

Municipal Water and Wastewater Infrastructure - Estimated Investment Needs 1997 to 2012

A report to CMHC prepared by CWWA¹
April, 1997

Summary

Questions are often posed as to the investment needed for the renewal and enhancement for municipal water and wastewater infrastructure in Canada. Reasons for posing these questions vary from political to managerial to commercial, and there is also the perspective of infrastructure research and development.

Several estimates have been made in recent years and there is a wide variance amongst them. The variance is no doubt caused by several factors, not the least of which is the possibility, indeed probability, of differing "end points" for the investment, e.g., renewal and enhancement to "what standard of service". There is of course, also the general paucity of data on which to base any estimate, and the likelihood that different unit cost and growth assumptions have made.

This report acknowledges these various estimates, attempts to consolidate them where possible and in any case to compare them with an estimate made by the Association itself.

The "end points" of the CWWA estimate are that all "urban" residents of municipalities should be connected to public water and wastewater systems; that water supplies should meet the *Canadian Drinking Water Guidelines*; that storm and sanitary sewer systems should be separate; and that wastewaters would be treated to Level III wastewater treatment standards. Also included as an endpoint, although this does not relate to the quality of treated water or wastewater, is the objective that all water customers should be metered in order to provide a uniformly imposed system of water pricing that reflects the full costs of service, thereby providing an opportunity for water demand management using the pricing mechanism.

There is a further, very significant assumption - that the end points will be achieved through the application of currently available and traditional technology. Technological innovations are available that almost certainly could reduce the investments need to meet the endpoints - however, the implementation of the technology will require changes in management attitude and probably changes in the regulatory framework within which the water and wastewater industry operates.

¹ The methodology was developed by CWWA staff and tested conceptually with a number of engineering and economic consultants who are members of CWWA and who provided data referenced above. However the end result, good or bad, is solely the responsibility of CWWA.

There is very little information available on which to base any estimates, and what information there is, is very fragmentary. The best we can do is to set out the methodology employed, the data used, and the assumptions made so that any disagreements with the resulting estimates might be reduced by modifying the methodology or revising the analysis that led to the estimates (i.e., revising the data or changing the assumptions). It is also hoped, from the macro-economic standpoint, that some of the errors on the micro-economic level will cancel each other out. Thus, on a national level, the estimate will have a lesser degree of error than, say, on a provincial basis, and even less than any attempt to provide estimates on a sub-provincial basis.

The report shows that using this crude but simple methodology to estimate future demands for water and wastewater services on a broad regional and national basis and by applying crude cost factors to these needs, the estimated annual investment would be to spend \$5.8 billions over the next 15 years (\$1.8 billion on water systems, \$4.0 billions on wastewater systems) leading to a total investment of \$87 billions in the period 1997-2012 (\$27 billions on water and \$60 billions on wastewater). In addition some \$1.5 billions would be required to complete the metering of all water customers.

These figures are shown in summary in Table A below:

Table A - Summary of Investment Needs by Area of Investment (\$ billions)

Water	Mains	Storage Tanks	Treatment Plants	Subtotal
	11.5	1.2	13.8	26.5
Wastewater	Sewers	Sewer Separations	Treatment Plants	Subtotal
	10.7	36.5	13.2	60.4
Metering				1.5
Total				88.4

Table A indicates there is more than twice as much investment required on the wastewater side as on the water side - \$60 billions to \$26 billions, but in terms of the nature of the work, there is much more to be done in underground services (water mains, sewer systems and sewer separations) than in above ground systems (plants) - \$59 billions to \$27 billions.

Having made this estimate, other questions can logically be posed: what happens at the end of this 15 year period? Is there no further investment required? Is it just a question of maintaining the system from here on in? Well the answer to that is that further investments will be required to meet continuing expansion of the populations to be served, and to meet new and more stringent water and wastewater quality standards. What the level of these investments might be is entirely speculative, but it should be noted that investment in improving then nation's water and wastewater infrastructure is a continuing process and requirement.

