





WATERSHED PLANNING



2017 WATERSHED PLANNING UPDATE

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1. INTRODUCTION

1.1 WATERSHED PLANNING – OUR PURPOSE

The City of Calgary works to ensure we have a healthy, resilient watershed capable of providing clean, reliable water for our current needs and future generations. The City is dedicated to implementing the Government of Alberta's *Water for Life Strategy* through an integrated water management framework that ensures reliable and resilient water servicing for Calgary and regional customers. The City provides drinking water and wastewater treatment to about 1 in 3 Albertans. Working with the Province and regional partners, The City aims to protect the water supply, use water wisely, keep rivers healthy and build resiliency to flooding. The City delivers on this commitment through three lines of service: water treatment and supply, wastewater collection and treatment, and stormwater management.

Increased pressure on watersheds from growth in the region as well as the impacts of a changing climate make watershed management one of Calgary's most critical resiliency challenges. The City's commitment to watershed protection considers the needs of a growing customer base and balancing the economic, social and environmental impacts of our decisions, programs, and actions. Sustainable management of our shared water resources is the driving force behind an integrated watershed management approach.



1.2 OUR GOALS

We endeavor to achieve the following goals to protect public health and the watershed:

1. **Protect our water supply** by reducing risks to our water source.
2. **Use water wisely** through responsible and efficient use.
3. **Keep our rivers healthy** by reducing impacts on the rivers.
4. **Build resiliency to flooding** through mitigation, emergency planning, and education.

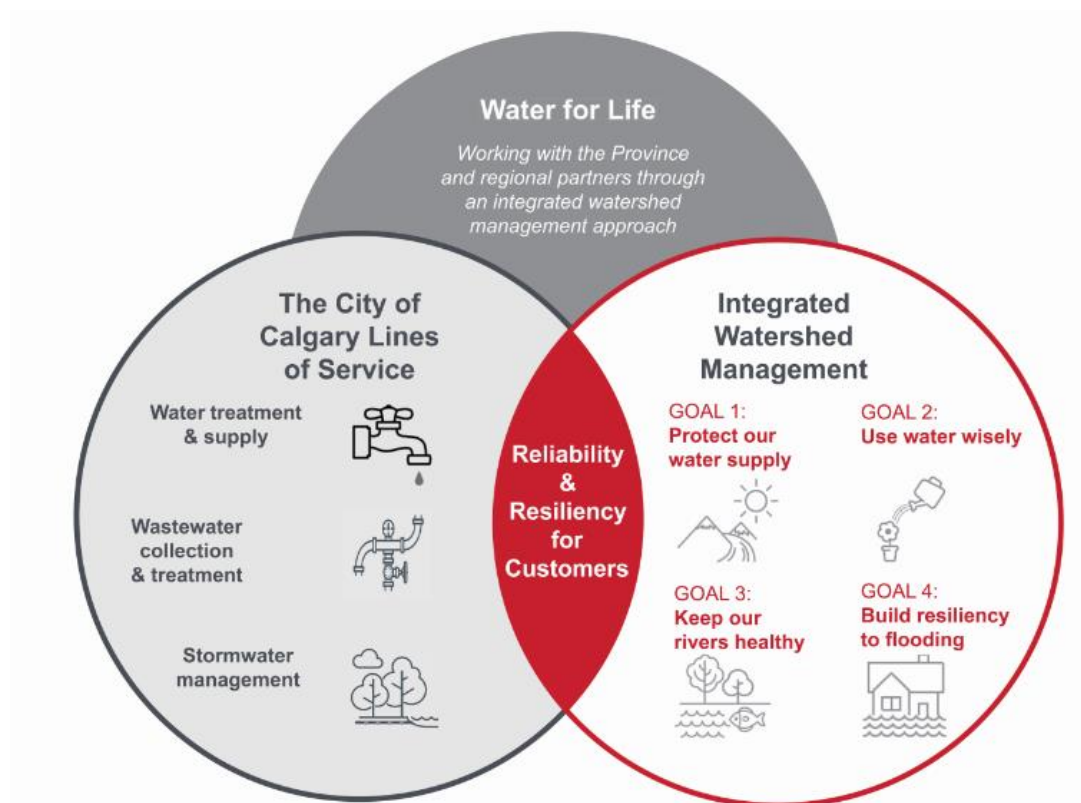


FIGURE 1.1 WATERSHED PLANNING DIVISION - STRATEGIC FRAMEWORK

The City's integrated watershed management framework (Figure 1.1) is designed to be flexible in delivering these goals while also responding effectively to emerging issues and customer needs. We use adaptive management to evaluate progress, risks, and the effectiveness of our services. This approach guides business decisions and investment planning for a sustainable watershed.

We work to achieve the four goals by:

- Collaborating closely with partners on common issues
- Conducting research and analysis to manage risks
- Developing and delivering strategies, plans and programs
- Advocating for sound policy
- Investing in infrastructure and business improvements
- Using innovation to optimize business decisions

This report describes the actions taken to achieve the goals, and address The City's watershed challenges and priorities.

1.3 ALIGNMENT WITH COUNCIL PRIORITIES

The City's watershed management goals are aligned with the priorities set by City Council's *2015-2018 Action Plan*, with a focus on the priorities outlined in Table 1.1. Examples of how our work helps achieve these priorities are highlighted throughout this report.

Table 1.1 Council's 2015-2018 Action Plan Priorities related to protecting watershed health

H3.1 Align preparedness and natural resource plans to implement a whole systems approach to manage the inter-relationships between flood protection, water quality and quantity, and land use.
H3.2 Continue to strengthen the strategy and actions for the Drainage line of service to improve its overall performance and condition.
H4.1 Collaborate with staff and regulators to enhance environmental performance and contribute to regulatory decision-making.
H4.2 Support the implementation of the Calgary Metropolitan Plan through an integrated approach to the watershed. <i>(to be replaced by the new Regional Growth Plan)</i>
H6.1 Proactively seek and collaborate with partners to conserve and protect air, land and water resources.
H10.1 Operate facilities and systems to ensure compliance with regulatory requirements and to protect public health and mitigate the impacts of our business on air, land and water.
H10.2 Effectively use research to improve decision-making and environmental performance.
N2.1 Implement recommendations from the Flood Expert Management Panel as directed.
N2.2 Continue to invest in priority flood resilient infrastructure to reduce the impact of and vulnerability of future events.
N5: Systematically invest in established neighbourhoods as they evolve to accommodate changing community need
N8.1 Support the development of measures to integrate watershed protection with land use planning.
N8.2 Support incorporation of Low Impact Development source control practices in public land development and redevelopment. <i>(Green stormwater infrastructure)</i>
W5.1 Integrate feedback from customers and stakeholders to drive programs and service improvements, and enable two-way communication.

2. GOAL #1: PROTECT OUR WATER SUPPLY

Economic and urban growth in Calgary and the region is dependent on a safe, reliable, and secure water supply. The region is prone to drought and future water supply is limited because of climate change impacts and the provincial closure of the South Saskatchewan River Basin to new water licenses. These impacts are expected to increase pressures on The City's water and wastewater treatment plants, as well as Calgary's stormwater system. Watershed protection aligns with the Provincial Water for Life Strategy, South Saskatchewan Regional Plan and supports regional watershed management plans of which The City is a partner. An integrated water supply management approach will help identify risks facing water supply and operations, and recommend actions to address challenges.

2.1 WATER SUPPLY MANAGEMENT

Calgary's shared water resources in the watershed require long-term integrated planning to meet the needs of customers, especially as climate variability continues to impact water availability. To address this water management priority, The City's Water Supply Management Framework will align various water supply, demand and infrastructure plans. In 2017, we drafted the Source Water Protection Plan, and prioritized regional servicing issues, climate adaptation and drought management. The framework will provide flexibility to enhance water supply resilience, both now and in the future. It will help to set a basis for planning and decision-making and build greater synergies among plans related to water efficiency, source watershed protection, drought, climate change, infrastructure planning, and regional servicing. Figure 2.1 illustrates key plans and programs related to this framework.

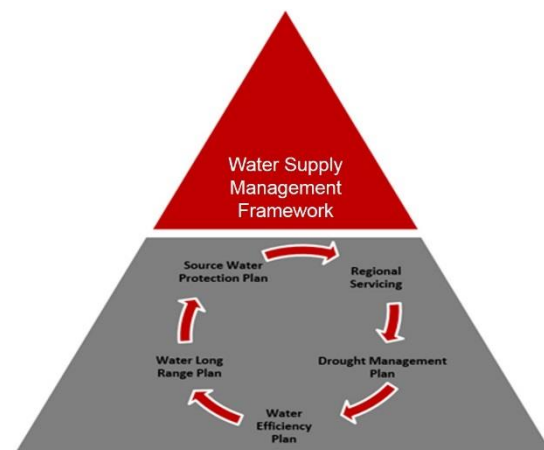


FIGURE 2.1 KEY PLANS AND PROGRAMS OF WATER SUPPLY MANAGEMENT FRAMEWORK

2.2 CLIMATE IMPACTS ON WATER MANAGEMENT

Climate change will alter how and when we receive precipitation in Calgary's watershed, affecting both water quantity and water quality. Mountain snowpack melting may occur earlier in the year, precipitation will fall with greater intensity, and summers will become hotter, drier and longer. With increasing temperatures and drought conditions, water demands will likely increase. Snowmelt water may fill reservoirs earlier in the year and will have to support increased water demands for a longer, hotter outdoor water use season. Water management practices and storage capacity for both extreme flood and drought will be priorities in preparing for climate change.

