# REDUCING ENVIRONMENTAL IMPACTS

The treatment of river water to produce clean, safe drinking water generates waste or “residual” streams. Some of these streams, such as the underflow from clarifiers and filter backwash, contain solid material that is a mixture of the suspended solid material removed from the river water and the solids produced by the addition of alum and, at times, powdered activated carbon. Some of these residual streams, such as filter backwash or treated water that does not meet the drinking water specification, also contain chlorine that can be toxic to fish. These waste streams have historically been released back to the river.

EPCOR has evaluated alternative strategies for managing these waste streams. Any successful strategy must balance reduction of environmental impact on the river against cost and our primary objectives to meet drinking water treatment standards and to protect public health. Other environmental impacts, such as the energy footprint resulting from processing and transport of residuals to alternate disposal locations, must also be factored into the equation.

## The Importance of Dechlorination

Drinking water contains residual chlorine, which is added at the treatment plants to disinfect the water. While it is important to ensure a minimum residual in the water delivered to all customers for protection of public health, the chlorine residual can be toxic to fish as it damages their gills. EPCOR has committed to eliminating all discharges of chlorinated water from its facilities to the river or any other water bodies. This includes routine discharges of chlorinated water from the E. L. Smith and Rossdale Water Treatment Plants arising from filter backwashes, filter-to-waste and release of water that does not meet drinking water specifications. EPCOR is also eliminating discharges of chlorinated water arising from activities at field reservoirs and in the water distribution system wherever possible.

### Dechlorination at the Water Treatment Plants and Field Reservoirs

Bisulfite dechlorination systems have been in place and operating at the E. L. Smith and Rossdale WTPs since 2009 and 2012, respectively, and meeting AEP approval limits since 2010 and 2012. These systems remove chlorine from chlorinated water streams including filter backwash, filter-to-waste and plant by-by passes before the water is returned to the river. As well, procedures are in place to ensure that all planned discharges of chlorinated drinking water from the field reservoirs are dechlorinated prior to release.

In 2017, there were no releases of chlorinated water to the river from the water treatment plants or field reservoirs due to failure of the dechlorination systems. There was, however, one event where chlorinated water was released to the river inadvertently during a construction project. This incident was reported and reviewed. Preventative measures were put into place to prevent another occurrence from taking place.

In the past year, EPCOR has continued to improve our procedures and to identify other potential sources of release of chlorinated water to the river at the water treatment plants. All sources of chlorinated water at both treatment plants (like service water) have been identified and labelled. Shutdown permits were updated to include environmental risks and procedures required to mitigate those risks. An innovative in-house dechlorination unit was also designed and built by employees and was put into service during the annual washing of the clarifiers at the Rossdale Water Treatment Plant.

### Dechlorination of Water Released to the Environment in the Distribution System

EPCOR also has procedures in place to dechlorinate drinking water released into the environment from the distribution system. This includes both planned releases (e.g. flushing and draining of pipes for maintenance) and unplanned releases (e.g. water main breaks and other emergency events). While it may be difficult to ensure 100% dechlorination of all releases, the procedures will ensure the majority of water released from the distribution system is dechlorinated and that potential environmental impacts are mitigated**.** In 2017, there was one significant

release of chlorinated water from the distribution system during planned maintenance work to replace a defective valve on a pipe. Dechlorination pucks were quickly deployed to neutralize the chlorine in the water that was released before it reached a nearby creek. This release was reported to AEP.

## Residuals Solids Management Program

EPCOR's Residuals Solids Management program strives to reduce the impact of solids present in the residual streams released into the North Saskatchewan River from its water treatment plants. Complete, year-round diversion of all solid residual streams from both Edmonton water treatment plants would require building very large, expensive treatment facilities at both water treatment plants and would involve trucking large volumes of solid material to landfills. This zero-discharge option was determined to be very costly and would result in other environmental impacts such as construction of large facilities near the river, energy use and trucking and off-site disposal of solids. The environmental benefit of this option is not clear. The volumetric flow and background solids concentration in the river fluctuates significantly during the year due to natural phenomena, which means that very large facilities would be required to manage the load during all seasons.

