ALBERTA WATER COUNCIL

Looking Back: Evaluating Sector Improvements in Water Conservation, Efficiency and Productivity

About the Alberta Water Council

The Alberta Water Council (AWC) is a multi-stakeholder partnership with members from governments, industry and non-government organizations. All members have a stake in water. The AWC is one of three types of partnerships established under the *Water for Life* strategy: the others are Watershed Planning and Advisory Councils and Watershed Stewardship Groups.

The AWC regularly reviews implementation progress of the *Water for Life* strategy and champions the achievement of the strategy's goals. The AWC also advises the Government of Alberta, stakeholders, and the public on effective water management practices, solutions to water issues, and priorities for water research. However, the Government of Alberta remains accountable for the implementation of the *Water for Life* strategy and continues to administer water and watershed management activities throughout the province.

Alberta Water Council
14th Floor, Petroleum Plaza South Tower
9915-108 Street
Edmonton, AB T5K 2G8

Tel: 780-644-7380
Fax: 780-644-7382

Email: info@awchome.ca
Web: www.awchome.ca

Cover Photos Credit (left to right):
Saint Mary Dam. Credit Jay White, Aquality Environmental Consulting Ltd.
Alberta Farmscape. Jay White, Aquality Environmental Consulting Ltd.
Refinery. Credit David Rushford, Cenovus Energy

Contents

Acronyms

AAMDC	Alberta Association of Municipal Districts and Counties
AER	Alberta Energy Regulator
AFPA	Alberta Forest Products Association
AIPA	Alberta Irrigation Projects Association
AUMA	Alberta Urban Municipalities Association
AWC	Alberta Water Council
CAPP	Canadian Association of Petroleum Producers
CEP	Conservation, efficiency and productivity
CIAC	Chemistry Industry Association of Canada
GoA	Government of Alberta
GDP	Gross Domestic Product
TDL	Temporary diversion licence
WURS	Water Use Reporting System

List of Tables

List of Figures

Executive Summary and Recommendations

The Alberta Water Council's (AWC) project "Evaluating Water Conservation, Efficiency and Productivity" was undertaken to (1) evaluate and report on the contributions of Alberta's water-using sectors to water conservation, efficiency and productivity (CEP) goals, and (2) assess and recommend improvements to the AWC CEP process that was followed to support this work. This work supports the Government of Alberta's *Water for Life* strategy, *Our Water Our Future; A Plan for Action* and previous AWC CEP work.

To date, four AWC CEP project teams (including this one) have contributed to work on water CEP. It should be noted that the context of past project teams is important to fully understanding the work and findings of this report. For more details on past project teams see http://awchome.ca/Projects/CEP/tabid/209/Default.aspx

In 2003, the *Water for Life* strategy set a target to improve efficiency and productivity of water use in Alberta by 30% from 2005 levels by 2015. In 2004, the AWC became a platform to support major water-using sectors as they voluntarily developed sector plans and reported progress toward this target. Through a multi-stakeholder process, sectors agreed to report on how their CEP activities contributed to *Water for Life* goals and CEP desired outcomes. While sectors voluntarily adhered to the AWC's CEP process to develop, implement and report on their respective plans, each plan is unique and reflects the circumstances of individual sectors.

Each plan and implementation progress report was reviewed to evaluate the sectors' contributions—both individually and collectively—to achieving specified goals. Documents relevant to the AWC's CEP history and the process followed by sectors were examined, and subject-matter experts from the Government of Alberta provided updates on water use reporting to inform this work.

This evaluation demonstrated that:

- Alberta's seven major water-using sectors improved water use efficiency and productivity by 32% over the reporting period, exceeding the *Water for Life* target of 30%.
- Overall, there was a 25% reduction in net water use over the reporting period and many sectors reported improvements in efficiency and productivity.
- Sectors attained CEP desired outcomes.
- Most sectors achieved their individual targets.
- Most sectors increased their production output over this period.

The AWC CEP process that supported major water-using sectors as they enhanced their CEP activities was viewed as a success. Sectors took an adaptive management approach towards CEP efforts as they adjusted their planning, implementation and reporting activities. The CEP process guided sectors in developing plans and setting goals and it provided a forum to discuss challenges and share knowledge. It also raised the profile of water use by sectors and the significance of CEP efforts in water management. Finally, this process brought important perspectives to the forefront that were not considered previously.

Gaps and opportunities for improving CEP planning, implementation and reporting were documented for individual sectors and collectively. Key findings highlighted a desire to:

- maintain the culture of CEP work and continue reporting on sector progress
- improve data collection, availability and usability and raise awareness of the importance of reporting

The major water-using sectors want to keep building on the CEP foundation that was created through the CEP process. Four recommendations emerged from this project; these will support sectors as they continue advancing CEP work.

Recommendation 1

Major water-using sectors collaborate with the Government of Alberta and other partners including the Alberta Water Council to continue reporting CEP trends and progress. Reporting will occur through the Alberta Water Council at five-year intervals using the performance indicators and baseline data in Appendix C (ongoing).

Recommendation 2

Major water-using sectors continue working with the Government of Alberta to resolve existing challenges with the Water Use Reporting System to improve data collection, management and reporting tools to track CEP trends and report progress (ongoing).

Recommendation 3

Major water-using sectors raise their members' awareness of the responsibility to report their water use and encourage reporting where appropriate (ongoing).

Recommendation 4

The Government of Alberta continue working to make the Alberta Water Use Reporting System publicly accessible (ongoing).

1.0 Introduction

The Government of Alberta (GoA) formally recognized the fundamental role and importance of water when it adopted the *Water for Life* strategy in 2003. *Water for Life* is the guiding strategy for managing Alberta's water resources. The strategy emphasizes the dependence of communities and the province's economic well-being on clean, sustainable water supplies and healthy aquatic ecosystems. It highlights the importance of working collaboratively with partners to advance the strategy's goals and key directions.

Water for Life highlights the importance of working collaboratively to achieve the goals of the strategy.

Water for Life identified the development of "water conservation and productivity plans for all water using sectors" as a key medium-term action, to be followed by long-term action to "establish an on-going monitoring program to ensure all sectors are achieving water conservation and productivity objectives."[1]

The *Water for Life* strategy was renewed in 2008, followed by the *Water for Life* action plan in 2009. The renewed strategy maintained the focus on the original goals of achieving:

- safe, secure drinking water
- healthy aquatic ecosystems
- reliable, quality water supplies for a sustainable economy

1 Government of Alberta. 2008. *Water for Life* action plan. p. 22.

Three key directions that support achieving the goals were also reiterated:

- knowledge and research
- partnerships
- water conservation[2]

One of the actions identified under the key direction of water conservation was to encourage all sectors to develop and implement sector plans for water conservation, efficiency and productivity. This action was intended to support the achievement of specific outcomes including:

> "Demonstration in all sectors of best management practices, ensuring overall efficiency and productivity of water use in Alberta improves by 30% from 2005 levels by 2015.[3] This will occur when either:
>
> - demand for water is reduced, or
> - water use efficiency and productivity are increased." [4]

2 More information on *Water for Life* is available online at http://aep.alberta.ca/water/programs-and-services/water-for-life/strategy/downloadable-information-about-the-water-for-life-strategy.aspx

3 Original *Water for Life* timelines do not align with the timelines examined by the sectors as some sectors took early action on CEP and thought it was important to recognize these efforts.

4 Government of Alberta. 2008. *Water for Life*: A Renewal. p. 15.

The 2009 *Water for Life* action plan reaffirmed this intent and listed the following specific actions to achieve these goals and outcomes:

"Work with key water sectors to:

- develop conservation, efficiency and productivity (CEP) plans
- implement CEP plans
- establish an on-going monitoring program to ensure all sectors are achieving CEP outcomes" [5]

In the 2013 GoA-led Water Conversation, Albertans stressed that water conservation ought to be something that each individual, business and industry strives to achieve.[6] The resulting 2014 report *Our Water, Our Future; A Plan for Action* committed the GoA to ensuring that major water-using sectors make improvements in CEP. This would be accomplished by continuing to support the voluntary approach to CEP efforts by working with the Alberta Water Council (AWC) to examine planning, implementation and reporting progress and evaluate the success of this process. A key action under the theme of water management was to "ensure major water use sectors make concrete, measurable and demonstrative improvements in water conservation, efficiency and productivity." [7]

One of the AWC's primary roles is to provide a forum for discussion and resolution of provincial water management issues.[8] Through its multi-stakeholder consensus based decision-making process, the AWC has played a significant role in supporting the major water-using sectors as they voluntarily developed and implemented their CEP plans. This report describes the work of the fourth, and most recent, AWC project to improve water CEP in Alberta.

5 Government of Alberta. 2008. *Water for Life*: A Renewal. p. 21.

6 Government of Alberta. 2014. *Our Water, Our Future; A Plan for Action*.

7 Government of Alberta. 2014. *Our Water, Our Future; A Plan for Action*. p. 15.

8 Alberta Water Council. 2014. *Alberta Water Council Business Plan* 2014–2016. Available online: http://awchome.ca/LinkClick.aspx?fileticket=RkTeOqX167Y%3d&tabid=59. Accessed November 2016.

1.1 AWC Involvement in Water Conservation, Efficiency and Productivity

Since 2007, three AWC teams created and built on a foundation that led to the current project (Figure 1). The first team developed specific desired outcomes, definitions and common principles to guide improvements in water CEP. It also offered examples of performance metrics and environmental indicators that sectors could consider adopting in their plans. The second team developed a framework and annotated table of contents to serve as a template for sectors to follow, and made 21 recommendations to further support water CEP improvements. The third team supported the major water-using sectors, offering assistance and suggestions to overcome challenges as plans were created.[9]

1.2 Purpose of the Evaluating Water Conservation, Efficiency and Productivity Project Team

The Evaluating Water Conservation, Efficiency and Productivity Project Team[10] was established in 2015 to:

- evaluate and report on the contributions of the water-using sectors' implemented CEP opportunities to achieving the three goals of *Water for Life*, the specific *Water for Life* outcome of a 30% improvement in overall efficiency and productivity from 2005 levels by 2015, and the AWC-approved CEP desired outcomes
- evaluate the process undertaken by the AWC to achieve CEP objectives and make recommendations for potential future enhancements to sector planning, implementation and reporting, if needed

Participants included representatives from the seven major water-using sectors, governments and non-government organizations.[11]

9 The Alberta Water Council hosts a wide array of information and reports related to the Water Conservation, Efficiency and Productivity project teams on its webpage http://awchome.ca/Projects/CEP/tabid/209/Default.aspx

10 See Appendix A for the team's Terms of Reference.

11 See Appendix B for a full list of team members.

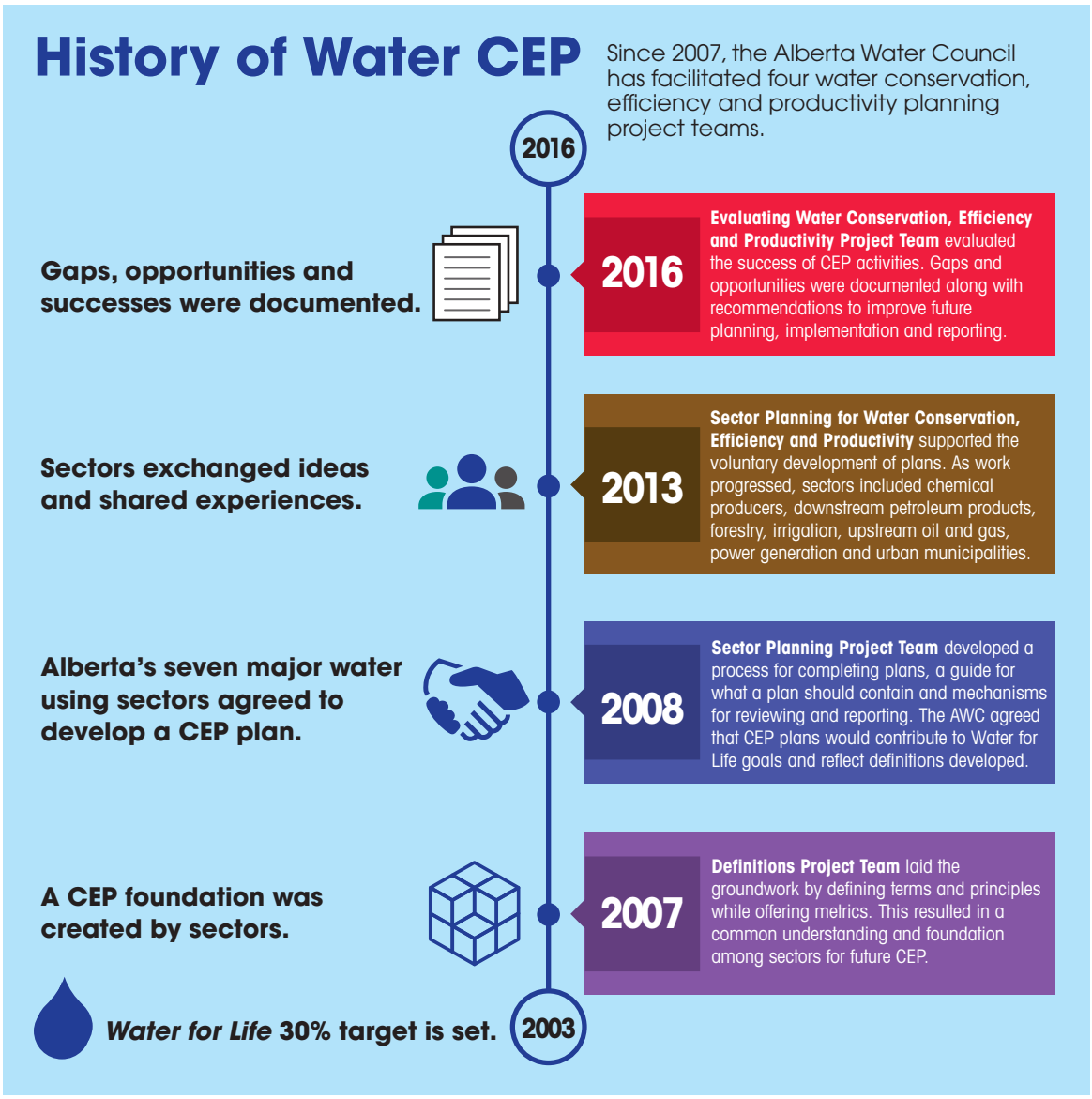


Figure 1: History of AWC Involvement in Water Conservation, Efficiency and Productivity

Water Conservation, Efficiency and Productivity Terminology

In 2007, the AWC approved desired outcomes, principles and definitions to guide CEP work.

a) Desired Outcomes:

- demand for water is reduced
- water use productivity is increased
- resources are conserved to maintain healthy aquatic ecosystems
- water quality is maintained or enhanced

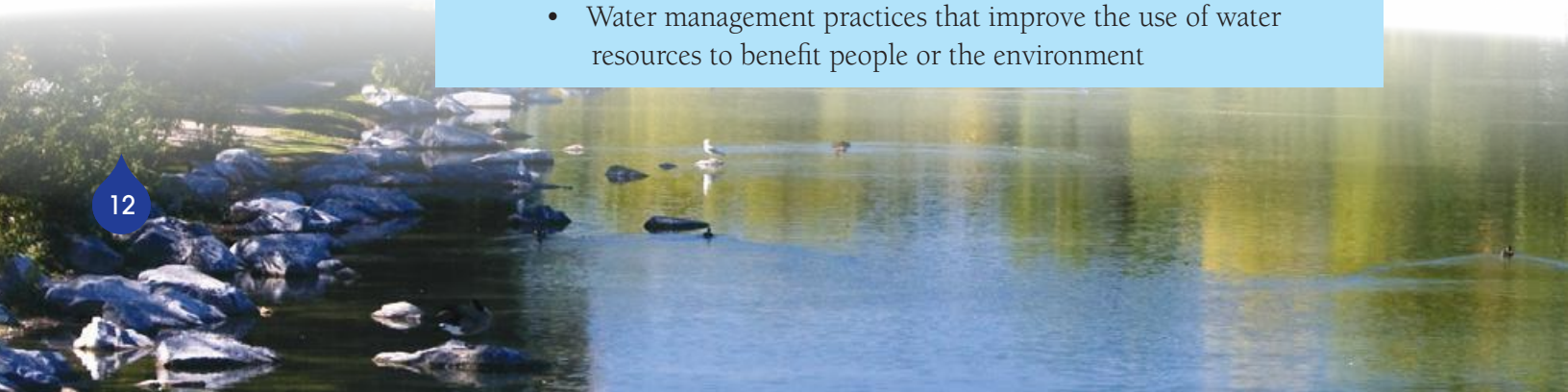
b) Principles:

- Fresh water is a finite and vulnerable resource, essential to sustain life, economic development and the environment.
- Water has an economic value in all its competing uses.
- Water has non-monetary values that enhance the quality of life.
- Sectors are accountable for what they control.
- Sectors have different opportunities for making progress in conservation, efficiency and productivity and are not necessarily comparable to other sectors.
- Sector plans will make every reasonable effort to protect and enhance aquatic ecosystems and meet ecosystem objectives.
- All stakeholders will work collaboratively, resolve differences through consensus processes, and support Best Management Practices.
- The Alberta Government will assure that goals for water conservation, efficiency and productivity are achieved.

c) Definitions

1) **Water Conservation:**

- Any beneficial reduction in water use, loss, or waste
- Water management practices that improve the use of water resources to benefit people or the environment



2) **Water Efficiency:**
   - Accomplishment of a function, task, process, or result with the minimal amount of water feasible
   - An indicator of the relationship between the amount of water needed for a particular purpose and the quantity of water used or diverted

3) **Water Productivity** is the amount of water that is required to produce a unit of any good, service, or societal value.

