

WATERSHED PLANNING



2016 WATERSHED PLANNING UPDATE

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1. INTRODUCTION

1.1 WATERSHED PLANNING – OUR PURPOSE

The City of Calgary takes a customer-focused approach to ensure we have a healthy, resilient watershed capable of providing clean, reliable water for our current needs and future generations. We work with regional partners on integrated watershed management, which includes addressing the important relationship between watershed protection, climate resiliency and land use.

Increased pressure on our watershed from population and economic growth in the region as well as climate change impacts make watershed management one of Calgary's most critical resiliency challenges. Considering these pressures, The City continues to provide reliable and safe drinking water for customers, monitors the quality of water returned to the river from wastewater treatment, and manages the impact of stormwater on communities and rivers. We also engage with customers on conserving water, preparing for flood and drought, upgrading infrastructure and keeping our watershed healthy.

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 our 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.

WATERSHED PLANNING DIVISION – STRATEGIC FRAMEWORK

GOAL 1:

Protect our water supply

- Integrated Water Supply Management Strategy
- Source Water Protection Plan
- Drought Management Plan
- Strategic regional servicing and partnerships
- Modelling and monitoring
- Climate action planning
- Raw water management
- Water reuse planning



GOAL 2:

Use water wisely

- Water Efficiency Program
- Citizen water conservation education and outreach
- Industrial, commercial, institutional water conservation outreach
- Infrastructure renewal



GOAL 3:

Keep our rivers healthy

- Stormwater Management Strategy
- Total loading management
- Stormwater targets
- Citizen education and outreach
- Green stormwater infrastructure
- Riparian Action Program
- Wetlands conservation
- Wastewater quality
- Fish habitat restoration



GOAL 4:

Build resiliency to flooding

- Flood Mitigation and Resilience Program
- Flood recovery
- River engineering
- Forecasting and monitoring
- Citizen education and engagement
- Community Drainage Improvement Program



Figure 1.1 Watershed Planning Division – Strategic Framework

The 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, emerging 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 other 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

As Calgary and the region grow, demand for our drinking water increases, which results in greater pressures on our water supply. It is also anticipated that climate change will negatively affect the water supply and quality in southern Alberta, as changes in temperature, precipitation, seasonal demand patterns, and river flows occur. These changes are expected to increase pressures on The City's drainage system, and water and wastewater treatment plants.

Watershed protection in Calgary aligns with the provincial Water for Life Strategy and supports regional watershed management plans of which The City is a partner. A climate adaptation plan is being developed for the Water Utility as part of The City's renewed Climate Program (UCS2017-0054) as well as an integrated water supply management strategy that will help address risks facing water supply and operations, and recommend actions to address these challenges.

2.1 WATER SUPPLY MANAGEMENT

The City has taken steps to improve water supply management and protect Calgary's source water. Source water is water in its natural or raw state, prior to withdrawal for treatment and distribution as a drinking water supply. Source water protection and the Drought Management Plan are focus areas of work for 2017 within the overall integrated water supply management planning. The Source Water Protection Plan and an update to the Drought Management Plan will be initiated in 2017.

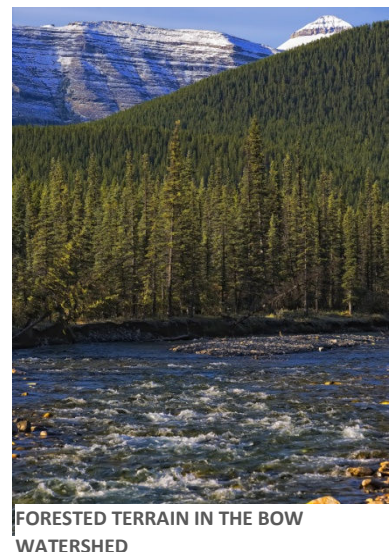
The Glenmore Gates upgrade project currently underway is a key capital investment that provides a benefit to water supply management, particularly during the winter. Raising the height of the gates on the crest of the Glenmore Dam will increase water supply security, improve drought resilience, and be used for flood mitigation.

2.2 SOURCE WATER PROTECTION

In 2016, The City completed a Source Watershed Assessment and Risk Characterization study to improve our inventory and assessment of current and long-term risks to The City's source water in the Bow and Elbow Rivers. Overall, the two highest risks identified by the study included:

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

A range of lower priority risks were also confirmed, including upstream waste management, pipelines, agricultural runoff, and recreational activities. The cumulative effects of multiple human stressors, combined with disturbances such as fire, flood, and climate change, could lead to more frequent water quality deterioration events. With the completion of the Source Watershed Assessment and Risk Characterization study, the next step is development of a Source Water Protection Plan through engagement with targeted stakeholders.



2.3 DROUGHT MANAGEMENT

Calgary is located in a semi-arid climate, and is a growing metropolitan region neighbouring large agricultural areas. Reliable, secure, high quality water is essential for Calgary and the region. However, we know that the region has experienced prolonged, severe droughts in the past. Compounding this issue are climate change and competing demands for water (irrigation, municipalities, etc). Planning and preparing for drought is an essential part of The City's watershed management work.

Recent dry conditions resulting in low flows on the Elbow and Bow rivers reinforced the need to update The City's Drought Management Plan. To address the immediate need to improve preparedness and decision-making, The City created Drought Operational Guidelines for the Water Utility. These new guidelines set drought phases, actions and governance to establish a coordinated water shortage

response. Further engagement and collaboration across the Corporation will also ensure that The City leads by example in preparing and managing water supply during drought conditions.

In 2017, The City will start the second phase of the project, which will strengthen long-term drought resiliency. This includes a review of the strategic components of the current plan: a revised risk assessment, an update to drought triggers and indicators, and a greater focus on customer and external stakeholder engagement. This will inform the development of long-term mitigation and adaptation strategies to integrate other watershed priorities such as flood, reducing water demand, and climate impacts.

2.4 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 an extensive distribution system, and to customer taps, the water is tested at every step of the process to ensure its quality is maintained before reaching the customer. The City of Calgary's drinking water is safe and reliable, and meets or is better than The Guidelines for Canadian Drinking Water Quality. Results of The City's



THE CITY TESTS DRINKING WATER FROM SOURCE TO TAP

monitoring on Key Drinking Water Quality Parameters for 2016 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.

2.4.1 WATER TESTING AND SAFETY

The City's water quality experts test drinking water, wastewater daily, and stormwater regularly to ensure high standards are met. Over 500 different parameters are monitored, including pH, turbidity, E.coli, nutrients, total suspended solids and metals. The City's water quality laboratories have an ISO 17025 designation from the Canadian Association for Laboratory Accreditation.

