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Pilot Testing for Iron and Manganese – Lessons Learned and Takeaways at Three Groundwater Treatment Plants

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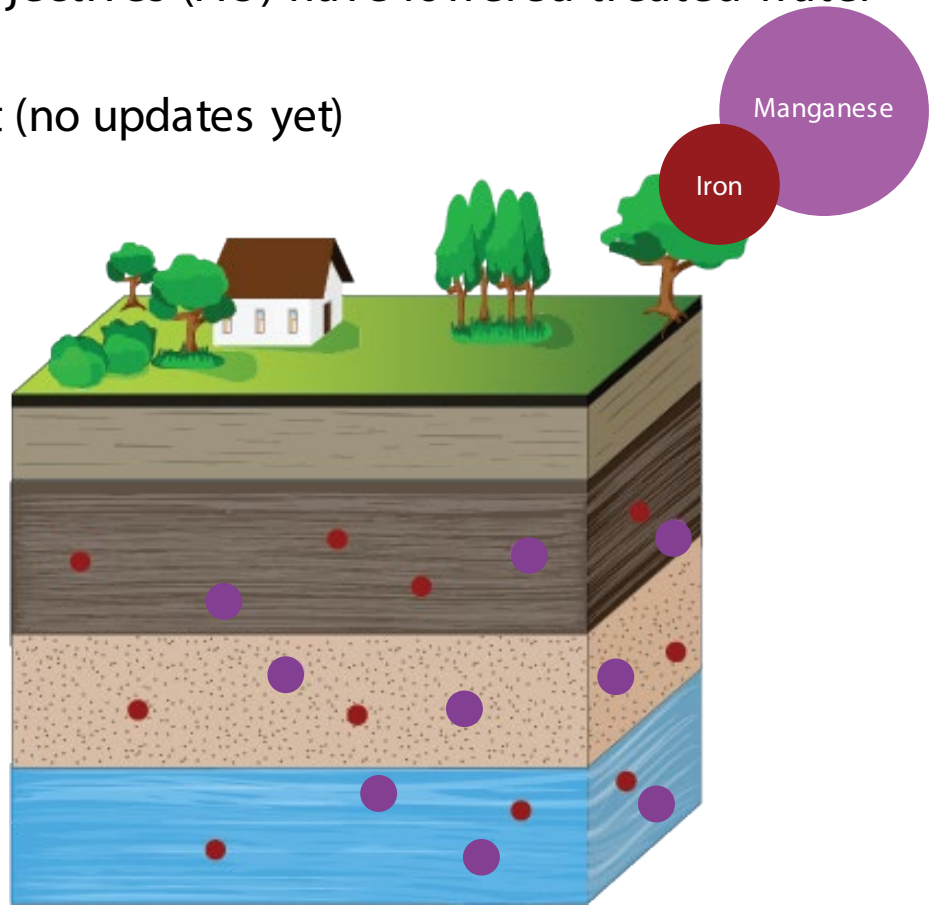
- We want to answer the question: Why pilot iron and manganese treatment equipment?

Iron and Manganese in Ontario

- Iron and manganese are common inorganic compounds found in both surface and groundwater sources.
- Recent changes in 2019 to Health Canada Aesthetic Objectives (AO) have lowered treated water manganese concentrations from 50 ppb to 20 ppb.
- Ontario Drinking Water Standards expected to follow -suit (no updates yet)

