



# Impact of infrastructure management on the contamination of drinking water with pathogens



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Connecting Water Resources...

*Bringing Research to Life!*



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# Why a project linking infrastructure management and pathogens?

- **Because waterborne disease outbreaks are caused by DS failures**
- Cabool, Missouri (1990)
  - Outbreak of hemorrhagic *E. coli* O157:H7
  - 240 cases of diarrhea and 4 deaths
  - Waterborne contaminants entered the distribution system through 2 **major pipe breaks** and 43 service meter failures during unusually cold weather
- Gideon, Missouri (1993)
  - *Salmonella* outbreak
  - 400-500 cases of illness and 7 deaths
  - Likely source of contamination was bird droppings on two **finished water storage facilities**



# Components of Safe Drinking Water Production Distribution Systems

## Integrity of DS is key

### *Payment studies on DS*

- Ingress is possible in pressurized systems
- Contamination is frequent during repairs/replacement
- Backflow prevention
- Pipe failures in ageing infrastructure are a growing concern.



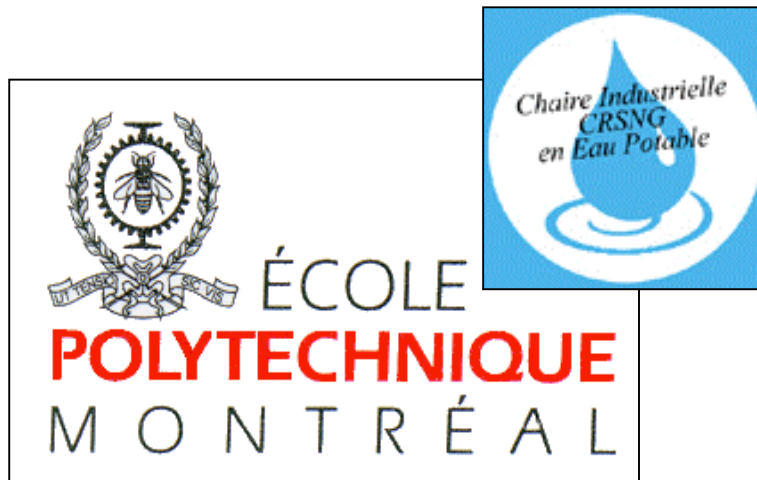


## Objectives of this research project

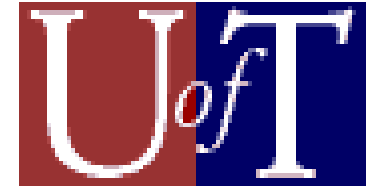
to evaluate the potential impact of different distribution system interventions on the contamination of drinking water by pathogens

- ◆ inventory and classification of DS events and interventions
- ◆ study of pipe deposits & transitory low pressures
- ◆ preparation of protocols to monitor the impact of some of the most important of these events in full-scale DS
- ✓ ***What causes the non compliance events***
- ✓ ***What impact risk do they pose?***
- ✓ ***Strong focus of USEPA regulators for revision of Coliform Rule***