A reliable, secure and high quality water supply is essential for Calgary and we are taking action to plan for an uncertain climate future. This past year, The City identified impacts climate change will have on the Water Utility and a number of mitigative actions were identified. These actions will be built into work plans, and a key task in 2018 will be examining changes in rainfall intensity so we can understand potential impacts to stormwater management.

Priorities over the next business cycle include a technical analysis to support changes to how water infrastructure and programs are designed and prioritized, collaboration with stakeholders on climate adaptation initiatives, and development of a program to report on climate adaptation progress in the Utility. Many of these actions will be integrated into existing and planned projects and programs with some new critical actions being included in the business planning process for 2019-2022.

2.3 SOURCE WATER PROTECTION

The City of Calgary draws its water from the Bow and Elbow rivers. This water is ultimately generated in the source watershed, which includes all land from which water collects and flows downstream to the Bearspaw and Glenmore water treatment plants (Figure 2.2). Source water protection is the first line of defense to minimize the risk of contamination of our drinking water supply. The City completed a Source Watershed Assessment and Risk Characterization study, which identified the two highest risks as:

- Potential for major wildfires in the forested headwaters causing contamination.
- Current and future land development resulting in higher contamination risks from increased stormwater runoff.

Calgary's Source Water Protection Plan is based on mitigating risks to Calgary's source watershed, best practices from other jurisdictions, and water quality evaluation data. Extensive internal, external and First Nations engagement conducted in 2016-2017 also informed the Plan. The Plan will be finalized in 2018 and establishes four goals to proactively prevent, reduce or mitigate key source water quality risks as part of a multi-barrier approach to providing safe, clean, high-quality drinking water to our customers. These goals were selected based on risk priorities, commitments to customers and stakeholder engagement:

1. Protect the source watershed through enhanced land use planning processes and requirements
2. Promote innovation in stormwater management to protect source water quality
3. Leverage key partnerships for risk mitigation
4. Effectively involve stakeholders and citizens through education and research.

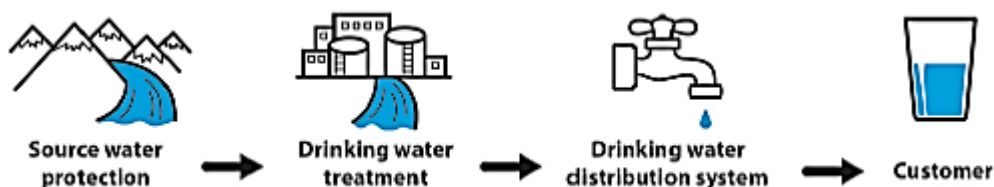


FIGURE 2.2 SAFE DRINKING WATER STARTS AT THE SOURCE AND IS MANAGED THROUGHOUT THE DISTRIBUTION SYSTEM

2.4 DROUGHT MANAGEMENT

The summer of 2017 was characterized by record high temperatures and very little precipitation, resulting in low flows on the Bow and Elbow rivers, and lower levels at Glenmore Reservoir. Southern Alberta and some Calgary regional municipalities were significantly impacted by drought conditions and imposed water use restrictions. Infrastructure investment at The City's water treatment plants and community efforts on water conservation allowed us to manage water supply and demand, resulting in no need for water restrictions.

The City has developed guidelines, including four drought phases, to guide actions in the event of drought conditions:



FIGURE 2.3 CALGARY'S FOUR DROUGHT ACTION PHASES

While a public drought advisory was not required in 2017, an internal drought Advisory phase was in effect from August 29-October 2 of 2017 to increase The City's state of readiness:

- Increased water quality and quantity monitoring of watershed, operational and regional conditions
- Corporate-wide collaboration on readiness for additional water conservation measures if necessary
- Managing water treatment operations to maximize production and storage efficiency
- Prioritizing where and how much water is used in park spaces.

Regionally, we increased our operational communication with Alberta Environment and Parks, TransAlta and the Irrigation Districts to share successes and challenges and discuss opportunities to improve Bow River operations. This collaboration will continue in 2018 and beyond.

In 2018, The City will develop a long-term drought management plan that considers climate change adaptation as well as Calgary's drought response readiness. Examining drought vulnerabilities and risks will help us develop and prioritize drought strategies to minimize impacts on the watershed and customers.

2.5 WATER QUALITY

The City takes a source-to-tap view of drinking water quality, which means that as water travels from the mountains, through our water treatment plants across the city through the distribution system and to customer taps, the water is tested at every step to ensure its quality is maintained. The City's drinking water is safe and reliable,

and meets or is better than the Guidelines for Canadian Drinking Water Quality. Monitoring results on key drinking water quality parameters can be found at www.calgary.ca/water. Calgary's wastewater treatment plants help ensure that the ecological integrity of the Bow River is protected for downstream communities. Treated wastewater in Calgary consistently complies with Alberta Environment & Parks' regulations.



THE CITY TESTS DRINKING WATER FROM SOURCE TO TAP

2.5.1 CALGARY'S SOURCE WATER QUALITY

Both the Bow River near the Bearspaw Dam and the Elbow River near the Glenmore Reservoir provide very high quality water supply to The City's water treatment plants, according to The City's long term analysis. We use the federal Water Quality Index (WQI) to track conditions, which translates data from multiple water quality parameters into a score from 0-100, along with a descriptor (Excellent, Good, Marginal, Poor). The Bow River typically has 'Excellent' water quality, while the Elbow River typically has 'Good' water quality. Over the last decade, we've observed consistently high WQI ratings near the City's water treatment plants (Figure 2.4).

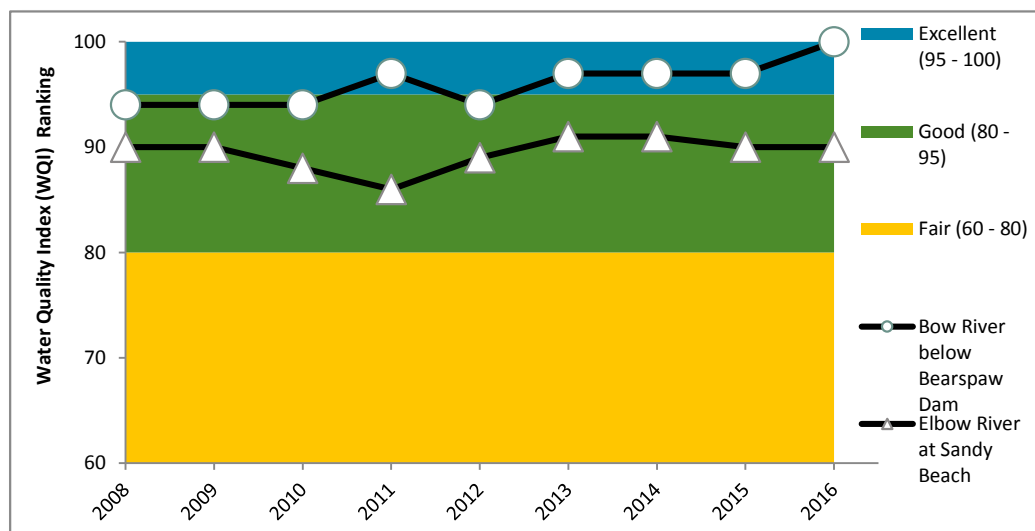


FIGURE 2.4 WATER QUALITY INDEX - CALGARY'S SOURCE WATER

With a larger flow, the Bow River is expected to be more resilient to changes in water quality compared to the Elbow River. However, current and future infrastructure and land use changes could impact The City's source water quality. Maintaining source water quality is part of the multi-barrier approach for producing safe drinking water.

2.5.2 LEAD SERVICE CONNECTION AND WATER QUALITY IMPACTS

Calgary's drinking water quality meets or performs better than all federal and provincial health guidelines. Our water quality team closely monitors drinking water daily from the river, to our treatment plants and throughout the distribution system, which delivers water to homes and businesses.

Lead is not found in our source water in the Bow or Elbow rivers. Prior to 1950, lead was commonly used for water service piping. Copper and plastic pipes have since replaced lead. A service connection is the water pipe that connects from The City's water main to the piping inside residences and businesses. The service connection is on both public and private property. A lead service connection is a connection made out of lead piping.

