand

Indicator: *Average annual production/day*
Definition: Total annual water production divided by 365.
Comment: This is a macro-index only requiring the minimum of meterage information.

Maybe useful for year to year comparisons of production, but has no context information (i.e., size of population, changes in population served). The indicator can also be calculated seasonally or monthly.

Indicator: *Peak day demand*
Definition: Highest single day demand in any calendar year.
Comment: This is a macro-index only requiring the minimum of meterage information.

Maybe useful for year to year comparisons of peak day production, but has no context information (i.e., size of population, changes in population served).

Indicator: *Average Daily Base Residential Demand*

Definition: Average daily indoor water demand – calculated by measuring demand during non-irrigation months divided by residential population.

Comment: Unless all residential customers are metered, the accuracy of this index will depend on the ability of the utility to subtract ICI and system demands and uses from average total demand during winter months. Even if all residential customers are metered it is necessary to delineate between the demands of single-family homes and those of multi-family apartment buildings. If customer sectors are based on meter size alone it is possible that large multi-family building would be included with the demands of the ICI customer sector.

Indicator: *Average per capita demand (sometimes called Gross per Capita Demand)*

Definition: Average total daily water production divided by total population served.

Comment: This is a macro-index only requiring the minimum of meterage information.

Maybe useful for year to year comparisons but has no context information (i.e., changes in ICI demand).

Indicator: *Peak day demand ratio (design)*

Definition: Ratio of “peak day” demand to “average annual day” demand.

Comment: Used when determining need to increase infrastructure or for determining if seasonal conservation measures may be appropriate or need. Also used for designing new infrastructure.

Indicator: *Percentage water loss*

Definition: Total annual production minus total annual sales divided by total annual production.

Comment: A simple indicator of water loss in the distribution system and a simple indicator of “unaccounted for water” – relies on metered sales information. Maybe refined by deducting estimates of non-revenue water uses such as fire response, street washing, and municipal park irrigation which are typically unmetered uses.

This indicator has been replaced by the more accurate indicator ILI (see below).

Indicator: *Ratio of average night flow to average daily flow*

Definition: Average night flow as a percentage of total average daily flow.

Comment: A simple indicator of potential water loss in the distribution system and a simple indicator of the presence of “unaccounted for water.

Indicator: *Infrastructure Leakage Index (ILI)*

Definition: Developed by the IWA Water Losses Task Force to more accurately assess system leakage.

The ILI is defined as the current annual real losses (CARL) divided by the unavoidable annual real losses (UARL). The UARL represents the lowest technically achievable annual real losses for a well-maintained well-managed system and is the likely lower bound on water losses. As a performance indicator (PI), the ILI represents a measure of the combined performance of three infrastructure management methods for real losses - the speed and quality of repairs, active leakage control and assets management – under a certain average operating pressure.

Current annual real losses (CARL) are calculated by deducting from total production, known sales volumes and estimated metered and unmetered authorized and unauthorized uses – leaving essentially losses through leakage in distribution mains, at storage facilities and in lines leading to customer meters.

Unavoidable annual real losses (UARL) can be calculated on site, or can use an equation developed by measurements in a large number of utilities around the world. The user friendly version of the UARL equation is: UARL = (5.41 x Lm + 0.15 x Nc + 7.5 x Lp) x P; Where: Lm = Length of mains, Nc = Number of service connections, Lp = Length of private pipe, and P = Average pressure.

Comment: Even though ILI has been computed in an increasing number of countries, its usefulness has not been tested for and cannot be recommended with confidence for systems with:

- Less than 5000 connections,
- Less than 35 PSI pressure on average, throughout the system.
- Less than 32 connections/mile of mains.

Indicators of customer demand

Indicator: *Average per capita residential consumption*

Definition: Average total daily volume of water sold to all residential customers divided by residential population.

Comment: Requires metering of all residential customers for accuracy. This indicator does not delineate between the water demands of single-family and multi-family homes.

Indicator: *Average single-family residential consumption*

Definition: Average total daily volume of water sold to single-family residential customers divided by single-family residential population.

Comment: Requires metering of all residential customers for accuracy. This indicator does not delineate between indoor and outdoor water demands.

Indicator: *Average multi-family residential consumption*
Definition: Average total daily volume of water sold to multi-family residential customers divided by multi-family residential population.
Comment: Requires metering of all multi-family residential customers for accuracy. This indicator does not delineate between the water demands of single-family and multi-family homes.

Indicator: *Indoor (winter) residential water use*
Definition: Average daily volume of water sold to residential customers during non-irrigation (winter) months divided by residential population.
Comment: If metering permits the calculation of this index, it can be used in conjunction with the indoor residential water use indicator to identify the level of outdoor water use in a system. The value will change from year to year depending upon weather conditions.