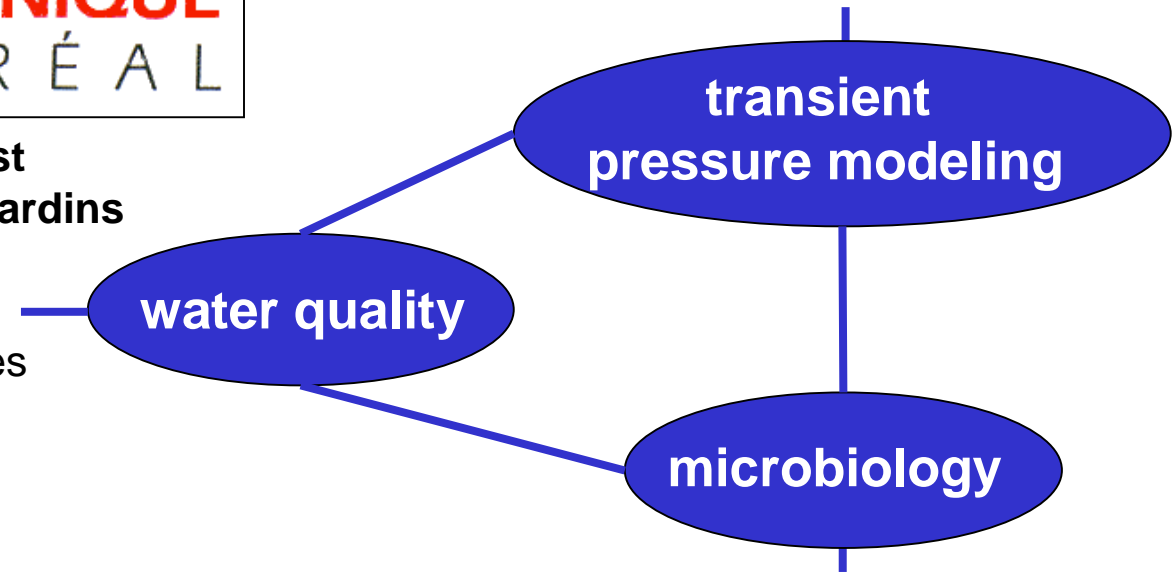
# Participating organizations



**Pr. Michèle Prévost**  
**Pr. Raymond Desjardins**  
1 PhD student  
2 Master students  
Research associates



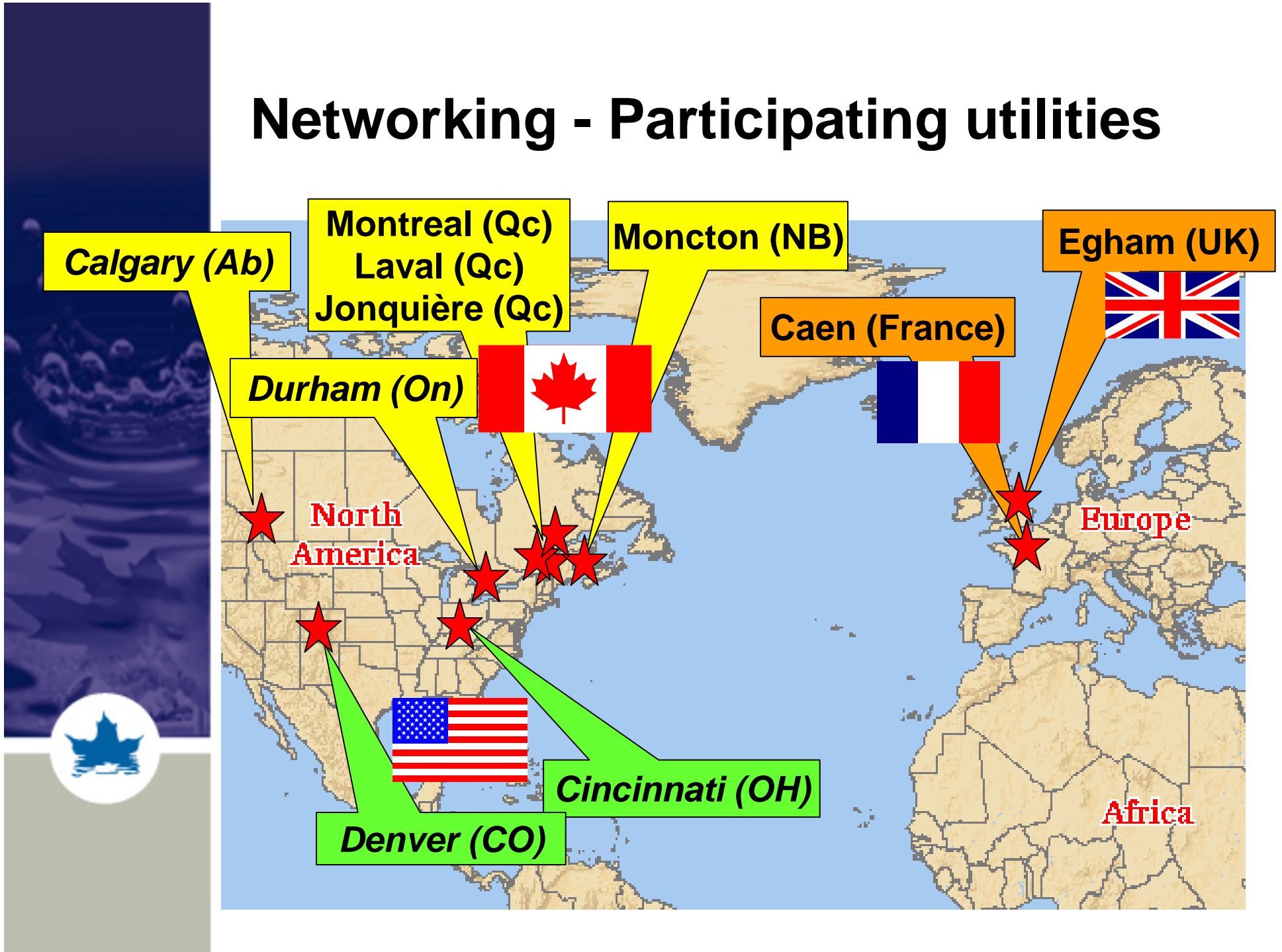
**Pr. Brian Karney**  
1 PhD student  
1 Master student  
Research associates