The City of Calgary's Drinking Water Safety Plan (DWSP) identifies and assesses risks in the drinking water system and the control measures in place to effectively reduce these risks. Calgary's DWSP provides a summary of risks related to the source of water, treatment plants, distribution system, and how water is delivered to customers. In 2016, a review of all 157 risks was conducted and implementation of an action plan to manage 27 high risks to Calgary's drinking water safety was started. The DWSP is a living document, and these risks will be reviewed again in 2017, as required by the Province, and risk mitigation actions will continue to progress.

2.4.2 EMERGING SUBSTANCES OF CONCERN (ESOCs)

The City has been monitoring a number of Emerging Substances of Concern (ESOCs) in Calgary's wastewater, drinking water and surface water since 1998. ESOCs include substances such as pharmaceuticals, pesticides and personal care products. The City's research on ESOCs helps to

understand their potential impacts on ecosystems and human health. A revised ESOC Strategy is being implemented from 2016 to 2018, which will ensure strategic monitoring and testing, and leverage research partnerships to direct resources where needed. Being proactive positions The City as an industry leader, helps inform new science, and prepares for new guidelines and regulations.

2.5 REGIONAL COLLABORATION

The City collaborates with organizations in the region including other municipalities, regional customers, irrigators, TransAlta, watershed partnerships, and other stakeholders on a wide range of shared watershed interests. Activities include:

- Regional water and wastewater servicing
- Watershed management
- Western Headworks stormwater management
- Operations management for flood and drought mitigation
- Regional stormwater management initiatives
- Raw water management

In 2017, The City will prepare for the establishment of a new Calgary regional Growth Management Board. The Board will be required to develop a statutory long-range growth plan and metropolitan servicing plan within several years. This includes regional service delivery of water and wastewater utilities.

2.6 PRIORITIES IN 2017

Table 2.1 summarizes activities The City plans to take to continue protecting our water supply in 2017.

Table 2.1 Goal #1: Protect Our Water Supply – 2017 focus

2017 Planned Actions
Advance water resource plans: Develop a strategic framework for an Integrated Water Supply Management Strategy. Development of the Source Water Protection Plan, including targeted stakeholder engagement. Complete a risk assessment, update drought triggers, and undertake stakeholder engagement for the Drought Management Plan.
As part of the climate resiliency program, complete a climate adaptation plan and energy and carbon management plan for the Water Utility.
Continue to mitigate risk to drinking water quality: review risks for Drinking Water Safety Plan and continue implementing the Emerging Substances of Concern (ESOCs) strategic plan.
Prepare for the establishment of a new Calgary regional Growth Management Board, which over several years will develop a regional servicing plan, including regional service delivery of water and wastewater services.

3. GOAL #2: USE WATER WISELY



3.1 CALGARY'S WATER USAGE

In 2005, Council adopted the Water Efficiency Plan that included 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’ reduce water usage over the last 13 years, despite population growth during that time in Calgary and the region. In 2016, annual water withdrawn from the Bow and Elbow rivers was 174,433 million litres (ML), remaining below the 2003 benchmark of 212,500 ML (Figure 3.1).

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 sources for downstream users, minimize water pollution, maintain the health of local watersheds, and reduce greenhouse gas emissions. Supporting customers with outreach and education programs increases awareness and encourages behaviours and actions that benefit both citizens and the watershed.

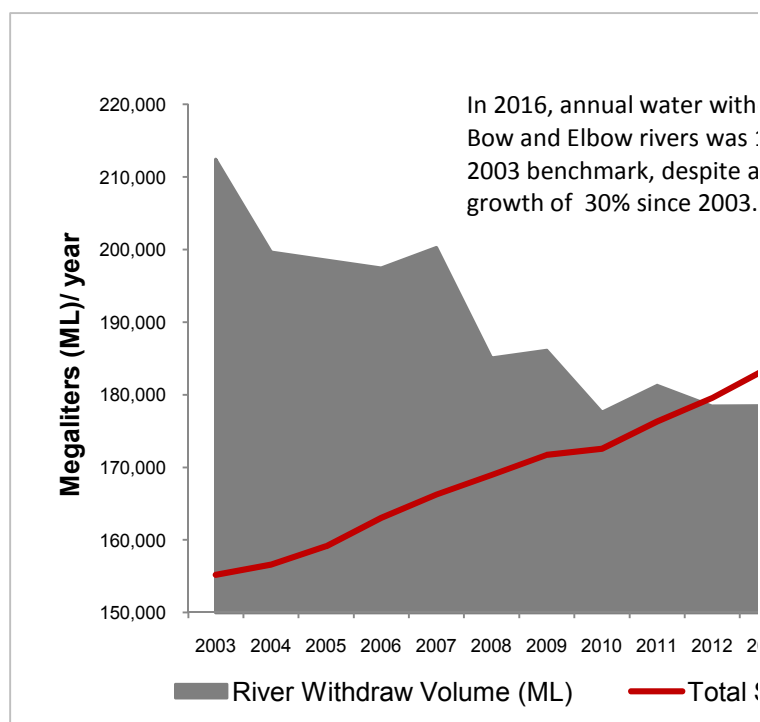
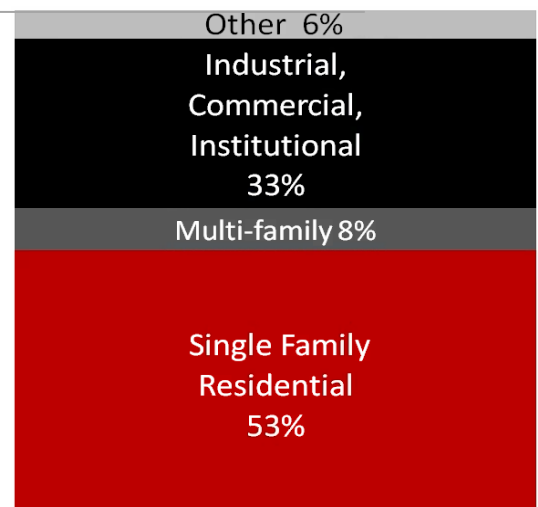


Figure 3.1 Annual water withdrawal (ML/year) from the Bow and Elbow rivers compared with service population

3.2 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. It is calculated by dividing the annual demand by the city population and the number of days in a year. It includes Calgary customers only and not regional customers. In 2016, Calgary’s overall water use (including residential, ICI and municipal demand in Calgary) was 359 litres per capita per day (lpcd), well on track to meet the 2033 target of 350 lpcd (Figure 3.3) and a 30% decrease since 2003. Of the overall water use in 2016, single-family residential demand was estimated to be 214 lpcd.

