



# Application of Ion Exchange in Municipal Drinking Water Treatment: Organics Reduction

2013 Clean and Safe Drinking Water Conference  
Gander NL  
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Solving Today's  
problems with  
Tomorrow  
in mind



- ◆ Water Treatment in NL
- ◆ Ion Exchange Processes
- ◆ Strong Base Anionic Resins
- ◆ Application of Resins in Water Treatment for Organics Reduction
  - Features
  - Configurations
  - Advantages
  - Limitations
- ◆ Case Study: BoMont, NS
- ◆ Summary



## THM troubles grow in N.L. water supplies, tests show

Number of communities with high levels of disinfection byproduct have nearly doubled since 2000

By Jen White, CBC News | Posted: Feb 12, 2013 5:35 PM NT | Last Updated: Feb 12, 2013 10:02 PM NT 28



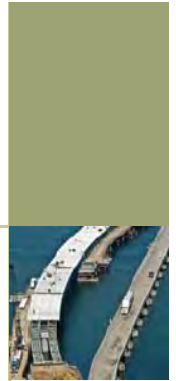
There are  
technological  
fixes!

In fact, over the past 13 years, the number of Newfoundland and Labrador communities with high levels of THMs in their drinking water has nearly doubled.

And more than 160 water supplies in the province currently exceed HAA guidelines.



# Water Treatment in NL



- ◆ 489 public drinking water sources in NL
- ◆ 26 water treatment plants
  - 7 of which are PWDUs
- ◆ Direct Chlorination of surface water
- ◆ Disinfection of water supplies is paramount for the protection of public safety
- ◆ Typical objectives include:
  - Turbidity reduction
  - Organic matter reduction (color, TOC, UV<sub>254</sub> etc.)
  - Metals reduction
  - Disinfection (pathogen removal)
- ◆ Many types of effective treatment processes available to meet objectives
  - Not all suitable at small scale and rural environments



# Water Treatment in NL



Port Aux Basques



Gander

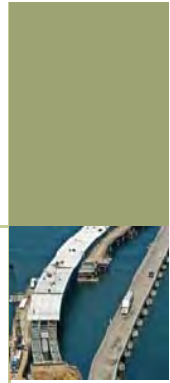


Come By Chance

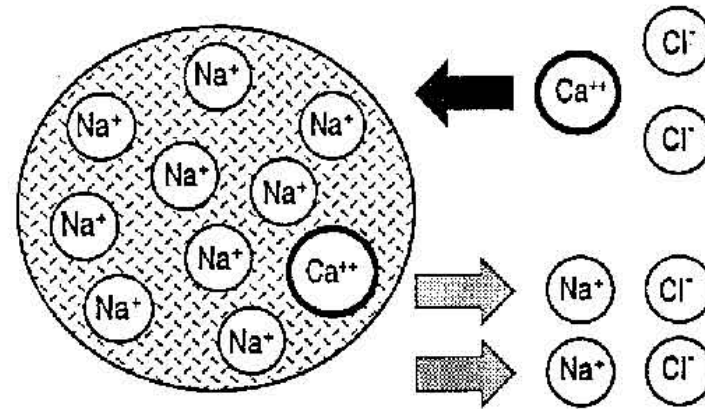




# Ion Exchange Processes



- ◆ Ion exchange processes have existed for many years (IEX)
- ◆ Many applications (municipal, industrial, power generation)
- ◆ Can be designed to remove a host of constituents (ions) or very specific ones
- ◆ Most common application is water softening



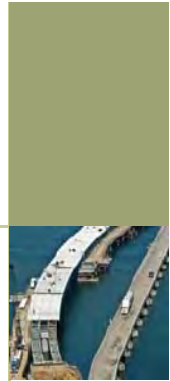
[www.aquatechnology.net](http://www.aquatechnology.net)



[www.axeonwater.com](http://www.axeonwater.com)



# Ion Exchange Processes



[www.hydrogroup.biz](http://www.hydrogroup.biz)

[www.fixit-plumbing.com](http://www.fixit-plumbing.com)



# Strong Base Anionic Resins



[www.aqdaps.com](http://www.aqdaps.com)

- ◆ SBA resins typically operate in a chloride cycle
- ◆ Anions in feed water are exchanged for chloride ( $\text{Cl}^-$ ) or hydroxide ( $\text{OH}^-$ )
- ◆ Natural organic matter is negatively charged
- ◆ Resin becomes saturated and is regenerated with salt and caustic
- ◆ Appearance is identical to a typical softener
- ◆ Often referred to as "Organic Scavenging"