Indicator: *Average summer residential water use*
Definition: Average daily volume of water sold to residential customers during irrigation (summer) months divided by residential population
Comment: If metering permits the calculation of this index, it can be used to identify the level of outdoor water use in a system. The value will change from year to year depending upon weather conditions.

Indicator: *Average summer single-family residential*
Definition: Average daily volume of water sold to single-family residential customers during irrigation (summer) months divided by single-family residential population
Comment: If metering permits the calculation of this index, it is an indicator of summer peak water use. An index can be constructed to compare this (summer) use with winter use.

Indicator: *Average winter single-family residential*
Definition: Average daily volume of water sold to single-family residential customers during non-irrigation (winter) months divided by single-family residential population.
Comment: If metering permits the calculation of this index, it is an indicator of indoor water use. Values are not typically affected by changes in weather from year to year.

Indicator: *Average daily non-residential water use*
Definition: Total volume of water sold to non-residential customers divided by 365.
Comment: A basic indicator, which could also be calculated on a seasonal or a monthly basis to determine seasonal patterns.

Indicator: *Percentage non-residential water use*
Definition: Total volume of water sold to non-residential customers divided by total water produced on an annual basis.
Comment: Indicator of non-residential water demands within a system. Can change significantly from year to year if large industries move into or out of the municipality.

Indicator: *Average per non-residential customer*
Definition: Average daily volume of water sold to non-residential customers divided by number of non-residential (i.e., industrial, commercial, and institutional) customers.
Comment: Does not delineate between different classes of ICI customers, e.g., a bookstore vs. automotive assembly plant. Not considered too useful unless supported with a significant level of context.

Indicator: *Residential water use ratio*
Definition: Average residential water use as a percentage of total water use.
Comment: May provide an indication of the effectiveness of residential conservation and efficiency programs, provided the ICI use is considered stable. Indicator does not delineate between indoor and outdoor water demands. May change from year to year.

Indicator: *Total municipal use per year*
Definition: Total volume of water used by municipality (e.g., for fire fighting, mains flushing, etc.) on an annual basis.
Comment: Although this is not a performance indicator in the conventional sense, it is an indicator of authorized but non-metered use. It is an input datum for the IWA ILI.

Indicators from wastewater system

Indicator: *Average daily flow*
Definition: Total annual wastewater flows divided by 365.
Comment: This is a macro-index only. Confounding factors can include groundwater influent in the collection system, and presence of combined sewers with annual climatic variations.

Indicator: *Average dry weather flow*
Definition: Average daily wastewater flows during periods of dry weather.
Comment: While a macro-index, it can provide an indication of indoor water use as long as there is virtually no groundwater infiltration into the collection system (e.g., from high ground water table).

Indicator: *Average wet weather*
Definition: Average daily wastewater flows during periods of wet weather.
Comment: Can be used in conjunction with average dry weather flow indicator to estimate levels of inflow (and potentially infiltration) into the system. Confounding factors can include groundwater influent in the collection system, and presence of combined sewers with annual climatic variations.

Indicator: *Peak day*
Definition: Highest wastewater flow during 24-hour period in a calendar year.
Comment: Confounding factors can include groundwater infiltration into the collection system, and presence of combined sewers with annual climatic variations.

Indicators of water resource use

Indicator: *Source use.*
Definition: Percentage of water allocation used annually.
Comment: May be calculated on a seasonal or monthly basis.

Indicator: *Average Day Demand / Existing Water Licence Capacity*
Definition: Percentage of water allocation used to meet average day demands.
Comment: May be calculated on a seasonal or monthly basis.

Indicator: Inefficiency of water resource use.
Definition: Real water losses as a percentage of total system input volume.
Comment: Real water losses is not just "unaccounted for water", but is the denominator of the IWA ILI.

Progress Indicators

Indicator: *Water savings from measure implementation*
Definition: Measured water consumption after implementation vs. measured water consumption prior to program implementation.
Comment: There may be extraneous factors at play – for example an irrigation ban to reduce summer demand may be affected by a wetter than normal summer period.

Indicator: *Percentage per capita water demand reduction achieved from year to year*
Definition: Current year's per capita water usage as a percentage of previous year's per capita water consumption.
Comment: A simple index to demonstrate continued progress in a multi-year conservation program.

Indicator:	*Cost of conservation programs/person served*
Definition:	Annual expenditures on conservation programs divided by the total population served.
Comment:	This indicator could be refined to reflect residential program costs versus ICI program costs.

