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REPORT

Calgary Metropolitan Region Board

Water Use and Conservation in the Calgary Metropolitan Region Study

OCTOBER 2019

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1 INTRODUCTION

1.1 Background

The Municipal Government Act proclaimed the Calgary Metropolitan Region Board Regulation (AR190/2017) which re-instated mandated regional planning for the Calgary area, and established the Calgary Metropolitan Region Board (CMRB) in January 2018. Members of the CMRB include: City of Airdrie, The City of Calgary, City of Chestermere, Town of Cochrane, Foothills County, Town of High River, Town of Okotoks, Rocky View County, Town of Strathmore and a portion of Wheatland County. **Figure 1-1** shows the CMRB municipality boundary.

The objective of the CMRB is to promote long term sustainability, and the economic well-being of the Calgary Metropolitan Region (CMR), through environmentally responsible land use planning and coordination of regional infrastructure investment and service delivery. Key to planning and servicing new development is availability of water, which is complicated in the Calgary region by the closure of the South Saskatchewan River Basin (which includes most land area from Red Deer south to the Montana border) to any new water license applications. Those applications that were deemed complete when the closure occurred will be processed by the Province of Alberta over time.

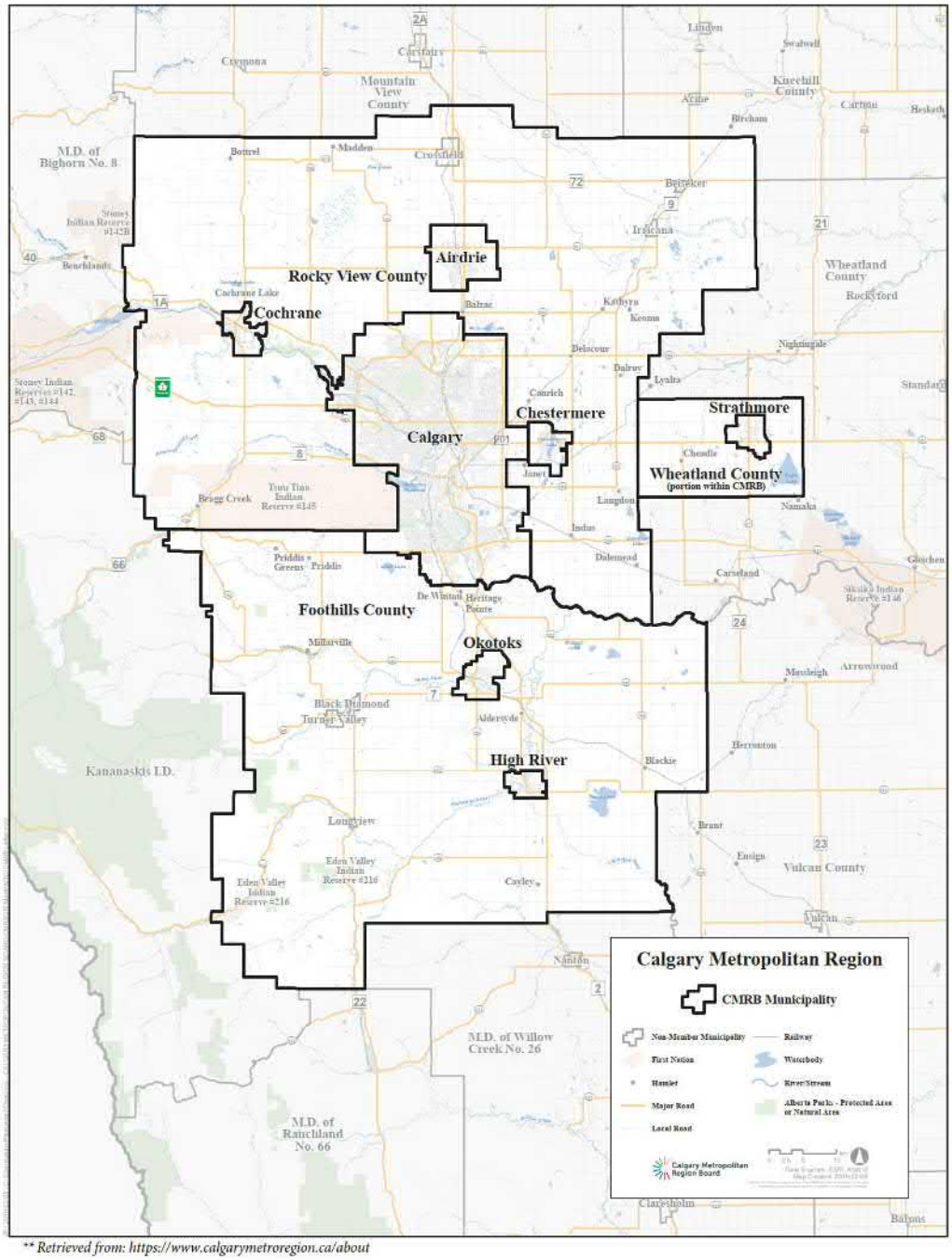


Figure 1-1
Calgary Metropolitan Region Board – Municipality Boundary[1]

[1] Figure 1-1 Retrieved From: https://www.calgarymetroregion.ca/about

1.2 Project Objective

Water conservation and efficiency are key to supporting sustainable growth in the CMR. The main objectives of the Water Use and Conservation Study are to define existing water consumption across the region, and to develop a common understanding of water conservation and efficiency that each community can use to improve their water conservation programs. For communities that lack water conservation programs, this information will assist in developing such programs with the collaboration of other municipalities in CMR. A key deliverable of this project was to develop a normalized and practical "definition" for water use tracking across the various municipalities within the CMR.

This collective information will inform data gaps, areas for potential improvement, further discussion and collaboration opportunities amongst the municipalities, and future policy development surrounding water conservation and efficiency opportunities.

1.3 Project Scope of Work

The key steps undertaken by the Associated Engineering's (AE) project team are indicated below.

Task 1 – Project Kickoff Meeting
Task 2 – Information Gathering
Task 3 – Review Water Use Data
Task 4 – Examples of Water Conservation Best Practices
Task 5 – Status Evaluation
Task 6 – Reporting
Task 7 – Project Management and Meetings

Two interim reports were submitted to the CMRB for commentary, and have been incorporated into this final report, Water Use and Conservation in the Calgary Metropolitan Region Study.

- Interim Report #1: Water Use and Normalization (covered Tasks 2 and 3)[1]
  - Submitted on July 4, 2019.
- Interim Report #2: Water Conservation Status Evaluation (covered Tasks 4 and 5)[2]
  - Submitted on July 23, 2019.

[1] Task 2: Information Gathering, Task 3: Review Water Use Data
[2] Task 4: Examples of Water Conservation Best Practices, Task 5: Status Evaluation

2 METHODOLOGY

The first step of the Water Use and Conservation Study was to collect background information and review water use data. This provided a basis to understand current water use and an overview of the information being collected, tracked and monitored. The following information was provided by the CMRB:

- Municipal Context Reports (dated February 15, 2019).
- Demand Management – Data Requirements Questionnaire (dated March 14, 2019).

Municipality Specific Information:

- Historical Population and Water Consumption Data.
- Public Notices regarding Water Rates.
- Public Notices regarding Water Conservation Initiatives.
- Water Conservation Study Reports.
- Water Use Bylaws.

Where information was not provided or made available from the municipalities, supplementary information was obtained through municipality websites; however, as data gaps still exist, these are identified and discussed further in Section 5.

Once the recorded data was reviewed, interviews were conducted with each municipality on their current methods on measuring water use, water conservation and efficiency measures, existing water use regulations and bylaws, and rate structure. These interviews with municipalities took place from May 30, 2019 to June 20, 2019 via phone. A log of interview questions and responses is attached in **Appendix A**. The following summarises the requests that were made of each municipality:

- Annual Water Consumption Data (m^3) for the past 10 years (2008 to 2018):
  - Divided by "type" of user, i.e., Residential, Commercial, Irrigation, etc.
- Annual Population and/or Population Growth Rate.
- Annual Water Production Data (m^3) for water treatment plants (WTPs) that are owned and operated by the municipality or Annual Water Volume Data (m^3) purchased from an adjacent municipality, for the past 10 years (2008 to 2018).
- Additional clarifications regarding Water Rate Structures, Water Conservation Initiatives and Studies, and Water Use Bylaws.

Using the information received from the CMRB and interviews with member municipalities, per capita water use (L/c/d) was estimated using historical population and water consumption data from the past 10 years (2008 to 2018).

This was followed by a review of the applicable water use regulatory regime, and research on best management practices in other jurisdictions in Canada and the United States to provide insights of what others have done regarding water efficiency as part of an overall water management program.

3 DATA COLLECTION AND REVIEW

3.1 Water Sources

The following table summarizes the water source and main water users for Water Treatment Plants (WTPs) that are owned and operated by municipalities within the CMRB boundary. This information provides context on how each municipality is supplied with potable water (either by one or more WTPs or purchase from a Regional Supply). The volume of annual water production versus purchased water is analyzed in Section 4.0 and used to estimate unaccounted for water.

Table 3-1 - Water Sources and Main Users

Municipality	WTP	Source	Main Water Users
Airdrie	N/A	Regional Supply from City of Calgary	Services City of Airdrie.
Calgary	Bearspaw WTP	Bow River	Services City of Calgary and Regional Servicing to Airdrie, Chestermere, Strathmore and Tsuu Tina First Nation.
	Glenmore WTP	Elbow River	
Chestermere	N/A	Regional Supply from City of Calgary	Services City of Chestermere.
Cochrane	Cochrane WTP	Bow River	Services Town of Cochrane.
Foothills County	Heritage Heights WTP	Groundwater	Services 2 Schools and 1 Arena. No Residential Servicing.
	Cottonwood WTP	Groundwater	Services 14 Residential Properties.
	Blackie WTP	Groundwater	Services the Hamlet of Blackie.
	Fish Creek Ranch WTP	Groundwater	Services 1 Residential Property and 1 Bulk Water Station.
	Red Deer Lake WTP	Groundwater	Services 1 (Red Deer Lake) School.
High River	High River WTP	Highwood River	Services Town of High River and Regional Servicing to Hamlet of Aldersyde, Hamlet of Cayley and Cargill Meats.
Okotoks	Okotoks WTP	Sheep River Aquifer	Services Town of Okotoks.
Rocky View County	Bragg Creek WTP	Elbow River	Services Hamlet of Bragg Creek.
	East Balzac WTP	Graham Reservoir	Services Hamlet of East Balzac and Cross Iron Mills.
Strathmore	N/A	Regional Supply from City of Calgary	Services Town of Strathmore.
Wheatland County	N/A	Groundwater	The portion of Wheatland County within the CMRB Boundary is serviced by individual groundwater wells. There is no piped supply.

Other sources of water include privately owned and operated water systems such as individual groundwater wells and rural water co-operatives. These systems often have their own water withdrawal licences with Alberta Environment and Parks (AEP), water treatment and distribution infrastructure, none of which is connected to the major water supply systems listed in the table above. Like the municipally owned WTPs, each of these privately-owned water

systems have their own operating permit regulated by Alberta Environment and Parks (AEP). The following municipalities have a combination of the systems described above:

Foothills County
In Foothills County, several rural residential properties are serviced by individual groundwater wells or private water co-operatives. The Hamlets of Aldersyde and Cayley are of interest to this study because they are serviced by a regional supply from the Town of High River.

In addition to the five WTPs and three re-treatment (re-chlorination or testing/pumping facilities) that are owned by Foothills County, there are five additional WTPs that are privately owned, but are operated by Foothills County. These are Square Butte Ranch WTP, Millarville Racing and Ag Society WTP, Ravencrest WTP, Longview WTP and the Sheep River Regional Utility Corporation (SRRUC). Foothills County is a 10% share owner in SRRUC along with the Town of Black Diamond, Town of Turner Valley, and Village of Longview. These systems service the country residential customers.

Rocky View County
In Rocky View County, numerous rural residential properties are serviced by individual groundwater wells or private water co-operatives. The study area for Rocky View County is focused primarily on the two WTPs that Rocky View County owns and operates: East Balzac and Bragg Creek. The East Balzac WTP is unique because it services primarily industrial and commercial developments.

Wheatland County
Only a small portion of Wheatland County (330 km^2) is located within the CMRB boundary. This portion of Wheatland County includes the Hamlet of Cheadle, Eagle Lake, commercial/industrial developments and rural residential subdivisions. This area is serviced by private groundwater wells. Examples of other WTPs that are owned and operated by Wheatland County, but are located outside of the CMRB boundary, are listed below. While these WTPs fall outside of the study area, water use data has been obtained to provide an overall picture of water use and conservation in Wheatland County.

- Carseland WTP (services the Hamlet of Carseland and the Speargrass Golf Course Community).
- Rosebud WTP (services the Hamlet of Rosebud).
- Standard WTP (services the Village of Standard, the Village of Rockyford and the Hamlet of Gleichen).

3.1.1 Rural Water Co-Operatives and Country Residential Water Use Estimation

Country rural subdivisions, acreages and rural residents are serviced by rural water co-operatives, individual wells, trickle feed, and/or bulk water. Water use data for was not made available during this study for rural water co-ops and individual groundwater wells located within the study areas of Foothills County, Rocky View County and Wheatland County.

Rural water co-operatives (co-ops) were first formed when farmers, ranchers, and rural residents came together to create distribution systems to service their homes with potable water and to provide non-potable water for livestock and irrigation. The water co-ops were formed to pool resources, to share ownership and costs, and to share the benefits of a self-owned system. Rural water co-ops are sometimes covered by franchise agreements that specify service areas. The governing legislation for rural water co-ops includes the Rural Utilities Act and the Rural Utilities Regulation (151/2000).

The Alberta Federation of Rural Water Co-operatives (AFRWC) was formed in 1994 in Southern Alberta to address the needs of Alberta's rural residents during a time of water shortage and drought. The AFRWC is a collective entity recognized by the Government of Alberta whose mission is to ensure that water co-ops have access to reasonable priced insurance coverage, support and training. Today, there are over 170 water co-ops in Alberta. 101 of these water co-ops are members of the AFRWC, with over 6,700 connections.

There are several rural water co-ops located within the CMR that are members of the AFRWC, these include: 26 in Foothills County, 49 in Rocky View County and 3 in Wheatland County. This total of 78 rural water co-ops that are members of the AFRWC are not the only water co-ops located within the CMR. For example, Rocky View County estimates that water services are available from over 70 privately or co-operatively run water systems, and additional residences are serviced by private groundwater wells. Rocky View County does not regulate, own or operate any of the 70 rural water co-ops or private water systems within the municipality; nor do they have any jurisdiction over how the water is used, hence no information on water use was available. Foothills County and Wheatland County were not able to provide the estimated number of water co-ops and private water systems that service their residents, therefore the AFRWC information has been used as a basis for this study.

To determine the significance of the rural water demand, an estimated total of 99 rural water co-ops within the CMRB boundary was used to perform a sensitivity analysis based on a range of assumed average population that each rural water system services (recognizing that actual numbers serviced by each co-op varies significantly). Assuming an average of 100, 200 or 300 people are serviced by each water system, the rural water co-ops demand could range anywhere from 0.7% to 2.0% of the region's total water demand, as shown in the table below.

Table 3-2 - Estimated Regional Significance of Rural Water Co-Operatives

County	Rocky View	Foothills	Wheatland	Total	Percent of CMR Population (1.5 Million)
Estimated No. of Rural Water Co-Ops	70	26	3	99	
Estimated Population Serviced	7,000	2,600	300	9,900	0.66%
	14,000	5,200	600	19,800	1.32%
	21,000	7,800	900	29,700	1.98%

A map showing the location of the AFRWC private water co-ops and a summary table outlining the facility name, owner and water source are attached in **Appendix B**.

To help paint a picture of typical rural water use, the water diversion licenses for several of the above water co-ops were randomly selected to review the volume of diversion allowed (this does not mean that these co-ops are using all the available diversion, it only illustrates what the potential water demand could be). The annual volume of water diversion and maximum pumping rate under the Water Act is summarized in the table below as a potential indicator of the relative size of 22 of the 99 known private water systems.

Table 3-3 - Maximum Annual Rate of Diversion for Select Rural Water Co-Operatives

Facility	Annual Diversion (m^3) *	Maximum Rate of Diversion (L/s)	Purpose
Rocky View Water Co-Op Waterworks System	1,768,813	70.0	Municipal Water Supply
Cochrane Lake Estates (Montara) Waterworks System	1,227,314	100.0	Municipal (Subdivision) Water Supply
Harmony Waterworks System	917,221	90.0	Storage, Commercial & Municipal Water Supply
Langdon Crossings Subdivision Waterworks System	400,000	5.7	Municipal (Subdivision) Water Supply
Lakes of Muirfield Waterworks System	345,365	114.0	Municipal and Commercial (Industrial Subdivision) Water Supply
Westridge Waterworks System	329,341	29.0	Municipal Water Supply
Bearspaw Meadows Estates II Waterworks System	212,160	N/A	Golf Course Irrigation
Bar Kay Cee Ranch Waterworks System	148,018	85.0	Water Storage for Recreation
Irricana Waterworks System	117,181	5.7	Municipal Water Supply
Longview Waterworks System	98,678	8.5	Municipal Water Supply
Emerald Bay Waterworks System	92,511	7.4	Municipal Water Supply and Golf Course Irrigation
Cayley Waterworks System	86,344	7.0	Municipal Water Supply
Aldersyde and Area (Abild/Maple Leaf) Waterworks System	66,608	32.0	Municipal (Regional Water Supply)
Priddis Greens Development Waterworks System	63,915	28.0	Commercial Water Supply
Mountain River Estates Waterworks System	33,304	5.7	Municipal Water Supply
Blackie Waterworks System	29,546	7.3	Municipal Water Supply
Yankee Valley Estates Subdivision Waterworks System	19,710	0.9	Municipal Water Supply
Rancher's Hill Phase 3 Subdivision Waterworks System	15,200	0.8	Municipal Water Supply
West View Estates Waterworks System	10,361	3.0	Municipal Water Supply
Georgian Del-Rich Waterworks System	9,868	0.6	Municipal Water Supply
Wintergreen Woods Waterworks System	7,400	16.0	Municipal Water Supply
Big Hill Creek Estates Waterworks System	4,934	0.5	Municipal Water Supply

** Annual Diversion Volume and Maximum Diversion Rate Data Obtained from Alberta Water License Viewer: https://www.alberta.ca/alberta-water-licence-viewer.aspx*

The per capita water use could not be determined in this study because there are no known service population records for each rural water co-op. Due to the lack of historical population data, correlating the Maximum Annual Rate of Diversion (m^3) to equivalent population is immaterial.

Most country residential areas within Foothills County are serviced by individual groundwater wells. There are approximately fifteen residences that are serviced by trickle (low pressure) feed connections, which supply individual cisterns via regional water lines from the Hamlet of Cayley (supplied by the High River WTP) and Hamlet of Millarville (supplied by the SRRUC WTP in Turner Valley). The trickle feed systems are metered and monitored to ensure that the systems are used for potable indoor use only; no outdoor use including external fixtures (faucets), irrigation, agriculture or livestock watering is permitted on the trickle feed systems. The available flow is restricted by the resident's cistern capacity. The remaining country residential users are supplied by bulk water stations at a high rate of $\$5/m^3$ to achieve cost recovery on bulk water sales for distribution and treatment. The rural municipalities did not have information on any country residential water use rates. Based on the limited information provided, and qualitative feedback from Rocky View County and Foothills County, the country residential is assumed to have high water usage due to large lawn areas, significant landscaping features, and a perceived desire for well manicured green landscapes which require regular irrigation.

3.2 Water Measurement and Consumption

In this phase of the study, Associated Engineering reviewed how water consumption data is collected and measured for each of the CMR municipalities. This information informed the user types and volume of water used based on the types.

It is typical for municipalities to use metering and a billing system to measure water use. Based on the data provided from phone interviews with the municipalities, 98% to 100% of water users in CMR municipalities are metered. Water use is typically tracked by the following user types:

- Residential.
- Industrial, Commercial and Institutional (ICI).

In Foothills County, user types (i.e., Residential and ICI) are not differentiated, rather, users are billed a flat rate based on their meter size. In many other CMR municipalities, the ICI water use is further broken down into the following categories.

- Bulk Water.
- Municipal.
- Irrigation.

The following table, Table 3-4, summarizes how each municipality is currently tracking water use.

Table 3-4: Current CMR Municipality Water Use Data Tracking

Municipality	Water User Type					
	Residential	ICI	Bulk Water	Municipal	Irrigation	Non-Potable
Airdrie	Metered Billing Data	Metered Billing Data	Industrial and Commercial Use	City Buildings, Recreation Centre, Parks Irrigation* Sewer Flushing and Public Works Vehicle Washing Fire Fighting and Hydrant Use are un-accounted for.	Parks, Multi-Family Residential, ICI Property and Golf Course Irrigation. Captured stormwater is treated and used for Municipal Irrigation in some locations (Non-Potable).	Parks Irrigation in two locations (Hill Crest and Windsong)
Calgary	Metered Billing Data, Including Single Family Residential Irrigation and Average Estimated Water Use for Un-Metered Residential Properties	Metered Billing Data Including Bulk Water, YYC Airport, ENMAX District Energy and Operations, Top-Up Water for Developed Lakes, Non-Sewer (Water for Consumptive Purposes), ICI Cooling Towers and Cooling at ENMAX Centre	Bulk Water is Captured under ICI, Including Industrial Facilities and Rural Residential	City Owned Facilities Including Pools, Fire Halls and Municipal Buildings Public Works Use, Hydrant Use, Flushing, Dust Control, Fire Fighting and Street Sweeping are un-accounted for.	ICI Property Irrigation, Multi-Family Residential Property Irrigation and Parks Irrigation	Stampede Rodeo (Private Water License)
Chestermere	Metered Billing Data	Metered Billing Data Including ICI Properties, Schools and Recreation Centres	N/A	Public Works Vehicle Washing, Street Sweeping Fire Fighting in un-accounted for.	Parks Irrigation**	Parks Irrigation, Private Property Irrigation (Lakefront)
Cochrane	Metered Billing Data	Metered Billing Data Including Recreation Centre, Spray Lake Sawmill, Long-Term Care Homes and Golf Course Restaurant	Rural Residential and Non-Residential Use	Not Recorded	Multi-Family Residential Irrigation, Public Green Space Irrigation and Parks Irrigation. Parks Irrigation is unmetered, but the total volume is estimated.	Golf Course Irrigation (Private Water Licenses) and Agricultural Irrigation
Foothills	Metered Billing Data by Meter Size: 5/8” Meters are Assumed to be for Residential Properties	Metered Billing Data by Meter Size: > 5/8” Meters are Assumed to be for ICI Properties Including Car Wash, Recreation Centre and Arena	Rural Residential	Public Works is unmetered, but portable water meters are used to record potable water use. Hydrant Use and Fire Fighting are un-metered, but the duration of hydrant use is reported, and the total volume is estimated.	Not Recorded	Road Construction (draws directly from sloughs)

Municipality	Water User Type					
	Residential	ICI	Bulk Water	Municipal	Irrigation	Non-Potable
High River	Metered Billing Data Including Hamlet of Aldersyde and Hamlet of Cayley	Metered Billing Data Including Car Washes, Brewery, Lafarge Precast Plant, Hospital, Recreation Centre, Cargill Meats and ICI Irrigation	N/A	Public Works Use, Maintenance Water and Hydrant Use Hydrant Use and Fire Fighting are un-metered, but the duration of hydrant use is reported, and the total volume is estimated.	Parks Irrigation	N/A
Okotoks	Metered Billing Data	Metered Billing Data Including Commercial (Box Stores, Shopping and Car Washes), Industrial Business Districts and Public Facilities	Rural Residential Users in Foothills County and Commercial Users	Parks Irrigation (Sports Fields Only) Flushing and Fire Fighting are not metered.	Separate Irrigation Meters installed on some Multi-Residential, ICI and Public Irrigation systems.	Non-Potable Bulk Water Sales/Use for Industrial, HydroVac, Landscaping, Construction Users and some sports fields including Seaman Stadium.
Rocky View	Metered Billing Data	Metered Billing Data Including CrossIron Mills, Cooling Towers, Bragg Creek Commercial Area, Gas Station and East Balzac Industrial Area	N/A	Public Works Vehicle Washing and Services for Municipal Buildings Fire Fighting is un-accounted for (Bragg Creek does not have a hydrant system)	Captured Stormwater is used for Irrigation in some locations (Non-Potable)	Non-Residential Irrigation
Strathmore	Metered Billing Data, Including Residential Irrigation	Metered Billing Data Including Parks Irrigation, Recreation Centres, Schools and Retail	Non-Residential Use. There is a ticketing system to track bulk water use, which is not reconciled. Bulk Water Use data is not readily available.	Agriculture Grounds and Hydrant Use are un-accounted for.	Residential Irrigation is tracked under Residential and Parks Irrigation is tracked under ICI (separate irrigation meters).	N/A
Wheatland	Metered Billing Data for Hamlets, Including Residential Irrigation	Metered Billing Data Including Gas Stations, Grocery Stores and Small Services	Agriculture (Metered) and Public Works (Un-Metered)	Industrial Developments (Private Water Licenses) and Hydrant Use are un-accounted for.	Western Irrigation District (Non-Potable) No Parks Irrigation	Public Works Use and Dust Control

** Airdrie started metering Parks Irrigation in 2015. Prior to 2018, not all irrigation was captured in the Municipal water use total.*

*** Chestermere started metering Parks Irrigation in 2017.*

3.3 Rate Structure

Rate structures reviewed in this study to show the varying charges between municipalities. This information can help to correlate and inform on user behaviour and consumption rates. The following table summarizes the rate structure for CMR municipalities.

Table 3-5: Water Utility Rate Structures

Municipality	Residential	ICI	Comments
Airdrie	50% Fixed and 50% Variable	Same as Residential	The fixed and variable consumptive rates are based on meter size and are the same for Residential and ICI users. The fixed cost contributes to the base revenue stream.
Calgary	Usage Rates Differ Based on Single Family or Multi-Family Residential	Usage Rates Differ Based on Meter Size (> or < 75 mm)	Uniform Rate Structure. All customers have a fixed component of their rates based on meter size. Irrigation meters have a separate charge at a higher rate than regular water use.
Chestermere	Two-Tiered Variable: 0 to 18 m^3 and > 18 m^3	Two-Tiered Variable: 0 to 100 m^3 and > 100 m^3	The fixed and variable consumptive rates are different for Residential and ICI users. The variable rate increases for higher water users. This rate structure has appeared to reduce water consumption, although there was initial push back from the public on increased utility rates.
Cochrane	Fixed Plus Three-Tiered Variable: 0 to 25 m^3 26 to 60 m^3 and > 60 m^3	Fixed, Based on Meter Size	Multi-family residences are billed at the first-tier rate only. Irrigation water users also have their own fixed rate, based on meter size. The variable consumptive rates are different for ICI and Irrigation users. There are also separate consumptive rates for Bulk Water sales.
Foothills County	Variable	Same as Residential	Residential and ICI water users are billed based on a variable consumptive rate structure (per monthly m3 consumed). The variable consumptive rates are based on meter size and are the same for Residential and ICI users. The variable rate increases substantially as the volume of water consumption increases, to prevent over-use. For Bulk Water sales, rates are higher than piped supply to achieve cost recovery for distribution and treatment.
High River	Fixed Plus Four-Tiered Variable: 0 to 27 m^3 28 to 54 m^3 55 – 108 m^3 > 108 m^3	Fixed Plus Three-Tiered Variable: 0 to 16 m^3 16 to 180 m^3 > 180 m^3	The fixed and variable consumptive rates are based on meter size and are slightly different for Residential and ICI users. The Town of High River has separate rate agreements with Cargill Meats and Foothills County (high water users). There have been several rate increases over the past 10 years, but this has not resulted in a significant water use reduction.
Okotoks	Three-Tiered Variable: 0 to 23 m^3 24 to 68 m^3 > 68 m^3	Same as Residential	The variable consumptive rates are the same for Residential and ICI users. The Town of Okotoks has observed that water use reporting is more accurate with the three-tiered rate structure, allowing them to address water loss more efficiently.
Rocky View County (Bragg Creek)	Fixed Plus Variable	Same as Residential	Per monthly m^3 of water consumed.
Rocky View County (East Balzac)	Three-Tiered Fixed: 0 to 49m^3 50 to 499 m^3 and > 500 m^3 Plus Variable	Same as Residential	
Strathmore	Fixed Plus Two-Tiered Variable: 0 to 30 m^3 and > 30 m^3	Same as Residential	The fixed rates are based on meter size and are the same for Residential and ICI users. Since 2008, the Town of Strathmore has increased their water rates approximately every 1-2 years.
Wheatland County	Fixed Plus Variable	Same as Residential	The fixed and variable consumptive rates are the same for Residential and ICI users. There is a capital levy for future improvement. Wheatland County has increased their water rates to move towards cost recovery.

3.4 Water Use Definition and Scale Normalization

Based on a review of the data provided, a normalized and practical definition for potable water use tracking across the CMR was developed. This definition of water use tracking is summarized in the following table.

Table 3-6 - Normalized "Definition" for Water Use Tracking

Consumer Type	Unit	Normalized Definition
Residential	L/c/d	• Single Family or Multi-Family Residential Indoor and Outdoor Water Use • Residential (Lawn and Garden) Irrigation
Industrial, Commercial and Institutional (ICI)	m^3	• **Industrial:** Gas Plant, Fertilizer Manufacturing, Meat Packing, Aggregate Processing • **Commercial:** Car Wash, Grocery Store, Restaurant, Gas Station, Shopping Centre (e.g., CrossIron Mills) • **Institutional:** Recreation Centre, Pool, Arena, School, Long-Term Care Home, Hospital
Bulk Water	m^3	• **Residential:** Rural Residential, with no piped service • ****ICI:** Contractor, Developer or ICI Customer • **Municipal:** Public Works, Chemical Mixing for Agricultural Application
Municipal	m^3	• Fire Fighting and Hydrant Use • Construction Water (from hydrants) • Flushing Sewers • Public Works Vehicle Washing • Municipal Office and Operations Buildings Servicing
Irrigation (Potable Water)	m^3	• Municipal Parks & Sports Field Irrigation* • Large Residential Developments Irrigation • Golf Course Irrigation
Non-Potable	N/A	• Agricultural or Crop Land Irrigation • Construction, Road Maintenance and Dust Control • Watering Cattle and Livestock

** In some CMR municipalities, the source of Municipal Parks & Sports Field Irrigation water is stormwater re-use or raw surface water (e.g. pumping from lakes or sloughs). These non-potable water uses are not measured or tracked.*

In reviewing the data provided, some water users/categories may not fit well in this definition of normalization. For example, large Institution, Commercial, Industrial (ICI) water users such as Cross Iron Mills or Cargill Meats and Municipal Parks/Sports Field Irrigation do not have residential populations, which skews the "per capita" water consumption unit comparison. For future considerations, these users might be expressed in terms of volume per area of land use (m^3/m^2 or m^3/ha) or in terms of building area for food processing industries. This type of approach would require that municipalities record the area of land that is used for ICI and Irrigation purposes, over time, to be able to accurately compare the historical trend.

4 OBSERVED WATER USE TRENDS

4.1 Historical Population Growth

Several CMR municipalities provided their historical population data for the past 10 years (2008 to 2018). The data shows that populations in the CMR have been steadily increasing over this period of time.

The population growth rates were calculated between 2008 and 2018. In every municipality, the population has increased every year except. Figures 4-1 and 4-2 show the population growth in CMR municipalities. Population growth rates are listed in **Appendix C**.

Foothills County, Rocky View County and Wheatland County were not able to provide enough historical population data for their service areas in order to plot a meaningful comparison to the historical populations of other CMR municipalities (Figure 4-2).

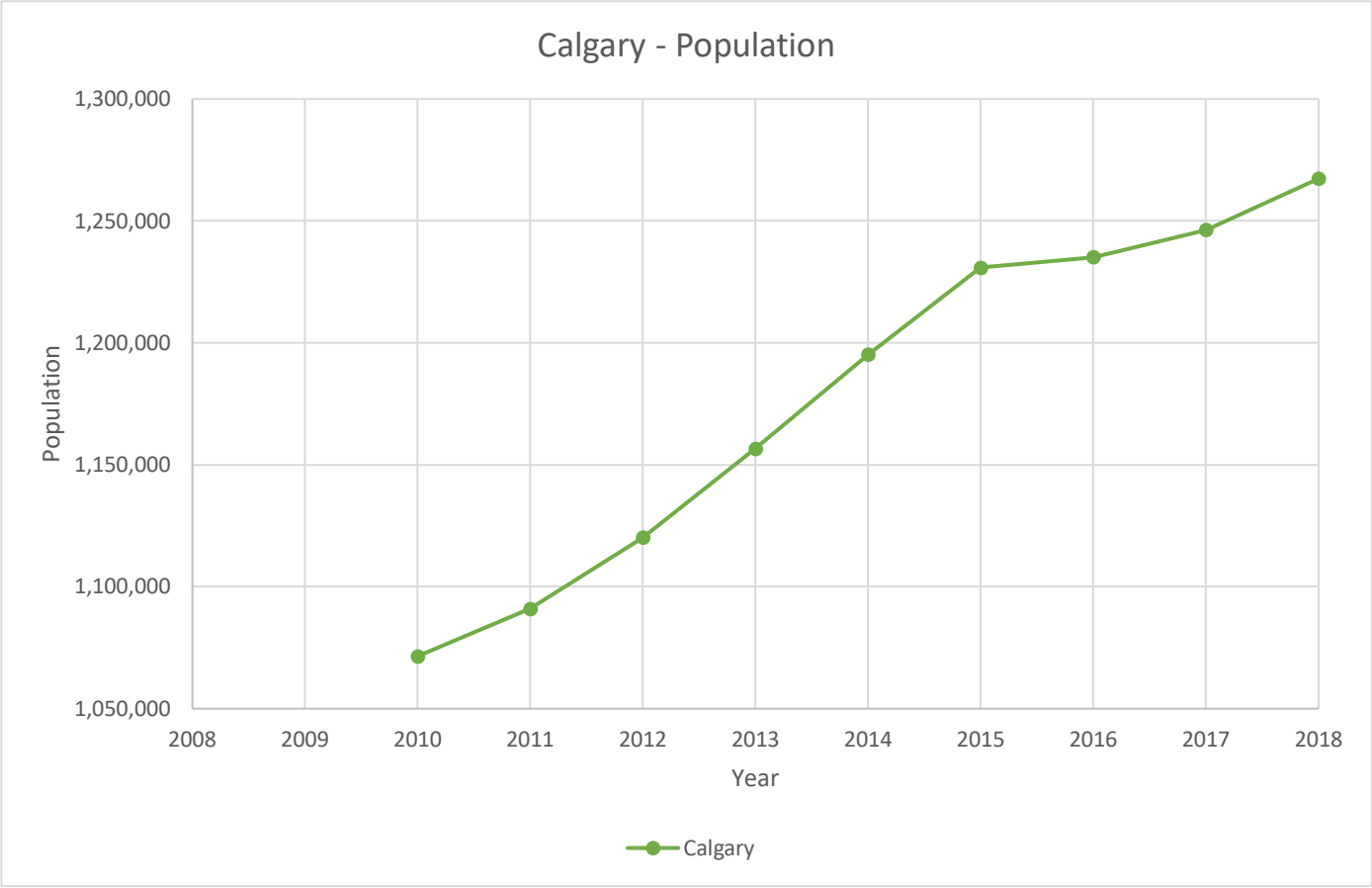


Figure 4-1: Historical Population in the City of Calgary

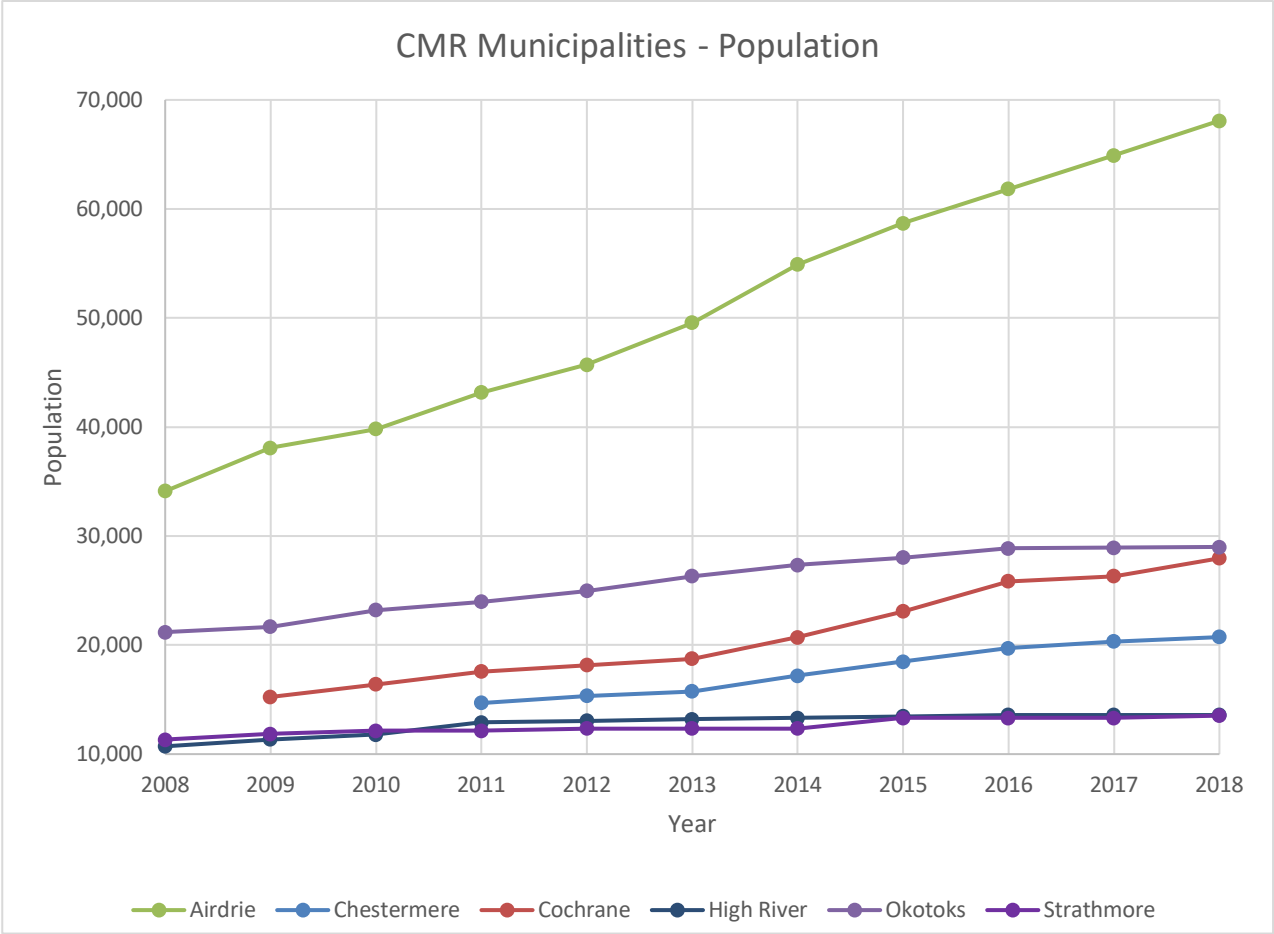


Figure 4-2: Historical Population in Other CMR Municipalities

4.1.1 Population Data Assumptions and Limitations

Assumptions and data sources specific to each CMR municipality that were used in this study are listed below.

