Transitioning from Conventional Treatment to Integrated Treatment

Martin Gravel, P.Eng.
Senior Water Treatment Engineer
CH2M HILL Canada

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Gander, NF

NEWFOUNDLAND DESIGN ASSOCIATES LIMITED
CONSULTING ENGINEERS

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Presentation Outline

- First Half
  - Review the past and examine the present
- Second Half
  - Look at new trends
- Summary
- Questions

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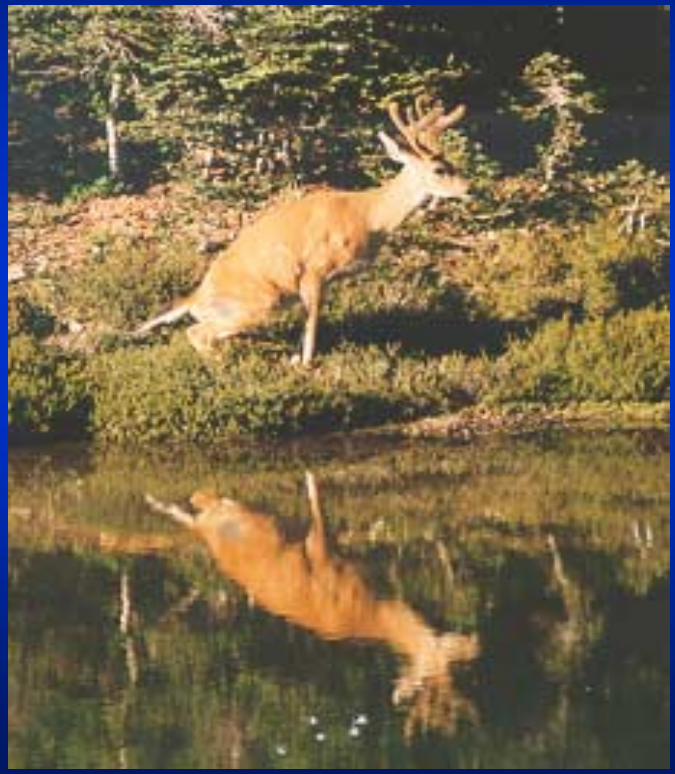
Why Do We Treat Water?

- All surface waters can be contaminated by animals (bacteria, viruses, *Giardia, Cryptosprodium*)



