Region of Peel

Water Efficiency Plan

Final Report

Prepared by Veritec Consulting Inc.

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Executive Summary

The need for water efficiency planning

The Regional Municipality of Peel developed its Water Efficiency Plan (WEP) in response to ever-growing demands on the water supply and wastewater treatment system. The current population is expected to increase by 230,000 or 23% by the year 2015, and with increasing population comes increasing water demands. Reducing excessive water use makes good fiscal and environmental sense, and implementing the WEP will reduce the necessary cost of water and wastewater infrastructure expansion. In fact, it is estimated that it would cost about $112 million for new infrastructure to provide the equivalent supply of water and wastewater treatment as will be made available by implementing the WEP, which will only cost about $33 million.

A profile of water demand in Peel

Data on water use and related water supply and wastewater treatment systems in Peel Region was collected and analyzed to develop the WEP. Currently, when all demands for water are calculated – residential, industrial, commercial, institutional and municipal – the overall average demand rate in Peel Region is about 500 litres per capita per day (Lcd). Residential water, i.e., water used in and around the home, currently ranges between 280 and 300 Lcd, or about 58% of the total Regional demand.

Summertime water use and peak day demand

During the warm summer months, per capita water demands increase by about 20%, due primarily to outdoor water use. Added to this significant seasonal increase in demand on the water supply system is peak day demand – the one day in the year when demand for water is 50% more than the average daily demand. This increase is of particular concern since water treatment plants must be designed and built to meet demands that are far greater than what is required during most days of the year. Implementing the WEP will reduce both summer and peak day demands.

Projected increases in water demands

Based on current projections for population growth and water use, the following changes in water demand between 2003 and 2015 are expected:

- Average Annual Day Demand (AADD)[1] will increase to more than 613 mega[2] litres (ML/d), or about 18% over the next 10 years from the 2003 level of 518 ML/d.
- Peak day demand will increase to 932 ML/d from its 2003 level of 780 ML/d, an increase of almost 20%.

[1] Determined by dividing the total annual water supply by 365 days in a year.
[2] Million

The goal and objectives of the Water Efficiency Plan

The goal of the WEP is to clearly define measures needed to reduce water use, including system leaks and wastewater flows. Consistent with the goal of the WEP, three objectives informed the development of the plan; they can be summarised as follows:

1. To reduce capital costs for new water supply and wastewater facilities over the long term by implementing water efficiency measures to reduce average annual day demands, peak day demands, and wastewater flows
2. To achieve significant reductions by the year 2015, i.e., savings of:
   - AADD – 8 to 10% (50 to 60 ML/d)
   - Peak day demand – 8 to 10% (75 to 90 ML/d)
   - Wastewater flows – 5 to 7% (30 to 40 ML/d)
3. To sustain water use reductions over the long term and to adjust the WEP as required to ensure maximum water savings are achieved

Identifying water efficiency measures

Water efficiency measures selected for implementation were carefully screened and vetted to ensure they were:

- Technically feasible
- Applicable to Peel Region
- Socially acceptable to Peel's population
- Cost-effective compared to infrastructure expansion

The five measures that successfully met all the screening criteria are:

- System leak detection
- Toilet replacement
- Clothes washer replacement
- Indoor water audits
- Outdoor water audits[3]

Each of these measures can be applied to one or more of four water use categories or areas: municipal, single-family residential, multi-family residential, and/or ICI (industrial, commercial and institutional). One of the initial intents of the WEP is to get Peel's "own house in order," i.e., maximize water savings in municipal buildings and properties.

By implementing these measures in conjunction with other best management practices[4],
- considered by leaders in water efficiency as the best methods for achieving water savings,
- the Region can expect to maximize its water use reduction targets.

[3] Watering restrictions are generally considered as an emergency measure to be implemented during extended dry periods (drought) and are, therefore, not considered as part of this plan.

[4] See Appendix C for a complete list of Best Management Practices as identified by the California Urban Water Conservation Council.

Water Efficiency Plan savings targets

The WEP identifies realistic and achievable savings targets that meet the Region's goals, i.e., Peak Day reductions of 8.7% (81.1 ML/d), AADD reductions of 8.5% (51.8 ML/d), and wastewater flow reductions of 6.4% (39.2 ML/d).

Costs and benefits assessed

The projected total cost for implementing the WEP over the next 12 years is $33 million. This compares with a cost of $112 million for new infrastructure to provide the equivalent supply of water as will be realized through water use efficiency. In other words, the cost of the plan is expected to be less than one-third the cost of expanding Peel's water and wastewater infrastructure and will allow growth into the future.

The targeted water savings previously identified are based on expected participation rates established by assessing projected population and employment growth, historical water demands, and experiences in other jurisdictions.

Implementing the Water Efficiency Plan

Due to the size and scope of WEP, it is recommended that a phased implementation of water efficiency measures be undertaken. Phasing the implementation:

- Enables pilot testing of water efficiency measures in order to identify potential barriers and make the necessary modifications or changes to ensure successful roll-out of the initiative
- Allows the Region to secure early successes with the more readily employable measures, learn from these experiences and build the necessary expertise to implement the more difficult and resource intensive measures
- Ensures flexibility in the implementation, allowing for refinements and adjustments to the WEP as changes in regulations, technology, budgets and other influencing factors arise

Establishing a water efficiency project "team" to manage the implementation of the WEP will enable a more co-ordinated, readily manageable roll-out. A project team, working toward the same goal and objectives and sharing information, resources, and expertise will be able to exercise greater control over the implementation process, thereby increasing the likelihood of success.

Securing participation in water efficiency

Most water efficiency measures require the participation of target audiences to achieve success. In order to secure the participation of residents, businesses, industries and other facilities within the Region, community outreach and marketing should be completed as part of an implementation plan throughout the implementation schedule. Water efficiency benefits everyone – communicating this and working co-operatively with external audiences to help them realize the benefits is key to meeting water saving objectives.

Ongoing tracking, monitoring, assessment, and, where necessary, program refinement, will be undertaken throughout the 12-year implementation period. All water efficiency measures will be monitored and evaluated, allowing for changes and modifications as needed to meet water savings targets. Knowing what works, doesn't work, and what enables the water efficiency project team to stay ahead of the game and ensure all water efficiency measures meet their targets is essential for program success.

The value of the Water Efficiency Plan

The WEP lays the foundation for establishing a successful water efficiency program that both residents and the ICI sector within Peel Region can participate in and take pride in the results. Not only will the Region be reducing water use, it will reduce costs associated with infrastructure expansion, avoid energy and chemical costs associated with treating water and wastewater, reduce climate change-causing carbon dioxide emissions, and provide opportunities for water customers to save money on their water bills.

The water saved as part of the WEP will help to offset the need for both water supply and wastewater treatment infrastructure expansion. Ultimately, the greater the amount of water saved through implementation of the WEP, the longer the high costs of capital projects can be avoided and the greater the economic, environmental and community benefits to the Region.

1.0 Background and Content

Peel is one of the fastest growing regions in Canada, with a population projected to increase by about 23% or 230,000 by the year 2021[5] – two-thirds of this projected growth is expected to be in Brampton. Associated with this significant population growth is a corresponding increase in demands for water (Figure 1).