Airdrie
The historical population data for the City of Airdrie was retrieved from:
https://www.airdrie.ca/index.cfm?serviceID=485

Chestermere
The historical population data for the City of Chestermere was retrieved from:
https://www.chestermere.ca/100/Demographics-Population

Cochrane
The historical population data for the Town of Cochrane was retrieved from:
https://www.cochrane.ca/386/Demographics Municipal Census information was unavailable for 2010 and 2012 therefore the residential populations for those years was interpolated.

High River
The flooding of the Highwood River in 2013 contributed to the loss of reliable population data. The residential population for the Town of High River is interpolated from 2012 through to 2015.

Foothills County
The population of Foothills County in 2018 was 22,936. Historical population data for the Foothills County service area was not available, therefore the population growth rate was not able to be calculated.

Rocky View County
The residential population of East Balzac was 1,250 in 2006, 1,197 in 2014 and 1,150 in 2018 which is decreasing over time. The populations in East Balzac for 2011, 2012 and 2014 to 2017 were interpolated assuming this decreasing trend.

The residential population of Bragg Creek was 454 from 2006 to 2013, and 459 in 2018. Given that there appears to be no significant change in these numbers over time, the population from 2015 to 2017 was assumed to remain at 454.

Wheatland County
The population of Wheatland County was 8,285 in 2011 and 8,788 in 2016 which is an increasing trend over time.

The population of the portion of Wheatland County within the CMRB boundary was 897 in 2016. Historical population data for the portion of Wheatland County within the CMRB boundary was not available, therefore the population growth rate could not be calculated.

The number of active accounts for the Carseland WTP, Rosebud WTP and Hamlet of Gleichen services areas were provided by Wheatland County for 2018. An average of two people per account was assumed to determine an equivalent population for 2018.

The population of Carseland, Rosebud and Gleichen was retrieved from Statistics Canada for 2016. In the absence of any additional data it assumed that the population of Speargrass remained unchanged between 2016 and 2018.

The population serviced by the Carseland WTP (including Speargrass) appeared to decrease over time. The populations of Gleichen and Rosebud appeared to increase over time. Using the estimated populations in 2016 and 2018, the 2017 population was interpolated assuming the above noted trends.

4.2 Historical Water Use

Municipalities were asked to provide their water consumption data for the past 10 years (2008 to 2018). The total annual consumption for each municipality includes Residential, ICI, Bulk Water, Municipal, and Irrigation water users, where consumption data for these users was provided. The total annual consumption does not include water loss such as leakage, water main breaks, theft, unmetered/unaccounted for water use or metering inaccuracies.

To observe and compare the water consumption trends across the municipalities, an annual water consumption rate was estimated based on the data provided by the municipalities. The annual water consumption for each municipality (in m^3) was divided by the population to determine the per capita water use rate (in L/c/d). In general, based on the

observed data, per capita water consumption appears to have decreased over the last 10 years, as shown in Figure-4-3. The Alberta Urban Municipalities Association (AUMA) published the Urban Municipal Water Conservation, Efficiency and Productivity Plan – Targets and Actions for the Urban Municipal Sector in 2014. This document sets a target for Alberta's urban municipal sector to achieve an average per capita residential water use of 195 L/c/d and a total per capita water use of 341 L/c/d (including ICI, Municipal & Irrigation) by 2020. All the CMR municipalities are below the AUMA's total per capita water use target.

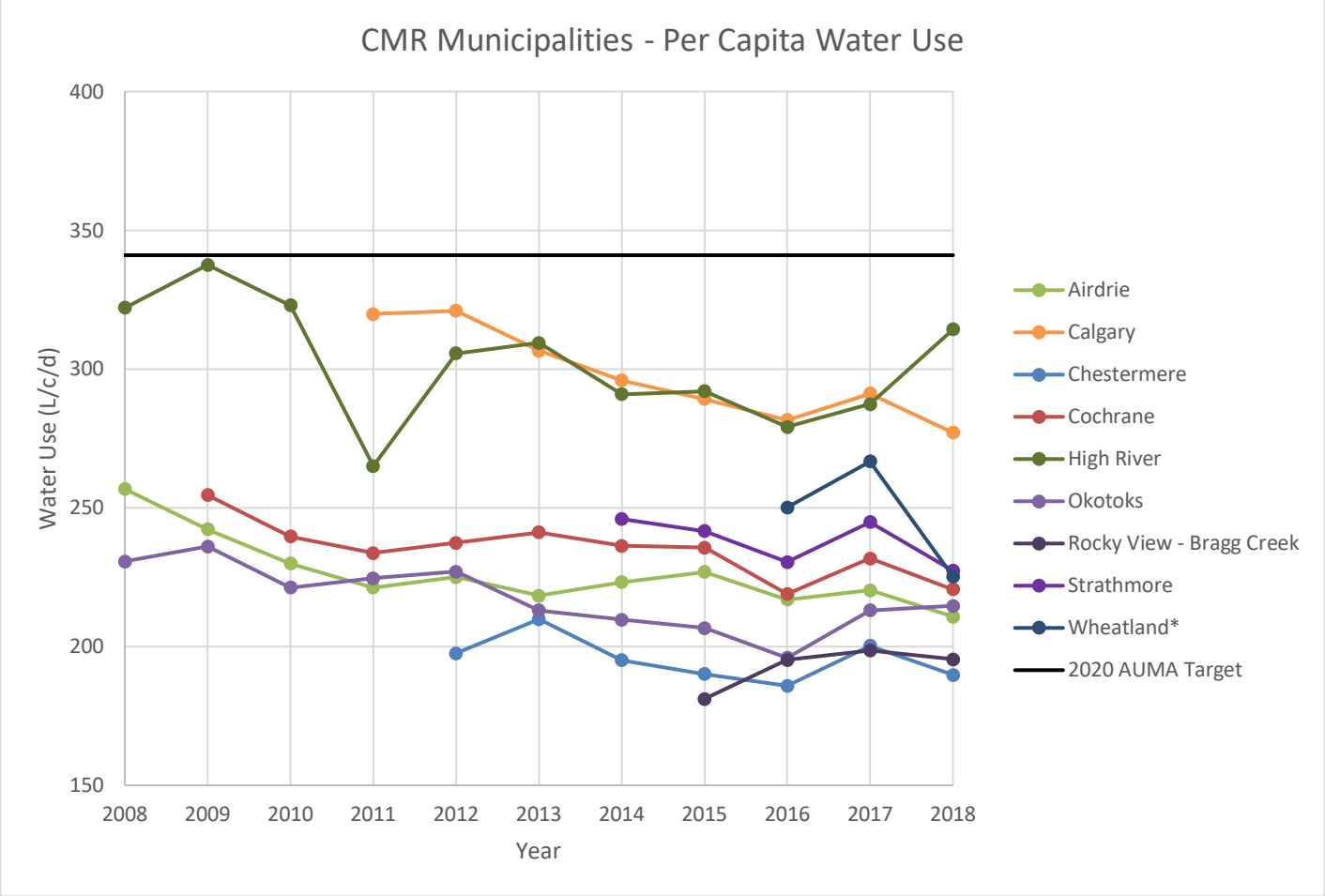


Figure 4-3: Per Capita Water Use

** The per capita water use shown for Wheatland County is estimated from the water consumption and population data available for the Carseland WTP, Rosebud WTP and Hamlet of Gleichen service areas.*

Slight variances can be observed in the data due to annual fluctuations in temperature, precipitation, weather events, and other anomalies. For example, CMR municipalities have indicated that more precipitation and cooler temperatures were observed during 2016, compared to 2017 which was hot and dry. This is reflected in the per capita water use trend where a reduction in water use is observed in 2016, followed by an increase in water use in 2017 (primarily due to increased irrigation). While these micro spikes tell a small part of the story about water use in the CMR, the general decreasing trend in water use over the past decade is of the greatest interest in this analysis.

The following table outlines the overall change in per capita water use, for the period of record for each municipality. With the expectation of Bragg Creek, the per capita water use in the CMR has decreased from 2% to 37% over the period of record.

Table 4-1: Overall Change in Per Capita Water Use

Municipality	Airdrie	Calgary	Chestermere	Cochrane	Foothills	High River	Okotoks	Rocky View (Bragg Creek)	Strathmore	Wheatland
Recorded Period	2008 - 2018	2011 - 2018	2012 - 2018	2009 - 2018	2008 - 2018	2008 - 2018	2007 -2018	2013 -2018	2014 -2018	2016 - 2018
Per Capita Water Use (L/c/d) from first to last recorded period	257 to 211**	320 to 277	198 to 190	255 to 221	N/A	322 to 314	231 to 215	181 to 195	246 to 227	250 to 225
Change in Per Capita Water Use (%)	-18%	-20%	-4%	-13%	N/A*	-2%	-11%	+8%*	-8%	-10%

** The per capita water use for Foothills County, East Balzac (Rocky View County) and the regional supply from High River to Foothills County (Aldersyde, Cayley and Mazzeppa Gas Plant) were not calculated due to a lack of historical population data. Further, Cargill Meats consumes over 2 million cubic meters per year of water, therefore it was excluded from the per capita consumption analysis for the Town of High River.*

*** Recent data provided by The City of Airdrie shows a slight increase in per capita water use of 274 L/c/d for 2018 only. A confirmation of water use data consistency is recommended.*

For each municipality, the billed water use data was broken into Residential and ICI. Where metering or billing data differentiated by user type was available, the ICI total was further broken into Irrigation, Bulk Water and Municipal Water. Graphs showing the per capita water use, for each category are attached in **Appendix D**.

4.3 Estimating Unaccounted for Water

The total per capita water use is based on metered billing data. This includes metering inaccuracies but excludes other forms of unaccounted for water such as leakage, bleeders, theft or hydrant use. The unaccounted-for water or "water loss" is quantified by the difference between produced/purchased water and metered billing data. "Produced water" refers to the total volume of potable water that is produced by a Water Treatment Plant. "Purchased water" refers to the total volume of water supplied by an adjacent municipality. Chestermere, Strathmore and Airdrie purchase their water from the City of Calgary while Aldersyde and Cayley purchase their water from the Town of High River.

Table 4-2: Estimated Water Loss, Causes and Correction

Municipality	Estimated Water Loss (%)	Estimated Water Loss (L/c/d)	Suspected Causes (Reported from Interviews)	Correction Initiatives
Airdrie	23%	No Purchased Water Data	Unmetered water including leakage, fire fighting and hydrant use	• Internal water loss study • Leak detection program • Data analysis of monthly water use
Calgary	17 – 28%	65 – 100	60% of water loss is leakage land 40% is roughly estimated and tracked (un-metered water use and running bleeders to prevent freezing)	Calgary rolled out universal metering in 2003. By 2014, 97% of properties were metered.
Chestermere	17 – 27%	39 - 71	Meter inaccuracy, water theft, leakage and fire fighting	• Monitoring night flows and leak detection • Meter replacement program replacement of aging copper water services in older neighborhoods
Cochrane	13 – 17%	49	Increased leakage during summer	Reviewing areas with high water losses
Foothills	10%	No Historical Population Data	Line Loss	Meter replacement program completed
High River	40%	138 – 427	20% of Water loss is leakage and 20% is unaccounted for (metering inaccuracies, theft and errors in billing data)	• Meter replacement program • Water main replacements • Weekly night flow analysis Monitoring • Leak detection
Okotoks	23 – 35%	63 – 123	Leakage, meter inaccuracy and/or programming, fire services use, developer use for new developments and system main flushing	• Leak detection tool • Zone metering and GIS to identify water loss • Internal initiative to understand metering inaccuracy
Rocky View (Bragg Creek)	Negligible	No WTP Production Data	Limited leakage (due to new water infrastructure), no hydrant system	Ongoing monitoring
Strathmore	16 – 19%	No Purchased Water Data	Many water users are un-metered (agriculture grounds, public works, hydrant use), metering inaccuracy and aging ductile and cast iron pipes in the downtown core	• Ongoing pipe replacement program in the downtown core • investigation of metering inaccuracy
Wheatland	47 – 52%	264 – 317 m^3/d*	Aging infrastructure, point specific leaks, unaccounted for water is used for dust control and pump testing	• Leak detection and repair program • Actively replacing aging infrastructure

** The estimated water loss for Wheatland County is expressed in terms of m^3/day since the populations for the Carseland WTP, Rosebud WTP and Hamlet of Gleichen service areas are largely unknown, as discussed in Section 4.1.1.*

The Urban Municipal Water Conservation, Efficiency and Productivity Plan – Targets and Actions for the Urban Municipal Sector, published by AUMA in 2014 sets a target for Alberta's urban municipal sector to maintain the volume of "unaccounted for" water at 10% of total water use. It is estimated that Chestermere, Foothills County and Bragg Creek are currently meeting this water loss target.

According to the AUMA,"…identifying and mitigating water loss represents the single greatest supply-side opportunity for water providers to conserve water, recover lost revenues, and improve overall operational efficiency."

5 DATA GAP IDENTIFICATION

Data gaps can primarily be attributed to inconsistencies in how information is collected and tracked due to the resources that are available to each municipality. The following data gaps were identified from the collected background information and reviewed water use data. For each observed data gap, a recommended path forward such as additional data collection is outlined below. Consideration could be given to sharing resources between several CMR municipalities to assist in carrying out the recommendations.

Population

The lack of available or reliable historical population data is a large data gap in the Water Use and Conservation Study. Per capita use is an excellent metric for gauging water use trends but requires municipalities to record their residential / service population each year. Rural municipalities where residents are serviced by a combination of Municipality owned WTPs, rural water co-ops and individual groundwater wells such as Foothills County and Rocky View County should also record the population that is serviced by each type of facility (i.e., public, co-op and individual wells) to accurately track per capita demand. Further, municipalities that service many visitors per day (e.g., CrossIron Mills in East Balzac) may have to develop a simplified (and consistent) method of estimating their number of visitors each year.

Water User Categories – Residential and ICI

All municipalities with a piped supply should record their water consumption by user type (e.g., Residential or ICI), rather than by meter size. Those municipalities with a bulk water station should record Bulk Water consumption by user type (determined by type of account at the card lock), even if Bulk Water rates are the same for all users. Consistency of categories established at the outset would improve data collection across the CMR and allow for data comparison and analysis.

Water Use Data

Additional water use data or clarification is required for the following municipalities:

- **Foothills County:** There is a significant variation between the billing data provided by Foothills County and the water distribution data provided by the Town of High River, for the Hamlets of Aldersyde and Cayley.
- **Town of Strathmore:** Annual volume of water purchased from the City of Calgary Regional Supply and the annual volume of Bulk Water use.
- **Town of High River:** Metered consumption data for Municipal (maintenance water) use.

The absence of water use data for the privately-owned water co-ops is a large data gap. This information is required to show water use trends by population and water use types, specifically to determine typical rural residential water use in Foothills County, Rocky View County and Wheatland County. If the CMRB is interested in obtaining this data for further studies, there are two recommended paths forward:

1. Water diversion licenses under the Water Act require that facilities measure the total volume of raw water diverted each month and report this information to AEP. The volume of water diversion, water consumption and historical population data for the areas serviced by rural water co-ops can be requested by submitting a Freedom of Information and Protection of Privacy (FOIP) request to AEP. The FOIP Act requires public bodies to respond within thirty (30) calendar days of receiving the request. Water consumption and historical population data could also be requested directly from the private water co-ops. AE has received contact information for the following private co-ops in Rocky View County and requested said data. We are awaiting a response.
    - Cochrane Lake Estates (Montara) Waterworks System (also known as Horse Creek)

- Bearspaw Meadows Estates II Waterworks System (Blazer Water Systems Ltd.)
- Rocky View Water Co-Op Waterworks System

2. Request water consumption and historical population data from the Alberta Federation of Rural Water Cooperatives (AFRWC).

6 REGULATORY OVERVIEW

The current regulatory framework for water management is shaped by the history of regulations and land development of western Canada. Historically, settlers had rights to water from riparian areas on their lands. In the late 19th century the federal government asserted ownership over resources to achieve fair division; such resources included fishing (fisheries)[2] and water diversion[3]. The federal Crown's ownership over water (in terms of diversion) was passed to the provincial Crown in the early 20th century. The provincial Crown set up a system of water licencing based on a First In Time, First In Right principle, which is still in place today under the *Water Act*. This principle resulted in many older first licences issued for agricultural uses, but generally overlooked indigenous water users. Water diversion (licenced supply) was historically the focus of water management.

In the last 15 years, public concerns about water use and sustainability have led the province to develop the *Water for Life Strategy* (2003), a policy tool that reaffirmed three goals of a provincial water strategy to:

1. Safe, secure drinking water supply
2. Healthy aquatic ecosystems.
3. Reliable, quality water supplies for a sustainable economy.

These goals are to be achieved through research, knowledge, partnership and education. *Water for Life* is *not* a regulatory policy, but it was an important first step into the direction of management of water in a watershed context. The current *Water Act* does not directly apply environmental protection principles such as environmental sustainability; precautionary principle; cumulative impacts; and inter-generational equity[4].

Since 2004, in support of the *Water for Life* strategies, the Alberta Water Council (AWC) has supported Alberta's seven major water-using sectors in voluntarily developing, implementing and reporting on water conservation, efficiency and productivity (CEP) plans to contribute to the target. AWC has been tracking an inventory of municipal CEP plans indicating water consumption, targets of reduction, and proposed actions (attached in **Appendix E)**.

Water supply infrastructure must meet the Provincial Standards and Guidelines for Municipal Waterworks[5]. In addition, Alberta Environment and Parks (AEP) provides guidelines for best practices for municipal waterworks[6]. The Guidelines contain several sections relevant to water security. For example, the source water protection section outlines some basic principles on how watershed management can help address raw water quality issues. Raw water storage is put forward as a strategy to deal with unreliable water supply and to reduce raw water turbidity. Best practices for distribution system design to address varying demands are also included. These standards and guidelines outline opportunities for municipalities to integrate best practices into their water supply systems and management.

[2] The *Fisheries Act* (1868) originally regulated fishing, but was updated in 1970 to include fish habitat and pollution prevention.
[3] *Northwest Irrigation Act* (1894) evolved to the *Alberta Natural Resources Act* (1931) and the *Water Resources Act* (1931), which later became the *Water Act* (2000).
[4] Environmental Law Centre (2013). Comments on Water Conversation. http://elc.ab.ca/Content_Files/Files/ELC_Comments_re_AB_Water_Conversation.pdf. Accessed March 25, 2019.
[5] Alberta Government 2012. Standards and guidelines for municipal waterworks, wastewater and storm drainage systems. Part 1 Standards for municipal waterworks of a total of 5 parts.
[6] Alberta Government 2012. Standards and guidelines for municipal waterworks, wastewater and storm drainage systems. Part 2 Guidelines for municipal waterworks of a total of 5 parts.

Controls for water demand (i.e., conservation and re-use) are not currently driven by regulatory requirements for water users with existing licences. Rather, these activities are generally voluntary for municipalities. Provincial and federal regulations allow for much flexibility and freedom for municipalities to implement bylaws and water use restriction programs as appropriate for their communities.

AUMA recommends that all communities pass bylaws that allow the municipality to control water usage during times of scarcity[7], regardless of their current water supply. This is a legal tool that is available to all municipalities. Another option is to investigate whether water usage peaks at unsustainable rates during the summer (compared with constant usage throughout the year), and then implement outdoor water use restriction programs accordingly. Several municipalities within the CMR have already implemented these types of water use restrictions, as described in Section 5. An inquiry has been made into the most recent update of AUMA Policy Paper 2014 on water consumption based on the water conservation measures implemented. No response had been received at the time of this report being finalized.

The key message is that Municipalities have a unique opportunity to play a (local) regulatory role in water security, where provincial and federal regulations may fall short (e.g. non-point source pollution in urban areas, cumulative effects management), through the application of bylaws. As well, other forms of non-policy approach such as collaborative projects, public education and communication combined with policies will help to promote change and curb behaviour.

[7] https://auma.ca/advocacy-services/programs-initiatives/water-management/water-conservation/legal-tools

7 OBSERVED BEST MANAGEMENT PRACTICES (IN OTHER JURISDICTIONS)

The following is a series of available information through literature reviews on municipalities and cities within Alberta, across the country, and outside of Canada in addition to the CEP list in **Appendix E**. We have also gathered information through interviews to gain professional and organizational perspectives on water security in these communities.

Table 7-1 below lists the municipalities whom we have contacted and/or researched. These municipalities were selected to provide varying perspectives from across the country and outside of Canada with consideration for geographic and climatic differences. Specifically, some of the municipalities and cities in the United States are experiencing more extreme weather affecting both water quality and quantity. Lessons learned from these areas provide valuable examples that could be implemented in the CMR.

Table 7-1: Municipalities that AE Contacted and/or Researched

Canadian Municipalities	US Municipalities
Cowichan Valley Regional District	Bozeman, Montana
Metro Vancouver, BC	Salt Lake County, Utah
City of Kelowna, BC	Faribault, Minnesota
Capital Regional District – Victoria, BC	Fort Collins, Colorado
Regional Municipality of Wood Buffalo	
City of Toronto, Ontario	
City of Barrie, Ontario	

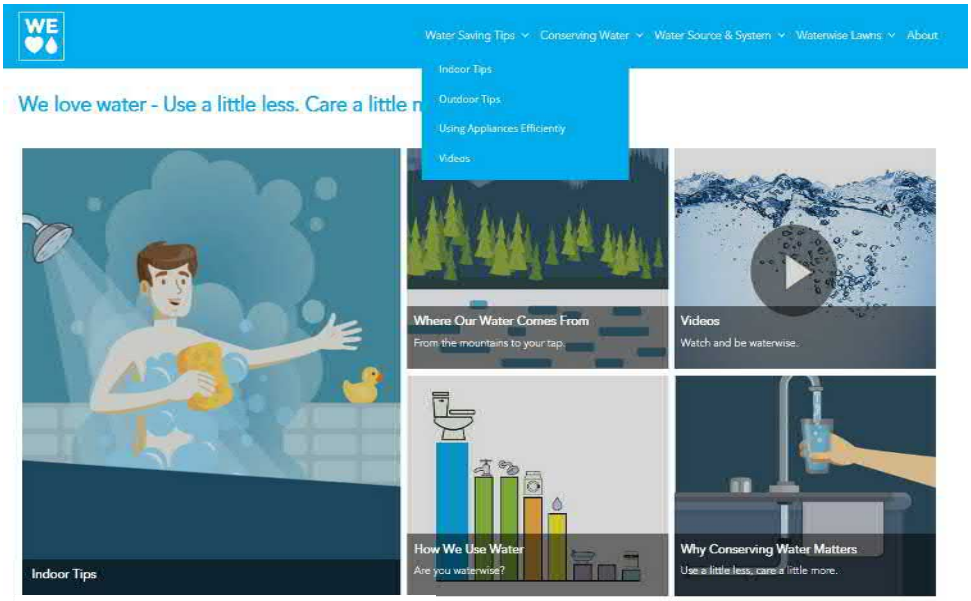
7.1 Canadian Municipalities

The implementation of water consumption Best Managed Practices (BMPs) by other jurisdictions have been delivered through a combination of bylaws, local government actions/activities/initiatives, programs, public engagement/communications, toolkits, manuals, and guidelines. BMPs have been identified and implemented for the municipalities based on their regional needs.

Rural and urban communities in Alberta have grown at an average rate ranging from 0.5% to 11% over the last 10 years (Alberta Government, Municipal Population List). Research indicated that communities are concerned that climate change impacts such as drought and floods will affect the quantity and quality of water supply. In response to the increasing water demand, some communities have implemented strong water conservation programs to reduce water consumption, alleviate water production demand, and slow water withdrawal from the natural system. It is also observed that on-going water conservation initiatives, such as drought management, have been given higher priority due to climate change impacts.

Almost all cities in Canada we observed have implemented some form of conservation through water restriction use (eg. lawn watering stipulated on certain days of the week), education and public awareness. Specifically, in areas where drought is a main concern, there is more extensive information and education on water usage such as restrictive use. Other web sites, such as the one shown below in **Figure 7-1**, offer interactive information including tips, videos and educational information mainly to curb careless water consumption behaviour. The messaging is often geared towards having the public, individual landowners and businesses take ownership of one's action and the consequences that these actions have on water resources. In addition, there are bathroom fixtures rebate programs implemented by the

cities across Canada to replace high flow fixtures with low flow ones. In some cities these rebate programs extend to washing machine replacements. Technologies on low flow fixtures are also implemented in commercial and institutional buildings to reduce overall consumption in these high use areas. As such, these initiatives are becoming standard practice, as can be seen in green structures such as LEED rated buildings.



http://www.metrovancouver.org/welovewater/Pages

Figure 7-1: Metro Vancouver Website Educating on Water Efficiency

Another BMP to reduce water consumption noted in other jurisdictions is metering water consumption and using a tiered water rate system to encourage reduction in water consumption. Communities who have no metering or that have a flat rate system were observed to have higher water consumption in liters per capita per day.

Many jurisdictions have an overarching document or framework to communicate goals, objectives, tasks/strategies within the various levels of government and participants. The collaboration efforts often apply to the following tasks:

- Identify an urgency to act.
- Establish goals and objectives.
- Conduct assessment to identify risks and prioritize impacts.
- Identify targets and timeline of meeting the targets.
- Identify metrics for comparison and measurement of success.
- Include design checklist, handbook, examples, tools and references of technologies to enhance the plan.
- Establish monitoring requirements and reporting.
- Establish a communication avenue with the public through engagement, education and reporting.
- Provide comparative discussion and identify gaps.
- Report on an annual basis to show progress and improvements, if any.

Champions and leadership groups are identified to ensure commitment, continuity and actions are being undertaken with noted improvements. Active participants with clear roles and responsibilities are also defined. This is clearly voiced in jurisdictions such as the City of Barrie, who have created a specific task force to ensure success in their water security program. The City of Barrie has also embarked on a Building Adaptive and Resilient Communities

(BARC) program by developing and implementing a Climate Change Adaptation Strategy Plan. They have formed the following three implementation groups:

1. **Project Team** – lead the development of the adaptation strategy and provide research and consultation.
2. **Adaptation Team** – contribute to adaptation planning effort and provide overall strategic direction.
3. **Stakeholder Advisory Group** – provide sector-specific knowledge, input, and advice from the community perspective.

Retaining human resources to ensure completion of tasks and continuity of effort is one of the challenges discussed with other jurisdictions. Initiatives are often not successfully implemented due to lack of resources and support. Support in this discussion includes resources (financial and human), and timely and effective communication between different levels of government. Lack of support would risk the initiatives being postponed, delayed or cancelled. To mitigate this risk, committees and tasks forces are deliberately formed to ensure accountability and responsibility for long term success of the program.

Appendix F outlines the details of initiatives and BMPs implemented in the Canadian municipalities that were interviewed. These BMPs have been implemented for municipalities based on their regional needs. References are listed together with the sources (web addresses) where further details can be found.

The per capita water use rates for the Canadian municipalities that were studied, as reported in 2018 are as follows:

Table 7-2: Per Capita Water Use in Canadian Municipalities

Municipality	Per Capita Water Use (L/c/d)
Cowichan Valley Regional District	376[8]
• **Cowichan Bay**	232
• **Ladysmith**	233
• **North Cowichan**	318
• **Mill Bay**	252
Metro Vancouver, BC	444[9]
City of Kelowna, BC	675[10]
Capital Regional District – Victoria, BC	280[11]
Regional Municipality of Wood Buffalo	No Water Use Data Available
City of Toronto, Ontario	657[12]
City of Barrie, Ontario	No Water Use Data Available

The CMR water consumption rates are generally lower than the ones observed in other jurisdictions summarized above; however, a direct comparison may not be relevant, as there are variations in water consumption that can be attributed to the different types of industries, climate, water use types, and meter structure.

[8] https://www.bclocalnews.com/news/cowichan-bay-leads-the-valley-in-water-conservation/
[9] http://www.metrovancouver.org/dashboards/services/water/Pages/Average-day-per-capita-water-use.aspx
[10] https://www.obwb.ca/wsd/water-usage/residential-water-use
[11] https://www.theglobeandmail.com/news/british-columbia/in-victoria-less-is-more-when-it-comes-to-paying-for-water/article1215390/
[12] https://www.toronto.ca/311/knowledgebase/kb/docs/articles/revenue-services/customer-service/call-centre/call-centre/city-of-toronto-average-water-consumption.html

7.2 United States Municipalities

There is numerous water resilience information available from the United States Environmental Protection Agency (US EPA) to address water security issues. The US EPA has developed numerous websites that provide a vast amount of material and resources including a basic review of climate change and its impact on water resources and communities, a tool kit to assess vulnerabilities, economic tools to assess costs and benefits, emergency response planning, and training. Creating Resilient Water Utilities (CRWU) is one of the initiative programs that provides drinking water, wastewater and stormwater utilities with practical tools, training and technical assistance to increase resilience to extreme weather events. CRWUs goal is to assist water sector utilities by promoting a clear understanding of potential long-term adaptation options. A document entitled Adaptation Strategies Guide for Water Utilities, 2015[13] includes BMP strategies for:

1. Drought management.
2. Water quality degradation.
3. Floods.
4. Ecosystem changes.
5. Service reliability, demand and use.

The above is also supplemented with sustainability briefs on green infrastructure and water demand management.

The US EPA developed a database of case studies to demonstrate implementation of BMPs conducted by cities across the US to address local climate issues faced by water and wastewater utilities[14]. We have selected cities from the case study database mainly from the Southwest, Midwest and Great Plains, shown on **Figure 7-2,** because these areas are experiencing extreme climate impacts that could be characteristic of Alberta's future climate condition.

Figure 7-2: US Regions

[13] https://www.epa.gov/sites/production/files/2015-04/documents/updated_adaptation_strategies_guide_for_water_utilities.pdf

[14] https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=03d35ca84b5944f8b3ab59bf3a981462

The following municipality case studies are relevant to this study and are summarized in **Appendix G**:

1. Bozeman, Montana.
2. Salt Lake County, Utah.
3. City of Faribault, Minnesota.
4. Fort Collins Utilities, Colorado.

The examples shown can be reviewed for best practices that the CMR might consider for implementation.

7.3 Observed BMPs Effectiveness and Hierarchy of Application

During our interviews and research, we did not inquire about time frames and measurement of program effectiveness. The discussions were mainly qualitative in nature. Conservation initiatives implemented did not generally have a prescribed hierarchy evaluation or ranking, as these initiatives were usually implemented collectively. The hierarchy could be implemented based on an evaluation of the current state of urgency. The message is that there is no one-size-fits-all solution and that any solutions identified should be reviewed regularly to adjust to new information and trends. Different initiatives should be implemented based on the goals and timing that is unique to each municipality. Ultimately, the water consumption reduction goals can be set individually by each municipality based on their regional, geographical and hydrological boundaries.

For example, AUMA in their 2014 report for urban municipal water CEP Plan[15] identified proposed water use targets for residential water of 195 L/c/d and 341 L/c/d for total per capita water use by 2020. Rather than being prescriptive, setting targets gives municipalities flexibility, and water utilities and users can contribute to achieving the targets using various combinations of BMPs relevant to their community. Targets previously set in 2001 have driven a gradual decrease of water use from 519 L/c/d to 395 L/c/d in 2009.

Water pricing and metering have a high impact on water consumption patterns, as shown in Figure 7-3. Municipalities with no metering tend to have higher consumption rates than those with metering. A country like Singapore is a model of effective water management out of necessity because for decades they have been experiencing water scarcity, poor water quality, and increase population. These types of factors push the boundaries of strict policy implementation on water consumption, advancement in water and wastewater treatment technology, water efficiency fixtures, and high water pricing to curb behaviour[16]. Current water consumption in Singapore is 150 L/c/d with a target of 140 L/c/d in 2030.

High water pricing has demonstrated to have affected individual usage decisions and has encouraged conservation and efficiency. In the discussion paper titled *Worth Every Penny: A Primer on Conservation-Oriented Water Pricing*, attached in **Appendix H**, we see countries that have the highest water pricing have the lowest water consumed per capita. Canada is one of the highest water consumers per capita compared to various Western European countries.