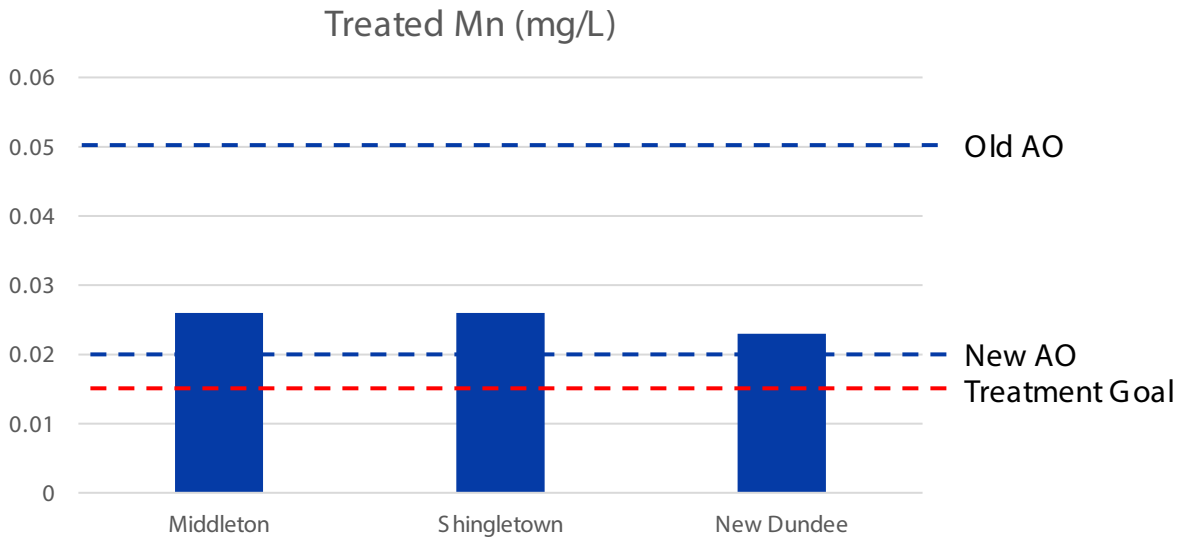


Region of Waterloo Water Supply System

- Waterloo – located in SW Ontario, 90 minutes northwest of Niagara Falls
- One of the fastest growing municipalities in Ontario
- Majority of water supply is through groundwater
- In anticipation for the Health Canada guideline revisions, a system-wide assessment of the municipal wells was completed. Five wells sites were recommended for treatment upgrades.
- Three sites are being presented today:
  - Middleton Water Supply System
  - Shingletown Water Supply System
  - New Dundee Water Supply System
- Pilot testing was completed during the planning process of the project.

Existing Water Supply Systems

Water Supply Site	Site Capacity (L/s)	Treated Mn (mg/L)	Mn AO Limit (mg/L)	Treated Fe (mg/L)	Fe AO Limit (mg/L)
Middleton	455	0.026	0.02	0.043	0.3
Shingletown	158	0.026	0.02	0.016	0.3
New Dundee	8	0.023	0.02	0.021	0.3



- Goal at each site was to lower the treated Mn concentration to 0.015 mg/L Mn
- Middleton and Shingletown both completed pilot testing.

Why Consider Pilot Testing?

- Pilot testing is the process of reviewing a treatment technology or approach on a smaller scale for a stipulated period, to inform future design decisions:
  - Temporary pilot plants
    - customized to match full scale equipment
    - often mounted on trailers for mobility
  - Permanent pilot plants
    - offer capability to refine and optimize process parameters
    - allow for experimentation not possible at full scale
- Why consider pilot testing for this project?
  - Identify process and operational parameters
  - Compare different alternatives
  - Determine chemical and dosing quantities
  - Proof of concept for possible residuals recycling
  - Enable better understanding of O&M costs

Key Pilot Testing Considerations

- What are the goals of the pilot testing?
- What would make the testing successful, and what kinds of results are not wanted?
- Keep goals to a manageable number, and be ready to review large amounts of data, to refine and identify the important results
- A detailed Pilot Testing Plan should be prepared for review, to well define the goals, and state constraints from the outset
- Clearly identify the required resources and staffing and complete early coordination to support the pilot test

Key Considerations
Which parameters can be scaled?
How long should we pilot for?
What processes should be piloted?

