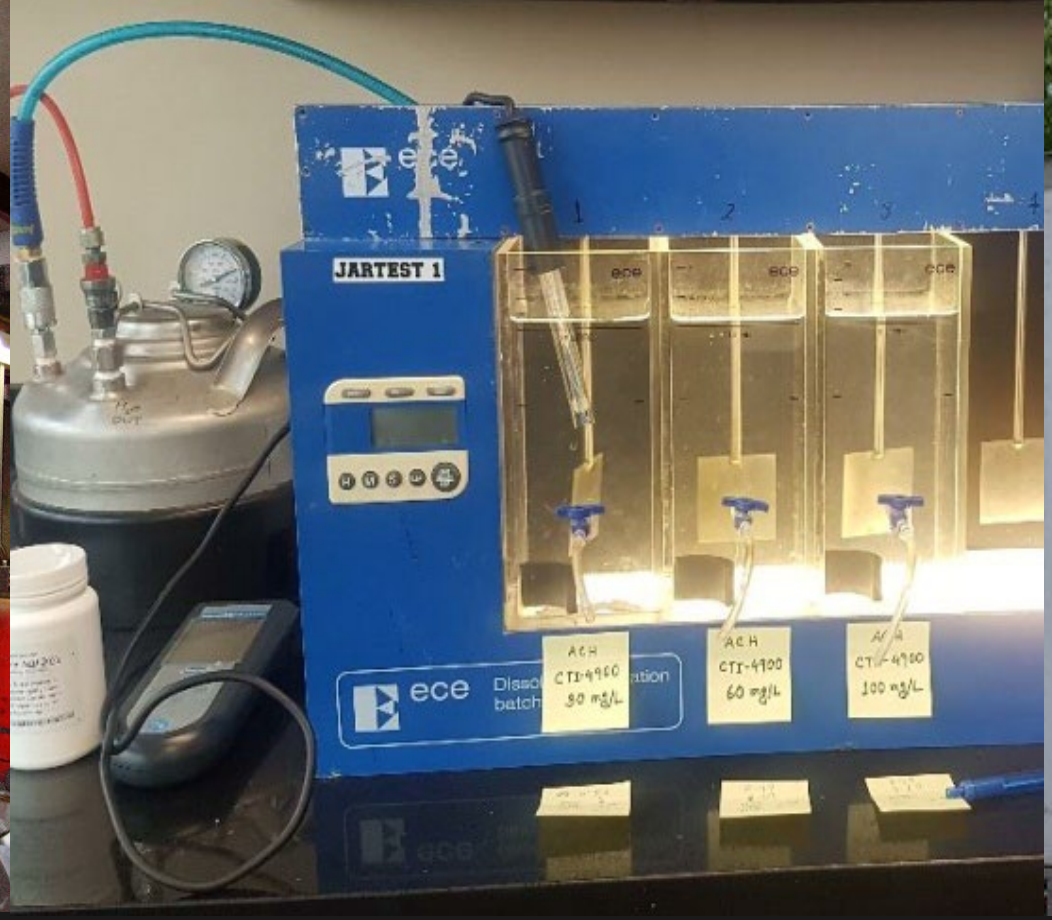

NWWC 2022

PILOT TESTING – A FUNDAMENTAL ELEMENT OF DESIGN

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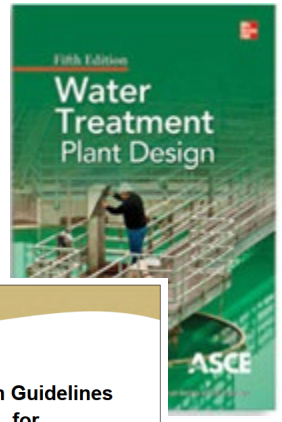
TAKE HOME MESSAGE

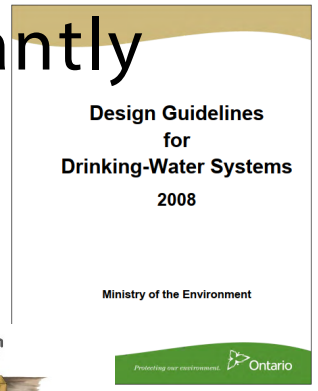
- Pilot testing can be valuable when designing or operating a water or wastewater treatment system

- Why testing?
- Types of testing
  - Bench scale
  - Pilot testing
- 3 Case Studies

IS TESTING REALLY NEEDED?