[15] https://www.auma.ca/sites/default/files/Advocacy/Document_library/80674_2014_cep_plan.pdf

[16] https://www.fluencecorp.com/water-management-in-singapore/

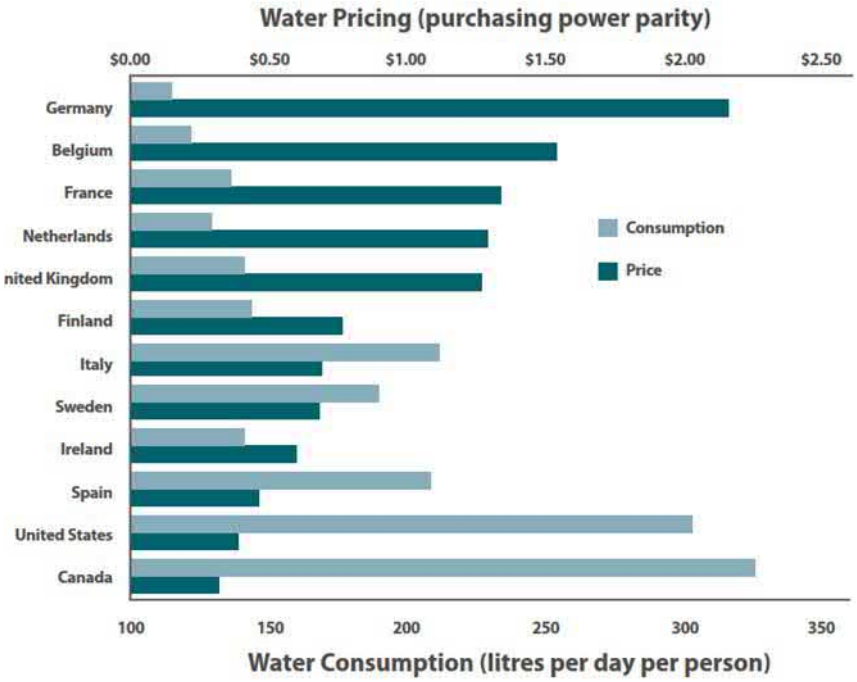


Figure 7-3 - Global Water Pricing

Another "most observed" BMP is rebate programs that encourage purchase of low water flow fixtures, as well as setting bylaws for new construction that mandate use of low water flow fixtures. This is on the understanding that any rebate program will eventually reach a level of saturation and have to be terminated. Though this is a good initiative, the application of a single BMP sometimes does not completely achieve the decrease in overall water usage that is desired. In a case study conducted in the Town of Cary, North Carolina, it was found that despite an overall decreasing trend in residential water use, new homes still tended to use about 20% more water on average than older homes without the newer and more efficient water fixtures[17]. The higher consumption was determined to be mainly due to outdoor in-ground irrigation systems installed in the newer homes.

Supplementing the BMPs with educational information provides effective messaging to communicate to water users the "why". The types of information from one community to the next depending on their individual goals and objectives. Examples of educational information that can be shared with consumers include:

- Definition of water supply and explanations as to why water is a finite resource.
- Availability of water and water stress issues relevant to the community.
- Uncertainty of climate change.
- Quality of water and impacts from urban and agriculture activities.
- Tips for conserving water in residential and commercial sectors.

[17] USEPA, December 2016. Best Practices to Consider when Evaluating Water Conservation and Efficiency as an Alternative for Water Supply Expansion. EPA-810-B-16-005.

The Adaptation Strategies Guide for Water Utilities by the US EPA lists the best practices for water system management including conducting audits, water loss minimization, metering, water rate structures, end use water conservation and efficiency measures for ICI, residential, as well as considerations for developing a water conservation plan.

However, messaging itself without a meter structure or appropriate water pricing to measure individual effectiveness has led to poor uptake of water conservation behaviours. For example, the per capita water use in Metro Vancouver is 444 L/c/d which is higher than what is typically observed in urban centers. Only 3 of the 22 municipalities in the Metro Vancouver area have a residential water metering program. Despite best efforts on water conservation education, most residents are charged a flat rate regardless of the volume of water that they consume. This rate structure and lack of metering does not incentivise residents to repair leaks or change their behaviour with respect to water use. In 2009, the City of Abbotsford and the District of Mission experienced a water shortage that nearly emptied the municipalities' reservoirs. These municipalities are now spending $200 million on a third raw water supply line to increase the capacity of their water system.[18]

Lastly, the application of BMPs needs to have a well executed plan with dedicated leaders or champions to ensure the message and information are delivered effectively and consistently so that programs on water conservation and efficiency are maintained with continuity to ensure improvement, progress and longevity.

[18] https://www.theglobeandmail.com/news/british-columbia/in-victoria-less-is-more-when-it-comes-to-paying-for-water/article1215390/

8 EXISTING WATER CONSERVATION AND EFFICIENCY EFFORTS IN THE CMR

8.1 Existing Water Use Bylaws

The conducted interviews and information requests determined that there are observable but varying water conservation and efficiency efforts being made by the CMR municipalities. The following table lists CMR municipality bylaws that relate specifically to water conservation and efficiency in the respective communities.

Table 8-1: Existing Water Use Bylaws

Municipality	Water Use Bylaw	Comments
Airdrie	"Waterworks" Bylaw No. B-04/2019	Section 59 & 60: Fixtures Section 63: Water Conservation
Calgary	"Water Utility" Bylaw No. 40M2006	Part 7: Water Conservation • Low Water Use Fixtures • Once-Through Cooling • Water Wastage
Chestermere	No Bylaws	Changes are anticipated to Bylaws in the future.
Cochrane	Water Utility Bylaw No. 04/2013	• Expanded list of low flow fixtures • Requirement for all premises to have a pressure reducing valve installed • Timely water meter installation • Allowing a stream of water to run off property is prohibited • Time of day watering restrictions • Unauthorized hydrant use is prohibited
	Land Use Bylaw No. 01/2004	Contains landscaping requirements.
Foothills	"Water Use Restrictions" Bylaw No. 119/2005	Section 3: Water Conservation Strategies Section 5: Wasting Water
High River	"Water System" Bylaw No. 3810/95	
	"Water Conservation" Bylaw No. 4212/2008 *	Section 4: Water Conservation Section 6: Wasting Water Section 7: Low Flow Plumbing Fixtures
Okotoks	"Provision of a Water Utility" Bylaw No. 24-18	• Aggressive implementation of fixtures using 4 L/min or less • Established standards for indoor water consumption
	"Land Use" Bylaw No. 40-98	• Requirement for 12" of topsoil for grading • Xeriscaping program
Rocky View	No bylaws	Area Structure Plans (ASPs), rather than bylaws, are driven at restricting water use.
Strathmore	"Water Utility" Bylaw No. 18-06	Part 32: Water Conservation and Once-Through Cooling Equipment Part 33: Outdoor Watering Restrictions
Wheatland	No bylaws	Water rates and water conservation policies regulate usage.

** This Bylaw is only implemented during hot summer months. High River is currently working to implement odd/even watering days throughout the year, not just during hot periods. This amendment to the Water Conservation Bylaw is currently running through council.*

8.2 Water Conservation and Efficiency Measures (Reported from Interviews)

The following table summarizes the existing water conservation measures, BMPs and initiatives that each municipality is using to reduce metered water use. This does not include measures to prevent water loss such as leak detection, water main repair/replacement or correcting metering inaccuracies. These forms of water loss are discussed in **Section 4.3: Estimating Unaccounted for Water**.

Table 8-2: Existing Water Conservation and Efficiency Measures

Municipality	Existing Conservation and Efficiency Measures
Airdrie	• There is a residentially focused Public Education Program which provides information, brochures and tips related to indoor water conservation. • Outdoor watering restrictions impact all users including Residential, ICI and Municipal. • Toilet Replacement Rebate Program.
Calgary	Indoor Use: • A 12-year long residential toilet replacement program was recently completed, which funded the upgrade of 70,000 residential toilets to low flow units. • Ongoing Toilet Replacement Program for hotels and multi-family residential properties. • Upgraded filtration equipment in their WTPs to reduce process water use. • There was a program focused on replacing pre-spray rinse valves in restaurant dish pits. This was discontinued once only high efficiency spray valves were available in the market. • Rebate Program for ICI users who install high efficiency indoor fixtures. • Internal efforts to reduce water use in municipal operations include: bus and light rail transit vehicle wash water re-use systems and a closed loop non-potable water re-use system at the fire training facility. Outdoor Use: • Public Education Program: only use 1" of water per week for outdoor irrigation. • Rain Barrel Subsidy Program: the first 1,000 rain barrels are subsidized by the City by $15 each. The sale price to the end user is $70. • Public Education Program: landscaping options, turf grass recommendations, Native and water efficient vegetation. There are homeowner watering guides available online related to yard smart landscaping. • Golf courses use non-potable on-site stormwater for irrigation. • Yard smart educational collateral online and in print. Educators are present at public events.
Chestermere	• No new water conservation initiatives since 2000.
Cochrane	• New homes have been using low flow fixtures since 2006. • Watering restrictions and Public Education initiative to teach residential users how to water their properties. • Rebate programs for: toilets, laundry machines, climate-based irrigation controllers, rain barrels, lawn alternatives (eg. wood mulch and fescue sod).
Foothills	• None.
High River	• Rebate Program for low flow fixtures. • Rebate Program for rain barrels. • Public campaigns.

Municipality	Existing Conservation and Efficiency Measures
Okotoks	• Rebate Program for residential xeriscaping and lawn replacement with artificial turf. • Rebate Program for installation of water meters. • A residential toilet replacement program was recently completed. • Public Education Program (since 2002): University students go door-to-door to help set up live water usage tools, helping residents to budget their water use per month. This program is also implemented for ICI developments. • Ongoing Commercial user engagement. • New developments do not have irrigation. Developers are working with drought tolerant landscaping. • "Brown lawn is good" campaign.
Rocky View	• Use of captured stormwater for irrigation. • Applicants for Development Permits are required to submit a Water Conservation Strategy. • Low-flow toilets are mandatory for new developments. • Water use is restricted for large industrial developments in the East Balzac business area.
Strathmore	• There is existing communication with the public on tips to conserve water.
Wheatland	• Rebate Program (since 2015): for low-flow water fixtures. • Toilet Rebate Program is still in operation.

8.3 Water Conservation Status Evaluation

The various initiatives that CMR municipalities have taken part in during the past 10 years to conserve water is summarized in the following Table. The intent is to show what each municipality has implemented and what more they can do to reduce water consumption. This list is based on collective observations of implementation and is not an exhaustive list of all of the potential water conservation strategies.

Table 8-3: Comparison of Water Conservation Measures

Municipality	Water Conservation Measures										
	Metering	Variable Water Rate Structure	Water Use Bylaws	Low-Flow Fixture Subsidy / Program*	Outdoor Watering Restrictions	Rain Barrell Subsidy	Non-Potable Water Use for Irrigation	Non-Potable Water Use/Re-Use for Municipal	Drought Tolerant Landscaping	Public Education Programs	Water Use Restrictions for ICI
Airdrie	✓	✓	✓	✓	✓		✓			✓	
Calgary	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Chestermere	✓	✓					✓				
Cochrane	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Foothills	✓	✓	✓					✓			
High River	✓	✓	✓	✓		✓				✓	
Okotoks	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Rocky View	✓	✓		✓			✓				✓
Strathmore	✓	✓	✓								✓
Wheatland	✓	✓	✓	✓			✓	✓			

**The Town of Strathmore has observed increased solids deposits in their sanitary sewers due to the installation of low-flow fixtures. The reduced flows into the sewer system do not achieve the required conveyance/cleansing velocity, therefore additional flushing is required by the Town. AE notes that the installation of low-flow fixtures is still considered a BMP in terms of water conservation and efficiency. Achieving the required cleansing velocity in the sanitary sewer system is a design issue that should be addressed for all new developments and accounted for during the retrofit of existing systems.*

9 OPPORTUNITIES FOR THE CMRB

Based on the information provided and what has been observed to-date, the following are opportunities for CMRB to consider during development of their Growth and Servicing Plan to further address water security collaboratively.

1. Address Data Gaps

The CMRB should encourage consistency in data collection and address the data gaps identified in this study. Accurate accounting of the volume of water distributed to end users can help identify sources and volume of leakage as well as prioritizing abatement measures. Suggestions to improve harmonization of data collection across the CMR and address data gaps are listed below:

- **Population**
  - Record the residential population each year that is serviced by municipal supply.
  - Record the residential population each year that is serviced by rural water co-ops or individual groundwater wells.
  - Record the estimated number of visitors each year to large commercial developments (e.g., CrossIron Mills in east Balzac).

- **Water Use Data**
  - Record water consumption by user type (e.g., residential or ICI).
  - Record bulk water consumption by user type, determined at the card lock.
  - Record municipal water and irrigation water consumption separately from residential and ICI.
  - Monitor and record hydrant use (e.g. temporary meters or implementing a requirement to report the duration that a hydrant was operational for).

- **Land Use Area**
  - Record the area of ICI land use and irrigated areas each year.

- **Rural Water Co-Ops**
  - Obtain water use and historical population data for the rural water co-ops. The following means could be used to acquire the data:
    - Submit a Freedom of Information and Protection of Privacy (FOIP) request to AEP.
    - Request data from rural water co-op operators directly.
    - Request data from the Alberta Federation of Rural Water Cooperatives (AFRWC).

- **Country Residential**
  - Collect information to understand the water use habits of country residential users to better inform potential conservation measures.

2. Reduce Water Loss

As discussed in Section 4.3, a significant volume of potable water is unaccounted for due to leakage and metering errors. To further conserve water, the sources of water loss should be identified and mitigated. Options for consideration include: water audits, water loss studies, night flow analysis, acoustic or helium leak detection, zone metering, monitoring spikes in monthly water use, meter replacement programs, regularly checking and calibrating water meters, water main break repair, and replacing aging infrastructure prior to leakage.

3. Set Targets

A set of specific and measurable targets for residential water use, total water use, and water loss reduction could be determined and agreed to collectively by all CMR municipalities as a region.

When determining water use targets, it is important to acknowledge the difference between urban and rural lifestyles and how that correlates to water use. Additionally, there are different levels of jurisdiction over rural water co-ops in the CMR. The AUMA targets of 195 L/c/d for residential water use and 341 L/c/d total water use are specific to urban municipalities. Since there are different levers for rural municipalities, there may have to be different targets for urban versus rural settings, with consideration for where municipalities have jurisdiction.

In rural settings where the municipality does not have jurisdiction to implement BMPs, the municipality can take a leadership role in public education and the CMRB may agree to less aggressive water use targets for these areas. Additionally, the CMRB might also examine implementing a unit area water use target for irrigation in rural settings. Other options for consideration are to use raw water, reclaimed stormwater or reclaimed wastewater for rural residential irrigation.

4. Implement Conservation and Efficiency Measures

Based on the information gathered for this study the following recommendations on water conservation strategies are provided to the CMRB for consideration.

Municipalities have flexibility to implement local bylaws to engage and curb behaviour for water consumption. Through implementation of bylaws, public education programs, and community engagement, municipalities can take a strong leadership role in water efficiency. Actions could include:

- **Implement Conservation Strategies**
  - Develop a water Conservation and Efficiency Plan (CEP) and establish targets and objectives for water reduction. For municipalities that already have a plan, identify areas for modification, and improvements, if required.
  - Evaluate the effectiveness of current water conservation initiatives to determine if existing programs should be continued, modified or terminated.
  - Evaluate the effectiveness of current bylaws to determine if modifications are required for improvement.
  - Identify champions and leaders at the municipal level and allocate resources to keep momentum in water conservation programs or initiatives.

- **Public Engagement**
  - Communicate the current water conditions in the CMR to the public. Clarify that water scarcity will only be exacerbated by time, population growth and climate change to emphasize the importance of water conservation. Develop public engagement materials using examples from other jurisdictions who are currently experiencing drought conditions to change the public's perspective on water use. Explain the water cycle and communicate that water is a finite resource.
  - Develop clear messages on why water conservation is important using local data and facts on water consumption in each municipality and the current environmental status to educate the public. Develop content that is relevant to the local hydrological and geographical environment.
  - CMR municipalities should take a unified role in preparing and presenting public engagement materials to present a consistent message throughout the region.

- **Review Water Rates**
  - As discussed in Section 7.3, data from other countries showed a reduction in water consumption when there is a high cost associated with water use. Raising water rates has been shown to effectively curb water use behaviour. Municipalities can conduct an evaluation to determine if the current water pricing or rate structure reflects the long-range costs of operating and maintaining the water utility. The proposed water rate should consider stresses on the water system and encourage and reward users for water conservation.

5. Consult with the Experts

When implementing water conservation and efficiency measures, it is important that the CMRB consult with other jurisdictions who have experience with the implementation of similar measures.

- Engage scientific communities or associations to gain insights and/or share knowledge about water security holistically. These may include the AUMA, University of Calgary, University of Alberta, Alberta Water Council, or Bow River Basin Council.
- Several CMR municipalities have successfully implemented water conservation and efficiency efforts within their communities and could be a good resource to other member municipalities who want to undertake similar efforts. Refer to Table 8-3: Comparison of Water Conservation Measures to identify other municipalities to consult with on their strategies and implementation. Suggestions for action may include:
  - Look to the Town of Okotoks who have strongly advanced their water conservation and efficiency efforts with successful implementation in their community. They can provide valuable insights and lessons learned from their experience.
  - Many cities in the U.S. are currently experiencing water shortages and water quality issues due to the change in climate. It would be prudent to look to our southern neighbours for relevant resiliency strategies to avoid potentially “reinventing the wheel”. Additionally, there are lessons to be learned from their “mistakes”.
- There are many BMPs for water conservation within water utilities. A specific resource that provides good guidance is the USEPA Best Practices to Consider when Evaluating Water Conservation and Efficiency as an Alternative for Water Supply Expansion. For example, for end use water conservation and efficiency such as rebate programs for indoor and outdoor water fixtures, or water use restrictions, this document indicates the need to identify the customer profile to better implement water conservation initiatives and provides suitable metrics to measure success. Furthermore, the document has also identified tools to track performances.

6. Consider Seasonality

When implementing BMPs, it is important to consider the season in which a BMP will have the most impact.

During winter, river and aquifer levels are lower and there will be less raw water supply available. There is generally no residential watering or irrigation. The BMPs that have the most impact during the winter season are metering, public education on indoor water use behaviour, and rebate/replacement programs for low-flow fixtures.

The spring freshet can create water treatment challenges that may limit WTP capacity. During the summer (post freshet), river and aquifer levels are higher and there will be more raw water supply available. Water demand also peaks during this time due to an increased requirement for residential watering and irrigation. The BMPs that have the most impact during the spring and summer are outdoor watering restrictions (e.g. bylaws) and rebate programs for lawn replacement and water smart landscaping. During spring and summer, CMR municipalities may also look at implementing a xeriscaping rebate program.

7. Perform Additional Studies

It is recommended that the CMRB undertake additional studies once further information is gathered to enable full cost accounting and identify the most cost effective BMPs to set priorities. Use available resources to help create a new regional water conservation plan or modify existing municipality plans. A useful tool is the Water Conservation Guide, 2013,[19] developed for the Province of British Columbia in collaboration with the Okanagan Basin Water Board. This document provides step-by-step processes for identifying geographic boundaries, community profiling, exploring conservation options, choosing the most effective measures, and putting the plan into action.

[19] https://www.obwb.ca/newsite/wp-content/uploads/WCG_Design3.0_Web.pdf

10 STAKEHOLDER ENGAGEMENT

Associated Engineering (AE) attended the following meetings to engage with stakeholders at various stages of the project. Comments provided during the stakeholder engagement has been incorporated into this final report.

Table 10-1: CMRB Stakeholder Meetings

Stakeholder	Date	Location	Project Stage
Water Table	May 16, 2019	High River	Project Kick-off
Joint Intermunicipal Servicing Committee & Land Use Committee	June 6, 2019	Mount Royal University	Project Introduction
CMRB Project Manager & Water Expert	July 8, 2019	Phone	Draft Interim Report #1 – Water Use and Normalization
Water Table	July 10, 2019	Strathmore	Draft Interim Report #1 – Water Use and Normalization
Water Table	August 1, 2019	Chestermere	Draft Interim Report #2 – Water Conservation Status Evaluation
Intermunicipal Servicing Committee	September 5, 2019	Winsport - Calgary	Final Report – Recommendation for Approval

CERTIFICATION PAGE

This report presents our findings regarding the Calgary Metropolitan Region Board Water Use and Conservation in the Calgary Metropolitan Region Study

Prepared by:

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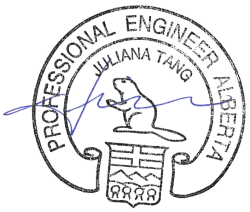
Reviewed by:



2019-10-01

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2019-10-01

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ASSOCIATED ENGINEERING
QUALITY MANAGEMENT SIGN-OFF
Signature: _____

APEGA Permit to Practice P 3979

APPENDIX A – INTERVIEW LOG

CMRB WATER USE AND CONSERVATION STUDY
Interview Questions and Responses

Airdrie – May 31, 2019	
Questions	**Responses**
1. A population growth rate between 4.35% to 10.44% was reported. Do you agree with this observation? Population data retrieved from: https://www.airdrie.ca/index.cfm?serviceID=485	- The latest census information will be released on June 3. - Overall, the population data looks reasonable, except for the high of 10.44% (Airdrie noted a high of 10.76%, over the past 10 years).
2. Can you clarify what "Municipal" water includes?	- City buildings, Recreation Centre, Parks irrigation and Public Works vehicle washing. - Airdrie did not meter all Parks irrigation uses until 2018 (started adding irrigation meters in 2015). Prior to 2018, Parks irrigation water use was not captured in the Municipal total. This is reflected in an increase in Municipal water use from 2015 to 2018.
3. Are flushing and hydrant use accounted for? Are they metered?	- Yes, flushing is included in the Municipal water use total. - Fire fighting and other hydrant uses are not metered or recorded.
4. Are there any issues with water loss (e.g., leakage, metering errors, potential by-passing of meters etc.)? Have these issues been rectified?	- Airdrie observes approximately 23% of unaccounted for water and is in the process of identifying the issues. - The anticipated causes include leaks and fire fighting (hydrant use). Airdrie intends to complete an internal study to identify the causes of unaccounted for water by the end of 2019. - A leak detection program in place, to be completed by Airdrie. A data analyst is currently working on analyzing monthly water use.

Airdrie – May 31, 2019	
Questions	**Responses**
5. The rate structure is based on both fixed and variable rates. Can you clarify which users have fixed and variable rates?	- Municipal water is on a variable rate. - Residential and ICI water users' rates are 50% fixed and 50% variable. The flat rate is fixed, based on the meter size. For example, an ICI user with a 3" meter size will be billed a fixed rate of $9.67 per day. The fixed cost contributes to the base revenue stream.
6. Are all Residential and ICI users metered? What are the water rates?	- All Residential and ICI water users are metered. Water audits are currently in progress to confirm this. - Airdrie provided AE with their fixed water rates (by meter size) on May 31.
7. We observe almost no change in ICI water use and an increase in Municipal water use. Do you agree with this observation? Are there any incentives for ICI users to reduce water consumption? Are there any internal initiatives to reduce Municipal water use?	- Municipal water use (i.e., Parks irrigation) was not fully metered until 2018, there is not enough data to support this observation. With an increase in residential population, the Residential and ICI water use is expected to increase slightly. - Existing water conservation initiatives are primarily residential focused. - Outdoor watering restrictions will impact all users including residential, ICI and Municipal. The Water Works Bylaw reflects this new change.
8. We observe a reduction in overall water consumption. Do you agree with this observation? Are there any other initiatives to reduce water consumption?	- See above. - Airdrie plans to continue public education programs, recognizing that with increasing population, it is important to continue public education. Airdrie has allocated budget this year for public education initiatives such as booths set up at farmers markets and commercial spaces to provide information and brochures about water conservation.

Airdrie – May 31, 2019	
Questions	**Responses**
9. Are there any other water conservation initiatives? If yes, what has been implemented?	- Indoor water conservation tips. - Toilet replacement/rebate program.
10. Are there any bylaws that regulate water consumption (e.g., water use restriction during long periods with no rainfall)?	- Waterworks Bylaw No. B-04/2019. Section 59 and 60 on low flow fixtures. Section 63 on water conservation.

Chestermere – May 30, 2019	
Questions	**Responses**
1. Please clarify Purchased Water vs. Billed Water. What are the recent mitigations to reduce water losses?	- Purchased Water is the direct meter reading from Calgary. - Billed Water is from the billing system. - Water loss is the difference between Purchased Water and Billed Water. This can be attributed to meter inaccuracy, water theft and leakage. - A leak detection study was conducted in 2015. Chestermere continues to monitor for leaks when a spike in the night flows is observed.
2. What is included in ICI water usage?	- All ICI properties, schools and Recreation Centres.
3. What Municipal Water uses (e.g., Public Works, vehicle washing, Parks irrigation, etc.) are included?	- Vehicle washing, street sweeping, and Parks irrigation are metered. Chestermere started metering Parks irrigation in 2017. Fire fighting is not metered and is captured in the water loss.
4. Who are the users for Purchased Water and Billed Water?	- Residential, ICI and Municipal (Public Works).

Chestermere – May 30, 2019	
Questions	**Responses**
5. We observed a slight reduction in water overall consumption. Do you agree with this observation?	- There was an increase in water use in 2017 due to the addition of meters for Parks irrigation. 2017 was also quite a dry year. During sub-division development in 2016, a large amount of water was used for flushing pipes. - Yes, there is a general reduction overall.
6. Are all residential and ICI users metered? What are the water rates?	- 99% of residential and ICI users are metered. - The water rates (tiered system) are provided in the CMRB Demand Management Questionnaire.
7. A population growth rate between 6.99% to 1.93% was reported from 2015 to 2018. Do you agree with this observation? Population data retrieved from: https://www.chestermere.ca/100/Demographics-Population	- Yes, this sounds right.
11. Are there any water conservation initiatives? If yes, what has been implemented?	- Meter replacement program – an oversized meter was replaced that was not recording properly. - Chestermere is replacing aging copper water services in older neighbourhoods to address leakage. - There have not been any recent public engagement or education initiatives. There were some initiatives back in 2000, but no follow up since the meter and copper service replacement.
12. Are there any bylaws that regulate water consumption (e.g., water use restriction during long periods with no rainfall)?	- There will be in the future. Chestermere is implementing changes to Bylaws with the intention of decreasing water consumption.
13. With the tier water rate system, have you observed a reduction in Residential or ICI water use?	- There are variable rates for higher water users. This has appeared to curb negative behaviour and reduce water consumption.

Chestermere – May 30, 2019	
Questions	**Responses**
	- There was initial push back from the public on increased utility rates, but this appears to have helped reduce water consumption.

Calgary – June 20, 2019	
Questions	**Responses**
1. Is the population data provided (for Calgary and Regional customers) from census data?	- From Stats Canada census results. - Where indicated, data is from Municipal census.
2. We noted a population growth rate ranging from 0.7% to 3.5%. Do you agree with this observation?	- Yes. Calgary notes a growth rate of 0.35% – 3.33% within Calgary and 0.69% – 3.66% including Regional users.
3. We noted a decrease in overall per capita water consumption. Do you agree with this observation?	- Yes.
4. What contributed to the spike in water consumption in 2017?	- A hot, dry summer resulted increased irrigation and cooling consumption. - Cooling towers are present in the downtown and on large campuses (Foothills Hospital, SAIT, U of C). Cooling tower consumption is included within the ICI total. - Water Utility Bylaw does not allow new once-through cooling systems. Older ones may be grandfathered in.
5. What percentage of water users are metered?	- 98.06% as of May 2018 (approximately 7,000 unmetered users). - Unmetered users are primarily residential properties where the water intake is built in and structural damage would be required to install a meter (e.g., older home with a renovated, finished basement). This estimated water use is accounted for in the “Residential Flat” total. This may not be accurate and is based on an average. These users pay a high flat rate to encourage installation of meters.

Calgary – June 20, 2019	
Questions	**Responses**
	- Some ICI developments may have their own water licenses for non-potable use (e.g., stampede rodeo).
6. What is your rate structure?	- Rates are uniform for Residential and ICI users. There is a base rate, plus linear variable rate ($/m^3). No tiered system. Rates were confirmed by Calgary. - Calgary provided separate rates agreements for Regional users.
7. Have the water rates increased in the past 10 years? Do you notice an impact of increased rates on water consumption?	- $1.75/m^3 in 2008, increased to $3.25/m^3 in 2018. Linear increase over the past decade. - Yes, Calgary has noticed a decrease in water consumption from 0.6 m^3/count/day in 2008 to 0.55 m^3/count/day by 2018. - Calgary observed a per capita water use of 356 L/c/d including Regional users in 2018. - The decrease in water use can be attributed to conservation initiatives, not necessarily rate increases.
8. The “ICI Other” total includes Bulk Water, ENMAX, Lakes, and Non-Sewer Categories. Can you elaborate on what is included in these categories?	- Bulk water includes water trucks hauling to industrial facilities or rural properties (likely outside of Calgary, or to sites with no piped supply). Calgary to confirm who can purchase a card for bulk water. - ENMAX includes district energy and operational use. - Lakes include developed lakes within the City that require top-up water (e.g., Mahogany Lake). - Non-Sewer Categories include metered services providing water for consumptive purposes (e.g., food storage, cooling, and bottled water). These facilities are not generating wastewater at a typical rate/scale to water use.
9. Is Residential Irrigation metered separately from other Residential water use? Is Parks Irrigation included in “Municipal Irrigation”? What is GS Irrigation?	- Single family residential irrigation is included in the Residential total. - Multi-family irrigation is metered separately under the Irrigation total. - Parks irrigation is included in Municipal Irrigation. - GS Irrigation includes metered water used for irrigation at ICI locations. There is a separate meter on site for irrigation. This provides rate benefits as there are less sewer charges.

Calgary – June 20, 2019	
Questions	**Responses**
10. What is included in "Municipal"? Are there other non-metered water uses (i.e., fire fighting)?	- City owned facilities including pools, fire halls and Municipal buildings. - Public Works use including hydrant use, flushing, dust control, fire fighting and street cleaning and un-metered. Estimates of non-revenue water use are captured in the water loss.
11. We observed a "Water Loss" ranging from 65 to 100 L/c/d. Do you agree with this observation? What are the main causes of water loss (i.e., metering inaccuracies, leakage theft).	- Unbilled and metered water use. - Frozen water pipes – customers are requested to run bleeders (un-billed but accounted for). - Calgary is not aware of users running bleeders without their permission. - Calgary is not aware of theft. Hydrant use is roughly tracked and is minimal. - Landscapers and developers apply for a permit to use water from hydrants. - 60% of water loss is leakage. 40% is roughly tracked or estimated. - Calgary to provide estimates for the breakdown of unaccounted for water.
12. Who are the primary customers at Bulk Water stations?	- Calgary to confirm: if there was a watering restriction, what happens with bulk water stations? There is a bylaw for permitted uses (e.g., down well).
13. What water conservation initiatives have been implemented?	- In 2003, Calgary rolled out universal metering. 97% of users were metered by 2014. - The Water Utility Bylaw was implemented in 2006. This mandates the use of low flow fixtures (now this is all that is available on the market). This Bylaw also mandated for new construction and renovation to use low flow fixtures (required to obtain a permit). - There was a 12 year-long residential toilet rebate program which funded 70,000 residential toilets being upgraded. - Process changes were implemented in WTPs. Calgary upgraded filtration equipment to reduce process water use. - A hotel/motel and Multi-family Residential toilet replacement program is still ongoing. - There was a program focused on replacing pre-spray rinse valves in restaurant dish pits. This was discontinued because the market has caught up - only high efficiency spray valves are available for purchase.

Calgary – June 20, 2019	
Questions	**Responses**
	- The next water conservation opportunity will focus on outdoor water use (Residential and Parks Irrigation). Calgary plans to update their Water Efficiency Plan, to determine recommendations. - Public education program: 1" of water per week for outdoor irrigation. - Calgary offers rebates to ICI users for installing high efficiency indoor fixtures (1 day buy back program). - There is a rain barrel subsidy program. The first 1,000 rain barrels are sold at $15 each. - There are homeowner water guides available online related to yard smart landscaping. Public education program: landscaping options, turf grass recommendations, Native and water efficient vegetation. This does not include xeriscaping or lawn replacement.

Foothills – June 4, 2019	
Questions	**Responses**
1. The Municipal Context Report identifies 7 WTPs (as indicated in the Municipal Context Report) that are operated by Foothills County. Is there any production data available for these WTPs? What regions are currently serviced by water co-ops? Can you provide water use data?	- There are 5 WTPs that are owned and operated by Foothills. The remaining 3 provide re-treatment (re-chlorination or testing/pumping facilities). • Heritage Heights WTP services 2 schools and 1 arena. There are no residential services (all residences are well fed). • Cottonwood WTP services 14 residents. • Blackie WTP services the Hamlet of Blackie. • Fish Creek Ranch WTP services 1 residence and 1 bulk fill station. • Red Deer Lake WTP services the Red Deer Lake school. - There are 5 WTPs that are privately owned, but operated by Foothills: Square Butte Ranch WTP, Millarville Recreation and Ag Society WTP, Ravencrest WTP, SRRUC (10% share owner with Black Diamond/Turner Valley) and Longview WTP. - There are other water co-ops that are privately owned and operated: 3 are a substantial size, and several are very small systems. Some private water co-ops

Foothills – June 4, 2019	
Questions	**Responses**
	are so small (servicing less than 14 people) that no treatment is required. These are essentially shared well systems. - Foothills provided production data for the 5 WTPs that they own and operate. - No water consumption data is available for the privately owned WTPs that are operated by Foothills. - A meter replacement program was recently completed. Foothills provided the total metered (water use) data for the 5 WTPs that they own and operate. - Prior to 2017, water losses were approximately 25%. Now they are below 10% due to the meter replacement program. The remaining 10% can be attributed to line loss.
2. Do you have consumption data that you can share? If not, is your report of 0.5 m^3/day for serviced residents still valid? What does "serviced residents" refer to (i.e., per household)?	- No comment on what "serviced residents" refers to. - Rural users on the trickle fill system use up to 300 US gallons per day. - The Industrial/Commercial corridor (north of Aldersyde) is restricted to 0.5 US gallons per minute by the available line flow. This area is also metered, and usage is monitored under development rules.
3. Are all residential and commercial metered? If not, what is the billing system? If yes, what are the water rates?	- Foothills is unable to separate what is Residential vs. ICI water use. Water consumption is tracked by meter size, not user type. - The rate structure is based on the size of meter. Any meter larger than 5/8" is likely an industrial user. - The rate increases substantially as the m^3 of water consumption increases, to prevent over-use. The variable rates are the same for Residential and ICI users. - Hydrant use and fire fighting are unmetered, but is roughly tracked. The fire department reports on how long the hydrant is operated for, and a volume can be calculated. - Public Works uses portable water meters to record potable water use. Non-potable Public Works use are not metered (e.g., road building draws water directly from sloughs). - The trickle feed systems are for potable and household use only, not agricultural irrigation or livestock. Customers sign an agreement when they connect to the

Foothills – June 4, 2019	
Questions	**Responses**
	piped system. The trickle feed systems are monitored by meters, and the available flow is restricted by their cistern capacity.
4. Do you service the rural areas? If yes, in what capacity (i.e., irrigation, residential)?	- Most country residential areas within Foothills County are all serviced by individual groundwater wells. There are approximately 15 residences that are serviced by trickle (low pressure) feed connections. These connections are serviced by the Cayley water line (from High River) and Millarville water line (from SRRUC WTP in Turner Valley). - There are 3 bulk water sites, typically used by rural residential customers. To achieve cost recovery on bulk water sales for distribution and treatment, rates are the highest ($5/m3). The majority of rural residential users are supplied by bulk water, not trickle fill.
5. Can you provide water use and population data?	- Yes. Foothills provided the total population in 2018. This cannot be broken out by the population serviced by municipal water, or population serviced by private wells. - Foothills is unsure of what percentage of the population is serviced by private wells.
6. Are there any water conservation initiatives since Bylaw No.119/2005? Are these still being implemented. If yes, what has been implemented?	- No.
7. Are there any other users that we have not included that you can inform us of? Other information:	- Cargill Foods uses 2 Million US gallons per day. They are supplied by the High River WTP. - There are no high ICI water users such as car wash or Recreation Centre. The ice rink runs off of ice recycling (water collection from the Zamboni) and is therefore a low water user. There are no institutional water users. - A servicing agreement in place with SRRUC and High River WTP for customers serviced by the Millarville and Cayley water lines (Residential and ICI) to follow the watering restrictions and rules of the municipality that services them.

Foothills – June 4, 2019	
Questions	**Responses**
	- The Aldersyde service is also provided from the High River WTP.
8. Why is Foothills no longer allowing private water co-ops?	- The Municipal Government Act requires Foothills to take over the ownership and operation of a private WTP that fails. - If a developer builds a new WTP, this will be owned and operated by Foothills. - Existing private water co-ops will be eventually taken over by Foothills once they fail (plan to grandfather out private water co-ops).

