

# City of Edmonton Gold Bar Wastewater Treatment Plant

## Challenge

Located in the North Saskatchewan River Valley, the Gold Bar Wastewater Treatment Plant (WWTP) treats wastewater for a population of 700,000 people in the greater Edmonton area. Current treatment capacity is 82 MGD (310 ML/d). The wastewater treatment processes consists of pretreatment, primary treatment, activated sludge secondary treatment, a second set of bioreactors using a specialized biological reaction process to remove remaining impurities, and medium-pressure UV disinfection.

Recently, neighboring industries have expressed an interest in using treated effluent from the Gold Bar WWTP as a replacement for river water in various process applications. In particular, Petro-Canada's Edmonton refinery, after discussions with the City of Edmonton, had devised a plan whereby municipal wastewater would be treated and reused within the refinery for industrial purposes. The Edmonton refinery is Petro-Canada's largest refinery. It processes approximately 135,000 barrels per day of crude oil into a wide range of consumer products.

In 2002, Petro-Canada began modifications to its Edmonton, Alberta refinery for the desulfurisation of diesel fuels to ensure reduced sulfur concentration levels in the fuel. To achieve the new lower sulfur levels, the Petro-Canada refinery would require significantly more water, of similar quality to high pressure boiler feedwater, for the hydrogen and steam used in the desulfurisation process. The Alberta government recently introduced initiatives



to balance municipal and industrial water use with the need to preserve the water quality, aquatic life, and aquatic habitat in the North Saskatchewan River. As a result, Petro-Canada could not increase its freshwater withdrawals from the river for use in the new desulfurisation process. Thereby, in order to meet one set of fuel-based regulations Petro-Canada also had to be compliant with another set of water-related environmental regulations. Petro-Canada needed to find a solution that was environmentally responsible yet also economically viable.

## Solution

To ensure sufficient water supplies to the refinery, Petro-Canada considered a variety of options including building an onsite system to treat water from the North Saskatchewan River, and purchasing water from the City of Edmonton. The City authorities approached Petro-Canada with a proposal to provide membrane-treated wastewater effluent from its Gold Bar WWTP that could be further processed to make the hydrogen and steam.

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Following a thorough cost benefit and environmental evaluation of the options, Petro- Canada agreed to work with the City of Edmonton to develop a system that would enable it to use recycled municipal wastewater for its manufacturing needs at the refinery. GE Water & Process Technologies ZeeWeed ultrafiltration (UF) membranes were selected to treat secondary effluent from the City of Edmonton's Gold Bar WWTP instead of drawing fresh water from the river. GE PRO 450 reverse osmosis machines were also selected to remove ionic impurities. The treated wastewater is then used in the production of hydrogen and steam at the Edmonton refinery, as well as to replace 30% of cooling tower makeup currently supplied via the existing river system.

This undertaking is Canada's first major industrial project to use the combination of hollow fibre UF and spiral wound reverse osmosis membranes for municipal wastewater recycling, proving that membrane technology is a cost-effective means of meeting increased water demands and reducing the environmental burden of industrial operations. This water management solution will reduce the amount of water withdrawn from the North Saskatchewan River and will reduce the amount of conventionally treated wastewater entering the river from the Gold Bar WWTP.

## Results

The North Saskatchewan River is beginning to face increasing water demands due to the growth of the Industrial sector as well as population growth in the area. Environmentally, the benefits of using recycled municipal wastewater instead of drawing directly from the River are significant. Water which would otherwise have been discharged to the North Saskatchewan River is treated again and used for a high purity application resulting in a reduction in contaminant loading to the River. The 1.3 MGD (4,921 m<sup>3</sup>/d) ZeeWeed membrane system has helped Petro- Canada save over 700,000,000 USgal (2,650,000 m<sup>3</sup>) of water since its commissioning in October 2005.

From a capital perspective, the ZeeWeed membrane system allowed for tens of millions of dollars in savings since Petro- Canada no longer needed to expand the river intake system and the raw water treatment plant. Boiler feedwater treatment systems were still required, but these dedicated treat-

ment plants could now be designed to handle consistent quality recycled municipal wastewater throughout the entire year instead of dealing with the extreme variations in raw water quality of the North Saskatchewan River. Supplying the eventual boiler feedwater system with very consistent feed saves in capital cost for additional pretreatment. Furthermore, since land is no longer required for expansion of the water treatment system, this land can now be used for refinery hydrocarbon processing equipment.

## Process Overview

After screening, secondary effluent is pumped to an elevated membrane flow distribution channel, which distributes the flow evenly between the two membrane trains. The membranes are contained within isolated concrete tanks increasing the redundancy, reliability and flexibility of the system.

By dividing the system into identical units, the overall system configuration simplifies operations and maintenance activities.

Permeate pumps draw from the common suction header and provide the typical -1 and -8 psi (-6.9 to -55 kPa) vacuum that draw water from the outside in through the hollow fiber membranes, leaving the suspended solids behind.

Periodically, the flow of permeate is reversed to backwash any foulants from the outside of the fiber. The surface of the membrane is also scoured by air introduced through a diffuser at the base of the membrane module. The air carries with it a high velocity stream of water that passes upward through the fiber bundle, sweeping away highly concentrated solids from the membrane surfaces.

Treated effluent from the ZeeWeed system flows through the 3.4 mile (5.5 km) pipeline to Petro- Canada's hydrogen and steam supplier. Two 400 gpm (2.18 ML/d) GE RO systems at the steam plant reduce the conductivity of the treated effluent from approximately 1000 micromoles to 10-15 micromoles. The high purity water then flows through a GE sodium zeolite softener.

The steam plant is currently installing two new 600 gpd (3.27 ML/d) skid-mounted RO systems to meet increasing production by Petro- Canada. The skid-mounted systems can be quickly delivered and installed, and are scheduled to begin service in early 2008.