Project Title: Filter Operation Effects on Pathogen Passage
Project Number: 490
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Objectives (<75 words):
The overall goal of this project was to evaluate the impact of filter design and operational parameters on pathogen and surrogate removal during drinking water treatment and to develop practical guidelines and strategies for estimating and minimizing pathogen passage through filtration.

Background (<75 words):
The emergence of parasitic protozoa as etiological agents of waterborne disease has prompted renewed interest in evaluating the efficacy of water treatment processes. Increasingly stringent regulations for drinking water quality will require effective removal of pathogenic protozoa and enteric viruses. Disinfection alternatives may be constrained by current operating conditions or by regulations. Therefore, a multi-barrier approach to pathogen removal will become increasingly reliant on granular media filtration.

Highlights (<100 words):
Breakthrough and suboptimal coagulation were the two most important issues with regard to the vulnerability of filters in terms of potential pathogen passage. Ripening and hydraulic steps proved to be of less significance. Pre-oxidation may substantially improve particulate control.

Most notable was the finding that suboptimal coagulation substantially deteriorated pathogen removal, even at turbidities which were below 0.3 NTU.

Approach (<125 words):
The research was conducted at bench, pilot and full scale. Following a critical literature review (Task 1), Task 2 evaluated benchmark pilot scale systems at two locations. The removal of both pathogens and surrogates were determined at various points in the filter cycle and in response to several critical events.

Task 3 examined mitigating measures for filter operational effects (i.e. it investigated ways of increasing process robustness). These investigations were conducted at bench, pilot and full (demonstration) scale using surrogates, and examined chemical and physical factors affecting filter performance, the mode of filter operation and the impact of pre-oxidation.

In Task 4, the results of Tasks 2 and 3 were utilized to develop a way of quantifying particle removal robustness.
Results/Findings (<200 words):

Breakthrough Phase
- Vulnerable period for pathogen passage
- Oocyst passage (not detachment of previously captured oocysts) appears to be an important mechanism, however the experimental design tested passage, not detachment
- Turbidity value may not be adequate predictor of increasing oocyst passage
- Changes in turbidity may occur only after substantial deterioration of Cryptosporidium removal
- Particle counters may provide a more sensitive indication of pathogen passage, but still fall short of predicting the full extent of the deterioration of Cryptosporidium removal

Suboptimal Coagulation
- Suboptimal coagulation substantially deteriorated pathogen removal—even at turbidities which were below 0.3 NTU
- Turbidity may be adequate indicator of poor coagulation performance
- Particles provide more sensitive indication of poor coagulation performance

Hydraulic Step
- Changes in hydraulic loading typically did not deteriorate Cryptosporidium removal, with the exception of one experiment where turbidity, particles, and Cryptosporidium all increased substantially.
- Possibly, turbidity may be adequate monitoring parameter for measuring significant hydraulic events

Ripening
- Minimal or moderate deterioration (compared to suboptimal or breakthrough) may result during filter ripening

Pre-oxidation
- Pre-oxidation may substantially improve particulate control
- Choice of oxidant (chlorine, ozone, permanganate) may be less important that presence of any pre-oxidant

Impact (<100 words):

The potential benefits with regard to the application of the findings of this research include: an awareness of the importance of the specific coagulation and filter operation events responsible for the breakthrough of Cryptosporidium oocysts in filters; better understanding and control of filters; and hopefully a reduction in the incidence of cryptosporidiosis attributable to drinking water. The findings of this project may have regulatory implications. The groups which will benefit most directly from this research are regulators, utilities and consultants.

Participating Utilities: Region of Ottawa-Carleton (Britannia Plant)
Ottawa, ON
Windsor Utilities Commission (Weeks Plant)
Windsor, ON

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