In Calgary there are 601 active lead service lines out of a total of 336,452 active water service lines - about 0.2 per cent of the total service count (Figure 2.5). These service lines are predominantly confined to the inner city area. For many years, The City has been managing lead through several initiatives including the Tap Water Sampling Program and Customer Rebate Program for filtration devices. Lead service connections are typically replaced when nearby water mains are replaced, when sites are redeveloped and when determined necessary through the tap water sampling program.

Health Canada is updating their guideline for lead in drinking water. The new guidelines will change the health risk-based maximum acceptable concentration (MAC) from 10 ug/L to 5 ug/L. The City was consulted by Health Canada during the update process. We anticipate that Health Canada will adopt these new lead guidelines in 2018. A review of The City's current practices on lead management is required so that we can develop a new strategy to meet the new MAC for lead. That strategy may include a more aggressive lead service replacement program for 2019-22, which would require additional capital investment in this program.

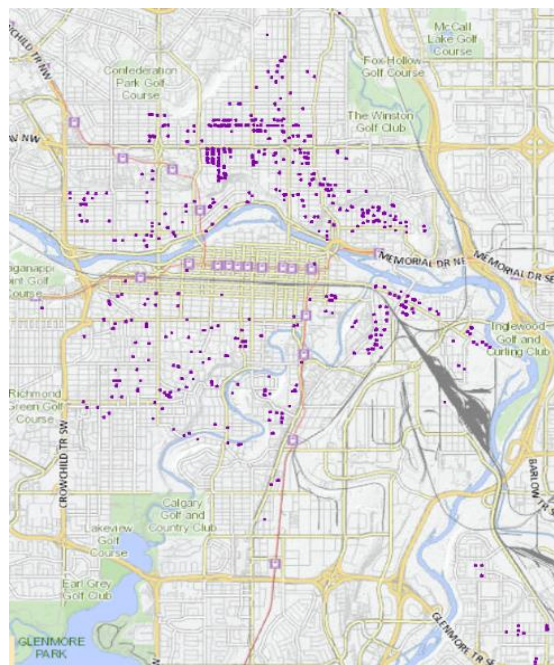


FIGURE 2.5 LEAD SERVICE PROPERTIES

2.6 REGIONAL COLLABORATION

Under the *Modernized Municipal Government Act*, a mandatory Growth Management Board is established for the Calgary region on 2018 January 1. Under the new Board, all municipalities are required to amend statutory plans and make decisions consistent with the growth plan for the entire region. This is a significant shift from the voluntary nature of the Calgary Regional Partnership (CRP), where priority for water and wastewater servicing was given to CRP members. The City is committed to providing existing customers with continued water and wastewater servicing and will work with the new Calgary Metropolitan Region Board on the new regional growth plan and servicing plans which will be developed over the next three to five years. The City's regional water, wastewater and stormwater servicing policy is presented in a separate report to Council (IGA2018-0089).

Alberta Environment and Parks, The City of Calgary, and the Western Irrigation District (WID) entered into a Western Headworks Stormwater Management Agreement in 2013. This agreement allows The City to discharge stormwater into the Western Headworks Canal, which is owned by the WID. This agreement also specifies some obligations The City has to fulfill, including payment of an annual fee, best management practices and water quality monitoring. The objective is to achieve net-zero increases in run off volumes, rates and loadings for urban stormwater entering the Western Headworks Canal.

The City is participating in the assessment of a regional stormwater solution for lands east of Calgary, known as the Cooperative Stormwater Management Initiative (CSMI). CSMI partners are comprised of

representatives from The City, City of Chestermere, Rocky View County, Town of Strathmore, Wheatland County and the Western Irrigation District. A Master Stormwater Agreement is under review to determine The City's future participation in CSMI. Details on the status of this initiative are in a separate report to Council (IGA2018-0090).

The City participated in the Provincial Bow River Working Group project that made recommendations for flood and drought mitigation in the Bow River watershed in an August 2017 report. A number of 'quick wins' were identified to improve flood and water supply resiliency in the region if implemented. Additionally, a proposed flood-focused reservoir upstream of Calgary would have short-term water supply benefits for Calgary, with three locations identified for further study. However, the majority of reservoir scenarios to address drought were focused on southern Alberta agricultural irrigation downstream of Calgary. More details on this initiative are found in a separate report (UCS2018-0092).

2.7 PRIORITIES IN 2018

Table 2.1 summarizes activities The City plans to take to continue protecting our water supply in 2018.

Table 2.1 Goal #1: Protect Our Water Supply – 2018 focus

2018 Planned Actions
Finalize The City's Source Water Protection Plan.
Initiate Drought Vulnerability Risk Assessment.
Examine changes in rainfall intensity to better understand impacts to the Water Utility.
Initiate development of an expanded strategy to address the new federal guidelines on lead.
Work with the Calgary Metropolitan Region Board to ensure future regional water servicing aligns with The City's Water Supply Management Framework and associated plans and programs.
Continue to ensure best management practices are adopted to manage stormwater, erosion and sedimentation for urban stormwater entering the Western Headworks Canal.
Determine direction and participation in regional stormwater management activities.

3. GOAL #2: USE WATER WISELY

3.1 WATER EFFICIENCY PLAN

In 2017, The City continued to implement recommendations made in the 2016 Water Efficiency Plan (WEP) Update. This included a shift in focus away from residential customer or user incentive based programs to industrial, commercial and institutional (ICI) customers, and outdoor water use. These programs aim to continue reducing overall water consumption and achieving The City's 2033 water demand target. Targeting outdoor water use helps reduce water demand, specifically aiming to reduce the peak day demand, an important consideration in planning new water treatment plant infrastructure.



CITY STAFF INTERACTED WITH OVER 4,000 CALGARIANS ON WATER EFFICIENCY IN 2017

In 2017, The City began implementing the revised WEP, with focus on:

- Understanding customer water usage data (e.g. high water users)
- Benchmarking water use
- Water use planning and forecasting
- Partnership development with the landscaping industry to support water efficiency programming.

Market and customer research was conducted to support program design. This data helps deliver targeted programs and services effectively and cost-efficiently, in ways that work for the customer. For example, program development is underway for the ICI and landscape sectors and residential programming is being redesigned.

There are two programs in the research and development phase that will support ICI water efficiency: the capacity buyback program and an irrigation efficiency program. The capacity buyback program encourages and rewards ICI organizations that reduce water use, and involves a customer water audit and report that provides options to increase their water efficiency. Once permanent water-saving measures are implemented, a one-time rebate is provided based on water savings. Irrigation specific programming focused on identifying and offering opportunities to increase the efficiency of irrigation systems and inform, educate and guide practices to reduce excess watering.

To support residential customers and ongoing reduction in outdoor water use, research is currently underway to redesign the YardSmart Program. The program is based on market research and working with the landscape sector, garden supply partners, developers and builders to drive change and reduce outdoor water use. These changes will help further address peak day demand. In the meantime, water efficiency communications and messaging will continue to be delivered through events and targeted education programs for indoor/outdoor residential and ICI customers, through traditional and social media channels and existing partnerships.

3.2 CALGARY'S WATER USAGE

Calgary's Water Efficiency Plan includes a "water neutral" goal of accommodating future population in 2033 with the same amount of water removed from the rivers in 2003. The City's water efficiency measures have been successful in helping Calgarians' meet this goal by reducing water usage over the last 14 years, despite population growth during that time in Calgary and the region. In 2017, annual water withdrawn from the Bow and Elbow rivers was 188,507 million litres (ML), remaining below the 2003 benchmark of 212,500 ML (Figure 3.1). This was about 8 per cent higher than in 2016, likely due to uncharacteristically hot and dry summer and fall, despite minimal population growth over the year.