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Viruses

- 0.02 - 0.09 microns
- Hepatitis, Polio, Meningitis

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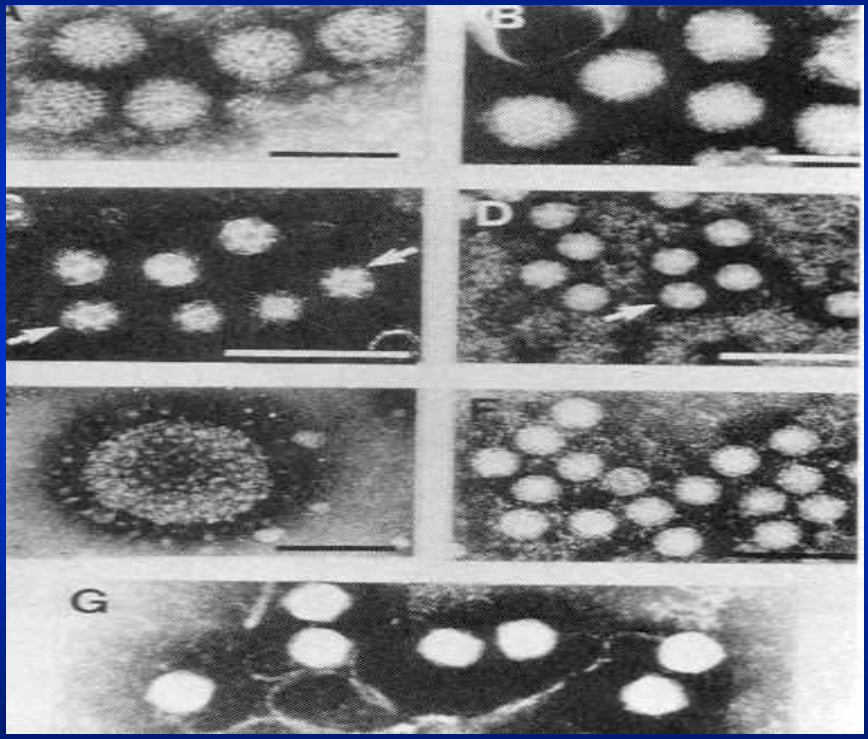
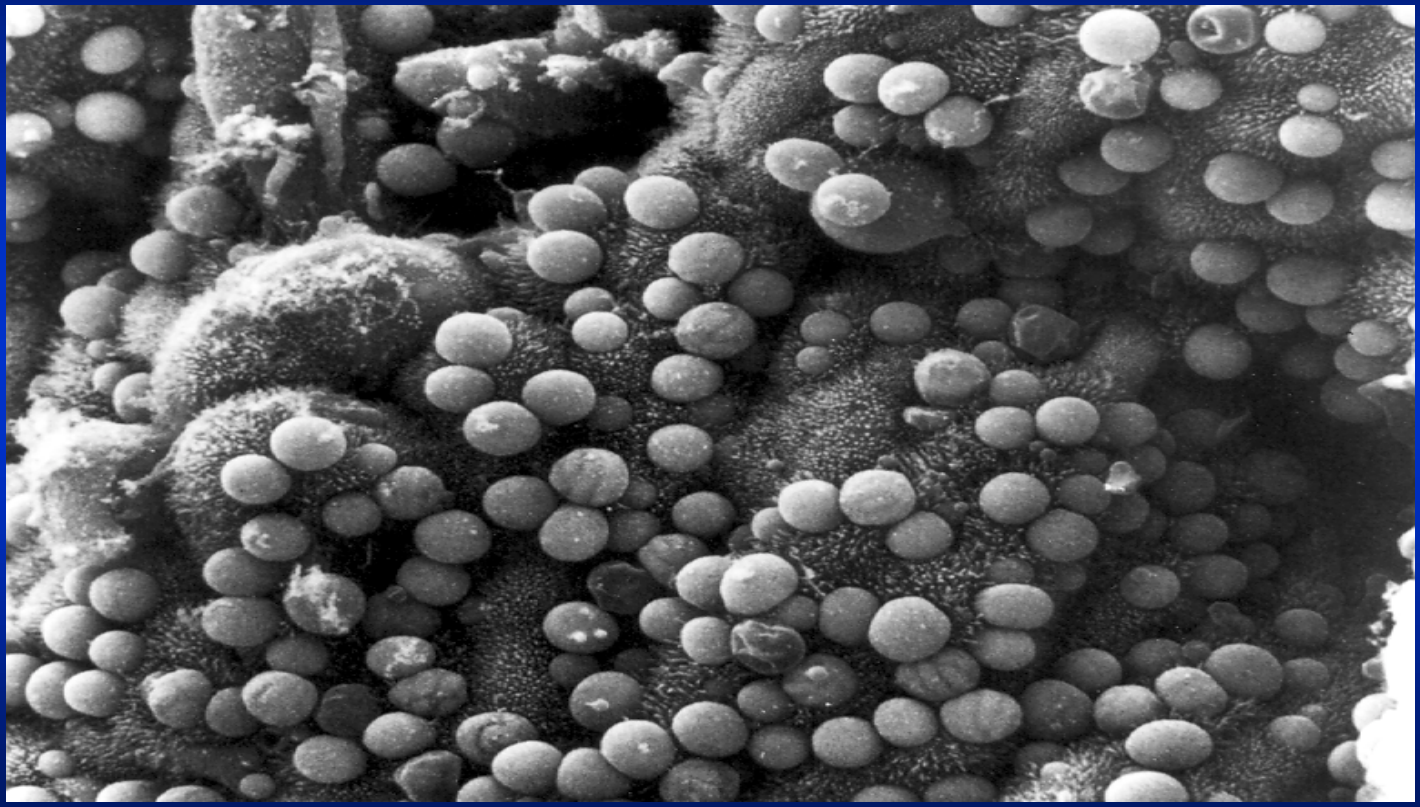
Viruses



Bacteria

- 0.2 - 2 microns
- First link to water-born disease
- Typhoid, cholera, salmonella

Cryptosporidium



Cryptosporidium

- 3 - 9 microns
- Identified in late 1970's
- Very resistant to chlorination

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Giardia

Giardia

- 8 - 18 microns
- First outbreaks in the 1960's
- Resistant to chlorination

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Key Water Quality Parameters

- Bacteria
- Viruses
- *Giardia*
- *Cryptosporidium*
- THM's
- Arsenic
- Sodium
- Iron and Manganese
- Turbidity
- Corrosiveness (copper, lead)
- Hardness
- Taste and Odour