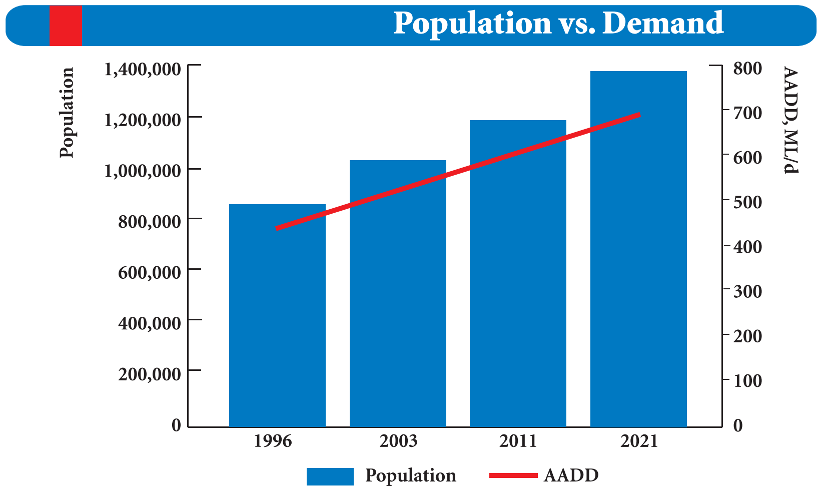


FIGURE 1

To accommodate this increase while ensuring fiscal responsibility and meeting its commitment to "preserve, protect and enhance Peel's natural environment and resources," (Strategic Plan), the Region of Peel has developed this Water Efficiency Plan (WEP).

The WEP will enable the Region to make more effective use of the water supply without negatively impacting the current level of service. By utilizing carefully screened and vetted water efficiency measures, Peel is expecting to significantly reduce average per capita water demands, average system peak day demands,[6] and average wastewater flows over the next decade. In fact, Peel's Master Plan[7] recommends including a water efficiency program in concert with infrastructure expansion – good for Peel, its residents businesses and the environment.

Currently, when all demands are included, e.g., residential, industrial, commercial, institutional and municipal, Peel's overall average demand rate is about 500 litres per capita per day (Lcd). Residential demands (i.e., water used in and around the home) are generally between 280 and 300 Lcd.

During the summer, per capita water demands increase by about 20%, primarily as a result of outdoor water use, whereas peak day demands are generally 50% greater than the average daily demand. In fact, in August 2001, the peak day demand of the Southern Peel system basically equalled the system's entire production capacity.

[5] Currently 688,600 in Mississauga, 497,000 in Brampton, and 71,400 in Caledon – total of 1,257,000.
[6] The day in the year when water demand is the highest.
[7] Water and Wastewater Servicing Master Plan for the Lake Based System, May 1999

Demands can vary from year to year, e.g., daily demands for 2000 and 2002 are shown in Figure 2a and Figure 2b. The demand profile in 2000 is relatively flat, whereas in 2002 there is an overall increase during the summer months and a significant increase on peak days (note that in 2002 there were actually multiple periods of high demand).

Based on current projections for population growth (Figure 3) and projected demand (Figure 4), without the WEP average annual day demand (AADD) will increase to about 613 mega[8] litres (ML/d) in 2015 from about 518 ML/d in 2003, an increase of about 18% in 12 years. Furthermore, peak day demand is projected to increase to 932 ML/d in 2015[9] from its 2003 level of 780 ML/d, an increase of about 152 ML/d.

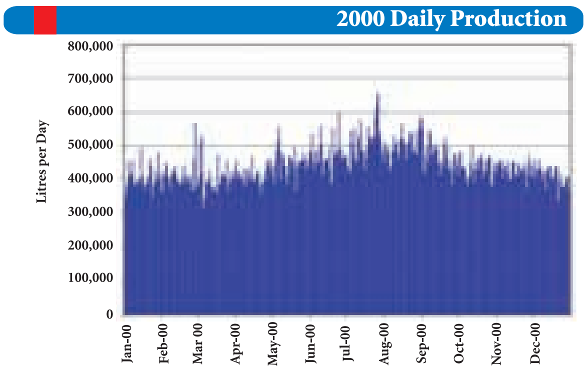


Figure 2a

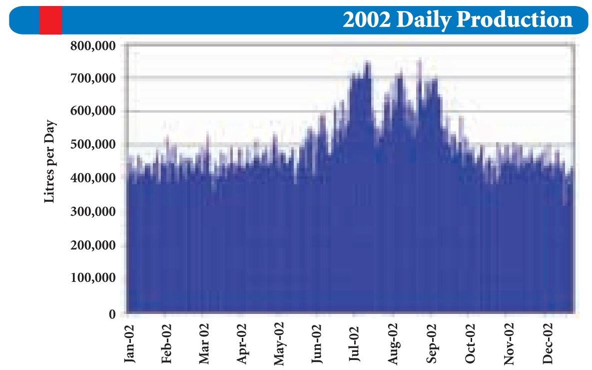


Figure 2b

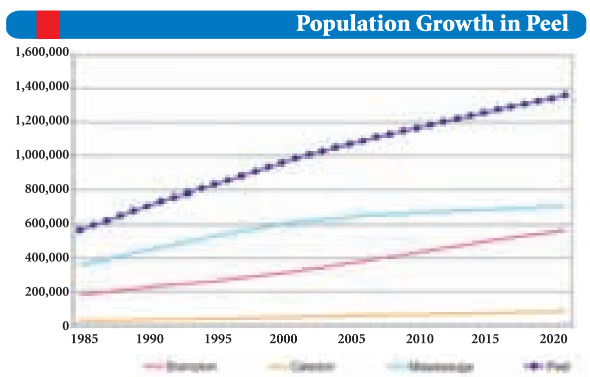


Figure 3

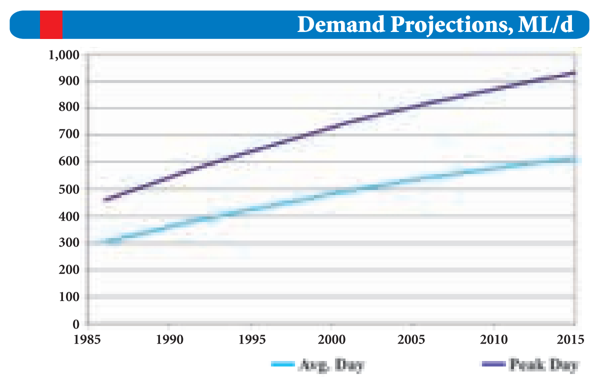


Figure 4

[8] Million
[9] Based on the average actual peaking factor between 1992-98 of 1.51.

2.0 Water Efficiency Plan Goals and Objectives

The goal of the WEP is to clearly identify appropriate and cost-effective water-efficiency measures and to define an approach to reduce water use (including water loss through system leakage) and wastewater flows.

Consistent with this goal, three clear objectives have been established; they can be summarized as follows:

1. To reduce capital costs for new water supply and wastewater facilities over the long term by implementing, monitoring and, as required, modifying those water efficiency measures focused on reducing the AADD, peak day demand and wastewater flows
2. To cost-effectively achieve significant water and wastewater savings by the year 2015, i.e., about 8 to 10% reduction in AADD (50 to 60 ML/d), 8 to 10% reduction in peak day demands (75 to 90 ML/d) and 5 to 7% reduction (30 to 40 ML/d) in wastewater flows
3. To sustain water use reductions over the long term and to adjust the WEP as required in response to changes in population, distribution, water demand projections, legislation and/or any other aspect that may impact the selection and implementation of water efficiency measures

3.0 Benefits to Water Efficiency Planning

To develop Peel Region's WEP, data pertaining to population growth, water demands and related water supply and wastewater treatment systems was secured and evaluated. A cost-benefit analysis was undertaken comparing the costs of implementing each proposed water efficiency measure with meeting the same demands by providing new water supply/distribution and wastewater collection/treatment infrastructure.

In addition to meeting increasing demands in a cost-effective manner, there are other significant benefits to implementing a comprehensive Region-wide WEP. The Water Efficiency Plan:

- demonstrates Regional leadership and a vision for a sustainable water supply
- is a "living document" offering a level of flexibility unlike constructing or expanding infrastructure[10]
- reduces projected water production requirements, thereby reducing associated energy/chemical costs and CO_2 emissions
- reduces ecological impact of drawing water and discharging wastewater
- enhances Regional self-sufficiency by conserving water resources
- offers opportunity for reduced water bills to the end-user
- promotes "demand side" awareness and participation with the public.