1.3 Approach

Building on the early AWC work, the major water-using sectors reported progress in implementing their CEP plan according to an agreed schedule and using the guidance provided.[12] These progress reports included successes and challenges in implementing CEP activities and achieving targets set out in the sector plans.[13] The reports also provided the data that were used to evaluate how successful sectors were in meeting CEP desired outcomes, the 30% target and the three *Water for Life* goals. This report documents the:

- sector-specific context and criteria for success in water CEP
- implementation successes and barriers
- contributions to *Water for Life* goals, the 30% target and CEP desired outcomes

In some cases, sectors relied on additional information obtained from Alberta's Water Use Reporting System (see text box on the next page) to supplement their reports. Individual sector reports (see Section 3) were reviewed to determine how to report and measure the success of implemented CEP opportunities in a consistent fashion. The methodology, rationale and results of this evaluation appear in Section 4.

12 Recommendation 1 of the 2013 report *Sector Planning for Water Conservation, Efficiency and Productivity*. Available online: http://awchome.ca/LinkClick.aspx?fileticket=_iYr_JXytVQ%3d&tabid=209. Accessed July 2016.

13 All progress reports are available online: http://awchome.ca/Projects/CEP/tabid/209/Default.aspx.

The AWC CEP process[14] over the nearly ten years of work was also evaluated, which involved identifying strengths, gaps and opportunities for improvement. Recommendations to improve CEP planning, implementation and reporting appear in Section 5.

Alberta's Water Use Reporting System (WURS)

The *Water for Life* strategy signalled a new approach to water management in Alberta. Acknowledging that government has the mandate to manage water resources, but shares responsibility for its management the strategy emphasized that all water users were to be stewards in the protection and wise use of water. From this approach, came a commitment from major water-using sectors to develop plans to conserve water and use it more efficiently and productively.

In 2006, the GoA launched the online WURS as a way for water licence holders to electronically report their water use. In combination with further education and awareness initiatives, the reporting system was primarily meant to support greater understanding of how water was being used. Reporting to the system was initially voluntary; subsequently, licence amendments were issued that made reporting a condition in many older licences, as well as in new or renewed licences. The GoA continues to upgrade WURS to make it easier for licence holders to report.

In support of increased transparency, the GoA is working to make the database available on its website so the public can have access to the reported information. The *Water for Life* commitment to work together to ensure wise use remains a strong ethic among Albertans, and the GoA is committed to work with licence holders to build understanding on how to use the system and why it is important to report usage.

14 Throughout the report, the CEP process refers to the work supported by the AWC's four project teams, recognizing that many sectors were also undertaking work to improve water conservation, efficiency and productivity independently of this process.

2.0 Provincial Context for CEP Planning

Alberta's water profile is characterized by variability and extreme contrasts in climatic events (i.e., floods and droughts).[15] The uneven distribution of water supply and demand adds to the challenge of managing water in Alberta—more than 80% of the water supply is located in the northern part of the province, while 80% of the demand is in the south.[16] Add to this the legal obligations associated with trans-boundary water agreements between Alberta and other jurisdictions, and one can begin to understand the complexity of drivers behind the GoA's water CEP management efforts. In addition to the *Water for Life* strategy and *Our Water, Our Future; A Plan for Action*, other important environmental, social and economic drivers also triggered the need for new approaches in water management in the early 2000s. These factors continue to influence water-using sectors as they incorporate CEP efforts into their business practices.

Limits to Water Availability in Southern Alberta

In regions where access to water is limited and demands are increasing, fulfilling water needs is a growing concern. In 2006, the GoA approved the Water Management Plan for the South Saskatchewan River Basin (SSRB) and closed three of the four sub-basins to new water licence applications (i.e., the Bow, Oldman and South Saskatchewan sub-basins). Although these sub-basins are closed to new surface water licences, groundwater licences are still being issued. The Approved Water Management Plan for the SSRB recognized that the limits for water allocations had been reached or exceeded in those sub-basins. Junior licences were not able to receive their total allocations in drier years and water diversions had adversely affected the aquatic environment. Closing the sub-basins was a critical step

15 German-Canadian Centre for Innovation and Research. 2015. *Alberta Water Report*. p.1.

16 Government of Alberta. 2010. *Facts about water in Alberta.* p. 4.

to protect existing licences and prevent further negative effects on aquatic ecosystem health. However, as water demand continues to grow, so does the pressure on existing water supplies. As licensees approach the limit of their existing licensed allocations, the need for greater water efficiency and productivity is becoming more pressing.[17, 18]

2.1 Environmental Drivers

Annual precipitation in Alberta can vary greatly, making it a challenge to predict how much water can be diverted in a given year to meet various needs. For example, the irrigation sector is vulnerable to fluctuations in water regime (Figure 2). In dry years water diversions by licensees increase to meet the needs of irrigated crops, while in wet years users tend to divert less.

17 Water Matters. *Water Rights Trading*. Available online: http://www.water-matters.org/topic/water-rights-trading. Accessed July 2016.

18 Alberta Environment. 2006. *Approved Water Management Plan for the South Saskatchewan River Basin*. Available online: http://esrd.alberta.ca/water/programs-and-services/river-management-frameworks/south-saskatchewan-river-basin-approved-water-management-plan/documents/SSRB-ApprovedWaterManagementPlan-2006.pdf. Accessed July 2016.

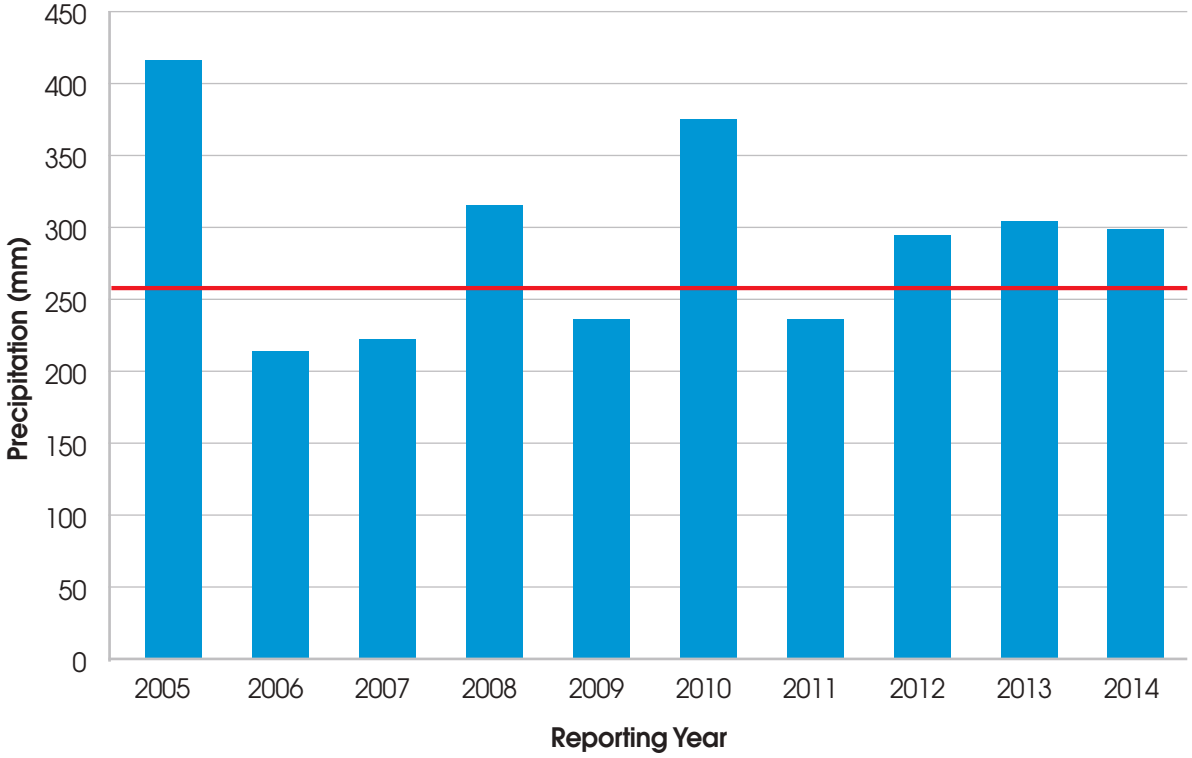


Figure 2: Growing Season Precipitation (mm) in the Irrigated Region of Alberta (average of Brooks, Bow Island and Lethbridge)

Horizontal line indicates mean precipitation from 1970 to 2014 (i.e., 260 mm).
Source: Alberta Irrigation Project Association's Irrigation Sector 2005–2015 Conservation, Efficiency and Productivity Report.

Extreme events such as droughts and floods have occurred throughout Alberta's history, and adverse climatic events are expected to become more frequent in the future. In 1984, Alberta experienced a particularly severe drought, as this was the eighth consecutive dry year and the driest year since 1916. A drought from 2001–2002 was devastating.[19]

19 Sauchyn, Dave et al. 2002 *Aridity on the Canadian Plains: Future Trends and Past Variability*. Prairie Adaptation Research Collaborative. Available online: http://www.parc.ca/pdf/research_publications/earth1.pdf. Accessed June 2016.

During a drought, there may be insufficient water to meet demands from all users. In some cases, water users may not be able to withdraw water without increasing the risk of harm to the aquatic environment.[20] Licences to divert water from surface water bodies are commonly issued with a condition that requires the maintenance of a passing or residual flow rate or water level; conditions may also be applied that require the licence holder to follow specific water conservation objectives or management frameworks that have been established. These clauses and conditions may be determined based on instream objectives, significant water levels (e.g., for lakes or reservoirs), environmental flow needs, or other concerns such as navigation. As our understanding of aquatic ecosystem needs has advanced, recommendations for instream flow needs have generally become increasingly linked to scientifically-based flows for healthy aquatic ecosystems. Where a condition is specified in a licence, the licensee must know the pertinent instream flow requirement or the management or conservation objective. In times of water shortage or drought, a licensee should be prepared for diversion rates or volumes to be reduced.

In 2013, many communities in Alberta were affected by flooding. The flood cut off dozens of communities and prompted the largest evacuation in Canada in more than 60 years with up to 100,000 Albertans told to leave their homes. Economists projected damage losses and recovery costs from the flood to exceed $6-billion including a record $2-billion in insured losses.[21] In Alberta, 66 communities, including Calgary, High River, Slave Lake, Drumheller and Peace River, have development within a flood plain, making them especially vulnerable to flooding.[22]

20 Government of Alberta. 2010. *Facts about water in Alberta.* p. .26.

21 Government of Canada. 2014. *Canada's Top Ten Weather Stories for 2013: Alberta's Flood of Floods*. Available online: https://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=5BA5EAFC-1&offset=2&toc=hide . Accessed November 2016.

22 Government of Alberta. 2010. *Facts about water in Alberta.* p.25.

The potential impacts of climate change are expected to stress Alberta's water supply. Of particular concern is the predicted increase in average temperatures and the subsequent impact on precipitation patterns and water resources. Temperatures in Alberta could increase by up to 4°C by the 2050s, with the greatest increases during the winter and spring in the north. Summer river flows are expected to decrease due to a combination of low snow and ice accumulations, an increasing amount of winter precipitation falling as rain and earlier spring runoff.[23] As extreme events and climate change lead to variability in water supplies, CEP efforts could improve our ability to adapt and cope with variable precipitation patterns and water availability.

2.2 Social Drivers

Alberta's population has grown steadily, increasing by 37% over the CEP reporting period (2000–2014) (Figure 3). At the onset of the AWC's CEP work, rapid population growth was expected to increase water demand across the province. Alberta's population is projected to reach five million by 2026 and six million by 2039, much of which will be concentrated in urban centres, particularly in the Edmonton-Calgary corridor.[24] Meeting the water demand of a growing population became a key driver for CEP efforts, particularly in urban municipalities. Water demand for industrial use is also increasing.[25] The 2013 GoA-led Water Conversation[26] also demonstrated that Albertans want all water users to conserve water and use it as efficiently and productively as possible.

23 Pembina Institute. 2009. *Heating up in Alberta: Climate Change, Energy Development and Water*. p. 4.

24 Government of Alberta. 2015. *Population Projection: Alberta 2015–2041–Highlights*. Available online: http://finance.alberta.ca/aboutalberta/population-projections/2015-2041-Alberta-Population-Projections-Highlights.pdf. Accessed June 2016.

25 Population Action International. 2011. *Why Population matters to water resources.* Available online at http://pai.org/wp-content/uploads/2012/04/PAI-1293-WATER-4PG.pdf. Accessed June 2016.

26 For more information about the 2013 Water Conversation go to http://aep.alberta.ca/water/water-conversation/default.aspx

Managing Low Flows in the Battle River Basin

Located in east-central Alberta, the Battle River Basin is the only basin in the province whose water supply is derived entirely from rain, snow melt and groundwater, with no runoff from the mountains. The Approved Water Management Plan for the Battle River Basin (2014) identifies a number of strategies to address the challenges associated with the naturally low volumes of the basin and the cumulative effects of municipal, industrial and agricultural activities. The plan recommends setting (1) a Water Conservation Objective to ensure that 85% of the natural flow is left in the river, and (2) a water allocation limit for the basin. In 2015 and 2016, low flows prompted the closure of the Battle River Basin to new temporary diversion licences.[27]

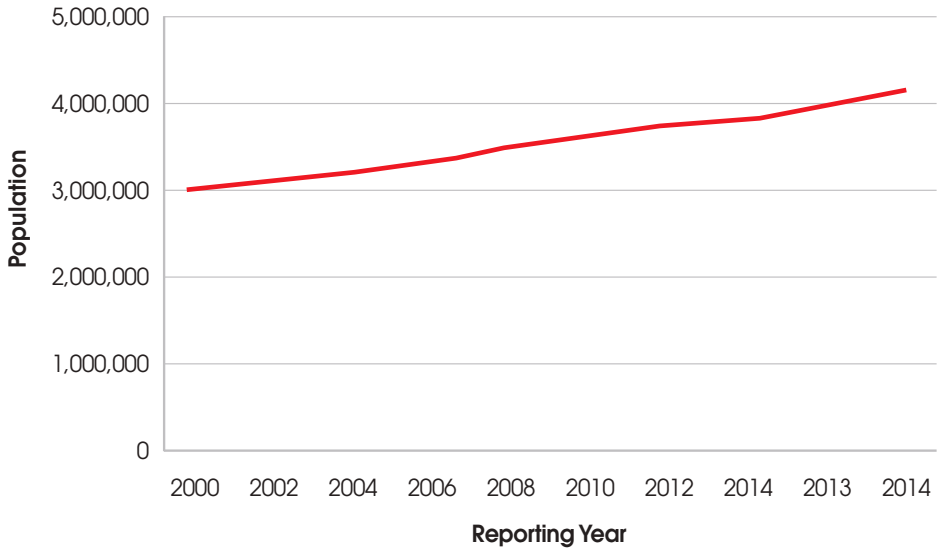


Figure 3: Population Growth in Alberta over the CEP Reporting Period

Source: Data obtained from http://economicdashboard.alberta.ca/Population

27 Government of Alberta. 2014. *Approved Water Management Plan for the Battle River Basin (Alberta)*. Available online: http://aep.alberta.ca/water/programs-and-services/river-management-frameworks/documents/WaterManagementPlanBattleRiverBasin.pdf. Accessed August 2016.

2.3 Economic Drivers

Rapid economic development in Alberta in the early 2000s was another key driver for the CEP work, as industrial production and associated water demand were expected to grow significantly during the reporting period. Reliable water quality and quantity will be integral to maintaining the province's ability to support economic growth. Over the CEP reporting period, Alberta's Gross Domestic Product (GDP) increased by 58% (Figure 4). The adoption of innovative water-efficient technologies and processes became an important strategy to enable economic growth within the limits of the available water supply. In light of Alberta's recent economic downturn, water efficiency gains will continue to be instrumental in cost-effective water use by industries.