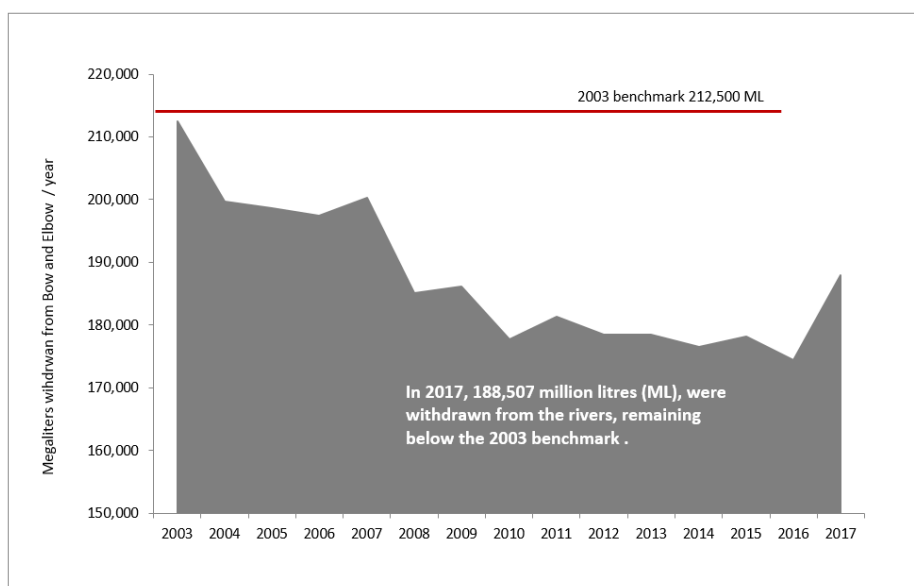


FIGURE 3.1 ANNUAL WATER WITHDRAWAL (ML/YEAR) FROM THE BOW AND ELBOW RIVERS

Reducing water demand can delay the need for infrastructure expansion projects and create operational savings. Lowering water demands in Calgary will also help protect drinking water supply for downstream users, minimize water pollution, maintain the health of local watersheds, and reduce greenhouse gas emissions. Supporting customers with water efficiency and education programs increases awareness and encourages behaviours and actions that benefit both citizens and the watershed.

3.3 CALGARY'S PER CAPITA WATER DEMAND

Single and multi-family residential customers make up the majority of Calgary's water demand, followed by ICI customers (Figure 3.2). Per capita water demand is the average volume of water used per person per day. In 2017, Calgary's overall water use (including residential, ICI and municipal demand in Calgary) was 378 litres per capita per day (lpcd), well on track to meet the 2033 target of 350 lpcd (Figure 3.3) and a 29 per cent decrease since 2003.

Of the overall water use in 2017, single-family residential demand was estimated to be 224 lpcd, slight increase from recent years. The increase was due in large part by the extended hot and dry conditions in the summer and fall of 2017. This suggests a shift to programming focused on outdoor water conservation and ICI processes has the potential to bring summer water consumption down across Calgary.

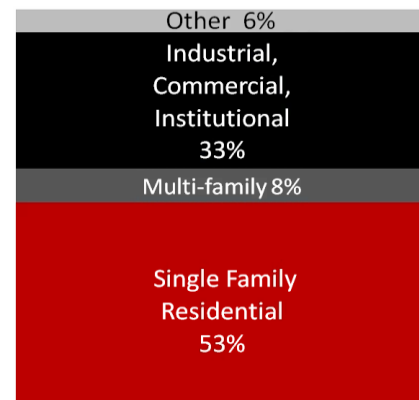


FIGURE 3.2 WATER DEMAND BY CUSTOMER TYPE

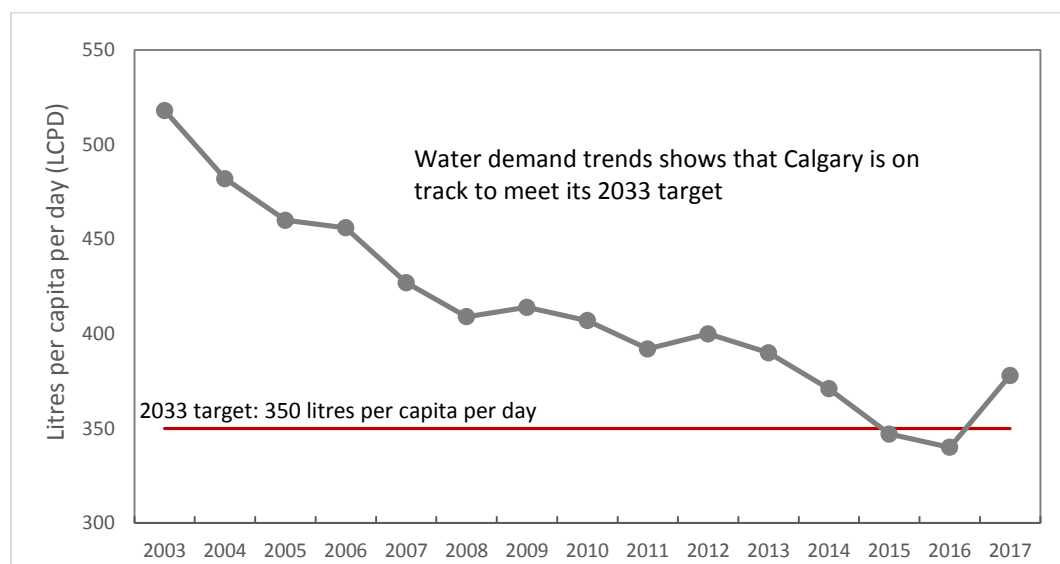


FIGURE 3.3 CALGARY'S TOTAL PER CAPITA WATER DEMAND TRENDS OVER TIME

3.3.1 CONSERVATION AND EDUCATION PROGRAMS

The City of Calgary has developed a number of programs since 2005 to encourage conservation and water savings for customers. Through customer actions, we have been successful at keeping water demand within our WEP goals. The program has also provided residential customers with savings through reduced water consumption. Collective actions by customers have resulted in considerable water savings in Calgary. In 2017, the YardSmart program reached over 5,000 Calgarians through rain barrel sales, Beauty on a Budget classes, Diggin' In workshops, and other public events. We also interacted with over 4,000 customers regarding water conservation and stormwater education at events such as Feeding 5,000, Earth Hour, and the Canada 150 Celebration. The



**YARDSMART DIGGIN' IN GARDENING
DEMONSTRATION**

City also gave tours to 1,127 people through school and public tours at the Glenmore Water Treatment and Pine Creek Wastewater Treatment Plants. Audiences were engaged in water conservation and watershed protection through programs and education efforts of The City's various watershed education partners such as River Watch, Yellow Fish Road, and Alberta Science Network.

3.4 PEAK DAY DEMAND

The one day in a year that Calgary requires the most water is referred to as the peak day demand. This typically occurs in the spring or summer, as water demand can spike from outdoor watering activities and cooling of buildings. Peak day demand is an indicator of the maximum amount of water being used by Calgarians. In 2017, Calgary's peak day water demand occurred on July 7, and was almost 762 ML, which is below the 950 ML water treatment plant capacity (Figure 3.4). This year's peak day was higher than in 2016 and can likely be attributed to the significantly drier and hotter than average summer conditions experienced in Calgary in 2017.

Although the peak demand remains under the current water treatment plant capacity, it is important to continuing monitoring, as it can be highly variable from year to year based on population, conservation practices, and potential climate change and weather impacts. The peak day demand is a primary driver for investment in water treatment plants, as both Bearspaw and Glenmore water treatment plants must produce sufficient water to meet demand on the peak day, especially with population growth. Reducing peak day demand through outdoor water efficiency programs, targeting the commercial and irrigation and landscaping sectors could help delay the need of water treatment plant investments.

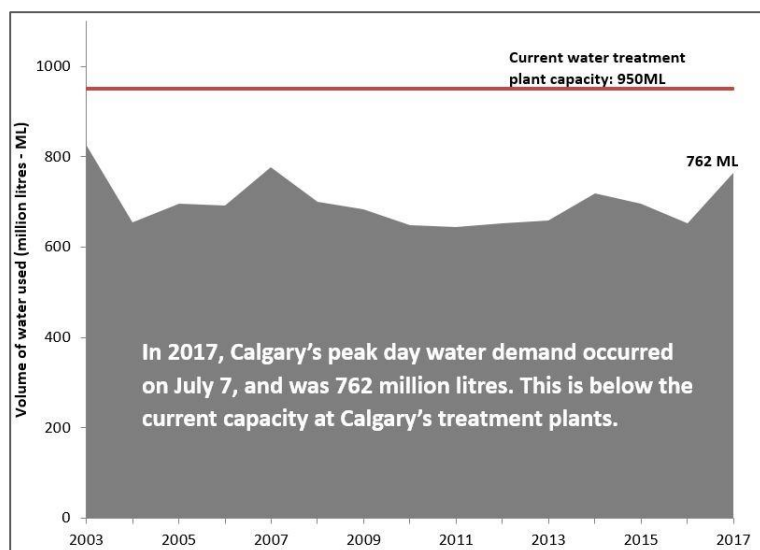


FIGURE 3.4 PEAK DAY DEMAND – MAXIMUM VOLUME OF WATER USED IN CALGARY IN ONE DAY

3.5 LEAK DETECTION

To reduce non-revenue water loss, as well as protect property, the environment, and drinking water quality, we conduct leak detection testing on City infrastructure. This is a critical part of our infrastructure maintenance program, as water from leaks in underground pipes with good soil drainage does not typically reach the surface and can go unnoticed for a long time. Leaks that are identified through the leak survey program are scheduled for repair. Leak detection and repair completion rates are monitored on a section-by-section basis. In 2017, City crews surveyed 241 kms of water mains and identified and fixed 14 leaks, leading to estimated water savings of 6.5 million litres per day, enough water to serve over 29,000 people per day.