Figure 3.2. Calgary’s 2016 water demand by customer type

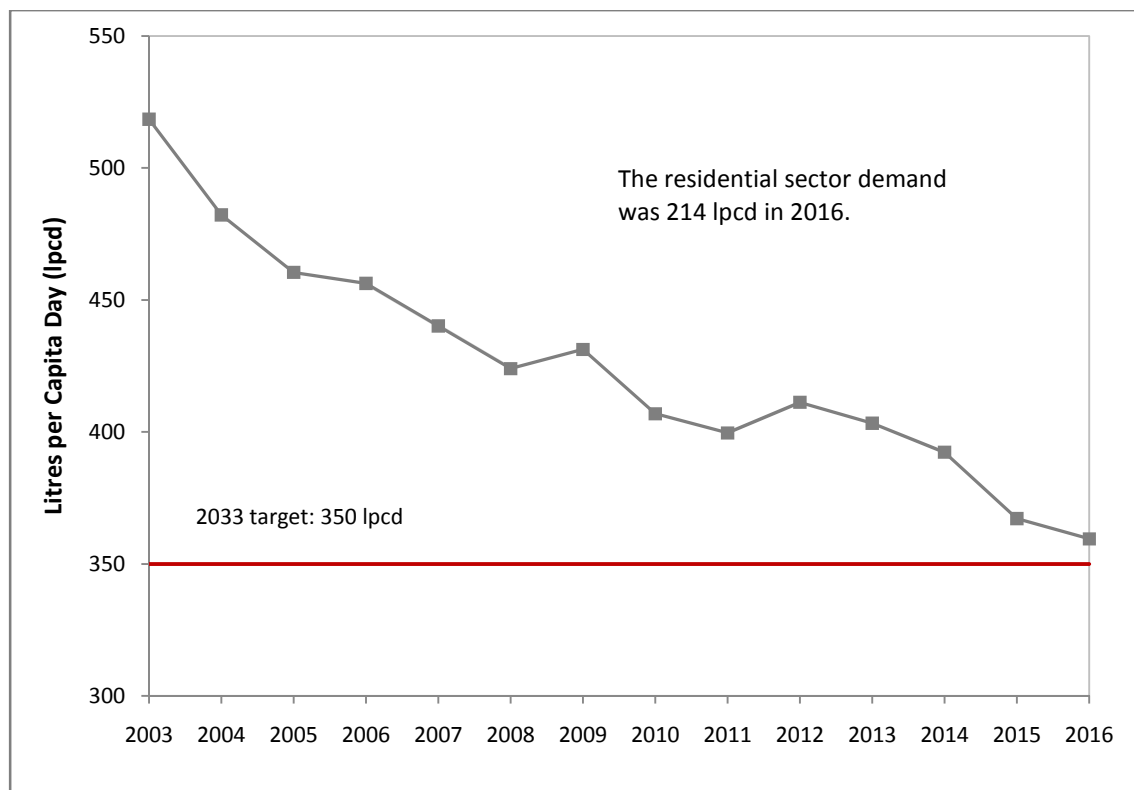


Figure 3.3 Calgary’s total per capita water demand over time

3.3 PEAK DAY DEMAND

The one day per year that Calgary requires the most water is referred to as the peak day demand. This typically occurs in the spring and summer months, as water demand can spike from outdoor watering activities. Peak day demand helps indicate when the maximum amount of water is being used by Calgarians. In 2016, Calgary’s peak day water demand occurred on June 6, and was almost 300 million litres (ML) below the 950 ML threshold, established for 2033, and accounts for the current capacity of Calgary’s water treatment plants (Figure 3.4). The peak day was earlier than usual in 2016, and usually

occurs later in the season during July or early August. This can be attributed to the drier spring and above average rainfall over the summer.

Although the peak demand remains under the threshold, it may increase in the future based on population projections, conservation practices, and potential climate change impacts. The peak day demand is a primary driver for investment in water treatment plants as Calgary's two water treatment plants Bears paw and Glenmore must keep up with the water consumed on those peak days. With more population growth anticipated, the next water treatment plant expansion is expected to be required in the next five to ten years. However, reducing peak day demand through targeted water efficiency programs, particularly for the irrigation and landscaping sectors, could help delay the need for the expansion. Because the peak day occurs during outdoor watering season, The City is increasing its water efficiency programming focus towards the irrigation and landscaping sectors.

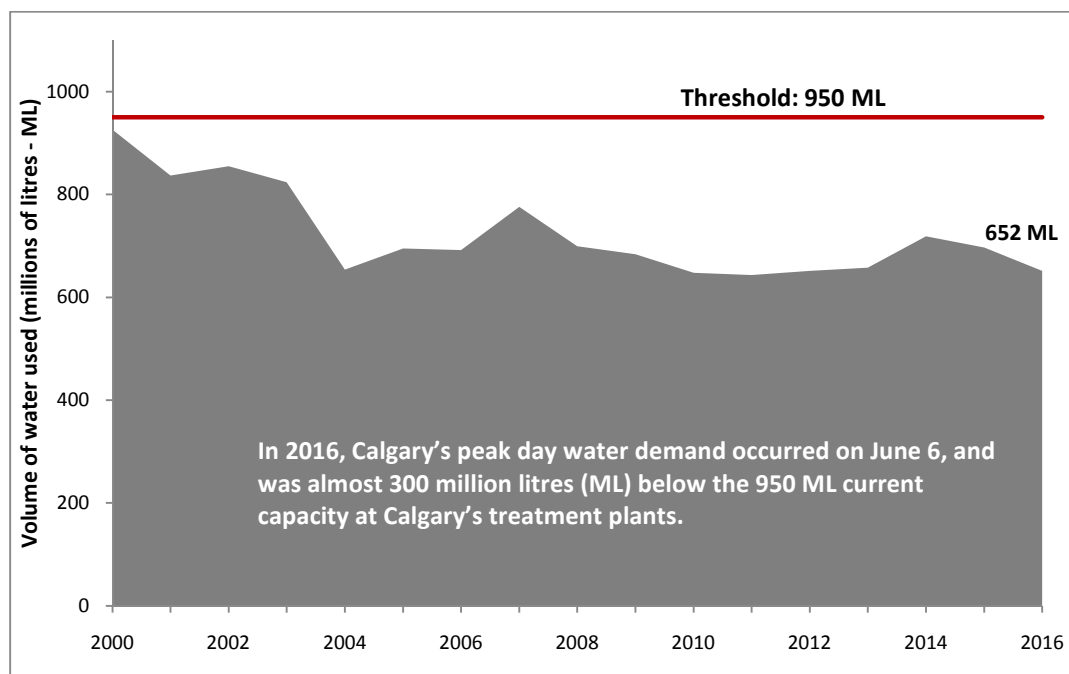


Figure 3.4 Peak day demand – maximum volume of water used in Calgary in one day

3.3.1 LEAK DETECTION

In order to reduce non-revenue water loss, as well as protect property, the environment, and drinking water quality, leak detection testing on City infrastructure is carried out. 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 2016, City crews surveyed 400 kms of water mains and identified and fixed 32 leaks, leading to estimated water savings of 10 million litres per day.