The CWWA estimate is also shown below in Table B with the other estimates that have been identified and which can be used as possible benchmarks. The figures are in \$ billions.

Table B - Summary of Municipal Infrastructure Investment Need Estimates - 1997 to 2012

Estimate	Annual Investment Need		Total Investment Need	
	Low	High	Low	High
FCM - McGill	1.40		21.00	
Winnipeg as a "model"	4.35		62.25	
National Round Table - (George Powell/Delphi Group)	4.70		70.50	
National Round Table - (Environment Canada/Peat Marwick)	4.67	6.00	70.00	90.00
CWWA - water and wastewater system expansions and upgrades	5.80		86.96	
CWWA - metering	0.10		1.49	
CWWA - total	5.90		88.45	

Infrastructures municipales d'eau potable et d'eaux usées Estimation des investissements requis de 1997 à 2012

Rapport rédigé pour la SCHL par l'Association canadienne des eaux potables et usées (ACEPU)¹
Avril 1997

Résumé

On demande souvent combien il en coûterait pour renouveler et améliorer les infrastructures municipales d'eaux potables et usées au Canada. Les raisons pour lesquelles on pose cette question sont d'ordre **politique, administratif et commercial**, mais on envisage également l'aspect de la **recherche-développement dans le domaine des infrastructures**.

Ces dernières années, des estimations très variées ont été avancées. Cette variation est sans aucun doute causée par divers facteurs dont un, qui n'est pas le moindre, est la possibilité, voire la probabilité, que les «objectifs ultimes» des investissements soient différents, p. ex. «la norme de service» que le renouvellement et les améliorations envisagés devraient atteindre. Il faut bien sûr tenir compte aussi du manque général de données sur lesquelles peuvent être fondées les estimations et de la probabilité que les hypothèses soulevées relativement au coût unitaire et à la croissance soient différentes.

Ce rapport tient compte de ces différentes estimations, tente de les rassembler lorsque c'est possible et les compare avec la propre estimation de l'ACEPU.

Les «objectifs ultimes» de l'estimation de l'ACEPU sont que tous les résidents «urbains» des municipalités devraient être branchés aux installations publiques d'eaux potables et usées; que l'alimentation en eau devrait respecter les Recommandations pour la qualité de l'eau potable au Canada; que les réseaux d'égouts pluviaux et sanitaires devraient être séparés; et que les eaux usées devraient subir un traitement tertiaire conforme aux normes de traitement des eaux usées. Autre objectif ultime, qui ne concerne toutefois pas la qualité de l'eau ou des eaux usées traitées : la consommation d'eau de tous les consommateurs devrait être comptée afin de favoriser la création d'un système de tarification de l'eau uniformément imposé qui tient compte du coût réel de ce service, offrant ainsi la possibilité de gérer la demande en eau.

On suppose en outre, et c'est là une hypothèse très importante, que les objectifs ultimes seront atteints à l'aide des techniques traditionnelles actuelles. Il existe des innovations technologiques qui pourraient presque à coup sûr réduire les investissements requis pour réaliser les objectifs. Cependant, la mise en oeuvre de cette technologie nécessitera des changements dans les attitudes de gestion et probablement des changements au sein du cadre réglementaire qui régit l'industrie de l'eau et des eaux usées.

1. La méthode a été mise au point par le personnel de l'ACEPU et a fait l'objet d'essais conceptuels auprès d'un certain nombre de consultants en génie et en économie membres de l'ACEPU, lesquels ont fourni les données dont il est question ci-dessus. C'est toutefois l'ACEPU qui est responsable des résultats, qu'ils soient favorables ou non.