3.6 PRIORITIES IN 2018

The City will continue working with customers to encourage responsible and efficient use of water. Activities planned for 2018 are summarized in Table 3.1.

Table 3.1 Goal #2: Use Water Wisely – 2018 focus

2018 Planned Actions
Continue to build our understanding of the ICI sector-Water profile, values, and preferences to inform water conservation programming.
Design and develop education, outreach and communications programming to reduce outdoor water use to address peak day demand.
Continue to provide education and outreach to citizens about the Water Utility, leaks and high-water consumption, outdoor water use, and the importance of conservation.
Continue aligning water efficiency, demand forecasting and infrastructure planning.

4. GOAL #3: KEEP OUR RIVERS HEALTHY

As the Elbow and Bow rivers flow through Calgary, they supply our city's drinking water, provide recreation, and support aquatic ecosystems. Calgary's stormwater and treated wastewater is released into these two rivers. Excess nutrients, sediment, bacteria and other pollutants that enter our rivers can negatively impact fish and wildlife, the ecosystem and drinking water. The City works diligently to manage these risks and protect the areas adjacent to rivers and creeks.

Protection of Calgary's waterways is guided in part by The City's Approval to Operate from the Province, which outlines sediment management and pollutant loading objectives for the Bow River. The City's Approval to Operate its wastewater system is up for renewal in 2018 and is informed by the Receiving Water Assessment and Total Loading Management Plan (TLMP). The TLMP ensures that pollutant loadings to the Bow River remain below certain levels by guiding future stormwater and wastewater source control practices and infrastructure decisions.

The City also has a Stormwater Management Strategy, approved by Council in 2005 that aims to reduce pollution from stormwater runoff entering the rivers. We are continuously working to improve the way stormwater is managed, through research and evolving strategies and programs. Managing water quality is a major component of our alignment to the South Saskatchewan Regional Plan. This section highlights the results of these efforts in 2017.

4.1 WASTEWATER MANAGEMENT

4.1.1 APPROVAL TO OPERATE

The City of Calgary operates its wastewater system, which includes three wastewater treatment plants and a wastewater collection system, under the Environmental Protection and Enhancement Act. The approval applies to the construction, operation and reclamation of our wastewater system. The current approval expires October 1, 2018 and on November 8, 2017, The City of Calgary submitted an application to renew the approval for another 10 years to Alberta Environment and Parks (AEP). Obtaining the approval from AEP ensures that The City continues to operate its wastewater system in accordance with environmental regulations.

4.1.2 WASTEWATER TREATMENT PLANTS

In 2017 the three wastewater treatment plants in Calgary (Bonnybrook, Pine Creek and Fish Creek) produced treated effluent compliant with the Municipal Approval to Operate and Federal temporary authorization limits (Fish Creek only) established to protect river water quality.



THE BONNYBROOK WASTEWATER TREATMENT PLANT IS UNDERGOING MAJOR UPGRADES

Major upgrades to the Bonnybrook Wastewater Treatment Plant continue to ensure regulatory requirements are met and to support population growth. In 2017, The Bonnybrook Expansion Project included the completion of phase 1 of the Plant D expansion that included upgrades and expansion of the sludge digesters. This resulted an increase in capacity, hydraulic mixing performance and processing of biogas production. Detailed design of the remainder of the project is scheduled to be complete early in 2018.

A \$162 million contract for Plant D Secondary Treatment work was awarded in November 2017. This will increase the installed treatment capacity by 20 per cent and meet the effluent quality parameters specified under the Provincial Approval to Operate. The project is scheduled to start in March 2018 with Plant D Secondary Treatment online by September 2021. The remaining budget requests will be included in the 2019-22 One Calgary submission. Construction of the flood protection berm also started in 2017. This berm will provide flood protection for the plant, minimizing disruption to operations if another 2013 flood were to occur.

4.1.3 RECEIVING WATERS ASSESSMENT

Alberta Environment and Parks has indicated they may reduce ammonia discharge limits from the Bonnybrook and Pine Creek wastewater treatment plants in the future. The City is addressing this possibility through a Receiving Waters Assessment to examine the impact of the effluent from our wastewater treatment plants on the Bow River. The assessment screened more than 121 substances to see which of them could have an impact on the aquatic habitat. Un-ionized ammonia was determined to have potential to exceed the Provincial and Federal water quality guidelines. Major exposure (chronic toxicity) of this substance can have lethal impact on fish.

There is also a high likelihood that Provincial un-ionized ammonia guidelines could be exceeded downstream of the Fish Creek wastewater treatment plant (WWTP), prior to the South Catchment Upgrade/Expansion. Environment Canada has given temporary authorization to allow un-ionized ammonia discharges. However, The City is proactively addressing this issue with AEP because of anticipated regulation of discharges from Fish Creek WWTP.

4.1.4 BIOSOLIDS MANAGEMENT

One of the largest projects completed this year at Bonnybrook was the construction and commissioning of the biosolids dewatering facility that will provide biosolids to The City's new composting facility. Biosolids, a nutrient-rich organic material produced by wastewater treatment are a valuable resource that The City has been using for decades. Our current Biosolids program includes Calgro™ program, demonstration projects, and the organics composting facility. The Calgro™ program has provided biosolids to local farmers as fertilizer since 1983. The treated biosolids are safely applied under the soil to agricultural lands following Provincial guidelines, and used to grow grains, oilseed, legumes, forage crops, trees and sod.

The Biosolids Demonstration Project initiated in 2013 in partnership with SYLVIS is providing nutrients for one of the largest willow plantations in North America. The Calgary Zoo is currently obtaining all of their veterinary-



CALGARY ZOO GIRAFFES BEING FED CITY OF CALGARY WILLOW PLANTATION BRANCH

recommended browse and forage willow requirements from this plantation. The woody material from the willow harvest may also be used in the future as a feedstock for a number of other initiatives, including The City's new composting facility.

The City of Calgary's composting facility is the largest of its kind in Canada, producing compost from food and yard waste collected from the Green Cart and biosolids produced at Bonnybrook wastewater treatment plant. The facility will produce a compost that is safe to use in commercial and residential applications and will add valuable nutrients to the soil. Biosolids and green cart waste are kept separate and composted separately in the facility.

4.1.5 INDUSTRIAL, COMMERCIAL AND INSTITUTIONAL (ICI) CUSTOMERS

Some industrial, commercial, and institutional establishments produce wastewater that may have a higher concentration and contain different contaminants that cause it to exceed wastewater quality guidelines – this is called high-strength wastewater. In 2016, The City initiated the Wastewater Loading Management Program to improve management of high-strength wastewater from ICI customers, as this wastewater is technically challenging and expensive to manage and treat. The program is an opportunity to identify and implement cost-effective, resource efficient, reliable, and equitable strategies that meet customers' needs for wastewater load management while at the same time contributing to optimal use of existing wastewater treatment plant capacity.



PINE CREEK WASTEWATER TREATMENT PLANT

The City continued to advance the program in 2017 by completing a current state assessment increasing The City's understanding of customer needs, wastewater system operating sensitivities and operational efficiencies. This work has set the foundation from which to build enhancements and make business process improvements. Work on the Program will continue in 2018 to identify and assess wastewater load management options.

4.2 TOTAL LOADING MANAGEMENT



THE CITY WORKS TO REDUCE POLLUTANTS FROM STORMWATER AND WASTEWATER

Pollutant loadings into the waterways can affect water quality and river health, and can create maintenance issues for Calgary's wastewater and stormwater infrastructure. The City's Total Loading Management Plan ensures that pollutant loadings to the Bow River remain below certain levels. The plan includes provincially set pollutant loading objectives for both wastewater treatment plants and stormwater. This helps minimize the impact of wastewater discharges and stormwater runoff on the Bow River's water quality and contributes to maintaining a healthy aquatic ecosystem. Total loadings are also related to river flows so will vary somewhat depending on seasonal fluctuations.

4.2.1 TOTAL SUSPENDED SOLIDS IN THE BOW RIVER

Total suspended solids include organic and inorganic materials that are suspended in stormwater and treated wastewater. These materials enter our waterways and can impact water quality and aquatic habitat. Figure 4.1 shows that The City has remained under the Provincial guideline for total suspended solids (TSS) loadings into the river from stormwater and wastewater sources. Urban runoff from stormwater contributes a significantly higher proportion of total suspended solids to the Bow River compared to wastewater effluent.