Rocky View – June 3, 2019	
Questions	**Responses**
1. For the East Balzac and Bragg Creek water use data provided, what is the population that these WTPs are serving? Is there population data available for East Balzac and Bragg Creek?	- The Bragg Creek WTP services predominantly residential users and the East Balzac WTP services predominantly ICI users (including Crossiron Mills, cooling towers and industrial area). - Rocky View provided population data for East Balzac and Bragg Creek. - The Area Structure Plans for East and West Balzac can provide guidance on general land use. ASPs are available on Rocky View's website.
2. Where is the Bragg Creek WTP located?	- At the north end of Burnside Drive. The WTP services the hamlet boundary and Elkana Ranch (just outside of the hamlet boundary).

3. Is there any water use data available for the 70 private and co-operative water systems? What does "typical" rural water use look like for these systems?	- No information available. Rocky View does not regulate the private and co-operative water systems.
	- The following organizations can provide a picture of typical rural water use:
	  o Blazer WTP – franchise agreement that service rural residents and acreages.
	  o Rocky View Water Co-op.
	  o Alberta Federation of Rural Water Co-operatives (AFRWC).

Rocky View – June 3, 2019	
Questions	**Responses**
	- Rocky View provided contact information for the Blazer WTP and the Rocky View Water Co-op. - Some co-ops are metered. Rocky View was unable to provide consumption data for the co-ops.
4. There are 7 WTPs listed that are private systems in the Municipal Context Report. Do these WTPs service mostly residential or ICI users?	- The 7 WTPs listed in the Municipal Context Report are the main WTPs and mostly service residential users. ICI mainly consists of a small local strip mall or gas station.
5. Do you have water use data for Municipal?	- Rocky View provided information on Public Works water use (e.g., truck washing, public buildings). - Bragg Creek does not have a hydrant system. They use a quick hook up to fill their fire trucks. - Rocky View uses temporary meters to track construction water use. - There is no bulk water station. - Rocky View provided what is included in the ICI water use total.
6. Are there any issues with water loss? If yes what are they?	- Water infrastructure is new, so there is limited leakage. - Bragg Creek is 100% metered. Monitoring is being done.
7. Do you have separate water use data for Crossiron Mills?	- Yes, Rocky View to provide. - Rocky View to request the estimated number of visitors to Crossiron.
8. Are there any water conservation initiatives?	- See Area Structure Plans. - Rocky View uses captured stormwater for irrigation.

Wheatland – June 6, 2019	
Questions	**Responses**
1. The Municipal Context Report indicates that there is 1,000 acre-ft of water allocated to Wheatland. How much water is used on an annual basis and what is the typical water use (e.g., rural residential, agriculture, construction)?	- The 1,000 acre-ft was allocated back in 2011 for 5 anticipated developments (750 residential and 250 commercial). These developments were never completed; therefore the water license was not used.

Wheatland – June 6, 2019	
Questions	**Responses**

Is the water used by all 8,800+ people based on 2015 census?	- The current population of Gleichen, Rockyford and Standard are serviced by 1 WTP with regional services.
	  o Standard WTP (located in Standard) services the Hamlet of Gleichen and the Villages of Standard and Rockyford.
	  o Rosebud WTP (groundwater) services Rosebud.
	  o Carseland WTP services Carseland and Speargrass.
	- Irrigation is provided by the Western Irrigation District.
	- There is 1 privately owned and operated WTP that services 250 people, located north of the CMRB boundary.
	- County to send annual reports for the 3 WTPs that they own and operate.

2. Is there any population data available?	- Population data is available in the census report. - Water consumption is increasing due to population growth.
3. What type irrigation of service is provided?	- Residential lawn watering – this is metered. - No Parks irrigation.
4. Is the water consumption metered? If yes, which users are metered?	- All Residential and ICI users in Hamlets are metered. There is not a lot of ICI developments. The main ICI users are gas stations, grocery stores and small services. Wheatland provided the Residential and ICI water use data that is available. - Residential and ICI users are billed at the same rate (flat rate + variable rate per m^3) for both water and wastewater. There is a capital levy for future improvement. Wheatland provided water consumption data that shows a downward trend.
5. Are there any ICI developments that use the allocated water?	- Industrial developments have their own water licenses from the Bow River. Wheatland does not have information about their water use, or jurisdiction. - Public Works uses non-potable water for dust control. This water is from groundwater wells, lagoons or ponds.

Wheatland – June 6, 2019	
Questions	**Responses**
	- There are 2 potable water bulk fill stations. The one in Gleichen is metered. The one at the Public Works office is un-metered. - Bulk water in Gleichen is used mainly for agriculture and for spraying chemicals on their agriculture fields. - Fire hydrants are not metered. - The Hamlet of Cheadle is serviced by groundwater. - There is an existing industrial park near Cheadle. Not all ICI developments in this are in operation.
6. Are there any water conservation initiatives? If yes, what has been implemented?	- Since 2015, Wheatland has provided a water rebate program to its ratepayers to reduce water consumption in the municipality. The program supports rate payers who retrofit water appliances with low-flow fixtures. - There is currently a toilet rebate program. - There are no water use or watering restrictions. - Wheatland has increased water rates to provide cost recovery.
7. Is there any water loss in the system?	- There are known major leaks due to aging infrastructure. Wheatland is investing in leak detection and repair, and actively replacing the old infrastructure.

Okotoks – June 4, 2019	
Questions	**Responses**
1. We observed a reduction in overall water consumption. Do you agree with this observation?	- Yes, the per capita water consumption is decreasing due to a combination of water conservation Bylaws, rates, and public education. - Gross water consumption is increasing.
2. There is a significant difference between produced water and billed water. Can this be attributed to water loss in the system, or other non-metered water uses?	- Okotoks is using a leak detection tool in combination with zone metering and GIS to identify water loss in the system

Okotoks – June 4, 2019	
Questions	**Responses**
	- With the tiered water rate system, reporting is more "accurate". Okotoks is working to understand potential problems in the system and is able to address water loss more efficiently. - Okotoks provided assumptions on the causes of water loss.
3. What is included in ICI, Irrigation and Bulk Water? 4. What is included in Municipal water use (is Municipal water use included in the ICI total)? Is it metered?	- Municipal water use includes flushing, fire fighting and Parks irrigation (sports fields only). - Okotoks confirmed the water consumption data that was provided by the CMRB. - Bulk Water is potable water that is sold to rural acreages in Foothills County. There is also Bulk Water available for non-potable water use (e.g., industrial customers, hydrovac, landscape companies and construction). - The highest ICI water user is the Recreation Centre, followed by grocery stores and car washes. - The majority of water use is residential.
5. What percentage of residential and ICI water use is metered?	- 100%.
6. What water conservation initiatives have been implemented?	- Low flow fixture Bylaw– aggressive implementation of fixtures using 4 L/s or less. Okotoks established standards for indoor consumption. - Outdoor water use is a challenge. Okotoks set a Bylaw requirement for 12" of topsoil for grading plus a xeriscaping program (there are rebates on residential xeriscaping). This has resulted in a reduction in yard watering. - Okotoks has advanced metering that can monitor real time water use, monitor Public Works water consumption and provide quick feedback. Monitoring allows for problems to be identified and addressed quickly. - There has been a public education program since 2002. University students go door-to-door to help set up live water usage tools. This helps residents to budget their water user per month. - The public education program has been aggressive due to a limited water license allocation. Through the water conservation program, residents save money through conservation to allow for future development. This program is implemented in

Okotoks – June 4, 2019	
Questions	**Responses**
	residential and industrial/institutional developments. Commercial engagement is on-going. - New developments do not have irrigation. Developers are working with the existing policy (e.g., drought tolerant landscaping). Okotoks recently completed a "brown lawn is good" campaign. - Okotoks provided the Water Conservation, Efficiency and Productivity Plan and the Environmental Master Plan.
7. Okotoks is currently updating the Municipal Development Plan. What growth rate do you anticipate? Any major increase of water users (e.g., ICI)?	- A regional water supply (raw or potable) is in discussion. This would supplement the current WTP, for resiliency planning. - Okotoks to provide the anticipated population growth rate. - Okotoks intends to grow ICI sectors to create local jobs and grow the economy. The Municipal Development Plan has allocated water to ICI developments.
8. What is the rate structure for residential and ICI?	- There is a 3 tier water rate system.

Strathmore – June 10, 2019	
Questions	**Responses**
1. We observed a reduction in water consumption. Do you agree with this observation?	- Yes, Strathmore is working towards a reduction in water consumption. The target is a 10% reduction in water use over time. AE provided the water use data provided by the CMRB to Strathmore for confirmation.
2. We noted an increase in population (except for 2012). Do you agree with this observation?	- In general, yes. There was a small population increase in 2012. Strathmore to review population data provided by AE.
3. What percentage of residential and ICI water users are metered?	- 98% of water users are metered. The agriculture grounds (annual stampede) that has two service lines that are not metered. This is a private development.
4. What is included in your ICI data? (e.g., irrigation, bulk water, Public Works).	- Residential users are metered, so there is less water use for irrigation. - Parks irrigation is included under ICI. - There is one bulk water station (currently excluded from the data).

Strathmore – June 10, 2019	
Questions	**Responses**
	- Hydrant use are not monitored (source of water loss). Strathmore intends to implement monitoring of these water uses in the future. Strathmore is working to develop protocols for fire fighting.
5. Can you provide data for the volume of water that is purchased from Calgary?	- Strathmore provided purchased water data (annual flow rate and peak flows).
6. Are there significant water losses in the system? What can these be attributed to (e.g., leakage, faulty metering, theft, etc.).	- Water loss is estimated to be between 16% and 19%. - Within the downtown area, there are several 100 mm and 200 mm ductile and cast iron pipes that were installed in the 1950's. These are a possible source of leakage. On-going pipe replacement is in progress to reduce the number of leaks. - There could be faulty meters, but there is no proof. There is currently a discrepancy between billing and metering, to be investigated.
7. What percentage of residents are serviced by bulk water vs. piped supply?	- No residents are serviced by bulk water. - The bulk water station is used by contractors, and used for flushing sewers prior to doing CCTV inspection. The operations department also uses bulk water. - There is a ticketing system to track bulk water use.
8. Is the flat water rate the same for all sizes of meters (ICI and Residential)?	- Water rates provided by Strathmore. - Irrigation meters are tracked under both Residential (14 irrigation meters) and ICI (44 irrigation meters) depending on who owns the meter.
9. Since increasing water rates, have you noticed a reduction in water use?	- Strathmore provided data to show reduction in water use.
10. Are you aware of the water conservation bulletins? Are they active?	- There is existing communication with the public on tips to conserve water.
11. Are there any bylaws that regulate water consumption (e.g., water use restrictions during long periods with no rainfall)?	- Strathmore provided Water Bylaw. Information is also available on their website.

Cochrane – June 3, 2019	
Questions	**Responses**
1. We observed a reduction in water consumption. Do you agree with this observation?	- Yes. Cochrane calculates water use based on the volume of water produced from the WTP. The WTP was estimated to be produce 270 L/c/d in 2018. - Billing data is based on what was billed to the water users. There is unaccounted for water in the system (losses).
2. What water conservation initiatives have been implemented (i.e., outdoor use restriction, low flow fixtures, rain barrels, metering)?	- Low flow fixture Bylaw implemented in 2006. New homes are following this Bylaw. - Public education around existing Bylaws. - Watering restrictions and public education initiatives to teach residents how to water their property. This program is mainly focused on residential users, as most of the land use is residential. - There are hot weather periods, but wet weather periods help to reduce water usage. - There are 400 ICI utility accounts. 270 of these accounts use less than 25 m^3 per month of water. - The largest ICI users consume 65% of the total monthly ICI water volume. These include the Recreation Centre, Spray Lake Sawmill and long-term care homes. - The 2 golf courses have their own water licences to draw water from the Bow River for irrigation. The golf course restaurant uses potable water from Cochrane
3. Are there any issues with water losses?	- Leakage is estimated to account for between 13% and 17% of water produced. There is typically more leakage in the summer. - Cochrane is reviewing areas with high water losses to reduce leakage.
4. What does Bulk water include? What does Irrigation include?	- Bulk water includes sales from 2 bulk fill stations. These stations are used for both residential and non-residential use. - Residential use refers to acreages outside of Cochrane. Bulk fill stations are used to fill potable water cisterns ($4/$m^3$). - Non-residential use refers to landscaping and subdivision construction work within Cochrane ($2/$m^3$).

Cochrane – June 3, 2019	
Questions	**Responses**
	- Irrigation is 100% metered except for Parks irrigation. Cochrane is implementing a plan to install meters in larger parks and will have better irrigation data in the future. See "Park Use" in the spreadsheet provided for annual usage. - Other irrigation include condo developments and green spaces. No potable water is provided for agricultural irrigation.
5. Do you agree with population growth rates between 1.77% and 10.7%?	- On average, the range is agreeable.
6. What is your water rate structure?	- Residential rates are based on a 3 tier rate structure. - Multi-family residential users are billed at the first tier rate only. - Non-residential users are billed at a flat rate per meter size + a consumptive rate of $1.31 per m^3. - Irrigation is billed at a flat rate per meter size (same as non-residential) + a consumptive rate of $1.56 per m^3. - These rates are separate from bulk water use.

High River – June 13, 2019	
Questions	**Responses**
1. There is one WTP in High River. Can you provide water production data for this WTP?	- All treated water is metered. - There are 15 raw water wells (GUDI) that feed the WTP. Each have their own meter and there is a common raw water intake meter in the WTP. There is also a magnetic flow meter for the treated water entering the distribution system. - High River has 3 water licenses.
2. The Municipal Context Report lists Cargill Meats and Foothills County as high water users. Which areas of Foothills County do you service? Are they metered?	- High River provides water to Cargill Meats and the MD of Foothills. They hold their own water licenses, and water is treated by High River's WTP. High River oversees these water licenses.

High River – June 13, 2019	
Questions	**Responses**
	- High River services the Hamlet of Cayley and Town of Aldersyde in Foothills County. Aldersyde re-distributes the water, but High River does not monitor where it goes. Cayley and Aldersyde each have their own meter. - High River provided consumption (billing data).
3. Can you provide water consumption (billing) data for Residential, ICI, Municipal and Irrigation?	- 100% of customers are metered. - Residential is billed separately from ICI. - The largest ICI users are car washes, a brewery, the Lafarge precast plant, the hospital and a recreation centre.
4. How are Municipal water uses (i.e., Parks Irrigation, Flushing, Vehicle Washing, Construction, Fire Fighting, etc.) billed and tracked?	- Municipal water is tracked separately under “maintenance water”. - Water used from hydrants is recorded. The fire department documents how long the hydrant was used for. This is tracked for water audits but is not billed. - High River irrigates a few parks, and this is metered. - Other irrigation uses are also metered. For example, if the High School wishes to irrigate, High River would issue them their own meter and they would be billed. - High River provided consumption data (annual total). - There are errors in the 2013-2015 billing data due to the flood wiping out meters in downtown core and 80% of the neighborhoods. This was followed by a full meter replacement program. During the flood, the WTP production meter remained online.
5. The Municipal Context Report indicates that water use was 475 L/c/d in 2016. Do you agree with this observation? Has this decreased in the past 2 years?	- Yes. Leaks and unaccounted for water contribute to this high water usage. - There has been no notable decrease in water use in the past 2 years. - There were huge water loss issues in 2007. High River formed a partnership with Water for Life and Alberta Water Council CEP. Water conservation initiatives brought the water use down to 275 L/c/d. The infrastructure leakage index (ILI) dropped from 18 to 8.5. - Conservation initiatives included a rebate program for low flow fixtures and rain barrels and public campaigns. High River hired Veritec Consulting to perform Night Flow Analysis and leak detection.

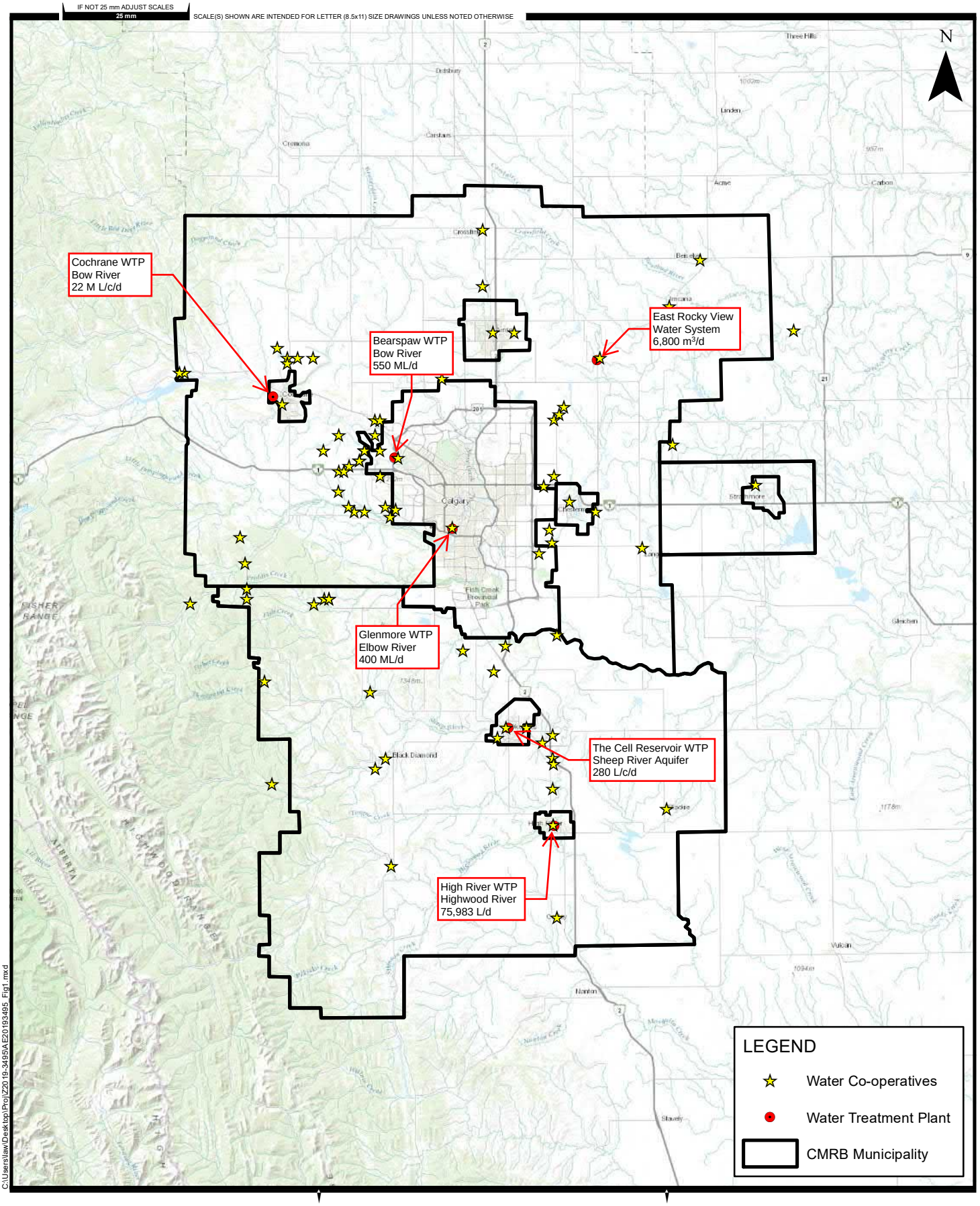
High River – June 13, 2019	
Questions	**Responses**
	- The flood contributed to the loss of meters and reliable population data in 2013. There is no confidence in the water use data after 2013.
6. Are you able to provide population data for the past 10 years (2008 – 2018)?	- High River provided federal census information for population data.
7. The Municipal Context Report indicates approximately 40% water losses. What are the main causes of water loss.	- 20% is unaccounted for water. - This can be attributed to theft at hydrants by local contractors, issues in entering the billing data (new Bellamy system) and meter inaccuracy. The meter feeding the north section of town was reading significantly low and was recently replaced. Meter inaccuracies are still prevalent after the meter replacement program. - 20% is leakage. - High River has undertaken significant water main replacements since 2013. There are some areas with known leaks that still need to be fixed. - Recent water hammer damage (from closing a hydrant too quickly) resulted in a large main break. A high reduction in pressure was observed. Replacing this main caused the pressure to increase in other pipes, causing additional leaks. - High River performs Night Flow Analysis every Sunday night (when Cargill and MD of Foothills are offline) to provide a benchmark. - High River is aware of the water loss issues and is passionate about conserving water.
8. What were the results of the water loss study and Water Conservation Bylaw? Improvements?	- There is a Water Bylaw and Water Conservation Bylaw. - The Water Conservation Bylaw is only implemented during hot summer months. High River is currently working to implement odd/even watering days throughout the year, not just during hot periods. This amendment to the Water Conservation Bylaw is currently running through council.
9. What is the current rate structure for Residential and ICI?	- There is a base rate, per meter size (ranges from $24 - $32). - There is a variable rate per volume of water consumed (e.g., for $0.61/$m^3$ for 0-60 m^3)

High River – June 13, 2019	
Questions	**Responses**
	- The rates are different for Residential and ICI users. - High River has separate agreements with Cargill Meats and the MD of Foothills (assume higher rates). - There have been a few rate increases over the past 10 years. This has not resulted in a significant water use reduction.

APPENDIX B - PRIVATELY OWNED RURAL WATER CO-OPS

IF NOT 25 mm ADJUST SCALES
25 mm

SCALE(S) SHOWN ARE INTENDED FOR LETTER (8.5x11) SIZE DRAWINGS UNLESS NOTED OTHERWISE



C:\Users\law\Desktop\Proj\Z2019-3495AE20193495_Fig1.mxd

AE PROJECT No.	2019-3495
DATE	2019 MAY
SCALE*	1:800,000
COORD. SYSTEM	NAD 1983 10TM AEP FOREST
REV	0
DESCRIPTION	ISSUED FOR DRAFT
DRAWN BY	LAW

Associated Engineering

FIGURE 1

Area Overview

FACILITY	OWNER	MUNICIPALITY	SOURCE TYPE	SOURCE NAME
Airdrie Waterworks System	City of Airdrie	Rocky View County	Regional Supply	Tributary to Nose Creek
Aldersyde & Area (Abild/Maple Leaf) Waterworks System	MD of Foothills No. 31	Foothills County	Regional Supply	Highwood River
Abild Industrial Park Waterworks System	MD of Foothills No. 31	Foothills County	Regional Supply	
Maple Leaf Waterworks System	Maple Leaf Water Co-op Ltd	Foothills County	Regional Supply	
Apple Creek Golf And Country Club Waterworks System	Tarman Inc.	Rocky View County	Surface	un-named creek
Balzac Waterworks System	Rocky View County	Rocky View County	Surface	Creek/Reservoir
Bar Kay Cee Ranch Waterworks System	Bar Kay Cee Club	Foothills County	Ground - GUI	North Branch Fish Creek
Bearspaw Manor Estates Condominium Waterworks System	Bearspaw Manor Estates Condominium Plan No. 901 0914	Rocky View County	Regional Supply	
Bearspaw Meadows Estates II Waterworks System	Blazer Water Systems Ltd	Rocky View County	Surface	Bow River
Bearspaw Ridge Subdivision Waterworks System	Bearspaw Ridge Water Co-operative Ltd.	Rocky View County	Regional Supply	
Beiseker Waterworks System	Village of Beiseker	Rocky View County	Regional Supply	
Big Hill Creek Estates Waterworks System	Big Hill Creek Estates Community Association	Rocky View County	Ground - Non-GUI	
Bingham Crossing Waterworks System	Bingham Crossing Properties Inc	Rocky View County	Regional Supply	Calaway Park Waterworks
Black Diamond Waterworks System	Town of Black Diamond	Foothills County	Regional Supply	Turner Valley Waterworks
Blackie Waterworks System	MD of Foothills No. 31	Foothills County	Ground - Non-GUI	
Bragg Creek Waterworks System	Rocky View County	Rocky View County	Surface	Elbow River
Calaway Park Waterworks System	Calalta Waterworks Ltd	Rocky View County	Surface	Elbow River
Calling Horse Estates Subdivision Waterworks System	Calling Horse Estates Co-op Association Ltd	Rocky View County	Regional Supply	
Canada Country Marketing	John & Doreen Knight	Wheatland County	Ground - Non-GUI	
Canal Court Waterworks System	Gemini Design Studios Inc.	Unknown	Ground - Non-GUI	
Cayley Waterworks System	MD of Foothills No. 31	Foothills County	Regional Supply	Highwood River
Chestermere Waterworks System	Town of Chestermere	Rocky View County	Regional Supply	
Cochrane Lake Estates (Montara) Waterworks System	Regional Water Services Ltd	Rocky View County	Surface	Bow River
Cochrane North Lands Waterworks System	Prominence Development Corporation	Rocky View County	Ground - Non-GUI	
Cochrane Waterworks System	Town of Cochrane	Rocky View County	Surface	Bow River
Cottage Club Waterworks System	Cottage Club Ghost Lake Inc	Rocky View County	Ground - Non-GUI	
Cottonwood Estates Golf/Residential Waterworks System	Cottonwood Homeowners Association	Foothills County	Ground - Non-GUI	
Crossfield Waterworks System	Town of Crossfield	Rocky View County	Regional Supply	
Deerhaven Estates Subdivision Waterworks System	762265 Alberta Ltd	Rocky View County	Ground - Non-GUI	
Diamond Ridge Estates Subd Waterworks System	Diamond C Water Co-op Ltd	Rocky View County	Ground - Non-GUI	
Elbow Springs Golf Course Waterworks system	Allred's Golf Courses Ltd.	Rocky View County	Ground - GUI	
Elbow Ranger Station Waterworks System	GOA - Tourism, Parks, Recreation and Culture	Foothills County	Ground - GUI	n/a
Elbow River Estates Subdivision Waterworks System	Elbow River Estates Co-op Ltd	Rocky View County	Ground - Non-GUI	
Elbow Valley Water Corporation Waterworks System	Elbow Valley Water Corporation	Rocky View County	Regional Supply	
EMCOR Business Park Waterworks System	590140 Alberta Ltd	Rocky View County	Ground - Non-GUI	
Emerald Bay Waterworks System	Emerald Bay Water & Sewer Co-op Ltd	Rocky View County	Ground - GUI	
Georgian Del-Rich Waterworks System	Georgian Del-Rich Utility Co-op Ltd	Rocky View County	Ground - Non-GUI	
Ghost Reservoir Campground Waterworks System	GOA - Tourism, Parks, Recreation and Culture	Rocky View County	Ground - GUI	
Glencoe Golf Waterworks System	Glencoe Golf & Country Club	Rocky View County	Surface	Elbow River

FACILITY	OWNER	MUNICIPALITY	SOURCE TYPE	SOURCE NAME
Green Haven Estates Waterworks System	Green Haven Development Corp.	Foothills County	Ground - Non-GUI	
Harmony Waterworks System	Harmony Developments Inc	Rocky View County	Surface	Bow River
Hawks Springs (Springs at DeWinton) Waterworks System	Sincerus (Hawk Springs) G.P. Ltd	Foothills County	Ground - Non-GUI	
Heritage Pointe Golf Course And Residential Development Waterworks System	Corix Utilities (Foothills Water) Inc.	Foothills County	Surface	Bow River
High River Waterworks System	Town of High River	Foothills County	Ground - GUI	
Highpoint Estates Subdivision Waterworks System	Highpoint Estates Ltd	Rocky View County	Ground - Non-GUI	
Irricana Waterworks System	Village of Irricana	Rocky View County	Regional Supply	
Lakes of Muirfield Waterworks System	Wheatland County (Muirfield Land Corporation)	Wheatland County	Surface	Western Irrigation District
Langdon Crossings Subdivision Waterworks System	Langdon Waterworks Ltd	Rocky View County	Ground - Non-GUI	
Longview Waterworks System	Village of Longview	Foothills County	Ground - GUI	
McLean Creek Campground Waterworks System	GOA - Tourism, Parks, Recreation and Culture	Village of Longview	Ground - GUI	
Millarville Racing & Ag Society Waterworks System	Millarville Racing & Ag Society	Foothills County	Ground - GUI	
Mount Vista Estates Waterworks System	Mount Vista Estates Co-op Ltd	Rocky View County	Ground - Non-GUI	
Mountain River Estates Waterworks System	Mountain River Estates Ltd	Rocky View County	Surface	Elbow River
North Springbank Waterworks System	North Springbank Water Co-op Ltd	Rocky View County	Ground - GUI	
Poplar View Waterworks System	Poplar View Water Co-op Ltd	Rocky View County	Surface	Bow River
Prairie Royale Waterworks System	East Prairie Royale Residents' Association	Rocky View County	Ground - Non-GUI	
Prairie Schooner Estates Waterworks System	Prairie Schooner Estates Ltd	Rocky View County	Ground - Non-GUI	
Hawk's Landing/Nest at Priddis Creek Waterworks System	Hawk's Landing Services Co-op Ltd	Foothills County	Regional Supply	
Priddis Greens Development Waterworks System	Priddis Greens Services Co-op Ltd	Foothills County	Surface	Priddis Creek
Prince Of Peace Waterworks System	Prince Of Peace Luthern Church of Calgary	Rocky View County	Regional Supply	
Ranchers Hill Water Co-op Waterworks System	Ranchers Hill Water Co-op	Foothills County	Ground - Non-GUI	
Rancher's Hill Phase 3 Subdivision Waterworks System	William & Janet Brogden	Foothills County	Ground - Non-GUI	
Rocky View Water Co-Op Waterworks System	Rocky View County	Rocky View County	Surface	Bow River
Salt Box Coulee (Sandstone) Waterworks System	Salt Box Coulee Water Supply Company Ltd	Rocky View County	Ground - GUI	
Sandstone Springs Waterworks System	Newnorth Projects Ltd.	Foothills County	Ground - Non-GUI	
Serenity Estates Waterworks System	Serenity Estates Ltd.	Rocky View County	Ground - Non-GUI	
South Conrich Waterworks System	AMAR Development Ltd.	Rocky View County	Ground - Non-GUI	
Square Butte Ranch Waterworks System	Square Butte Ranches Ltd	Foothills County	Ground - GUI	
Strathmore Waterworks System	Town of Strathmore	Wheatland County	Regional Supply	
Turner Valley Waterworks System	Town of Turner Valley	Foothills County	Surface	Sheep River
Twelve Mile Coulee Waterworks System	Twelve Mile Coulee Water Co-op Ltd	Rocky View County	Surface	Bow River
Valiant Ranches (Ravencrest) Waterworks System	Ravencrest Water System Ltd	Foothills County	Ground - Non-GUI	
Valley View Acres Subdivision Waterworks System	Valley View Acres Utilities Ltd	Foothills County	Ground - Non-GUI	
Warner Business Park Waterworks System	Murcia Developments Ltd.	Foothills County	Regional Supply	
Westridge Waterworks System	Westridge Utilities Inc	Rocky View County	Surface	Elbow River
West View Estates Waterworks System	West View Water Supply Ltd	Rocky View County	Surface	Elbow River
Windmill Water Co-Op Waterworks System	Windmill Water Co-Op Ltd	Rocky View County	Regional Supply	
Wintergreen Woods Waterworks System	Wintergreen Woods Water Utility Ltd	Rocky View County	Surface	Elbow River

FACILITY	OWNER	MUNICIPALITY	SOURCE TYPE	SOURCE NAME
Yankee Valley Estates Subdivision Waterworks System	Yankee Valley Estates Ltd	Rocky View County	Ground - Non-GUI	