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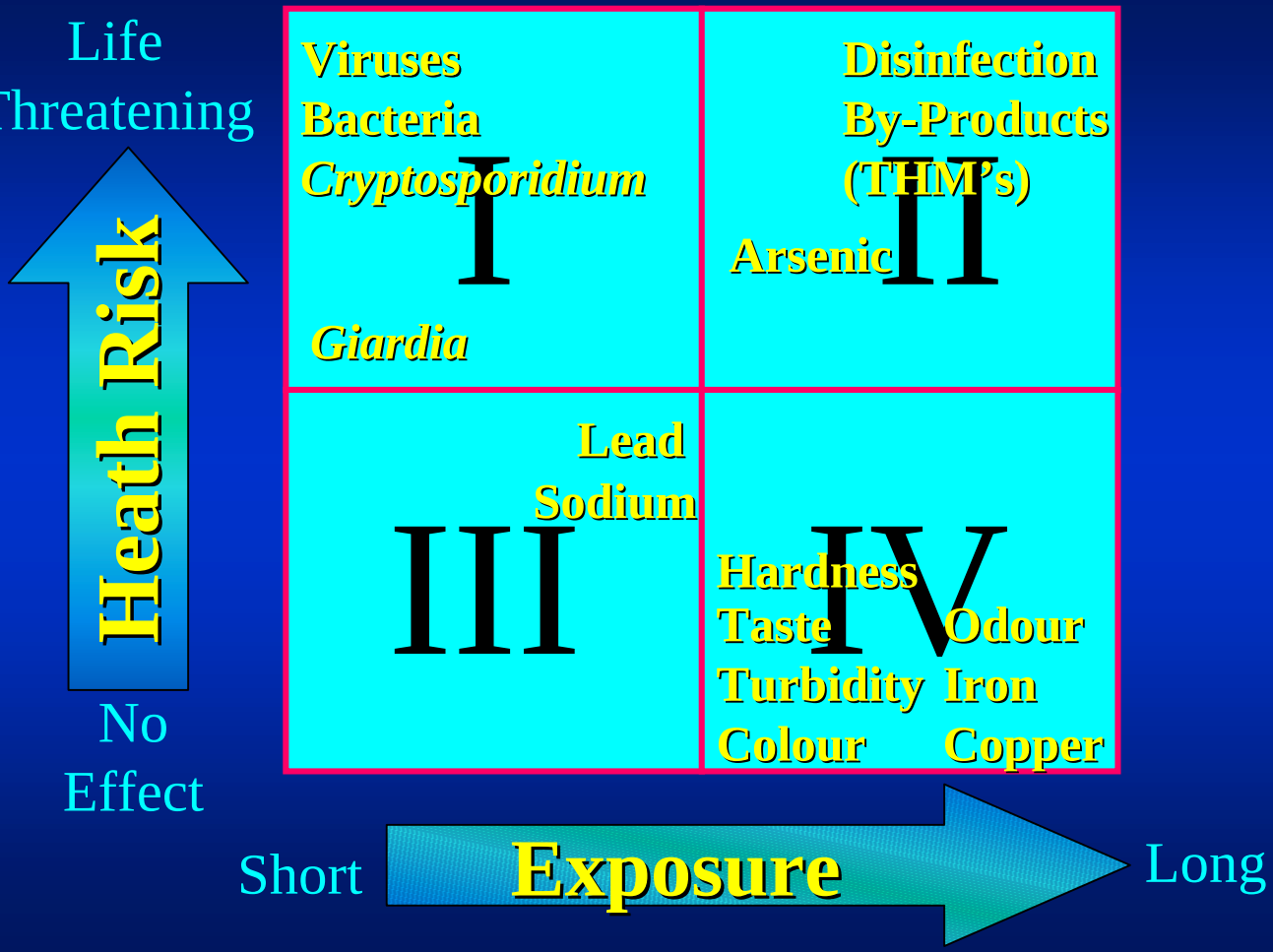
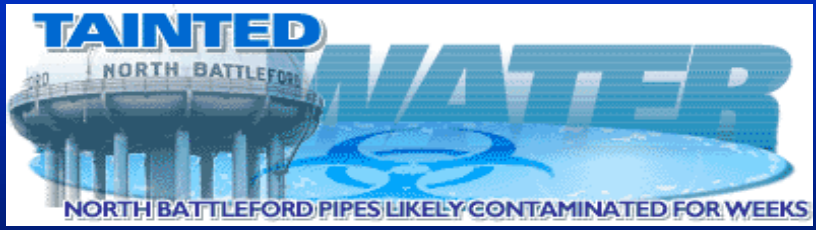

Life Threatening
Heath Risk
No Effect
Viruses
Bacteria
Cryptosporidium
I
Giardia
Disinfection By-Products (THM's)
Arsenic
II
Lead
Sodium
III
Hardness
Taste
Odour
Turbidity
Iron
Colour
Copper
IV
Short
Exposure
Long

Our Primary Responsibility

- To protect public health
  - the public must be able to rely on and assume the supply of drinking water is safe!



