New weapons for fighting odour in long forcemains

By Paul Eybergen and Ken Campbell

When design started on the new Embro, Ontario sewage pumping station and forcemain, everyone knew controlling odours was going to be a fight.

Embro is a village of about 1,000 people located around 13 km (as the forcemain flows) northwest of the sewage collection system in Woodstock. The County of Oxford owns and operates all water and wastewater systems throughout the area in which Embro is located. The County undertook a Class EA, which concluded that wastewater from the new communal sewage collection system in Embro would best be pumped to Woodstock, rather than to a new wastewater treatment plant located nearby.

There were some significant design challenges for the pumping option. The forcemain had to be oversized to a 200-mm-diameter pipe, as smaller-diameter pipes running such a long distance at the minimum scouring velocity, ended up with unreasonably high friction losses. The volume of the 200-mm pipe over the 13 km was 430 m^3. The design average day wastewater flow was only 380 m^3/d, resulting in an average travel time of over 27 hours. In the early days of the system when flows are lower, travel time would be longer — as much as two to three days! This long wastewater detention period was certain to create a lot of hydrogen sulphide and major odour challenges.

To deal with odour, a six-point approach was developed:

1. Keep the forcemain full. In addition to a check valve to prevent wastewater from flowing back to the pumping station when the pumps are turned off, a control valve system at the forcemain discharge was designed to close when the pumps were off, to prevent the forcemain from partially draining out at the discharge end. This would prevent the pipe from being partially drained and re-filled every cycle, releasing foul air discharges at multiple high points along the forcemain. The idea was that odours could be best managed by concentrating them at the discharge location.

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2. Use a stripping chamber. Because wastewater was discharging into a gravity sewer system running through a future residential area, it was decided to provide a stripping chamber. Coarse bubble aeration driven by a small blower was designed to remove the majority of volatile odours so they would not be released in the downstream sewers.

3. Air-tight maintenance hole cover inserts. Air-tight sewer inserts were added under the covers to stop air flow and prevent the escape of any odours not removed at the odour control facility.

4. Biofilter. The odour control facility included a fan to draw air from the top of the stripping chamber and the downstream sewers, and send it to a two-stage biofilter. Treated air was then discharged into an exhaust stack at the top of the unit.

5. Swabbing. A swab launch system was included in the pumping station design, to allow swabs to be easily introduced into the forcemain. Using forcemain swabbing for odour control was an approach successfully used by the County of Oxford operations staff on another problematic wastewater forcemain. Swabs remove biofilms that adhere to

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The biofilter.

Buried stripping chamber (foreground).

The swab launcher configuration.

Flow control valves at the end of the forcemain.

the pipe walls and house the sulphur-reducing microorganisms responsible for the formation of the hydrogen sulphide.

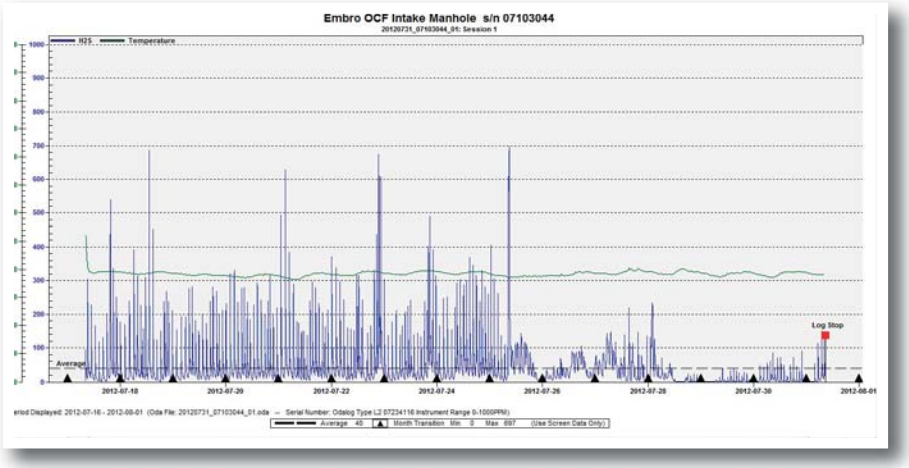
6. Chemical addition. In case the steps listed above were inadequate, chemical addition in the pumping station was provided as a backup. This alone was not considered, due to its high operating cost, as well as concerns that chemical addition alone might not be successful in fully controlling odours due to the extended travel times involved.