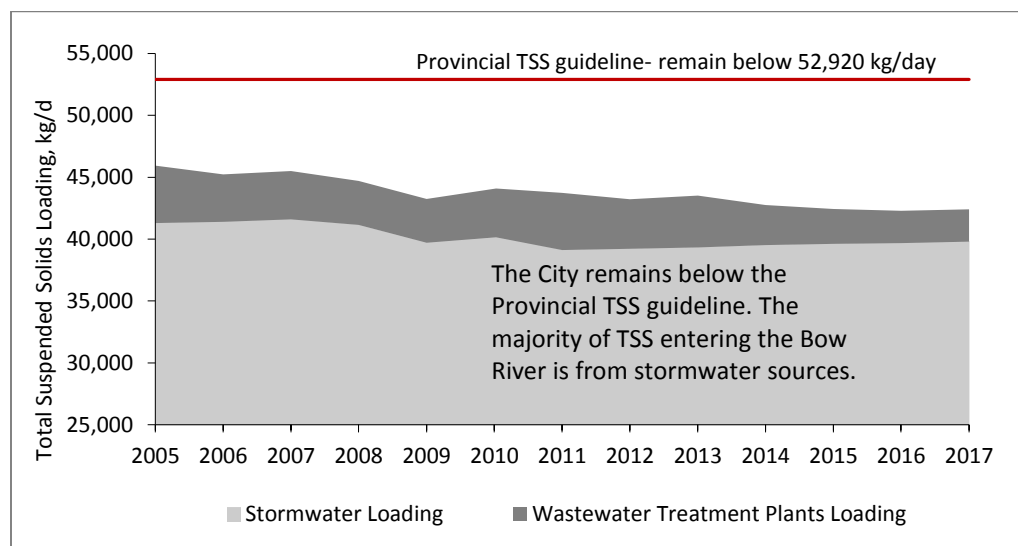


FIGURE 4.1 TOTAL SUSPENDED SOLIDS (TSS) LOADING TO THE BOW RIVER FROM STORMWATER AND WASTEWATER

4.2.2 PHOSPHORUS IN THE BOW RIVER

Phosphorus is a nutrient that can have detrimental impacts to fish and other aquatic life when present in high concentrations. Too much phosphorus can cause accelerated plant growth, algae blooms and low dissolved oxygen. The City's Total Loading Management Plan has set a total loading objective for Total Phosphorus. At 210 kg/day, the primary source of Total Phosphorus entering the Bow River in Calgary is from treated wastewater effluent, with the remaining 86 kg/d contributed from stormwater (Figure 4.4).

Figure 4.2 shows reported Total Phosphorus loadings from both stormwater and wastewater to be below the Provincial guidelines in 2017. Treated wastewater contributes more than double the amount of Total Phosphorus to the Bow River compared with stormwater sources.

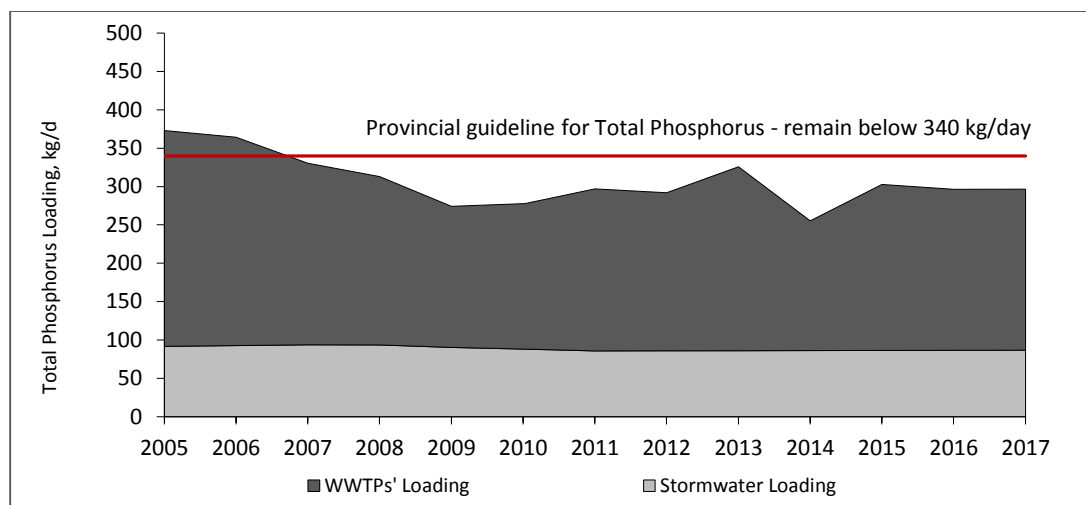


FIGURE 4.2 TOTAL PHOSOPHORUS LOADINGS TO THE BOW RIVER FROM WASTEWATER AND STORMWATER

4.2.3 TOTAL LOADING MANAGEMENT PLAN UPDATE

Every five years as part of the Total Loading Management Plan (TLMP) update, The City evaluates stormwater and wastewater pollutant loadings and screens for parameters that can impact the aquatic ecosystem. In the 2017 TLMP update, total suspended solids (TSS) and total phosphorus (TP) continue to be the key parameters identified that require management to mitigate environmental impact to Calgary's watershed.

The City uses computer models to simulate total pollutant loadings to the Bow River. In 2017, further refinements to the Bow River Water Quality Model incorporated changes in wastewater treatment, and stormwater infrastructure, and integrated more robust stormwater management information. The model will be used to assess the impact of future wastewater treatment plant effluent and stormwater infrastructure on the Bow River. It will also provide guidance for a renewed Stormwater Management Strategy scheduled to be complete in 2022.

As part of the TLMP update, The City conducted a Total Loading Objectives Assessment to re-assess loading objectives. Recommendations from the assessment are part of the application package for the renewal of The City's Wastewater Approval in 2018.

4.3 STORMWATER MANAGEMENT

The City's 2005 Stormwater Management Strategy's goal is to maintain TSS loadings from stormwater in the Bow River at or below 2005 levels, even with a growing city. In 2017, estimated TSS loadings from stormwater to the Bow River were 39,799 kg/day, which is below the 2005 benchmark (Figure 4.3). Stormwater retention ponds, wetlands, and green stormwater infrastructure projects are effective in reducing TSS loadings to the rivers.

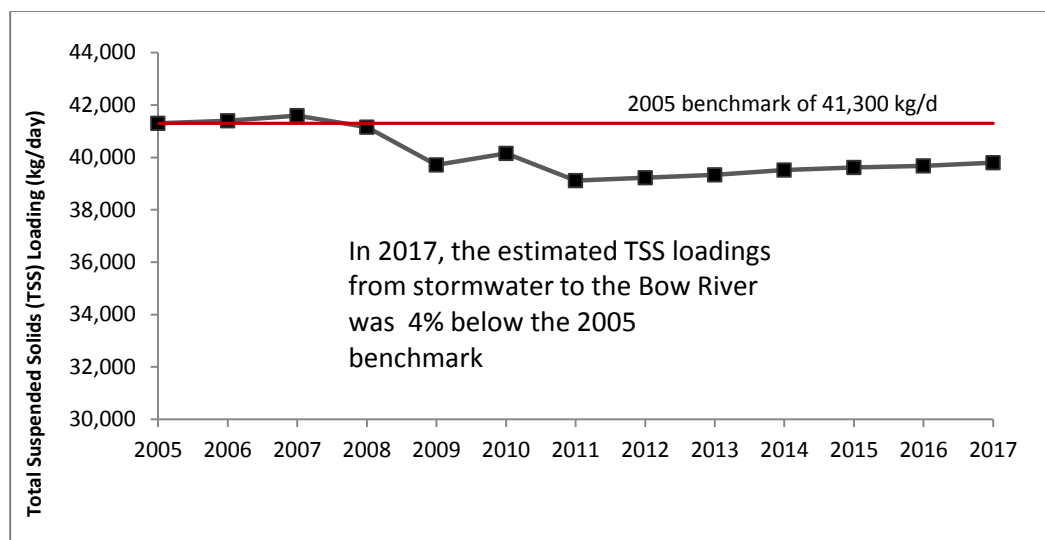


FIGURE 4.3 TOTAL SUSPENDED SOLIDS (TSS) TO THE BOW RIVER FROM STORMWATER

4.3.1 STORMWATER MANAGEMENT STRATEGY UPDATE

As Calgary and the region grow, stormwater management presents several unique challenges because it typically has no discrete point of origin, leading to management limitations and is tied to land use practices, planning and development. Both wastewater and stormwater are sources of water pollution in our watershed, however wastewater is manageable with infrastructure upgrades, leaving stormwater as the greater challenge as Calgary continues to urbanize and the climate changes.

Various stormwater and land management practices have helped manage impacts of a growing city (e.g. innovative technologies to manage stormwater drainage, introduction of green and natural infrastructure and erosion and sediment control measures). The City's stormwater management system has benefitted from investments put in place over the last decade or so, including innovative stormwater quality retrofits, the Community Drainage Improvement Program, and green stormwater infrastructure.