[10] For example, WEP measures can be implemented or not as required, whereas it is generally not practical to build only part of a treatment plant.

4.0 Water Demand Components

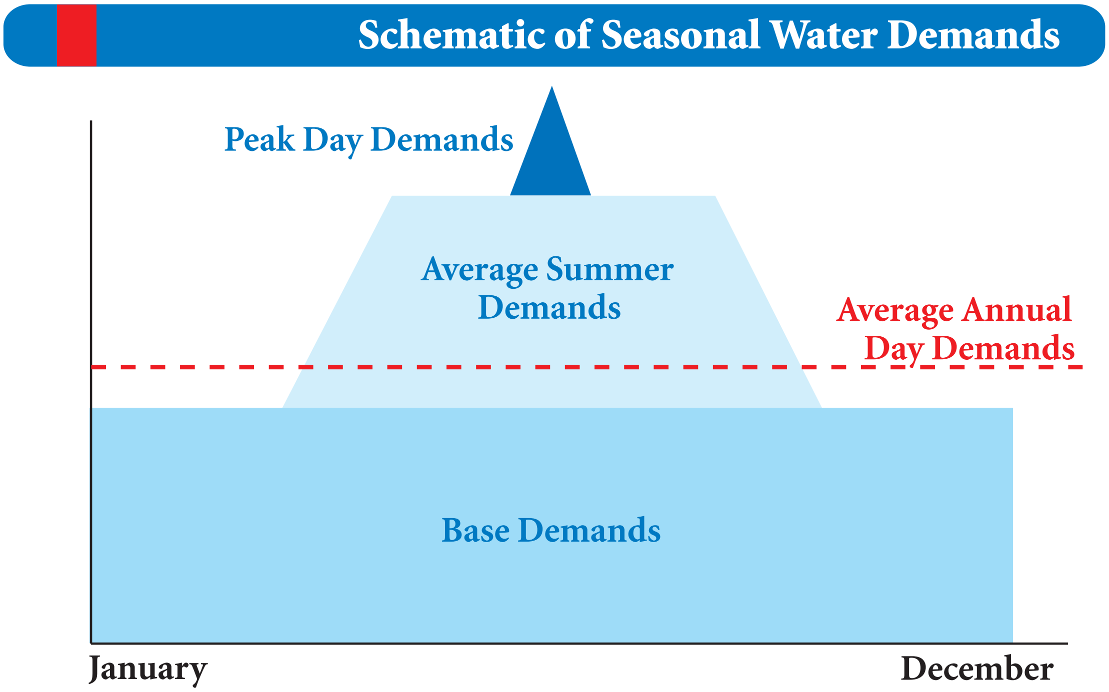


FIGURE 5

4.1 Average Annual Day Demand

In 2003, the water supply system provided an average of about 489 ML/d to the over one million residents in the Region of Peel. The average annual day demand (AADD) is determined by dividing the total annual water supply in any calendar year by 365 (number of days in the year). As such, AADD calculations include base (winter) demands, average summer demands and peak day demands (see Figure 5). Although the AADD generally increases in concert with growing populations, its value can fluctuate from the general trend from year to year. This fluctuation occurs largely because of changes in outdoor water demands, i.e., during hot and dry summers there is a significant increase in outdoor water use and therefore a corresponding increase in AADD, while cool and wet summers result in lower average day demands.

4.2 Peak Day Demand and Peaking Factor

The peak day demand is the single day in the year – generally occurring during summer – when the demand for water is the highest. Peak day demands vary from year to year both in magnitude and scheduling. In 2000, the peak day occurred on July 27 (654 ML/d); in 2001 on August 10 (727 ML/d); in 2002 on August 28 (750 ML/d); and in 2003 the peak day demand reached 706 ML/d on June 26 (see Figures 2a and 2b).

In Peel the peak day demand is about 50% greater than the AADD, and more than 70% greater than the average base demand (i.e., during winter) when there is virtually no outdoor water use. As such, reducing peak day demands can significantly improve the ability of the water system to meet customer needs.

Due to the variability of peak day demands and the fact that it is not possible to predict long term weather patterns, Regional planners and designers utilize a design peaking factor (ratio of peak day to average annual day demands) when projecting long term peak day water demands. The peaking factor used by planners is generally conservative – it is usually slightly higher than historical peak day to AADD ratios would suggest, thereby providing a margin of safety when planning and designing water supply systems. For example, the average ratio of peak day to average day demands in the Region of Peel from 1995-2003 was about 1.50 (ranging from 1.40 in 1998 to 1.60 in 2001), while the design peaking factor is currently set at 1.64 for new development after 1995.[11] Historical data, rather than design factors, have been used to determine the peak day savings associated with implementing the WEP.

4.3 Non-Revenue Water

Non-revenue water is the term used to describe water used for flushing mains, cleaning reservoirs and fighting fires, water used during construction projects, water that leaks from the distribution system, and other non-billed water uses or loses. Every water system has at least some level of non-revenue water. Non-revenue water in Peel makes up about 13% of the total treated water used (Figure 7).

4.4 Wastewater Flows

Wastewater flows are often fairly similar to average annual day water demands. Although not all water supplied to customers returns as wastewater (e.g., water used for irrigation, outdoor washing, products, evaporative cooling, etc., is not returned as sewage) there is usually some inflow of rainwater and infiltration of groundwater into the sewer system. Although the percentage of inflow and infiltration (I&I) varies from system to system, it is generally accepted that about 70% of the water supplied to a distribution system is returned as wastewater.

[11] As of January 1996, the Ontario Building Code (OBC) began requiring that all new construction be fitted with water-efficient toilets and showers, thereby reducing associated demands. Historically, Peel used a value of 912 litres per capita per day (Lcd) when calculating peak day demands. The new value of 730 Lcd reflects these changes to the OBC.

4.5 Gross and Net Per Capita Water Demands

Figure 6 and Figure 7 illustrate that although Peel's residential sector makes up about 92% of the Region's water accounts, it accounts for only about 58% of the water demands. And although it represents only 8% of the accounts, the industrial, commercial, institutional (ICI) sector uses about 29% of the water. About 13% of water produced by the Region is non-revenue water.[12]

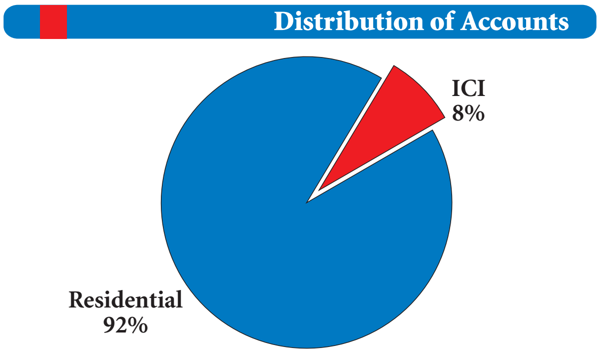


FIGURE 6

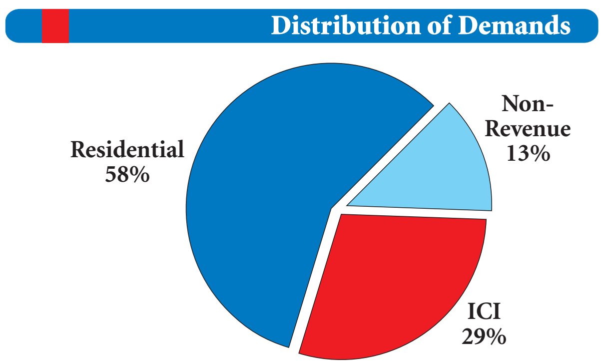


FIGURE 7

A system's water demands are commonly described as either gross or net (residential) per capita demands. Gross per capita demand is the total amount of water produced in any given year, divided by 365 days per year, divided by the total population. In Canada the value is usually stated as litres per capita per day, or Lcd. Because gross per capita demand includes the water demands of all customer sectors, as well as water used for fire fighting, mains flushing, irrigation, etc., and the water lost through system leakage, this value tends to change from year to year. For example, from 1992 until 2001 the gross demand varied between a low of 480 Lcd in 1992 and a high of 521 Lcd in 1999.