Annex G – Excerpts from Reports Regarding Benchmarks

Extract from the Seattle Public Utilities 2007 Water Quality Annual Report

Measures of Water Consumption for Saving Water Partnership Utilities*: 1990, 2000 & 2007					
				Percent Change Since	
	1990	2000	2007	1990	2000
Total Billed Water Consumption	121 mgd	108 mgd	94 mgd	-23%	-13%
Residential Consumption	79 mgd	72 mgd	64 mgd	-19%	-12%
Non-Residential Consumption**	43 mgd	35 mgd	30 mgd	-30%	-15%
Avg. Single Family Use per household	231 gpd	194 gpd	166 gpd	-28%	-15%
Avg. Multi-family Use per Household	142 gpd	120 gpd	100 gpd	-30%	-17%
Residential: Avg. Use per Person	84 gpd	70 gpd	60 gpd	-29%	-15%
Non-Residential: Avg. Use per Employee**	71 gpd	51 gpd	45 gpd	-37%	-11%
mgd = millions of gallons per day; gpd = gallons per day					
** While most of the decrease in non-residential consumption is due to conservation, some of it is due to changes in the economy. During times of economic slowdown, water consumption tends to decrease.					

*Members of the Saving Water Partnership:		
City of Bothell	Coal Creek Utility District	King County Water District No. 90
City of Duvall	Highline Water District	King County Water District No. 119
City of Mercer Island	King County Water District No. 20	King County Water District No. 125
City of Seattle	King County Water District No. 45	Northshore Utility District
Cedar River Water & Sewer District	King County Water District No. 49	

Australian Projected Household Water Use

Projected Water Use for a Four-Person Household

ROOM	WATER USE	AMOUNT (L)	
		Per day	Year*
Bathroom	**showers** (Assumes 4 showers per day, 2 x 4 minute + 2 x 5 minute. **basin** (hand washing & teeth brushing)	**112.5** **5**	**42,525** **1750**
Kitchen	**sink & cooking/drinking** (Assumes dishes washed manually once a day @ 10 litres + 5 litres per day general sink use + 10 litres for drinking & cooking)	**25**	**8750**
Laundry	**washing machine & trough** (Assumes 4 loads of washing per week @ 35 litres per load + 25 litres water use via trough = 165 litres week)	**23.5**	**8250**
Toilet	**toilet flushing** (Assumes about 5 full flushes @ 6 litres/flush & 6 or 7 half flushes @ 3 litre/flush per day)	**50**	**17,500**
TOTAL		**225**	**78,775**

* (based on 350 days in house, allowing for time away)

Extract from: McQuire, Stuart. Water not down the drain: a guide to using rainwater and graywater at home, first edition, Fish print, 2008

Excerpts from Environment Canada's 2008 Municipal Water Pricing Report

Reference: 2008 Municipal Water Pricing Report – Municipal Water Pricing: 2004 Statistics
http://www.ec.gc.ca/water/en/manage/data/e_MUP2004.htm

Table 1 - 2004 Average Daily Water Use, Water Metering, by Province and by Population Size Group

Province/ Territory	**Aver. DTF[14] (L/Capita)**	**Aver. DRF[15] (L/Capita)**	**% Residential Clients Metered**	**% Business Clients Metered**
NL	780	501	0.0	49.4
PE	569	238	1.5	93.1
NS	546	321	93.3	98.6
NB	1384	438	47.8	82.1
QC	848	424	16.0	34.9
ON	481	260	92.0	98.2
MB	466	219	96.7	96.7
SK	516	303	98.2	98.9
AB	488	271	88.6	98.9
BC	649	426	29.8	87.1
YK	932	645	8.0	100.0
NT	437	257	97.2	100.0
NU	134	113	76.1	14.8
# of municipalities surveyed by population size group (000's)				
below 1	777	429	38.7	55.5
1 to 2	668	436	43.4	50.4
2 to 5	946	497	34.3	51.3
5 to 50	701	433	49.2	72.4
50 to 500	555	305	62.3	88.1
500+	589	291	73.2	84.4
Total	609	329	63.3	83.0
Responding Population	25,454,421	25,333,378	25,698,580	20,960,777

Table derived from 2004 Municipal Water and Wastewater Survey summary database (for responding municipalities), Sustainable Water Management Division, Environment Canada.

[14] DTF – Daily Total Flow
[15] DRF – Daily Residential Flow

Table 2 - 2004 Conservation Measure Instances by Province / Territory and Size Group

Code #	Number of Municipalities Reporting Conservation Measures			
	Conservation Measures	**Ontario**	**Other Provinces / Territories**	**Subtotal**
	None	78	208	286
1	Advice given	33	31	64
2	Customer water audits	1	12	13
3	Efficiency kits available	2	12	14
4	Efficiency oriented (metered) water billing	54	61	115
5	Information with billing	20	20	40
6	Lead by example - efficient municipal/company facilities	14	6	20
7	Media - TV, radio, newspaper, etc.	18	35	53
8	Other	3	8	11
9	Outdoor advertising - billboards, buses, etc.	7	4	11
10	Rebate programs - efficient appliances, fixtures, rain barrels, etc.	17	6	23
11	Retrofit installation programs	1	5	6
12	School curriculum programs	1	7	8
13	System - leak detection and repair	27	46	73
14	Tours of water facilities	8	20	28
15	Voluntary measures - restrictions	15	25	40
16	Water supply (source) level directly linked to pricing level	0	7	7
17	Water use bylaws - fines	56	79	135
	Missing	33	63	96
Total		**388**	**655**	**1043**