This program has emphasized minimizing the loading of solids to the river during the fall and winter seasons, when river flow and the background suspended solid concentration are lowest and the relative impact of the solids discharged on the river quality is greatest. This is achieved by reduction at source, that is by optimizing and minimizing the amount of alum added without compromising drinking water treatment. If less alum is added to the water for treatment, the amount of solid residuals produced and discharged to the river (especially the amount of chemical residuals) is reduced.

## Solids Residual Reduction Strategy

Since 2009, the Rossdale and E. L. Smith Water Treatment Plants have converted to direct filtration mode of operation during the winter months to reduce the amount of residuals released to the river. The switch from conventional mode to direct filtration mode involves reducing alum dosing during treatment by up to 80%. This reduces the total mass of solids residuals produced during treatment that has to be discharged to the river by up to 50%. EPCOR's Stewardship Commitment was to operate in direct filtration mode from November to February, and to build facilities to divert the remaining solids produced during these months to on-site solids treatment facilities for eventual landfill disposal (E.L. Smith plant) or sewer disposal (Rossdale plant).

Early on, we determined that direct filtration can only be operated successfully under variable raw water colour conditions with appropriate alum dosing and use of clarifiers for some settling. This option, however, eliminated the possibility of on-site treatment and disposal of solids during the fall and winter without substantial capital investment. With approval from AEP (Sept 2013), we modified our residual reduction plan to focus on extending the operation of direct filtration into the fall (September to October) and spring seasons (March), when the water quality of the river is often amenable to direct filtration treatment.

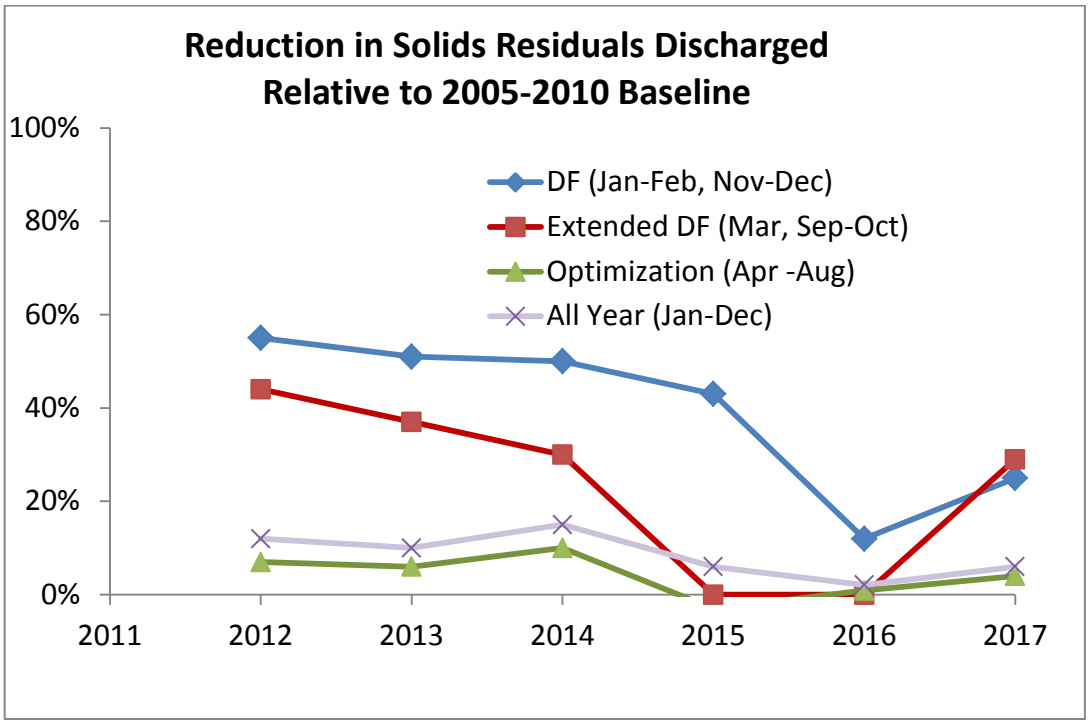
The graph below summarizes the solids discharged to the river from the two water treatment plants as a result of implementing this strategy since 2012. The amount of solids discharged to the river varies considerably from year to year and depends heavily on the raw water conditions in the river. To determine the effectiveness of the solids reduction strategy against this background variation, EPCOR determines the reduction in solids discharged from the two treatment plants relative to the amount that would have been discharged using the 2005-2010 conventional treatment strategy.