Gross Per Capita Demands = Average Daily Production ÷ Population

Comparing the gross per capita demands of different water systems can be misleading because cities with large ICI sectors will tend to have larger gross demands even though the residential demands may actually be similar or even smaller.

[12] Based on billing data from 1992-2001.

Net or residential per capita demand is the total annual water demand of the residential sector (single-family and multi-family), divided by 365 days per year, divided by the residential population in any given year. Between 1992 and 2001 the net demand varied between a low of 276 Lcd in 1992 and a high of 313 Lcd in 1998. Note that net residential water demands include both indoor and outdoor water uses and, therefore, during hot and dry summers when more irrigation is practiced, an increase in net demands would be expected. For example, between 1992 to 2001, when there was less than 400 mm of rainfall during the summer months, the net demand was 301 Lcd; when there was between 400-500 mm of rainfall the net demand was less at 282 Lcd, and; when there was greater than 500 mm of rainfall the net demand was only 278 Lcd.

From 1992 to 2003, Peel's gross per capita demands were an average 171% of net per capita demands (Table 1).

Net Per Capita Demands = Average Daily Residential Demand ÷ Population

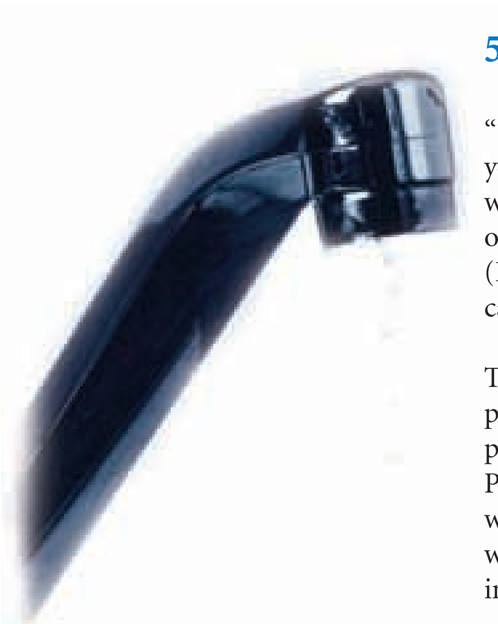
Residential per capita demand values are often used to help identify the potential for reducing water demands, i.e., a relatively high demand indicates a substantial opportunity for reduction, while a low demand indicates that many water efficiency measures may already be in place and working.

Table 1 – Example of Historical Gross and Net Demands

YEAR	Gross Deamnd Lcd	Net Demand Lcd
1992	180	276
1993	508	278
1994	514	281
1995	514	288
1996	508	277
1997	493	290
1998	508	313
1999	521	303
2000	189	282
2001	516	296
2002	457	301
2003	439	293

5.0 Forecasting Water Demand

Forecasting future water demand is a critical part of planning and determining the level of water efficiency required to maximize existing water supply and wastewater treatment or to reduce infrastructure expansion. Even with an aggressive water efficiency program the Region of Peel will require major infrastructure expansion to accommodate future population growth. It is estimated that it would cost about $112 million for new infrastructure to provide the equivalent supply of water and wastewater treatment as will be realized by implementing the WEP (see Section 8.2 – Equivalent Cost of Supply).



5.1 Forecasting Methodology

"The rate of water demand varies with the time of day, time of year, weather conditions, economic environment, and discharge water pressure among other variables. Total demand is evaluated on a population basis, with industrial, commercial and institutional (ICI) demand and unaccounted for demand included in the per capita consumption rate."[13]

The Region estimated the water supply needed to service the planned growth in Peel by applying certain design criteria to population and employment land allocation provided by the Planning Department. Population growth in each pressure zone was projected until the year 2031 and associated water demands were calculated in 5-year increments. These projections were used in the development of this WEP.

5.2 Factors Affecting Water Demand

There are many factors that can affect changes in water demands, e.g., population growth, weather, changes in household demographics or lot sizes, changes in the size or composition of the ICI sector, changes in technology, changes in regulations, policies, or water rates, or even changes in public perception or attitudes toward water use.

In 1996, the Ontario Building Code began requiring the installation of water-efficient fixtures including 6-litre toilets (often called ultra-low flush or ULF toilets) in new construction.[14] Prior to 1996, the Code permitted the use of 13.25-litre toilets called Water-Saver models. As a result, homes built after 1996 are expected to have a lower per capita water demand rate than homes built earlier. The Code's requirement for the use of ULF toilets in new construction will have a significant impact on projected demands in Peel because of the significant projected growth over the next 20 years. This impact is included in the calculations of demand projections and savings.

Climate change is another factor that impacts water demands over the long term, in particular outdoor water use and peak day demands. Although insufficient data on the impact of climate change on water use over time makes it impossible to predict the future impact on demand, it could be significant.

[13] Region of Peel Water And Wastewater Master Plan, May 1999, page 3-1.
[14] Includes both new homes/apartments as well as renovations.

Weather – specifically the day-to-day and seasonal variability in temperature, precipitation, and sunlight – can have a dramatic affect on average summer day water demands, and peak day demands in particular. Not surprisingly, extended periods of hot and dry weather generally result in higher lawn watering demands, and Peel Region's highest daily water demands typically occur during the summer months, primarily the result of increased outdoor water use. Variations in demand from year to year can be a direct result of changes in weather. As an example, in 1999 the peak day demand equated to about 521 Lcd, while in the very next year, 2000, the peak demand reduced to 489 Lcd – a drop of about 6% simply due to changes in weather.[15]

In light of the variability of factors affecting demand, from weather through to the economy, demographics, and population growth, it is difficult to accurately project the water demands in any given year. The demand projections used to develop this WEP are based on historical averages, changes to the Ontario Building Code, and population projections provided by Peel's Planning department.

6.0 Water Efficiency Measures

The increasing demands for water in Peel can be met through either supply-side management (infrastructure expansion), demand-side management, or a combination of both. Demand-side management focuses on where water is currently used, how it is used, and how it could be used more efficiently. Peel's Master Plan has identified a combination of both supply-side and demand-side management as the most acceptable approach.

Any activity, regulation, incentive, or practice that results in the cost-effective reduction of water consumption can be part of a demand-side management program and, as such, can be defined as a potential water efficiency measure.

6.1 Selection of Measures

Although there are many ways to reduce water use, not all of them are applicable to Peel. Therefore, all potential water efficiency measures were subjected to a screening process before being included in Peel's WEP.

6.2 Screening Process

A screening process is used to identify measures that will be studied further for cost-effectiveness and implementation considerations. Screening criteria particular to conditions – weather, demographics, new development, the nature of the ICI sectors, etc. – within Peel Region were established. Each water efficiency measure was evaluated based on the following criteria and only those measures meeting this criteria have been short-listed for consideration.

[15] Based on water production data.

Technical Feasibility
- Measures must be based on proven technology and experience, and must reduce water demands as intended.

Applicability
- Measures must address inefficient water demands occurring in the Region and be within the Region's jurisdiction.

Social Acceptability
- Measures must satisfy the values and priorities of the community (participation rates may be greater for measures that are more socially acceptable).

Cost-Effectiveness
- Cost-effectiveness is generally a function of the level of rebate offered and the water savings per fixture/appliance/action. Therefore, it must cost less to successfully implement the measure than to meet the same water demand through infrastructure expansion.