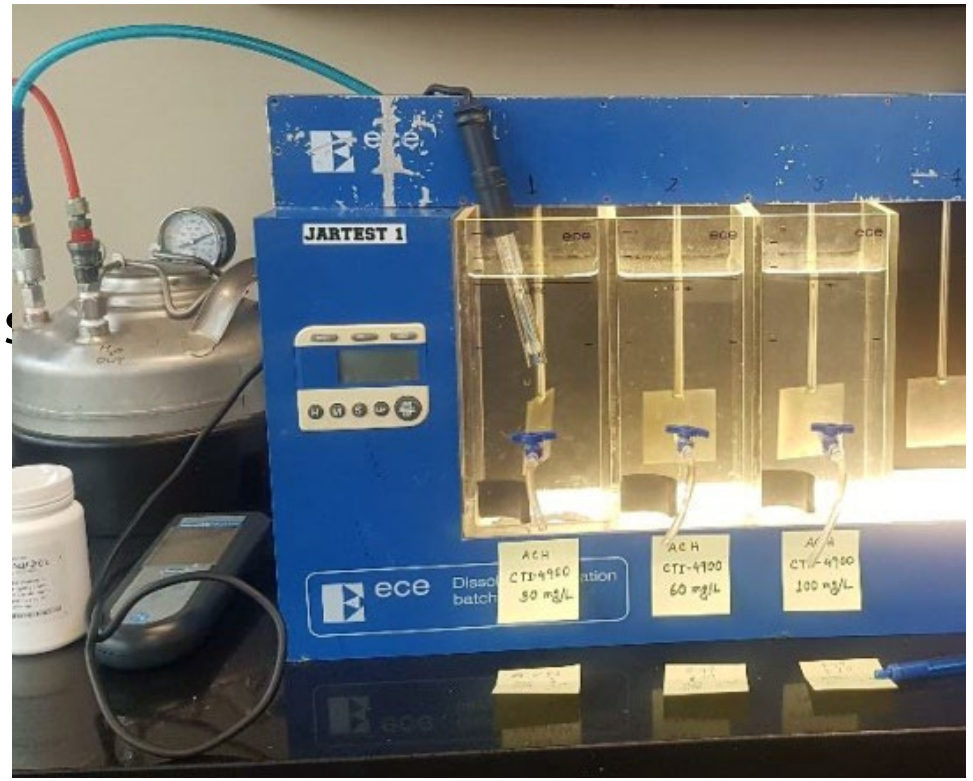
- Generally, for typical treatment processes
  - Industry standard design guidelines can inform general sizing
  - Past experience from operators, consultants, suppliers
- Performance of treatment system can be significantly impacted by source water matrix
- Use of standard guidelines could potentially lead to
  - Over sizing treatment system
  - Under sizing treatment system
- New treatment process
  - Big investment
  - Make sure it is the best alternative





BENCH-SCALE TESTING

- Testing for specific water sample
- Define broad range of design parameters
- Help to optimize operation
  - Jar testing for coagulant and polymer dosing
- Screen potential treatment technologies
  - Confirm ability to meet treatment objectives
- Limitation
  - Results are only for snap shot in time
  - Seasonal changes in water quality may not be captured
  - Longer performance items like filter run time may not be assessed.



BENCH-SCALE TESTING APPROACH

Equipment Supplier

- Operations provide water samples
- Bench-scale jar tests conducted by suppliers
- Equipment Surveys based on bench scale testing results to support design

Independent Lab

- Less "ownership" by suppliers
- Separate from supplier to avoid procurement concerns
- Good for initial stages of design

PILOT TESTING

- Real time results over longer period of time
- Temporary pilot plant
  - Solve immediate problems
  - Explore alternative treatment technologies
  - Often trailer mounted type systems
  - Can be customized to mimic full scale equipment
- Permanent pilot plant
  - Used to refine design parameters
  - Aid in operations
    - Determine impact of changes to flow, chemical dosage, filter media etc.
    - Allow operations to experiment in a way that could not be comfortable done at full scale

SO, PILOT TESTING IS GREAT FOR EVERYTHING?