Our Secondary Responsibility

- To provide an aesthetically pleasing drinking water
  - clear and colourless
  - tastes great and inoffensive smell

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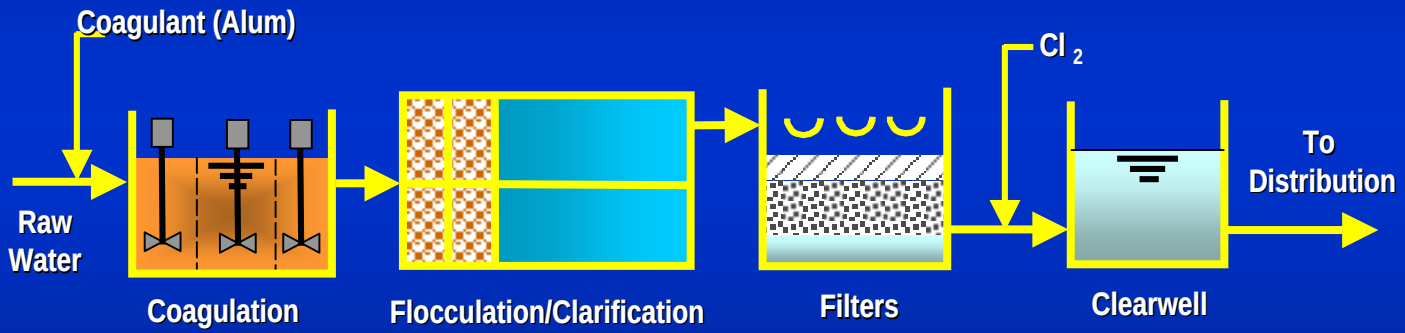
History of Conventional Treatment

- like an “Old Friend”
- more than 80 years old
- proven record on most surface waters - met past needs
- developed from the fact that there was readily available filtration media - sand
- cost-effective

Classic Conventional Treatment Process Train



Performance History

- Prior to 1989, provided means of particle removal that could shield bacteria and viruses from disinfectant and improve aesthetics (colour removal)
- Now an important part of a reliable pathogen removal strategy
- Significant part of a multiple barrier process
  - clarification
  - filtration
  - chlorination

Flexibility

- Optimized chemical treatment, especially if filters are operated at high filtration rates (>6 gpm/ft^2)
- Multiple trains can allow for shutting down part of the plant during low winter flows
- Plant can be designed for easy future expansion
- Newer process technologies can be “integrated” - talk about that later

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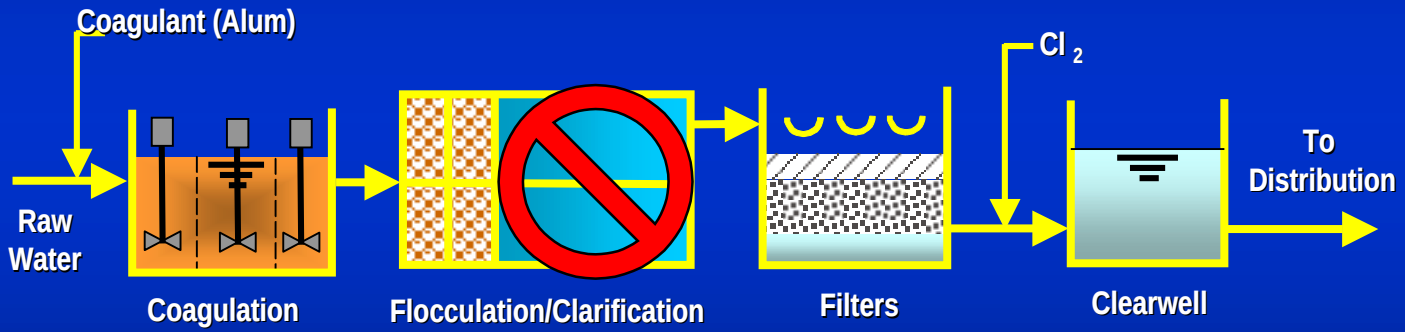
Classic Conventional Treatment Process Train



"Direct Filtration"

Benefits of Conventional Treatment vs. Direct Filtration

- Removes higher percentages of naturally occurring organic matter, thereby reducing formation of disinfection by-products
- Provides additional contact time for taste and odour control strategies
- Reduces solid loadings on filters, permitting higher filtration rates and higher productivity
- Reduces impact of algae on filtration process
- Reduces oxidant and disinfectant demand

The "Weakest Link"

- Can meet all current microbial and DBP regulations but uncertainty remains for future regulatory changes (e.g. more pathogens)
- Can handle large but gradual changes in water quality, however sudden changes can cause plant upsets and reduced pathogen removal efficiency
- Chemical dependency
- Just not "sexy" enough compared to new emerging technologies (e.g. membranes)

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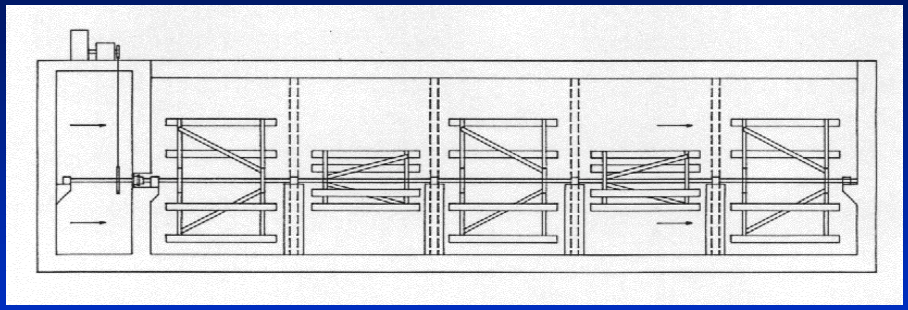
Fundamentals of Conventional Treatment

