The Deloro Mine Site Demonstration Project

K.Volchek, D.Velicogna, W.P.Wong, C.E.Brown
SAIC Canada, Environment Canada

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Scope of the presentation

- √ Deloro mine site
- √ Focus on arsenic in water
- √ Removal experience
- √ Our approach
- √ Results and discussions
- √ Conclusions and future work

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Deloro mine site

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Gold mining: 1866-early 1900s

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Processing of silver and cobalt ores:
since early 1900s

Manufacturing of arsenic-based
pesticides: since 1950s

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Widespread contamination of soil and groundwater resulting from decades of industrial activities

- √ heavy metals, primarily arsenic
- √ low-level radioactive wastes

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Deloro mine site

1979: The Government of Ontario takes control over the site

Ministry of the Environment's actions to date:

- ✓ Demolishing contaminated buildings

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- ✓ Covering 'red mud' tailings (arsenic-rich ore smelting products)
- ✓ Removing sludge
- ✓ Sealing mine shafts

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- ✓ Dealing with off-site concerns
- ✓ Monitoring surface and groundwater quality

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- ✓ Removing sludge
- ✓ Sealing mine shafts
- ✓ Dealing with off-site concerns
- ✓ Monitoring surface and groundwater quality
- ✓ Controlling arsenic loadings to the Moira River

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Deloro mine site

Controlling arsenic loadings to the Moira River

Water treatment plant was built in 1982

Ferric precipitation technology is used to capture and remove arsenic from the water

Average daily loading of arsenic reduced from 52.1 kg in 1983 to less than 10 kg presently

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Source: Harvard University's Bangladesh Arsenic Project

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Focus on arsenic

- √ WHO's recommended limit in groundwater: 10 µg/L
- √ USA: current limit 50 µg/L
  to be reduced to 10 µg/L by 2007
- √ Canada: current limit 25 µg/L
- √ High levels of arsenic:
  - Anthropogenic – at former mining sites;
  - Natural – in soil and rock (Bangladesh, Taiwan, Southwestern USA, Atlantic Canada)

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Focus on arsenic

√ ferric co-precipitation is often used at mining sites

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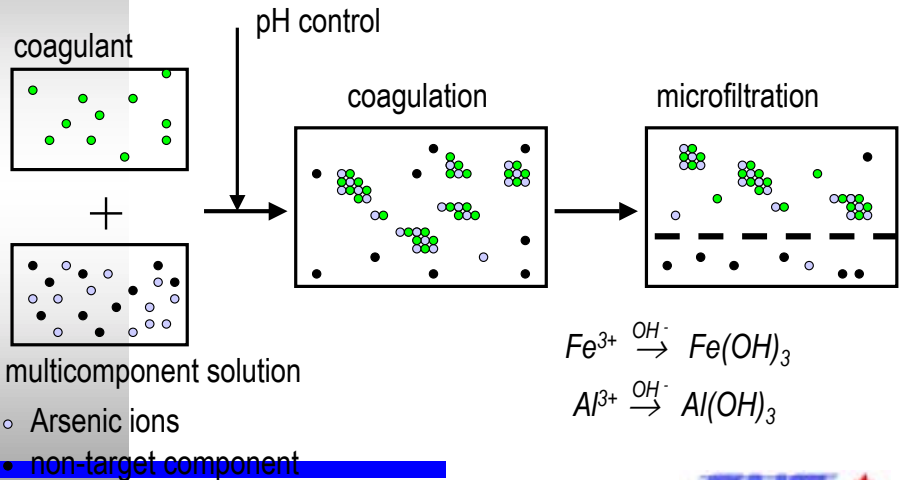
Idea: *To use a fine filter that would reject small non-settleable particles*