**Dr. Pierre Payment**



# Networking - Participating utilities



# How are we meeting our research objectives?

## ✓ Literature review

- Coliforms and other pathogens occurrence in distribution systems: extent of the problem (Besner *et al.*)
- "**Explaining the occurrence of coliforms in distribution systems**" (Journal AWWA, vol 94, no.8, p. 95-109; August 2002)
  - emphasis on pressure transient phenomenon
  - all pathogens are considered (not only coliform bacteria)

## ✓ Identification of the types of interventions affecting water quality

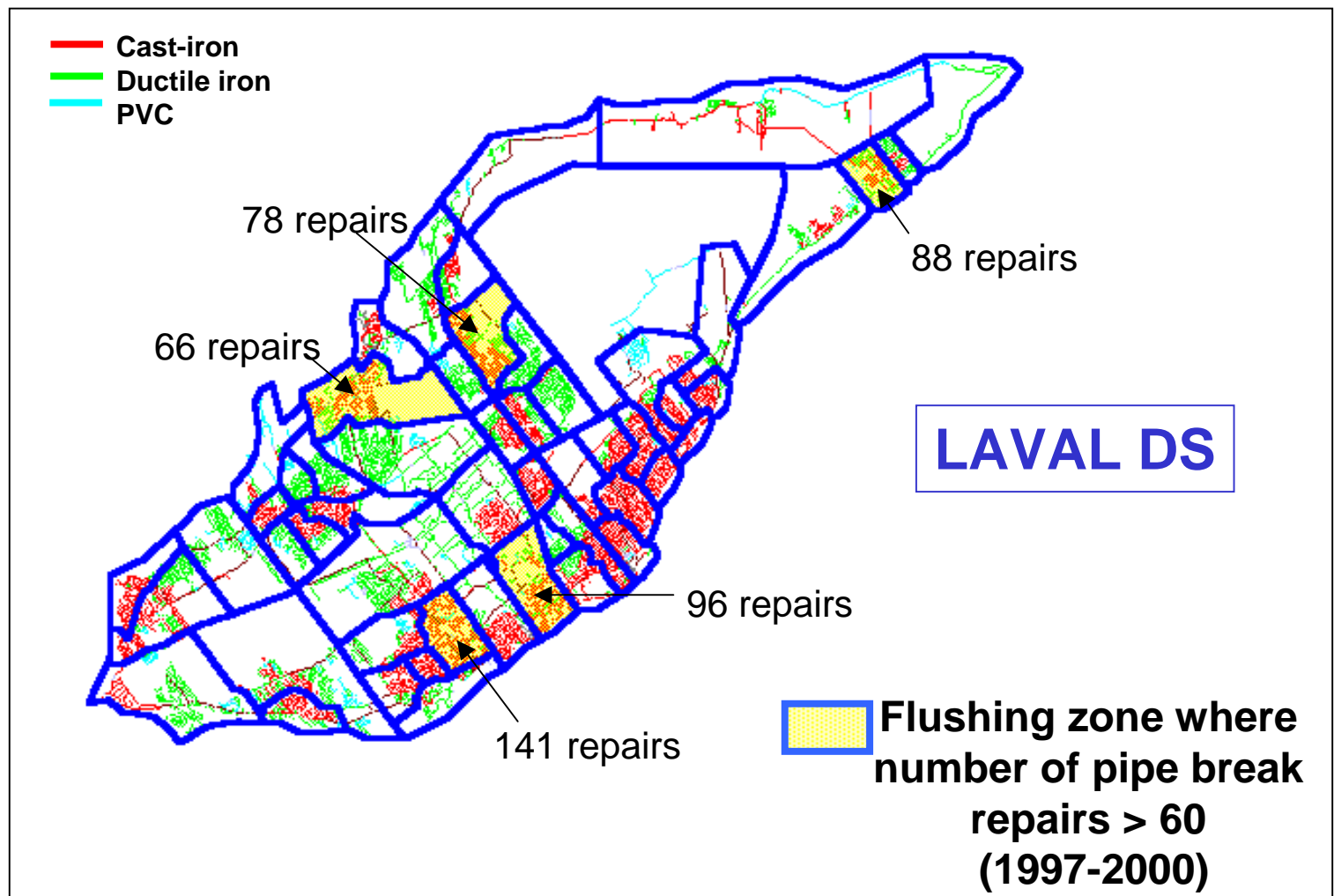
- Causes of turbidity complaints in 4 distribution systems (*Montreal, Laval, Caen (France), Egham (UK)*)
- Databases available to determine types, frequencies and locations of interventions
- Related AWWARF study on causes of complaints