For example, in 2017, we achieved a 25% reduction in solids discharged during the winter direct filtration period (Jan-Feb, Nov-Dec) relative to conventional operation with same raw water conditions. We were able to operate in direction filtration mode for several days in late spring (March), before runoff, and in early fall (Sep-Oct). This resulted in an additional 29% reduction during this period relative to conventional operation with same raw water conditions. Finally, through optimization of alum addition during conventional operation from April to August, we reduced the

solids discharged by 4% relative to conventional operation. For the entire year, the amount of solids discharged was reduced 6% with the most substantial reductions occurring in the fall and winter when the river is more sensitive to solid discharges.

As the graph shows, our success with this strategy has varied from year to year and has depended heavily on river conditions and the ability to run in DF mode. Reducing solids discharge in the range of 40 to 50% was achieved from 2012 to 2014 in the fall and winter when the river water conditions were favorable for DF operation. The most challenging year to date for direct filtration was 2016 due to an early spring runoff and very high colour levels in the river in the fall and early winter. In 2016, we achieved a 12% reduction in solids released to the river during the normal direct filtration season (Jan-Feb, Nov-Dec) and there was no extended DF operation. Fortunately, 2017 was a better year for direct filtration operation. Even though spring runoff came very early in 2017, with run-off conditions appearing in late February, we were able to achieve a 25% reduction in solids release during the direction filtration season (Jan-Feb, Nov-Dec) and a 29% reduction during the extended direction filtration operation (Mar, Sept to Oct). This was an improvement over 2016 but still not as good as 2012 to 2014.

In 2017, EPCOR set an internal environmental performance target for the number of days in direct filtration operation at both water treatment plants. EPCOR was able to exceed the internal performance target of 120 plant-days in direction filtration operation. This new performance target provides additional incentive for EPCOR to continue to find ways to improve direct filtration operation.




*DF = Direct Filtration*
*Baseline load is calculated using 2005-2010 conventional treatment strategy and actual raw water conditions*

## Environmental Monitoring

EPCOR continued to investigate the environmental impact of the solids that are discharged to the river in 2017 and to build on the work we completed in previous years (2013-2016). The focus of this program has evolved over the years, and has included monitoring water quality, sediment quality, benthic invertebrate communities and toxicity downstream of the discharge points. In 2017, emphasis was given to monitoring the impact of the solids discharges

on dissolved oxygen (DO), dissolved aluminum, sediment toxicity, and benthic invertebrate communities. The key findings from 2017 were:

- The discharge of the clarifier blowdown stream, the most concentrated residuals stream, does not have a significant effect on DO concentrations in the river.
- The addition of sodium bisulfite to dechlorinate waste streams did not have a significant effect on DO concentrations in the river.
- Dissolved aluminum concentrations in some samples collected from the river in the mixing zone downstream of the water treatment plant discharge points did exceed Alberta Surface Water Quality Guidelines. EPCOR will explore this further in 2018.
- Benthic invertebrate communities were similar in abundance, community composition and diversity upstream and downstream of the Rossdale WTP. Benthic invertebrates were highly variable between and among sampling locations, and more testing will be needed to confirm whether or not the benthic community is impacted by WTP operation.
- The growth rate and survival rates of chironomids were significantly lower downstream of the Rossdale WTP than upstream. The cause for the decreased growth and survival observed in the toxicity tests is unclear. Chironomids are small organisms used to test the ecological impact of discharges on sediment communities.