On dispose de très peu de données sur lesquelles il serait possible de fonder quelque estimation que ce soit et les données que l'on possède effectivement sont très fragmentaires. Au mieux, on peut exposer la méthode employée, les données utilisées et les hypothèses formulées de telle sorte que tout désaccord avec les estimations résultantes soit limité en modifiant la méthode ou en révisant l'analyse qui a mené à ces estimations (révision des données ou modification des hypothèses). On espère aussi, d'un point de vue macro-économique, que certaines des erreurs survenant à l'échelle micro-économique s'annuleront d'elles-mêmes les unes les autres. C'est ainsi que, à l'échelle nationale, l'estimation comportera un plus faible degré d'erreur que, disons, à l'échelle provinciale et encore moins que si l'on tentait de fournir des estimations à des échelons inférieurs au niveau provincial.

Le rapport indique qu'en utilisant cette méthode rudimentaire, mais simple, pour estimer la demande future de services en matière d'eau potable et d'eaux usées, tant sur le plan régional que national, et en appliquant à ces besoins des facteurs de coût bruts, on estime à 5,8 milliards de dollars l'**investissement annuel** qu'il faudrait faire au cours des 15 prochaines années (1,8 milliard pour les installations d'eau potable et 4,0 milliards pour les installations d'eaux usées), soit un **investissement total** de 87 milliards de dollars durant la période 1997-2012 (27 milliards pour les installations d'eau potable et 60 milliards pour les installations d'eaux usées). De plus, quelque 1,5 milliard de dollars seraient nécessaires pour poser des compteurs chez tous les consommateurs d'eau.

Ces chiffres sont résumés dans le Tableau A ci-dessous.

**Tableau A - sommaire des investissements requis par secteur d'investissement
(en milliards de dollars)**

Eau	Conduites maîtresses	Citernes	Usines d'épuration	Total partiel
	11,50	1,20	13,80	26,50
Eaux usées	Égouts	Séparation des égouts	Usines d'épuration	Total partiel
	10,70	36,50	13,20	60,40
Installation de compteurs				1,50
Total				88,40

Le Tableau A montre qu'il faudra consacrer deux fois plus d'argent aux eaux usées qu'à l'eau potable (60 milliards contre 26 milliards). Pour ce qui est de la nature des travaux, toutefois, il y a beaucoup plus à faire dans le sol (conduites maîtresses, égouts et séparation des égouts) qu'hors-sol (usines), soit 59 milliards comparativement à 27 milliards.

Une fois cette estimation faite, d'autres questions peuvent logiquement être posées : Qu'arrivera-t-il à la fin de la période de 15 ans? Il ne sera plus nécessaire d'investir? À partir de ce moment, faudra-t-il seulement entretenir les installations? Des investissements additionnels seront effectivement nécessaires pour suivre l'expansion démographique et pour satisfaire à de nouvelles normes plus rigoureuses en matière de qualité des installations d'eaux potables et usées. L'importance de ces investissements est entièrement spéculative, mais on remarquera que les

investissements consacrés à l'amélioration des infrastructures d'eau potable et d'eaux usées du pays sont un processus et une obligation continu.

L'estimation de l'ACEPU figure aussi au Tableau B en compagnie d'autres estimations qui ont été réalisées et qui pourraient servir de repères. Les chiffres sont donnés en milliards de dollars.

Tableau B - Résumé des estimations touchant les besoins d'investissement en matière d'infrastructures municipales - de 1997 à 2012

Estimation	Investissement annuel requis		Investissement total requis	
	Faible	Élevé	Faible	Élevé
FCM - McGill	1,40		21,00	
Winnipeg pris comme «modèle»	4,35		62,25	
Table ronde nationale (George Powell / Delphi Group)	4,70		70,50	
Table ronde nationale (Environnement Canada / Peat Marwick)	4,67	6,00	70,00	90,00
ACEPU - expansion et amélioration des installations d'eaux potables et usées	5,80		86,96	
ACEPU - installation de compteurs	0,10		1,49	
ACEPU - total	5,90		88,45	

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Introduction

There has been considerable speculation, discussion and estimation over the last several years on the future investment needs for the municipal water and wastewater treatment infrastructure in Canada. Articles and reports have been prepared, and commentary has been included in various documents dealing with municipal infrastructure renewal needs, impacts of new drinking water quality standards, impacts of more stringent wastewater effluent standards, and the discussion has entered topical magazines and reviews on environmental and engineering matters.