3.3.2 METER CALIBRATION

Calibration of the treatment plant and transmission flow meters was required in 2016 to ensure that water demand is accurately measured. An accurate understanding of water demand is essential to forecasting infrastructure capacity needs and capital spending as Calgary grows. This data is also used to calculate the rate of water conservation and the amount of water loss, which are important considerations for system maintenance and future planning.

3.4 WATER EFFICIENCY PLAN

In 2016, The City completed an update to the Water Efficiency Plan (WEP), which includes a shift in focus towards market-based programming to continue reducing water consumption. Refinements to the WEP will work towards achieving The City's 2033 water demand target. New programs under development are aimed at industrial, commercial and institutional (ICI) customers including market-based programs targeting the irrigation and landscape sectors. Targeting these outdoor sectors helps address the peak day demand (Figure 3.4).



THE CITY IS SHIFTING WATER CONSERVATION EFFORTS TO IRRIGATORS AND LANDSCAPERS

Historically, many of our water efficiency strategies focused on offering rebates to customers to replace old, inefficient plumbing fixtures and appliances with new efficient models. These rebate programs were successful; however, most plumbing fixtures and appliances available at retail outlets are now efficient. The City is shifting focus towards high water users with customized programs and strategic intervention. New programs will drive water use reduction through efficient business operations and the products and services provided by the ICI sector to their customers. By shifting the focus to the ICI sector, The City can continue to realize water savings in a sector that has historically had less programming.

There are two programs in development that will support ICI water efficiency: The capacity buyback program and a Calgary irrigation efficiency program. Capacity buyback will occur when The City audits an ICI customer and provides them with options to install water-saving equipment. Once changes are made, The City re-checks their new water consumption and provides a rebate on the average savings.

In 2017, The City will begin implementing the revised WEP, with focus on: tracking customer water usage data, benchmarking water use, and water use planning and forecasting to support water efficiency programming into the future. 2017 will be spent conducting research and strengthening relationships with the ICI sector to:

- Understand the targeted ICI sectors and their water use profiles
- Determine what motivates them to adapt certain behaviours
- Inform program development to target the customers and have successful program uptake.
- Build networks to increase reach and participation within the ICI community
- Identify internal and external resources and expertise to leverage

Water efficiency communications and messaging continues through events and targeted education programs for indoor/outdoor residential and ICI customers, as well as traditional and social media, and partnerships.

3.5 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 citizen actions on these programs, we have been able to keep water demand within our Water Efficiency Plan goals and provide residential customers with savings through reduced water consumption. Collective actions by citizens have resulted in significant water savings in Calgary.

Over 83,700 toilets have been replaced through the Residential Toilet Replacement Program since 2003. With near total adoption of water efficient toilets to the market, The City marked the end of this program in 2016.



THE CITY WORKS WITH CITIZENS AND THE ICI SECTOR TO REDUCE WATER CONSUMPTION

In 2016, the Yard Smart program reached over 10,000 Calgarians through rain barrel sales, Beauty on a Budget, Diggin' In workshops, and other public events. We also reached 11,355 citizens with water conservation and stormwater education at events such as Mayor's Environmental Expo, Canada Day, and Marda Gras. The City also gave tours to 1,283 Calgarians through school and public tours at the Glenmore and Pine Creek Plants.

3.6 PRIORITIES IN 2017

The City will continue working with customers to encourage responsible and efficient use of water. Activities planned for 2017 are summarized in Table 3.1.

Table 3.1 Goal #2: Use Water Wisely – 2017 focus

2017 Planned Actions
Build new water efficiency programs focussed on targeted industrial, commercial, and institutional (ICI) customers. Conduct research and strengthen relationships with targeted ICI sector to: understand water use profiles, build networks, and inform program development.

Align water efficiency programming, demand forecasting and infrastructure planning.

Continue to provide outreach and education to citizens about water conservation.

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 opportunities, and support aquatic and riparian 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 waterways, fish and wildlife, the ecosystem and drinking water.

Protection of Calgary's waterways is guided by The City's Approval to Operate that is granted by Alberta Environment and Parks, 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. The City's Total Loading Management Plan is a product of the process to receive this approval. It ensures that pollutant loadings to the Bow River remain below certain levels. The City also has a Stormwater Management Strategy, approved by Council in 2005 that aims to reduce pollution from stormwater runoff from entering the rivers.

4.1 WASTEWATER MANAGEMENT

Bonnybrook Wastewater Treatment Plant is the largest of three wastewater treatment plants in Calgary. It is undergoing major upgrades to ensure advanced wastewater treatment for a growing population while minimizing impacts to the Bow River. The upgrades and plant expansion will ensure regulatory and capacity requirements are met. The City is also improving one of the secondary treatment processes at the Fish Creek Wastewater Treatment Plant through ongoing capital maintenance.



THE BONNYBROOK PLANT IS UNDERGOING MAJOR UPGRADES

The City is conducting a comprehensive Receiving Water Assessment that will inform The City's 2018 application to renew its Approval to Operate. This study provides an assessment of The City's treated wastewater effluent as it is released into the Bow River and will help determine the impact of treated wastewater on river water health and inform any actions The City may need to take to address effluent issues.

4.1.1 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



PINE CREEK WASTEWATER TREATMENT PLANT

wastewater quality guidelines – this is called high-strength wastewater. In 2016, The City initiated the Win-Win Wastewater Program to improve management of high-strength wastewater from ICI customers, as this wastewater is technically challenging and expensive to manage and treat. The Win-Win Program is an opportunity to identify and implement cost-effective, resource efficient, reliable, and equitable win-win strategies that meet customers' needs for wastewater load management while at the same time contributing to optimal use of existing wastewater treatment plant capacity.

Fats, oils and grease (FOG) are a considerable problem for Calgary's wastewater system, and are The City's number one cause of sanitary sewer blockages and backups. Managing property damage, cleaning, response and assessment of FOG costs The City millions of dollars each year. In 2016, a new FOG receiving facility was commissioned at the Bonnybrook Wastewater Treatment Plant. The City also formalized the FOG program, which started as a pilot in 2012. The program's objective is to reduce the improper disposal and management of FOG. The food service sector is a significant source of FOG and The City's program educates business owners of their responsibilities to properly dispose of FOG. In 2017, we will focus on additional inspections, strengthening relationships with industry, and targeted education and communication activities.

4.2 TOTAL LOADING MANAGEMENT

Total pollutant loadings into the waterways can create significant impacts on our watershed, affecting water quality and river health, and can create maintenance issues for Calgary's wastewater and stormwater infrastructure. The City's Total Loading Management Plan (TLMP) includes Provincial pollutant loading objectives for both stormwater and wastewater treatment plants. This minimizes the impact of wastewater discharges and stormwater runoff on the Bow River's water quality and maintains a healthy aquatic ecosystem. Figure 4.1 shows that The City has remained under the Provincial objective for total suspended solids (TSS) loadings into the Bow River from stormwater and wastewater sources. Stormwater contributes a significantly higher proportion of total suspended solids to the Bow River compared to wastewater effluent.