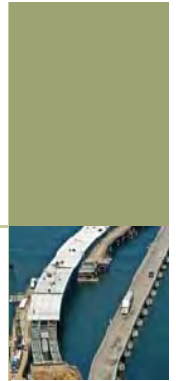
# Organic Scavenging - Features

- ◆ Organic scavenging resins also called OCR (Organic Carbon Resin)
- ◆ Many types of resins
  - Styrene - based
  - Acrylic – based
  - Gels
  - Type I
  - Type II
- ◆ Complex molecular chemistry
- ◆ NOM is a heterogeneous soup and varies from location to location
- ◆ OCR can be selective in the types of organic matter that will be exchanged/absorbed



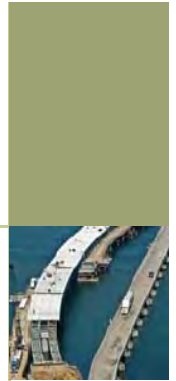
# Organic Scavenging - Considerations

- ◆ Raw water must be free from other “impurities”
  - Turbidity reduction
  - Metal reduction
  - Softening
- ◆ Range of organic matter concentrations must be known
  - Required to determine rate of treatment and time between regenerations
- ◆ No chemical addition during operation
  - Significantly less complex than alternative processes
- ◆ Salt brine tank required for regeneration
- ◆ Good quality (i.e. treated) water needed for regeneration
- ◆ Equipment redundancy



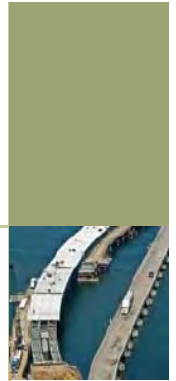
# Organic Scavenging - Advantages

- ◆ High rates of organic matter reduction are possible
  - Very low THMs and HAAs!!
- ◆ Simple process operation – no chemical addition
- ◆ Only consumable is salt
- ◆ Readily available for small and very small systems
- ◆ Avoid high pressure filtration or coagulation-processes
- ◆ Performance over wide range of feed water color when sized appropriately
- ◆ Low power consumption
- ◆ Little operator oversight



# Organic Scavenging - Limitations

- ◆ Diminishing removal rates
- ◆ Incomplete regeneration cycles and permanent fouling
- ◆ Odour – amine “throw” (fishy)
- ◆ Sensitive to pre-treatment conditions
  - May require elaborate pre-filters and/or metal removal and/or softening
- ◆ Biological fouling
- ◆ Resin loss during backwash
- ◆ Variability between locations
- ◆ Alkalinity consumption
- ◆ Ongoing salt costs





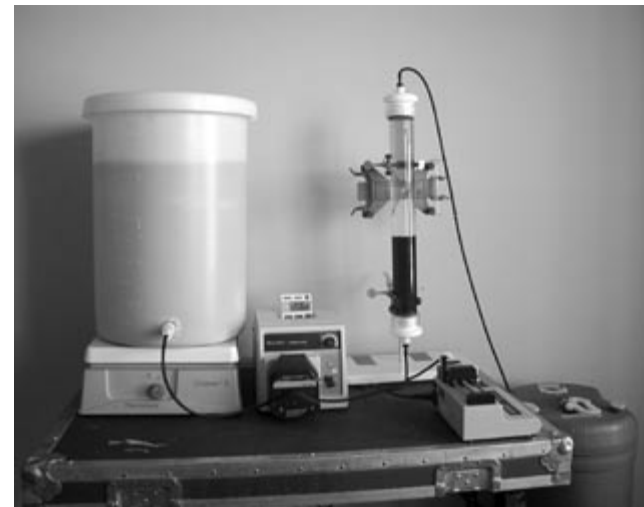
## Case Study – BoMont WTP

- ◆ BoMont Subdivision – Enfield, NS
- ◆ 25 homes
- ◆ River water source
- ◆ Obsolete existing system
- ◆ Treatment regulations