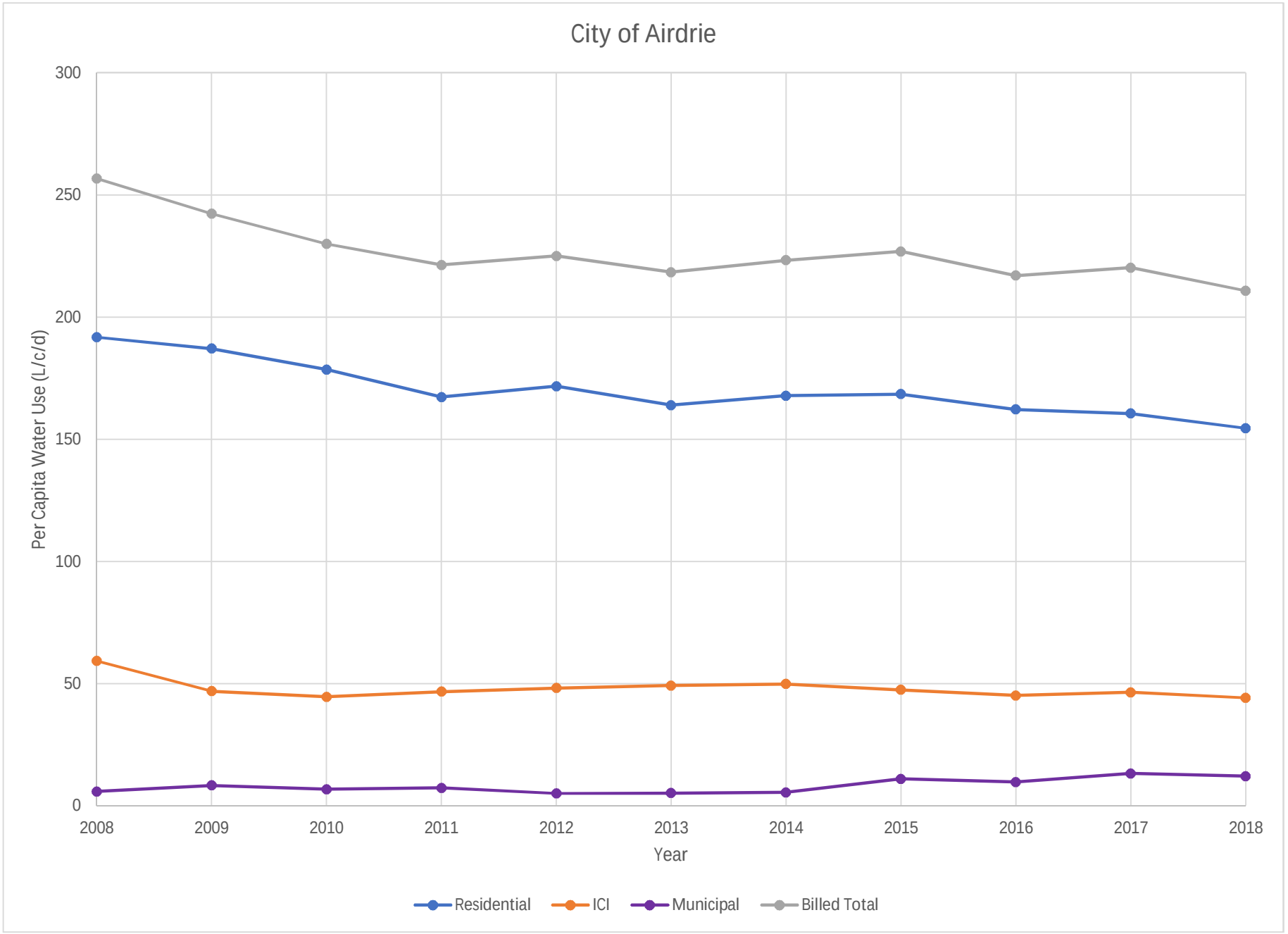
APPENDIX C - POPULATION GROWTH RATES

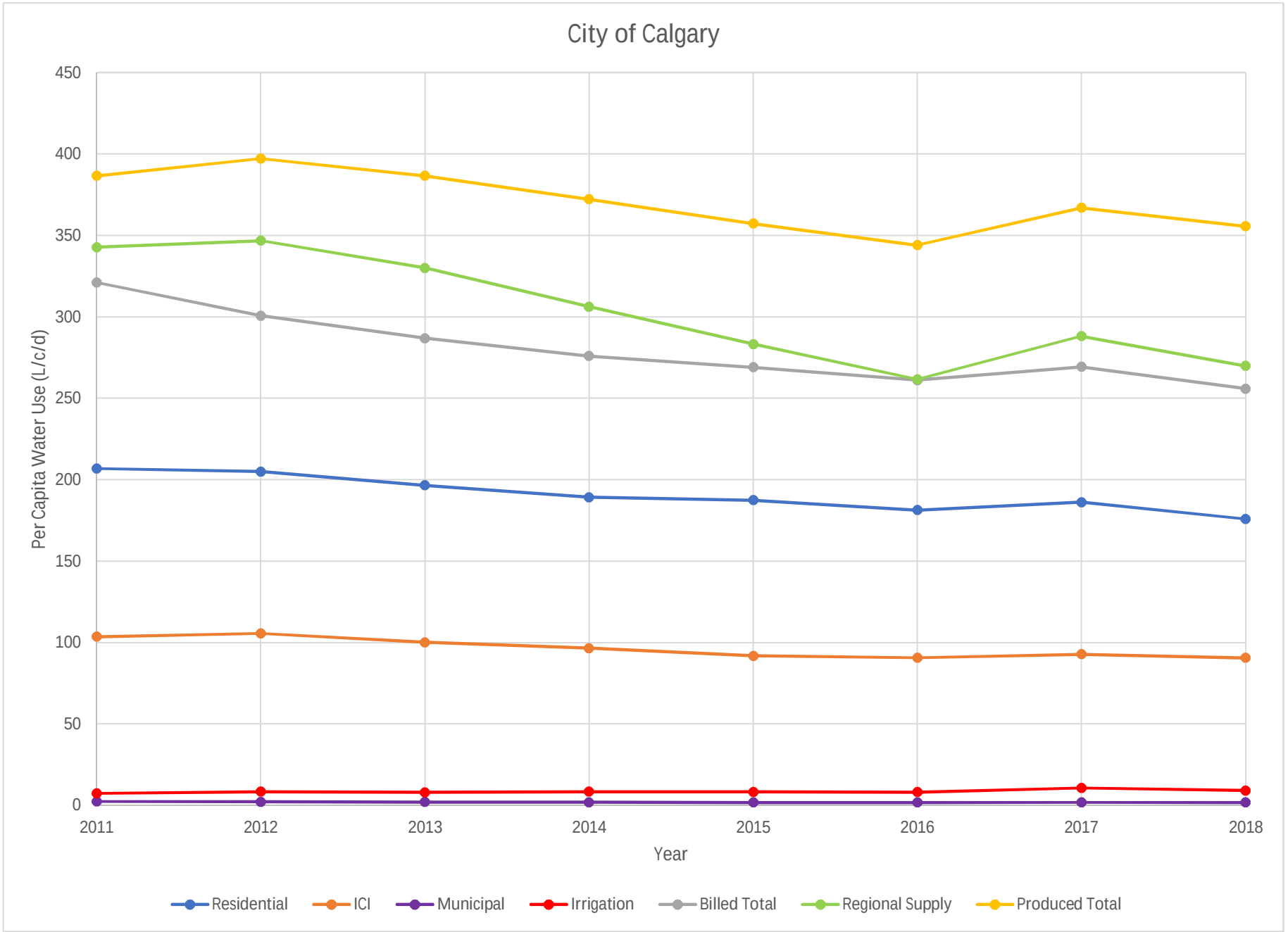
Population Growth Rates

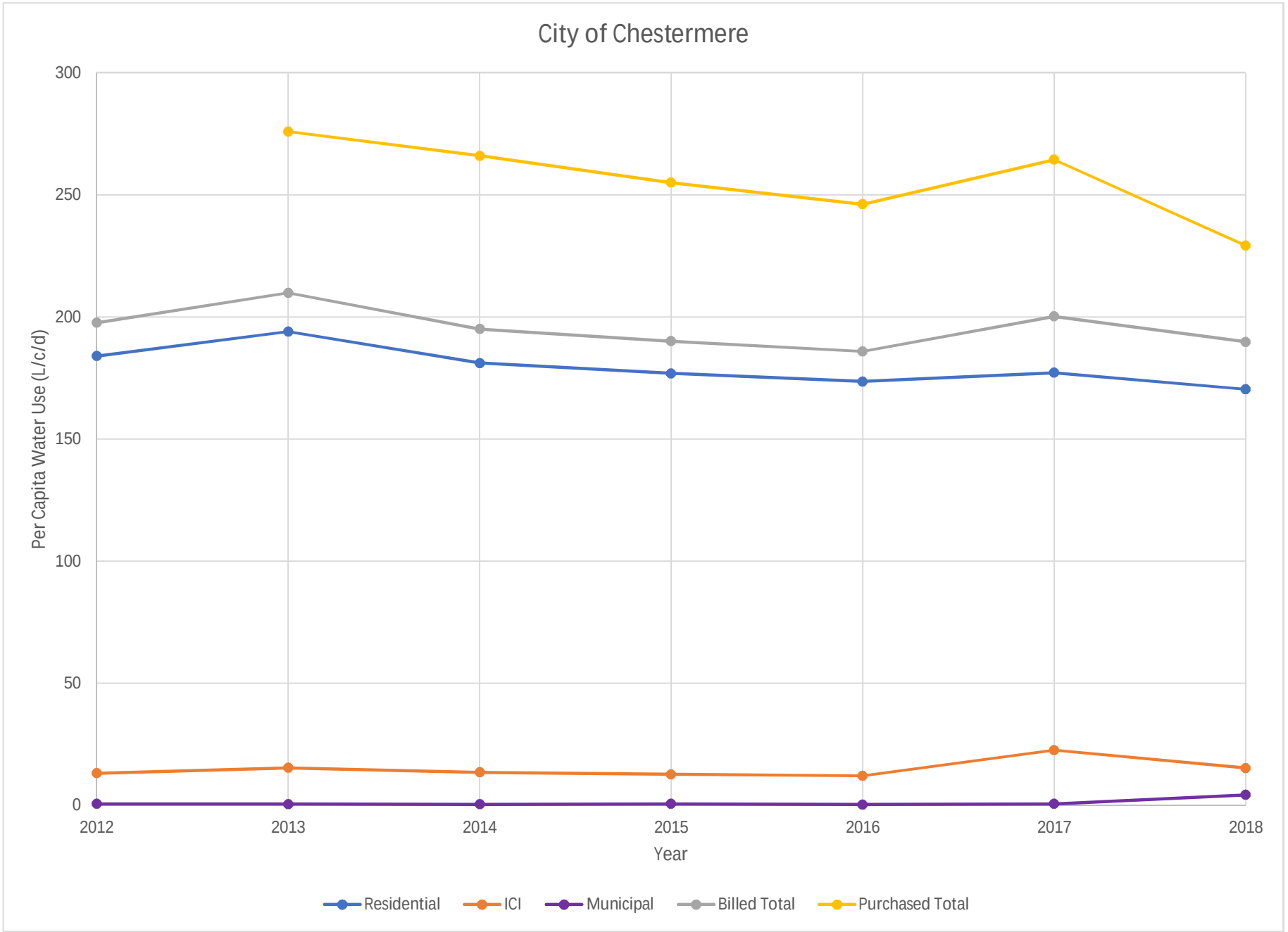
Population Growth Rate											
	Year										
Municipality	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Airdrie	N/A	10.44%	4.35%	7.72%	5.59%	7.77%	9.71%	6.47%	5.10%	4.74%	4.65%
Calgary	N/A	N/A	N/A	1.78%	2.61%	3.15%	3.22%	2.90%	0.34%	0.90%	1.66%
Chestermere	N/A	N/A	N/A	N/A	4.36%	2.60%	8.38%	6.99%	6.18%	3.03%	1.93%
Cochrane	N/A	N/A	7.12%*	6.65%	3.22%*	3.12%	9.46%	10.29%	10.71%	1.77%	5.87%
Foothills	Not Available										
High River	N/A	5.55%	3.71%	8.80%	1.02%*	1.01%*	1.00%*	0.99%*	0.98%	N/A	N/A
Okotoks	5.62%	2.31%	6.51%	3.25%	3.93%	5.16%	3.70%	2.45%	2.38%	0.63%	0.42%
Rocky View	Not Available										
Strathmore	2.06%	4.25%	2.48%	0%	1.72%	0%	0%	7.32%	0%	0%	1.49%
Wheatland	Not Available										

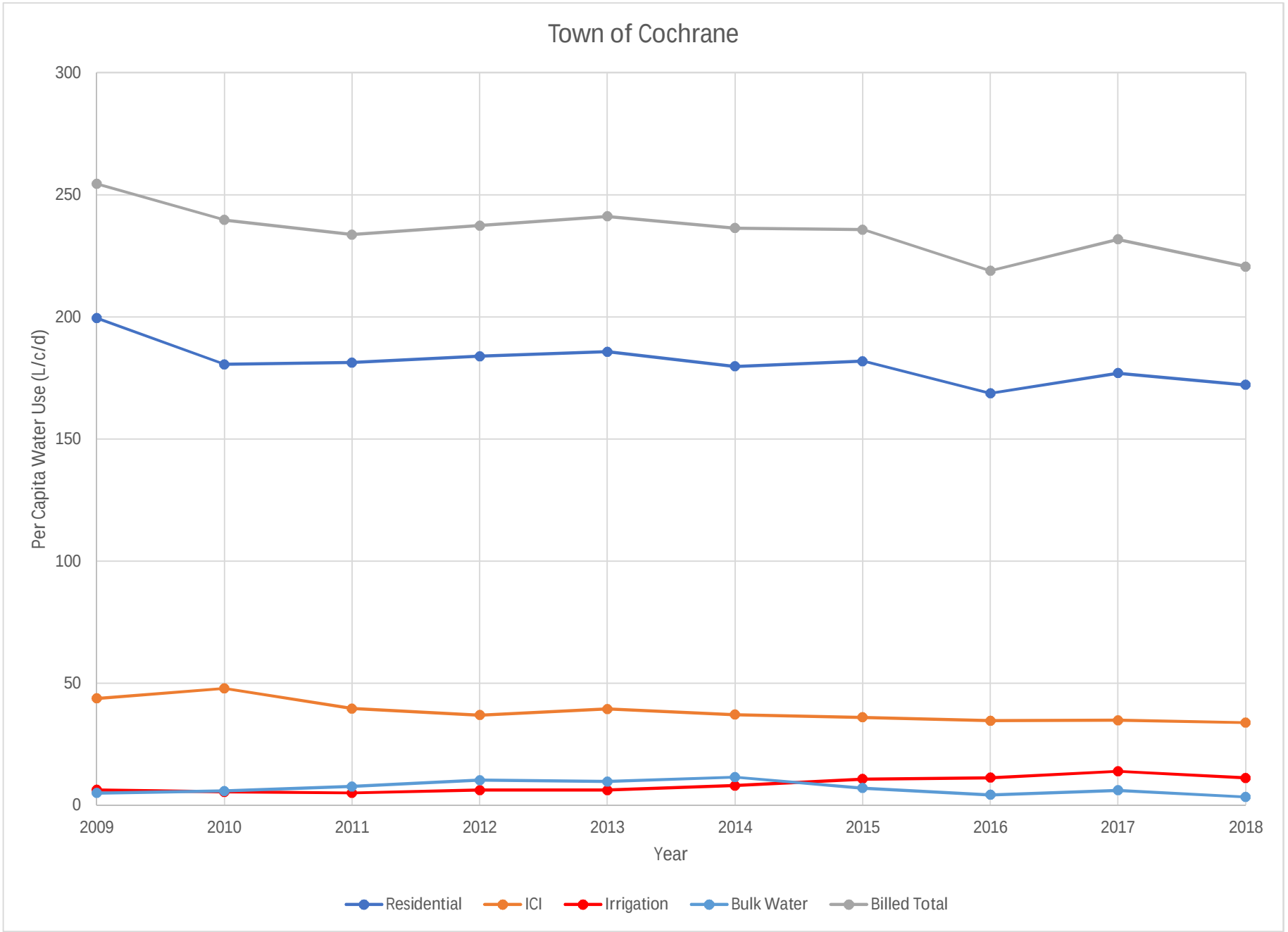
* *Population interpolated to determine growth rate.*

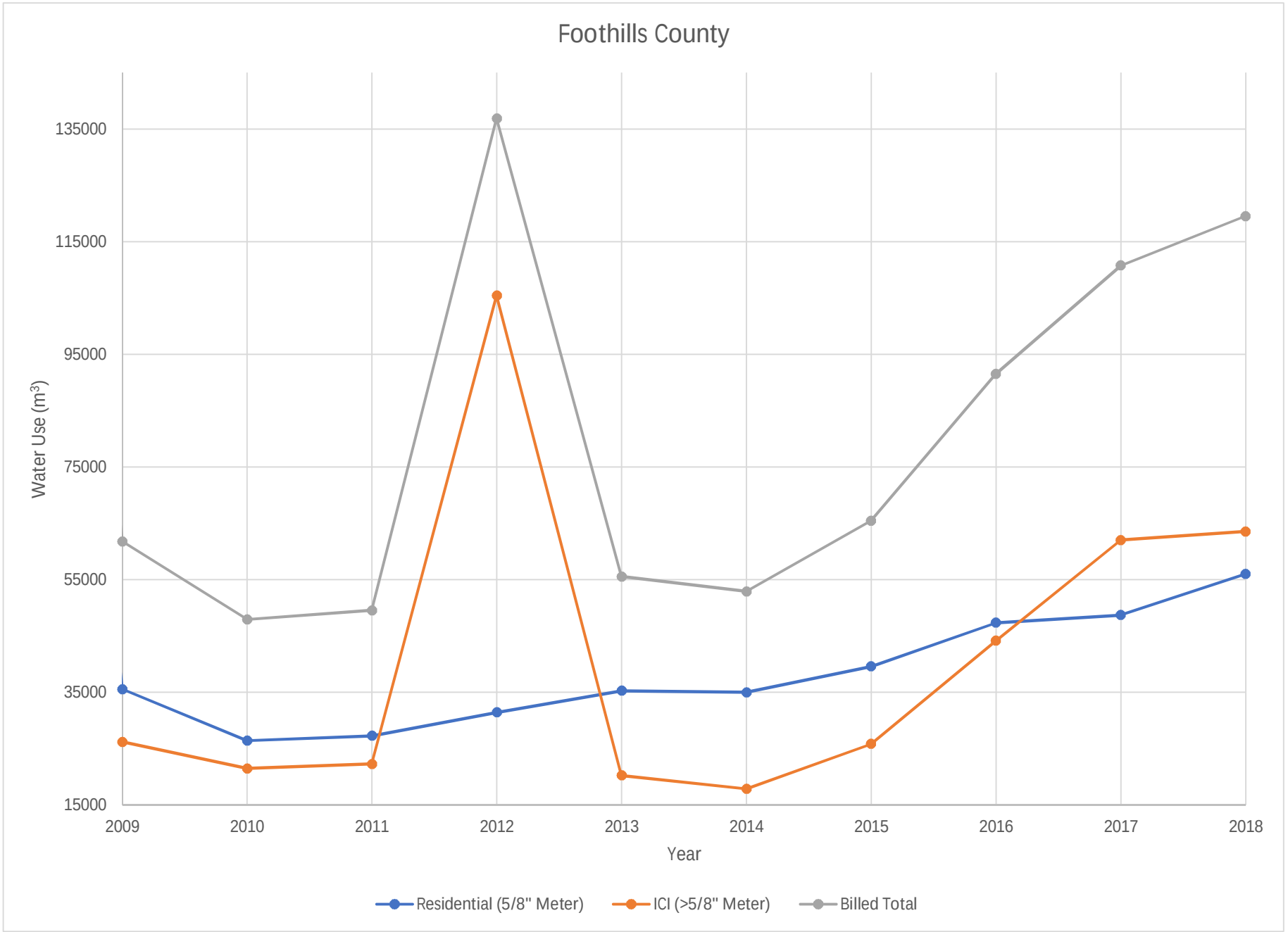
APPENDIX D - PER CAPITA WATER USE

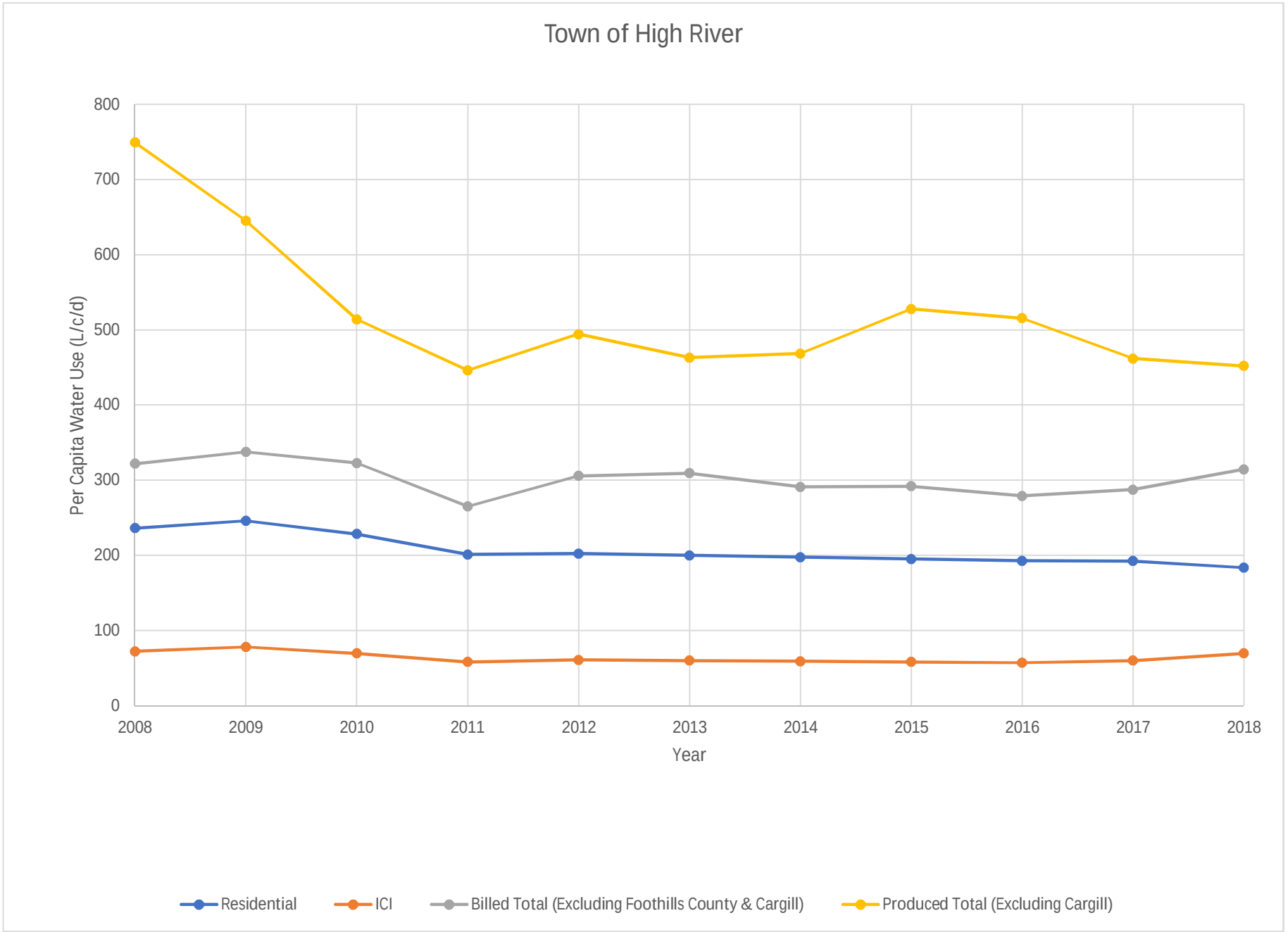

City of Airdrie
Per Capita Water Use (L/c/d)
300
250
200
150
100
50
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Residential
ICI
Municipal
Billed Total

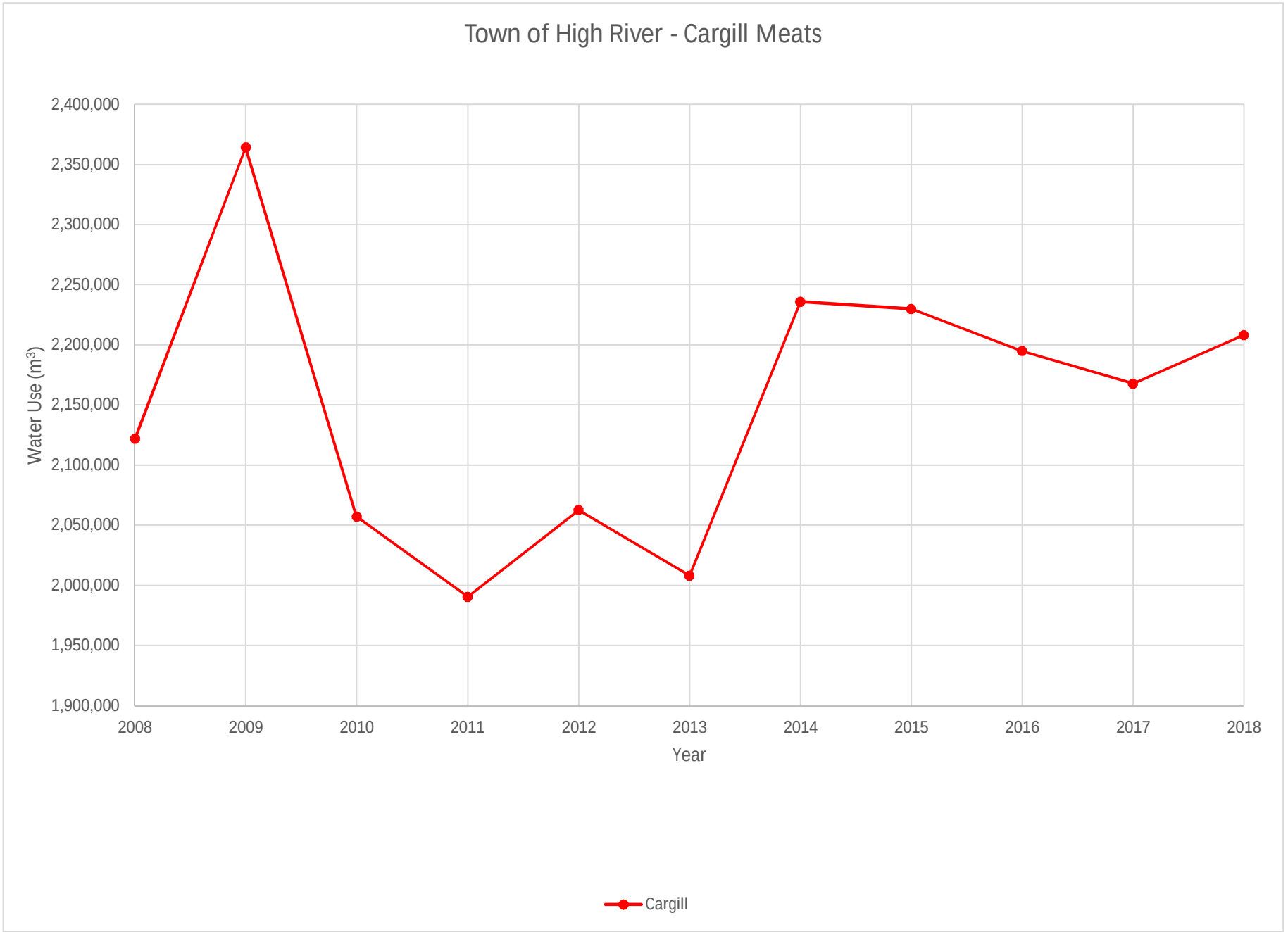

City of Calgary
Per Capita Water Use (L/c/d)
450
400
350
300
250
200
150
100
50
0
2011
2012
2013
2014
2015
2016
2017
2018
Year
Residential
ICI
Municipal
Irrigation
Billed Total
Regional Supply
Produced Total

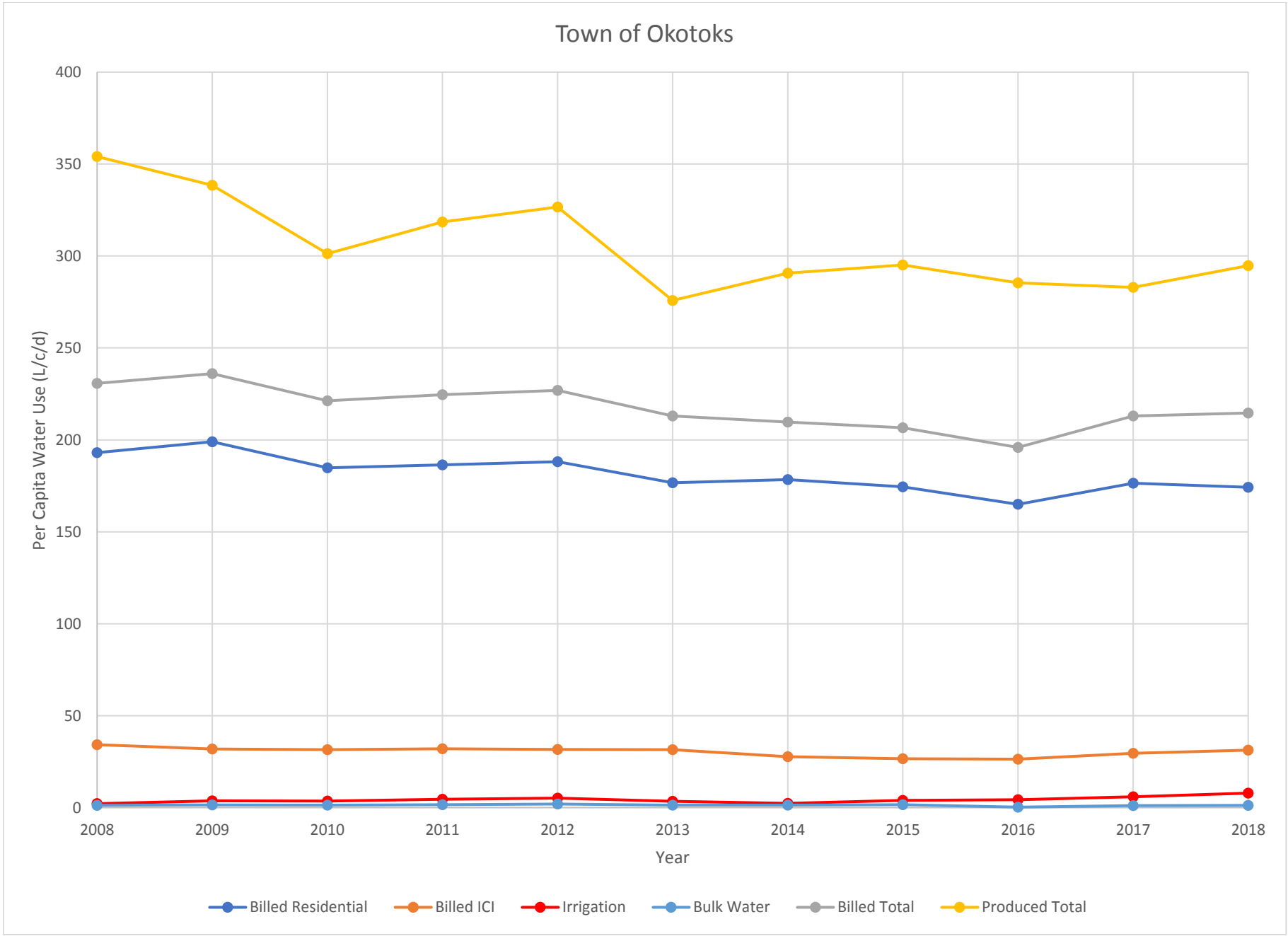

City of Chestermere
300
250
200
150
100
50
0
Per Capita Water Use (L/c/d)
2012
2013
2014
2015
2016
2017
2018
Year
Residential
ICI
Municipal
Billed Total
Purchased Total

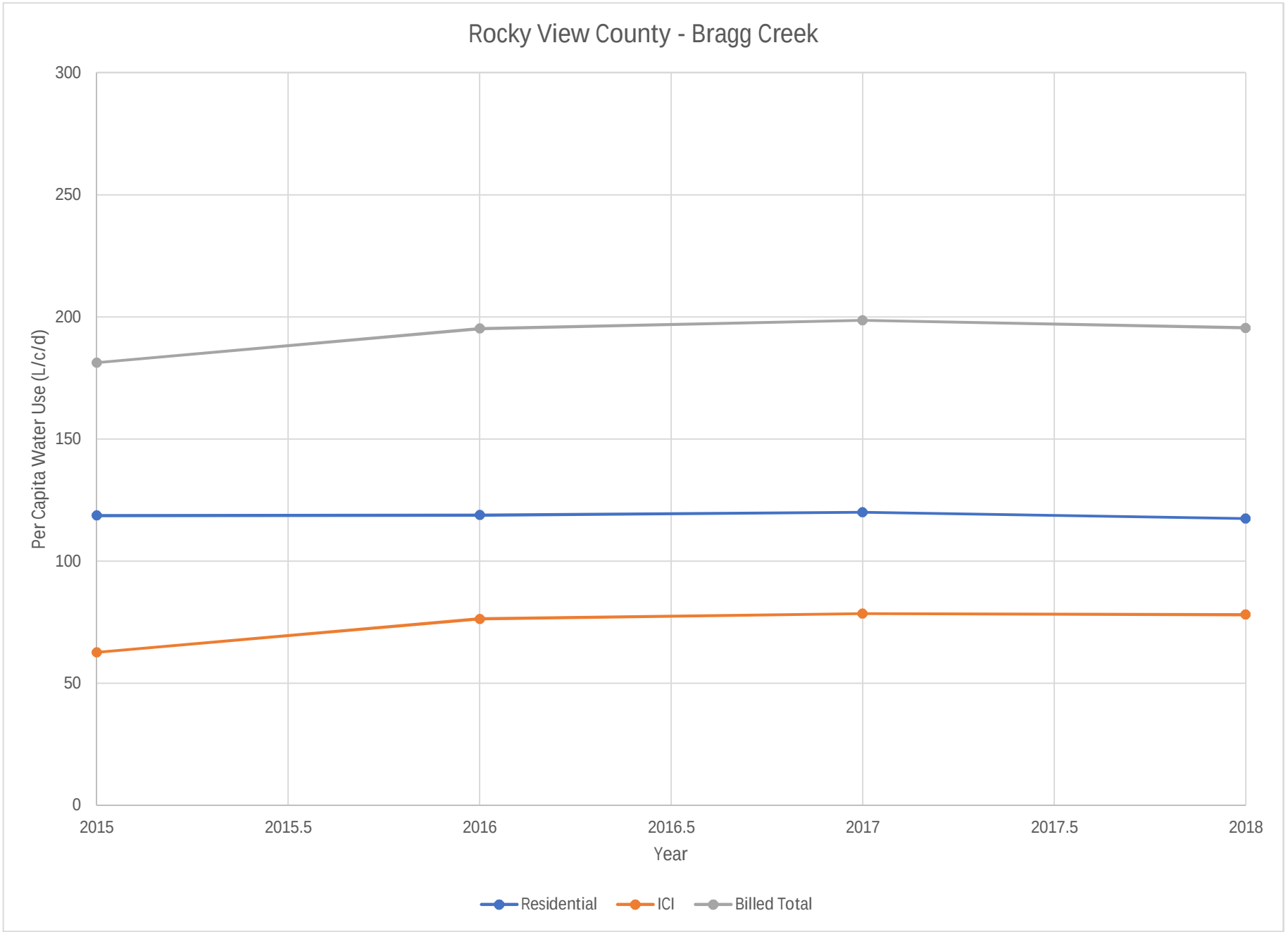

Town of Cochrane
300
250
200
150
100
50
0
Per Capita Water Use (L/c/d)
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Residential
ICI
Irrigation
Bulk Water
Billed Total

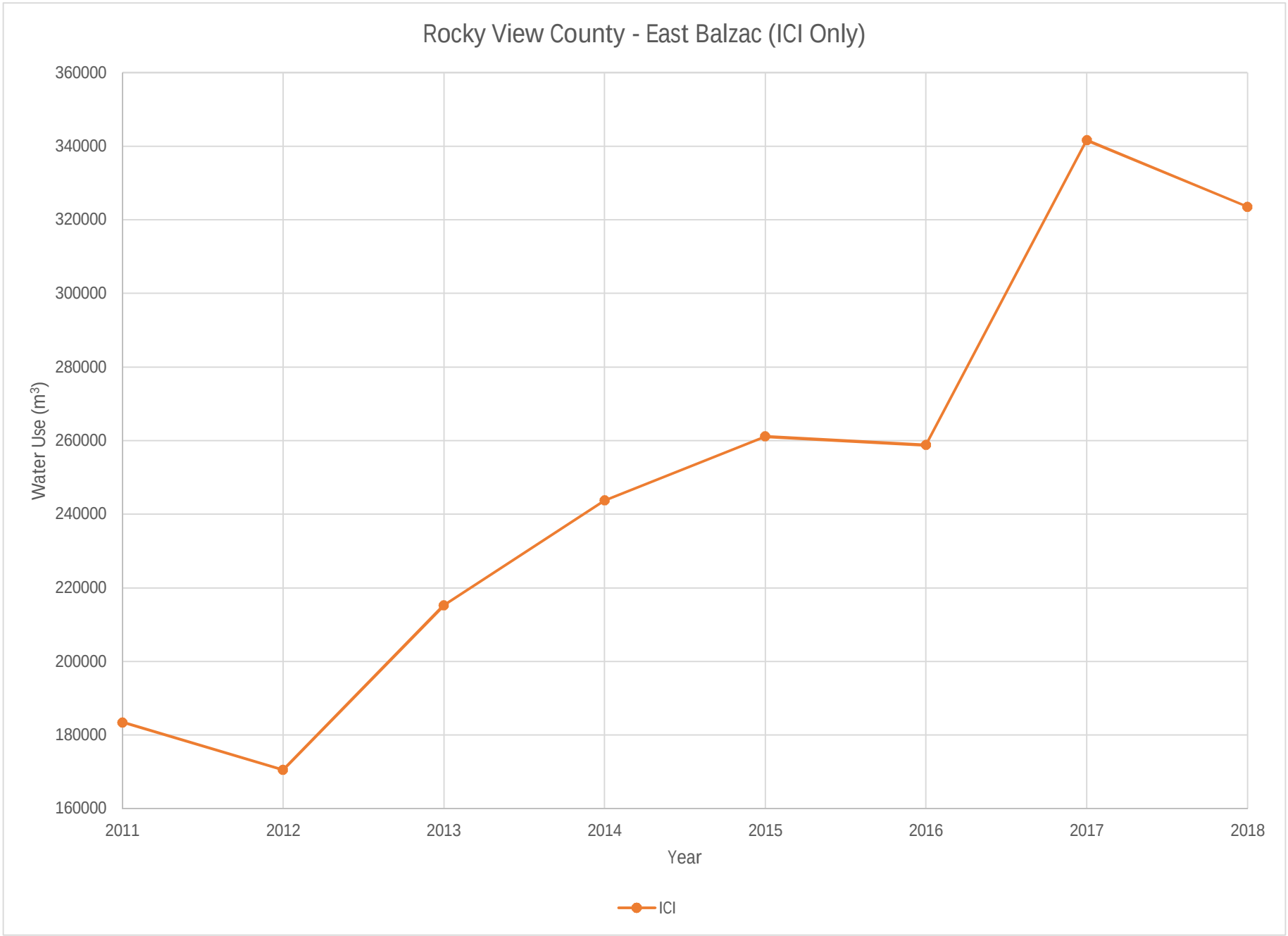

Foothills County
135000
115000
95000
75000
55000
35000
15000
Water Use (m³)
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Residential (5/8" Meter)
ICI (>5/8" Meter)
Billed Total