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Bench-scale studies

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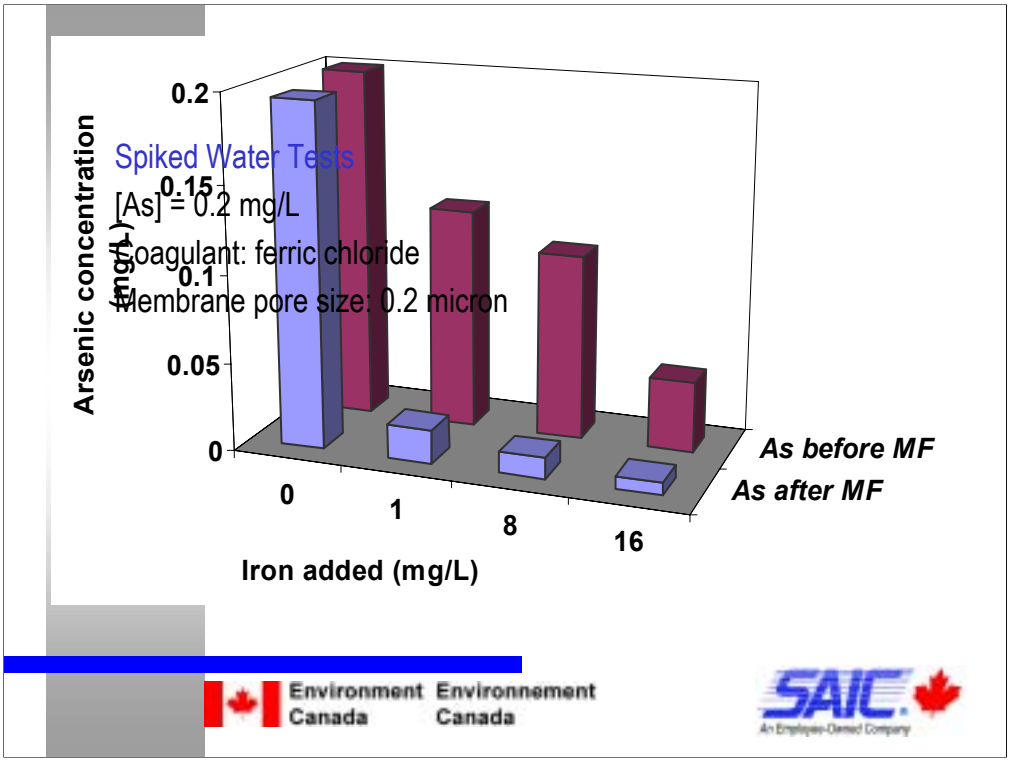
Spiked Water Tests
[As] = 0.2 mg/L
Coagulant: ferric chloride
Membrane pore size: 0.2 micron
Arsenic concentration (mg/L)
0.2
0.15
0.1
0.05
0
0
1
8
16
Iron added (mg/L)
As before MF
As after MF
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In-house pilot-scale studies

Chemically processed effluent brought from the plant and treated within 24 hours in the lab

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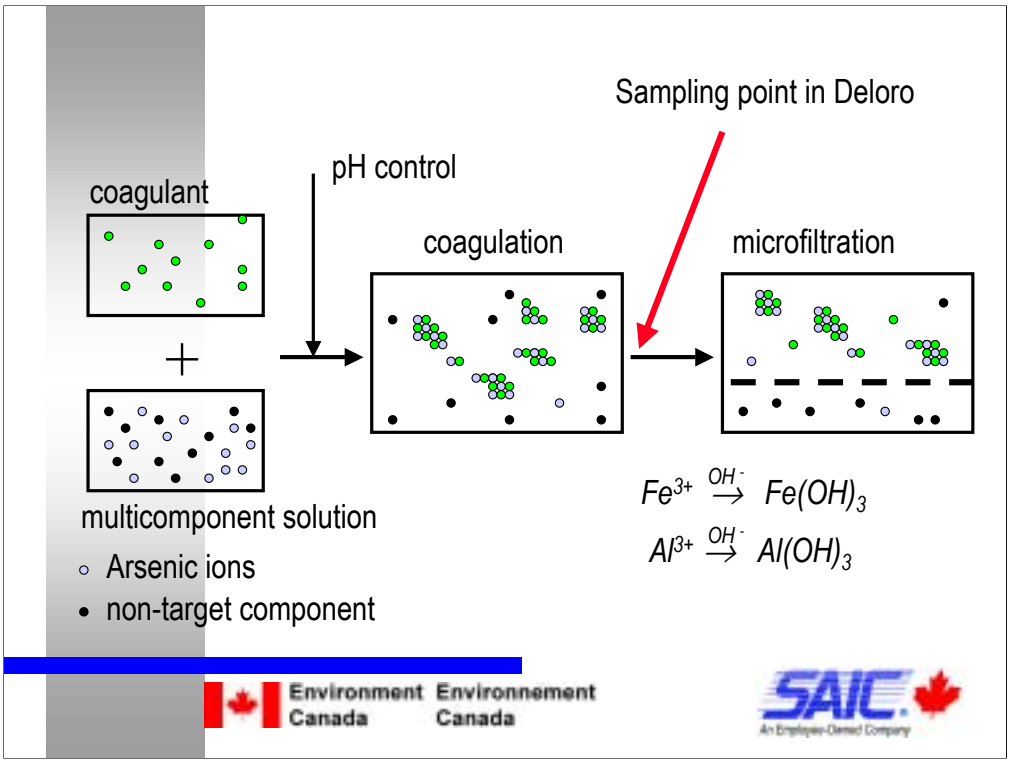
Sampling point in Deloro
pH control
coagulant
coagulation
microfiltration
multicomponent solution
Arsenic ions
non-target component
$Fe^{3+} \xrightarrow{OH^-} Fe(OH)_3$
$Al^{3+} \xrightarrow{OH^-} Al(OH)_3$
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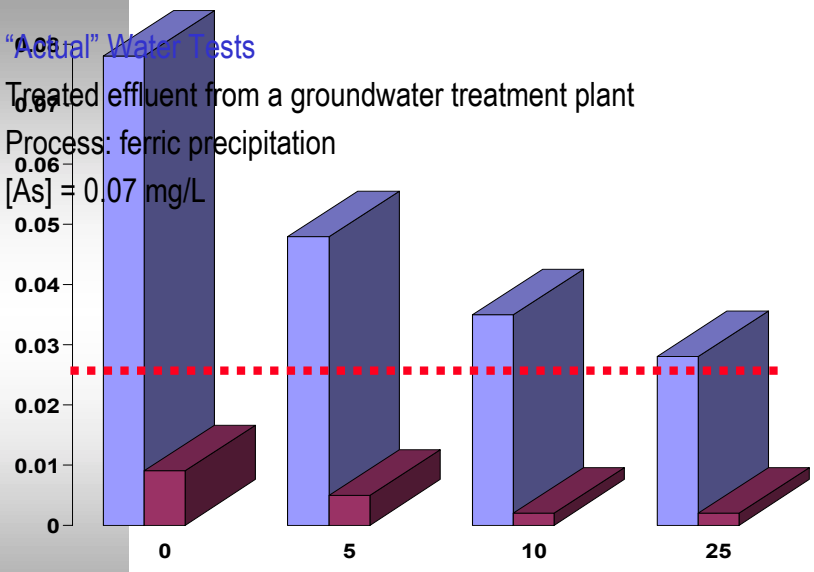
"Actual" Water Tests