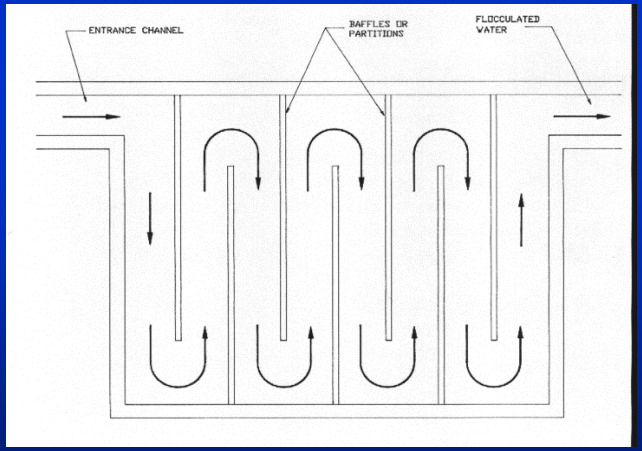
- Coagulation/ Flocculation
  - Definition: Chemical / physical process of blending or mixing a coagulating chemical into a stream and then gently stirring
- Coagulation
  - Chemical process of destabilizing the charge on suspended solids and colloids
- Flocculation
  - Physical process of gentle mixing to enhance contact of destabilized particles and to build floc particles
- Minimum detention time: 30 minutes

Rapid Mixing

- Basin or in-line mixers
- Mechanical or hydraulic
- Design parameters:
  - mixing energy
  - detention time
  - location of injection



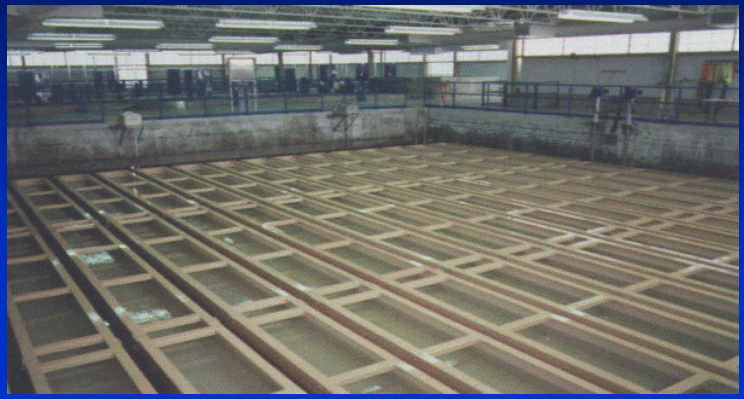
- Mechanical flocculators
  - axial
  - paddle
  - walking beam



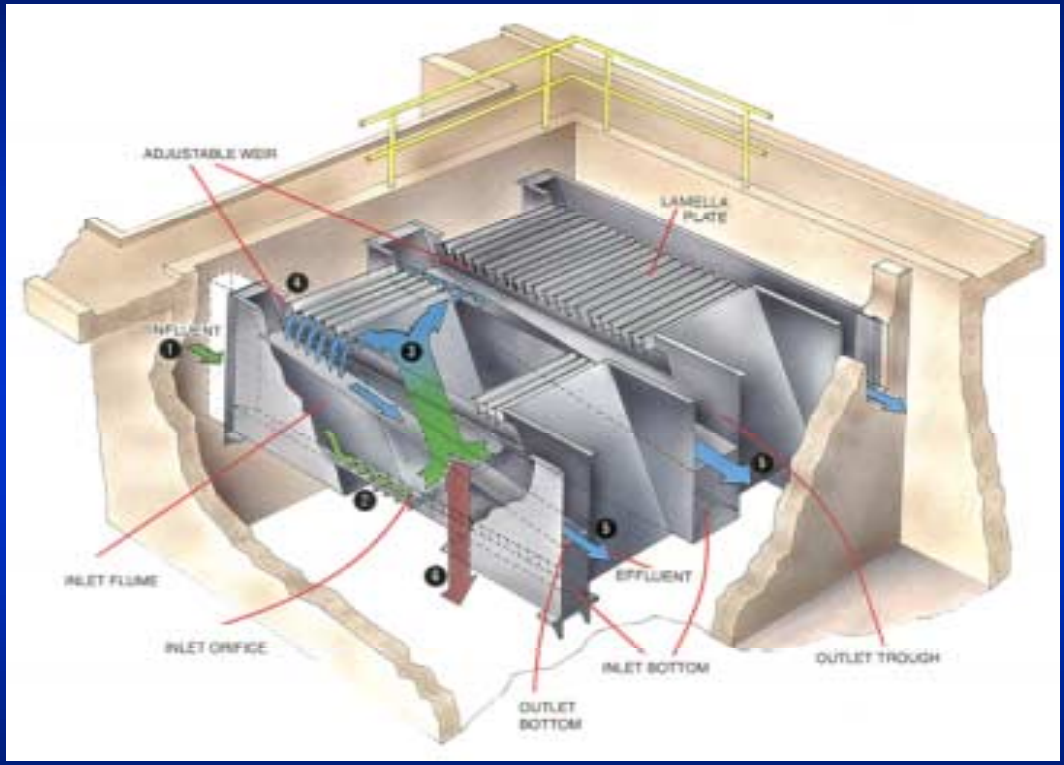
- Hydraulic Flocculators
  - serpentine
  - spiral