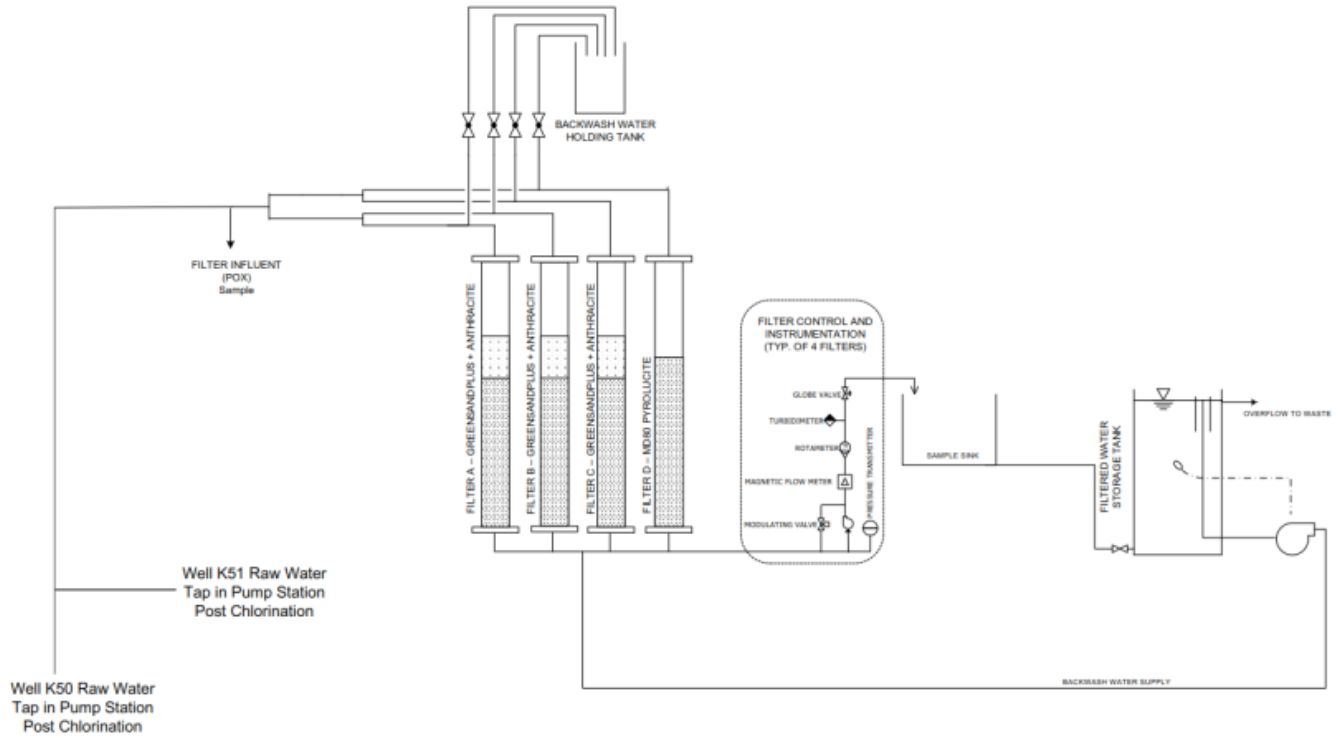
Pilot Testing Objectives

- Based on previous experience, the Region elected to complete pilot testing for conventional oxidation and filtration using manganese dioxide media and manganese dioxide coated media (GreenSand). The goals of the pilot test were:
  1. Determine the filter loading rate to meet the objective of 0.015 mg/L
  2. Compare results between two different media (manganese dioxide vs. manganese dioxide coated sand)
  3. Determine wastewater characteristics, settling rates, backwash frequency and volumes
  4. Determine the impact of recycling backwash supernatant through the filters with the raw water

Goals were confirmed and documented in a Pilot Testing Plan.

Pilot Testing Scope of Work

- 14 day run period
- Four different media configurations
  - Manganese dioxide
  - Manganese dioxide with anthracite
  - Manganese dioxide coated sand
  - Manganese dioxide coated sand with anthracite
- 3rd party tester
- Treated (chlorinated) water was tested
- Measured influent, effluent, backwash solids and supernatant concentrations
- Used effluent for backwash
- Recycled supernatant into raw water to measure performance
- Pilot testing cost at each site equaled ~$50,000, and took approximately 5 months from quotation to reporting