The reasons for making these estimates vary from political (e.g., should the senior levels of government be asked to help fund municipal infrastructure programs?), to managerial (e.g., what capital investment plans should I be making as a system manager?), and to commercial (e.g., should the construction industry be gearing up to deal with particular areas of future infrastructure investment?). There is also the perspective of infrastructure research and development, e.g., where are the big investments needed? and what are the opportunities to focus research and development on means to reduce this need? That is to say, if we have to spend \$80 billions over the next 15 years, maybe it is worth spending 0.1% of that, or \$80 millions, on R&D to reduce the needed investment.

The discussion paper represents a fairly straight-forward approach of predicting on a macro-economic scale these investment needs.

The estimates developed arise from four categories of investment needs:

- a. maintenance of the current infrastructure in a good operating condition (since a large portion of Canada's population is adequately served by the current infrastructure),
- b. expansion of the current infrastructure to urban Canadians who currently do not receive complete services (e.g., some are connected only to water services and not to wastewater services),
- c. improvement in the current infrastructure (some portions of the current infrastructure are of a rudimentary level of service), and
- d. growth of the current infrastructure to meet population pressures (some areas of Canada are forecast to be subject to exceptional growth in population over the next 15 years).

Finding data on which to base these estimates is difficult - Canada has little data readily available on municipal infrastructure. Provincial data exists, but it is largely not available. Federal data is reasonably good where it exists, but the coverage is incomplete. Industry data is sometimes relevant, but its reliability and applicability is moot. Nevertheless, estimates are required and would be useful for macro-economic planning purposes.

The discussion paper sets out the methodology, the assumptions and the data used in arriving at these estimates (which are reported on in the next section). It does so in the belief that the methodology, assumptions and data are reasonable, but like any other process of estimating macro-economic figures, can be subject to error or to difference of opinion. At least, with the methodology set out and described, improvements can be made to the estimates by adjusting any of the or their analytical components.

For comparative purposes, other estimates of infrastructure needs studies that have been made by various organizations have been collected and included as benchmarks - when you are exploring the unknown, it is sometimes comforting to find sign posts along the way!

It is hoped that the discussion paper will stimulate further investigations and a refinement of the investment needs.

Methodology

The methodology followed in the discussion paper is to take the best available aggregated statistics on the size of the water and wastewater industry based on populations served (available nationally and by province for several years) and the levels of service provided, and then to formulate estimates of current and future capital investment, replacement capital needs and expansion or enhancement capital needs by applying to those population based-data, aggregated investment, cost and other factors derived from various sources. Where appropriate the data have been converted to standardized units (e.g., population served per km of water main, cost of a treatment plant per capita served) to facilitate the process of estimation.

The advantage of this is fundamental simplicity and perhaps a minimization of overall error by the use of aggregated statistics and factors.

The disadvantage is that the level of accuracy on a province-by-province basis may be high since the expansion factors are aggregated nationally, and may not, indeed will not, reflect regional variations. Thus the value of the estimates diminishes as the level of dis-aggregation increases.

Results

The following table summarizes by province, the investment needs found under the present methodology, by province. Where there may have been a range in estimated investment, e.g., water metering, the higher cost has been included.