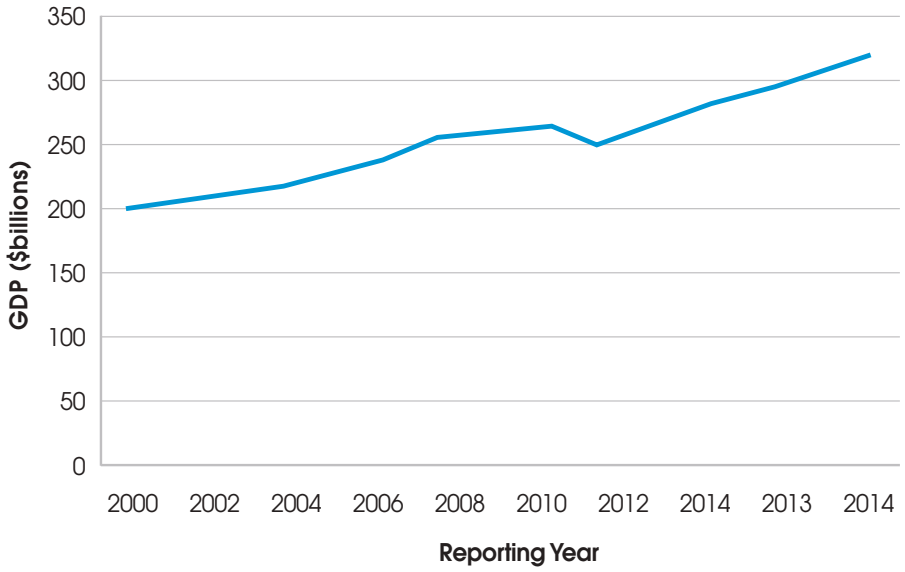


Figure 4: GDP Growth in Alberta over the CEP Reporting Period

Source: Data obtained from http://economicdashboard.alberta.ca/GrossDomesticProduct

3.0 Individual Sector Contributions

The seven major water-using sectors presented progress reports on the implementation of their CEP plans in October 2015 to the AWC,[28] documenting the following components:

- unique context and success criteria for CEP planning and implementation
- improvements in efficiency and/or productivity and how they were achieved
- contributions to CEP desired outcomes and the three goals of *Water for Life*
- future CEP opportunities

This section presents key considerations in each sector's approach to CEP planning and implementation, including how sectors defined productivity and efficiency measures and selected baseline and reporting years, and how sectors reported their results.

3.1 Chemical Producers

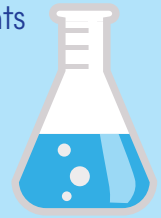
For the purpose of CEP planning, the Chemical and Petrochemical Sector is represented by members of the Chemistry Industry Association of Canada (CIAC). Member companies are responsible for some 200 sites across the country that produce chemicals and resins for manufacturing processes and provide technology, services, marketing, and research and development for chemical products. The chemistry industry is positioned at the crossroads between Canada's resource base—including mining, forestry, agriculture and oil and gas—and Canada's manufacturers, including the food and beverage sector, construction, plastics and rubbers, textiles and clothing, electrical and electronics and transportation equipment. Water use in the chemistry industry involves withdrawing water from the source and transporting it to the facility, then cleaning and treating it to render the water suitable for use in chemical

28 The October 2015 CEP progress reports are available at: http://awchome.ca/Projects/CEP/tabid/209/Default.aspx.

processes. Subsequently, chemical facilities treat their wastewater prior to discharging effluent to the receiving environment. The Chemical Sector's CEP plan covered CIAC member companies in Alberta, focusing on large facilities. The plan identified existing efforts towards responsible water use and examined future opportunities for CEP.

The Chemical Sector's facilities are typically high capital, fixed-cost facilities that have a long asset turnover cycle. Due to the unique conditions of each operation, no two facilities are identically designed. Engineered to operate as efficiently and economically as possible, newly built plants leave little scope for improvements in energy and water consumption. Older plants offer some opportunities, but projects to do this are often very expensive relative to the efficiency gained.

Chemical Sector's Highlights



21% ↓ in total water diversion

49% ↓ in return flow

11% ↓ in net use

3.1.1 Criteria for Success

The Chemical Sector's CEP plan[29] focused on establishing annual reporting on water intake and consumption over the CEP period. Until regular reporting was in place, it was difficult for the sector to develop specific targets to reduce water use. It was also a challenge to find agreement on a common measure and target for improvements in efficiency or productivity among CIAC's members. Annual reporting was a first step in establishing ongoing monitoring, with the intent of eventually developing a sector-wide metric and target.

29 The Chemical Sector's CEP plan is available online at: http://awchome.ca/LinkClick.aspx?fileticket=vD9vxq9yCk0%3d&tabid=209

3.1.2 Sector Contributions

The Chemical Sector is a relatively small water user, but decreased total water diversion by 21% and net water use by 11% over the reporting period.[30] However, this decrease in water intake and consumption is not attributable to CEP improvements, but rather to two events: (1) the shutdown of some operating units between 2005 and 2010, and (2) the economic downturn of 2008–2009 when economic conditions forced plants to operate below capacity.

An objective of the Chemical Sector's CEP plan was to establish water use monitoring in its operations. Annual water use reporting began in 2012 with the use of metering and monitoring devices and the sector now has three years of relatively comparable data. Some adjustments are still needed in the annual survey to achieve acceptable consistency in reporting.

The CEP process was an opportunity for the Chemical Sector to consider best practices that can contribute to reliable, quality water supplies in Alberta. Figure 5 outlines additional contributions of the Chemical Sector to the three goals of *Water for Life*.

3.1.3 Future CEP Opportunities

Continuous improvement in water use is expected to occur through Responsible Care™, which is CIAC's commitment to innovate for more environmentally friendly products and processes in its member companies. Small incremental measures are implemented through Responsible Care™ to reduce process waste and enhance water use efficiency. Major step-changes in water use efficiency occur only when significant capital investments are made or if a less efficient process train is shut down. Some of the CEP options identified in the sector plan have proved to be either technically impossible or prohibitively expensive to implement. In the Industrial Heartland/Capital Region, the concentration of

30 The Chemical Sector selected 2005 as its baseline year and 2014 as its reporting year.

facilities within reasonable proximity to each other provides greater potential for innovative solutions. Through the ongoing review of CEP plans, future opportunities are expected to be identified and evaluated.

Safe, secure drinking water supplies

- The Chemical Sector's water usage stays relatively consistent from year to year. If surface water is used as a source, the water is treated to a point that many potential contaminants (i.e., regulated substances) and undesirable substances (e.g., suspended sediment, bacteriological components, organics) are removed. Water returned to the river goes through extensive testing to meet regulatory requirements and strict environmental standards before discharge. The sector therefore has little impact on surface water bodies used as drinking water sources.

Healthy aquatic ecosystems

- As with the goal of safe, secure drinking water, water quality impacts on aquatic ecosystems are assumed to be small.

Reliable, quality water supplies for a sustainable economy

- Where appropriate, companies work together to divert water for multiple water licence allocations through existing infrastructure to limit environmental footprint. In some cases, treated wastewater is used as raw water at another facility after the intended use.

Figure 5: Contributions of the Chemical Sector to the Three Goals of Water for Life

3.2 Downstream Petroleum Products

The Downstream Petroleum Sector, represented by the Canadian Fuels Association, includes crude oil refiners; product distribution terminals; associated pipelines; truck, rail and marine transportation; and retail/wholesale gasoline, diesel and lubricant marketers. In 2009, this sector represented <0.1% of Alberta's total water allocation and <2% of the Alberta industrial allocation.[31] In refineries, the cooling system uses approximately 60% of the intake water, which is returned to the source after being treated to a high quality. The refining process uses another 35–40% of water by direct contact with crude or production of steam and hydrogen. Finally, approximately 1% of intake (including municipal sources) provides for sanitation purposes.

Downstream Petroleum Sector's Highlights

2% ↓ in total water diversion

3% ↑ in return flow

4% ↓ in net use

15% ✓ improvement in water productivity

Contaminated water from refining operations is treated in advanced wastewater treatment plants and then tested to confirm it meets regulatory criteria before being returned to the environment. Marketing and distribution operations are not significant users of water and they typically source water from municipal systems or, occasionally, from groundwater sources.

31 Canadian Fuels Association. 2015. *Progress Report*. Available online: http://awchome.ca/LinkClick.aspx?fileticket=KHw2RzaZ94E%3d&tabid=209. Accessed July 14, 2017.

The Downstream Petroleum Sector has evaluated each CEP opportunity identified in its plan based on a cost-benefit analysis and the feasibility of application. CEP opportunities cannot be applied uniformly to all refineries or refinery processing units due to:

- the complexity of each operation
- the design of the facilities and units
- the life cycle stage of the facilities and units
- the specific company business operating plans

3.2.1 Criteria for Success

The Downstream Petroleum Sector did not outline specific targets for success in its 2012 CEP plan. However, at the end of its first reporting period (2000 to 2009), the sector reported a net improvement in productivity of 30%.[32] Based on that result, in its 2012 CEP report, the sector indicated that its target was to continuously improve water productivity from the baseline year by 2015.

3.2.2 Sector Contributions

The downstream petroleum industry has examined and implemented many opportunities for water CEP and some represent ongoing continuous improvement. The following CEP opportunities have already been implemented and have contributed to the positive CEP results observed to date:

- reuse of water from municipal treatment plant source
- optimization of wastewater disposal by redirecting wastewater for reuse that previously would have been injected into deep well disposal
- ongoing maintenance and program upgrades to reduce evaporative losses from cooling towers

32 The Downstream Petroleum Sector measured water productivity as cubic metres of water used per cubic metre of crude oil processed.

- upgrades to marketing and distribution facilities to prevent operational impacts to surface and groundwater
- leak detection and repair programs, effective in reducing steam trap leak loss
- recycling and diversion of clean stormwater for use in refineries
- internal reuse and recycling of process water

As reported to the AWC in October 2015, the Downstream Petroleum Sector reduced its total water diversion and net water use from baseline levels by 2014.[33] While a first report in 2009 indicated water productivity had already improved by 30%, the period 2009–2014 saw increased water use in the sector due to:

- additional processing required to comply with environmental regulations affecting refined fuel product specifications (i.e., low sulphur gasoline and diesel)
- economic trends
- crude slate changes requiring refinery reconfigurations

By the end of 2014, water productivity had improved by 15% from the baseline year. Implemented CEP opportunities have also contributed to the three goals of *Water for Life* (Figure 6). The Downstream Petroleum Sector expects that any future CEP gains will be incremental due to continuous improvement.

33 The Downstream Petroleum Sector used the average of 2000 to 2002 data as its baseline year, and 2014 as its reporting year.

Safe, secure drinking water supplies

- This goal is met by advanced wastewater treatment systems at facilities. For example, refinery discharge data have been reported to Environment and Climate Change Canada since 1974 and effluent quality into the North Saskatchewan River is well within the guidelines under the federal *Fisheries Act*.

Healthy aquatic ecosystems

- As with the goal of safe, secure drinking water, maintaining the quality of effluents contributes to healthy aquatic ecosystems.
- Marketing and distribution operations have invested in upgrades to prevent water contamination due to leaks and spills.

Reliable, quality water supplies for a sustainable economy

- This goal is met by the sector's small water use footprint, which represents less than 0.1% of Alberta's total water allocation and less than 2% of Alberta's industry water allocation. Facility rationalization in marketing and distribution operations has reduced demands on municipal water systems.

Figure 6: Contributions of the Downstream Petroleum Sector to the Three Goals of Water for Life

3.3 Forestry

The Forestry Sector's CEP plan,[34] developed by the Alberta Forest Products Association (AFPA), focused on the sector's largest water users: pulp and paper mills. Alberta's seven pulp and paper mills are all located in the Peace and Athabasca watersheds where their licences to withdraw amount to less than 1% of annual river discharge. They only withdraw water as it is needed and actual water use is less than the licensed amount.[35] Environmental factors are well documented through federal and provincial monitoring programs. Data are readily available for the most part due to the limited number of facilities and the pulp and paper mills' long history of collaborating on environmental issues such as water use.

Forestry Sector's Highlights

10% ↓ in total water diversion

6% ↓ in return flow

40% ↓ in net use

20% ✓ improvement in water productivity

34 The Forestry Sector's CEP plan is available online at: http://awchome.ca/LinkClick.aspx?fileticket=LmpICOHFkys%3d&tabid=209

35 The total annual licensed water diversion by Alberta's pulp and paper mills is 229,060,332 m 3 or 151,349,974 m^3 from the Athabasca watershed (less than 1% of average annual discharge) and 77,709,358 m^3 from the Peace watershed (less than 0.1% of average annual discharge). For more information see http://awchome.ca/LinkClick.aspx?fileticket=LmpICOHFkys%3d&tabid=209

3.3.1 Criteria for Success

The AFPA CEP plan's vision is that Alberta's pulp and paper mills become world leaders in water-use reduction technologies and process operations, and that they reduce water consumption and improve efficiency and productivity. The plan had three goals:

- keeping water withdrawals and returns from Alberta's seven pulp and paper mills at 2009 or improved levels
- utilizing research and technology to improve productivity by a further 5% over the next decade
- continuing work with partnerships to improve water quality and support ecosystem health

3.3.2 Sector Contributions

At the end of 2014, water productivity had improved by 20% from the baseline year.[36] Research and technology have played a major role in improving the sector's water productivity. Examples of implemented technological improvements include:

- A new evaporator plant and cooling tower at Weyerhaeuser in Grande Prairie led to a 15% reduction in water use.
- A dispersed aeration system at Alberta Newsprint Company in Whitecourt removes contaminants from wastewater streams from the paper machine, allowing reuse of these streams in the process and thereby decreasing water usage.
- A treated final effluent recovery/reuse project at Alberta Newsprint Company took about 20% of effluent back into the mill's water supply intake in 2014.
- Slave Lake Pulp implemented a bio-methanation project with power generation to recover cooling water back into the process.

36 The Forestry Sector measured water productivity as the number of cubic metres of water required to produce one dry metric tonne of pulp. The sector used 2000 as its baseline year and 2014 as its reporting year.

- A number of beneficial reuse projects have been undertaken (e.g., providing the energy sectors with effluent for various uses).

Through both regulatory processes and voluntary CEP improvements, Alberta's pulp and paper industry is also contributing to the three goals of *Water for Life*. Figure 7 outlines these contributions in more detail.

Safe, secure drinking water supplies

- Discharges are maintained within approval limits.
- Best management plans and practices are in place to limit environmental incidents that could affect water supplies.
- Water management plans are a component of Forest Management Plans and are designed to limit impacts in areas being harvested. Setbacks, erosion control practices, stream crossings, road building and consideration of potential hydraulic and ecological impacts are all considered as part of these plans with the goal to minimize potential impacts.

Healthy aquatic ecosystems

- Most of the water withdrawn by the seven pulp mills is treated and returned to the river. By only withdrawing what is needed (58% of licensed volumes), and by treating and returning water that is not consumed in production (93% of water diverted), Alberta's pulp mills are ensuring that more water is available in the river to maintain aquatic ecosystem health.
- Processes are in place to ensure that facilities are operating within discharge limits for total suspended solids, biological oxygen demand and toxicity. Environmental effects monitoring is used as a regulatory tool for the pulp and paper sector provincially and federally to measure effects downstream from facilities.
- Mills collaborate with Watershed Planning and Advisory Councils, research groups and others to ensure that potential impacts are understood, managed and, where appropriate, mitigated.

Reliable, quality water supplies for a sustainable economy

- By only withdrawing what is needed and by treating and returning water that is not consumed in production, Alberta's pulp mills are ensuring that more water is available in the river to meet other downstream needs.

Figure 7: Contributions of the Forestry Sector to the Three Goals of Water for Life

3.3.3 Future CEP Opportunities

Given the progress already made, it may be a challenge for the Forestry Sector to make further technological gains around water productivity, but implementation of some CEP opportunities continues. For example, Alberta Newsprint Company is evaluating new biomass dewatering technology that uses up to 1000 litres/minute less water than the current dewatering system; this project is on the 2017 capital project list.

3.4 Irrigation

In addition to providing water for crops, the Irrigation Sector supplies water for livestock, rural communities, wetlands, recreational opportunities, commercial and industrial use, and other purposes in accordance with its water licences. Collectively, irrigation districts are licensed to divert approximately 3.4 billion m^3 of water. The Alberta Irrigation Projects Association (AIPA), which represents all 13 irrigation districts in Alberta, coordinated the development of the sector's CEP plan.[37] Irrigation water use is variable and highly dependent on weather, especially rainfall. To account for this, the sector uses ten-year averages to show trends in its water use with less variability due to weather. Water efficiency in the Irrigation Sector can be improved by making infrastructure and management changes in two areas: (1) on-farm application systems, which are purchased and controlled by the farmers, and (2) the irrigation district conveyance infrastructure.