How did the system work?

The sanitary pump station and odour control facility went online in October 2011. The first four points in the odour control system, as listed above, did their job. The control valve system successfully kept the pipe full and the stripping chamber (lined with an anti-corrosive concrete coating) successfully drove off heavy concentrations of odours.

The biofilter took a little time to commission and get properly adjusted and for operators to become familiar with the system's functions. Once it was fully operational, it worked well, reducing H_2S levels to below detectable levels in the area surrounding the stack discharge.

After about six months and with 20% of Embro customers connected, odours started occurring in the vicinity of the



Forcemain profile.

odour control facility and neighbours started to complain. The system was not keeping up. Oxford's operators started investigating and found H_2S spike levels over 300 ppm in the stripping chamber. This concentration not only exceeded the capability of the biofilter, but is dangerously toxic if inhaled and was thus an operational concern.

The pumping station wet well operating range, i.e, levels at which pumps start and stop, was reduced, making cycles more frequent but for shorter periods. Makeup water was also introduced to the pumping station wet well to reduce the forcemain turnover time. These steps mitigated the problem for a couple of months, but high H_2S levels eventually returned.

Through trial and error, operations staff determined that swabbing the forcemain every three months immediately

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Swabbing the forcemain

In June 2012, the 13-km long, 200-mm-diameter forcemain was swabbed for the first time while the sanitary pump station was in operation. A contractor was hired to launch six 250-mm-diameter foam swabs into the 200-mm pipe, five minutes apart.

A 50-mm water service that had been installed at the SPS was utilized to insert the swabs into the forcemain with a specialized launcher provided by the contractor. The swab launching was completed within two hours.

The six 250-mm swabs were received three days later at the odour control facility. It was later determined that it was best to leave the control valve open during the last part of the process. This ensured that the swabs cannot be directed to the overpressure relief valve piping, where they could get jammed.

The swabs were allowed to enter the maintenance hole immediately upstream of the air stripping chamber. A fibreglass grate was installed before the pipe exited the maintenance hole in order to allow the liquid to continue to flow while the swabs were retained.

reduced H_2S concentrations at the stripping chamber to less than 100 ppm. They would then see a gradual rise with spikes up to about 300 ppm, at which concentration the biofilter reached its limit and the next swabbing was implemented.

It is anticipated that, as the pumped volume increases and retention time in the forcemain decreases, the required swabbing frequency will also decrease.

On a few, very cold, windy days in the winter, the biofilter froze up and became inoperative. In these situations, an odour control chemical was injected at the pumping station, which reduced odour at the discharge. This approach was not desirable on a full-time basis, since the cost of continuous application would be substantially higher than the swabbing approach. Chemical treatment costs about $30 per day ($900 per month) compared to approximately $1,000 for a contractor to launch six swabs at every event.

The County will be working to improve protection of the biofilters from the elements to reduce the chance of future freeze-ups.

There are two key ingredients to successfully managing tough odour control challenges. The first is to recognize the challenge and include as many "tools" as possible for the operator to use. The second is a system operator who takes on the challenge and spends time to monitor the odour situation, determining how to make use of all the tools provided in the most efficient manner.

Using the range of odour control tools provided, the County of Oxford operations staff have successfully managed to operate the new Embro pumping station and forcemain with only minor odour complaints.

Paul Eybergen is with County of Oxford. Ken Campbell is with R.V. Anderson Associates Ltd. E-mail: kcampbell@rvanderson.com

"Slow" swabbing

During the design of the Embro pumping station and forcemain, the engineer was concerned about how the swabbing could be done.

Assuming the swabbing approach would be to keep the swab in continuous motion, a continuous supply of water and/or wastewater up to the 430 m^3 pipe volume would be required. The municipal wastewater supply, supplemented by all available water from the municipal water supply, could not generate the required flows. The engineer assumed that water would need to be trucked, or pumped from a local creek (assuming a permit to take water could be obtained). The operator, however, had a much simpler idea.

The operator's idea was that swabbing could be completed by allowing the pumps to push the swabs in their normal pump cycle. The swabs would start, stop and slowly pass through the forcemain, just like sewage in the normal operation. This was a technique that the swabbing contractor had previously demonstrated to work effectively, and it worked in the Embro forcemain.