# BoMont WTP – Design Considerations

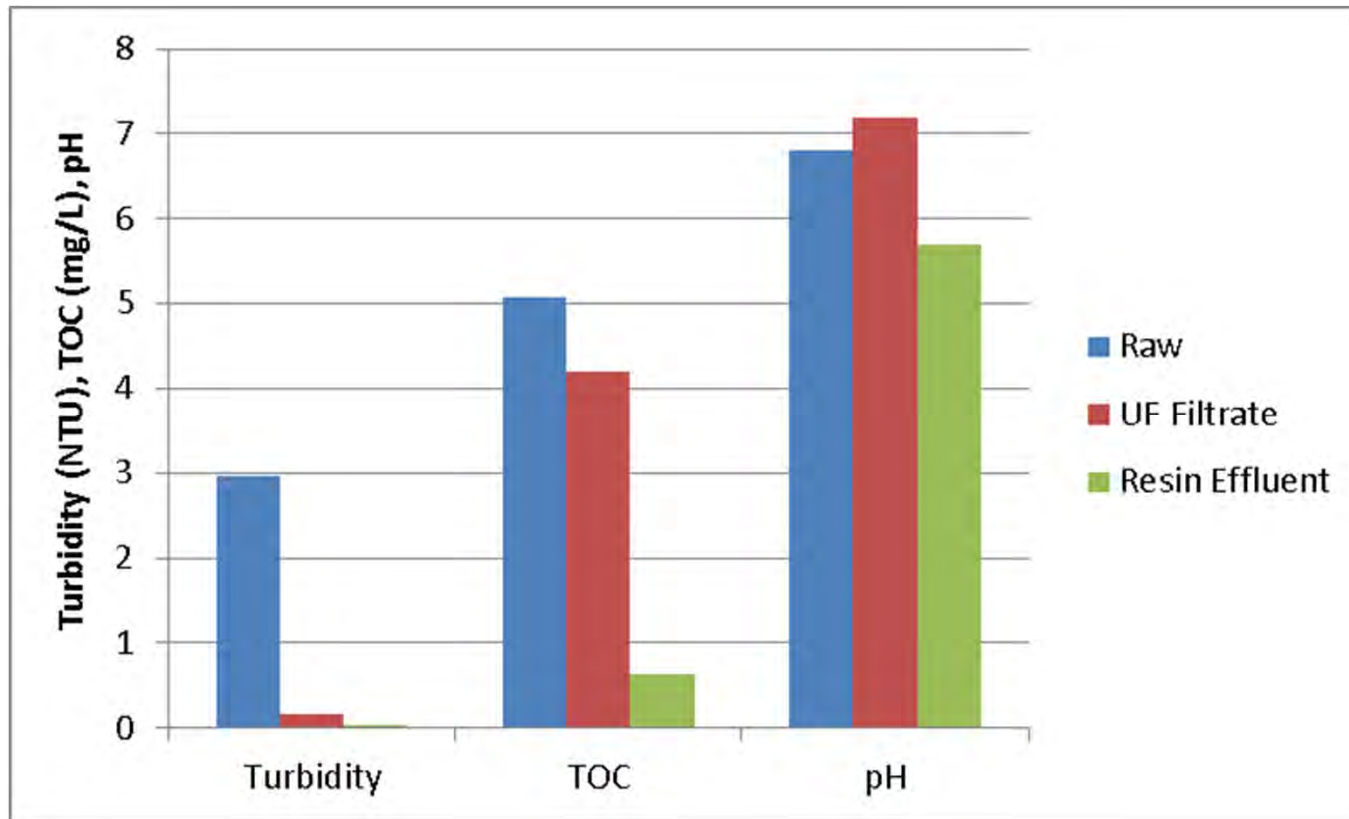
- ◆ Limited wastewater disposal options
- ◆ Unmanned facility
- ◆ Design flow unsuitable for many process options
- ◆ Capital budget limitations
- ◆ Several treatment options:
  - Pressure filtration
  - Advanced oxidation
  - High pressure membranes (NF or RO)
  - Ion Exchange
- ◆ Variable raw water quality
  - Color: 15 – > 50 TCU
  - Turbidity: 1 – >100 NTU
  - TOC: 2.0 - >10 mg/L
  - Fe/Mn
  - Nutrients
  - Low mineral content (hardness, alkalinity, TDS etc.)
- ◆ Completed bench-scale study using UF membrane-IEX resin



[www.nae.edu](http://www.nae.edu)



# Bench-Scale Results

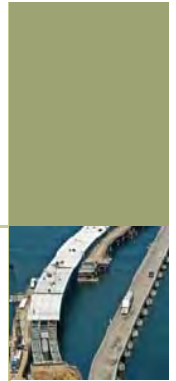


- ◆ Excellent organics reduction (color reduced from 43 TCU to 0 TCU)
- ◆ Depressed pH
- ◆ Complete turbidity removal