Fundamentals of Conventional Treatment

- **Clarification / Sedimentation**
  - removes bulk of heavier and larger floc particles by gravity
  - usually large rectangular quiescent tanks and/or upflow clarification
  - not included in “direct filtration” plants
  - surface loading rates of 0.5-1.0 gpm/ft^2
  - provides 70-90% particle removal
- **Minimum detention time of 1-2 hours**
  - helps plant operators to adjust to rapid changes in raw water quality e.g. large solids loadings



- **Upflow Clarifiers :**
  - radial upflow
  - inclined plate and tube settlers
  - solids contact


ADJUSTABLE WEIR
LAMELLA PLATE
INFLUENT
INLET FLUME
INLET ORIFICE
EFFLUENT
INLET BOTTOM
OUTLET TROUGH
OUTLET BOTTOM

Fundamentals of Conventional Treatment

- **Filtration**
  - Definition: passage of water through a porous medium for removal of suspended solids
- **Driving Force**
  - Filters operate normally operate under gravity flow
  - Configuration can be “rapid rate” dual media filters or slow sand filters
- **Particle Removal Efficiency**
  - Sand, depth <1 m 90-99%
  - Dual Media, depth <1m 99-99.9%
  - Deep Bed, depth >2m 99-99.99%

Rapid Rate Filter

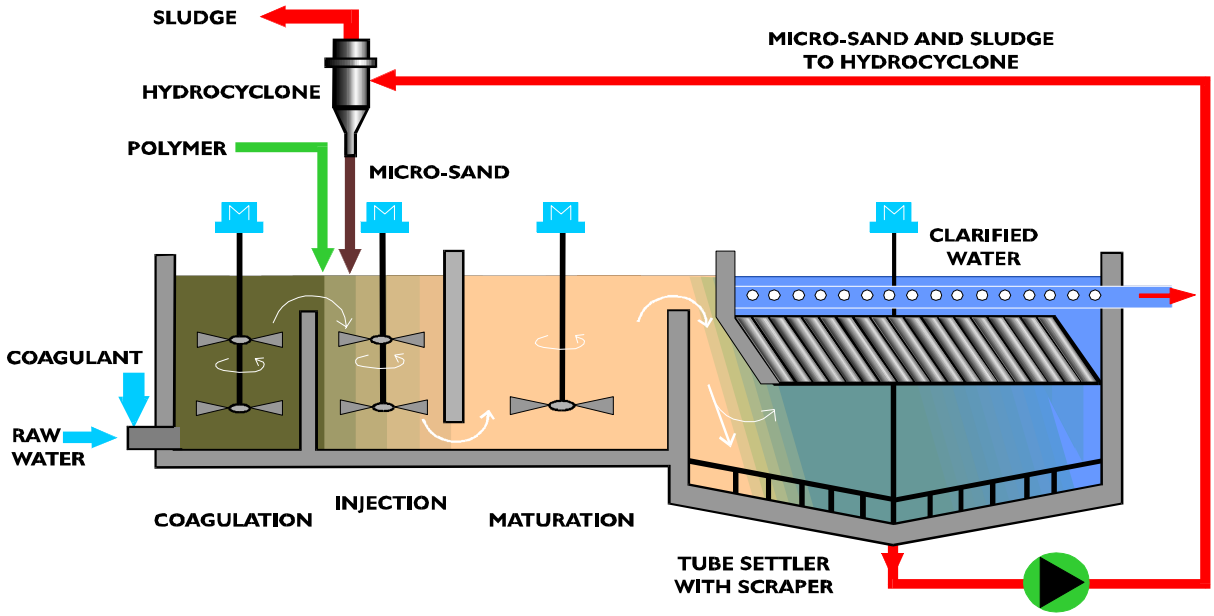
Regulatory Performance

- Typical microbial removal/inactivation regulatory requirements:
  - Viruses 4 log (99.99%)
  - Giardia 3 log (99.9%)
  - Crypto 2 log (99%)
- Typical conventional treatment reduction credits (with chemical inactivation):
  - Viruses 2 log (99%) plus 2.0 log with chemical disinfectant
  - Giardia 2.5 log plus 0.5 log with chemical disinfectant
  - Crypto 2 log (99%)
- Direct filtration only 2.0 log Giardia credit!