- [x] Chemical processes (THM reduction, coagulant selection)
- [x] Biological processes (crypto control, Biofiltration)
- [ ] Hydraulics (flocculation speeds)
- [ ] Conventional situations with un-challenging water
- [x] Existing System (Optimizing chemical doses)
- [x] Directly comparing treatment alternatives

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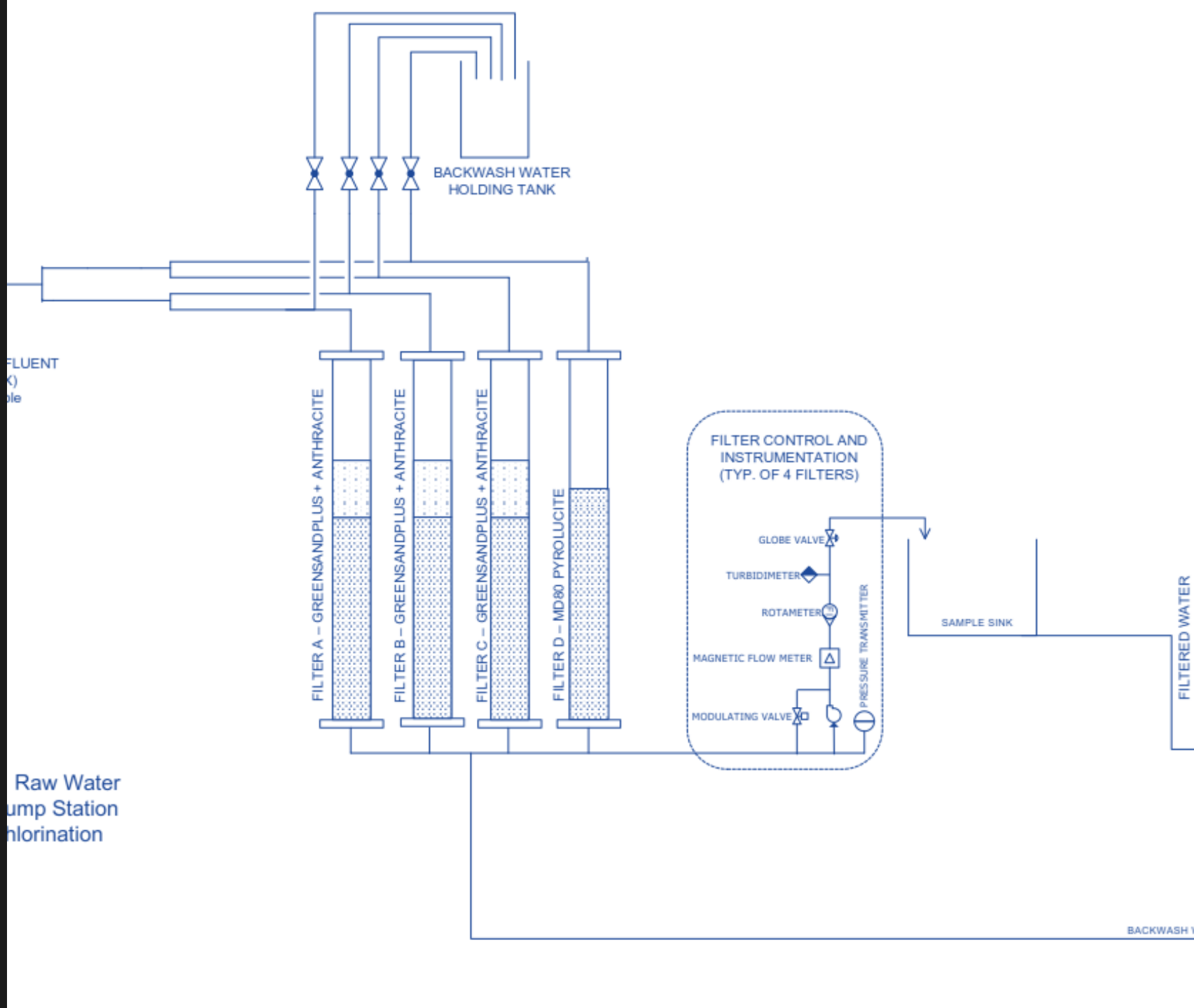
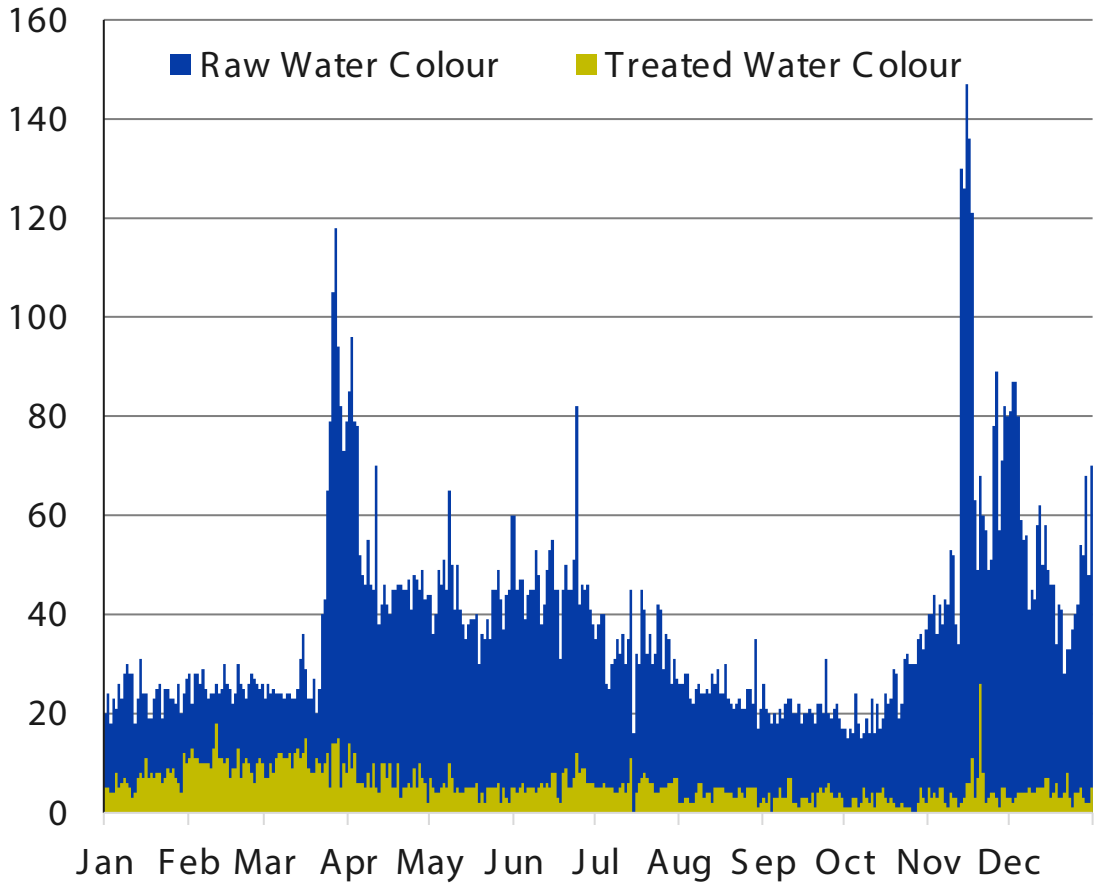
CASE STUDIES