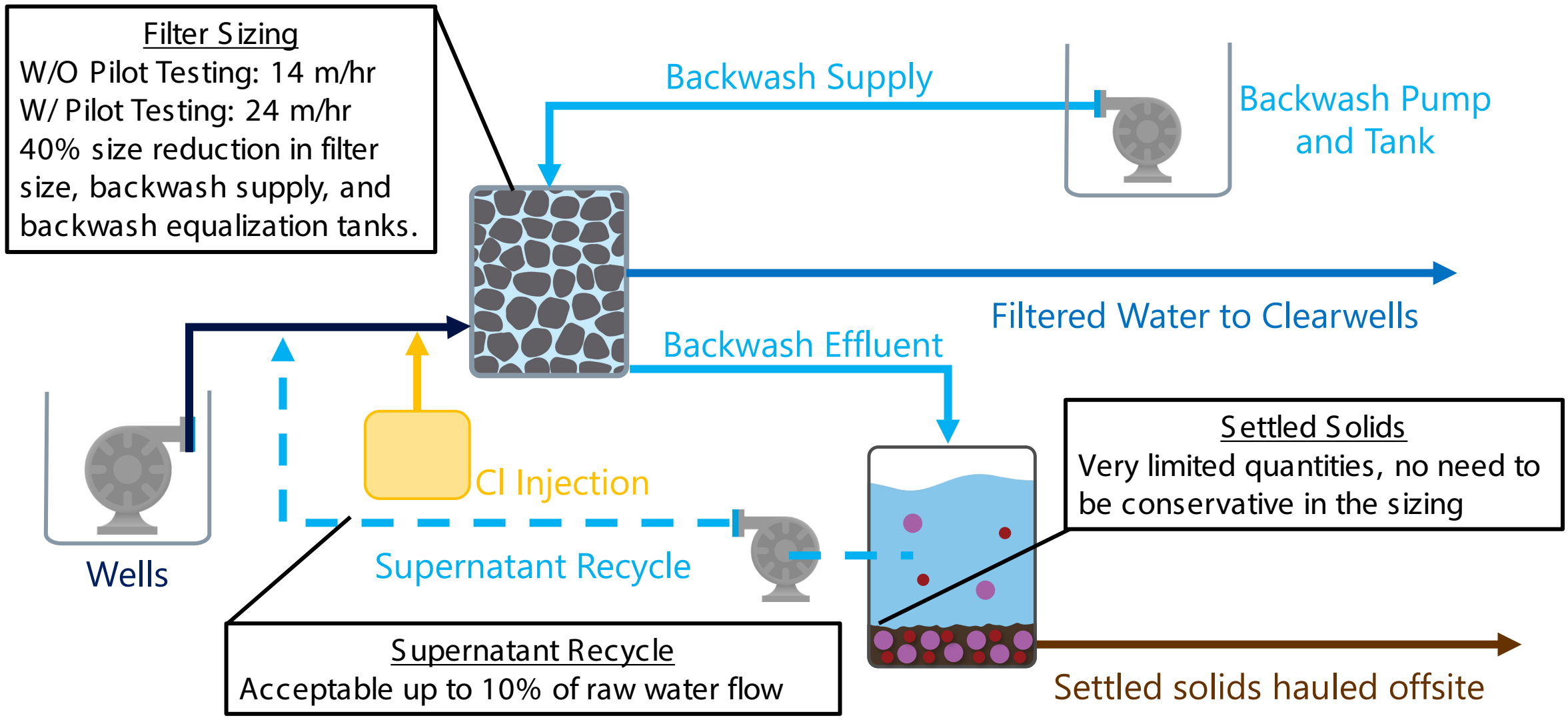


Pilot Testing – Results

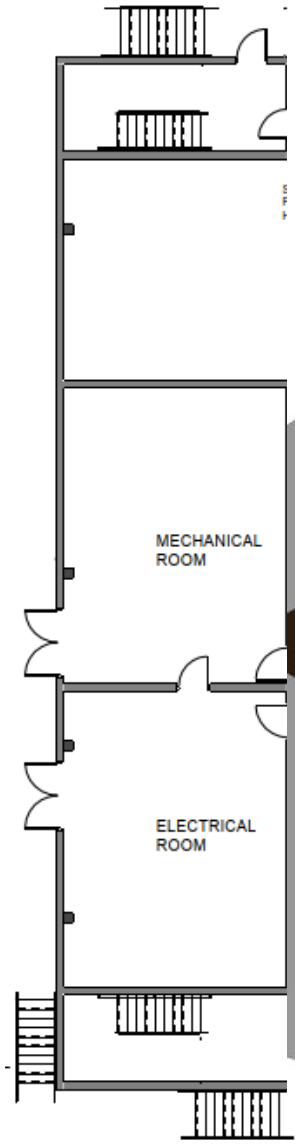
Water Supply Site	Middleton	Shingletown
Filter Loading Rate?	Up to 24 m/hr viable	Up to 24 m/hr viable
Best Media Configuration?	All performed equally	All performed equally
Did it filter down to the Target Concentration?	All media met target	All media met target
Filter Breakthrough or Terminal Headloss	None observed over 5 days of continuous run	None observed over 5 days of continuous run