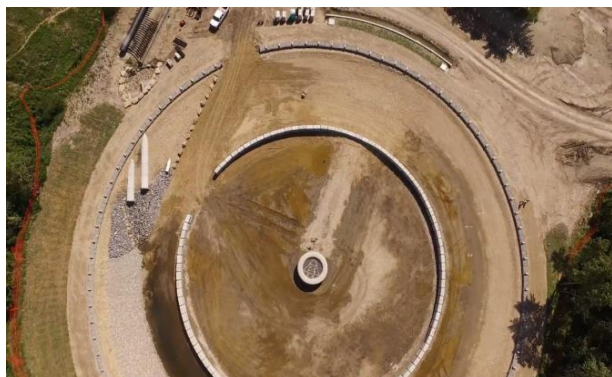
As practices and standards have evolved and new issues such as climate impacts have emerged, an improved understanding of stormwater impacts warrants a fresh look at stormwater management. A revamping of the 2005 Stormwater Management Strategy is required to ensure progress on sustainably managed stormwater.

In 2017, The City completed a framework to facilitate the update of the Stormwater Management Strategy. Over the next three years, The City will conduct extensive stakeholder engagement with customers, internal and external stakeholders and the development industry to advance the strategy. New stormwater quality targets are also being examined to provide key input on the new Strategy.

4.3.2 STORMWATER QUALITY RETROFIT INVESTMENTS

The City constructs stormwater quality retrofit projects such as wet ponds or constructed wetlands across the city. These projects improve the quality of water by removing solids and other pollutants before it enters our rivers.

The construction of the Bowmont East Stormwater Quality Retrofit pond in Dale Hodges Park was completed in 2017 and it will be operational in 2018. The project is anticipated to reduce the amount of sediment that enters the Bow River from the 1687 ha catchment by approximately 50 per cent, and will restore the natural park area located within the disturbed Klippert lands. This project includes the use of a circular Nautilus Pond™, which is a form of advanced stormwater treatment technology. The



BOWMONT PARK - STORMWATER WILL ENTER THE PARK THROUGH THIS CIRCULAR NAUTILUS POND™, WHERE MOST SEDIMENT PARTICLES ARE REMOVED.

The 37th Street Stormwater Quality Project includes construction of an oil-grit separator, to be completed in 2018. The project will provide stormwater treatment for a currently untreated developed catchment area, which discharges via the 37th Street Storm Trunk. This project will improve water quality in this sensitive area, which includes the Weaselhead Flats natural environment park and the Glenmore Reservoir, which provides Calgary's drinking water.

innovation represented in this project is the result of a partnership with the Public Art Program.

The Riverbend Trunk pond is being constructed to accommodate increased road runoff, facilitate future development, manage flows and provide stormwater treatment for industrial areas, which to date have not received treatment. Design of this facility is expected to be complete by February 2018, with construction completion scheduled for 2019.



STORMWATER IS FURTHER TREATED IN NATURAL-LOOKING WETLANDS AT BOWMONT PARK

4.3.3 STORMWATER PONDS

There are over 300 wet and dry storage ponds in Calgary's stormwater drainage system. These ponds reduce the amount of sediment and other pollutants entering our rivers. They also provide some flood mitigation by holding stormwater and releasing it slowly back into the stormwater system, reducing peak flows. The City's Pond Condition Assessment Program continued in 2017, with approximately 26 per cent of wet ponds and wetlands analyzed since the inception of the program in 2015.

The program identified the need for regular maintenance to ensure that the ponds are operating effectively. The program also identified five wet ponds that require structural modifications to function properly, meet regulatory requirements, and ensure safety standards are met.



SAFETY SIGNAGE AT A STORM POND

In 2017, effort was undertaken on two wet ponds and catchment areas (Hidden Valley and Confederation Park) to define options for modifications and improvements. This work is continuing in 2018 with work on the additional three ponds expected to start in 2018 and phased over the next business cycle. These projects include design, construction, maintenance and addressing operational challenges such as algae growth.

Research into options to control algae in Calgary's wet ponds will continue in 2018. Information collected through several seasons will capture both cool and hot temperatures, ensuring that cost-effective solutions are implemented and have been properly tested for future use.

4.3.4 GREEN STORMWATER INFRASTRUCTURE



THIS RAIN GARDEN IS AN EXAMPLE OF GREEN STORMWATER INFRASTRUCTURE

Green stormwater infrastructure (GSI), also known as low impact development, uses natural processes to treat stormwater and allows water to be absorbed and filtered by soil and vegetation. GSI is a key opportunity to improve Calgary's adaptation to climate change and to foster resiliency. The City is completing an internal GSI Strategy, which outlines the challenges and opportunities of using GSI as a viable stormwater management tool. A work plan developed in 2017 will support the implementation of GSI over the next two budget cycles. The strategy and work plan will be completed in 2018 at which time The City will determine how to advance this work.

4.3.5 EROSION AND SEDIMENT CONTROL

Construction activity in Calgary exposes highly erosive subsoil, which is easily transported off-site by wind and water. In 2017, to protect the watershed and storm infrastructure from the impacts of construction site sediment, City staff conducted 415 site inspections and reviewed 521 erosion and sediment control plan applications. When implemented, the erosion and sediment control plans approved during the year are expected to reduce soil loss from construction sites by 27,922 tonnes. This results in less sediment entering our waterways.

4.4 RIPARIAN ACTION PROGRAM

Riparian areas are located along the edges of rivers and creeks within our watershed. They are unique ecosystems largely defined by the complex interactions that happen when land meets water. Networks of healthy, well-connected riparian areas provide many ecological, social and economic benefits including water quality protection, resilience to flood and drought, biodiversity, and recreational opportunities.



VOLUNTEERS CONTRIBUTING TO A RIPARIAN PLANTING PROJECT ALONG THE BOW RIVER

The City's Riparian Action Program provides direction and management actions to maintain and improve riparian health, and minimize further loss of riparian areas. The program also provides guidance on outreach and education actions by offering various opportunities to connect Calgarians with the rivers.

The City continued to advance this program in 2017 by completing the mapping of ephemeral and intermittent streams throughout Calgary. These streams appear either after a heavy rainfall or snow melt event, or only exist during part of the year. Mapping them helps us understand how they function, so we can plan to protect these types of streams.

Bioengineering incorporates plant materials with synthetic support materials to stabilize river banks, reduce erosion and establish vegetation. Seventeen bioengineering and riparian planting projects were either designed, undergoing construction or completed in 2017. Citizens and education partners contributed to a riparian planting project along the Elbow River, and stakeholders have learned about the Riparian Action Program through presentations and workshops. Opportunities to help connect citizens with our rivers and riparian areas will continue in 2018, including identifying partnerships with key education and stewardship organizations.

4.4.1 MONITORING RIPARIAN HEALTH

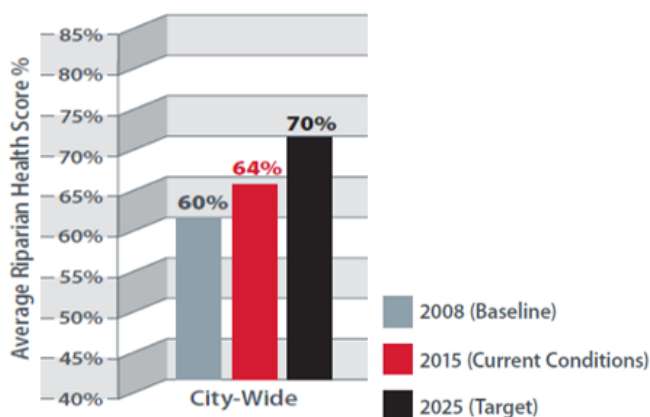


FIGURE 4.4 CITY WIDE RIPARIAN HEALTH SCORES

The Riparian Monitoring program is underway to measure riparian health trends and the success of riparian restoration projects. The City will monitor over 50 bioengineering bank restoration sites and 15 riparian planting restoration sites for the next 5 years to gather an understanding of restoration performance and plant health. Since 2013, the number of restoration sites using bioengineering techniques has exceeded the number of hard engineering projects.

Monitoring to date indicates that Calgary's city-wide riparian health is improving (Figure

4.4). Baseline surveys of riparian health were conducted across 57 sites in Calgary. Healthy riparian areas generally have diverse plant cover, deeply rooted and stable banks, minimal disruption from humans, wildlife or livestock, and experience minimal artificial flows.

Assessments showed that overall riparian health scores in Calgary have improved, with 25 per cent of sites showing an improving health trend and very few sites showing a declining health trend. Overall, the City-wide average riparian health score at monitored sites increased by four per cent.

Key factors contributing to this trend include restoration and management improvements, and natural vegetation recovery. We are making progress towards our 2025 target for average city-wide riparian health of 70 per cent. The Riparian Monitoring Program will continue to measure progress towards our riparian health targets, as well as provide recommendations on the effectiveness of various

bioengineering techniques, which combine living and non-living plant materials to help stabilize river and stream banks.