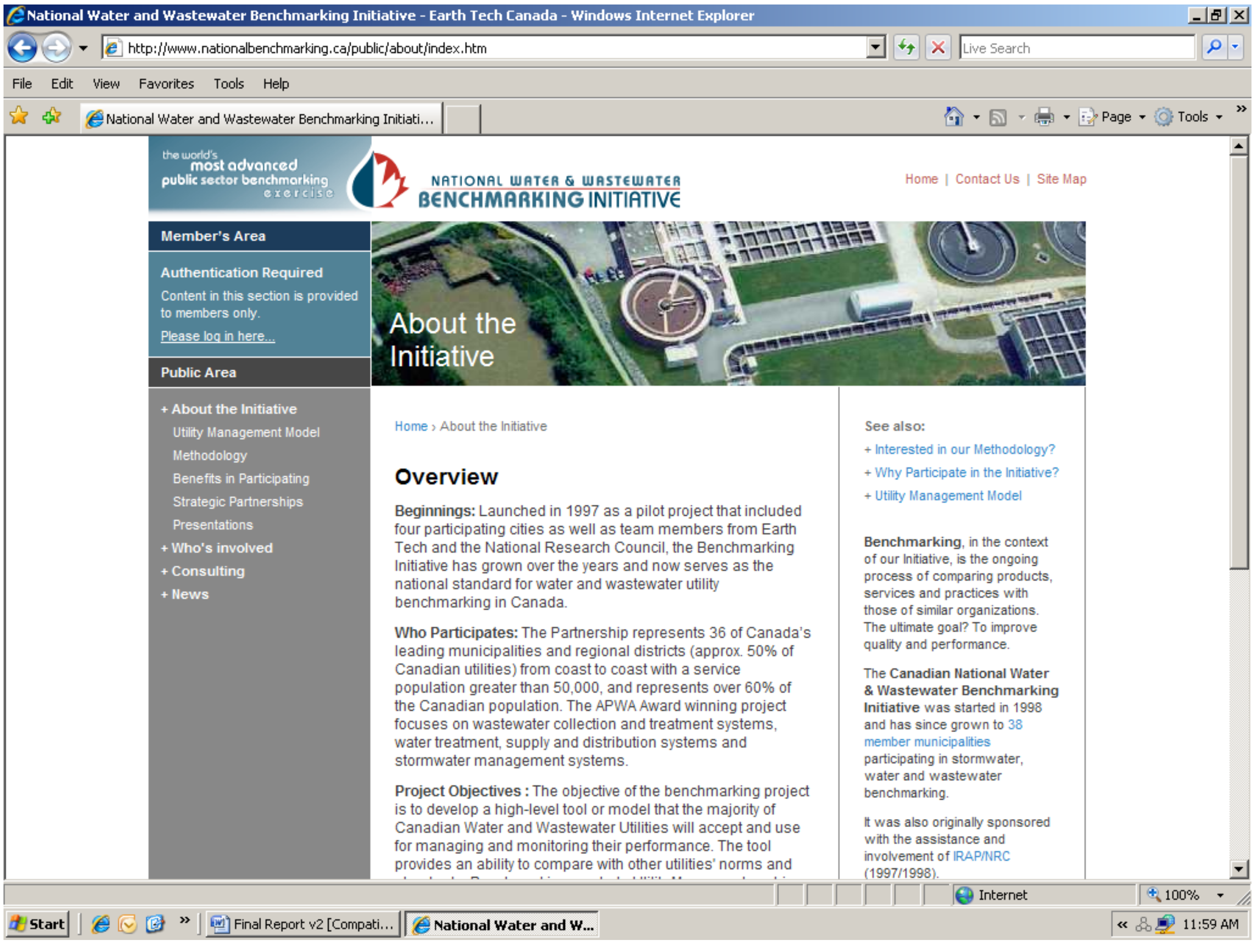
Table derived from 2004 Municipal Water and Wastewater Survey pricing summary database, Sustainable Water Management Division, Environment Canada

Ontario Municipal Benchmarking Initiative

A limited number of conservation and efficiency indicators and benchmarks are available from this site.

National Water and Wastewater Benchmarking Initiative

A limited number of conservation and efficiency indicators and benchmarks are available from this site.



International Bench Marking Network

A limited number of conservation and efficiency indicators and benchmarks are available from this site.