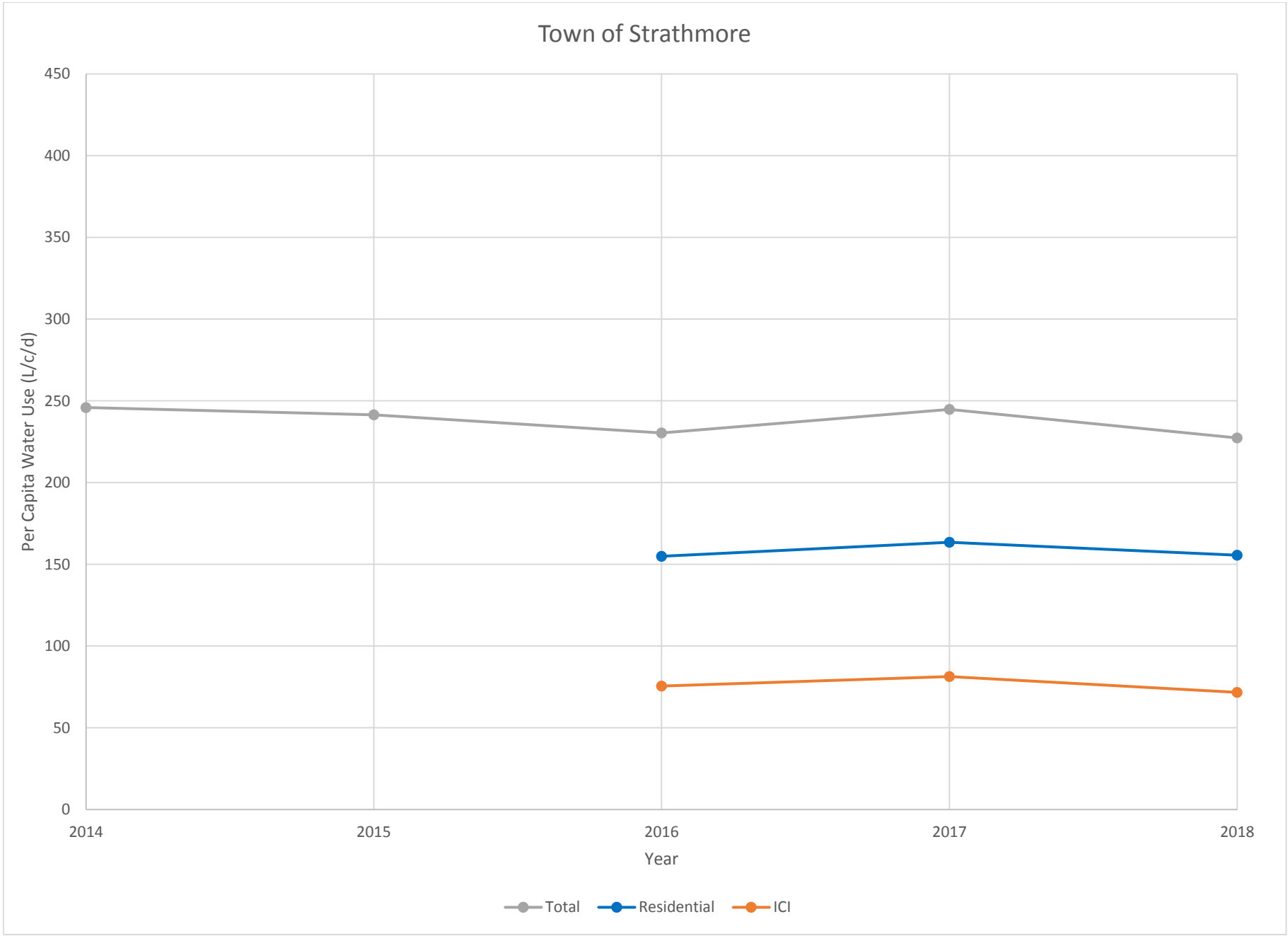

Town of High River
Per Capita Water Use (L/c/d)
800
700
600
500
400
300
200
100
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Residential
ICI
Billed Total (Excluding Foothills County & Cargill)
Produced Total (Excluding Cargill)


Town of High River - Cargill Meats
2,400,000
2,350,000
2,300,000
2,250,000
2,200,000
2,150,000
2,100,000
2,050,000
2,000,000
1,950,000
1,900,000
Water Use (m3)
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Cargill


Town of Okotoks
Per Capita Water Use (L/c/d)
400
350
300
250
200
150
100
50
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Billed Residential
Billed ICI
Irrigation
Bulk Water
Billed Total
Produced Total


Rocky View County - Bragg Creek
300
250
200
150
100
50
0
Per Capita Water Use (L/c/d)
2015
2015.5
2016
2016.5
2017
2017.5
2018
Year
Residential
ICI
Billed Total


Rocky View County - East Balzac (ICI Only)
360000
340000
320000
300000
280000
260000
240000
220000
200000
180000
160000
Water Use (m3)
2011
2012
2013
2014
2015
2016
2017
2018
Year
ICI


Town of Strathmore
Per Capita Water Use (L/c/d)
450
400
350
300
250
200
150
100
50
0
2014
2015
2016
2017
2018
Year
Total
Residential
ICI

APPENDIX E - INVENTORY OF MUNICIPAL CONSERVATION, EFFICIENCY AND PRODUCTIVITY PLANS

Inventory of municipal CEP plans

Municipality	Guiding Document	Water Consumption (Baseline)	Water Loss (Baseline)	Targets	Proposed Actions
City of Brooks	*Water Conservation, Efficiency & Productivity Plan* (2011)	2011 – 648 lcd (total) 2011 – 423 lcd (residential)	N/A	• reduce per capita usage to the Canadian average by 2025; • reduce peak day demand from current level (19,977,651 l/day)	• water audit; • conservation-based pricing; • water-efficient fixtures rebate program; • education and outreach; • voluntary restrictions
City of Calgary	*Water Efficiency Plan: 30 in 30, by 2033* (2007)	2006 – 451 lcd (total)	2006 – 12%	• 100% metering by 2014; • keep daily peak demand below 950 ML; • reduce average daily per capita demand by 30% (from 500 to 350 lcd) by 2033	• system leak detection and main replacement; • treatment process upgrades; • water audits; • metering; • low-flow plumbing fixture bylaw; • rain barrel promotion; • water reuse pilot; • toilet, washing machine, spray valve rebate program; • irrigation audits; • education and outreach
Town of Canmore	*Environmental Sustainability Action Plan* (2010)	2000 – 511 lcd (total) 2000 – 222 lcd (residential) 2008 – 839,527 m^3 (ICI)	2008 – 17%	• by 2015, reduce water losses to 10% or less; • by 2035, reduce annual per-capita water consumption by 50% from 2000 levels; • by 2035, reduce per-capita residential water consumption by 50% from 2000 levels (i.e., to 111 lcd); • by 2035, reduce total annual ICI water consumption by	• expand scope of meter calibration program; • conduct water audit; • continue water fixture retrofit program; • re-assess need for revival of water conservation rebate program; • conduct analysis of water demand of ICI sector to identify opportunities for improving water CEP; • research and promote opportunities for water reuse and recycling

Municipality	Guiding Document	Water Consumption (Baseline)	Water Loss (Baseline)	Targets	Proposed Actions
				30% from 2008 levels	
Town of Cochrane	*Sustainability Plan: Think long-term. Look at the whole. See the connections.* (2009)	2008 – 239 lcd total 2008 – 150 lcd (residential)	N/A	• reduce per capita water use by 15% from 2008 levels by 2029	• universal metering; • 3-tiered water rate structure; • outdoor watering restrictions; • rebate programs (mulch, rescue, rain barrels, toilets, washing machines, climate-controlled irrigation systems); • nature scape requirements; • low flow fixtures building code; • climate-controlled irrigation systems; • water audit
EPCOR/City of Edmonton	*Only Tap Water Delivers: 2010-30 Edmonton Long Term Water Efficiency Report*	2008 – 223 lcd (residential) 2008 – 337 lcd (total)	N/A	N/A	• water efficient fixtures bylaw; • metering; • conservation-oriented pricing; • end-use water audits; • education and outreach; • pressure management; • toilet and washing machine rebate program; • water reuse;
Village of Marwayne	*Water Conservation, Efficiency and Productivity Plan 2012-2022*	2006 – 372 lcd (total)	2006 – 17.3%	• reduce water demand by 20% to 297 lcd by 2020; • reduce unaccounted for water to 10% by 2020	• metering program; • water system audits; • leak detection and repair; • tiered water rates; • education and outreach; • investigate water efficient fixtures rebate program; • Infrastructure renewal plan
Town of Morinville	*Water Conservation, Efficiency and Productivity Plan* (2012)	2011 – 227 lcd (total) 2011 – 149 lcd (residential)	2010 – 9.1%	• Morinville has the lowest per capita water consumption rate of comparable municipalities in	• education and outreach; • water meter replacement program; • outdoor watering restrictions;

Municipality	Guiding Document	Water Consumption (Baseline)	Water Loss (Baseline)	Targets	Proposed Actions
				the Capital region by 2035; • reduce total water use by 5% from current 5 year average of 267 lcd by 2020	• water efficient fixtures bylaw; • toilet rebate program; • sale of rain barrels; • 3 tier water rate structure; • xeriscaping contest; • drought-resistant plants; • recirculate/reuse water from spray park
Town of Okotoks	Water Conservation, Efficiency and Productivity Plan (2014)	2010 – 295 lcd (total) 2010 – 162 lcd (residential)	N/A	• reduce total water demand to 275 lcd by 2017 • achieve a waterworks leak rate of 5% or less	• seasonal outdoor watering restrictions; • automated metering; • education and outreach; • enhanced automated leak detection; • meter update program; • comprehensive asset management plan; • consumption-based pricing; • water-efficient fixtures bylaw; • min topsoil depth bylaw; • reclaimed water demonstration project; • water efficient fixtures and appliance rebate programs; • outdoor water conservation rebate program (rain barrels, irrigation systems, mulch, fescue); • xeriscaping demonstration project; • climate-controlled irrigation system; •
City of Red Deer	*Environmental Master Plan: Our Environment, Our Future* (2011)	2009 – 424 lcd (total) 2009 – 242 lcd (residential) 2009 – 135 lcd (ICI)	N/A	• reduce water use for all categories by 8% from 2009 levels by 2015; • reduce water use for all categories by 15% from 2009 levels by 2020;	• toilet rebate program; • naturescaping contest; • rain barrel sales; • environmental standards for City buildings, including water conservation measures; • water meter

Municipality	Guiding Document	Water Consumption (Baseline)	Water Loss (Baseline)	Targets	Proposed Actions
				• reduce water use for all categories by 25% from 2009 levels by 2035	replacement program; • review of water and wastewater rate structures; • incentives for low flow fixtures and appliances; • rain water capture program; • water audit program for ICI customers
City of Spruce Grove	*Community Water Conservation Program: Blueprint for Success 2012-2015*	2009 – 295 lcd (total)	2009 – 12%	• reduce water demand by 15% to 250 lcd by 2015; • keep peak day demand below 12,700 m^3; • keep non-revenue water below 7%	• universal metering and meter upgrades; • volume-based pricing; • water efficient fixtures bylaw; • encourage revision to the plumbing code for greater flexibility in grey water use; • water audit and leak reduction; • new software to determine most efficient pipe flushing process; • education and outreach; • water conservation program identity; • industrial, commercial and institutional water use analysis; • utility rate study/water pricing reform; • low flow toilet rebate program; • water efficient appliance rebate program
City of St. Albert	*Water Conservation, Efficiency and Productivity Plan (2012)*	2011 – 260 lcd (total) 2011 – 200 lcd (residential)	2009 – 5.0%	• reduce water demand to 200 lcd by 2020 (total); • maintain water loss at 7% or lower	• water efficient fixtures bylaw; • escalating block rates; • industrial, commercial, and institutional programs; • investigate opportunities for rainwater harvesting; • rain barrel program; • low flow toilet rebate program; • education and outreach;

Municipality	Guiding Document	Water Consumption (Baseline)	Water Loss (Baseline)	Targets	Proposed Actions
					• xeriscaping demonstration
Strathcona County	*Water Conservation, Efficiency and Productivity Plan (2012)*	2006 – 238 lcd (residential) 2011 – 192 lcd (residential)	2011 – 7.5%	• reduce per capita residential water usage by 20% from 2006 levels by 2020 (i.e. 200 lcd)	• pressure reduction; • stormwater reuse; • waterwise landscaping; • review water pricing structure; • leak detection program; • rain barrel program; • water-efficient fixtures rebate program; • water-efficient appliances rebate program; • education and outreach; • water efficient fixtures bylaw

APPENDIX F - BEST MANAGEMENT PRACTICES IN CANADIAN MUNICIPALITIES

LEGEND

- Source Water Protection
- Water Effeciency
- Communication and Education
- Collaboration and Resource Coordination

City/Region	Theme			
	1 Source Water Protection	2 Water Efficiency	3 Communication and Education	4 Collaboration and Resource Coordination
Cowichan Valley Regional District	Protecting Water Supply (Surface and Groundwater) https://www.cvrd.bc.ca/2159/Water-Supply	New Normal Cowichan A Multi-phased Project to Take Action on Climate Adaptation https://www.cvrd.bc.ca/2101/Climate-Change	Water Balance Tool https://cvrd.waterbalance-express.ca/	Official Community Plan No. 2500 Outlines, Policies, and Objectives that Should Utilize BMPs https://www.cvrd.bc.ca/DocumentCenter/View/567/Area-G-Bylaw-Section-1?bidId=
		Water Use Restrictions http://cvrdnewnormalcowichan.ca/water-use-restrictions/	DroughtSmart for Home http://cvrdnewnormalcowichan.ca/drought-tools-for-home/	Cowichan Basin Water Management Plan. BMPs for Water Efficiency with Water Infrastructure Improvements https://www.cvrd.bc.ca/DocumentCenter/View/76414/CBWMP-cvrd-actions-Nov-26-2015
Metro Vancouver Area	Stormwater Source Control Design Guidelines 2012 http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/StormwaterSourceControlDesignGuidelines2012StormwaterSourceControlDesignGuidelines2012.pdf	Water Wise Conservation https://vancouver.ca/home-property-development/conserving-and-protecting-water.aspx	Waterwise Lawn Care Guide http://www.metrovancouver.org/services/water/conservation-reservoir-levels/waterwise-lawn-care/Pages/default.aspx	Integrated Stormwater Management Plans Lessons Learned to 2011 L http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/ISMP_Lessons_Learned-April_2012.pdf
	Single Lot Residential Development for On-site Stormwater Management http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Region-wideBaselineOnsiteStormwaterManagement-Feb2017.pdf	Drinking Water Management Plan http://www.metrovancouver.org/services/water/WaterPublications/DWMP-2011.pdf	"We Love Water" Initiative http://welovewater.ca/	Monitoring and Adaptive Management Framework for Stormwater Integrated Liquid Waste and Resource Management http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Monitoring_Adaptive_Management_Framework_for_Stormwater.pdf
	Best Management Practices Guide for Stormwater http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/BMPVol1a.pdf	Drinking Water Conservation Plan http://www.metrovancouver.org/services/water/WaterPublications/DrinkingWaterConservationPlan.pdf		
City of Kelowna		Water Smart Program https://www.kelowna.ca/city-services/water-wastewater/water-conservation		Okanagan Groundwater Monitoring Project https://www.obwb.ca/newsite/wp-content/uploads/2013/09/groundwatermonitoring_compiledreport.pdf
		Landscape Irrigation Guide https://www.kelowna.ca/sites/files/1/docs/city-services/2010-05-03_landscape-irrigation-guide-web_brochure.pdf		
		Landscape Water Efficiency https://www.kelowna.ca/city-services/water-wastewater/water-conservation/outdoor-water-conservation/landscape-water		
Capital Regional District - Vancouver Island	Protection of Leech Water Supply Area https://www.crd.bc.ca/service/drinking-water/watershed-protection/leech-protection	Climate Change Projections - 2017 https://www.crd.bc.ca/docs/default-source/climate-action-pdf/reports/2017-07-17_climateprojectionsforthecapitalregion_final.pdf	Water Conservation Program (Home) https://www.crd.bc.ca/education/water-conservation/at-home/household-water-use	CAP Annual Reports https://www.crd.bc.ca/docs/default-source/crd-document-library/annual-reports/environmental-protection/climate-action-program/2017-climate-action-year-in-review.pdf?sfvrsn=2e2ff1ca_2
	LID Practices https://www.crd.bc.ca/education/water-conservation	Climate Action Program (CAP) https://www.crd.bc.ca/about/what-we-do/sustainability/climate-change-a-priority	Water Conservation Program (Business) https://www.crd.bc.ca/education/water-conservation/at-work/audits-technical-services	
		Regional (CRD) Climate Action https://www.crd.bc.ca/docs/default-source/climate-action-pdf/2015_carip_survey_crd.pdf?sfvrsn=81415aca_8	School Programs & Resources https://www.crd.bc.ca/education/school-programs	
		CRD Corporate Climate Action http://www.rmwb.ca/living/Services-and-Utilities/Water/Water-Conservation-Tips.htm		

City/Region	Theme			
	1 Source Water Protection	2 Water Efficiency	3 Communication and Education	4 Collaboration and Resource Coordination
RMWB		Metering http://www.woodbuffalo.ab.ca/living/Services-and-Utilities/Water/Metering.htm	Conservation Tips http://www.rmwb.ca/living/Services-and-Utilities/Water/Water-Conservation-Tips.htm	
		Meter Upgrades http://www.woodbuffalo.ab.ca/living/Services-and-Utilities/Water/Meter-Upgrades.htm		
City of Toronto	The City's Wet Weather Flow Master Plan https://www.toronto.ca/services-payments/water-environment/managing-rain-melted-snow/the-citys-wet-weather-flow-master-plan/	How to Use Less Water (Online Information) https://www.toronto.ca/services-payments/water-environment/how-to-use-less-water/	Sustainable Neighbourhood Action Program (SNAP) https://trca.ca/conservation/sustainable-neighbourhoods/	Provincial Flood Forecasting and Warning Program https://www.ontario.ca/law-and-safety/flood-forecasting-and-warning-program
	Stormwater Management Programs and Projects https://www.toronto.ca/services-payments/water-environment/managing-rain-melted-snow/what-the-city-is-doing-stormwater-management-projects/other-stormwater-management-projects/	MyWaterToronto Online Tool (To view your water use by day, week, month or year) https://www.toronto.ca/services-payments/water-environment/how-to-use-less-water/mywatertoronto/	TRSPA Water Balance Tool https://trca.ca/conservation/drinking-water-source-protection/trspa-water-balance-tool/	
	Watershed Management https://trca.ca/conservation/watershed-management/	Be Water Smart Videos https://www.youtube.com/playlist?list=PLp11YxteHNp3iCCXMF1Wc2PJjaRVpLuFp	Climate Change https://trca.ca/conservation/climate-change/	
	Source Water Protection: Clean Water Act. https://www.ontario.ca/laws/statute/06c22			
City of Barrie	Lake Simcoe Watershed Protection Plan https://www.barrie.ca/Living/Environment/Documents/Lake%20Simcoe%20Protection%20Plan%20Part%201.pdf	Barrie Climate-Change-Adaptation-Strategy https://www.barrie.ca/Living/Environment/Conservation/Documents/Barrie-Climate-Change-Adaptation-Strategy.pdf	Source Water Protection Training https://www.barrie.ca/Living/Environment/Conservation/Pages/Source-Water-Protection.aspx	Barrie Climate-Change- Implementation Plan https://www.barrie.ca/Living/Environment/Conservation/Documents/Implementation%20Plan%20-%20Climate%20Change%20Adaptation%20Strategy%202018.pdf
	Lake Simcoe Phosphorus Protection Strategy https://www.barrie.ca/Living/Environment/Documents/Lake%20Simcoe%20Phosphorus%20Reduction%20Strategy.pdf	Toilet Rebate Program https://www.barrie.ca/Living/Environment/Conservation/Documents/Toilet-Rebate-Guidelines%202019.pdf		
	Lake Simcoe Protection Act https://www.ontario.ca/laws/regulation/r09219	Disconnect to Protect Rebate Program https://www.barrie.ca/Living/Environment/Wastewater-And-Sewers/Documents/Disconnect-to-protect-brochure.pdf		

APPENDIX G - BEST MANAGEMENT PRACTICES IN UNITED STATES MUNICIPALITIES

CITY OF BOZEMAN, MONTANA

Background

The city of Bozeman, Montana provides drinking water services to approximately 38,000 people. Snowpack melt captured in the Sourdough and Hyalite watersheds reaches the 22 million gallons per day (MGD) Sourdough Water Treatment Plant via local creeks and serves as the city's primary water source. In addition, an infiltration gallery and a 3.5 MGD water treatment plant delivers groundwater from the Lyman Creek Spring.

Challenges

Drought and wildfire are the two primary climate threats to the city of Bozeman, both of which have the potential to increase with a changing climate. The city of Bozeman is concerned that future droughts will impact management and allocation of their local water resources. Droughts also have the potential to impact water quality because of their tendency to increase the occurrence of blue-green algae. Wildfires in the Sourdough and Hyalite watersheds have the potential to negatively impact water quality due to erosion that can increase turbidity, sedimentation and metal concentrations. Direct damage to equipment, specifically the Hyalite Reservoir and its intake, is also a concern related to wildfire.

Planning Process

To better understand the vulnerabilities of its drinking water infrastructure and operations, the city of Bozeman assessed potential climate change impacts using the U.S. Environmental Protection Agency's (EPA) Climate Resilience Evaluation and Awareness Tool (CREAT). The CREAT assessment brought together individuals from EPA and various departments within the city of Bozeman to think critically about potential climate impacts, prioritize assets and consider possible adaptation options.

Resilience Strategies and Priorities

The city of Bozeman considered the potential consequences of drought, water quality changes and wildfires on their drinking water assets and operations. To assess each of these potential threats, the city considered how potential adaptive measures would help lower consequences. The table below summarizes how adaptation options were grouped into two packages: those that provided the highest potential return on investment, and those that are included in their Integrated Water Resource Plan (IWRP).

Type	Resilience Strategies
Highest return on investment	Community outreach related to Sourdough Creek to improve surface water quality
	Fire management activities surrounding Hyalite Creek to reduce the frequency and severity of wildfires
	Lake water management of Lyman Creek Spring to improve groundwater recharge
	Demand management of Hyalite Creek to increase water availability
	Rationing of Hyalite Creek to increase water availability
	Groundwater models including use of a monthly water balance model
IWRP	Demand management of water resources to increase water availability
	Hyalite Lake water resource acquisition to increase water production
	Lyman land acquisition for expansion or relocation of treatment plant
	Utilize alternate water supplies to improve groundwater recharge

Contact Information

For more information regarding the city of Bozeman's resilience planning, contact Jill Miller at jmiller@bozeman.net or Lain Leoniak at lleoniak@bozeman.net.

Office of Water (4608T) EPA 800-Q-15-012 December 2015

JORDAN VALLEY WATER CONSERVANCY DISTRICT (JVWCD)
SALT LAKE COUNTY, UTAH

Background

Created under the Water Conservancy Act in 1951, the Jordan Valley Water Conservancy District (JVWCD) provides drinking water and wholesale water retail services to about 700,000 people primarily located in cities and improvement districts within Salt Lake County, Utah. JVWCD currently delivers approximately 90 percent of its municipal water to cities and water districts on a wholesale basis, with the other 10 percent being delivered to unincorporated regions of the county. JVWCD has a contractual agreement to deliver treated water to Salt Lake City and Sandy City, which are both located beyond JVWCD's service boundaries. The district also delivers untreated water to irrigators in Salt Lake and Utah Counties. Approximately 90 percent of JVWCD's water is sourced from the Provo River System, which includes the Provo River itself, several Uinta Mountain lakes, Deer Creek and Jordanelle reservoirs, and snowmelt from the Wasatch Mountains. The remaining water supply is derived from groundwater sources located primarily in the southeastern portion of the Salt Lake Valley.

Challenges

JVWCD is principally concerned with the impacts of drought conditions and water quality degradation issues on water quality supply and demand. The district is concerned that an increased incidence of drought-like conditions will decrease the quantity of snowpack, leading to water supply and demand issues within its wholesale and retail service areas. Drought is also particularly impactful on JVWCD's water supply because more than half of its water is delivered within a three-month timeframe. Similarly, JVWCD is troubled by the potential impact of harmful algal blooms on its source water reservoirs, which may negatively impact water quality and lead to a strained water supply. Both drought and water quality issues will impact JVWCD's most critical assets, including its water treatment plant and source water reservoirs.

Planning Process

To evaluate the resilience of its drinking water service system to drought conditions and water quality degradation issues, JVWCD used the U.S. Environmental Protection Agency's (EPA's) CREAT. The assessment brought together individuals from JVWCD and EPA staff to think critically about potential vulnerabilities, priority assets, and strategies for strengthening infrastructure and operational resilience within JVWCD's entire service area.

Resilience Strategies and Priorities

Based on its previous experiences with water supply and demand issues, JVWCD has already taken action to improve its overall resilience. These measures have included performing an advanced metering infrastructure (AMI) upgrade, completing an upgrade to its supervisory control and data acquisition (SCADA) system, constructing an additional finished water reservoir at its main water treatment plant, developing a climate change management plan, and implementing two water conservation initiatives to date. Using the results of the CREAT assessment, JVWCD was able to evaluate the performance and costs of several potential drought management and water degradation strategies that, if implemented, could further strengthen the operational resilience of the system.

Type	Resilience Strategies
Current Measures	Implementation of AMI upgrade incorporating customer feedback
	Upgrade to SCADA system
	Construction of Jordan Valley Water Treatment Plant reservoir
	Development of climate change management plan
	Implementation of water conservation initiatives (1997-2010 and 2010-2017)
Potential Adaptive Measures	Adjust water rights timing
	Treat Casto and Dry Creek springs for additional water supply
	Diversify water supply portfolio
	Perform conservation measures to achieve 25% reduction in demand by 2025
	Create drought contingency plan
	Increase utilization of source water rivers
	Incorporate potable reuse
	Increase water conservation goal by up to an additional 5 percent
	Support efforts to maintain Utah Lake as a secondary municipal and industrial water supply
	Develop the Bear River Water Supply Project for surface water resource acquisition

Contact Information

For more information regarding JVWCD's resilience planning, contact Jeff King, Security and Emergency Response Coordinator, at JeffK@jvwcd.org.

Case Study: Water and Wastewater Utilities Planning for Resilience

CITY OF FARIBAULT, MINNESOTA

Background

The City of Faribault provides wastewater services to residential and industrial customers in Faribault, Minnesota, which is located about one hour south of Minneapolis, Minnesota. About 50 to 60% of all wastewater flow is from industrial customers, including a laundry facility and a food packaging plant. The water reclamation facility (WRF) is designed to treat an average flow of approximately 3.5 million gallons per day (MGD) and a peak wet weather flow of 7 MGD.

Challenges

The WRF is located near the confluence of the Straight River and Cannon River and is at risk of flooding. The City previously experienced issues related to overflows and bypass as well as infiltration and inflow (I&I) from heavy precipitation events. The WRF was impacted by previous flooding events due to high river levels. During a flooding event in 2010, the WRF was inundated and taken completely offline for approximately two weeks due to a damaged siphon box through which all flows are conveyed under the Straight River to the WRF. During that time, a temporary above-ground collection system had to be constructed to convey the wastewater from the City to the WRF for treatment. Following that flooding event, WRF assets were relocated away from the river, however flooding concerns still exist if the river re-channels within the floodway. It is expected that floodwaters could still damage infrastructure assets at their new locations.

Planning Process

To better understand the resilience of their wastewater infrastructure and operations to extreme flooding, the City of Faribault assessed potential impacts of environmental change and extreme weather events using the U.S. Environmental Protection Agency's (EPA's) CREAT and enhanced resilience through long-term planning using EPA's *Planning for Sustainability Handbook*. The assessment brought together individuals from the City of Faribault, state agencies and EPA staff to think critically about potential impacts, priority assets, and possible resilience strategies.

Resilience Strategies and Priorities

Based on experience with prior intense precipitation events, the City of Faribault has already taken action to protect their WRF from flooding and improve their overall resilience to extreme weather impacts. Using CREAT results, the City was able to evaluate the performance and costs of two priority actions that, if implemented, will provide additional protection to the facility: constructing a berm and building streambank stabilization. The City will continue to use the CREAT results and the information from EPA's *Planning for Sustainability Handbook* to conduct additional long-term infrastructure and financial planning. See the table below for all potential measures that were considered.

TYPE	RESILIENCE STRATEGIES
Priority Potential Resilience Measures	Permanent berm
	Streambank stabilization
Other Potential Resilience Measures	Watershed partnership
	I&I reduction program
	Accelerate or prioritize reconstruction program
	Opportunistic relocations of components
	Emergency alert system
	Promote in-cycle re-use (industrial customers)
	Adjustable fees during stress periods
	Incentives for limiting use (restaurants)
	Collaborate with watershed planning efforts
	Identify green infrastructure improvements

Contact Information

For more information regarding the City of Faribault's resilience planning, contact Travis Block at tblock@ci.faribault.mn.us.

Office of Water (4608T) EPA 800-R-17-007 August 2017

Case Study: Water and Wastewater Utilities Planning for Resilience

FORT COLLINS UTILITIES, COLORADO

Background

Fort Collins Utilities (FCU) provides drinking water and wastewater services to approximately 131,000 residential customers and various large water users in Fort Collins, Colorado. FCU also sells excess raw water to large agricultural users. Average daily production for the Water Treatment Plant (WTP) is 25 million gallons per day (MGD); over 50 MGD is possible in the summer months. FCU is served by two main surface water sources: the Cache la Poudre River and Horsetooth Reservoir.

Challenges

FCU is concerned with climate change threats that would present water quantity and quality issues for their service area. FCU is especially concerned about water quality issues caused by flooding, particularly flash flooding on burned landscapes following wildfires. Following the 2012 High Park Fire and a subsequent flash flood, FCU made a decision to shut down the Poudre River intake for three months due to uncertainty concerning changes to water quality from high turbidity and sedimentation events. FCU considered how climate change may increase the severity or frequency of these threats, and assessed the impacts of a worst case scenario where both the Poudre River and Horsetooth Reservoir sources would be compromised simultaneously from a water quality event following a wildfire.

Planning Process

FCU engaged in a series of webinars and an in-person meeting to conduct a climate change risk assessment using the U.S. Environmental Protection Agency's (EPA) Climate Resilience Evaluation and Awareness Tool (CREAT). The assessment brought together individuals from Fort Collins and EPA staff to think critically about potential climate impacts, priority assets and possible adaptation options. FCU has conducted previous climate change planning for their utility and with other city organizations, and used the CREAT assessment to build on and complement existing efforts.

Resilience Strategies and Priorities

For this assessment, FCU assessed the consequences from a wildfire threat to the Cache La Poudre River and Horsetooth Reservoir. FCU developed four adaptation plans in CREAT: existing adaptation measures are grouped into a "Current Measures" adaptation plan, while three other adaptation plans--All Potential Wildfire Measures, Source Watershed Protection and Management, and Water Treatment Plant Improvements--contain adaptation measures that would provide additional protection to FCU's assets from climate change threats in the future. Cost data for the potential adaptation plans were drawn from FCU's Master Plan.

FCU has requested funding to implement or further investigate adaptation options that will protect utility assets and operations from climate change-related impacts, including water quantity and quality issues driven by drought, wildfire, and floods. Increasing raw water storage is a priority adaptation option for FCU, as it has dual benefit to reduce consequences from both water quantity and quality issues. See the table below for all potential adaptive measures that were considered.

Type	Resilience Strategies
Source watershed management and protection	Improve the partnership with the Coalition for the Poudre River Watershed to reduce the consequences from water quality threat and prioritize forest management
	Improve early warning system for detecting high turbidity in water
	Partnership with the U.S. Forest Service–Arapaho Roosevelt for improved watershed protection
Water treatment plant improvements	Additional 10 million gallon (MG) finished water storage
	Enhance treatment capabilities to treat the lower quality Poudre River source
All potential wildfire measures	Improve the partnership with the Coalition for the Poudre River Watershed to reduce the consequences from water quality threat and prioritize forest management
	Improve early warning system for detecting high turbidity in water
	Partnership with the U.S. Forest Service – Arapaho Roosevelt for improved watershed protection
	Additional 10 MG finished water storage
	Enhance treatment capabilities to treat the lower quality Poudre River source
	Additional 8,100 acre-feet raw water storage

Contact Information

For more information regarding Fort Collins Utilities' resilience planning, contact Donnie Dustin at ddustin@fcgov.com.

Office of Water (4608T) EPA 800-S-16-005 January 2017

APPENDIX H - CONSERVATION-ORIENTED WATER PRICING

How to use price as a tool to improve water service provider financial performance and community water use efficiency

Worth Every Penny:

A Primer on Conservation-Oriented Water Pricing

Oliver M. Brandes, Steven Renzetti and Kirk Stinchcombe

University of Victoria

MAY 2010

POLIS Project on Ecological Governance
University of Victoria

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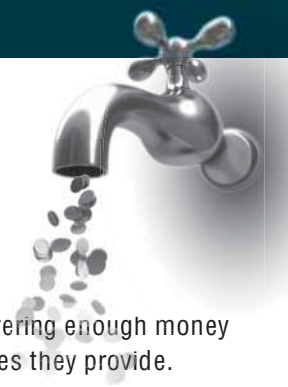
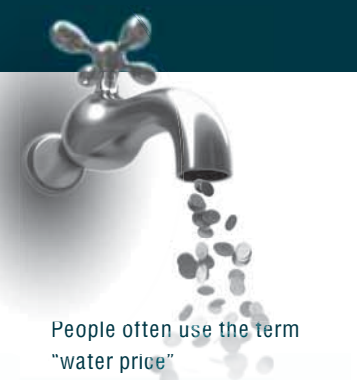
KEY MESSAGES



- **Conservation-oriented pricing** makes solid sense from both financial and environmental perspectives.
  - On average, Canadian utilities are currently not recovering enough money from their customers to cover the costs of the services they provide.
  - At the same time, Canadians are among the biggest users of water on the planet, which could result in significant regionalized environmental impacts.
- **Potential negative consequences** of conservation-oriented pricing on communities can be mitigated. For example, mechanisms to stabilize revenue can be implemented, and volume-based pricing does not have to mean harmful impacts on low income families.
- **One of the greatest benefits** of conservation-oriented pricing is that it allows individuals much greater control over their water costs. Depending on how it is implemented, those who choose to conserve may actually see a decline in the amount that they pay.
- **It's a question of fairness.** Why should prolific water users pay the same amount as those who do their best to conserve?
- **Remember that the objective of conservation-oriented pricing** is to cover the full costs of providing water services and no more. Someone ultimately has to pay these costs. It just makes sense to do so directly through the water bill.
- **Revenue generated** by conservation-oriented pricing can be reinvested in the water supply system to repair aging infrastructure, develop and enhance conservation programs and protect water sources. Ultimately, this is an investment in the future of communities.
- **Improved pricing** provides a strong incentive to innovate.
- **Many other places** are successfully doing it.

A 10-STEP PLAN FOR DEVELOPING A CONSERVATION-ORIENTED PRICING SYSTEM:

1. Have a plan.
2. Get buy in and authority from senior management and elected officials.
3. Get metered and start charging by volume.
4. Get the water bill right.
5. Improve accounting of water use in the community.
6. Account for expenditure and understand costs.
7. Consider starting with a seasonal surcharge.
8. Make it a part of a complete program.
9. Recruit the aid of senior government.
10. Take the long-term view.



People often use the term "water price" interchangeably to mean different things. The range of meanings includes selling and pricing water itself (the substance, for example in bottles or other containers) and selling and pricing water rights (the legal right to use, divert, or control water). In this document, when we refer to water price, we mean selling and pricing treated water services—the price associated with the provision of physical infrastructure and services required to treat and deliver water to homes, businesses and institutions.

We certainly recognize that water is much more than just a commodity and that it has significant ecological, spiritual and other values. We also recognize that pricing is but one of many possible tools that can be used to achieve greater water use efficiency, conservation and stewardship. For us, pricing is most certainly not an end in itself but rather an instrument that can help society achieve its goal of water sustainability.

ABOUT THE PRIMER

This primer provides an overview of conservation–oriented water pricing. It explains how it works, what the benefits are, and how water utilities can implement and transition to this system over time. The primer also offers advice on how to address some implementation challenges, including how to avoid negative effects on low-income families and how to maintain revenue stability for water utilities.

Engaging in the process of water pricing reform is a difficult and complex task. It requires not only sophisticated economic knowledge but also the involvement of a range of key players beyond just water managers, including municipal or regional senior staff and financial officers, local politicians and senior government. To successfully move pricing towards a conservation-oriented pricing system requires all of these decision makers to be engaged and supportive.

This primer focuses on promoting conservation-oriented water pricing as a key tool in the water manager's toolkit. It is written specifically to assist those seeking to lead change, particularly those who may not have an extensive background in finance or economics. More technical concepts—such as *marginal cost* and *price elasticity*—are explained in "tech boxes" throughout the document. To demonstrate what is possible and happening on the ground today, a number of case studies from around North America are also provided.