Table 1 - Investment Needs by Purpose and by Province
(\$ millions)

Province	Water				Wastewater				Water meters	Grand Total
	Mains	Tanks	Treatment	Subtotal	Sewers	Combined Sewers	Treatment	Subtotal		
NF	161.2	17.1	155.6	333.9	125.4	752.5	635.0	1,512.9	56.1	1,902.9
PE	36.0	3.8	16.3	56.1	60.5	121.0	40.0	221.5	5.7	283.3
NS	411.1	30.3	314.6	756.0	403.0	1,002.1	801.1	2,206.2	12.3	2,974.5
NB	270.2	22.8	161.9	454.9	323.2	821.1	264.1	1,408.4	32.4	1,895.7
QC	2,131.6	254.0	2,325.6	4,711.2	1,761.3	11,498.8	5,162.8	18,422.9	720.0	23,854.1
ON	5,156.0	489.9	6,528.7	12,174.6	4,839.3	12,067.2	2,049.2	18,955.7	247.1	31,377.4
MB	263.8	37.7	412.8	714.3	285.5	1,173.5	288.4	1,747.4	5.6	2,467.3
SK	169.1	28.1	303.3	500.5	170.5	927.6	315.2	1,413.3	1.4	1,915.2
AB	871.2	106.1	1,305.8	2,283.1	839.9	2,268.2	832.0	3,940.1	82.5	6,305.7
BC	2,036.4	169.1	2,284.1	4,489.6	1,851.1	5,785.9	2,791.8	10,428.8	321.2	15,239.6
YT & NWT	26.8	3.5	32.0	62.3	26.8	111.7	30.7	169.2	3.6	235.1
CANADA	11,533.4	1,162.4	13,840.7	26,536.5	10,686.5	36,529.6	13,210.3	60,426.4	1,487.9	88,450.8

Financial Aspects

Given an estimated median population over the period of 32 millions, the per capita investment needed to generate \$87 billions is \$2,766 for the period, or \$184 per year, or \$0.51 per day.

In broad terms, and there are difficulties with the following assessment (since some capital costs are already included in current water rates including sewer surcharges), water rates range between \$0.83 and \$0.96 per day per household and the average household uses about 1 cubic metre of water per day. Assuming an average of 3 persons per household, this amounts to a daily per capita cost of \$0.28 or \$0.32 for water and sewer services. To raise sufficient funds to meet the investment needs, the daily water rates would have to be increased from \$0.30 to \$0.81 per person, and the daily water (and sewage) bill per household would have to be increased from \$0.90 per day to \$2.70.

Conclusions

A number of conclusions can be drawn from this approach to estimating the Canada-wide investment needs for municipal water and wastewater infrastructure on the assumptions that

- a. the methodology, the data and the per capita and other parameters are reasonably accurate,
- b. the end points are to:
 - connect all residents of urbanized municipalities to centrally provided water and wastewater services,
 - ensure that all water supplies meet the *Canadian Drinking Water Guidelines*,
 - all wastewaters are treated to a level III treatment process, and that
 - all water customers are metered,
- c. traditional technology continues to be applied throughout the 15 year period, and that
- d. the end points do not change.

These conclusions include:

- a. approximately \$87 billions of dollars could be spent over the next 15 years or approximately \$5.1 billions per year,
- b. more than twice the amount needs to be spent on the wastewater side as compared to the water side (\$60.4 billions vs \$26.5 billions),
- c. approximately equal amounts need to be spent on water and wastewater treatment plants (\$13.8 and \$13.2 billions respectively),
- d. investment in underground infrastructure improvements (\$58.8 billions) is more than twice the amount required on treatment plants (\$27 billions),
- e. given an estimated median population over the period of 32 millions, the per capita investment needed is \$2,766 for the period, or \$184 per year, or \$0.51 per day.
- f. the funds needed to meet this investment could be provided if the average cost of water and sewer services as currently charged through water rates were to be increased.

References

The following materials or sources were used in the construction of this estimate:

1. Population statistics from Statistics Canada.
2. Unpublished data from the Environment Canada Municipal Water Use Survey of 1994.
3. The Report on Municipal Infrastructure prepared by McGill University for the Federation of Canadian Municipalities, in 1996.
4. Canadian Utility Profiles, prepared by the American Water Works Association from a survey of its Canadian water utility members, in 1995.
5. Information received from the City Of Winnipeg.
6. Information received from various engineering and economic consultants to the water and wastewater industry in southern Ontario.