4.4.2 RIPARIAN LAND USE PLANNING

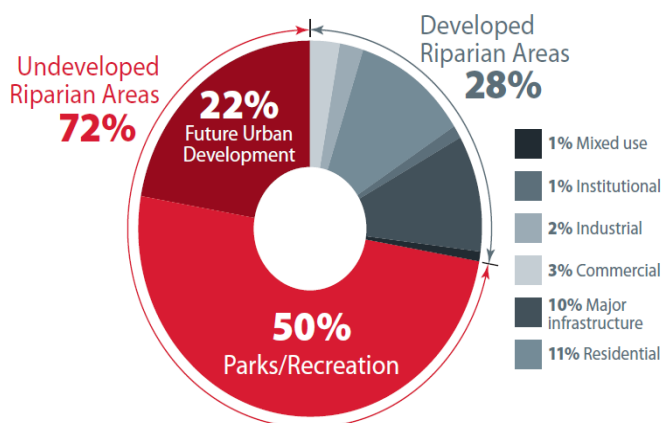


FIGURE 4.5 MAJOR LAND USE IN RIPARIAN AREAS (2012)

Less than one third (28 per cent) of riparian areas are developed in Calgary along major rivers and streams (Figure 4.5). The remaining portion is undeveloped, with 50 per cent conserved as parks and recreation areas, and 22 per cent awaiting future urban development.

Retaining open spaces along major rivers and creeks and critical ephemeral and intermittent streams is important to reduce further loss of riparian areas (Table 4.1).

Mapping projects like the Ephemeral and Intermittent Stream Mapping have helped identify riparian areas in future urban development areas, and will inform how to protect and manage development around these areas using appropriate planning tools.

Table 4.1 Riparian land-use indicators and targets

Outcome	Indicator	Area	Baseline	2026 Target
Further loss of riparian areas is minimized	Riparian open spaces along major perennial creeks and rivers	City wide	73%	No net loss
		Bow River	75%	
		Elbow River	62%	
		Nose Creek + West Nose Creek	67%	
	Riparian open spaces along ephemeral and intermittent watercourses	City Wide	36%	Tools are being evaluated to minimize the loss of ephemeral and intermittent streams during planning and development

functionality, the risks (regulatory, operational and environmental) associated with the Provincial policy and how it will translate into an approval process for both the Province and The City.

4.7 WATER REUSE

In 2017, The City initiated the rainwater and stormwater reuse program to have another mechanism available for watershed management. The scope of the initiative is to enable rainwater and stormwater reuse for internal plumbing and irrigation. This will ensure that proposed reuse systems are effective at managing risks associated with public health, environmental protection, and prevent cross contamination into The City's water infrastructure. The program will also ensure that The City is compliant with provincial regulations for approving water reuse systems. The City is working closely with the Province on this as they develop the future Provincial policy on water reuse.

To support this policy development, AEP initiated a pilot to use stormwater to maintain four natural wetlands within an urban development in northeast Calgary. The City is a part of the working group for this pilot and the work will be integral in expanding acceptable reuse applications for stormwater as well as paving the way to a practical approach to maintain wetlands in an urban context.

4.8 WATERSHED HEALTH INDICATORS

There are several watershed health metrics that can be used to strengthen urban development practices and understand the health of our watersheds. The City is reviewing and expanding the metrics used to evaluate watershed health in an urban context. A suite of indicators was identified and refined in 2017 by an interdisciplinary working group as the initial phase to develop a watershed health index for Calgary. Using this suite of indicators, a comprehensive watershed health index will be developed to be included in future Municipal Development Plan (MDP) reporting.

The metrics developed relate to water quality, habitat, landscape, hydrology and morphology. They were selected using criteria established by the working group and an assessment of best practices, with the intention that monitoring these indicators will inform appropriate watershed management and land use planning actions.



**WATERSHED HEALTH IS IMPACTED
BY URBAN DEVELOPMENT**

These metrics align with The City's strategies and plans, as well as regional watershed health assessments and indices. While a comprehensive index is being developed, this current information will be used to contextualize the final Municipal Development Plan Monitoring and Reporting process in Q2 2018. Impervious surfaces will be reported and new indicators on riparian health will be included as supplementary indicators. This is the last report before the MDP is reviewed.

The next phase of the watershed health index project will include a gap analysis and refinements of metrics to develop the index and examine watershed health issues within Calgary's sub-watersheds.

4.9 PRIORITIES FOR 2018

To continue reducing the impacts on the watershed and keeping our rivers healthy, The City's focus areas for 2018 are summarized in Table 4.2.

Table 4.2 Goal #3: Keep Our Rivers Healthy – 2018 focus

2018 Planned Actions
Negotiate with Alberta Environment and Parks The City's Approval to Operate 2018-2028.
Continue implementation of Bonnybrook Wastewater Treatment plant upgrades.
Advance the Wastewater Loading Management Program by identifying and assessing wastewater load management options.
Total Loading Management Plan: Negotiate new loading objectives with AEP. Assess new water quality model to better understand The City's loading impact on the watershed.
Continue work on The City's Stormwater Management Strategy and developing targets in alignment with customer commitments and engaging with key internal and external stakeholders.
Continue to invest in Stormwater Quality Retrofit projects
The Pond Condition Assessment Program will continue including pond redesigns, retrofits, and study of broader catchment areas to mitigate pond issues.
Complete the Green Stormwater Infrastructure Strategy and Work Plan. Evaluate resources for implementation over the next two business cycles.
Continue implementation of: riparian monitoring program, riparian restoration, bioengineering and fish habitat compensation projects, outreach initiatives, and integration of riparian maps in land use planning processes.
Complete the update of the Nose Creek Watershed Water Management Plan and report to Council.
Plan the next phase of developing a watershed health indicator and reporting on watershed health – initiate comprehensive gap analysis and refinements of metrics to examine watershed health issues within Calgary's sub-watersheds.

5. GOAL #4: BUILD RESILIENCY TO FLOODING



5.1 RIVER FLOOD MITIGATION AND RESILIENCY PROGRAM

The City continued to focus significant effort and investments in flood resilience and protection in 2017. As part of this work, The City delivered the results of a comprehensive Flood Mitigation Measures Assessment (FMMA, UCS2017-0266) in 2017. The FMMA results now serve as the framework for The City's long-term Flood Mitigation and Resilience Strategy. City Council endorsed the strategy on 2017 April 10, and identified flood mitigation as a top strategic priority for The City of Calgary.



FLOOD MITIGATION IS A TOP PRIORITY FOR CITY COUNCIL

The City continued to implement the recommendations made by an independent Flood Expert Management Panel as directed by Council in 2014. Significant progress has been made on these recommendations and as of 2017, 12 recommendations are underway and 15 are completed.

The City has received \$40.3 million for various flood mitigation and resilience projects through the Alberta Community Resiliency Program to date. In 2017, The City applied for \$81 million for six more community based flood mitigation projects (PFC2017-0462). Mitigation work that is already complete or is ongoing has reduced Calgary's financial exposure to flood damage by about 30 per cent. Updates on progress on The City's Flood Mitigation and Resilience Strategy is discussed in detail in a separate report (UCS2018-0092).

5.2 LOCALIZED FLOODING AND THE COMMUNITY DRAINAGE IMPROVEMENT PROGRAM

Intense rainfall events can trigger localized stormwater flooding and cause property damage. As we anticipate increased extremes in seasonal changes and high intensity rain events, The City understands that these climate change impacts are important to consider when planning future infrastructure investments and how we manage Calgary's stormwater drainage system.

The City organizes response strategies to mitigate these extreme events and safeguard public safety and property. Innovative operational and infrastructure measures to mitigate the impacts of localized flooding have been deployed, such as improved response times, and The City has made efforts to improve public awareness about these events.

Long-term resilience to local flooding is delivered through the Community Drainage Improvement (CDI) Program. The program invests in drainage infrastructure upgrades to mitigate localized flood risk, with a focus on established communities with the highest risk of stormwater flooding. The CDI Program delivered an estimated \$9.5M of planning, design and construction activities in 2017. A summary of current CDI investments and 2017 activities is found in a separate report (UCS2018-0092).

5.3 PRIORITIES FOR 2018

In 2018, The City will continue to build resiliency to river flooding and implement actions to reduce stormwater flooding, as summarized in Table 5.1.

Table 5.1 Goal #4: Build Resiliency to Flooding – 2018 focus

2018 Planned Actions
Continue to build resiliency to flooding - deliver implementation of key flood mitigation investments, advocate for upstream mitigation, pursue flood policy review, and advance Expert Panel recommendations.
Make progress on The City's drainage program - advance the Community Drainage Improvement program of stormwater infrastructure upgrades in communities experiencing local flooding. Continue evaluating options to accelerate delivery of the CDI Program.