CASE STUDY 1 – NEW WATER TREATMENT PLANT

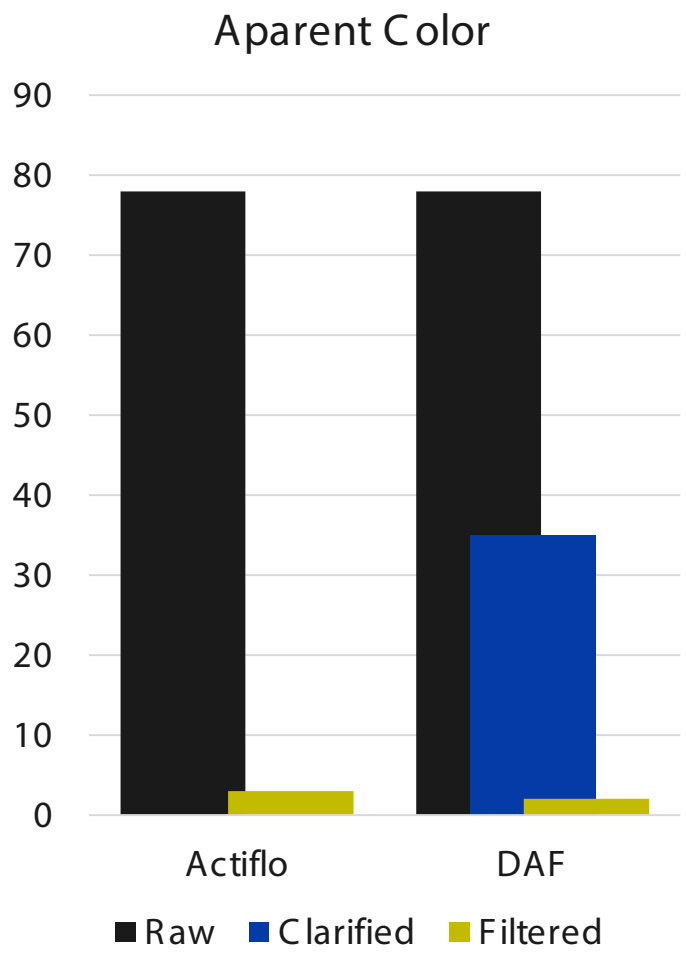
- River water source with distinct seasonal variations
  - Spring run-off – high color, some turbidity and T&O
  - Summer – algae, turbidity, T&O
  - Fall – lake turnover, turbidity and high color
- Challenge – What treatment process to choose?



BENCH SCALE TESTING – TREATMENT SCREENING

Spring Treatment Screening

- Bench scale studies first
  - screen treatment alternatives
  - gain information for cost comparison
- Colour Treatment screening
  - ✗ Pre-Oxidation– Independent Lab
  - ✓ Actiflo – Supplier Lab
  - ✓ DAF (high rate) – Independent Lab
  - ✗ Conventional Treatment – Independent Lab
- T&O Treatment screening
  - ✓ UV/H_2O_2 - Supplier