## ✓ Study of pipe deposits



# Study of databases available to determine types, frequencies and locations of interventions

– Temporal and geographical analysis of data (M.C. Besner)



# Study of pipe deposits (A. Carrière)

Characterization of type and distribution of deposits in 3 distribution systems (Laval, Montreal, Jonquière) (*MS degree*)

- Methodology: Unidirectional flushing

Quantities of deposits	Constituents of deposits	Microbial quality of deposits
<ul style="list-style-type: none"><li>- Highly variable (0.01 to 40g/m of pipe)</li><li>- Depends on<ul style="list-style-type: none"><li>▪ Pipe material</li><li>▪ Water characteristics</li><li>▪ Accumulation period</li></ul></li></ul>	<ul style="list-style-type: none"><li>- Iron</li><li>- Organic matter</li><li>- Silicium</li><li>- Calcium</li></ul>	<ul style="list-style-type: none"><li>- Highly colonized by bacteria (<math>\approx 10^{10}</math> cells/g)</li><li>- Not colonized by coliforms (only 1.2% of positive samples)</li></ul>



# Related work

## AWWARF project: Integrated water quality management

- Participating utilities: Cincinnati Water Works & Denver Water
- Main causes of customer complaints are studied using data available from utilities
- Results and literature will be useful for this project



# Year 1 Achievements

- **2 master degree dissertations**
  - Mesure de l'accumulation des dépôts dans les conduites d'eau potable et évaluation de la méthode de rinçage unidirectionnel pour les évacuer (A. Carrière, 2002)
  - Application d'une approche intégrée à l'étude des plaintes d'aspect en réseaux de distribution d'eau potable (B. Viret, 2002)
- **1 presentation at the 2002 AWWA WQTC conference and its corresponding proceeding:**
  - Unidirectional flushing: Loose deposits characterisation in the test zones of three Canadian distribution systems (A. Carrière *et al.*, 2002)
- **1 paper to be submitted in a peer-reviewed journal**
  - Evaluation of loose deposits in distribution systems through UDF (A. Carrière *et al.*)



# Prospective

- **Field measurement campaigns of transient pressures during specific events such as:**
  - fire fighting exercises
  - pipe flushing
  - power failure conditions
  - pipe breaks
- **Transient hydraulic modeling of DS study area**
- **Evaluation of some water quality parameters during events/interventions in DS**
- **Expansion of the work:**
  - vulnerability assessments & HACCP
  - Integration of break model layer





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