Time to Settle Solids	Indeterminate, minimal solids	Indeterminate, minimal solids
Supernatant Recycling	No loss in efficiency of filtering	No loss in efficiency of filtering
Backwash Frequency	No breakthrough or headloss observed, up to best operation practices	No breakthrough or headloss observed, up to best operation practices

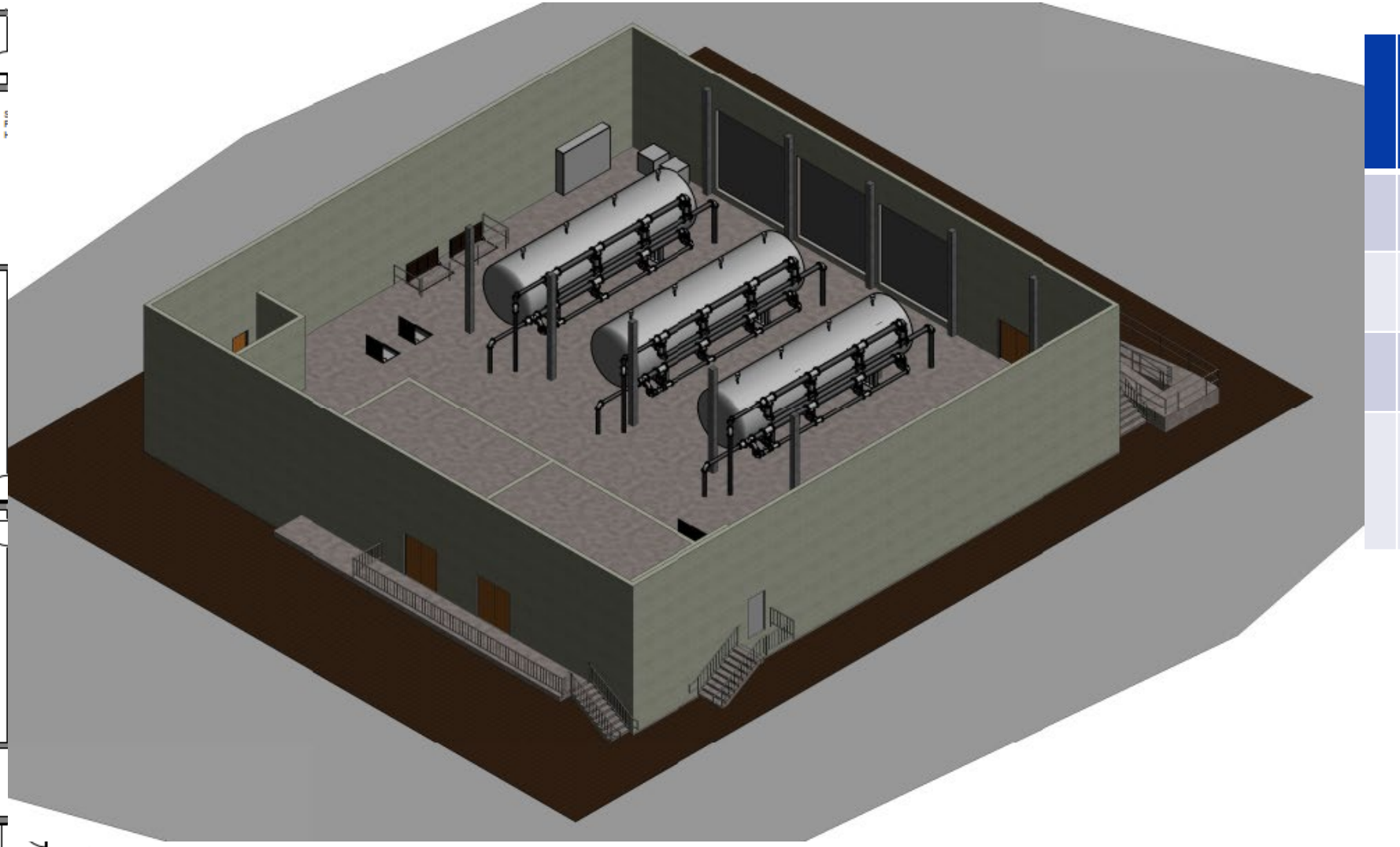
- Findings and results at both sites were summarized in pilot testing summaries, and party with 3rd party reporting