EPCOR will continue its environmental monitoring program in 2018.

## Impacts of Residuals Management Strategy on Drinking Water Quality

One of the primary objectives of the residuals management strategy is to achieve environmental benefit (reducing solids loading to the river), without compromising the health and safety of drinking water. Direction filtration has a slight impact on a few quality variables including turbidity, total aluminum, total organic carbon and disinfection by-products; however, the impact is minor and these parameters remain well within health-based guideline levels or approval limits. EPCOR monitors both the raw and the treated water for *Cryptosporidium* more intensively during direct filtration operation. We know that the frequency of detection of very low levels of *Cryptosporidium* oocysts in the treated drinking water at the Rossdale and E. L. Smith WTP tend to increase during direction filtration operation. Using Quantitative Microbial Risk Analysis, the risk associated with these very low level of parasites in the drinking water was determined to be well below negligible risk levels established by Health Canada and the World Health Organization. Very low levels of *Cryptosporidium* oocysts were detected in a few treated water samples during direction filtration in late October and early November 2017. The levels of oocysts in the raw water remained below the level of concern. EPCOR has UV disinfection in place to ensure that all oocysts that escape filtration are inactivated. Nevertheless, we continue to monitor this very closely.

## Continuous Improvement Initiatives

EPCOR has been investigating strategies to further reduce alum dosing and, thereby, reduce solids loading. These efforts have focused mainly on improving and optimizing direct filtration operation. In 2017, these included the following strategies:

- **The use of Zeta Potential (ZP), alternative filter polymers and doses**: ZP is a measure of the charge on the surface of very small particles in water. We have found that ZP is closely related to filtration polymer dose and this provides some insights into using filter polymer dose to improve direct filtration operation. In 2017, a new filter polymer was implemented in the water treatment plants based on the success of pilot plant testing. This new polymer has helped improve direction filtration performance.

- **Improving Cryptosporidium Oocyst Removal:** In 2014, EPCOR initiated a research project led by the University of Alberta to study the physical removal of *Cryptosporidium* oocysts during direct filtration operation. The study involved a combination of laboratory bench experiments and pilot-plant challenge experiments using surrogate particles in place of *Cryptosporidium* oocysts. The objective was to determine the mechanisms and variables affecting oocyst removal during filter operation. The project started in 2015 and received funding from the Natural Sciences and Engineering Research Council of Canada (NSERC) for two years. The experimental work for this study was completed in 2017. The results indicated that high levels of *Cryptosporidium* removal can be achieved during direct filtration operation under the right conditions. Polymer type, polymer dose and zeta potential were determined to be key variables for optimizing *Cryptosporidium* oocyst removal during direct filtration. The results of this study will be published in an open journal in due course.
- **Using Deep Bed Filters:** From 2013-2014, a comprehensive pilot study was completed to assess the feasibility of deep bed filters to provide additional plant capacity and facilitate direct filtration operation. An engineering analysis was also completed to determine the technical and economic feasibility of converting some of the filters at the E. L. Smith Water Treatment Plant to deep bed operation. In 2016, a proposal for a capital project to convert 12 of 18 filters at the E. L. Smith plant to direct filtration mode was approved as part of the EPCOR's 2017-2021 Performance Based Regulation rate application to the City of Edmonton. In 2017, an additional set of pilot plant studies was completed to determine the level of removal of *Cryptosporidium* removal in deep bed filters during direct filtration operation. As expected, removal of *Cryptosporidium* was consistently better in deep bed filters than in regular bed filters. Preliminary planning and design work has begun for implementation of Deep Bed Filters.