Although the principal focus of the primer relates to the use of water service pricing as a tool to promote water use efficiency and conservation in households, much of the discussion has general applicability to the commercial and institutional sectors as well. Agricultural and industrial water pricing, in contrast, have many different issues and considerations. They require separate attention and are beyond the purview of this primer.

Our hope is that this primer will assist in entrenching a community-wide commitment to water conservation, financial stability and innovation. We believe that a successful, comprehensive water conservation program starts by understanding how to use price as a signal to both manage water demand and sustain water infrastructure for the future. The best water conservation programs will use a variety of techniques and approaches, of which pricing is only one component. Additional resources and some tools to start down the path and help develop a comprehensive, integrated and long-term approach to sustainable water management are listed at the end of the document.

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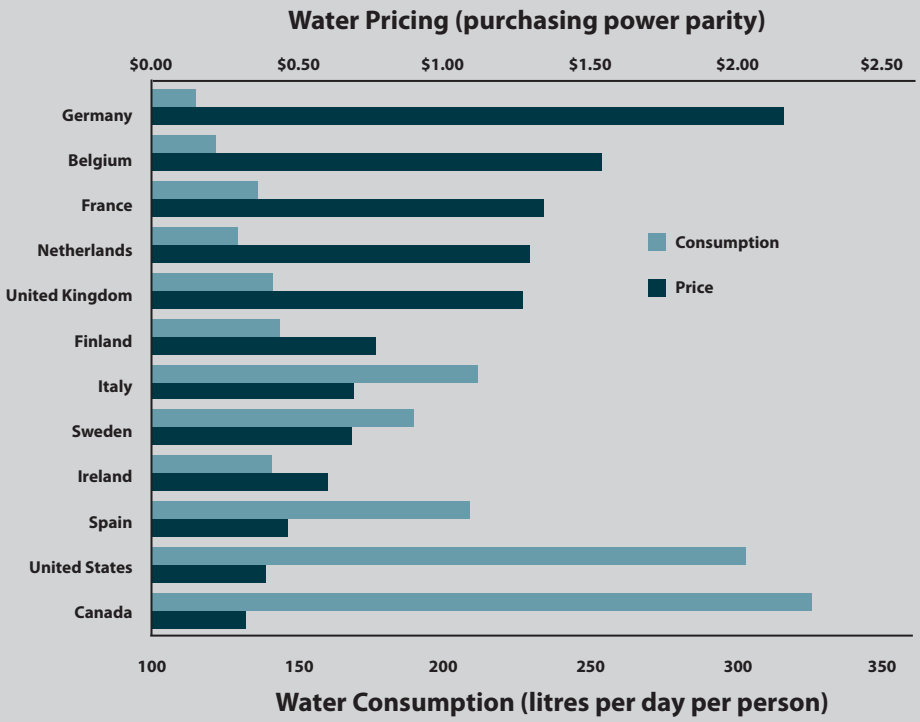
INTERNATIONAL COMPARISON OF MUNICIPAL WATER PRICES AND CONSUMPTION



Source: Council of Canadian Academies. (2009). *The Sustainable Management of Groundwater in Canada: Report of the Expert Panel on Groundwater.* Ottawa, ON. p 115.

SECTION I:

PRICING WATER SERVICES - SUSTAINING INFRASTRUCTURE

Inevitably, society has to pay for the infrastructure and services that store, treat and distribute water to our homes and businesses.[1] *Yet, Canadians typically pay only a portion of these costs through regular water bills. The remaining costs must be postponed, leading to deteriorating infrastructure. Alternatively, they must be subsidized from other sources, including infrastructure grants from provincial and federal governments or municipal government general revenue (usually generated from property taxes). This keeps the retail price of water artificially low.*

In addition to water being relatively cheap, Canada's water consumption is high compared to other countries. In fact, Canadians are among the biggest water users in the world.[2] Figure 1 compares municipal water service prices and consumption among various Western European and North American countries—and Canada comes out firmly last in both respects. The message is clear: *Canadians pay relatively little for their water, and their consumption is comparably high.*

When it comes to water conservation planning, pricing reform is a bit like the proverbial "elephant in the room" in the boardrooms and council chambers of

1. Expansion of infrastructure in almost all municipalities is paid for by development charges levied on the developer and paid for by the home owner as part of the price of the new home. However, future maintenance of this infrastructure is usually intended to be paid for through water bills.
2. It is important to note the challenges associated with international comparisons due to different data gathering approaches and varying levels of comparability and changes across data sets both between countries (and even between provinces in Canada) and across time. Nonetheless, we use this comparison to illustrate a point: even taking potential data deficiencies into account, Canadians use a significant amount of water compared to other places, with pricing being one of the elements that accounts for this difference.

Conservation-Oriented Water Pricing is a rate structure adopted by a water service provider where the costs of providing services are recovered, individual customers are metered and pay for the volume of water they use, and the price signal is sufficient to affect individual decisions and encourage conservation and efficiency.

Canadian water service providers and municipalities.[3] Too often the potential to use price as a signal to curtail water over-use and a way to improve long-term financial performance is simply overlooked.

CONSERVATION-ORIENTED PRICING: CHANGING CHOICES THROUGH THE WATER BILL

Fundamentally, the price charged for water services should:

1. provide enough revenue to water utilities and suppliers to cover the full costs of providing the service, including maintaining and replacing infrastructure;
2. signal the actual cost of supplying water and provide a financial incentive for customers to use it more efficiently;
3. promote innovation by encouraging inventors, engineers and scientists to develop water-saving devices, practices and technologies.

The basic concept of conservation-oriented pricing is that we should set community water rates sufficiently high to reflect the full costs of providing services, and to affect individuals' choices about how they use water. This includes behavioural choices about the quantity they consume and their purchase selections when they buy water-using technologies and services. The majority of people and organizations will change their behaviour because they recognize that conserving will lead to financial savings. In short, by setting a more appropriate price, people will change the value they place on water and modify their actions accordingly.

The water service provider is interested in achieving these greater efficiencies because it will mean better use of scarce operational capital, deferred future expansion costs and reduced environmental impacts.

A number of preconditions must exist to implement such a progressive pricing system:

1. individually metered water connections;
2. volumetric charging (where users are charged for the amount of water they use); and
3. a water rate that is sufficiently high to affect a user's decision making.

3. In this document we use the term "water service provider" generically to refer to all types of organizations, regardless of their institutional form: legislated water utilities, municipal water departments, corporatized public entities, public works divisions, etc.

TECH BOX 1: WATER, WASTEWATER, OR BOTH?

We might be tempted to think that volumetric charging applies only to water coming out of the tap. But when both water and wastewater services are being provided, volumetric charging can also be used to price wastewater. This can be done even when the sewer is not metered (as is almost always the case). Typically, this involves setting a volume-based wastewater charge based on a *discharge factor*—essentially an assumption about how much of the water that comes into a home or business is subsequently discharged to the sewer (i.e., the percent of water that goes down toilets and drains as opposed to water that goes onto lawns or cars or into swimming pools).

Provided that pricing information is clearly communicated, having a volume-based wastewater charge can magnify the effect of conservation-based pricing, simply because customers will realize that they will save on both their water and wastewater bills if they use less. That is, they will realize that the combined price that they pay for their water and wastewater services increases as they consume more.

Halifax Water in Nova Scotia, explored in Case Study 1, is an example of a water service provider that has had success with moving to volumetric wastewater charges, and is all the more interesting because they also include costs of stormwater infrastructure in their bill.

IS CONSERVATION-ORIENTED PRICING THE ELEPHANT IN THE BOARDROOM?

Case Study 1:

HALIFAX WATER, NOVA SCOTIA

Halifax Water provides utility services to more than 79,000 metered connections and a population of approximately 350,000 in the Halifax Regional Municipality. Halifax Water is an autonomous and self-financed utility. It also has a history of demonstrating Canadian leadership in other areas related to water demand management, most notably in pressure and leakage management.[i]

In 2007, utility services were merged, making Halifax Water the first regulated water, wastewater and stormwater utility in Canada. This created a unique opportunity to provide integrated, cost-effective and environmentally sound services across the full urban water cycle.

Halifax Water's billing structure consists of a fixed charge and three separate variable components, all of which are based on the customer's water consumption volume:

- a water consumption charge that reflects the cost of pumping and treating water and maintaining the distribution system;
- a wastewater and stormwater management charge that reflects the cost of operating both the stormwater and sanitary sewer systems; and
- an "environmental protection charge" that reflects infrastructure, operating and capital upgrade costs associated with the wastewater collection and treatment system.

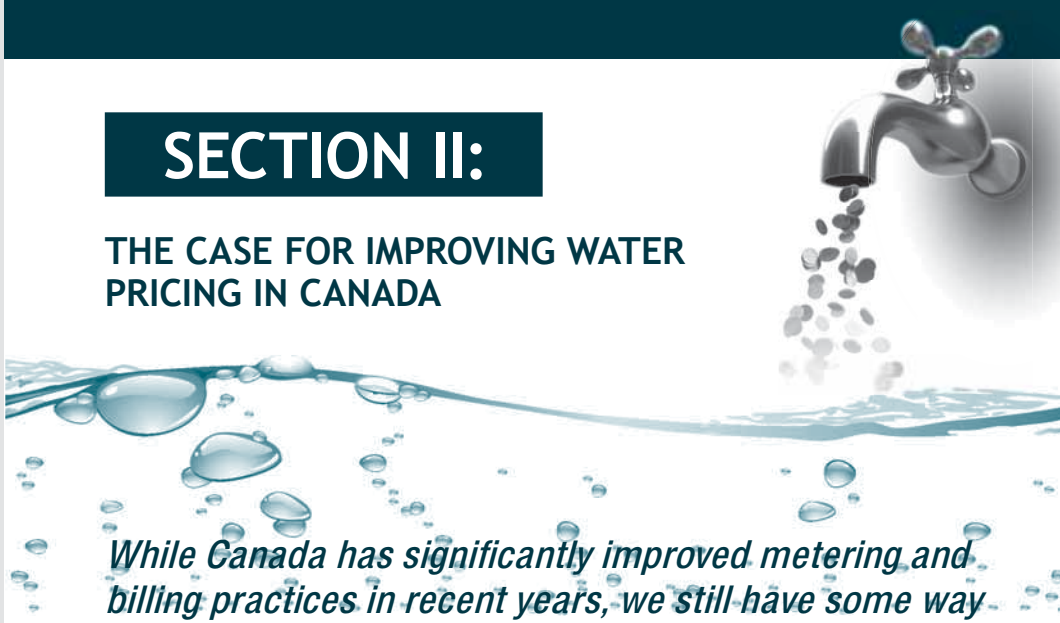
While the total cost for a typical residential water bill is not particularly high in Halifax, even by Canadian standards, the organization's approach is still interesting for a couple of reasons. First, Halifax Water is tasked with integrated management of all aspects of the urban water cycle, including stormwater, and is working towards full cost accounting and recovery across all components. Second, by having separate volumetric billing components for water, wastewater and stormwater, they provide direct information to customers about the costs of managing each of these sub-systems, and thereby indirectly inform customers about the environmental linkages between them.

Halifax Water has committed to continuously improving their approach to cost recovery as part of their integrated urban water management mandate.

For more information, see www.halifax.ca/hrwc/RatesAndFees.html

SECTION II:

THE CASE FOR IMPROVING WATER PRICING IN CANADA



While Canada has significantly improved metering and billing practices in recent years, we still have some way to go to meet the basic requirements of a conservation-oriented pricing system.

1. Metering

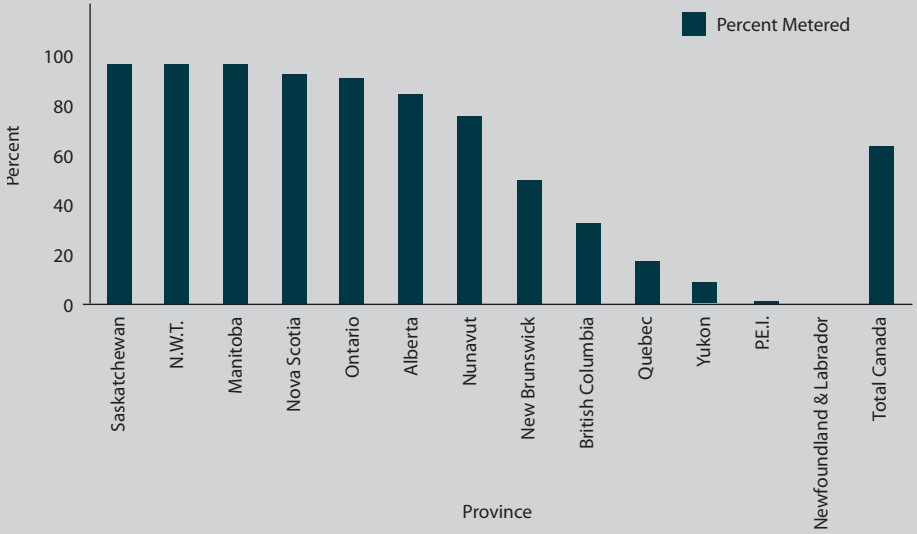
As of 2006 (the most recent year for which data are available), only 63.1% of customers living in single-family dwellings in Canada were metered.[ii] In other words, over one-third of Canadian homes still do not have a water meter. This is puzzling when you consider that universal metering is commonplace and expected in other utility sectors, such as electricity or natural gas. In these sectors, we would be very surprised indeed if usage were not metered.

The extent of metering is also highly variable from province to province (see Figure 2). In British Columbia, only 32.6% of residential customers are metered. In Quebec, only 16.5% of residential customers are metered. In Newfoundland, only a fraction of one percent of residential customers have a meter.[iii]

Some municipalities continue to resist meter installation, typically citing costs to homeowners or the belief that demand management goals can be met by other means, such as education. But based on the adage that "what gets measured gets managed," it is difficult to expect that Canadians will seriously embrace urban water sustainability objectives without adopting metering as a basic planning tool. As demonstrated by leading practices from around the world, metering is a foundational element of any comprehensive pricing program, not to mention crucial to any efforts to seriously address unaccounted for water, including system leakage.

Figure 2:

PERCENT OF CANADIAN SINGLE DWELLING RESIDENTIAL CUSTOMERS THAT ARE METERED



Responding Population = 27 927 531; based on single-family residential dwellings[4]
Source: Based on data from Environment Canada. (2009). *Municipal Water and Wastewater Survey: Municipal Water Use 2006 Summary Tables*. Ottawa, ON.

Two-thirds of Organisation for Economic Co-operation and Development (OECD) member countries already meter more than 90% of single-family houses.[iv] Without meeting this basic requirement, it is impossible to charge based on the volume consumed and is difficult to manage community consumption.

2. Volumetric Charging

About one-quarter of customers living in single-family dwellings in Canada still receive a flat rate water bill. This means that they are charged a pre-set monthly fee that provides for a virtually unlimited amount of water. Like an all-you-can-eat buffet, flat rate billing is a problem because it creates an incentive to over-consume (see Tech Box 2). Almost a quarter (23.4%) of Canadian homes were still on this kind of system as of 2004.[v] The good news is that the numbers for businesses are much better, and the number of residential customers on flat rates has also been steadily declining in recent decades. But we do still have some way to go.[5]

The remaining three-quarters of Canadians do face volumetric-based charging, so are billed for the volume of water they use. However, even when the structure is right, the per unit rate they pay may not be high enough to significantly affect their behaviour.

3. Sufficiently High Water Rates

What exactly defines a "sufficiently high" price for water? The question is certainly open to debate and often depends on context.

One way to assess whether Canadian water rates are "high enough" is to compare both our prices and our water consumption to other developed countries. As shown in Figure 1, above, Canada's municipal water service prices are the lowest among a number of similar European and North American countries, and our per capita use is among the highest.

Similar but more recent data come from a 2010 study by the OECD. This compared average per unit prices for water and wastewater services, including taxes, for households across 20 OECD and non-OECD countries (see Figure 3). Again, Canada's prices were the lowest of the responding countries, which included places such as South Korea, Poland and Hungary. Countries such as

TECH BOX 2: THE NUMBERS SAY IT ALL...

The evidence is striking that volumetric pricing is far more effective than flat rate pricing in reducing water consumption. The typical Canadian household on a flat rate system uses an average of 467 litres per person per day (L/p/day). The average for a household on a volumetric charging system is only 266 L/p/day or 43% lower, a sizeable difference by any standard.[vi]

A number of factors may explain this gap, including differences in housing stock, average family size and income, the accuracy of water use accounting practices and better system leak detection in metered areas. In some cases, past water-related challenges have driven utilities to use more effective pricing systems. However, these explanations account for only some of the discrepancy. There is no avoiding the fact that when a municipality introduces variable pricing, people respond by reducing their water use. In most cases, consumption drops over the next few years.

4. Because these data are based on stand-alone houses, these rates likely overstate meter coverage in Canada. Many people live in apartment buildings that have a single master meter rather than individual unit meters. These types of customers are not captured in the statistics.
5. Note: updated (2006) data on the rate of metering were available at the time of writing, but only 2004 data were available on water pricing. Also, the number of residential customers facing non-volumetric charging is higher (29.9%) if you include customers who are not billed separately for water but instead pay for water services through their local taxes based on property condition or some other assessment.

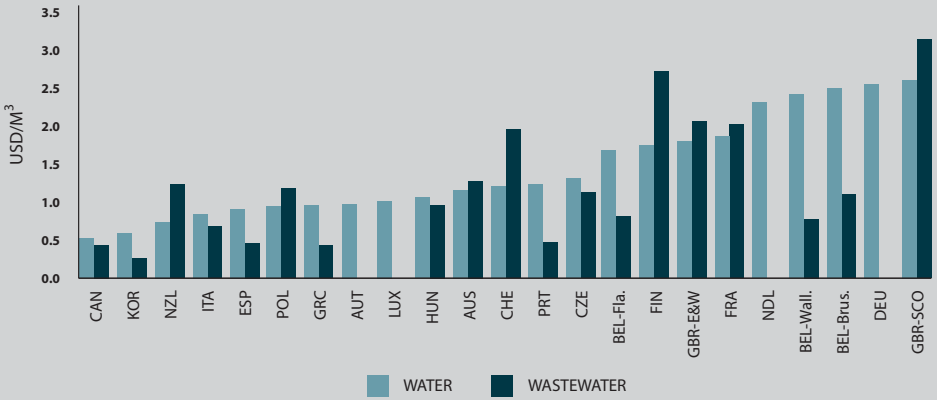
Australia, New Zealand, Great Britain and others in Western Europe all seem to charge much more for water, yet they enjoy a very comparable quality of life.[vii]

It is a bit perplexing that Canada is such a cheap supplier of water, but some likely explanations exist. Part of it is rooted in an historic "frontier" belief that we enjoy an endless supply. This "myth of abundance"—the popular misconception among many Canadians that we have an unlimited availability of fresh water—leads to a deep-seated overconfidence that we can afford to waste. This kind of thinking creates substantial political barriers to pricing reform.

In reality, our situation is really not so different from many other places. The technology we use to capture, treat and distribute water is similar to that used in other countries. The proximity of water supplies to major settlements is comparable to, for example, much of northern Europe. And finally, potable water supplies in the southern part of Canada are not really much more abundant than in many other parts of the world.[viii] Indeed, if anything, our low population densities and variable climate should mean *higher* average prices for water services than many developed countries.[ix]

Figure 3:

COMPARISON OF UNIT PRICES OF WATER SERVICES AND WASTEWATER SERVICES TO HOUSEHOLDS, INCLUDING TAXES (USD/M³)



Source: Organisation for Economic Co-operation and Development (OECD). (2010). Pricing Water Resources and Water and Sanitation Services. OECD Environment Directorate, ENV/EPOC/GSP(2009)17/FINAL, 18 January 2010.

WHY WATER UNDER-PRICING AND OVER-CONSUMPTION ARE PROBLEMS

If over-consumption and under-pricing are linked, why should we care? The answer is that there are a number of sound financial, social and environmental reasons to change water pricing models, including:

- water service providers experience higher operating costs due to the need to pump and treat water that is not always used efficiently;
- excess water treatment, pumping and heating requires significant energy inputs, which in turn can mean unnecessary greenhouse gas emissions;
- sewer flows are higher than need be, which results in unnecessary treatment and disposal costs and environmental impacts on receiving water quality and fish populations;
- because water demand is generally higher than it needs to be, new bulk supplies such as dams or new groundwater wells may need to be constructed sooner or larger than necessary, resulting in higher than necessary capital and overhead costs as well as environmental impacts;
- *peaking factors*—the point at which water use is greatest during the year (usually on hot summer days)—are very high because people have little incentive to moderate their consumption. This means that pipes, pumps, treatment plants and reservoirs must be constructed and oversized to meet excess demand on these very few days of the year, which inflates the price tag of our infrastructure;
- in order to curb demand, water utilities often have to rely on less effective and relatively more costly tools, such as outdoor watering restrictions or product rebates;

WHAT DO WE ACTUALLY SPEND?

As part of its 2010 study, the OECD assessed the share of net disposable income that households in different countries spend on water and wastewater services. For Canada, the figure is 0.3%, among the lowest of the 20 responding countries in the study (tied with Japan and Italy and ahead of South Korea).

Similarly, according to Environment Canada, the median expenditure per household for water services in 2004 was $37.93 per month for 25 cubic metres and $50.46 per month for 35 cubic metres. Compare this to the 2005 median expenditure per household per month for basic utility costs of water, fuel and electricity for principal accommodation, which was $192.30—representing 3.2% of total household expenditures. In other words, water bills account for about 20–26% of our already low basic utility costs.[x]

- equity and fairness: those who waste water and place excess demand on the system pay about the same as those who conserve; and
- under-pricing stifles innovation: consumers have little financial incentive to invest their scarce dollars in water efficient goods and services because it takes so long to recover their investment. As a result, scientists, inventors, engineers and investors also have little incentive to improve water using technologies.

Probably the biggest, and most surprising, implication of water under-pricing is that the amount of revenue we currently collect from water bills is often insufficient to cover the expenditure required to provide the service. In fact, the aggregate ratio of what Canadian water agencies brought in (revenue) compared to what they spent (expenditure) in 2007 was only 70%, and is actually falling (see Figure 4). In other words, water users are not even coming close to covering the full costs of the water services they enjoy—and it is getting worse.[6]

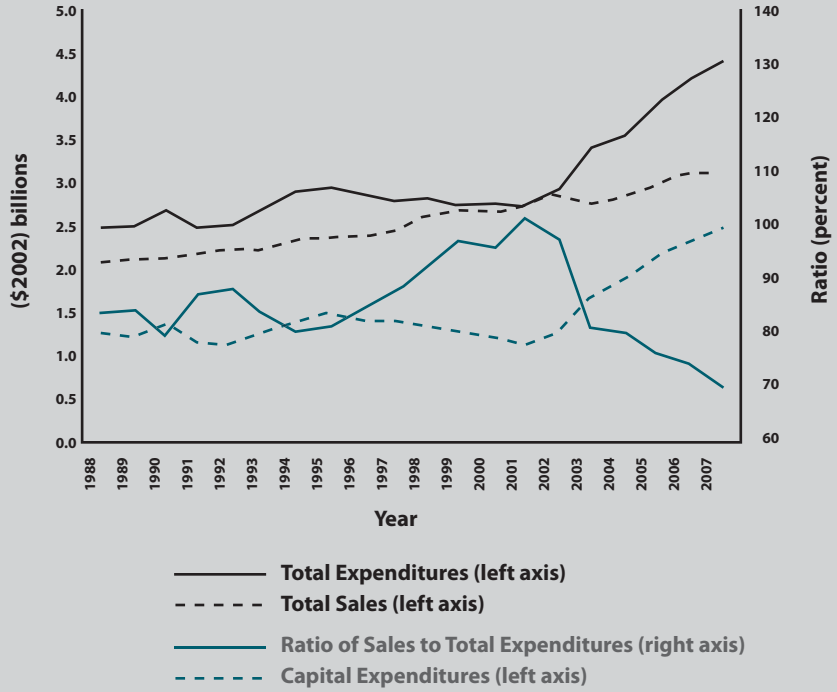
This situation means that there are generally not enough funds available to cover the costs of maintaining and replacing infrastructure, to implement necessary system upgrades, or to replenish the organization's reserve funds. As a result, senior levels of government are periodically called upon to inject large amounts of subsidy funding into infrastructure renewal—often leading to further overbuilt systems and future waste.[7] Alternatively, costs may be subsidized at the local level through property taxes, reserves, or other sources. In short, our water systems are neither self-funded nor financially sustainable—hence, the mounting water infrastructure deficits across Canada.

So why are we so far off the mark? The question is open to speculation, but experts have identified a number of core reasons. The pricing system in a typical Canadian municipality results from a complex mix of local politics, equity considerations, economic development motivations, industry past practices and sheer accident.[xi] The Canadian "myth of water abundance" discussed above is also part of the explanation. The public also generally

6. A positive feature of Figure 4 is that we are finally increasing the amount we spend on water system infrastructure ("Capital Expenditures"). However, much of this spending comes from unpredictable infusions from senior government programs. Reforming water prices would provide water agencies with predictable sources of funding to support infrastructure repairs. It could also have the added benefit of reducing future infrastructure needs by promoting water use efficiency and innovation.
7. The recent round of federal "stimulus" spending on infrastructure to combat the recession provides an excellent case in point. An alternative is to apply such senior government transfers to foundational water management elements, such as metering projects or efficiency and conservation programs.

Figure 4:

REVENUES AND EXPENDITURES OF CANADIAN MUNICIPAL WATER AGENCIES: 1988 TO 2007



Source: Renzetti, S. (2009). *Wave of the Future: The Case for Smarter Water Policy.* C.D. Howe Institute. Commentary No. 281, February 2009, p. 2.

has a poor understanding of the water challenges that lie ahead and so are not motivated to change practices or habits. Finally, history and entrenched expectations are against us as water has been supplied to households at very low prices for a very long time. This inertia presents a stubborn challenge for politicians, water managers and communities alike. Fortunately, solutions for moving to a more financially and environmentally sound pricing system exist.

TECH BOX 3:
THE PRICE ELASTICITY OF DEMAND FOR WATER

In basic economic theory, the key principle to explain why conservation-oriented pricing works is *price elasticity of demand*. In simple terms, people respond differently to changes in price for different goods and services. Some goods and services are very inelastic, meaning that people's consumption does not change much when the price goes up, so the seller's revenue will likely increase. Inelastic goods are typically ones that have few substitutes or where having them is a necessity. For example, the price of insulin is very inelastic for people who need to use it every day.

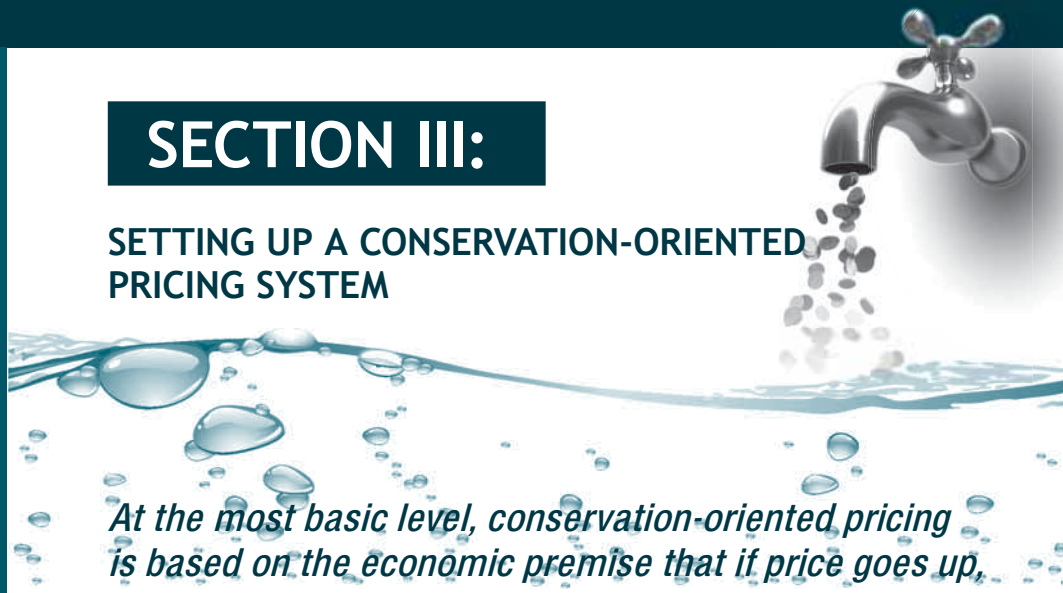
As it turns out, water is indeed generally an inelastic good, but less so than you might think.[8] This is not surprising considering that many uses are not really "essential" (like car washing or lawn watering). Economists have conducted many studies into this issue over the last 30 years. Many home technologies and simple behaviour changes can reduce consumption without significant difficulty or cost. Furthermore, the available evidence suggests that the higher prices get, the higher water's price elasticity becomes. Thus, as water service prices rise, we can expect households to increasingly (by proportion) reduce their demand for water. An important but subtle point is that household demand for water responds more to higher prices in the long run than in the short run. Changing consumer behaviour and retrofitting appliances takes time. So, it might take a while for a conservation-oriented rate structure to impact demand. Not surprisingly, studies also show that outdoor water use is much more sensitive (elastic) to price changes than indoor water use. Finally, the research indicates that industrial and commercial firms also respond to changes in price in much the same way that households do—by changing practices and replacing technologies.

It should be noted that studies often find widely different price elasticities depending on the context. Factors such as location, season, and the presence of other demand management programs all affect the responsiveness of price to demand.[xii] This can have a major impact on the results of any price modifications, so analysis of the predicted price elasticity in your area should be undertaken and carefully considered. Any effort to increase price requires anticipation of households' (and other water users') responses to the proposed rate changes in order to accurately predict the impacts on the water supply system and revenues.

8. Espey et al. (1997) reviewed 162 estimates of the price elasticity of water that were made between 1963 and 1993. They found an average price elasticity of -0.51. This is a measure of the expected change in demand when price increases by 1. Similarly, Dalhuisen et al. (2003) analyzed 300 studies conducted over the past 20 years and found an average price elasticity of -0.41.
Sources: Espey, M., J. Espey and W.D. Shaw. (1997). Price Elasticity of Residential Demand for Water: A Meta-analysis. *Water Resource Research*, 33(6), pp. 1369-1374, and Dalhuisen, J. M., R.J.G.M. Florax, H.L.F. de Groot and P. Nijkamp. (2003). Price and Income Elasticities of Residential Water Demand: A Meta-analysis. *Land Economics*, 79 (2), pp. 292-308.

SECTION III:

SETTING UP A CONSERVATION-ORIENTED PRICING SYSTEM



At the most basic level, conservation-oriented pricing is based on the economic premise that if price goes up, the quantity demanded will go down. The more the cost of water increases, the more consumption will drop.

This price relationship is, of course, more complicated. When establishing a new pricing regime, a water service provider and its governing body needs to carefully consider the actual sensitivity of water demand to price, which means considering the price elasticity of demand (see Tech Box 3). However, in general, this basic principle does hold up, and we can expect consumption to drop over time as price increases and people gradually change their fixtures, appliances and behaviour. It then becomes a subtle question of the extent or rate of change relative to the amount of the price increase.

With these concepts in mind, two main tasks need to be undertaken:

1. determine how much revenue is needed in order to cover the full costs of operating, both now and in the future; and
2. select from a number of different pricing approaches and billing structures to determine how you are going to set the rate in order to fully recover the costs.

HOW MUCH REVENUE DO YOU NEED TO COLLECT?

The key to effectively establishing conservation-oriented pricing is having a full cost accounting system in place. As the name suggests, this means all the costs that an agency incurs, including its capital costs, are recorded and then reflected in the price.[xiii] Full cost accounting includes a range of items, such as operations and maintenance, administration, overhead, reserves, costs of

complying with regulations, financial costs (depreciation, debt servicing, etc.) and capital costs.[9]

Beyond these obvious items, full cost accounting should also cover "soft costs", including environmental externalities. These include, for example, the cost of environmental management and source water protection. An agency might also want to set aside funds for projects to mitigate impacts on the environment from operations —for example, greenhouse gas abatement projects or restoration work to compensate for impacts on aquatic ecosystems from wastewater disposal.[10]

By having a full cost accounting system in place, the water service provider can accurately report all of its costs of operating. With this information in hand, costs passed on to customers through water bills can be explained. Without this, it can be difficult to justify the sometimes significant per unit rate increases to customers and elected officials.

Various utilities both in Canada and other countries have a long track record of full cost accounting; much can be learned from them. Seattle Public Utilities in Washington State, explored in Case Study 2, bases its retail prices on "cost of service studies", which are completed every two years. Charges applied are designed to achieve financial targets set out in these studies.

Many Canadian utilities are also making great strides in improving asset management systems. When tied to full cost accounting methods, this provides the information and planning foundation for creating infrastructure replacement funds.

HOW DO YOU SET THE RATE?

Once you know your costs, you need to set your rate, which is both a technical and political exercise. Some of the many issues that must be considered include:

- revenue needs;

9. Historically, utilities have used other accounting methods that did not always fully account for all the costs of operating. These older methods do not always account for the costs of depreciating assets such as aging pipes, which partly explains why most Canadian water service providers do not fully recover their costs. Analysts sometime refer to this as an "infrastructure deficit"—the difference between the funding needed for maintenance, repair, rehabilitation, retrofitting and replacement of existing deteriorated infrastructure and the funding available from all sources, including taxes, government subsidies, grants and private sector contributions.
10. Although not always easy to calculate, these environmental considerations and the ecological goods and services that flow from our watersheds and aquifers are critical to the long-term financial and ecological sustainability of the operation and are increasingly being taken into account in planning and decision making.

Case Study 2:

SEATTLE PUBLIC UTILITIES, WASHINGTON

Seattle Public Utilities (SPU) provides water services to 1.4 million people, mostly in King County, Washington. Seattle is known for having plenty of water in the winter, but there is far less precipitation during the summer when demand is highest. Residents depend on water stored in mountain reservoirs to meet demand and to provide enough water to release into rivers to maintain watershed function and populations of fish and other aquatic species.

SPU has a long history with conservation-oriented pricing, having first introduced volumetric charging decades ago. In 1989, they were among the first in North America to introduce a seasonal surcharge, wherein all customers pay more for water in the summer when demand is at its highest and availability is lowest. A drought surcharge was also added to bills for the first time in 1992, and included a strong rate penalty for excessive water use. SPU has also had volumetric wastewater charges for over 20 years. This charge is calculated on a household by household basis based on the amount of water each household uses in the winter months, when most water is discharged to the sewer system.

In 2001, SPU permanently introduced increasing block rate tiers for single-family residential customers. Three rate tiers are used. Tier three kicks in when a customer exceeds a water use of approximately 51 cubic metres. Around 10% of single-family residential customers fall into this category during the summer, and as a result face a much higher charge for that portion of their water demand. In 2010, the potable water charge at the third tier will be about US$ 4.04 per cubic metre. Of particular interest is that retail charges are based on "cost of service studies", which are completed every two years. Charges are set to achieve full cost recovery while components of the rate structures are also based on marginal costs. In any given year, rates and fees charged must be sufficient to pay the total costs of the water system and meet adopted financial targets. SPU refers to this as the "water system revenue requirement", defined as the minimum amount of operating revenue required to fund the water system operating budget and meet financial policy targets. This includes targets for net income, cash balances, financing of the capital improvement program, revenue stabilization fund balances and debt service coverage.

Since introducing peak usage charges and other demand management measures, SPU has seen significant and sustained reductions in their customers' water use. While water rates have continued to increase, the average customer bill has not increased as quickly because the average customer is using less water than in the past.

For more information, see:

- www.seattle.gov/util/Services/Billing/Rates_Summary/SPU_001469.asp
- www.seattle.gov/util/Services/Water/Rates/THIRDTIER_200312020910308.asp

- likely impact of the price change on the community;
- how to communicate the change to residents;
- strengths and weaknesses of the price structure that is currently in place;
- impacts on the organization's existing business systems;
- "buy in" and coordination of finance, human resources, IT, marketing and other parts of a water agency and across the whole municipal administration; and
- some pricing model changes may require regulatory approval from senior levels of government.