REDUCING TSS LOADING FROM STORMWATER AND TREATED WASTEWATER IS IMPORTANT TO MAINTAIN LEVELS BELOW PROVINCIAL GUIDELINES.

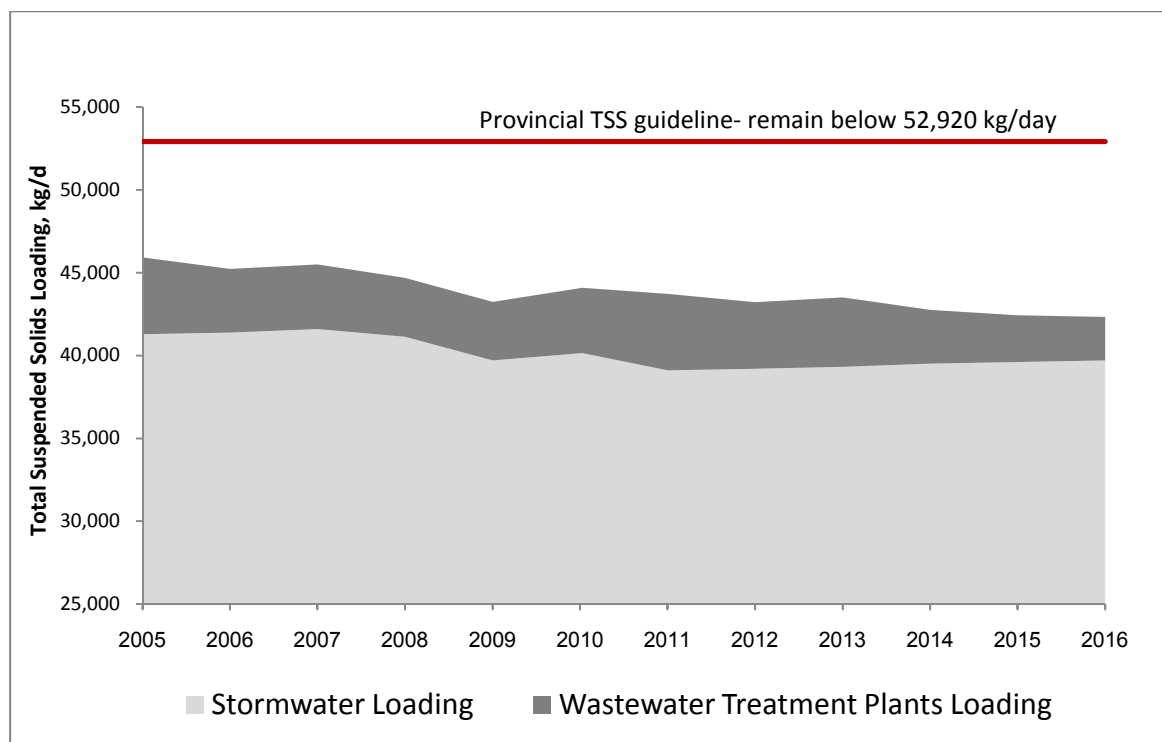


Figure 4.1 Total Suspended Solids (TSS) loading to the Bow River from stormwater and wastewater

In 2016, The City updated its stormwater model and Bow River Water Quality Model used to simulate and report on total loadings to the Bow River. Water quality regulatory compliance through the Total Loading Management Plan will be a major driver for a renewed stormwater strategic direction and initiating the development of watershed-level stormwater quality targets in 2017. New total loading objectives will be adopted after The City receives its Approval to Operate from the Province. These objectives and targets will play an important role in ensuring that The City continues to receive Provincial approvals to operate and the rivers remain healthy.

4.3 STORMWATER MANAGEMENT

As Calgary and the region grow, managing stormwater quantity and quality is an increasing challenge. Urban growth and changes to land use have significant impacts on water quality and the volume of stormwater because of growing impervious surfaces, leading to greater cumulative impacts. Substances such as pesticides, oil, and sediments can be picked up from residential, public, and industrial properties, and roadways and returned to the river through the stormwater system. This has a negative effect on watershed health. Stormwater contributes approximately ten times more Total Suspended Solids (TSS) to the rivers than treated wastewater; therefore, efforts to manage TSS loadings are strongly focused on stormwater. Recognizing these factors, The City's integrated watershed management approach aims to improve stormwater management and address



RAIN GARDENS USE NATURAL FEATURES TO MANAGE STORMWATER

stormwater volume and quality issues. To this end, The City has initiated an update to its 2005 Stormwater Management Strategy that will continue in 2017.

The City's 2005 Stormwater Management Strategy goal is to maintain TSS loadings from stormwater in the Bow River at or below 2005 levels, even with a growing city. In 2016, estimated TSS loadings from stormwater to the Bow River were 39,680 kg/day, which is below the 2005 benchmark of 41,300 kg/day (Figure 4.2). Total suspended solids include organic and inorganic materials that are suspended in stormwater and wastewater that enter our waterways. Stormwater retention ponds, wetlands, and green stormwater infrastructure projects are effective in reducing TSS loadings to the rivers.