6.3 Acceptable Measures

The following five measures were found to meet all of the screening criteria:
- System Leak Detection
- Toilet Replacement[16]
- Clothes Washer Replacement
- Outdoor Water Audits
- Indoor Water Audits

In addition to the above measures, there are other initiatives that are currently considered as best management practices (BMPs). These initiatives are considered by leading water efficiency agencies and experts to be the best means by which to secure water savings over the long term. Peel currently practices several BMPs, such as universal metering, billing meter calibration and replacement, water main rehabilitation and replacement, and customer outreach programs.

Each acceptable measure may apply to one or more water demand categories (municipal, residential or industrial, commercial and institutional) as shown in Table 2.

Table 2 – WEP Measures and Categories Affected

Measure	Municipal	Single-Family Residential	Multi-Unit Residential	Industrial, Commercial and Institutional
System Leak Detection	💧			
Toilet Replacement		💧	💧	💧
Clothes Washer Replacement		💧	💧	
Outdoor Water Audits		💧	💧	💧
Indoor Water Audits				💧

[16] Includes replacement of showerheads and aerators where applicable.

6.4 Rationale for Acceptable Measures

- **System Leak Detection:** All water distribution systems have some level of leakage. Leaks can be the result of broken water mains, a poor connection between pipes, or pinholes caused by long term pipe degradation. What's more, leaks can either surface or remain hidden underground for several years. This measure is technically feasible and applicable (a successful leak detection program has been implemented in the Region of York), socially acceptable (the public would support a leakage reduction program), and cost-effective (the use of system analysis ensures that the measure identifies and targets only those leaks that are cost-effective to repair).

- **Toilet Replacement:** One of the greatest potential savings in the WEP is from replacing non-efficient toilets with toilets that flush with no more than six litres (older models typically use between 13-20 litres per flush). The average life expectancy of a toilet is generally considered to be about 25 years – equating to a change-out rate of 1/25 or 4% per year or a total change-out of 40% during a 10- year program. At this time the Province has not mandated the installation of 6-litre toilets in replacement situations, i.e., residents can install non-efficient toilets in existing locations. By offering a rebate the Region hopes to make water-efficient toilets the "fixture of choice" when residents purchase new fixtures. Promoting the use of high-efficiency toilets (i.e., toilets that flush with at least 20% less than the six litres required by Code) and improving toilet performance in new construction are both included in this measure. The measure is technically feasible and applicable (programs across North America have been successfully implemented), socially acceptable (many residents in Ontario have opted to install water-efficient toilets in situation where they are not required by Code), and cost-effective (the costs of water-efficient and water-wasting toilets are similar).

- **Clothes Washer Replacement:** Clothes washers account for about 23% of the total indoor water demands of single-family homes[17] and a significant portion of water used in apartment complexes. Efficient washers use only about 60% of the water and 40% of the energy that conventional washers use,[18] but because of the associated high marginal cost, the Region's program will offer a rebate to those purchasing an efficient washer. The measure is technically feasible and applicable (programs across North America have been successfully implemented), socially acceptable (sales of water-efficient clothes washers is growing every year in North America), and cost-effective (the incentive level identified in this report was calculated specifically to ensure the measure is cost-effective).

[17] AWWARF Residential End Use Study.
[18] Manufacturer literature, various field studies.

- **Outdoor Water Audits:** Recent research indicates that irrigation reduction programs can be effective in reducing peak day water demands. Pilot programs completed in Durham and Halton have shown an average peak day savings of about 200 litres per single-family household. The pilot programs involved distributing water efficiency items (e.g., rain gauges, hose washers) and information pamphlets to households. Similar savings are expected in the multi-residential and ICI sectors as well. The measure is technically feasible, applicable, and socially acceptable (recent pilot programs completed in Durham and Halton have shown significant savings), and cost-effective (landscapes receive only as much water as required).

- **Indoor Water Audits:** This measure focuses on reducing water demands in the ICI sector. Although any quantified and long term water reduction measure will be eligible for a rebate from the Region, it is expected that the primary focus of the program will be the reduction of once-though cooling. The amount of the incentive will be directly related to the verified savings achieved at each site. All ICI sites will be eligible to participate in the program. The measure is technically feasible, applicable, and socially acceptable (a pilot program completed in Toronto has shown significant uptake and water savings), and cost-effective (the incentive level identified in this report was calculated specifically to ensure the measure is cost-effective).

7.0 Maximum and Target Water and Wastewater Savings

Once the acceptable water efficiency measures have been identified, it will be necessary to determine the theoretical maximum water savings and the target water savings associated with each measure. The definition of these terms is given below.

- **Theoretical Maximum Water Savings:** savings that could be achieved if a measure were to be applied to 100% of the fixtures, sites or customers. For example, maximum savings calculations assume that all non-efficient toilets in the Region – even those that are just recently installed – are replaced with efficient fixtures flushing with no more than six litres of water, and that these toilets meet all customer performance expectations and, do not require any additional flushing.

- **Target Water Savings:** expected savings based on a realistic participation rate, generally less than 100% of the fixtures, sites, or customers. For example, toilets have a practical lifecycle of about 25 years, therefore during a 12-year water efficiency program about 48% (i.e., 12/25) of existing toilets will be replaced naturally as they age. The target water savings involves only those toilets that are “naturally” replaced during the life of the program but does not require participants to replace toilets prematurely (i.e., before their 25-year lifecycle is concluded). Of course, target water savings are not guaranteed but are, as the name implies, only a target of what savings can realistically be expected of a successfully operated water efficiency program.

It is important to note that for "some measures, particularly those dependent on customer participation, the estimates or target water savings may reflect a degree of uncertainty and may be more clearly defined once water efficiency pilot programs have been implemented and the results of the pilots reviewed."[19] Nonetheless, potential water savings have been determined as realistically as possible and are based on such factors as the life expectancy of plumbing fixtures and appliances, results from pilot programs implemented in other areas, requirements of the Ontario Building Code, and on projected population and employment figures.

Maximum water savings must be calculated before target water savings can be identified; target water savings cannot exceed the maximum water savings threshold.

7.1 Maximum Water Savings

Table 3 illustrates the maximum water savings calculated for peak and average annual day water demands, and wastewater flows. See Appendix B for details of calculations.

Table 3 – Maximum Water Savings by 2015 (100% participation), ML/d

Category/Measure	Wastewater	Peak Day	AADD[20]
Municipal			
System leak detection	-	9.2	9.2
Single-Family Residential			
Toilet replacement	31.4	31.4	31.4
Clothes washer replacement	13.2	13.2	13.2
Outdoor water audits	-	29.5	3.1
Toilets in new construction	5.5	5.5	5.5
Multi-Unit Residential			
Toilet replacement (public)	1.2	1.2	1.2
Toilet replacement (private)	8.8	8.8	8.8
Clothes washer replacement	1.4	1.4	1.4
Outdoor water audits	-	1.0	0.1
Industrial, Commercial and Institutional			
Toilet replacement	12.2	12.2	12.2
Outdoor water audits	-	5.0	0.6
Indoor water audits	12.5	12.5	12.5
High-Efficiency Toilets	8.2	8.2	8.2
TOTAL	**94.4**	**139.1**	**107.4**
Projected Demands/Flows in 2005	**613.0**	**932.0**	**613.0**
Max Potential Savings Percentage	**15.4%**	**14.9%**	**17.5%**

[19] Water Conservation Plan Guidelines, United States Environmental Protection Agency, August 6, 1998.

[20] AADD values associated with irrigation measure assume that average summer day savings are 25% of the peak day savings and occur during the five summer months, i.e., AADD = 25% x Peak Day x 5/12.

7.2 Target Water Savings

Table 4 illustrates the target water savings (based on expected participation rates) calculated for peak day and average annual day water demands, and for wastewater flows. See Appendix B for details of calculations including assumptions and projections. Savings targets can be easily adjusted in the future based on the results of actual field monitoring and tracking by applying new values to calculations.