# BoMont WTP – Treatment Objectives

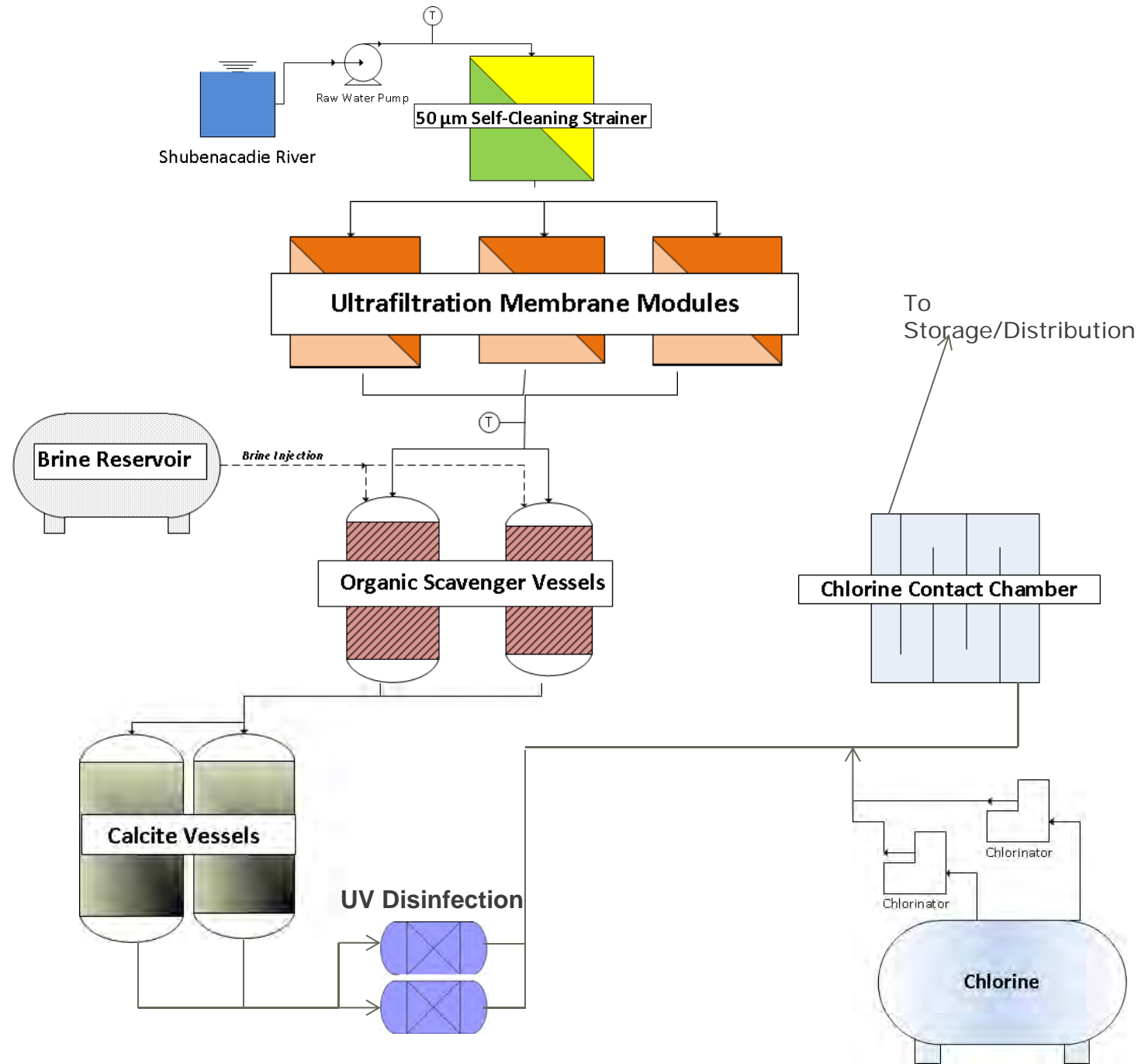
- ◆ Frequent severe source water turbidity events
- ◆ Periodic metals
- ◆ Disinfection, pH adjustment
- ◆ Final process configuration consisting of:
  - Self-Cleaning Strainer
  - 3 x Ultrafiltration Membrane Filters
  - 2 x IEX Carbon Scavenger Units
  - 2 x Calcite Media Beds (pH adjustment)
  - Redundant UV Disinfection
  - Chlorination
  - Chlorine Contact
  - Clearwell Storage
  - Highlift Pumping
  - Instrumentation and Controls
- ◆ IEX is central to the entire process!





# Process Flow Diagram







- ◆ New treatment plant constructed in 2011/2012
- ◆ Process commissioning in June 2012
- ◆ Ongoing testing and validation
  - System is considered a technology demonstration
- ◆ Water quality testing very good
- ◆ “Fishy” odour following IEX resin
  - Possibly linked to age and condition of resin, commissioning process, or regeneration types
- ◆ Odour solutions:
  - Mixed-bed arrangement (cation/anion)
  - GAC absorption

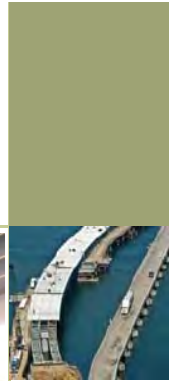
















# Construction





- ◆ Process has been shown to be effective and simple
- ◆ Important considerations of application-specific issues
- ◆ Odor control is critical for municipal applications





# Questions