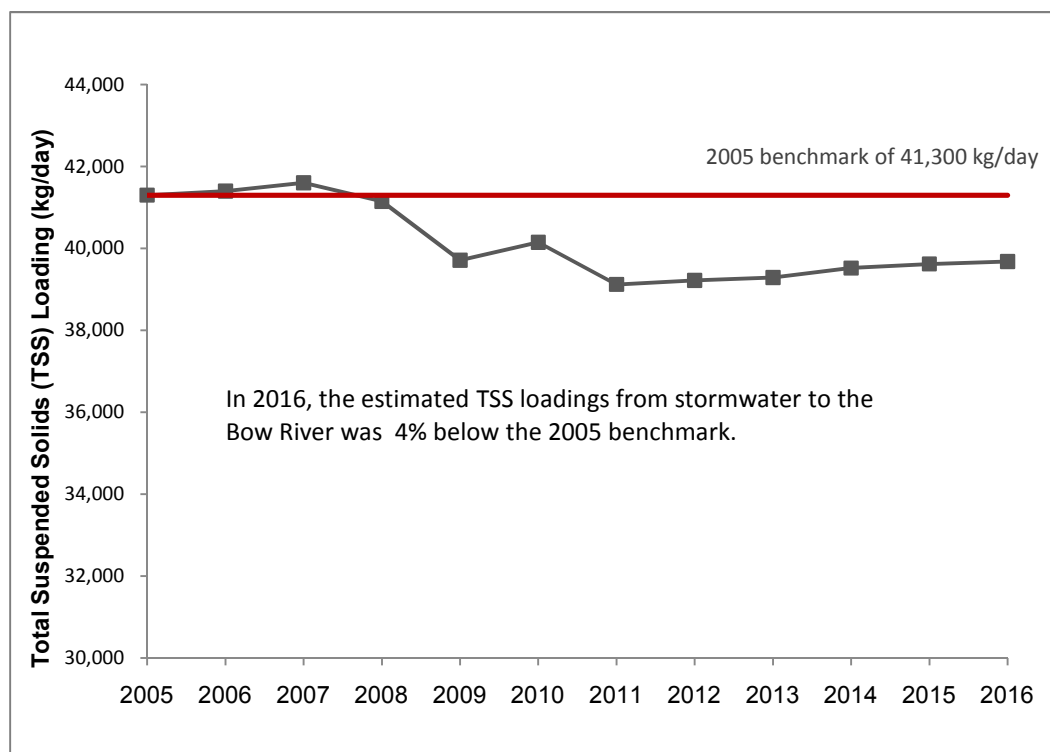


Figure 4.2 Total Suspended Solids (TSS) to the Bow River from stormwater

4.3.1 STORMWATER PONDS

Calgary's stormwater drainage system has over 300 wet and dry storage ponds. They hold water that exceeds the capacity of the underground storm-drainage pipes and function to reduce the amount of sediment and other pollutants entering the rivers. In anticipation of increased extremes in seasonal changes and increased high intensity rain events, The City is considering local precipitation trends to help plan future infrastructure investments and improve management of Calgary's stormwater drainage system.

The City continues to work with the community of Crestmont in preparation for cleaning the storm pond in this community. Pond condition assessments revealed the need for modifications to the Hanson Ranch constructed wetland. Further analysis of the storm pond in Confederation Park is being completed under the Confederation Park Drainage Study. This study will identify options for this pond

within the broader context of stormwater management within this large catchment. Research into options to control algae was initiated in 2016, and will continue in 2017. A second season of data is needed before the performance of available technologies can be assessed.

In 2016, to increase awareness of storm ponds and their role in protecting the watershed, The City created a communication plan, brochure, website materials and educational signage for some storm ponds. This work helps encourage safe use of storm ponds.

4.3.2 STORMWATER QUALITY RETROFIT INVESTMENTS

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

- The Bowmont East Stormwater Quality Retrofit Pond is under construction with completion expected in 2017. The project will reduce the sediment loading into the Bow River, and restore the natural park area located within the disturbed Klippert lands. This project includes the use of advanced stormwater treatment technology.
- The Riverbend Trunk Pond is being constructed to accommodate increased road runoff, facilitate future development, manage peak flows and provide stormwater treatment. Design of this facility is underway, with construction completion scheduled for 2018.
- The 37th Street Stormwater Quality Project is in design, with construction planned for 2017 and 2018. This project will provide stormwater treatment for a currently untreated developed catchment area, which discharges via the 37th Street Storm Trunk into the Glenmore Reservoir.
- In 2016, The City installed five sediment capture devices throughout Calgary, and two sediment separators to reduce sediment loadings to Nose Creek.

4.3.3 GREEN STORMWATER INFRASTRUCTURE



THE GREEN ROOF AT THE CITY'S WATER CENTRE IS AN EXAMPLE OF GREEN STORMWATER INFRASTRUCTURE

Expansion of impervious surfaces from urban development results in increasing volumes of water and pollutants entering Calgary's storm system. These pollutants may eventually end up in the rivers and creeks, and affect water quality. Green stormwater infrastructure (GSI) uses natural processes to treat stormwater that allow water to be absorbed and filtered by soil and vegetation. GSI practices improve stormwater quality and manage stormwater volumes. This ultimately reduces total loadings going into the river and ensures the continued health of our rivers. Implementing GSI practices also

supports other Corporate objectives around enhancing the public realm and creating complete and great communities.

The City is developing a GSI strategy, which explains the challenges and opportunities of using GSI as a viable stormwater management tool to improve river water quality. In 2016, The City completed internal

engagement to clarify challenges and identify opportunities to support the use of GSI. During 2017, The City will create a work plan to support the implementation of GSI and will engage with the development industry on future opportunities. Supporting GSI in public spaces requires collaboration and a commitment to exploring new ways of working across business units.

4.3.4 STORMWATER MANAGEMENT CHALLENGES

The City has made major advancements in stormwater management through actively managing stormwater using dry and wet storm ponds and land use planning in new greenfield developments. However, provincial stormwater management criteria have become increasingly stringent, and development in greenfield and existing communities is continuing at a rapid pace, resulting in a need to evolve stormwater management approaches.



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One of the major challenges with managing stormwater in the context of greenfield development is the integration of wetlands into development plans. Currently, provincial regulations do not allow stormwater to be directed to wetlands without a water license. To facilitate the use of wetlands as receiving bodies for stormwater, provincial requirements must be reconciled.

Stormwater management in the context of redevelopment is complex because of various factors including a lack of green space, large proposed development footprints, existing infrastructure, topography and environmental

sensitivities. These factors all make it difficult to apply current stormwater management standards. Therefore, The City is exploring innovative ways to manage stormwater in established communities.

To help address some of these challenges, The City is expanding its conventional stormwater infrastructure to include the use of green stormwater infrastructure, which uses natural processes to manage volume and quality of stormwater. To achieve this, The City is developing and enhancing Green Stormwater Infrastructure practice standards. Additionally, The City is exploring the viability of incorporating traditional and green stormwater infrastructure in established communities on public sites to improve stormwater management. The City is testing this approach in Renfrew, a community in the Nose Creek watershed, through its Integrated Stormwater Management initiative.

Using stormwater for irrigation is another innovative opportunity to manage stormwater and reduce the use of potable water for irrigation. At present, there is a limited understanding of the public health risks associated with stormwater use for irrigation. The Government of Alberta is establishing Alberta's Water Reuse and Stormwater Use Policy. Once complete, The City will update its internal processes and policies to support stormwater use.

4.4.5 NOSE CREEK WATERSHED WATER MANAGEMENT PLAN UPDATE

The Nose Creek watershed is one of Calgary's most sensitive watersheds. Stringent stormwater targets were created to prevent further pollution entering Nose Creek and its tributaries, as well as to protect the creek morphology and prevent further bank erosion. Still, water quality in the watershed is considered to be generally poor (e.g., high total suspended solids). Development across the watershed has resulted in increasing impervious surfaces, the loss of wetlands, and creek channelization. This produces increasing stormwater volumes and increased bank erosion, and consequently impacts to water quality. These impacts will be compounded by significant future development in greenfield areas within the Nose Creek watershed.