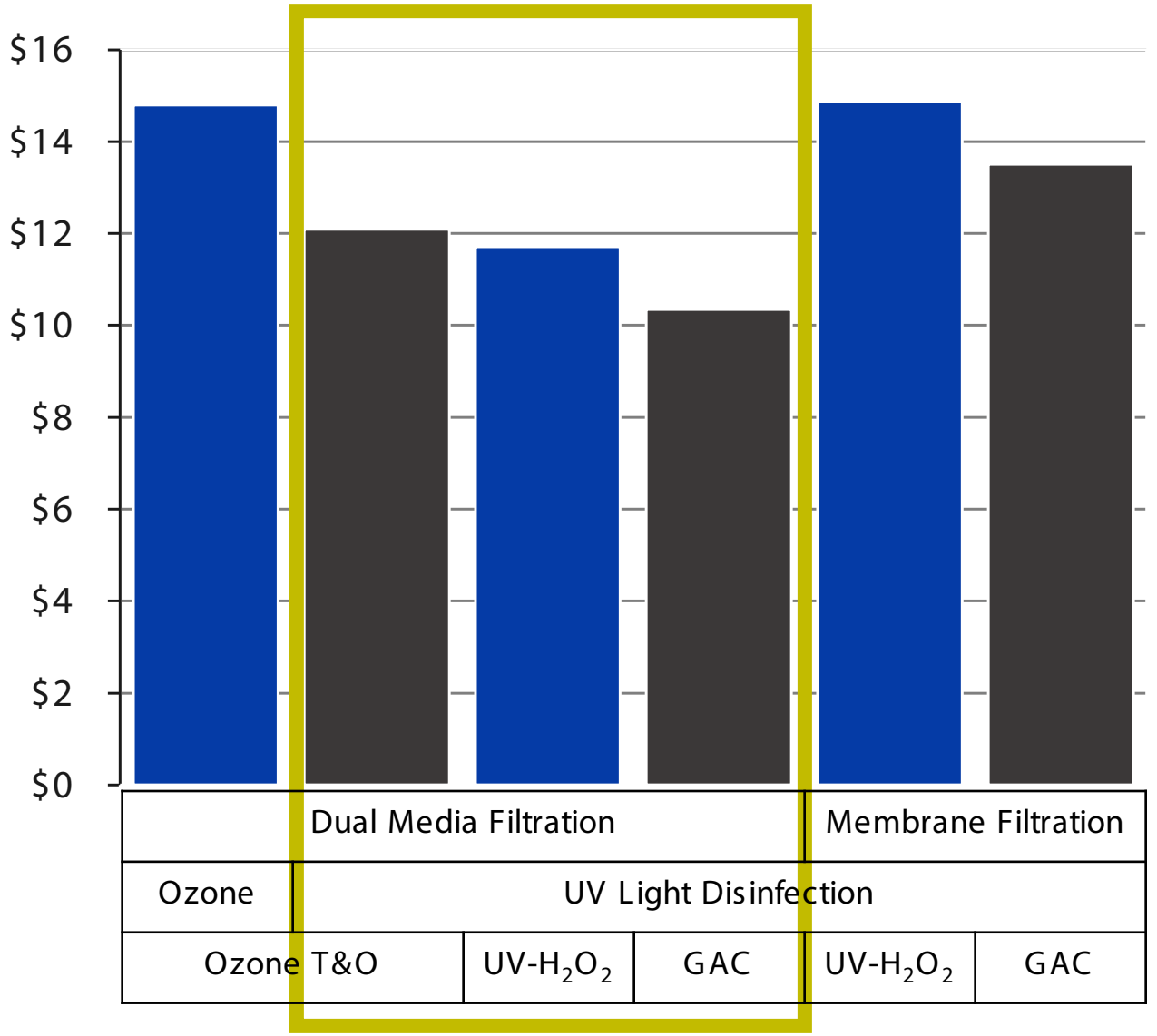


Summer T&O Testing

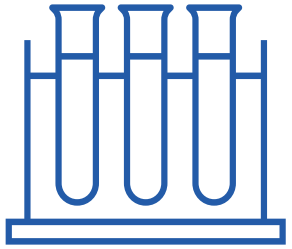
- Competitive Pilot Testing – 4 weeks in summer
  - Evaluate how each treatment might affect water quality to enhance or impair subsequent T&O Process
  - Gain operating information for cost comparison
- T&O Treatment screening of Pilot Tested pre-treated water
  - GAC – Independent Lab
    - Contact time for TOC and T&O removal
    - Estimated GAC replacement frequency
  - UV/ H_2O_2 – Supplier
    - Trucked water sample for pilot test
  - Ozone – Independent Lab
- Information for cost comparison

TREATMENT PROCESS SELECTION

- Comparative Life Cycle Cost Comparison
  - Capital Costs
  - O&M Costs from testing
- Pre-Selection of High Rate Clarification Equipment
  - Performance guarantee
  - Capital and O&M costs
  - Equipment footprint
  - Technical considerations
- Result was a close race
  - DAF was selected



TESTING COSTS



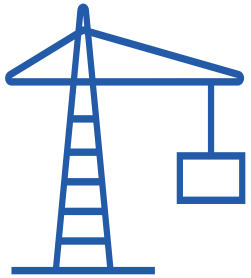
Bench Scale Testing

Spring Run-off testing
$50k
Summer T&O testing
$59k
Fall Color Event testing
$35k