Treated effluent from a groundwater treatment plant

Process: ferric precipitation

[As] = 0.07 mg/L



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On-site pilot tests

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On-site pilot tests

Unexpected problems

- ✓ Poor removal of arsenic (40 µg/L in the processed water), due to a high residual concentration of As(III)
- ✓ Membrane fouling that resulted in a significant flux decline, due to the presence of unused polymeric flocculant

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On-site pilot tests

Actions taken

- ✓ Aeration step was incorporated into the treatment train resulting in a more complete oxidation of As(III)
- ✓ Different membrane cleaning procedures were evaluated to increase the flux

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On-site pilot tests

Results

- ✓ The residual concentration of arsenic was reduced to less than 10 µg/L
- ✓ Membrane permeation flux increased as a result of cleaning. Additional work is required to optimize cleaning procedures and evaluate other membranes that are less sensitive to fouling.

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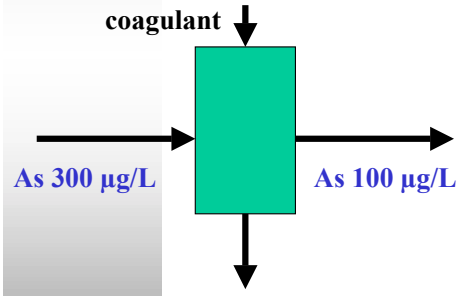
Conclusions and future work

√ Relatively simple, effective and inexpensive technology

√ Can be incorporated into existing ferric precipitation schemes



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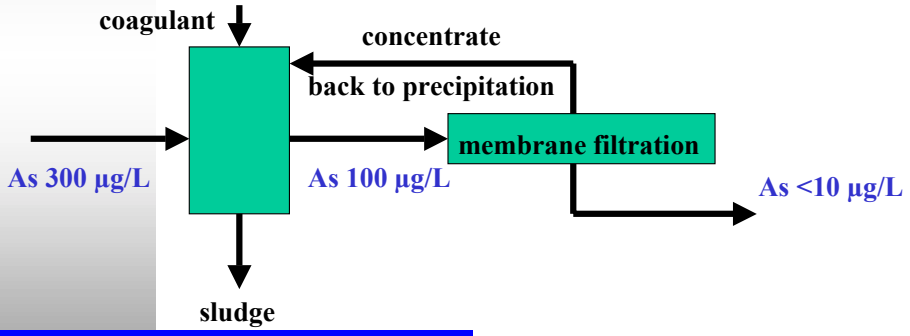

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Conclusions and future work

- √ Relatively simple, effective and inexpensive technology
- √ Can be incorporated into existing ferric precipitation schemes
- √ Oxygenation/aeration is required if case of a substantial As(III) content
- √ Required system throughput can be maintained by regularly cleaning the membranes
- √ Membranes with a different surface chemistry to be evaluated (field studies scheduled for the fall of 2003)
- √ Process cost to be calculated

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