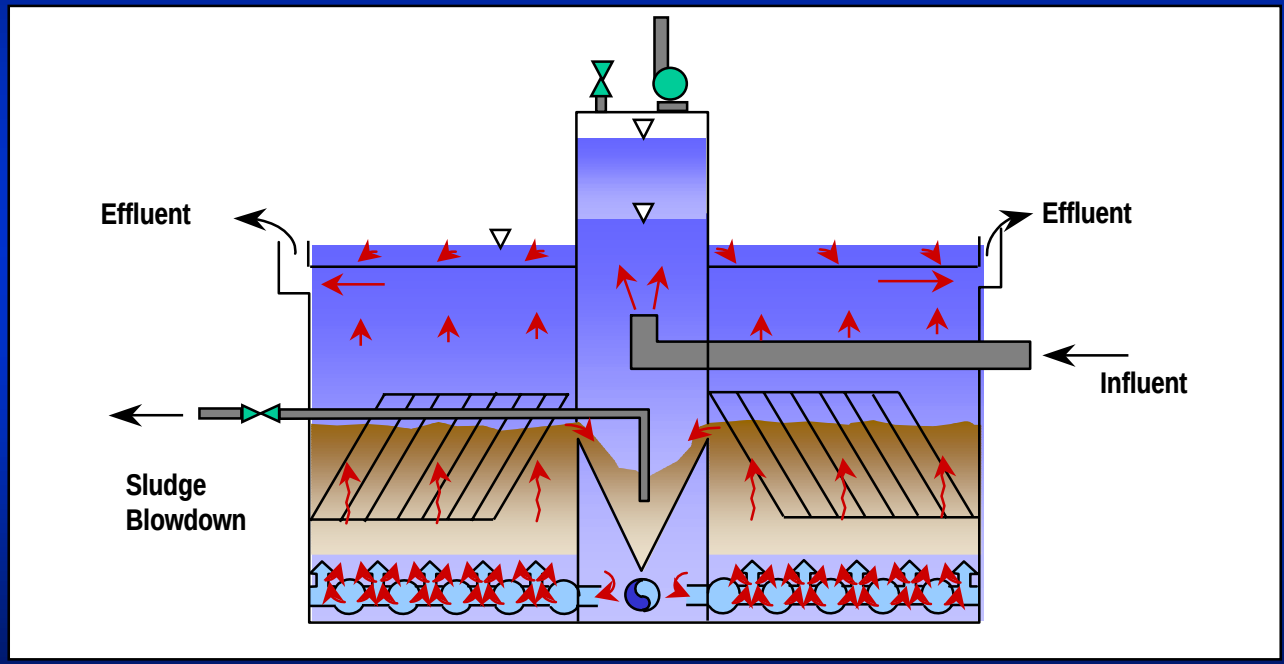
"Integrated Treatment": Modernizing Conventional Treatment

- The definition of conventional treatment is being challenged - or is it dead?
  - Emergence of updated and new technologies is revolutionizing the engineer's toolbox
  - Dissolved Air Flotation (DAF)
  - Sand-Ballasted Sedimentation (Actiflo)
  - New Upflow Solids Contact Units (Super Pulsator)
  - Biologically Active GAC Filters (BAC)
  - Membranes
  - Ozone
  - Ultraviolet Disinfection (UV)

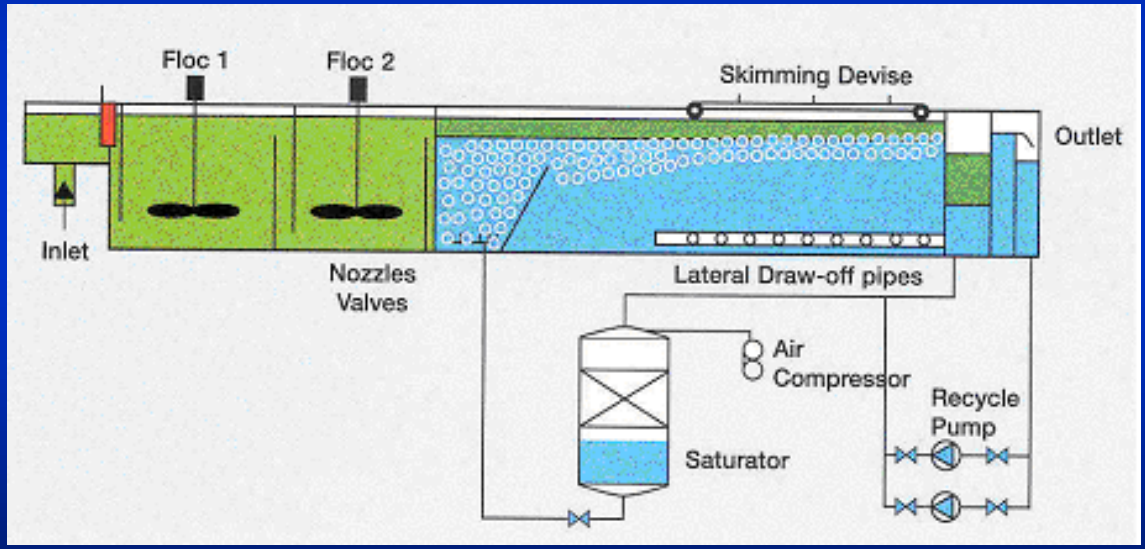
Sand-Ballasted Sedimentation (Actiflo)