Pilot Testing

$31-$43k each supplier

Only paid for
unsuccessful proponent



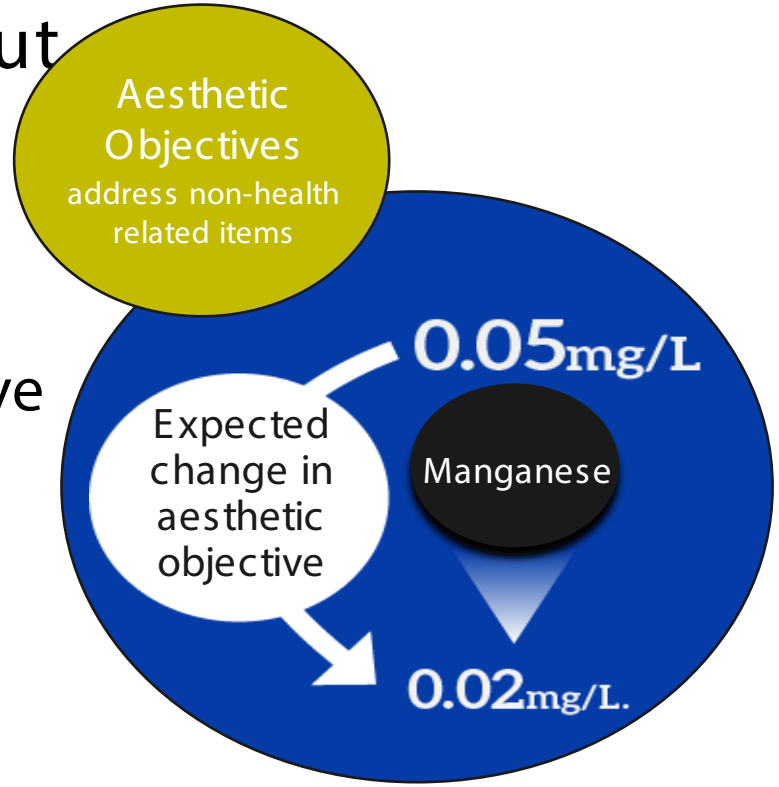
Construction

$24M

Total less than 1% of construction cost for confidence in the selected treatment train and design parameters

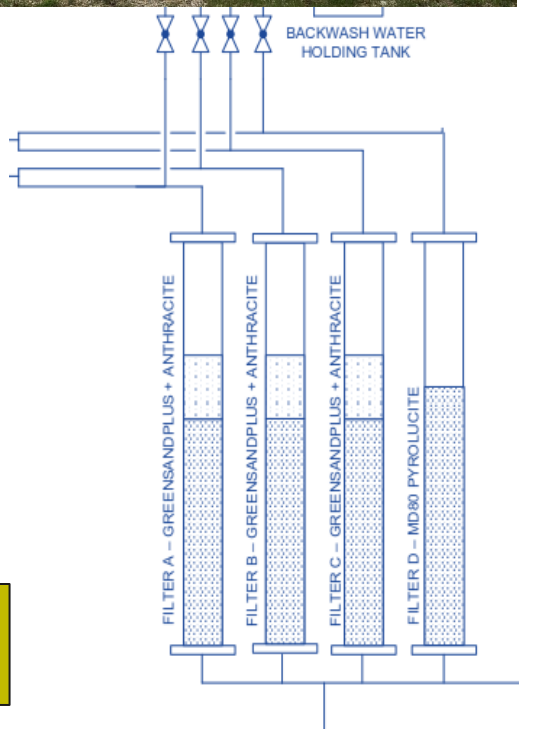
CASE STUDY 2 – MANGANESE FILTRATION

- Health Canada reduction in AO, with Ontario expected to follow
- Raw water levels were below 0.05 mg/L but above operating target of 0.015 mg/L
- Greensand Filtration
  - Tried and true technology, but low source levels could impact removal rate, also, could we achieve much higher than standard filtration rates?
- Piloting completed to
  - Confirm technology performance
  - Prove loading rates and compare media
  - Address site specific water quality



PILOT TESTING TO PROVE PERFORMANCE

- Independent company
  - 14-day trials using trailer mounted pilot
- Results proved:
  - Higher loading rates (+24 m/hr) successful
  - Multiple media alternatives
  - Confirmed filter run time (>5 days)
  - No impact of recycling supernatant on run time
- Copper > Provincial water quality objectives in residuals
  - << drinking water standards
  - impacted alternatives for backwash waste management
- Longer pilot duration would have been beneficial
  - Did not see sufficient solids in sludge for settling testing



$45k - Less than 0.2% of $30M construction cost estimate

CASE STUDY 3 – DESIGN AND OPERATION

- WTP with challenging river raw water source
  - Ammonia, Organics, Disinfection By-products, T&O, bromide
- Ozone was chosen to be added upstream of filters to:
  - ↓ coagulant use
  - ↓ chlorine demand
  - ↓ THMs and HAAs – reduction could be 50%
  - ↓ T&O in summer – reduction could be 50 to 78%
  - ↑ overall treated water quality
- What ozone dose?
  - Unused generator capacity is costly
  - Hydrogen peroxide for advanced oxidation needed?
- What filter media design?
  - GAC, Anthracite, Filtralite? T&O or THM reduction from biofiltration?