Irrigation Sector's Highlights

- 26% ↓ in total water diversion
- 11% ↓ in return flow
- 30% ↓ in net use
- 22% ✓ improvement in water productivity
- 30% ✓ improvement in water efficiency

37 The Irrigation Sector's CEP plan is available online at: http://awchome.ca/LinkClick.aspx?fileticket=Qh93ijEWpxs%3d&tabid=209

3.4.1 Criteria for Success

The Irrigation Sector's CEP plan has eight targets:

1. The Irrigation Sector will achieve a 30% increase in combined conservation, efficiency and productivity from 2005 through 2015.
2. By the year 2015, 70% of irrigated lands in districts will be under best management practices, namely low pressure drop-tube centre pivots, an increase from the 47% documented in 2005.
3. On a ten-year rolling average, the irrigation districts will keep diversions at or below the year 2005 reference benchmark of 2.186 billion m^3 per year.
4. Within regulations and utilizing water conserved through efficiency gains anticipated through these CEP efforts in the irrigation system, the Irrigation Sector will make additional water available for other uses such as food processing, environmental objectives, rural water networks, agribusiness and other water sharing.
5. Growth in irrigation districts will occur using saved water.
6. On a ten-year rolling average through 2015, irrigation districts will reduce the volume of water diverted from Alberta's rivers, lakes and streams per unit of irrigated area to a level below the 2005 benchmark of 445 mm.
7. The Irrigation Sector will achieve a 15% increase in efficiency, relative to 2005 levels, by the end of 2015.
8. The Irrigation Sector will increase its productivity by 15% from the reference yield of 2005, based on the indicator crops of sugar beets, potatoes and soft white wheat.

3.4.2 Sector Contributions

The Irrigation Sector met or exceeded its eight targets over the reporting period.[38] Improvements in efficiency and productivity led to a 26% reduction in total water diversion and a 30% reduction in net water use. Efficiency gains alone exceeded 30%, measured by the reduction in net water use per hectare. This was primarily due to reduced water diversions rather than increased irrigated area, although substantial future increases in irrigated area are expected in some districts. Water productivity, measured for three indicator crops (potatoes, soft white wheat and sugar beets) improved by 22% over the reporting period.[39] These improvements can be attributed to four main CEP activities:

- a transition from less efficient on-farm application systems to low pressure centre pivots, the current best management practice for irrigation in Alberta
- the replacement of canals by pipelines, which eliminate losses from evaporation, seepage and spill
- canal lining to reduce seepage, where replacing canals with pipelines was not feasible
- increased automation of canal control structures

From 2005 to 2014, the assessed acres increased by 5.2% and the average irrigated area grew by 1.2% while total water diversions declined.[40] These CEP improvements, combined with other initiatives led by the Irrigation Sector, have also contributed to the three goals of *Water for Life*. Figure 8 summarizes these contributions.

38 The Irrigation Sector used 10-year averages for all numbers reported, with a baseline year of 2005 and a reporting year of 2014.

39 The productivity measure is not as comprehensive as it would ideally be because it only uses three out of the dozens of crops grown in irrigation districts, but it is the best available data.

40 The assessed acres represent the area approved for irrigation for all districts, while irrigated area is the portion of the assessed acres that are irrigated at least once each year. The average irrigated area increased by less than the assessed area due to adequate rainfall reducing the need for irrigation in some years. For example, 2010 was an extremely wet year, and 13% of the acres irrigated in the previous normal year were not irrigated in 2010.

3.4.3 Future CEP Opportunities

While the Irrigation Sector expects to see future improvements in efficiency and productivity, these will likely occur at a slower rate. Many of the remaining canals are larger and will be more expensive to replace with pipelines, or in some cases they are too large to be replaced. In 2014, 52% of the district conveyance infrastructure, by length, consisted of buried pipelines. A realistic goal would be 65–70%. Similarly, the Irrigation Sector expects that 85–90% of the irrigated land could eventually be irrigated with low pressure centre pivots, up from 71% in 2014. Finally, while climate change could result in higher future water use, improvements in both on-farm irrigation systems and district conveyance infrastructure will result in much lower water use than would occur otherwise.

Safe, secure drinking water supplies

- Members of AIPA have made a formal declaration committing to supply water to communities prior to supplying water for irrigating crops in the situation of a drought.
- Some 30 communities, many rural water co-ops, and thousands of rural families get their water from the irrigation system. More water is now available for communities due to licence amendments by districts.
- Quality of the water being delivered to users including communities has been monitored for over 160 parameters over a five-year period. The study was completed in 2016 and results will be reported thereafter. The districts have committed to continue similar water quality monitoring after the completion of this study.

Healthy aquatic ecosystems

- Lower diversions have resulted in more water being left in the rivers most years.
- Districts have cooperated in functional flow work, which has resulted in millions of seedlings establishing in riparian areas along rivers downstream of dams in the Oldman River basin.
- Irrigation infrastructure includes over 50 reservoirs and over 330 km^2 of wetland projects created in partnership between irrigation districts and Ducks Unlimited Canada, which provide healthy aquatic ecosystems.

Reliable, quality water supplies for a sustainable economy

- Upgrading the irrigation district conveyance infrastructure has increased the reliability of the water supply to all users of the system, encouraging economic development.
- An allotment of water has been made available for commercial and industrial operations through amendments to irrigation district licences.
- The water quality study has provided growers with information required by food processors regarding the quality of water used to grow the crops they process; those data are available to others.

Figure 8: Contributions of the Irrigation Sector to the Three Goals of Water for Life

3.5 Upstream Oil and Gas

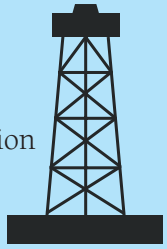
The Canadian Association of Petroleum Producers (CAPP) led the development of the upstream Oil and Gas Sector's CEP plan,[41] which focused on improving non-saline water use productivity in oil sands mining bitumen production, oil sands in situ bitumen production, and conventional oil production. The Oil and Gas Sector is the fourth largest water user in Alberta, after irrigation, commercial cooling and municipalities. In 2009, Alberta's total water allocation was 9.89 billion m^3, and of that, 8.5% was allocated to the oil and gas industry, including oilsands (i.e. industrial, injection and drilling).[42]

Upstream Oil and Gas Sector's Highlights

10% ↑ in net use

82% ↑ in hydrocarbon production

40% ✓ improvement in water productivity



Operators for these long-term activities must obtain term licences under the *Water Act* for surface water or non-saline groundwater withdrawals, and these licences have reporting requirements. For water withdrawals that are required for less than one year, such as well drilling and hydraulic fracturing operations, operators apply for temporary diversion licences (TDLs). The average duration of a TDL is one to two months, and most TDLs are issued for surface water. Most TDLs did not have water use reporting requirements in WURS until 2016. Beginning in 2013, the Alberta Energy Regulator (AER) required reporting of water use information for hydraulic fracturing operations. These data are not

41 The Upstream Oil and Gas Sector's Plan is available online at: http://awchome.ca/LinkClick.aspx?fileticket=Yd8tQfj6KM8%3d&tabid=209

42 *Ibid.* Page 10.

yet available from the AER, so hydraulic fracturing (i.e., shale gas, tight gas and tight oil production) was out of scope for the sector's CEP plan and progress report. Well drilling and completion volumes per well were estimated for the purposes of CEP planning.

Since the upstream Oil and Gas Sector is not permitted to treat and return oilfield wastewater to the environment in Alberta (with the exception of a few instances where water is not used directly in the production process, such as for cooling), most of the water used by this sector is consumptive. Once reuse or recycling has been optimized, wastewater is safely disposed of at approved waste management facilities, including disposal wells where fluids are injected in deep sub-surface formations.

3.5.1 Criteria for Success

The Oil and Gas Sector's CEP plan projected a 24% overall improvement in non-saline water use productivity by 2015 compared to baseline conditions.[43] Improvements were also projected for each sub-sector:

- Oil sands mining (Athabasca River water only) – 28%
- Oil sands mining (all non-saline sources) – 30%
- Oil sands in situ – 47%
- Conventional oil – 15%

43 The Oil and Gas Sector selected the average of 2002 to 2004 as its baseline year, and reported results at the end of 2014.

3.5.2 Sector Contributions

The adoption of the CEP opportunities identified in the sector plan were highly dependent on factors such as geographic location, availability of alternative (low-quality) water sources, reservoir characteristics, economics and evaluation of environmental net effects. CEP opportunities identified in the sector plan that had moderate to high impact on water use included:

- updates to equipment and operating procedures for improved water efficiency
- recycling of produced water from oil and gas wells instead of disposal
- alternative, less water-intensive oil sands tailings technologies and management techniques
- alternatives to non-saline water for drilling and fracturing fluids
- using saline groundwater for in situ steam generation

Projected improvements were met or exceeded for each sub-sector and for the sector overall. At the end of 2014, water productivity had improved by 40% from the baseline year.[44] Put another way, non-saline water use increased by only 10% over this period while hydrocarbon production increased by 82%.

By reducing the volume of non-saline water used per volume of hydrocarbon produced, the Oil and Gas Sector contributed to the three goals of *Water for Life* by limiting its impact on the volume of water available for potable groundwater, instream flows and other beneficial uses. Figure 9 outlines further contributions to *Water for Life*.

44 The Oil and Gas Sector measured water productivity as the volume of water in cubic metres required to produce one cubic metre of hydrocarbon.

3.5.3 Future CEP Opportunities

Technology and innovation have enabled these improvements in the sector's water use productivity. Although innovation will continue to be pursued, the easiest and most cost-effective measures have been implemented and further improvements in water CEP may be incremental. Nonetheless, some CEP opportunities were still in the pilot or evaluation stages so had not yet had a meaningful impact on water use in this reporting period. The draft Water Conservation Policy, which is pending final approval, would enable greater access to alternative sources of water. Until the policy is approved, broader opportunities across the sector may be unavailable.

Safe, secure drinking water supplies

- Strict regulations are in place to ensure oil and gas wellbores are designed, constructed and maintained to prevent migration of methane gas and chemicals into groundwater.
- As a best practice, industry tests domestic water wells in the vicinity prior to undertaking hydraulic fracturing or coalbed methane operations.
- Operators collaborate with government and with each other on regional groundwater monitoring programs.
- Applicable regulations and safety protocols are followed for fluid transport (by road, rail or pipeline), handling, storage and disposal to reduce the potential of surface release of oilfield fluids.

Healthy aquatic ecosystems

- Impacts of reduced non-saline water use on aquatic ecosystems varies from project to project depending on the changes in water volumes, timing of water withdrawals, and the source of the water (e.g., rivers, lakes, groundwater connections to surface waters).
- The identified opportunities related to water storage can change the timing of withdrawals, thus lessening aquatic impacts.

- For individual projects, impacts to aquatic ecosystems are minimized and monitored as part of *Environmental Protection and Enhancement Act* and *Water Act* approvals.
- Operators work with regulators and stakeholders to minimize environmental impacts to water at both a local and watershed level, including through regional groundwater and surface water monitoring programs.
- The upstream Oil and Gas Sector is not permitted to discharge wastewater to the environment in Alberta.
- Applicable regulations and safety protocols are followed for fluid transport (i.e. by road, rail or pipeline), handling, storage and disposal to reduce the potential of surface release of oilfield fluids.

Reliable, quality water supplies for a sustainable economy

The Oil and Gas Sector is the fourth largest water user in Alberta and a key driver of the provincial and Canadian economies, generating the following economic benefits:

- $9.1-billion in payments industry made for the use of Alberta's oil and gas resources in fiscal 2014/15, 18% of provincial government revenue. This figure does not include corporate, personal or municipal taxes.
- $105-billion in contributions paid to the provincial government over the last ten years.
- $26.7-billion in industry spending on exploration and development in conventional areas in 2014.
- $33.9-billion in investment spending in the oil sands in 2014.
- 155,000 people were directly employed in Alberta's upstream Oil and Gas Sector in 2014.

Figure 9: Contributions of the Oil and Gas Sector to the Three Goals of Water for Life

3.6 Power Generation

ATCO Power, TransAlta and Capital Power collaborated to develop the Power Generation Sector's CEP plan.[45] The plan included five types of power generation: coal, natural gas (simple cycle, combined cycle and co-generation), biomass, wind and hydroelectric. The Power Generation Sector holds water licences estimated to be around 1.86 Bm^3 per year, however net water use in the sector is low as water is used mainly for cooling and boiling processes, and is later returned to the environment. In hydroelectric power generation water loss is mainly attributable to evaporation from reservoirs; evaporative losses are accounted for as part of the sector's water use since this water is returned to the environment, but not directly to the river.

Power Generation Sector's Highlights

20% ↓ in net use

42% ✓ improvement in water productivity

A key challenge for the Power Generation Sector in developing its plan was that actual water use data are only available for coal generation. The sector developed performance indicators to estimate water use for natural gas, biomass and hydroelectric power generation, based on typical water consumption rates available from the Energy Technology Innovation Policy Research Group. Actual data for electricity production were taken from the Alberta Electricity System Operator's market statistics. This methodology allowed the Power Generation Sector to report on net water use for all its sub-sectors, but total water diversion and return flow data were not available for all sub-sectors.

45 The Power Generation Sector's Plan is available online at: http://awchome.ca/Projects/CEP/tabid/209/Default.aspx

3.6.1 Criteria for Success

The sector CEP plan forecasted a 31% improvement in water productivity by 2015 compared to baseline conditions.[46]

3.6.2 Sector Contributions

At the end of 2014, water productivity had improved by 42% from the baseline year. A number of CEP activities contributed to this improvement:

- the application of new technology (e.g., wind energy) and equipment to reduce energy consumption and water use
- the transition from coal-fired thermal facilities to natural gas and renewable energy
- water treatment improvements and the associated reduction in chemical and water use
- the use of low water use air-emission control equipment
- the use of cooling ponds to reduce the volume of diverted water

Figure 10 outlines further contributions of the Power Generation Sector to the three goals of *Water for Life*.

46 The Power Generation Sector measured water productivity as the number of cubic metres of water required to produce one unit of energy (megawatt hour). The sector selected the average of 2000 to 2002 as its baseline year, and reported results at the end of 2014. It is important to note that what changes here, is the ability to make electricity more efficiently (producing more megawatt hours with less water).

Safe, secure drinking water supplies

- The quality of effluents is well within the water quality standards from the federal *Fisheries Act*, which contributes to maintaining healthy aquatic ecosystems.
- Stormwater management and low impact development contribute to the protection of water sources.

Healthy aquatic ecosystems

- Similar to the goal of safe, secure drinking water, maintaining the quality of effluents contributes to healthy aquatic ecosystems.
- Resusing water within operations and using treated wastewater, cooling ponds and less water-intensive technologies have contributed to reducing water diversions.
- Generation facilities contribute to local habitat improvement opportunities.

Reliable, quality water supplies for a sustainable economy

- Technology shift from coal to natural gas uses less water to meet power generation needs.
- Co-benefits of generation facilities include the establishment of provincial parks and infrastructure sharing (e.g., community water source management, irrigation)
- Shepard Energy Centre reuses effluent from the City of Calgary's Bonnybrook Wastewater Treatment Plant.

Figure 10: Contributions of the Power Generation Sector to the Three Goals of Water for Life

3.6.3 Future CEP Opportunities

Establishing performance indicators to estimate water consumption was an important part of the Power Generation Sector's CEP work over the reporting period. Continuing to improve the availability of water use reporting data for all types of power generation would allow for greater accuracy in the sector's CEP planning and reporting.

The biggest opportunity for future improvements in water productivity in the sector will be changes in the generation mix. Unveiled in the fall of 2015, Alberta's Climate Leadership Plan committed to phasing out all coal-powered generation by 2030. As power generation transitions to more renewable energy and natural gas, water demand by the sector is expected to decrease. External factors will also continue to influence water use in the Power Generation Sector, in particular:

- The magnitude, location and timing of electricity demand affect power generation options and choices.
- Commodity prices and market dynamics influence the generation mix, and therefore water use.
- Regulations to reduce air emissions and greenhouse gases may affect water use, as air quality control technology requires water for operational purposes.
- Diversion from rivers to cooling ponds depends on precipitation; high precipitation will reduce the need for water diversion.

3.7 Urban Municipalities

Municipal water systems provide water for residential, commercial, industrial and institutional purposes in most urban municipalities in Alberta. In 2009, municipal water use accounted for 11.3% of water allocations in Alberta.[47] Municipalities face several challenges related to managing water resources:

- a scarcity of supply in many regions
- economic and population pressures
- the impacts of climate change
- concerns over aquatic and public health
- a shortage of qualified water and wastewater operators
- escalating costs associated with rising standards and maintaining aging water systems

Municipal Sector's Highlights

39% ↓ in average per capita residential water use

23% ↓ in average per capita total water use

The Alberta Urban Municipalities Association (AUMA) oversaw the development of the first CEP plan[48] in 2009. It included targets related to water use reporting, developing municipal CEP plans, conducting water loss audits and implementing incentives and disincentives to increase the uptake of water efficient fixtures and technologies. The 2009 plan raised awareness of the importance of CEP and contributed to a drop in municipal water use. It set

47 Government of Alberta. 2010. *Facts about water in Alberta.* p. 35.

48 The Urban Municipalities Sector's Plan is available online at: http://awchome.ca/LinkClick.aspx?fileticket=WnByoxget00%3d&tabid=209

a strong foundation for ongoing CEP work, but its targets did not capture the wide range of municipal efforts to reduce water use. In 2014, AUMA renewed its CEP plan with new outcome-oriented targets focused on making it easier to quantify the collective municipal contribution to the *Water for Life* goal of improving water efficiency.