Throughout 2016, The City worked with the Nose Creek Watershed Partnership to update its Nose Creek Watershed Water Management Plan. Work on the Plan will continue in 2017 to enhance watershed management. The Partnership will explore how to manage stormwater during redevelopment, enhance the management of water quality and work with Alberta Environment and Parks, and advance a provincial water reuse and stormwater use policy.

Though the Plan update is still underway, the Partnership has recommended delaying the implementation of the 2017 runoff volume control target and leaving the 2013 runoff volume control targets in effect until additional stormwater management tools are available. Stakeholders, including the development industry, spoke of the challenges in implementing a new target without additional stormwater management tools, such as expanded stormwater reuse or allowing wetlands to receive stormwater. This concern reflects the time needed by the Government of Alberta to advance its water reuse and stormwater use policy.

Once the updated plan is complete, the Partnership will create recommendations based on a sound technical foundation and appropriate stakeholder engagement to implement the plan.

4.4 RIPARIAN ACTION PROGRAM

Riparian areas exist along the edges of rivers and creeks within the watershed. Here, rich soils store water and support diverse plant and animal life. These areas support watershed health and provide a number of benefits such as clean water and resilience to flood and drought.

The Riparian Action Program strives to ensure that riparian health in Calgary is maintained and improved, while further loss of riparian areas is minimized. The Riparian Action Program document provides guidance on actions for land use planning, riparian health restoration, and citizen outreach and education. It also provides tools land use planners, engineers and citizens can use to help protect and restore riparian landscapes in Calgary. The City continued to advance the program in 2016 in the areas of riparian restoration, mapping, monitoring, and education and outreach. Research on citizen values regarding riparian areas was completed, and education and outreach programs will be piloted in 2017.



RIPARIAN AREAS SUPPORT WATERSHED HEALTH

Ephemeral stream mapping and restoration of four riparian sites in Calgary was completed in 2016. The City continues to monitor riparian sites and evaluate the state of riparian sites throughout Calgary, and explore opportunities to help citizens connect with riparian areas and the river. In addition, since 2013, The City has completed over 20 bioengineering projects, which combine traditional hard engineering materials with vegetation, to help stabilize river and stream banks and encourage vegetation to establish.



RIVERBANK RESTORATION USING
BIOENGINEERING TECHNIQUES

Riparian mapping has been used to inform the development of the Calgary River Access Strategy (CPS2017-0103), which will allow Calgarians better access to river recreation while protecting riparian habitats. The riparian maps identify sensitive riparian areas to direct recreation users away from these areas and encourage use of designated river access points.

Riparian areas play a role in creating healthy aquatic habitats, which are vital to our watershed. Healthy aquatic habitats are an important indicator of watershed health. As part of The City's commitment to a healthy watershed and ecosystems, we plan to construct up to three fish habitat projects to offset impacts caused by recovery works after the 2013 flood. These projects are expected to be completed in 2018 and will have numerous benefits including improved fish health and habitat, river aesthetics, and educational opportunities. The City is also collaborating with Alberta Environment and Parks on a bioengineering project near Pearce Estates Park.

4.5 WATERSHED HEALTH AND URBAN DEVELOPMENT

Calgary's Municipal Development Plan (MDP) policy regarding water is to "protect, conserve and enhance water quality and quantity by creating a land use and transportation framework that protects the watershed". The MDP uses percent of impervious surface to measure watershed health, with a 60-year target to achieve an impervious cover between 10-20 per cent in Calgary. Impervious cover reflects the overall coverage area of development.

Table 4.1 Impervious surface cover – as a percentage of Calgary's built area

Year	Impervious surface cover
1998	33%
2010	40%
2014	45%

Table 4.1 shows that Calgary's impervious surface cover has been increasing since 1998. The measurement includes impervious surfaces as a percentage of the built and natural areas footprint of the city; it does not include the undeveloped land on the perimeter that is within the city limits. The footprint size changes every year, and this calculation estimates how much impervious area is within

Calgary as urban development continues, and reflects how much area is left as green space as the city is developed.

The more land that is developed within a watershed, the more natural processes are altered, and the health of the watershed decreases. However, using impervious cover as the only metric of watershed health is limiting. With the increase of green stormwater infrastructure, new stormwater management techniques, and other green development practices, the impact of development on watershed health can be reduced. This is not captured when reporting only on impervious cover. Several other watershed health metrics can be used to strengthen development practices.

The City is reviewing and expanding the metrics used to evaluate watershed health. The natural and development context varies within Calgary's watersheds, and new metrics are being developed to complement the MDP metric, and will be monitored so appropriate watershed management action can be taken. The suite of metrics will be refined in 2017 and will include metrics on habitat, landscape, water quality, hydrology, and biodiversity. These will align with regional watershed health assessments and indices, such as those developed by the Bow River Basin Council in 2010. It is anticipated that the recommended metrics will be incorporated into the MDP update in 2019.

4.6 PRIORITIES FOR 2017

To continue reducing the impacts on the watershed and keeping our rivers healthy, The City's focus areas for 2017 are summarized in Table 4.2.

Table 4.2 Goal #3: Keep Our Rivers Healthy – 2017 focus

2017 Planned Actions
Implement viable options to maintain compliance now and in the future for wastewater treatment: Continue implementation of plant upgrades, and advance the Win-Win Wastewater project and FOG program. Complete the receiving water assessment (RWA).
Make progress on updating The City's stormwater management strategy and associated performance targets to ensure protection of the health of the river: advance the Total Loading Management program and study new loadings targets.
Make progress on a Green Stormwater Infrastructure (GSI) Strategy: create a work plan to support the implementation of GSI and engage with the development industry on future opportunities.
Contribute to the update of the Nose Creek Watershed Management Plan.
Advance the Riparian Action Program through engagement, riparian area restoration, integration of riparian maps in land use planning processes, and piloting of education and outreach programs in 2017.
Expand the metrics used to evaluate watershed health.

5. GOAL #4: BUILD RESILIENCY TO FLOODING



5.1 RIVER FLOOD MITIGATION AND RESILIENCY PROGRAM

The City continues to implement the 27 recommendations made by an independent Flood Expert Management Panel as directed by Council in 2014. At the end of 2016, 11 of the recommendations were complete and all remaining recommendations are in progress. In 2016, The City applied for \$19.5 million for flood mitigation through the Alberta Community Resiliency Program. To date, over \$28.8 million has been committed through the program for various flood mitigation and resilience projects throughout Calgary. Mitigation work that is already complete or is ongoing has reduced Calgary's financial exposure to flood damage by about 30 per cent.

A major component of The City's work on flood mitigation in 2016 was the completion of the Flood Mitigation Measures Assessment project. The project examined flood mitigation measures for Calgary through a consultative, citizen-focused approach. The City used citizen and stakeholder values and feedback to perform technical and sustainability assessments on structural and non-structural flood mitigation options for Calgary. The results informed a recommended direction forward for future mitigation measures.