From a technical point of view, two key considerations need to be addressed. First, an economic methodology for setting the price should be developed. The technical theory in this area becomes fairly dense, and a number of different approaches can be employed, as outlined in Tech Box 4.

Whichever approach to price setting is selected, the first objective of the organization should be to fully recover all its costs without relying on grants or general tax revenue, consistent with the concept of full cost accounting discussed above. Ideally, the price structure adopted will also be forward looking, meaning that it will include not just costs for things that happened in the past but will also seek to capture future costs, such as possible system expansion, future upgrades and infrastructure renewal. Ideally, the pricing approach should also inform individuals about the financial and environmental impacts of their decisions. In other words, the rate should allocate costs to customers in such a way that they are well informed about the full costs of the services they receive and want to receive into the future.

Second, a *rate structure*, or a way to compute and communicate the customer's bill must be established. As Tech Box 5 demonstrates, a number of different rate structures exist, each with its own advantages and disadvantages.

COMPONENTS OF A RATE STRUCTURE

In general, a conservation-oriented structure will often have two components. First, there is a *fixed charge* (sometimes called a *connection fee* or *meter fee*), which is the portion of the bill that does not change when consumption increases. Second, there is a *volumetric charge* that goes up as one uses more water.

TECH BOX 4: MARGINAL COST VS. AVERAGE COST PRICING

Economic literature generally recognizes long-term marginal cost pricing as the best pricing option for water utilities—at least in theory. Marginal cost essentially means the cost of producing one more unit of a good—for example, one more cubic metre of water. Marginal cost pricing therefore involves linking the volumetric component of a water bill to not only historic costs but environmental and future costs, such as costs of system maintenance and regulatory requirements.

Economists prefer marginal cost pricing because it tells consumers about the costs they are creating today, rather than just historic costs. This is especially preferable in situations where agencies' costs are rising. Marginal cost pricing also reflects the way that total costs rise with each user's consumption. In other words, it sends the right signal to consumers: if you use more water, here's what it will cost the agency and the community to supply it.

Marginal cost pricing is used in other regulated utilities, such as telecommunications, natural gas and electricity. It is also used in the water services sector in a few countries, but is not generally being used in Canada. Many reasons for this exist, but it is partly because determining marginal cost is complex, depending on weather, distance, how total use compares to system capacity, and many other factors. The existing empirical evidence, though limited, also indicates that the gap between our current water price and long-term marginal costs is significant.[xiv] It may not be practical or realistic to switch over without a significant transition period.

Most Canadian utilities use some form of average cost pricing, which involves setting prices so that average costs are just covered, allowing the producer to break even—usually as per a requirement of senior government. A number of variations are used, but in general, these approaches limit the water service provider to recover its costs on a full cost accounting basis. These models often do not allow a water service provider to accumulate reserves to meet future expansion or technology needs. These are always based on historic (or "sunk") costs, and so prevent achieving true economic efficiency.

SENIOR GOVERNMENTS' CRUCIAL ROLE

Senior governments play an important role in facilitating or inhibiting positive change. For example, Ontario has made efforts to bring in legislation that requires water and wastewater agencies to revise their accounting practices to record all costs and reflect them in their prices—see Ontario's yet-to-be-proclaimed *Sustainable Water and Sewage Systems Act* and the Financial Plans Regulation under the *Safe Drinking Water Act*. Alberta Environment has also developed a full cost accounting program to promote better fiscal planning for municipal waterworks systems, although on a voluntary basis. Other jurisdictions are slowly following suit. Many resources are now available to help with moving to this accounting method.

Existing senior government legislation also may create significant barriers to change by limiting which financial structures are allowed. This can constrain progressive municipal governments and water managers from implementing full cost pricing.

For the volumetric component, customers pay relative to use. Two types of rates are most common:

- a *uniform rate* (sometimes called a constant unit charge or single block rate): the per unit price does not change no matter how much you consume; and
- *inclining block rates*: the price per unit increases in incremental steps as consumption increases.

A third type of volumetric structure is the declining block, where the per unit price decreases as consumption increases. Declining block rates are typically offered only to very high volume users, such as industrial or institutional customers, but are still offered to residential customers in some places. Use of this structure is based on an oversimplified argument that when quantity purchased goes up, price should go down—the "volume discount" idea—which is usually supported by the argument that the fixed cost portion has already been paid and the higher consumption fees should be based on marginal operations costs only. This approach has very obvious drawbacks in terms of encouraging water use efficiency.[11] Figure 5 graphically compares the different kinds of rate structures.

There are pros and cons to uniform and inclining block systems, and both have their proponents (see Tech Box 6). Regardless of what approach

11. The declining block approach also ignores factors such as timing of use. Perhaps price could go down when time of delivery is not an issue, but when it all has to be supplied at once (for example, on hot summer days), price should go up because cost of delivery goes up. For these reasons and others, use of declining block structures has declined steadily in Canada for the past 20 years, from covering 24.0% of residential ratepayers in 1991 to only 7.9% in 2004 (see Endnote v).

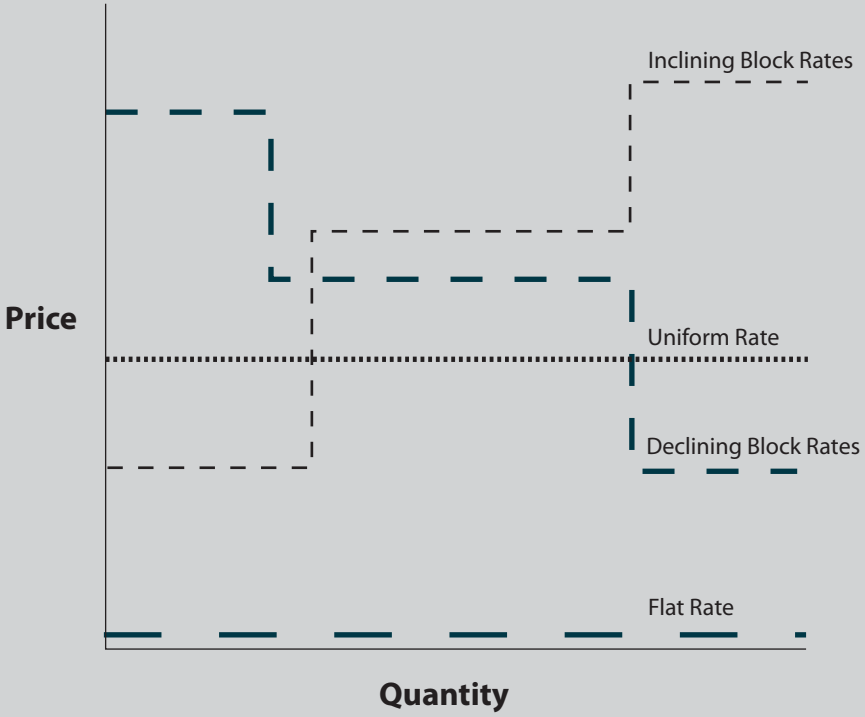
TECH BOX 5: TYPES OF RATES

TYPE	DESCRIPTION	COMMENT
Flat Rate	Fee is independent of actual water use	The least effective pricing structure for reducing demand; most common in utilities that are unmetered
One Part Rate	Includes a volumetric charge only	Less common at the retail level but often found at the wholesale level
Two Part Rate	Includes both a fixed and a variable rate	Recommended as best practice by the Canadian Water and Wastewater Association
Components of a Two Part Rate		
Fixed Charge	The portion of the bill that does not vary by volume of water consumed (though it may increase with increase in meter size)	Provides increased revenue stability; some local governments use parcel taxes in a way similar to fixed charges
Variable Charge	The portion of the bill that increases with the amount of water consumed	The most effective rate structure for reducing demand; requires full metering
Variable Charge Formats		
Uniform Rate Constant Unit Charge Single Block Rate	Price per unit is constant as consumption increases	Targets all users equally; simple to calculate bill
Inclining Block Rates	Price increases in steps as consumption increases	Targets high volume users; requires more complex calculating for billing
Declining Block Rates	Price decreases in steps as consumption increases	Charges low volume users the highest rate; typically used where utilities want to provide large industry with a lower cost of service
Excess Use Rate	Price is significantly higher for any consumption above an established threshold	Can be used to target high consumption during peak periods; more effective with frequent (e.g., bi-monthly) meter reading
Seasonal Surcharges	Price is higher during peak periods (i.e., summer)	Targets seasonal peak demand; tied to the higher marginal costs of water experienced during peak periods
Distance Rates Location-based Rates Spatial Rates Zonal Rates	Users pay for the actual cost of supplying water to their connection	Discourages difficult-to-serve, spatially diffused connections
Scarcity Rates	Price per unit increases as available water supply decreases (e.g., during drought)	Sends strong price signal during periods of low water availability; an alternative to outdoor watering restrictions
Lifeline Block	A first block of water is provided at low or no cost beyond the fixed charge in order to ensure everyone has a minimum amount of water to meet basic water needs	Used to address equity issues and ensure that all consumers' basic water needs are met

Source: Based on Wang, Y.-D., W.J. Smith, Jr. and J. Byrne. (2005). *Water Conservation-Oriented Rates: Strategies to Extend Supply, Promote Equity and Meet Minimum Flow Levels*. Denver, CO., American Water Works Association, p. 7, and Federation of Canadian Municipalities and the National Research Council. (2006). *Water and Sewer Rates: Full Cost Recovery*. In InfraGuide: National Guide to Sustainable Municipal Infrastructure. March 2006.

Figure 5:

TYPES OF WATER RATES ILLUSTRATED



Source: Based on Wang, Y.-D., W.J. Smith, Jr. and J. Byrne. (2005). *Water Conservation-Oriented Rates: Strategies to Extend Supply, Promote Equity and Meet Minimum Flow Levels*. Denver, CO., American Water Works Association, p. 7.

is employed, the most important considerations are whether the price set accurately informs consumers about the costs of their water use and whether it provides a signal that is sufficient to affect their decisions (i.e., is the price high enough?).

TECH BOX 6: THE GREAT RATE DEBATE: UNIFORM VS. INCLINING BLOCK

Which is the better approach: uniform or inclining block rates? Academics and practitioners continue to debate this question. Each approach has its supporters. From a conceptual point of view, the challenge really comes down to the need to balance equity among users with the relative ease of administration for the organization— including real practical challenges faced in the billing process and financial administration. Those who favour the inclining block approach argue that it can be more effective in addressing equity objectives. They point out that this approach targets those who are using above average amounts of water, which is likely to include a lot of discretionary use. They also argue that an inclining block approach will be more effective in reducing peak demand, again because it goes after high volume users (often people watering gardens) more aggressively.

Those who favour uniform rates argue that introducing differing rates for different volumes is inefficient because it creates artificial differences in price (referred to as *price distortions*). That is, it moves us away from the goal of effectively linking the price of water to the marginal cost of supplying it. They also argue that, in practice, when utilities use inclining blocks, the highest blocks tend to affect only those using extremely large volumes of water; most users pay only a low basic per unit amount for all or most of their consumption. Thus, in practice, these systems do not always work very effectively in creating an incentive for most people to conserve. They also contend that inclining block systems are unfair because they discriminate against households with larger numbers of people. They argue instead that there are other ways to more effectively address equity concerns. Finally, they point out that a uniform rate system is much simpler for residents and businesses to understand and react to, provided that the basic per unit price is sufficiently high to affect decision making.

A compromise solution that captures many of the best elements of both approaches is to have a very simple inclining block system with two or at most three tiers. The lowest tier would be based on a *lifeline block* equal to roughly the amount of water required to meet a typical family's basic needs.[12] Alternatively, the lifeline amount could be included at no additional cost as part of the fixed portion of the bill. The next tier of pricing would be a significantly elevated charge that is sufficiently high to affect general decision making. Finally, a third tier could be added which includes a very high charge for those who continue to consume excessive amounts.

12. Some go further and argue that if you have a lifeline rate or low price initial block, the price per unit for the next block should not be marginal but should be paid on everything consumed, including the lifeline amount. Otherwise, the subsidy goes to everyone, not just to the poorest or the lowest consuming part of the public. This does, however, create some billing and communication challenges (See Endnote v).

SECTION IV:

ADDRESSING THE CHALLENGES TO CONSERVATION-ORIENTED PRICING

Doesn't Increasing Volumetric Price Mean Unstable Revenue for the Water Service Provider?

One of the biggest challenges in moving to a conservation-oriented pricing system stems from the fact that most of the costs that a water service provider faces are fixed: items including payroll, debt payments, and plant costs. In fact, fixed costs can account for 75–80% of spending, and sometimes even more.

When an organization increases its reliance on volumetric pricing, revenue will inevitably fluctuate. Customers will use more water when it is hot and dry, less when it is raining, and much less if they are faced with watering restrictions during a drought.

Some water managers and elected officials believe that increasing per unit costs will create the so-called "pricing death spiral", which goes something like this: the price increases, demand drops, revenue drops correspondingly, the agency is faced with a budget shortfall and must raise prices again, the cycle repeats.

Fortunately, there are options to avoid this vicious cycle, avoid budget shortfalls and alleviate the impacts of revenue variability.

FIXED VS. VARIABLE COSTS

Fixed costs are expenses that do not change or cannot be changed with a change in short-term production or sales. An example from the water industry is that a water service provider must make its debt payments in any given month, regardless of how much water is used by customers.

Variable costs are expenses that do change with a change in production or sales. For example chemicals and energy required for treatment—which changes with the volume of water used.

First and foremost, careful planning goes a long way. The organization needs to ensure that it carefully and conservatively forecasts the impact that price change and other water use efficiency measures and trends will have on future consumption. It should then set its rates accordingly at a level that will allow it to fully recover costs.

As discussed above, volumes of academic research exist on the price elasticity of water. There is also plenty of experience with conservation-oriented pricing from around the world to draw upon. This, combined with local information, can be used to model predicted future water demand with sufficient accuracy, taking into account the impacts of pricing model changes and other demand management measures. All else being equal, the per unit price can then be set at the right amount needed to ensure that the water service provider can meet its budget requirements over the long term.

The water service provider can also use various pricing mechanisms to mitigate the impacts of revenue variability. For example, *rolling average price* can be set for a number of years. This will be designed to conservatively account for projected short-term fluctuations in water demand. This way, in some years there will be excess revenue that can be channelled into a reserve fund that can be tapped during lower demand years when there may be a shortfall in revenue.[13] Similarly, as noted above, most conservation-oriented rate structures will use a two-part system that includes both a fixed and variable component.[14] By including a fixed component, the worst impacts of revenue variability can at least be blunted. The fixed component can provide a significant degree of revenue certainty. Other options include support by senior governments to create revenue stabilization funding mechanisms for unexpected or severe revenue impacts (as is sometimes done in the energy sector).[xv]

Doesn't Conservation-Oriented Pricing Burden Low Income Families?

Some fear that a move to conservation-oriented pricing will hurt low income families who spend a disproportionate amount of their income on water. This is a particular concern for larger families who must use more water for basic needs like bathing.

13. In utilities that are regulated to a "zero profit" objective, some regulatory reform may be required to enable this kind of system.
14. This is the approach recommended by the Canadian Water and Wastewater Association (1992), but it should be recognized that many utilities have successfully moved forward with pricing reform by using a "100% volumetric" billing system that has no fixed fee component, so both methods are certainly possible.

This is an extremely important consideration. However we also have to question whether the best way to address this is to have a system that under-prices water for everyone and leads to waste and environmental impacts, especially when there are other, more efficient options available to help those in need.

As discussed in Tech Box 6, one of the best options to address equity issues is to offer a *lifeline block*. This is a volume of water that is roughly equal to the amount a typical family requires to meet basic needs. It is provided at a low per unit cost on the first tier of an inclining block system. Alternatively, it can be included at no extra cost as part of the fixed charge on the water bill.

In 2010, the OECD compared the proportion of income that the poorest 10% of the population spend on water and sanitation bills across 20 member and non-member countries. The study found that the poorest 10% of Canadian households spend 1.2% of net disposable income on these services. Of the countries surveyed, only South Korea was lower at 1.0%.[xvi]

Another good option is to provide giveaways or generous rebates to low income families for high efficiency toilets or other water saving technologies. Where a water service provider already has a rebate program in place, it can be redirected to more effectively target disadvantaged groups. For example, eligibility can be based on income, as is done with many other social programs. These options are best combined with non-financial tools, including education programs.

It is also worth noting that, depending on the extent of the rate increase, low income families who use less water than the average may actually experience a decrease in their water bills. This is simply because they may choose to use less water for discretionary activities, such as outdoor use. In any case, like all families, they will be given more control over their costs of water.

Other jurisdictions around the world have implemented pricing reforms quite effectively without causing undue hardship in the community. For example, the San Antonio Water System in Texas, a continental leader in water demand management, began improving their pricing system many years ago. Over time, they have introduced a whole range of measures to help low income people (see Case Study 3).

Case Study 3:

SAN ANTONIO WATER SYSTEM, TEXAS

The San Antonio Water System in Texas was an early leader in conservation-oriented pricing and has continued to innovate in the area over several decades.

San Antonio's bill calculation is fairly complex from the residents' point of view, but it has a number of interesting features. The organization employs an inclining block system that includes a small fixed monthly service charge. For the volumetric charge, customers pay a basic rate for every 100 gallons used until consumption exceeds 5236 gallons (9.7 cubic metres) per month. After that, the rate increases considerably over four different blocks. Customers also face a sewer charge component, with volumetric charging kicking in after 1496 gallons (5.66 cubic metres) per month.

San Antonio also provides a good example of how a seasonal surcharge can be used successfully. For their second, third and fourth price blocks, the cost per unit goes up during the period between July 1 and October 31 each year. This means customers will face significantly higher bills if their consumption jumps up during the summer due to discretionary outdoor water use.

Probably one of the most interesting facets of San Antonio Water System's approach is their affordability programs:

- They offer an affordability discount to low income residential customers who meet income eligibility requirements. The amount of discount received is based on tests that include household size, household income and type of service provided.
- In 1994, they initiated the "Plumbers to People" program to provide plumbing assistance to low income residential customers. The types of problems that can be repaired include leaking faucets and toilets or broken pipes—problems that cause consumption —and water bills—to go up.
- In 2000, they established "Project Agua" to provide further assistance to customers who are having difficulty making water bill payments. Available funds are used to help low income residential ratepayers who are elderly, disabled, or have young children.
- In 2007, they launched the "Kick the Can" toilet giveaway, which offers eligible customers up to two high efficiency toilets per household, absolutely free. Through this program, 30,000 toilets were installed in homes in 2007 alone. Of particular interest is that this work is funded through conservation-oriented pricing. A percentage of the revenue generated from the highest tier in the inclining block system goes into a fund that supports the program.

For more information, see www.saws.org/service/rates/

What about the Impacts on the Water Service Provider's Business Systems?

Changes to price structures will almost certainly have some impacts on existing business systems. This might include accounting, billing, asset management and demand forecasting systems, to name a few. Both business processes and computer-based information technology might be affected. As discussed further below, attention to billing systems is particularly important.

How significant the impacts will be varies depending on the organization's current situation. For example, a water service provider that is not universally metered and has flat rate pricing may face more challenges than one that already uses volumetric pricing.

Fortunately, most of the impacts on business systems are reasonably predictable and can be resolved with "off-the-shelf" technologies and practices. But again, careful planning is called for. We provide some further advice in the next section about how to smoothly make the transition.

Does Volumetric Pricing Lead to Privatization?

No evidence exists to support the claim that moving to conservation-oriented pricing leads to privatization of water resources. Indeed, a more compelling argument is that moving to full cost pricing strengthens rather than weakens public systems. Critics of water infrastructure privatization can actually be valuable supporters of price reform, but support requires that:

1. water must continue to be considered a common good owned by the Crown on behalf of the people, not a private good that can be bought and sold for profit;
2. fees for providing water services must be collected by a not-for-profit, publicly-owned, democratically accountable agency;
3. fees collected should be put back into infrastructure, source water protection, demand management programs, etc. and not into corporate profits; and
4. pricing systems must ensure that no one is denied water because of inability to pay.[xvii]

Indeed, places that have moved to conservation-oriented pricing often have strong support from citizens groups and social advocates. To build this kind of support, careful consultation and communication with key stakeholder groups

at the outset is strongly recommended to ensure that the objectives of pricing reform are fully understood by all.

I'm Sold on the Idea of Conservation-Oriented Pricing, but How Do I Convince Others?

Many politicians and senior managers worry, with very good reason, that they will be criticized by the community for trying to change water prices because there may be winners and losers.

When water rates go up, some residents will be angered and understandably feel frustrated. Some will view it as nothing more than a "tax grab." Others may feel that their past efforts to save water are being "punished" by the price increase. They might argue that water use efficiency results in lower revenue for the water service provider, which will then simply raise rates to make up the shortfall.

The problem is exacerbated by the fact that Canadians have enjoyed artificially under-priced water for decades—a kind of ecological and infrastructure subsidy resulting from historic policies governing the pricing of municipal services. As a result, unintentionally wasteful practices based on the use of widely available water consuming devices and appliances and socio-cultural practices (like lush green lawns) are quite firmly established in many households and have become the norm.

Treatment costs, pumping costs, labour costs, construction costs, etc., will almost certainly continue to go up over time. Inevitably, water bills will also have to rise, whether calculated on a flat or volume-based rate. With conservation-oriented pricing, the benefit to the consumer is that they get to exercise some control over the amount of the increase by modifying their consumption habits.

Tackling this problem takes courage, leadership, a long-term view and support from others. There is no substitute for building support through an effective consultation and public education campaign. No reforms, no matter how beneficial, will be well received unless they are clearly understood.

It may be helpful to continually remind residents about the environmental benefits of reducing water use so that they do not feel they are being asked to conserve for the sake of conservation itself. You might remind them that saving water will result in reduced greenhouse gas emissions because, for example, less water has to be pumped around systems and heated in homes. Environmental water quality may also improve because less sewage is produced, meaning that less treated water needs to be discharged. You can also take the opportunity to underscore the importance of healthy watersheds in terms of ecological goods and services that we all depend on. This can help the public understand the broader non-commodity values of water. Finally, by using less water, we will generally be more resilient to uncertainty and the impacts climate change will have on water supplies.

Another helpful approach is to highlight successes already happening around North America. The City of Guelph, Ontario, for example, has been able to justify significant pricing reform in recent years. When combined with their comprehensive approach to demand management planning and delivery, Guelph has become a Canadian leader in this field (see Case Study 4).

Case Study 4:

CITY OF GUELPH, ONTARIO

The City of Guelph has demonstrated that historical and political barriers to conservation-oriented pricing can be broken down. Guelph, one of Canada's fastest growing communities, relies solely on groundwater for its water. In working to sustain the community's finite supply, the City has set the ambitious goal of reducing overall water use by 20% by 2025 and has set a consumption target of using less residential water per capita than any comparable Canadian city.

In December 2008, Guelph City Council approved a 19% increase in water and wastewater user rates, following a number of other increases in recent years. The City's water rate has a two-part fee structure, including a relatively low fixed charge (at about $13/month) as well as a variable charge. The variable portion includes both water and wastewater components and bills water users on a uniform basis for each cubic metre of water and wastewater used. The end result is that residents pay a combined cost of just over $2 for every cubic metre—relatively high by Canadian standards.

This simple and consistent uniform rate structure allows the City to provide a straightforward and easily understood bill to the customer. In concert, the City also offers a comprehensive demand management program that includes product rebates, an outdoor water use program and other education resources.

In working to receive City Council's endorsement of this rate increase, Guelph staff noted that water and wastewater services and infrastructure needs are funded solely from the sale of water. As part of their rationale for a user increase, they also emphasized their need to comply with new regulatory requirements imposed by the provincial government.

Representatives from Guelph used a two-pronged message to achieve the desired outcome. First, they noted that, from a financial point of view, the rate increase would allow the City to replace necessary infrastructure as well as meet the needs of a growing community. Secondly, they treated improving efficiency as an equally viable approach to meeting community water needs as any other source of water supply and wastewater treatment. This bolstered the argument that conservation is the right thing to do from both economic and environment perspectives.

For more information, see:
- www.guelph.ca/water
- www.guelph.ca/waterconservation

SECTION V:

FROM CONCEPT TO ACTION - A STEP-BY-STEP PLAN TO REFORM YOUR PRICING REGIME

How quickly a conservation-oriented pricing system can be set up depends on a number of factors, including the political climate, the status of current water use efficiency programs, the state of water resources and watershed health, and the current approach to financial accounting and other business systems. The following is an overview of the steps to consider when transitioning to conservation-oriented pricing.

1. HAVE A PLAN...

Restructuring water services pricing models is time consuming, complex and absolutely political. Good preparation and commitment are critical. Key aspects that should be addressed include:

- develop a solid consultation and communications plan. Get community input early and often through forums such as stakeholder advisory committees;

A 10-STEP PLAN FOR SUCCESS:

1. Have a plan.
2. Get buy in and authority from senior management and elected officials.
3. Get metered and start charging by volume.
4. Get the water bill right.
5. Improve accounting of water use in the community.
6. Account for expenditure and understand costs.
7. Consider starting with a seasonal surcharge.
8. Make it a part of a complete program.
9. Recruit the aid of senior government.
10. Take the long-term view.

- systematically assess different rate structures and rank them objectively to determine the one that will be most appropriate for your location. This is one area where you may want some expert outside assistance; and
- build institutional capacity for the future: undertake cost analysis, including consideration of future capital costs; improve asset management systems; prepare customer service staff.

2. GET BUY IN AND AUTHORITY FROM SENIOR MANAGEMENT AND ELECTED OFFICIALS...

Securing senior management and political input and support early in the process is critical to success because it involves senior people who will champion the cause and allocate authority and resources to effect the change. Pricing reform will necessarily involve political and administrative decisions in other parts of the municipal organization. Unless there is broad commitment at all levels of the organization, progress will be slow.

3. GET METERED AND START CHARGING BY VOLUME...

As an obvious first step, water service providers that do not have universal metering will want to look at the benefits and costs of putting this in place, even if the organization has done so already at some point in the past. Simply put, metering is a critical starting point for understanding and managing water demand and for pricing water services appropriately—and senior governments are increasingly willing to support such infrastructure programs.

As mentioned, about a third of Canadian municipalities are not metered. So if you are in this situation, you are not alone. Moving to universal metering (and ultimately sub-metering of multi-residential buildings), then volumetric pricing, then to a truly conservation-oriented rate structure will take time—likely a number of years—and perseverance. On the plus side, you will be able to learn from the experiences of many other communities that are already moving down this path.

4. GET THE WATER BILL RIGHT...

For customers to respond to price changes, they need clear information about the link between their consumption and what it costs. This allows them to make decisions about behaviour changes or technology upgrades. The water bill is one of the most effective tools available to communicate this information.

Ideally, the bill that the customer receives will compare their home's consumption over time and to others in their neighbourhood and across the municipality. The more easily the information is understood, the better. Bar graphs and other illustrations often work well.

Moving to conservation-oriented pricing can sometimes prove challenging when dealing with older "legacy" billing systems. If there are no upgrades planned, and current billing systems do not have the functionality you want, you may need to be creative and use other approaches—for example, using generic bill inserts to communicate about price changes and how customers can control their costs.

5. IMPROVE ACCOUNTING OF WATER USE IN THE COMMUNITY...

Collectively, Canadians have some way to go in terms of truly understanding the factors that influence water demand in communities—climate, demographics, industrial and commercial demand, unaccounted for water (including system leakage), consumer end use, changing technology and so on. Prior to introducing pricing reform, municipalities should use the best information they have to account for current water use and to forecast future consumption. This will include looking at different situations with different conservation and demand management scenarios. This information, combined with improved accounting practices, will provide a solid foundation for establishing new rates.

6. ACCOUNT FOR EXPENDITURE AND UNDERSTAND COSTS...

Shifting to full cost accounting is another prerequisite of effective conservation-oriented pricing. With this type of accounting method, the water service provider can accurately report all of its costs of operating.

From there, you have a basis for understanding the cost of supplying water, which in turn gives you a sound basis for rationalizing the costs passed on to customers. Without this, it can be very difficult to justify the per unit rate increases involved in pricing reform.

7. CONSIDER STARTING WITH A SEASONAL SURCHARGE...

Moving to a full-fledged conservation-oriented pricing system that is effectively linked to the long-term marginal cost of water will probably not happen overnight in most places. However, one reasonably simple first step is to introduce *seasonal surcharges*—charging more for the volumetric component of the water bill during the summer when more water use is discretionary.[15] If combined with effective communication, this can be one way to employ price at a time when consumers have the most capacity to modify their water use.

If the water service provider already has a volumetric pricing system in place, introducing a seasonal surcharge can be relatively simple since it will not require major changes to administrative and billing systems. A prime example of this is the District of Tofino (Case Study 5), which has made good use of seasonal surcharges to bring down high summer water consumption in order to address significant supply constraints.

8. MAKE IT A PART OF A COMPLETE PROGRAM...

Conservation-oriented pricing reform will be more successful if it is part of a concerted, multi-faceted, conservation and demand management effort. A good place to start is by building on existing local water use efficiency initiatives. These may include rebates and retrofit programs, community-based social marketing efforts, rainwater harvesting, water reuse, water conserving urban designs, and outdoor watering restrictions, all of which can reinforce the impact of the price change.

9. RECRUIT THE AID OF SENIOR GOVERNMENT...

Federal and provincial governments can play an important role in the transition towards conservation-oriented pricing. They provide guidelines, best practices manuals and advice on matters such as asset management, full cost accounting and pricing systems. They can also set consistent pricing and metering policies (including incentives for universal metering), and create a conducive and supportive regulatory environment. Alberta and Ontario have already begun to do this by encouraging full cost accounting. Finally, senior governments can support broader efforts to reduce water demand by

15. More accurately, the objective might be to link the off peak season price of water to the short-term marginal cost of supply and the peak season price to the long-term marginal cost. The fixed component of the bill may also have to be adjusted by an amount necessary to avoid budget deficits or excessive surplus (Renzetti (2009), p. 14).

Case Study 5:

VANCOUVER ISLAND COMMUNITIES

British Columbia lags behind the national average for metering and volumetric pricing. But things are changing.

The ***District of Tofino***, on the west coast of Vancouver Island, has a winter population of less than 2000 and a peak summer population upwards of 20,000. Tofino received notoriety not only for being a premier vacation destination but also for its dramatic water shortage crisis in late summer 2006. Over the past several years, the village's water provider introduced a series of price reforms aimed at achieving demand management goals and addressing its municipal infrastructure deficit. The rate structure starts with a small fixed meter reading levy, five different consumption tiers on an inclining block scale, and different rates applied to residential and business categories. It has a number of appealing features from a conservation perspective. First, it includes a seasonal surcharge, which effectively doubles rates in the summer months when consumption is high (due to tourists and outdoor use) and water availability is very low. Second, in 2009, the District tacked an additional $1.50 levy onto every cubic metre at every level of consumption. Finally, the highest tiers in their inclining block system are charged at a very high rate by national standards. At the time of writing, consumption at the top tier was effectively charged $3 per cubic metre in the winter and $4.60 per cubic metre in the summer when the new levy is included, placing it among the highest in the country. Even consumption at the lowest tier is charged a substantial $3.30 per cubic metre in the summer with inclusion of the levy. Although seen as controversial, Tofino's leaders agreed that the changes were required in order to cover the cost of needed capital improvements (i.e., their infrastructure deficit) and to encourage necessary water conservation.

The ***Regional District of Nanaimo***, on the east coast of Vancouver Island, operates seven small water utilities, referred to as Water Local Service Areas. All seven are fully metered, and customers are billed on an inclining block system with six different consumption tiers designed to encourage efficiency. A customer would have to use a hefty volume of water to make it into the top tier (over 3.5 cubic metre/day). However, those who do, pay a premium at $3/cublic metre.

The ***Capital Regional District***, at the southern tip of Vancouver Island, is the bulk water supplier to municipalities in and around Victoria, and has been a leader in the field of full cost accounting for some time. Since at least 1995, the Capital Regional District has used full cost accounting to allocate the capital component of costs over the life of the assets. Its representatives have successfully argued that full cost accounting ensures sustainability of the water system, facilitates rate stability, leads to efficient resource allocation, creates the right fiscal environment for encouraging conservation and discourages overbuilding of infrastructure. In summary, they have demonstrated that it represents sound business practice.

reforming water allocation systems, modifying building codes to mandate the use of fixtures such as high efficiency toilets, or requiring commitments to conservation as a condition of infrastructure funding.

10. TAKE THE LONG-TERM VIEW...

Canadian water providers, policy makers and researchers still have much to learn about water use in our communities and about how people will respond to different pricing approaches. As our knowledge and understanding grows and communities become more familiar with conservation-oriented pricing, the sophistication of rate structures can increase. Demand for innovative and effective approaches to water use efficiency and conservation will also grow as communities adapt to the realities of climate change and its impact on our water supplies.

In the future, price, rather than outdoor watering restrictions, may well become the main tool to ration water during drought (known as *scarcity pricing*). Utilities might begin to use *distance pricing*, where users pay for the actual cost of supplying water to their individual connection. *Non-linear price schedules* and other more esoteric economic tools, where the mapping from quantity purchased to total price is not a strictly linear function, may become the norm.[16] Non-linear pricing is already commonly used in the mobile phone industry and even in the energy sector. Over time, this may become more common with water, particularly as "smart meter" technology proliferates.

Much of this is probably in the distant future for most Canadians. However it illustrates the idea that conservation-oriented pricing will be an evolving tool that can continue to help us manage water demand in our communities for many years to come.

WHERE TO GO FROM HERE?

Regardless of where water service providers are today, developing an effective conservation-oriented pricing structure will take time, courage and resources. Numerous political and historical barriers stand in the way—with many of these outside the sphere of influence of municipal water managers. Moving forward requires careful planning, communication and consensus building within the organization and the broader community.

16. For a brief discussion of non-linear pricing, see Renzetti (2009), p. 281.

One powerful motivator may help build consensus and perseverance—conservation-oriented pricing makes sound sense from both economic and environmental points of view. The objective is simply to cover the costs of supplying water and maintain the assets required to do so over the long term. It is also perhaps the most powerful instrument available to impact short-term water demand and thereby improve environmental performance. Wasting water and not being able to fund the operation of water systems are in nobody's best interest. It is not really a question of ***if***, but ***when***: when will Canadian communities begin to move to a 21st century approach to water infrastructure planning and pricing?

APPENDIX A: ADDITIONAL RESOURCES

Detailed Water Pricing Guidance

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Resources for Comprehensive Programs

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M52 Water Conservation Programs—A Planning Manual. (2006). Denver, Colorado, American Water and Wastewater Association. http://www.normas.com/AWWA/pages/30052.html.

Resources from Waste: A Guide to Integrated Resource Recovery (2009) Victoria, BC: Ministry of Community and Rural Development http://www.cd.gov.bc.ca/lgd/infra/resources_from_waste.html.

Good Governance for Water Conservation: A Primer. (2008). Vancouver, BC: UBC Program on Water Governance http://www.watergovernance.ca/publications/Primer.pdf.

POLIS Water Sustainability Toolkit http://poliswaterproject.org/toolkit.

Alliance for Water Efficiency Resource Library http://www.allianceforwaterefficiency.org/Water_Resources_Content_Listing.aspx.

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POLIS Project
on
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THE POLIS PROJECT

Created in 2000, the POLIS Project on Ecological Governance is a research-based organization housed at the University of Victoria in British Columbia. Researchers who are also community activists work together at POLIS to dismantle the notion of the environment as merely another sector, and to make ecological thinking and practice a core value in all aspects of society. Among the many research centres investigating and promoting sustainability worldwide, POLIS represents a unique blend of multidisciplinary academic research and community action.

Visit www.polisproject.org to learn more.

POLIS Project on Ecological Governance

watersustainabilityproject

The Water Sustainability Project (WSP) is an action-based research group that recognizes that water scarcity is a social dilemma that cannot be addressed by technical solutions alone. The project focuses on three themes crucial to a sustainable water future:

- Water Conservation and the Soft Path
- Water-Energy Nexus
- Water Law, Policy and Governance

WSP works with industry, government, civil society and individuals to develop and embed water conservation strategies to benefit the economy, communities and the environment. WSP is an initiative of the POLIS Project on Ecological Governance at the University of Victoria.

Visit www.poliswaterproject.org to learn more.

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