3.7.1 Criteria for Success

The 2014 AUMA plan identified two targets:

- **Water efficiency:** Alberta's municipal sector will achieve an average per capita residential water use of 195 litres/person/day (l/p/d) and an average per capita total water use of 341 l/p/d by 2020 (both of these targets are 30% below the baseline average).[49]
- **Water losses:** Alberta's municipal sector will maintain the volume of "unaccounted for" water at 10% of total water use (reported to be 10.1% in 2009).

3.7.2 Sector Contributions

The AUMA (representing Alberta's towns, cities and villages) reported improvements in its two water efficiency measures over the CEP reporting period:[50]

- a 39% improvement in average per capita residential water use, which can be attributed to municipal CEP initiatives that targeted the residential sector (e.g., rebates for products such as water-efficient fixtures and rain barrels, educational initiatives on how to reduce overall home and garden water use)

49 Average per capita residential water use represents water use in the residential sector only, while total average per capita water use also includes institutional, commercial and industrial uses, as well as water losses.

50 The Urban Municipalities Sector used the average of 2001, 2004 and 2006 as its baseline year and 2013 as its reporting year for both efficiency measures based on Statistics Canada Survey of Drinking Water Plants.

- a 23% improvement in total per capita water use, which can be attributed to increased water metering (almost all AUMA member municipalities are now fully metered) and a movement to increased pricing to cover the cost of water services, which incents all water users to reduce their consumption

Despite improvements in water efficiency, AUMA reported an increase in losses from the distribution system, from 10.1% in 2009 to 14% in 2013, exceeding its 10% target. Two main factors have contributed to this increase. First, municipalities have identified the need to upgrade aging water distribution systems, but often find it difficult to fund these upgrades or even find companies who are able to complete them. In response, AUMA's business arm, the Alberta Municipal Services Corporation, has launched a new water service to help municipalities develop a plan to implement water loss measures along with full cost accounting and water pricing that better cover the cost of maintaining water infrastructure. A second factor is that more municipalities are tracking water loss than in the past, which could be contributing to a greater rate of water loss being reported to Statistics Canada.

Beyond contributing to CEP efforts, the development of AUMA's original 2009 Water CEP plan served as a catalyst for the development of broader policy and other initiatives around watershed management and the viability of municipal water and wastewater systems. AUMA has also created a Water Management webpage at water.auma.ca that provides information, resources and municipal examples related to water conservation, municipal water and wastewater systems and watershed management. Figure 11 outlines how CEP planning and these related initiatives have further contributed to the three goals of *Water for Life*.

3.7.3 Future CEP Opportunities

In its 2014 CEP plan, AUMA committed to renewing the targets and actions of the plan in 2020. While conserving water resources remains a priority for municipalities, competing priorities and capacity limitations create barriers to implementing CEP initiatives. For example, the 2016 Canadian Infrastructure Report Card indicated that one-third of Canada's municipal infrastructure is at risk of rapid deterioration.[51] Solutions such as full cost accounting and greater cost recovery can help cover the expense of needed upgrades to water infrastructure and can incentivize conservation. However, without careful planning, municipalities could find themselves in a negative cycle where the combination of increased water rates and other conservation initiatives leads to a reduction in water consumption, which in turn reduces revenue. Increasing water rates to make up for lost revenue could again promote conservation and further reductions in revenue. Municipalities require assistance in asset management and establishing rate structures that ensure money is available for required maintenance and upgrades while sending appropriate signals on the value of water.

Municipalities and other water licence holders that have been required to report their water use through the WURS have seen some improvement over the last few years. However, reporting rates are not consistent enough to be used reliably for CEP purposes. To address this, the municipal sector has developed performance indicators for CEP reporting based on Statistics Canada's Survey of Drinking Water Plants. As reporting through WURS continues to improve, WURS is expected to become a more useful source of data to support ongoing planning and reporting. AUMA is working with the Alberta Association of Municipal Districts and Counties (AAMDC) and Alberta Environment and Parks to raise awareness among municipalities of the importance of reporting water use through WURS.

51 *Informing the Future: The Canadian Infrastructure Report Card*. 2016. Available online: http://canadianinfrastructure.ca/en/index.html. Accessed July 2016.

Safe, secure drinking water supplies

- Municipalities are responsible for providing drinking water to 90% of Albertans and they implement a number of water treatment and source water protection measures to ensure water safety and security. Maintenance and replacement of drinking water distribution systems are among the most effective ways to reduce water loss while at the same time reducing the risk of contaminants entering the water system. This is why AUMA's CEP plan includes a target focused on maintaining low levels of loss.

Healthy aquatic ecosystems

- Municipal CEP initiatives will have limited impact on aquatic ecosystems compared to other municipal initiatives such as those related to wastewater treatment, stormwater management, wetland conservation and participation on Watershed Planning and Advisory Councils. AUMA has developed a number of policies and initiatives over the last several years aimed at creating and enabling environment for municipal water stewardship.

Reliable, quality water supplies for a sustainable economy

- Municipalities supply water to businesses as well as residents. Many municipalities are moving towards full-cost accounting and water pricing structures that contribute to the long-term viability of municipal water and wastewater systems, distribute the costs of water services equitably among water users, and incent conservation. Many municipalities also work directly with local businesses and industry on water conservation initiatives (e.g., rebate programs for spray nozzles in restaurants and industrial water reuse initiatives).

Figure 11: Contributions of the Urban Municipalities Sector to the Three Goals of Water for Life

4.0 Assessing and Evaluating Implemented CEP Opportunities

Based on the sector reports, individual sector contributions were aggregated to show collective contributions and examined to determine the success of implemented CEP opportunities. This section documents this work and presents an evaluation of the collective contributions.

4.1 Collective Contributions

Determining how to aggregate and report sector-specific results and assess collective contributions was challenging given that each sector had its own methodology and units to measure water efficiency and productivity (Figure 12). This included the selection of different baseline and reporting years based on data availability and other sector-specific considerations. This flexibility allowed for greater accuracy in measures within each sector, but made it difficult to sum up results to a meaningful estimate of the overall contribution towards the 30% *Water for Life* target. To address these challenges, AWC used two strategies for reporting on collective contributions: (1) documenting trends in total water diversion, return flow and net use; and (2) developing business-as-usual scenarios for net use.

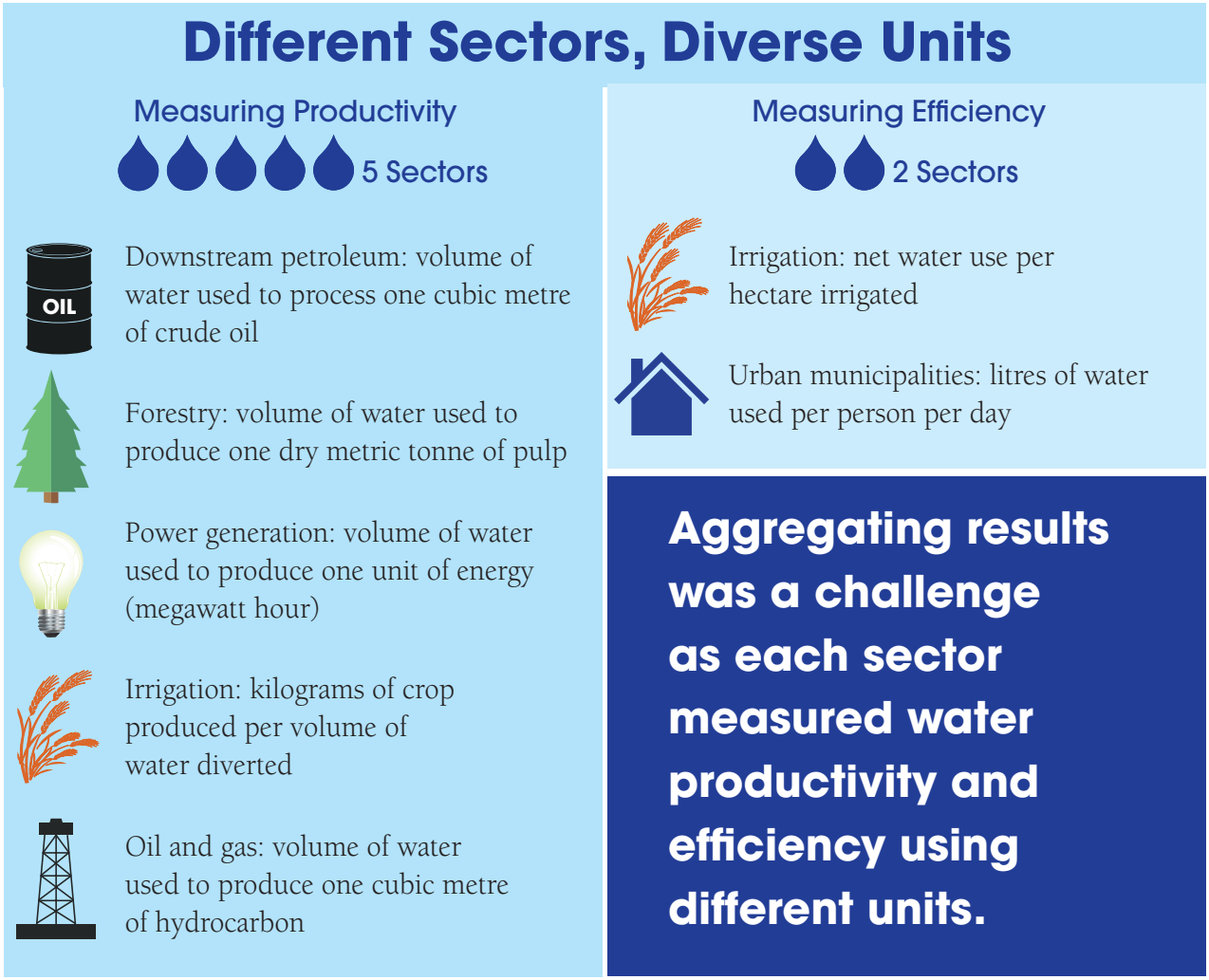


Figure 12: Different Sectors, Diverse Units

4.1.1 Trends in Total Water Diversion, Return Flow and Net Use

Unlike efficiency and productivity, total water diversion, return flow and net use were measured using consistent performance indicators across most sectors (i.e., volume of water). This made them appropriate indicators of trends in water use over the CEP reporting period. Figure 13 illustrates changes in total diversion, return flow and net use from the baseline year to the reporting year, summed up from the data reported by each sector. The total diversion and return flow charts exclude the Power Generation Sector as data on these variables were not available for some types of power generation. In addition, the Oil and Gas Sector is generally not permitted to return water to the river; return flow for this sector is minimal and assumed to be zero in reported numbers. Finally, these numbers exclude data from urban municipalities, as there were inconsistencies in how these performance indicators are tracked through the WURS due to a number of factors.[52, 53]

52 For example, the regionalization of municipal systems makes it difficult to compare data over time, as formerly stand-alone water and wastewater plants associated with individual licences transition to regional treatment plants that are often associated with complex water licence arrangements. In addition, municipalities have a number of federal and provincial water quality and quantity reporting requirements. Some water and wastewater operators are unaware that the data they provide to one system does not automatically populate another. Therefore, AUMA and AAMDC are working with Alberta Environment and Parks to raise awareness of specific requirements to report on use and return flow through the WURS.

53 Refer to the previous section of the report for more details on data from the Power Generation, Oil and Gas, and Urban Municipalities Sectors.

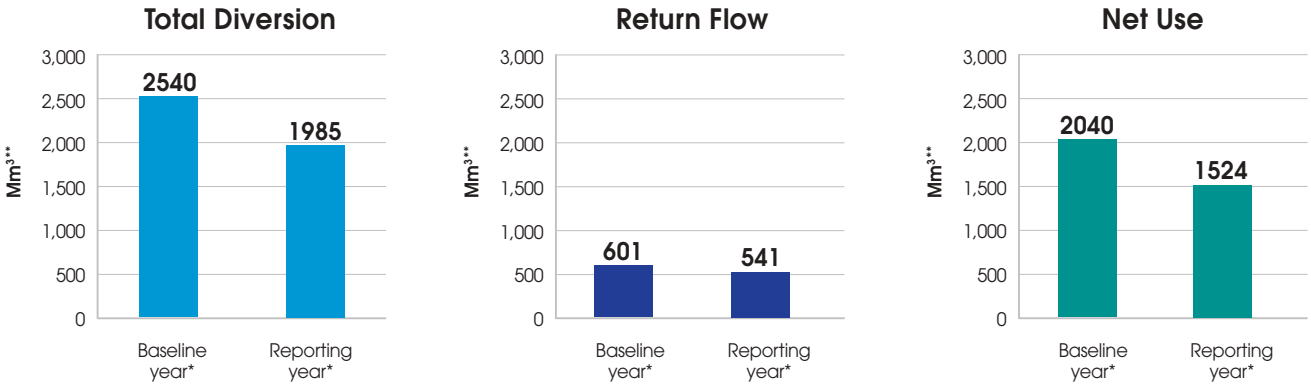


Figure 13: Collective Trends in Total Water Diversion, Return Flow and Net Use

*Baseline years and reporting years vary across the seven sectors

**Mm^3 refers to million cubic metres

Note: Because total diversion and return flow were not available for the Power Generation Sector, the numbers for net use and return flow do not add up to total diversion. The sector developed performance indicators to estimate water use for natural gas, biomass and hydroelectric power generation, based on typical water consumption rates available from the Energy Technology Innovation Policy Research Group. Actual data for electricity production were taken from the Alberta Electricity System Operator's market statistics. This methodology allowed the Power Generation Sector to report on net water use for all its sub-sectors, but total water diversion and return flow data were not available for all sub-sectors.

As well, baseline and reporting years differ for each sector, for reasons stated above. Baseline years ranged from 2000 to 2005, with some sectors using averages of multiple years to account for annual variations as documented in their individual reports; similarly, reporting years ranged from 2013 to 2014, again including some multi-year averages.

Based on the data presented in Figure 13, total water diversion decreased by 22% over the reporting period and net use dropped by 25%. Overall, sectors decreased their water use during the reporting period while increasing their respective production outputs (see Appendix C for data on each sector's production output).

4.1.2 Business-as-usual Scenarios

The reductions in total diversion and net use presented in Figure 13 illustrate water conservation over the reporting period, but they do not show what these improvements mean in terms of efficiency and productivity. Reductions in total diversion and net use occurred during a period when most sectors increased production, which reflects gains in efficiency and productivity.

To illustrate each sector's improvements in efficiency and productivity in terms of water use, the analysis quantified how much water would have been used by each sector had it achieved the levels of production in its reporting year with its baseline year water productivity. Business-as-usual scenarios[54] were used to report on each sector's improvements in efficiency and productivity represented in relation to its water use. The box below provides an example of the methodology used to develop the business-as-usual scenario.

54 Estimates of how much water would have been used by each sector had it achieved its reporting year production level with its baseline year water productivity.

Calculating Business-as-usual Scenarios: Example from the Downstream Petroleum Sector

	Net water use		Production (crude oil)		Productivity
Baseline year (2000-2002 average)	7.5 Mm^3	÷	22.7 Mm^3	=	0.33
Reporting year (2014)	7.2 Mm^3	÷	**25.4 Mm^3**	=	0.28

	Baseline year productivity		Reporting year production		Net water use
Projected for 2014	0.33	x	**25.4 Mm^3**	=	8.4 Mm^3

Difference between projected and actual net water use for the reporting year:
8.4 Mm^3 – 7.2 Mm^3 = **1.2 Mm^3**

The business-as-usual scenario indicates that, had the Downstream Petroleum Sector made no improvements in productivity over the reporting period, it would have required an additional 1.2 Mm^3 to achieve its 2014 production level.

Business-as-usual scenarios were calculated for the five sectors where net water use data and productivity or efficiency measures were available. The Chemical and Urban Municipalities Sectors were excluded from these calculations for the following reasons:

- The Chemical Sector is working on developing a productivity measure.[55] As the sector's net use only accounts for 1-2% of the total net use reported, its influence on the overall business-as-usual scenario would be minimal.

55 See Section 3 on this sector's individual contributions for more details.

- Only some municipal licensees reported net water use in a consistent way through the WURS, and a reliable estimate of net water use could not be established for the Urban Municipalities Sector.

Figure 14 presents the results of the overall business-as-usual scenario, along with individual sector scenarios. The darker blue or darker green shows the actual net use reported by each sector for its reporting year; the lighter blue or lighter green indicates the additional amount of water that would have been used in a business-as-usual scenario for the reporting year. Highlights from these results include:

- Total net use for the reporting year was 32% lower than the business-as-usual scenario, had the five sectors achieved their reporting year production levels with no improvements in water productivity. This corresponds to an additional 701 Mm^3 of water that would have been used.
- With no improvements in productivity, net use would have increased by 8% from the baseline year to the reporting year in the business-as-usual scenario. In contrast, the five sectors have achieved a 25% decrease in net use over the reporting period.

