Meeting water reuse limits in cold climates

By Ken Musyoka, Kevin Vieira and Merle Kroeker

The City of Dawson Creek, located in northeastern British Columbia, gets its water from the Kiskatinaw River, which is a tributary of the Peace River. This source is often plagued by high turbidity during the spring and low water levels in the summer. Recent growth in the oil and gas sector has led to increased pressure on the available potable water supply.

The industry normally procures potable water from the City at filling stations, for use in deep well injection, road dust control and mud preparation. An alternative of tapping potable water from Pine or Peace River to supplement that obtained from Kiskatinaw River was considered. Due to the large distance between the rivers and the City's reservoir, this option was considered to be too costly to be practical.

SAGR (Submerged Attached Growth Reactor) near completion.

To address the demand for potable water, the City decided to build a Reclamation Water Treatment Plant (RWTP) to produce a minimum of 4000 m^3/day of treated wastewater that meets the province's standards. This approach would provide the required non-potable water to the oil and gas sector, with the added benefit of reducing demand from the water supply. Other initiatives such as water conservation by-laws, adopting BC's "Living Water Smart" approach to water management, etc., would ensure adequate water supply for the City and

SAGR site provides cold temperature nitrification in Dawson Creek, BC.

satellite communities that also use its potable water supply.

The City issued a request for a proposal from the private sector to raise capital for upgrading the existing wastewater treatment facility to meet unrestricted public access reclaimed water standards. In return, the successful proponent was offered a 10 year right to 85% (3400 m^3/day) of the reclaimed effluent from the treatment plant. Possible uses for the reclaimed water are in oil and gas production, dust control, and/or sports field watering. Shell provided the winning proposal and contributed a significant portion of the required total capital.

Dawson Creek reserved the right to the remaining 15% (600 m^3/day) of reclaimed water for possible use in watering parks and sports fields. Alternatively, the City could offer this portion of reclaimed water for use in industry for a nominal fee. The estimated 25% reduction in potable water demand would ensure the City has an ample supply of water to meet future demands.

The process had to meet BC Municipal Sewage Regulations (MSR) for reclaimed water under the “Unrestricted Public Access” category. As a result, it would also meet and exceed the Canadian Council of Ministers of the Environment (CCME) requirements on a year round basis. (See Table 1)

After discussions with the City’s designated consultant, it was decided to add a Nelson Environmental Inc. SAGR® (Submerged Attached Growth Reactor) process to provide post lagoon BOD_5 and ammonia removal. It would also significantly reduce downstream demand on process equipment. Added benefits to upgrading the process would be a significant reduction in lagoon effluent TSS and pathogens. For final turbidity and TSS polishing following the SAGR®, cloth disk filters would be implemented followed by a chlorination unit for disinfection.

Developing the SAGR process

Lagoon-based treatment systems provide some ammonia removal (nitrification) capacity during the summer months.

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SAGR Process		Influent post lagoon	Effluent post SAGR	MSR Limits
Design Flow	m^3/day	4,000	4,000	
BOD	mg/L	20	<5	<10
Turbidity	NTU	N/A	<5	<2
TSS	mg/L	20	<10	<5
Fecal Coliform	CFU/100 mL	-	-	< 2.2*
Residual Chlorine	mg/L	-	-	> 0.5**
* median of 7 consecutive samples. < 14/100 mL for any single sample				
** at the point of initial use				

Table 1: Upgraded RWTP anticipated and required effluent.

However, many small communities in Canada and the northern United States are currently using lagoon systems for wastewater treatment, which often experience process water temperatures below 1 °C for extended periods during the winter. As a result, continuously discharging systems cannot meet low ammonia limits during the winter months.

An alternative is to store lagoon effluent for intermittent discharge when water temperatures improve. This approach is made impossible for many communities due to large capital and land requirements.

The SAGR process was developed to address these issues. The performance parameters and sizing of the process are based on extensive testing performed on post-lagoon demonstration systems located in Lloydminster, Saskatchewan and in Steinbach, Manitoba. Lloydminster was commissioned in 2008 and is currently in operation, while the Steinbach pilot was operated for three years between 2007 and 2010.

Depending on effluent requirements, the system design can be adjusted to meet ammonia levels of <1.0 mg/L in summer months, and <2.0 mg/L in winter months, with influent water temperatures as low as 0.5°C. For the Dawson Creek RWTP, three SAGR beds (modules) were constructed to operate in parallel, following the existing aerated lagoon system.

SAGR process system

The SAGR process can be utilized for nitrification following any secondary treatment process, including aerated or facultative lagoons. It is a clean gravel bed, with a horizontal flow distribution chamber at the front end. This distributes the influent wastewater across the width of the entire bed. The gravel provides the necessary surface area for growth and attachment of a nitrifying biomass within the bed and is sized to optimize bacterial growth and hydraulic flow. A horizontal effluent collection chamber at the back end collects all the treated effluent and channels it to the discharge structure. Sizing of the bed is based on influent loading rates and temperature, as well as the required rate of nitrification.

NEI LINEAR aeration was laid along the SAGR floor and provides continuous year-round aerobic conditions necessary for nitrification to take place within the bed. The aeration grid and bed layout are designed in such a way as to optimize biomass growth by balancing predation/decay with growth throughout the bed. This in turn minimizes long-term flow obstruction due to biomass overgrowth.

Commissioning and performance

Nelson Environmental staff provided operational training and commission on September 13, 2011, following successful completion of system construction.

All MSR effluent objectives are met prior to the disc filters with the exception of turbidity (no bacterial indicator data was provided). This trend is expected to continue and improve as the SAGR process matures to establish an optimal biomass film within the beds. (See Table 2)

Conclusions

Preliminary results indicate the upgraded facility is well on its way to meeting effluent quality objectives and solving the potable water availability concerns. There is a potential for capital cost recovery for the City of Dawson Creek, given the fact that demand for the reclaimed water by the local oil and gas industry is likely to remain high for the foreseeable future. The RWTP effluent quality far exceeds the recently published CCME effluent quality requirements. As a result, the City is ahead of the curve in meeting the 30 year grace period allocated by the federal government for wastewater treatment plant upgrades.

Shell gains an alternative source for process/fracturing water that is cost effective and of high quality. It has access to 3400 m^3/day of water over a 10 year period for their initial investment, amounting to significant long-term savings and capital recovery.

Ken Musyoka, Kevin Vieira and Merle Kroeker are with Nelson Environmental. E-mail: mkroeker@nelsonenvironmental.com

SAGR Process		SAGR Influent (Post Lagoon)	Effluent (Post SAGR)
BOD_5	mg/L.	11.8	< 2
TSS	mg/L.	10.6	4
TAN	mg/L.	31	0.13

Table 2. October 2011 SAGR influent and effluent averages.