Upflow Solids Contact Units (SuperPulsator)



Dissolved Air Flotation (DAF)



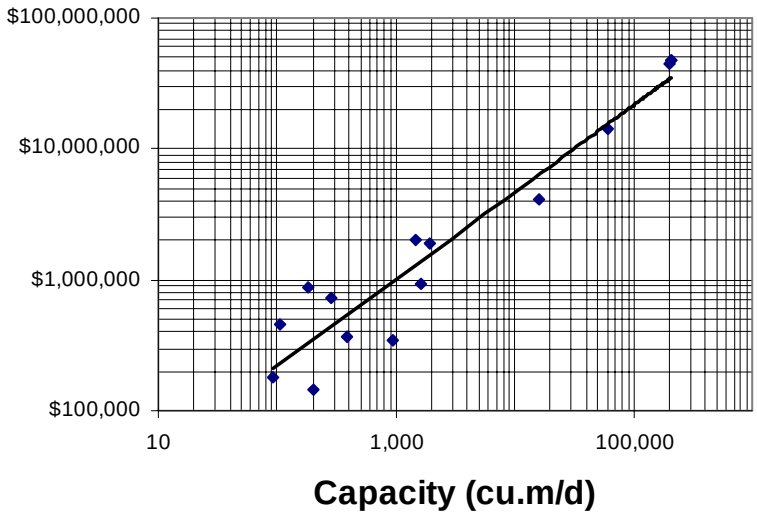
"Integrated Treatment": Modernizing Conventional Treatment

- **Integrated Treatment options consider:**
  - multiple barriers
  - reliability and process failures
  - likely changes in regulations/ advancement of science
  - ease of operation & maintenance
  - ease of expansion/ modularity
  - environmental impacts
  - capital and life cycle costs

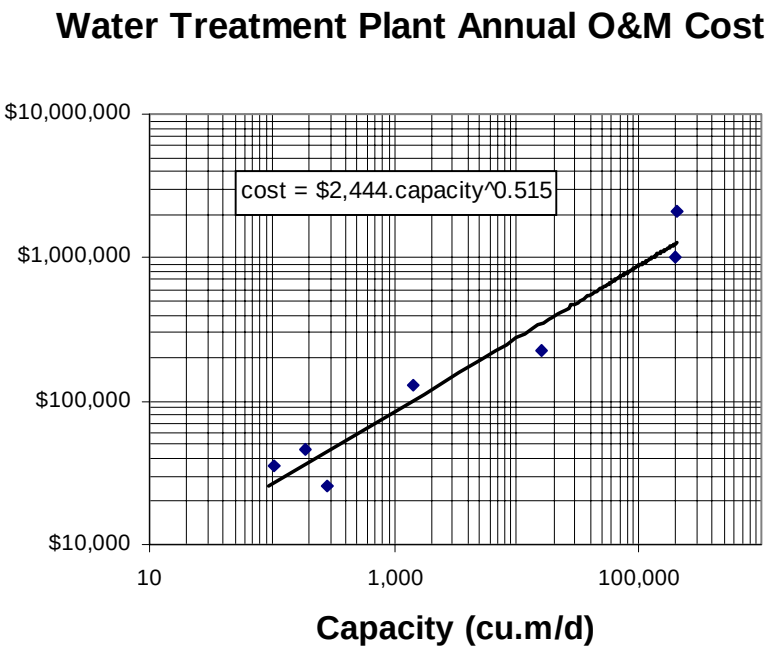
"Integrated Treatment": Modernizing Conventional Treatment

- Processes are integrated for each treatment situation:
  - Which filtration type?
  - What pre-treatment?
  - Which disinfectant (s) and where?
  - Other treatment needs
    - colour, taste and odour, pH, iron, manganese, hardness

CH2M Hill Cost Data



CH2M Hill Cost Data



Summary

- Conventional treatment is traditional and proven
- Emergence of new pathogens and changing regulations forcing change and optimization
- Choices for a variety of process units and disinfection methods altering tradition
- Move to “integrated treatment” approaches to meet treatment goals and life cycle evaluations
- Examine your own treatment practices and respect your responsibilities as a water supplier

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QUESTIONS?

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