Table 4 – Target Water Savings by 2015 (expected participation rates), ML/d

Category/Measure	Wastewater	Peak Day	AADD
Municipal			
System leak detection	-	9.2	9.2
Single-Family Residential			
Toilet replacement	13.8	13.8	13.8
Clothes washer replacement	2.6	2.6	2.6
Outdoor water audits	-	29.5	3.1
Toilets in new construction	5.5	5.5	5.5
Multi-Unit Residential			
Toilet replacement (public)	1.2	1.2	1.2
Toilet replacement (private)	8.0	8.0	8.0
Clothes washer replacement	1.4	1.4	1.4
Outdoor water audits	-	0.7	0.1
Industrial, Commercial and Institutional			
Toilet replacement	2.4	2.4	2.4
Outdoor water audits	-	2.5	0.3
Indoor water audits	3.1	3.1	3.1
High-Efficiency Toilets	1.2	1.2	1.2
TOTAL	**39.2**	**81.1**	**51.8**
Projected Demands/Flows in 2005	**613.0**	**932.0**	**613.0**
Target Savings Percentage	**6.4%**	**8.9%**	**8.5%**

The 2015 WEP target savings are defined, as follows:

- Wastewater Flow Reduction – 39.2 ML/d
- Peak Day Demand Reduction – 81.1 ML/d
- Average Annual Day Demand Reduction – 51.8 ML/d

8.0 Analysis of Water Savings and Costs

The cost-effectiveness of each of the identified WEP measures, or their cost/benefit ratios, is determined by comparing the Regional costs of implementing each of the measures to the costs associated with providing the same water through infrastructure expansion. For a measure to be cost-effective, the cost/benefit ratio must be less than 1.0. The closer the ratio is to 1.0, the less cost-effective the measure.

This analysis was the final step used to assess and screen the water efficiency measures. For each measure, the total cost of implementation and the estimated water savings were calculated. In turn, these values were compared with the costs of supplying an equivalent volume of water through infrastructure expansion.

8.1 Unit Cost of Infrastructure Expansion

The capital costs associated with expanding the water treatment/distribution and wastewater collection/treatment infrastructure[21] are presented in the following tables.

Water Treatment/Distribution[22]	
total cost of water supply infrastructure	$266,305,000
additional water supply (Lorne Park & Lakeview)	380 ML/d
Cost per L/d infrastructure	$0.70

Wastewater Collection Treatment[23]	
total cost of wastewater infrastructure	$316,820,000
additional treatment capacity (Lakeview & Clarkson)	171 ML/d
Cost per L/d infrastructure	$1.39

Based on these tables the unit cost to expand water supply infrastructure is $0.70 per litre per day and the unit cost to expand wastewater infrastructure is $1.39 per litre per day. Therefore, any measure that permanently reduces peak day water demands and does not affect wastewater flows (e.g., irrigation measures) will be considered cost-effective if it can be implemented for less than $0.70 per litre per day of water savings. Any measure that permanently reduces both water demands and wastewater flows (e.g., toilet replacement measures) will be considered cost-effective if it can be implemented for less than $2.09 per litre per day of water savings (i.e., $0.70 + $1.39 = $2.09).

- **Indoor and Outdoor programs must cost less than $2.09 per L/d**
- **Outdoor programs must cost less than $0.70 per L/d**

[21] Increasing water demands not only requires additional water and wastewater treatment capacity but often the expansion of trunk mains, pumping stations, storage reservoirs, trunk sewers, etc., as well.

[22] Region of Peel Master Plan, May 1999, Section 6.

[23] Region of Peel Master Plan, May 1999, Section 8.

8.2 Equivalent Cost of Supply

The goal of the WEP is to reduce projected demands and, therefore, infrastructure requirements. If the WEP measures were not to be implemented successfully, then all future demands would need to be serviced through infrastructure expansion. The term "equivalent cost of supply" represents the costs associated with expanding the Region's infrastructure vs. implementing the WEP.

Consider as an example the single-family toilet replacement measure. This measure is expected to save about 13.8 ML/d. Since this measure affects both water supply and wastewater treatment, an avoided unit cost of $2.09 per litre per day is used to determine its cost-effectiveness. The equivalent cost of providing 13.8 ML/d through infrastructure expansion is about $29 million (i.e., 13.8 million litres per day x $2.09 per litre per day), whereas the cost of implementing this measure is about $9 million.

8.3 Benefit to Cost Ratio

Of course it is important that each measure included in a WEP be cost-effective, i.e., the cost associated with successfully implementing a particular measure must be less than the equivalent cost of infrastructure expansion. The cost-effectiveness of each measure must be calculated individually.

The cost/benefit ratio for each measure is calculated by dividing the total cost of implementing the water efficiency measure (identified in Appendix B) by the equivalent cost of supply identified in Table 5. As stated earlier, this value must be less than 1.0 to be cost-effective.

A cost/benefit ratio is not applicable (N/A) for the system leak detection measure, e.g., system leak detection is an ongoing program in which new leaks occur and are repaired every year.

Table 5 illustrates the target water savings associated with each WEP measure (column A), the unit supply cost (column B), the total equivalent cost of supply associated with each measure (column A x column B), the cost of implementing each measure (column C), and the cost/benefit ratio (column C ÷ [column A x column B]).

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Table 5 – Cost/Benefit Ratio of Each WEP Measure

Category/Measure	WEP Savings ML/d (A)	Supply cost $/L/d (B)	Equivalent cost (AxB)	WEP costs (C)	Cost/Benefit Ratio (C)-(AxB)
Municipal					
System leak detection	9.2	$0.70	$6.40	$0.20	N/A
Single-Family Residential					
Toilet replacement	13.8	$2.09	$28.80	$9.20	0.32
Clothes washer replacement	2.6	$2.09	$5.40	$2.60	0.48
Outdoor water audits	29.5	$0.70	$20.70	$7.40	0.36
Toilets in new construction	5.5	$2.09	$11.50	$1.30	0.11
Multi-Unit Residential					
Toilet replacement (public)	1.2	$2.09	$2.50	$0.40	0.16
Toilet replacement (private)	8.0	$2.09	$16.70	$2.90	0.17
Clothes washer replacement	1.4	$2.09	$2.90	$0.30	0.10
Outdoor water audits	0.7	$0.70	$0.50	$0.20	0.40
Industrial, Commercial and Institutional					
Toilet replacement	2.4	$2.09	$5.00	$0.90	0.17
Outdoor water audits	2.5	$0.70	$1.80	$0.50	0.28
Indoor water audits	3.1	$2.09	$6.50	$0.80	0.12
High-Efficiency Toilets	1.2	$2.09	$2.90	$2.10	0.72

As shown in Table 5, each measure has a cost/benefit ratio of significantly less than 1.0, therefore, each individual measure is more cost-effective than the associated cost of expanding water and wastewater infrastructure.

The ratios for all measures are based on the associated water savings/participation rates and financial incentives offered. Increasing the financial incentive of a measure will decrease its cost/benefit ratio, making the program less cost-effective. However, if the water savings or participation rates are not achieved, the WEP has the flexibility to allow for an increase to the incentive as long as it does not exceed the maximum incentive or the cost/benefit ratio does not exceed 1.0.

A complete description of the calculations used to determine measure costs, savings and cost/benefit ratio is included in the detailed measure descriptions, Appendix B.

The entire cost of the program is expected to be about $33 million (including an additional 15% surcharge to cover supporting costs) with a cost/benefit ratio of 0.29, i.e., it is more than three times more cost-effective to achieve the water savings target through implementing the WEP than to expand the water treatment/supply and wastewater collection/treatment infrastructure.[24]

[24] Cost of WEP about $33 million; equivalent cost of supply about $112 million.