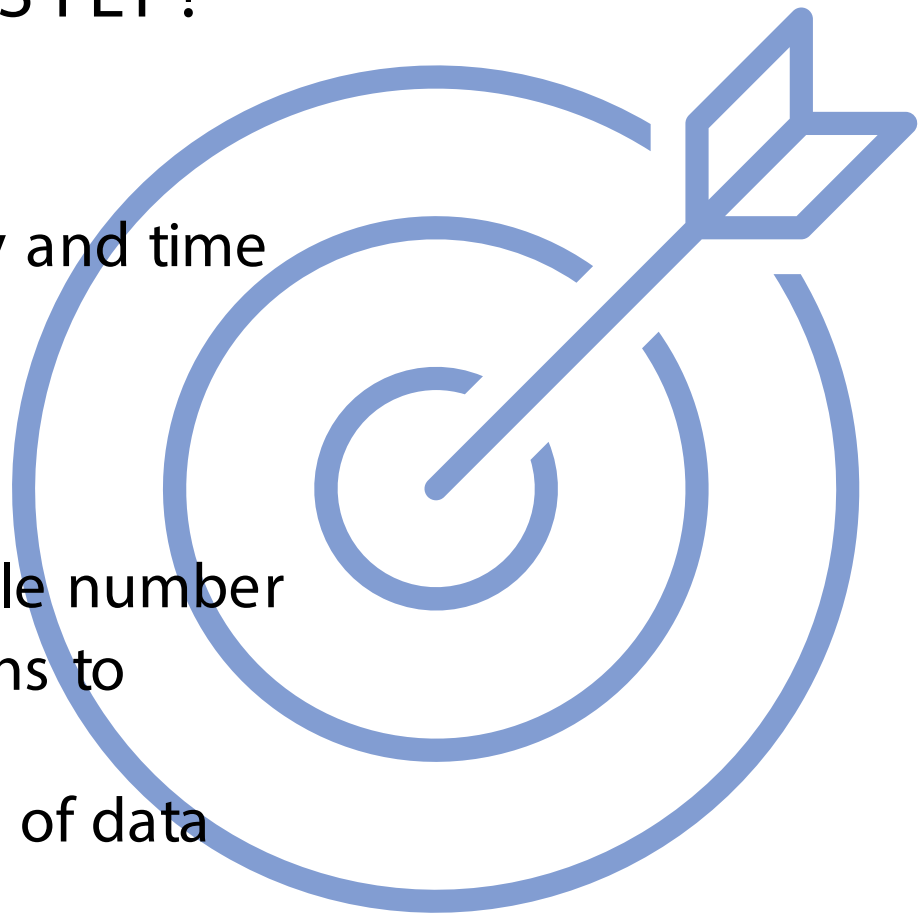
PILOT DESIGN – DESIGN AND OPERATION

- Owner designed the Pilot System
- Our team helped define pilot objectives, pilot testing plan, and review results
- Goal 1: Design
  - Pilot was operated for approx. 1-year to account for seasonal variation
- Goal 2: Optimize operation
  - Coagulant/polymer dose in pre-treatment
  - Ozone dose
  - Cost benefit analysis of chemical consumption

$200 to 400k + staffing and engineering support - Less than 1% of $55M construction cost

PILOT TESTING OBJECTIVES

- Determine goals - MOST IMPORTANT STEP!
  - What defines a success?
  - What results are unacceptable?
  - If not clearly defined, risk spending money and time without achieving desired results
- Refine and reduce objectives
  - Never just one problem to be solved!
  - Reduce goals to a manageable and testable number
  - One or two goals can take weeks or months to properly address
  - Need to be able to manage large amounts of data and isolate important results



HOW CAN PILOT TESTING GO WRONG?

- Poorly defined goals and objectives
- Not enough attention paid to specific scientific method/protocol
- Not enough staff
  - Full time job for one operator
- Uncommitted management

SUMMARY

- Pilot Testing:
  - Instills confidence in process selection
  - Confirms or defines detailed design parameters for right sizing systems
  - Offers preview of operating costs
  - Optimizes treated water quality
  - Optimizes cost of operation