These business-as-usual scenarios represent rough estimates, based on changes in production levels and no changes in water use productivity or efficiency over the reporting. External influences such as extreme events, climate change or regulatory changes that have affected the sectors' net water use were not considered as part of these scenarios. Therefore, the reduction in net use may not be wholly attributable to the implementation of CEP plans. Additionally, scenarios for net use were developed because data were more readily available for this performance indicator for most sectors. Some sectors have higher water diversions but eventually return most of the diverted water to the environment, resulting in relatively low net water use.

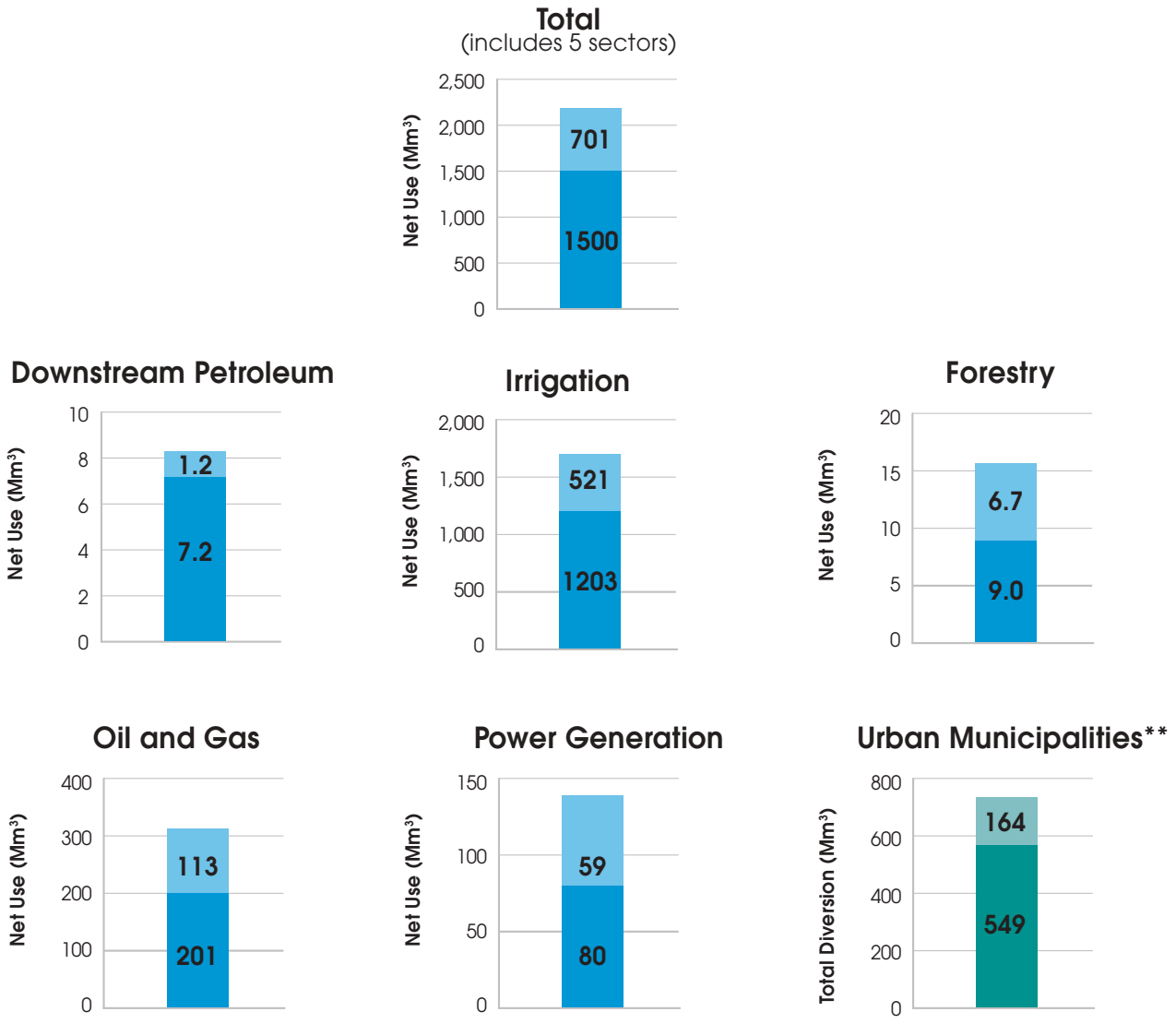
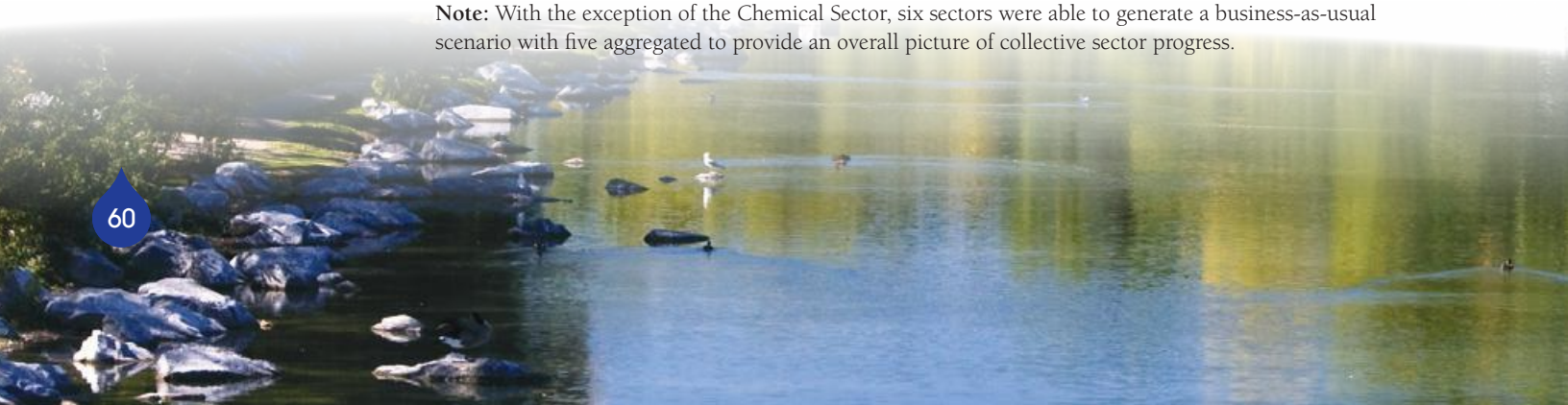


Figure 14: Reporting Year Net Water Use for each Sector Compared to Business-as-usual Scenarios

*Mm^3 refers to million cubic metres

**Net use data for the Urban Municipalities Sector were not available due to reasons outlined above and in their sector-specific write-up in Section 3. Total diversion numbers were used to provide a rough estimate of this sector's business-as-usual scenario; the difference in performance indicators did not allow this sector to be aggregated with the other five sectors.

Note: With the exception of the Chemical Sector, six sectors were able to generate a business-as-usual scenario with five aggregated to provide an overall picture of collective sector progress.



4.2 Outcomes

The evaluation was based on assessing sectors' collective contributions in four areas:

- CEP desired outcomes
- the three goals of *Water for Life*
- the 30% improvement target for efficiency and productivity
- sector-specific targets

Each section describes how each area was defined and assessed, and documents both quantitative and qualitative information that supported the evaluation. Associated challenges encountered through the reporting and evaluation process are also noted.

4.2.1 CEP Desired Outcomes

CEP desired outcomes were identified early in the AWC's CEP process[56]. This work evaluated success in relation to the five desired outcomes. Table 1 outlines the performance indicators used to assess success and the corresponding evaluation for each desired outcome.

56 The first AWC CEP team defined CEP desired outcomes here http://www.albertawatercouncil.ca/LinkClick.aspx?fileticket=DNItZciPdw8%3d&tabid=59

Table 1: Evaluation of Sectors' Collective Contributions to CEP Desired Outcomes

Outcomes	Key performance indicators	How was success defined?	Evaluation
Demand for water is reduced	■ Total water diversion ■ Total net use	A reduction in either indicator was considered success.	Success has been achieved: total water diversion has decreased by 22% and total net use by 25% over the reporting period.
Water use productivity is increased **Water use efficiency is improved**	■ % improvement in productivity and/or efficiency from sectors that reported on it	Any improvement in productivity and efficiency was considered success. (Note: Success in meeting the 30% target and other sector-specific targets will be evaluated in the next sections)	Success has been achieved: six sectors have reported improvements in efficiency and productivity (see section 4.2.3 for more details)
Resources are conserved to maintain healthy aquatic ecosystems **Water quality is maintained or enhanced**	■ Total water diversion	A reduction or no change in water diversion was considered success.[57]	Success has been achieved: total water diversion decreased by 22% and all sectors took innovative steps[58] that contributed to the *Water for Life* goal of healthy aquatic ecosystems (see section 4.2.2 on contributions to *Water for Life* goals for more detail)

57 A reduction in total water diversion should lead to improvements in aquatic ecosystem health, such as fish habitat. However, a number of other factors such as the timing of water withdrawal and return, and the quality of return flow water should also be considered when assessing the impact on surface water quality. Without that information, it is difficult to quantify the effect of reduced diversions on surface water quality or overall aquatic ecosystem health.

58 See Section 3 for more information on individual sectors' contributions.

The AWC concluded that sectors succeeded in meeting CEP desired outcomes. However, the CEP process has not been the sole driver of progress on these outcomes; each sector has also undertaken CEP activities in response to other social, economic and environmental drivers. Section 5 elaborates on this as part of the CEP process evaluation. Nonetheless, the reported progress has been achieved through voluntary measures by each sector.

Challenges were encountered when gathering data to report progress on water demand, productivity and efficiency. First, the variation in sectors' regulatory responsibilities for reporting on total diversion and net use influences the availability of data. In addition, not all sectors have an umbrella organization or association to facilitate data collection and reporting; as a result, some sectors were unable to include all member organizations in the CEP planning and reporting process. Finally, the WURS was a valuable source of information for some sectors as they developed their CEP plans. However, many sectors had incomplete datasets, which was an obstacle to reporting on water use and related performance indicators like productivity and efficiency. Some sectors had to contend with incomplete datasets due to a lack of reporting by licensees on WURS.

Progress on outcomes related to aquatic ecosystem health and water quality was more difficult to assess because the CEP process and the sector plans did not include direct performance indicators for aquatic health. Evaluating qualitative contributions to the *Water for Life* goal of healthy aquatic ecosystems was based on the progress made in reducing total water diversion over the reporting period. This assumes that by reducing total water diversion, sectors are leaving more water in the aquatic environment, which in turn might contribute to maintaining aquatic health and water quality.

4.2.2 *Water for Life* Goals

Contributing to the three goals of *Water for Life* was the second area considered in the outcome evaluation, and was challenging given its qualitative nature. All sectors implemented CEP activities that are connected to the three goals of *Water for Life*. Because the CEP process and individual sector plans did not include measurable targets to evaluate success in meeting the three goals of *Water for Life*, only CEP initiatives that are connected to the three goals could be reported on; comments on the success of these contributions in supporting the goals cannot be made.

Table 2 presents an overview of the regulatory requirements and voluntary activities documented by each sector and how they contribute to *Water for Life* goals. Although not all of these activities are a direct result of the CEP process, it is important to recognize the complementary nature of regulatory and voluntary approaches for water CEP. Regulatory requirements have enabled some CEP activities that may not have occurred otherwise. Voluntary contributions reported in Table 2 may not all be attributable to the CEP process either and may have occurred through other initiatives. Overall, voluntary efforts by the seven sectors have gone well beyond compliance requirements.

Table 2: Collective Contributions to the Three Goals of Water for Life

Activity	Description	Contributes to which *Water for Life* goal
Wastewater and effluent quality monitoring	■ The Downstream Petroleum, Forestry, Urban Municipalities, Chemical and Power Generation sectors all conduct wastewater treatment and monitor effluent quality, which is well within guidelines.	Safe, secure drinking water Healthy aquatic ecosystems
Land management practices	■ Many sectors are implementing land management practices that contribute to the protection of water sources. Examples include setbacks and erosion control practices in the Forestry and Oil and Gas Sectors and low impact development in the Power Generation Sector. In addition, municipalities use a variety of land management tools such as environment reserves and low impact development to protect aquatic ecosystems.	Safe, secure drinking water Healthy aquatic ecosystems
Maintenance and replacement of drinking water distribution systems	■ Maintenance and replacement of drinking water distribution systems by urban municipalities reduce water loss while reducing the risk of contaminants entering the water system.	Safe, secure drinking water Healthy aquatic ecosystems Reliable, quality water supplies for a sustainable economy

Activity	Description	Contributes to which *Water for Life* goal
Water quality monitoring activity	■ The Irrigation Sector has conducted a five-year study to monitor the quality of water delivered to users including communities. ■ Oil and gas operators collaborate with government and with each other on regional groundwater monitoring programs. ■ The Downstream Petroleum, Oil and Gas, Urban Municipalities, Forestry, Chemical and Power Generation sectors conduct surface water quality monitoring to minimize environmental impacts.	Safe, secure drinking water Healthy aquatic ecosystems
Decreased diversions	■ The Irrigation, Forestry, Urban Municipalities and Power Generation Sectors have reduced their water diversions, which has contributed to increasing the volume of water available for instream flows and other uses.	Safe, secure drinking water Healthy aquatic ecosystems Reliable, quality water supplies for a sustainable economy

Activity	Description	Contributes to which *Water for Life* goal
Alternative water sources	■ The Oil and Gas Sector's plan focused on reducing the use of non-saline water, thereby increasing the volume of water available for uses that require surface water and non-saline groundwater. ■ The reuse of grey water in the Power Generation Sector has contributed to reducing freshwater diversions.	Safe, secure drinking water Healthy aquatic ecosystems Reliable, quality water supplies for a sustainable economy
Impact monitoring	■ The Oil and Gas and Forestry Sectors are bound by legislation and regulation to monitor impacts to aquatic ecosystems.	Healthy aquatic ecosystems
Improving the reliability of water supply to other sectors	■ The Irrigation and Urban Municipalities Sectors supply water to other users through their systems. Different measures have contributed to increasing the reliability and long-term viability of these systems; examples include upgrades to the irrigation district conveyance infrastructure, and full cost accounting and water pricing by municipalities.	Reliable, quality water supplies for a sustainable economy

Activity	Description	Contributes to which *Water for Life* goal
Water reuse	■ The Oil and Gas, Forestry, Power Generation and Urban Municipalities Sectors reuse water in some of their operations or transfer their effluents to other sectors for reuse. Examples include the transfer of water effluent from the City of Edmonton's Gold Bar Wastewater Treatment Plant to the refining sector, the reuse of effluent from the City of Calgary's Bonnybrook Wastewater Treatment Plant by the Shepard Energy Centre, and the reuse of up to 20% of treated effluent by the Alberta Newsprint Company in its own processes.	Reliable, quality water supplies for a sustainable economy
Licence amendments and the cancellation of unused licences	■ Amendments to irrigation district licences have enabled districts to provide water for other purposes in addition to irrigation, such as municipal, commercial and industrial uses. ■ The Oil and Gas and Power Generation Sectors have cancelled unused licences, making water available for other uses.	Reliable, quality water supplies for a sustainable economy

4.2.3 Improvements in Efficiency and Productivity (30% Target)

Individual sector improvements in efficiency and productivity were documented in section 3. In summary, two sectors reported improvements in efficiency and five in productivity, with improvements ranging from 15% to 42% over the sectors' respective reporting periods. The challenge was to determine whether the individual sector contributions could be aggregated to measure collective success towards the provincial 30% target. Because efficiency and productivity were measured using different units and methodology across sectors, it was concluded that aggregating them would not produce a meaningful result. In addition, adding up improvements in efficiency and productivity within a single sector may result in some double counting of results. To address this, the results from the business-as-usual scenarios were used to quantify overall success towards the 30% target. These results showed that the sectors' net water use for the reporting year was 32% lower than the business-as-usual scenario, indicating that, collectively, sectors met the 30% target.

Individual sectors have contributed to different extents towards the improvement in net water use, based on sector-specific opportunities and contexts. However, this progress represents a significant amount of work and financial investment by all sectors, including efforts to mobilize each sector's participation in CEP planning and reporting, developing new technology and best management practices, and fostering collaboration within and among sectors.

4.2.4 Sector-specific Targets

In addition to the overall targets and desired outcomes set out in the CEP process, some sectors chose to set targets through their individual plans, based on their own context. The CEP process did not require sectors to set their own targets and not all sectors did. As part of the evaluation, the sectors' success in meeting their own CEP targets was considered where applicable. Section 3 documented many of these targets as part of individual sector reports and a detailed report on sector-specific targets is included in Appendix D. Overall, sectors were successful in achieving and in many cases surpassing their respective targets.