9.0 Implementation and Monitoring

The recommended water efficiency measures are scheduled for implementation over the entire planning period from 2004 to 2015. Some measures may initially be rolled-out as pilot programs to help clarify various implementation aspects (such as participation rates and public acceptance of measure) before moving ahead with the full program, while other measures will be implemented as full programs from the onset (e.g., measures that have been successfully implemented previously in other areas).

9.1 Implementation Schedule

It is expected that Peel's WEP will be implemented over a 12-year period from 2004 until 2015. The scheduling for the program roll-out will depend on Regional variables such as budget constraints, urgency for water/wastewater savings, public acceptance and staff resources. Although an implementation schedule has been identified, it is important to remember that any long term strategy should be flexible and enable program modifications based on monitoring, the availability and cost-effectiveness of new technology, budgetary changes, and other factors impacting individual programs.

One possible implementation scenario is identified in the implementation chart, Appendix A. This chart shows one potential schedule of measure roll-out and the associated annual and total costs, and the target water savings. It is expected that the WEP schedule will be updated and changed several times throughout the implementation period of the WEP to ensure that targets are met or to maximize results.

A phased approach to implementing the various WEP measures is beneficial from both project planning and management perspectives for the following reasons:

- It will allow for sufficient pilot testing of water efficiency measures to verify estimated uptake and related cost/benefit ratios

- It will permit a greater flexibility of program delivery, enabling modifications and adjustments on an "as-needed" basis (as opposed to infrastructure expansion projects)

- It will enable the Region to initiate those more readily manageable measures (e.g., replacing toilets in Regionally operated facilities requires fewer staff and participation rates can be maximized) in the early stages and, in turn, build experience and expertise for the more complex and resource intensive measures to be implemented in later phases

Based on this phased approach it is expected that Peel's WEP will take between three or four years to become fully operational (Figure 8). By utilizing the phased approach to implementation with measurable project milestones, the Region will be able to track individual water efficiency programs and ensure delivery is on-schedule and within the allocated budget. Furthermore, project tracking will enhance risk management capabilities, enabling Regional staff to identify potential barriers well before they arise and take appropriate action.

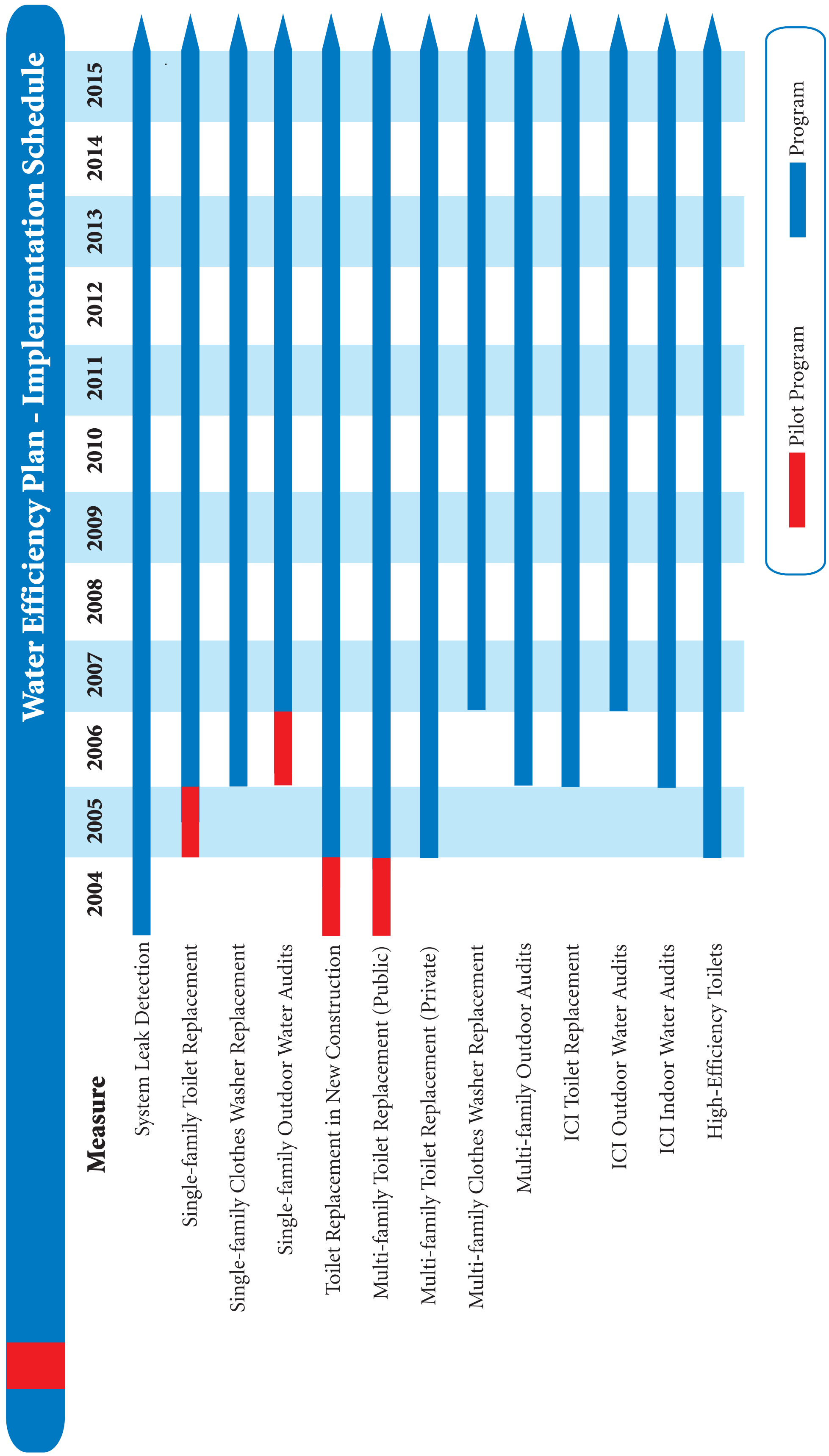
Water Efficiency Plan - Implementation Schedule
Measure
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
System Leak Detection
Single-family Toilet Replacement
Single-family Clothes Washer Replacement
Single-family Outdoor Water Audits
Toilet Replacement in New Construction
Multi-family Toilet Replacement (Public)
Multi-family Toilet Replacement (Private)
Multi-family Clothes Washer Replacement
Multi-family Outdoor Audits
ICI Toilet Replacement
ICI Outdoor Water Audits
ICI Indoor Water Audits
High-Efficiency Toilets
Pilot Program
Program

FIGURE 8

9.2 Implementation Plan

To ensure the continued relevance of the WEP, it must be treated as a living document that is revisited and modified as needed. For example, changes in the building code, population growth and distribution projections, Regional budgets, and other legislative or administrative factors may require that changes be made to the WEP. It should be noted that although the implementation of the plan may change, the program goals remain the same.

One of the most critical elements for success in project management is effective planning. The WEP clearly sets out what needs to be done to achieve required water use savings, but an implementation plan is needed to address how best to achieve those savings. It is strongly recommended that the Region develop an implementation plan early in Phase 1 to ensure the effective implementation of the WEP. The implementation plan should:

- provide specifics for the establishment of a project team (may include management, staff, consultants, public, stakeholders, etc.) to implement and manage the project
- determine and describe project management structure and function (i.e., how the team will operate, reporting structure, individual program design and management, etc.)
- identify human resources needs for the project, including required skills, experience, and roles and responsibilities for project team members
- set out detailed Work Breakdown Schedule (WBS), clearly delineating who does what and by when
- establish project budget requirements for the different phases of implementation

9.3 Marketing

Success in meeting the goals and objectives of the WEP rests in large part on the participation by residents and other stakeholders in the individual water efficiency initiatives. Effective marketing programs that reach and resonate with target audiences are critical to achieving required participation rates.