Updates on progress on the Expert Panel recommendations and the Flood Mitigation Measures Assessment are discussed in detail in a separate report (Flood Mitigation Measures Assessment Report and 2016 Flood Resiliency Update, UCS2017-266).

5.2 STORMWATER FLOODING

During the summer of 2016, Calgary experienced above average rainfall in many Calgary communities. Intense rainfall triggered localized stormwater flooding and in some cases resulted in property damage. Strategies were developed to mitigate future events and safeguard public safety and property. Innovative measures have been deployed in the short term until it can be assessed if permanent solutions can be implemented. Water Services will continue to deploy short-term measures to address the immediate threats of local flooding. The deployment of flood tubes proved successful in 2016.

5.2.1 COMMUNITY DRAINAGE IMPROVEMENT PROGRAM

Improved resilience to local flooding is delivered through the Community Drainage Improvement (CDI) Program. The City conducts studies to identify potential stormwater system improvement projects in communities prone to flooding. Evaluations are based on the amount of flooding and damage in each area and the cost-effectiveness of the upgrades. Reductions in stormwater flooding damages, measured in terms of economic, social and environmental impacts, are the focus of infrastructure investments.

In 2016, The City completed stormwater improvement projects in Haysboro at a cost of \$484,000, resulting in over \$20 million in social, economic, and environmental benefits. The City also advanced the design of two storm ponds and storm sewer upgrades in Woodlands, Woodbine, Cedarbrae and

Braeside. Construction of this infrastructure package, estimated at \$49 million, will commence in 2017 with anticipated completion by 2019.

The 2015-2018 Action Plan identified the need to explore opportunities to accelerate the delivery of these stormwater infrastructure upgrades. Three strategies are being advanced:

1. **Design Innovations:** These can yield more cost effective upgrades. The Christy Park project is based on a design that is \$9.5 million dollars less than the original conceptual design. The City will continue to pursue innovative designs and value-engineering to drive cost-efficiencies.
2. **External Funding:** The City is pursuing Federal and Provincial funding opportunities. The New Building Canada Fund is contributing \$2.1 million toward the construction of Pump Station #1 in Sunnyside. Other opportunities for funding CDI projects are linked to the potential to access river flood mitigation funding.
3. **Strategic Partnerships:** In 2017, The City is assembling a procurement package for the design and engineering management of a number of infrastructure upgrades. This approach has the potential to yield cost savings by establishing long-term partnerships with engineering consultants and contractors. The appetite in the market for this approach will be tested in 2018.

Additionally, Administration is exploring options to increase investments in the CDI program funded by the Drainage Service charge, and will report back to Council as part of the 2019-2022 business planning and budget process. The current CDI project list is included as an Appendix to this report.

5.3 PRIORITIES FOR 2017

In 2017, 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 – 2017 focus

2017 Planned Actions
Continue to build resiliency to flooding: advance Expert Panel recommendations, deliver implementation plan for key flood mitigation investments.
Make progress on The City's drainage program: advance the Community Drainage Improvement accelerated program of stormwater infrastructure upgrades in communities experiencing local flooding.

APPENDIX

Community Drainage Improvement Upgrades - Prioritization List

Project Name	Cost Estimate (\$000's)	Benefit/Cost Ratio *	Project Status	Construction Timing (Business Cycle **)
Christie Park Upgrades & Sarcee Trail (formerly Westgate)	\$ 4,112	20	<i>in construction</i>	2017
Woodlands/Woodbine - Pond D	\$ 21,515	9	<i>design</i>	2017-2019
Woodlands/Woodbine - Pond A (Cedarbrae/Braeside)	\$ 13,000	9	<i>design</i>	2017-2018
Woodlands/Woodbine - Local Improvements	\$ 6,307	6	<i>design</i>	2018-2019
North West Inner-City - 14.5 Street	\$ 766	15	<i>in construction</i>	2017
North West Inner-City - Pump Station #2 - Sunnyside ‡	\$ 9,096	4	<i>design</i>	2017-2018
North West Inner-City - Pump Station #1 - Sunnyside ‡	\$ 5,300	4	<i>design</i>	2018
North West Inner-City - Kensington Close	\$ 2,200	13	<i>to be funded</i>	2019-2022
North West Inner-City - Crescent Road	\$ 1,100	11	<i>to be funded</i>	Beyond 2022
North West Inner-City - 7th Avenue	\$ 2,000	8	<i>to be funded</i>	2019-2022
North West Inner-City - 19th Street & 9th Avenue	\$ 2,100	8	<i>to be funded</i>	2019-2022
North West Inner-City - Pump Station #4 - Hillhurst	\$ 11,700	8	<i>to be funded</i>	2019-2022
North West Inner-City - 19th Street & 6th Avenue	\$ 600	8	<i>to be funded</i>	2019-2022
North West Inner-City - Upper Plateau Separation	\$ 36,900	7	<i>to be funded</i>	TBD
North West Inner-City - Pump Station #3 - Hillhurst	\$ 8,400	7	<i>to be funded</i>	Beyond 2022
North West Inner-City - South of Riley Park	\$ 11,200	6	<i>to be funded</i>	Beyond 2022
Pineridge / Rundle Dry Pond B	\$ 4,175	6	<i>to be funded</i>	Beyond 2022
Palliser/Oakridge - Phase 2 and Phase 1	\$ 18,326	6	<i>to be funded</i>	Beyond 2022
Tuxedo/Mnt Pleasant - Phase 2, Phase 1 and Local Improvements	\$ 14,196	5	<i>to be funded</i>	Beyond 2022
Pineridge / Rundle Storage Duct #2	\$ 2,824	5	<i>to be funded</i>	Beyond 2022
Shawnessy Stormwater Upgrades	\$ 20,197	3	<i>to be funded</i>	Beyond 2022
North West Inner-City - 10th Street	\$ 10,900	2	<i>to be funded</i>	Beyond 2022
North West Inner-City - 14th Street	\$ 14,900	2	<i>to be funded</i>	Beyond 2022
Palliser/Oakridge - Phase 3	\$ 11,247	2	<i>to be funded</i>	Beyond 2022
North West Inner-City - 17th Street & 23rd Avenue	\$ 3,800	2	<i>to be funded</i>	Beyond 2022
Westgate - Ditch Upgrade	\$ 4,355	1	<i>to be funded</i>	Beyond 2022
Oakmount Dry Pond (Oakmont Way Rev Report)	\$ 492	1	<i>to be funded</i>	Beyond 2022
Total	\$ 241,708			

Notes:

* Benefit/Cost ratio is based on original project scope and costing

** Project construction schedules incorporate dependencies between projects, and may be subject to change with the addition of new projects.

‡ with funding from the Alberta Community Resilience Program

with funding from the Alberta Community Resilience Program and the Build Canada Fund