5.0 Evaluating the AWC CEP Process

Using a voluntary and consensus-based approach, the AWC has facilitated the CEP process since 2006. This process produced a suite of tools that guided the sector work.[59] The AWC provided a collaborative multi-stakeholder forum for sectors to share experiences, obtain feedback and adapt efforts where necessary.

The AWC table served as a forum for sectors to share experiences.

After examining sector-specific and collective contributions of implemented CEP opportunities, the CEP process was evaluated using methodology developed specifically for this purpose. This approach facilitated documenting strengths, gaps and opportunities in the planning, implementation, reporting and the overall CEP process (i.e., elements that applied to the entire process). Table 3 summarizes this work, and a statement of evaluation appears later in this section. The assessment of the CEP process was qualitative by nature. Future assessments would be strengthened by setting clear and measurable performance criteria to better support evaluation efforts.

59 These included CEP definitions, desired outcomes and a guide to developing CEP plans. For more information see http://www.albertawatercouncil.ca/Publications/tabid/59/Default.aspx#PT_reports

Table 3: Strengths, Gaps and Opportunities in the AWC CEP Process

Planning
Planning process
■ The planning process provided a framework for sectors to develop plans. It was flexible and allowed sectors to move forward as their specific circumstances warranted while providing a common foundation for ongoing planning and reporting.
Definitions and desired outcomes
■ Definitions and desired outcomes[60] were developed by consensus. They enabled CEP progress, but could be made more scientifically rigorous by being based on current literature and research.
Measuring success and performance
■ The process did not define how collective results would be reported and how performance measures would be used to assess the success of the CEP process. Common indicators would enhance future planning and reporting efforts.[61]
Other
■ The aspirational 30% target gave momentum to CEP work, but a new target may not be needed; sectors should define their next steps in CEP improvements based on their knowledge of opportunities and needs.
■ Sectors could consider a more streamlined planning and reporting format that would be consistent among sectors.

60 CEP definitions and desired outcomes were developed by the first AWC team through a literature review of work done by groups and agencies in Canada and elsewhere (e.g., Canadian Council of Ministers of the Environment Water Conservation and Economics Task Group). For more information see http://awchome.ca/LinkClick.aspx?fileticket=DNItZciPdw8%3d&tabid=209

61 Performance indicators agreed upon by the team were net use, return flow, water diversion, efficiency and productivity.

Implementation

Sector-specific improvements

- The CEP process resulted in developing data and data collection systems in many sectors as well as investments in process changes at the facility level.
- Sectors piloted technological advances to improve their systems. New advances (e.g., water efficient technologies) will need to be reviewed and implemented to achieve further improvements in CEP.
- Participation of the Environmental Sector and Lake Environment Conservation Sector strengthened CEP plans and reports.

Voluntary process

- Sectors considered the voluntary nature of the CEP process to be a success. Regulation and voluntary actions were complementary as the process evolved, and sectors achieved results that went beyond compliance and regulatory standards.

Reporting

Data availability

- The CEP process brought attention to gaps in data; for example:
  - Urban municipalities: lack of reporting by some users in the WURS.
  - Chemical producers: only CIAC members provided data for reporting; data from non-members were not available.
  - Upstream Oil and Gas: Although the AER has required reporting of water use information for hydraulic fracturing operations since 2013 under Directive 059: Well Drilling and Completion Data Filing Requirements,[62] the data are not yet available from the AER. As a result, hydraulic fracturing was not included in this sector's CEP plan or progress report.
- Clarification is needed regarding data requirements for future reporting; determining how to address data gaps and reporting data to WURS also need to be clarified.

62 For more information on Directive 059, see https://www.aer.ca/rules-and-regulations/directives/directive-059

Data usability

- In some sectors, available data were not usable or could not be easily translated for the purpose of CEP reporting. For example, there are gaps and incomplete datasets in WURS, which made it difficult to compare and establish trends and baselines over the evaluation period.

Data collection and reporting

- The CEP process:
  - created awareness of the importance for sectors to collect data and report on progress, which in turn is leading to greater recognition of efforts to improve CEP
  - helped sectors develop performance indicators to measure success
  - provided an opportunity for sectors to publicly report on progress
- A regular CEP reporting cycle should be established to support ongoing reporting.

Measuring success and performance

- Aggregating individual sector contributions to measure success was a challenge as each sector used different performance indicators and reporting years.
- Sectors reported on contributions to *Water for Life* goals, but no measurable outcomes were previously identified.
- Future efforts should:
  - identify and report on common key performance indicators
  - establish outcome-based and measurable CEP outcomes and associated indicators
- CEP is a process that reports, but does not necessarily drive, performance. Progress in water CEP does not imply success in the overall CEP process. Progress has been made but results cannot all be attributed to the CEP process.

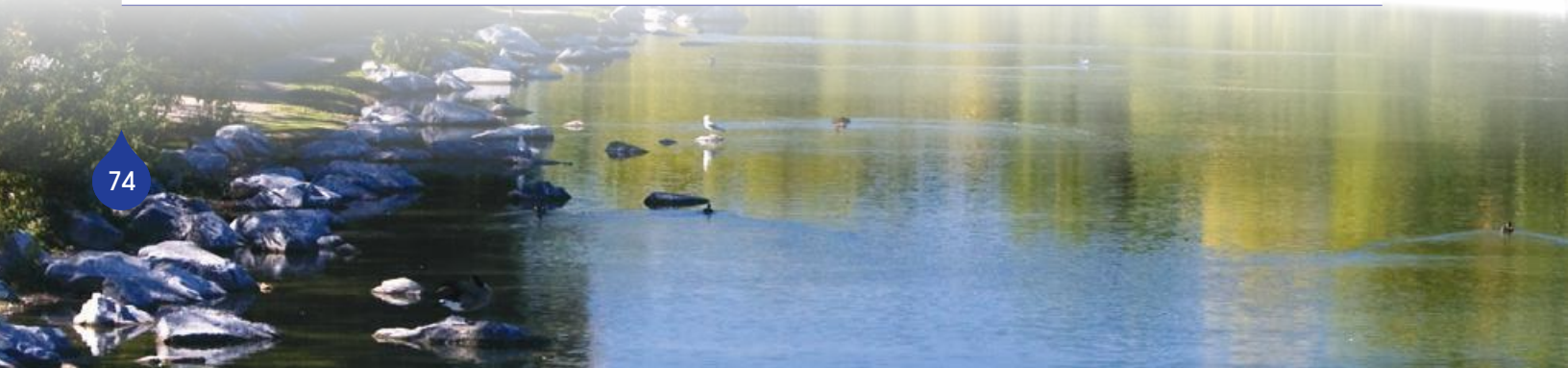
Water reuse

- Accounting for water reuse and greywater use is challenging. A means to track these types of alternate sources has not been developed because it is a relatively new trend. Future work must consider how water reuse and greywater use are accounted for in reporting and how these uses are affecting water diversions and water supply in restricted basins.

Overall

Awareness and behaviour change

- CEP has fostered behaviour change among sectors. It is now a known process and has increased the focus on the need to use water wisely, raised the profile of water and the importance of CEP work in its management, and created awareness about the work of sectors.



Collaboration and relationships

- The CEP process facilitated relationship-building and understanding among sectors and the GoA. It provided a forum for sectors to understand the challenges faced by others, raise concerns and discuss solutions.
- The AWC multi-stakeholder forum brought sectors together to share resources and knowledge and support innovation.

Investment of resources

- Sectors have invested significant time, expertise and funds in participating in the CEP process.
- A cost-benefit analysis of CEP initiatives would be a useful tool to understand whether sectors were able to save money by implementing their CEP plans. CEP strategies and new water conservation technologies appeared to be cost-effective while allowing for continued expansion and growth in most sectors.

The scope of CEP

- Many outcomes were deemed to be outside the original scope of CEP (e.g., the potential impacts of CEP on aquatic ecosystem health).
- Non-consensus items were not resolved through the process (e.g., issues related to return flow, consumptive use).
- Some sectors perceived the CEP process as a way for major water-using sectors to continue growing.

The AWC role in supporting CEP work

- Although each sector was responsible for implementing its own plan, a common framework for planning and reporting was valuable in supporting CEP efforts.
- There should be an ongoing role for the AWC in bringing sectors together for future reporting and maintaining the voluntary nature of the process.

The future of CEP

- A jurisdictional review of existing initiatives related to CEP could be valuable.
- Priorities in CEP planning and implementation could be enhanced based on patterns in water supply and demand at the regional or watershed level.
- CEP effort will need to align with ongoing water policy work (e.g., water reuse policy) and identify legislative barriers to implementation.
- How to link aquatic ecosystem health with work on water use remains unclear and needs more work; e.g., developing performance indicators to track trends or changes in aquatic ecosystem health.

Overall, the AWC CEP process was viewed as successful.

Overall, the AWC CEP process was viewed as a success. It provided a foundation that guided sectors in meeting or exceeding targets and developing common performance indicators to report progress. It raised the profile of water and the importance of CEP efforts in its management, created awareness of the distinctiveness and role of each sector in water management and facilitated the sharing of experiences among sectors. Sectors took an adaptive management approach as they learned and adjusted throughout the planning, implementation and reporting stages. The process allowed the documentation of gaps and opportunities for improving future CEP planning, implementation and reporting within each sector and collectively. Moreover, the CEP process brought important perspectives[63] to the forefront that were not considered from the start. In general, sectors thought the process and its resulting work was pioneering, collaborative and unique to Alberta.

5.1 Improving Future CEP Planning, Implementation and Reporting

Based on this work, the AWC makes four recommendations to improve future CEP planning, implementation and reporting efforts in Alberta.

Maintain the culture of CEP and report on sector progress.

Key finding

The CEP process motivated sectors to develop sector-level plans to identify and implement CEP activities, gather data and publicly report on progress. To do this in a meaningful way, they developed performance indicators. The AWC's multi-stakeholder forum enabled sectors to share experiences, resources and knowledge, which created awareness about the uniqueness and role of each sector in water management. The process also raised the profile and importance of CEP work in water management and increased the focus on how water is used in Alberta. Sectors remain committed to advancing their CEP initiatives and the AWC can continue to provide the setting for this work.

63 These included linkages between water CEP and consumptive use, return flows, water licensing and allocation, and the fate of water that is conserved, among others. For more details see Sector Planning for Water Conservation, Efficiency and Productivity (2013) at http://awchome.ca/LinkClick.aspx?fileticket=_iYr_JXytVQ%3d&tabid=209

The AWC proposes the use of five performance indicators to track the progress of the seven major water-using sectors as they report on future CEP trends. Sectors have agreed to collect and collate their data and report to the AWC every five years; they are encouraged to report any progress to the AWC before the five-year mark (e.g., annual, biennial milestones) where possible and appropriate. Aggregate numbers will be generated using the business-as-usual scenario similar to what was undertaken through this evaluation[64] while telling the story of each individual sector. The proposed performance indicators for reporting are:

- water diversion
- return flow
- net water use
- efficiency (sector-specific)
- productivity (sector-specific)

The data generated for the performance indicators through this evaluation[65] will set the baseline as sectors continue to track CEP trends and report on their progress. Sectors may identify other performance indicators in future reports, depending on the needs and opportunities.

> **Recommendation 1:** Major water-using sectors collaborate with the Government of Alberta and other partners including the Alberta Water Council to continue reporting CEP trends and progress. Reporting will occur through the Alberta Water Council at five-year intervals using the performance indicators and baseline data in Appendix C (ongoing).

Improve data collection, availability and usability and raise awareness of the importance of reporting.

Key finding

Most sectors have a well-defined process to report their water use (e.g., requirements to report to Statistics Canada, Alberta Environment and Parks

64 For more details on how sectors estimated their business-as-usual scenarios, refer to Section 4.

65 To see the performance indicators and baselines used by sectors, refer to Appendix C.

or the AER) but some face challenges with identified gaps in data collection, management and reporting systems. For example, not all licensees are required to report their water use in WURS. As sectors have inconsistent reporting requirements and methods, finding common performance indicators to evaluate water CEP was a challenge. Improvements to WURS are needed to remedy issues with incomplete or inaccessible datasets, inconsistency in reporting and data management for the seven major water-using sectors, and possibly others.

By amending over 3,000 water licences to require reporting to WURS, the GoA has committed to using WURS as the tool to improve water use reporting and to making data available to the sectors and the public. The GoA has been working with sectors to improve the effectiveness of the WURS and its capability to track improvements in CEP, but sectors need to continue working with the GoA to make further improvements if WURS is expected to be the primary source of water use data in Alberta. There is also a role for sectors to continue raising awareness and understanding on how to report their water usage and on the importance of doing so. This can include targeted education and awareness initiatives such as workshops with licensees, a how-to guide on reporting and other applicable tools.

Working with licensees who are members of the sectors that are expected to use WURS regularly provides an opportunity for improving and optimizing CEP data collection, management and reporting by all sectors. WURS can serve as a common platform for sectors to collect and share data, track CEP trends and report progress made on performance indicators.

Recommendation 2: Major water-using sectors continue working with the Government of Alberta to resolve existing challenges with the Water Use Reporting System to improve data collection, management and reporting tools to track CEP trends and report progress (ongoing).

Recommendation 3: Major water-using sectors raise their members' awareness of the responsibility to report their water use and encourage reporting where appropriate (ongoing).

Recommendation 4: The Government of Alberta continue working to make the Alberta Water Use Reporting System publicly accessible (ongoing).

5.2 Other Perspectives on the Future of CEP

Throughout the CEP process and this evaluation, sectors shared perspectives on several considerations for future CEP efforts. This section summarizes issues that were considered important but may be better addressed through mechanisms other than this CEP process.

5.2.1 Water Reuse

Water reuse is becoming more common among Alberta's major water-using sectors as one strategy to reduce water diversions. Examples include the City of Edmonton transferring effluent from the Gold Bar Wastewater Treatment plant to the refining sector, and the Shepard Energy Centre reusing effluent from the City of Calgary's Bonnybrook wastewater treatment plant. As water is transferred from one sector to another, accounting for reused water or greywater in CEP becomes a challenge and double counting may occur without a robust system in place. Ongoing work on the provincial water reuse policy should consider how to address these reporting challenges.

5.2.2 Watershed Resiliency and Climate Change

Water resources are unevenly distributed in Alberta. Environmental, social and economic drivers have created more stress on some watersheds than others, as illustrated by the closing of three sub-basins in southern Alberta to new licence applications. Climate change and variability is likely to affect watershed resiliency, as extreme events become more frequent and precipitation patterns change. Previous CEP work has focused on objectives at the provincial level, but there can be value in identifying priorities in CEP planning and implementation based on patterns in water supply and demand at a smaller scale (e.g., regional or watershed). A place-based approach would allow better alignment of CEP work with priorities in building watershed resiliency.

5.2.3 Healthy Aquatic Ecosystems

Because the CEP process was not designed to include measurable aquatic ecosystem health performance indicators, the impacts of CEP efforts on aquatic ecosystems could not be assessed. However, some sectors were able to report some qualitative contributions to the *Water for Life* healthy aquatic ecosystems goal and CEP desired outcomes related to aquatic ecosystem health in this report. While some sectors thought that healthy aquatic ecosystems were outside the scope of this work, other sectors believed they were in scope and should have been addressed through CEP.[66] All sectors acknowledged the importance of examining linkages between water use and aquatic ecosystem health, but concluded that this matter should be thoroughly addressed in a separate forum.

66 The concerns of sectors, including those related to healthy aquatic ecosystems were documented in the last AWC CEP report in Section 5. For more information see http://awchome.ca/LinkClick.aspx?fileticket=_iYr_JXytVQ%3d&tabid=209

6.0 Conclusion

The *Water for Life* strategy established a target to improve water efficiency and productivity by 30% from 2005 levels by 2015. Since 2006, Alberta's seven major water-using sectors voluntarily followed the AWC CEP process to develop, implement and report on CEP plans to contribute to the target. This evaluation demonstrated that water use efficiency and productivity improved by 32% over the reporting period, exceeding the target. Most sectors have reported improvements in efficiency and productivity, and net water use has dropped by 25% over the reporting period. Sectors have successfully achieved CEP desired outcomes and their individual targets. This work established a foundation to monitor CEP improvements and report water use. The AWC CEP process was a learning experience, and this evaluation highlighted the challenges involved in planning, implementing and reporting progress. When implemented, the recommendations will support sectors in advancing their CEP work, strengthening data collection and management, and improving reporting.

Glossary

Previous AWC CEP projects defined much of the terminology associated with this area. Definitions for water CEP were developed and adopted by the AWC in the 2007 report *Water Conservation, Efficiency and Productivity: Principles, Definitions, Performance Measures and Environmental Indicators*. Definitions for water allocation, diversion, return flow and water consumption can be found in the AWC 2008 report *Recommendations for Water Conservation, Efficiency and Productivity Sector Planning*. This glossary builds on those definitions and describes additional terminology used in the current work.

Business-as-usual scenario
Estimates of how much water would have been used by each sector had it achieved its reporting year production level with its baseline year water productivity.

Conservation
1) Any beneficial reduction in water use, loss or waste.

2) Water management practices that improve the use of water resources to benefit people or the environment.