Developing successful marketing initiatives requires familiarity with the individuals and groups to be reached. Through market research and inquiry it is possible to secure information about the needs and motivations of target audiences and to develop tailored marketing programs that tap into those needs and motivations. Further, market research is used to develop the key campaign message and the graphic identity, which can be tested and refined prior to roll-out.

Given the size and range of audiences in Peel Region to be reached through marketing, it is recommended that stakeholders be utilized to communicate water efficiency messages to their constituents. Stakeholders – community groups, non-governmental organizations (NGOs), business and trade associations – are knowledgeable about the needs of their membership and have both the credibility and infrastructure to reach them.

In order to ensure the development and implementation of an effective outreach and marketing program, it is recommended that a marketing strategy be developed and integrated with the implementation plan. A media plan should be included in the marketing strategy that identifies target media, describes the approach and methods to be used and covers media training requirements for WEP spokespeople. The marketing strategy should set out the budget and schedule for the marketing program.

Ongoing tracking and assessment of marketing initiatives should be undertaken in order to evaluate their effectiveness, and to troubleshoot and adjust strategies as required.

In summary, to ensure the marketing program in support of the WEP is successful in securing the required participation rates of residents and stakeholders, the following recommendations should be considered:

- Develop a marketing strategy as part of the project implementation plan.
- Identify key stakeholders and establish working partnerships with them.
- Conduct market research of target audiences and key stakeholders and use the research findings to guide the development of the marketing strategy.
- Test and refine outreach campaign messages and develop marketing programs tailored to the target audiences.
- Develop a media plan as part of the marketing strategy.

9.4 Human Resources

The number of personnel required to successfully execute the WEP is dependent in large part on how the plan is implemented. Determining project priorities and setting out the process for implementation will enable the Region to evaluate the human resource requirements for the project on a phase-by-phase basis. Based on the proposed phasing of water efficiency measures outlined in this plan it is expected that a single staff member may be sufficient during the first year, though ultimately a staff complement of about four (not including management or consultants) would be required.

The following table provides an expectation of staffing requirements.

Table 6 – Estimated Staffing Requirements

Measure	Full-time Staff Required
Leakage	0.10
Single-family Toilet	0.85
Single-family Clothes Washer	0.20
Single-family Outdoor Audit	0.30
Toilets in New Construction	0.25
Multi-Unit Toilet - Public	0.25
Multi-Unit Toilet - Private	0.25
Multi-Unit Clothes Washer	0.20
Multi-Unit Outdoor Audit	0.20
ICI Toilet	0.50
ICI Outdoor Audit	0.20
ICI Indoor Audit	0.20
TOTAL	**4.00**

9.5 Program Promotion

Program promotion can be achieved through public education and outreach. It is an important element of every program or measure roll-out and it can be delivered in a variety of ways, such as TV or radio advertisements, billboards, bus shelter posters, inclass student training and bill stuffers. In calculating the costs associated with WEP implementation an additional 15% of the measure costs has been added to cover program support costs (promotion, marketing, monitoring, tracking, etc.).

9.6 Program Monitoring

It is expected that most of the program monitoring, analysis and reporting will be completed in-house by Regional staff, though the Region may wish to have some portion of this work completed by outside resources.

A comprehensive monitoring strategy (to be developed as part of the implementation program) is necessary if the Region intends to assess the impacts of the water efficiency plan measures as they are implemented. The monitoring program must be dynamic and iterative, and able to identify any reductions in water use and wastewater flows that are a direct result of the WEP. Monitoring aspects may include billing data, sub-metering, customer satisfaction surveys and production metering.

The intent of a monitoring and tracking program is to compare the expected costs and savings to actual costs and savings associated with the implementation of each measure. Although there is no clear timetable established for assessing individual measure or program success, a review of measure status (i.e., the associated costs and water savings) should be completed when specific milestones are reached (e.g., when pilot programs are completed) or, in the case of long term measures (such as a toilet change-out measure), an annual evaluation may be warranted. Monitoring and data collection, however, should be ongoing throughout the entire implementation of each measure.

The purpose of a monitoring plan is to:

- track water savings and flow reductions compared to program goals
- review costs of implementation
- identify which measures meet targets
- identify which measures must be improved or discarded
- assess participation and capture rates
- provide feedback and course corrections where needed

Although the exact method selected by the Region for the monitoring of individual water efficiency measures depends upon the customer sector involved, budget, schedule, and other program related variables, there are several potential monitoring programs that can be adopted by the Region as required, such as:

Billing data analysis: Used to track customer water demands/savings. Should be able to compare the water demands of participants and non-participants (control group). Viable only when there is a significant change in water demands as a result of the measure, e.g., because there is a natural variation in household water demands from month to month and year to year, a measure that affects only a small changes in demands (replacing a 12 litre per minute showerhead with a 9.5 litre per minute showerhead for instance) may not "show up" in the analysis. Good for analyzing both large and small numbers of participants. Analysis is only as good as the data, i.e., estimated meter reads will lower the quality of data.

- **Site data logging/sub-metering:** Used to obtain detailed data regarding specific sites or specific processes within a site that cannot normally be obtained through logging the main water meter itself, e.g., data regarding irrigation, clothes washer, or cooling tower water use can be collected and segregated from other uses. Data can be used to show diurnal water demands, peak demands, average demands, etc.

- **Customer survey:** Used to determine customer satisfaction regarding a program in general or for elements within a program. It is important to the success of most WEP programs that customers "buy into" the program. Surveys can be analyzed in conjunction with collected site data to evaluate the relationship between what a customer claims vs. actual results, e.g., a customer's perception of how long they irrigate may be somewhat less than what actually occurs.

- **Interviewing wholesale/retail outlets:** Used when assessing implementation rates, e.g., to evaluate increases in sales of horizontal-axis washing machines or ultra-low-flush toilets as a result of a specific WEP measure.

- **Water production values:** Used to assess large changes in water demands typically associated with irrigation, e.g., to measure the effects of a voluntary or mandatory watering ban (often used in conjunction with precipitation and temperature data).

- **International Water Association (IWA) Water Balance:** Uses the International Leakage Index (ILI) FastCalc software program to determine the level of cost-effective leakage reduction available in each system.

10.0 Summary and Conclusions

If the WEP is not implemented, Peel Region will be required to make an even larger capital investment in new water and wastewater infrastructure in the future. This infrastructure will also have an ecological impact, increase energy consumption and treatment chemical usage (and related costs), and generate more climate change causing CO_2 emissions.

By undertaking the water efficiency measures set out in this plan, not only will the Region significantly reduce these costs and impacts, it will demonstrate leadership and create a vision for a sustainable water supply, instil community pride in a fiscally and environmentally responsible solution to high water use, provide cost savings to water use customers and ensure long term self sufficiency by conserving valuable water resources.

A great deal of research and analysis went into the development of the WEP. All water efficiency measures recommended for implementation were carefully vetted using a set of screening criteria designed to ensure the merit and applicability of each individual measure. Employing these water efficiency measures in conjunction with other best management practices will ensure the long term viability and success of the WEP.

The projected total cost the WEP over the 12-year implementation period is $33 million. Compare this to a cost of about $112 million for new infrastructure to provide the equivalent supply of water as is expected to be realized through implementing the plan. With a cost benefit ratio of 0.29, or about one-third the cost of expanding Peel's water and wastewater infrastructure, the WEP makes good economic sense.

The flexibility inherent in the WEP is a decided advantage over new infrastructure expansion, which cannot be altered and modified without incurring major costs. Further, the water conserving approach articulated in the plan is consistent with the Region's commitment to "preserve, protect and enhance Peel's natural environment and resources" as stated in its Strategic Plan.

In conclusion, the Water Efficiency Plan offers a cost-effective means of reducing water use and avoiding large capital investment in new infrastructure for years to come. Implementing water use efficiency is the responsible and prudent choice for a healthy, vital and growing Region.