Efficiency
1) The accomplishment of a function, task, process or result with the minimal amount of water feasible, or

2) An indicator of the relationship between the amount of water needed for a particular purpose and the quantity of water used or diverted.

Healthy Aquatic Ecosystem[67]
An aquatic environment that sustains its ecological structure, processes, functions and resilience within its range of natural variability.

Productivity
The amount of water that is required to produce a unit of any good, service or societal value.

67 Alberta Water Council. 2008. *Healthy Aquatic Ecosystems – A Working Definition*. p.1. Available online: http://www.awchome.ca/LinkClick.aspx?fileticket=dO4RIIJ9sSQ%3d&tabid=108. Accessed May 2016.

Net water use
The difference between the amount of water diverted and the return flow.

Return flow
Represents the water diverted from a water source and returned to the river after use, although the water quality characteristics may have changed during use. Typical return flows include discharges from sewage treatment plants, surplus flow in irrigation canals and water discharged from cooling ponds. Not all return flows go back to the original source of diversion or withdrawal.

Water allocation
The amount of water that can be diverted for use, as set out in water licences and registrations issued in accordance with the *Water Act*. Allocations include a maximum amount of water that can be withdrawn for use and the rate of withdrawal, the water source, the purpose for which the water is to be used and the location at which the diversion can occur.

Water diversion
Represents the amount of water withdrawn from the water source, subject to the restrictions of a licence.

Water reuse[68]
The multiple use of water within a licence before return flow is calculated. The reuse of water for a variety of purposes may result in less fresh water diverted under the licence, and may result in the reduction of return flow.

68 AUMA Glossary of water terms. Available online: https://auma.ca/advocacy-services/programs-initiatives/water-management/glossary-water-terms. Accessed June 2016.

Appendix A–Terms of Reference

Approved by the Alberta Water Council on October 29, 2015

CONTEXT

Water conservation and major water-using sectors voluntarily developing and implementing water conservation, efficiency and productivity (CEP) plans are pillars of the *Water for Life* (WFL) strategy. Improving overall efficiency and productivity of water use by 30% from 2005 levels by 2015 was identified as an aspirational specific outcome in the original WFL strategy (2003), and was reaffirmed in the renewed WFL (2008) and associated action plan (2009).

Since 2004, the Alberta Water Council (AWC) has supported the CEP initiative with three project teams: the first identified guiding principles and definitions related to CEP planning; the second developed a framework to guide the sectors in creating their CEP plans; and the third supported the seven priority water-using sectors as they developed their plans. The third team also made a recommendation for a fourth team. This team would report on the implementation progress of sectors' CEP plans, evaluate the overall CEP planning process, and make recommendations to enhance sector CEP planning, implementation and future reporting if needed.

The recently released Water Conversation Action Plan commits the Government of Alberta to ensuring major water-using sectors make concrete, measurable and demonstrative improvements in water CEP. This will be accomplished by continuing to support the voluntary approach to CEP planning by working with the AWC to examine implementation progress and evaluate the extent to which the CEP process was successful.

STRATEGIC INTENT (GOAL)

The purpose of this project is two-fold:

1. Evaluate and report on the contributions of the water-using sectors' implemented CEP opportunities to achieving the three WFL goals[69], the specific WFL outcome of a 30% improvement in overall efficiency and productivity from 2005 levels by 2015, and the AWC-approved CEP desired outcomes[70]; and
2. Evaluate the process undertaken by the AWC to achieve CEP objectives and make recommendations for potential future enhancements to sector planning, implementation and reporting, if needed.

OBJECTIVES

1. Understand each sector's unique context for CEP planning and implementation
2. Understand both individual sectors' contributions, and collective contributions, to the three WFL goals, the WFL target of improving efficiency and productivity by 30%, and approved CEP desired outcomes
3. Determine to what extent the CEP process was successful in achieving the intended outcomes listed in the strategic intent.
4. Determine if recommendations are needed to improve CEP planning, implementation and future reporting

KEY TASKS

1. Develop a work plan that includes key tasks, deliverables and timelines
2. Report on:
   i. each sector's experience, unique considerations and criteria for success in CEP planning and implementation (e.g., data availability, environmental factors, context)
   ii. each sector's implementation successes and barriers
   iii. individual sector contributions and collective contributions to the three WFL goals, the 30% improvement target, and CEP desired outcomes
3. Determine how to measure the overall success of implemented CEP opportunities
4. Evaluate the CEP process and consider the need for recommendations to improve planning, implementation, and future reporting
5. Provide regular updates to the AWC board

69 The three goals of the WFL strategy are (1) safe, secure, drinking water supplies, (2) healthy aquatic ecosystems, and (3) reliable, quality water supplies for a sustainable economy.

70 The following CEP desired outcomes were identified in the first CEP report: 1) demand for water is reduced; 2) water use productivity is increased; 3) resources are conserved to maintain healthy aquatic ecosystems; 4) water quality is maintained or enhanced.

TIMELINES and DELIVERABLES

The Project Team will provide the following deliverables to the Alberta Water Council:

- Present findings on the collective contributions to the three WFL goals, 30% efficiency and productivity target, and CEP desired outcomes . . . . . April 2016
- Draft recommendations . . . . . November 2016
- Final report and recommendations . . . . . March 2017

MEMBERSHIP

The AWC previously approved the following suggested membership:

- Seven priority sectors (sectors that developed CEP plans): chemical, forestry, irrigation, oil and gas, petrochemical, power generation, and urban municipalities
- Government of Alberta
- Environmental and other non-government organizations

BUDGET

No project-specific funding is expected to be required. AWC core funding is available to cover the following:

Stakeholder support	$ 7,500
Hosting	$ 5,000
Communications	$ 7,500
Total	$ 20,000

The project team will operate in a manner that is consistent with the rules, policies and procedures adopted by the Alberta Water Council, including the use of consensus to make decisions in a multi-stakeholder process.

Appendix B–Acknowledgements

The Alberta Water Council acknowledges the contributions of the following working group and project team members who volunteered their time and expertise on this project, along with their member organizations for supporting their participation.

Ahmed Idriss	Capital Power
Curt Horning	Alberta Environment and Parks
Dan Moore	Alberta Newsprint Company
Greg Moffatt	Chemistry Industry Association of Canada
Harpreet Sandhu	City of Calgary
James Guthrie	Imperial
Jay White	Alberta Lake Management Society
Jennifer Nitschelm	Alberta Agriculture and Forestry
Judy Stewart	Alberta Lake Management Society
Kim McLeod	Alberta Environment and Parks
Lorna Young	Chemistry Industry Association of Canada
Maureen Bell	Alberta Environmental Network
Rachel de Vos	Alberta Urban Municipalities Association
Richard Phillips	Alberta Irrigation Projects Association
Rob Hoffman	Canadian Fuels Association
Tara Payment	Canadian Association of Petroleum Producers
Tasha Blumenthal	Alberta Association of Municipal Districts and Counties
Vicki Lightbown	Alberta Innovates

Project managers: Anuja Ramgoolam, Marie-Claire St-Jacques, Andre Asselin and Kim Sanderson

The Alberta Water Council would also like to recognize the following individuals who informed the team's work.

Michael Seneka	Alberta Environment and Parks
Zahidul Islam	Alberta Environment and Parks

Appendix C–Summary of Data by Sector

	Chemical	Downstream Petroleum	Forestry	Irrigation	Oil and Gas	Power Generation	Urban Municipalities
Baseline year	2005	2002–2004 average	2000	2005	2002–2004 average	2000–2002 average	2005
Water diversion (Mm^3)	36.5	11.4	146	2 186	183	Not available*	Not available*
Return flow (Mm^3)	9.8	3.9	131	459	Not significant	Not available*	Not available*
Net use (Mm^3)	26.7	7.5	15	1 727	183	100.3	Not available*
Production output	Not available*	22.7 Mm^3 crude oil	2.4 million dry metric tonnes pulp	0.488 million hectares	92.5 Mm^3 oil equivalent	59 TWh	Population = 3,182,178

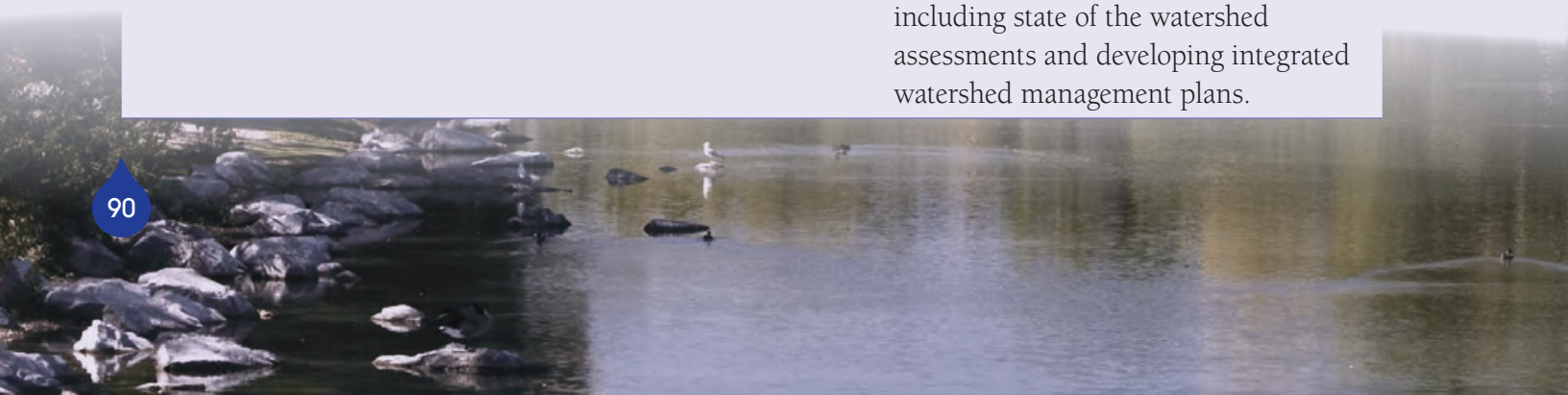
	Chemical	Downstream Petroleum	Forestry	Irrigation	Oil and Gas	Power Generation	Urban Municipalities
Reporting year	2014	2014	2014	2014	2014	2014	2015
Water diversion (Mm^3)	28.8	11.2	132	1 612	201	Not available*	Not available*
Return flow (Mm^3)	5.0	4.0	123	409	Not significant	Not available*	Not available*
Net use (Mm^3)	23.8	7.2	9	1 203	201	80.3	Not available*
Production output	Not available*	25.4 Mm^3 crude oil	2.6 million dry metric tonnes pulp	0.493 million hectares	168.2 Mm^3 oil equivalent	82 TWh	Population = 4,196,500

*For more information on why some data was not available in a specific sector, refer to Section 3 of the report.

Appendix D – Sector-specific Targets

Sector	Targets	Status
Chemical	No sector-specific targets were set in CEP plan.	
Downstream Petroleum	No sector-specific targets were set in CEP plan.	
Irrigation	Eight targets were set in the CEP plan: *Target 1:* The irrigation sector will achieve a 30% increase in combined Conservation, Efficiency and Productivity from 2005 through 2015. *Target 2:* By the year 2015, 70% of irrigated lands in districts will be under best management practices, namely low pressure drop-tube centre pivots, an increase from the 47% documented in 2005. *Target 3:* On a ten-year rolling average, the irrigation districts will keep diversions at or below the year 2005 reference benchmark of 2.186 billion m^3 per year. *Target 4:* Within regulations and utilizing water conserved through efficiency gains anticipated through these CEP efforts in the irrigation system, the irrigation sector will make additional water available for other uses such as food processing, environmental objectives, rural water networks, agribusiness, and other water sharing.	All targets were met or exceeded: *Target 1:* Exceeded the 30% (30% improvement in efficiency + 22% improvement in productivity = 52% combined improvement). *Target 2:* 70.7% of the irrigated districts area in Alberta is irrigated with low pressure pivots. *Target 3:* Water diversion for the reporting year was 1.612 billion m^3, a 26% reduction from the baseline year. *Target 4:* As of reporting year, 2.8% of licensed volume for irrigation has been assigned by districts for other uses. *Target 5:* The assessed acres increased by 5.2% over the reporting period and the average irrigated area increased by 1% from baseline to reporting year while diversions have declined (the assessed area is a simple comparison of 2014 to 2005, since the assessed area is not affected by the weather, whereas the actual area is a 10 year average, since it is affected by weather, as are diversion and return flow).

Sector	Targets	Status
Irrigation continued	*Target 5:* Growth in irrigation districts will occur using saved water. *Target 6:* On a ten-year rolling average through 2015, irrigation districts will reduce the volume of water diverted from Alberta's rivers, lakes and streams per unit of irrigated area to a level below the 2005 benchmark of 445 mm. T*arget 7:* The irrigation sector will achieve a 15% increase in efficiency, relative to 2005 levels, by the end of 2015. *Target 8:* The irrigation sector will increase its productivity by 15% from the reference yield of 2005, based on the indicator crops of sugar beets, potatoes, and soft white wheat	*Target 6:* Volume of water diverted was at 327 mm for the reporting year. *Target 7:* Efficiency improved by 30% from the baseline to the reporting year. *Target 8:* Productivity increased by 22% from the baseline to the reporting year.
Forestry	3 goals were outlined in the CEP plan in relation to the 2020 vision: 1. Keeping water withdrawals and returns from Alberta's seven pulp and paper mills at current (2009) or improved levels 2. Utilizing research and technology to improve productivity by a further 5% over the next decade 3. Continuing work with partnerships to improve water quality and ensure aquatic ecosystems are healthy	All goals were met: 1. Water withdrawals have decreased by 8% from 2009 to 2014. Return flow was 92% of withdrawals in 2009 and was maintained at about 93% from 2012 to 2014. 2. Improvement in productivity from 2009 to 2014 was 13% 3. A number of research initiatives have been carried in the forestry sector through partnerships. The forestry sector also participates actively in three Watershed Planning and Advisory Councils in the province, including state of the watershed assessments and developing integrated watershed management plans.



Sector	Targets	Status
Oil and Gas	The sector CEP plan projected a 24% overall improvement in water use productivity by 2015 compared to baseline conditions, which was selected as an average of 2002 to 2004. Improvements were also projected for each sub-sector: ■ Oil sands mining (Athabasca River water only) – 28% ■ Oil sands mining (all non-saline sources) – 30% ■ Oil sands in situ – 47% ■ Conventional oil – 15%	All targets were met or exceeded: Overall sector improvement was 40% from baseline to reporting year. Actual improvements for each sub-sector: ■ Oil sands mining (Athabasca River water only) – 48% ■ Oil sands mining (all non-saline sources) – 31% ■ Oil sands in situ – 58% ■ Conventional oil – 46%
Power Generation	CEP plan forecasted a 31% improvement in water productivity by 2015 from baseline year.	Sector exceeded the target, with a 42% improvement in water productivity.
Urban Municipalities	Targets of the 2009 plan were to: 1. By December 2010, all AUMA municipalities with water systems in place will report water use data through Alberta Environment's electronic Water Use Reporting System (WURS) 2. By December 31, 2011, AUMA member municipalities will develop Conservation, Efficiency and Productivity Plans according to the following participation rates: ■ 100% of municipalities with populations greater than 10,000 ■ 75% of municipalities with populations between 2,500 and 10,000 ■ 50% of municipalities with populations under 2,500	2009 plan: While progress was made in reducing water use, the targets of the plan as of October 2013 were not met. AUMA realized that the targets did not capture the broad range of municipal CEP initiatives (See AUMA's 2013 progress report)

Sector	Targets	Status
Urban Municipalities continued	3. By December 31, 2011, AUMA member municipalities will estimate their Infrastructure Leakage Index (ILI) and identify ways to reduce leaks according to the following participation rates: ■ 100% of municipalities with populations greater than 10,000 ■ 75% of municipalities with populations between 2,500 and 10,000 ■ 50% of municipalities with populations under 2,500 4. By December 2011, AUMA member municipalities will implement incentives and/or disincentives of their own choosing to increase the uptake of water efficient fixtures and technologies. Different programs may apply to new and existing developments. Participation rates will be: ■ 100% of municipalities with populations greater than 10,000 ■ 75% of municipalities with populations between 2,500 and 10,000 ■ 50% of municipalities with populations under 2,500	

Sector	Targets	Status
Urban Municipalities continued	Targets of the renewed AUMA plan (2014) are: 1. Alberta's municipal sector will achieve an average per capita residential water use of 195 litres/person/day (l/p/d) and a total per capita water use of 341 l/p/d by 2020 (both of these targets are 30% below the baseline average) 2. Alberta's municipal sector will maintain the volume of "unaccounted for" water at 10% of total water use (reported to be 10.1% in 2009)	2014 plan: 1. 2013 results already exceeded 2020 target for average per capita water use (169 l/p/d), and showed good progress towards the target for total per capita water use (375 l/p/d) 2. 2013 results were not meeting the target, with losses from distribution system estimated at 14%

ALBERTA WATER COUNCIL

www.awchome.ca