Why was the Pilot Testing a Useful Venture for these Plants?



Impacts to the Conceptual Design – Middleton WSS

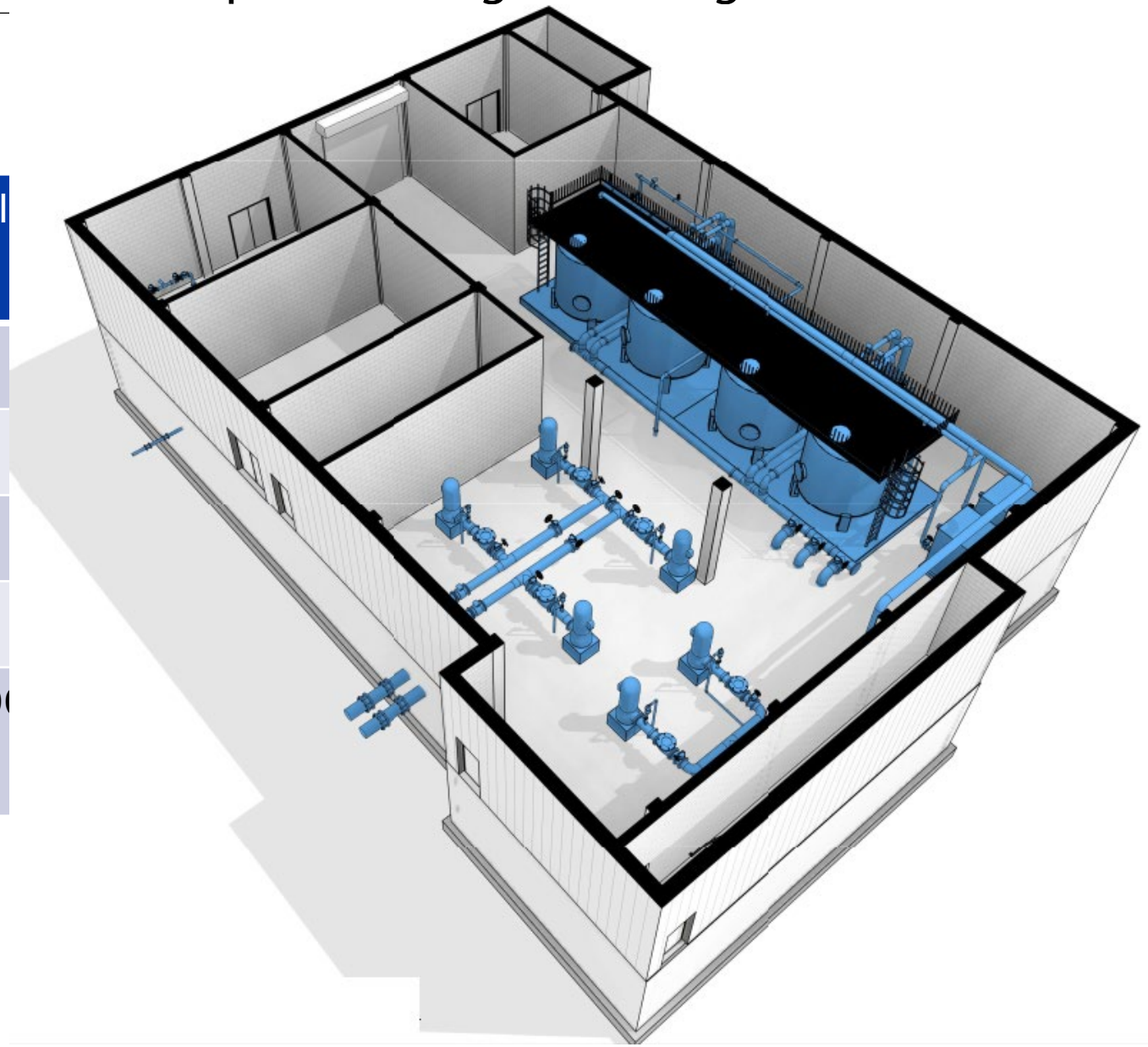


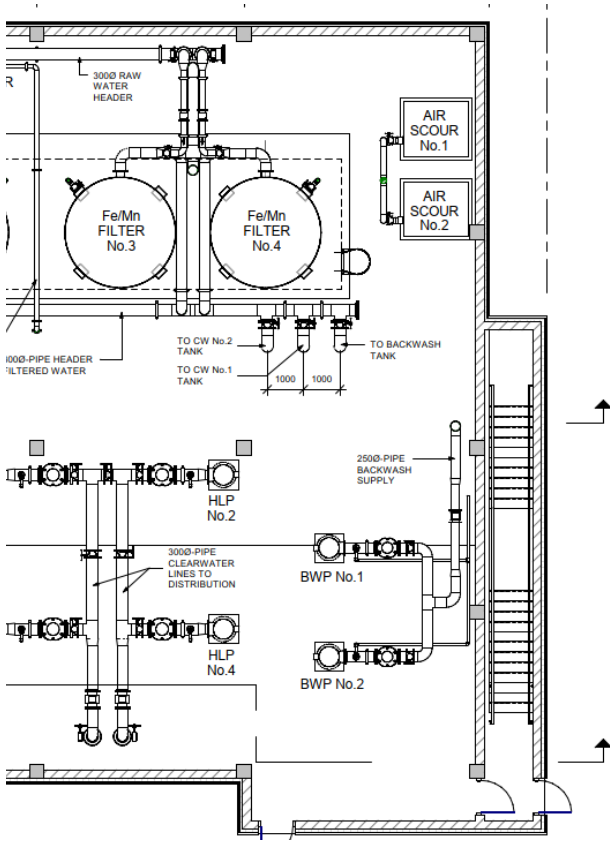


	W/O Pilot Testing
	14
	~5
	~1600
	$39,000,000 (est.)

Impacts to the Conceptual Design – Shingletown Wells

Parameter	W/ Pil
Filter Rate (m/hr)	24.4
Filter #	4
Footprint	750
Tankage (m^3)	550
Cost Estimate	$21,0





New Dundee Water Supply System

- Pilot testing not completed, why?

1. Third site, conceptual design completed after Middleton and Shingletown
2. Raw water composition from both wells was similar to Middleton and Shingletown
3. Low design flow (8 L/s)

- Prior pilot testing did however play an important role in many design aspects

1. Confidence to size filters to 14.4 m/hr (highest recommended by AWWA without pilot testing)
2. Supernatant recycling remained viable
3. Settling times and settled solids values and concentrations were carried forward with a high confidence

When Should you Pilot Test Iron and Manganese Treatment?

- Pilot testing should be considered prior to new installations of iron and manganese treatment equipment.
- The process should be completed once a preferred technology is confirmed

Why?

1. Pilot testing presents an opportunity to increase the filter loading rate beyond the industry standards, which directly impacts sizing of major components.
2. The pilot testing cost versus capital cost savings is high, and the ratio of cost vs savings increases the larger the facility.
3. Results can indicate multiple viable configurations, allowing for more options and driving competition

Conclusions

- Three conceptual designs conducted for iron and manganese treatment upgrades in Region of Waterloo.
- Pilot testing at two of the largest facilities for a preferred technology yielded positive results and provided confidence in design parameters.
- Design parameters allowed for cost savings in filter and tankage sizing, and better understanding of some operational challenges, like supernatant recycling, backwash composition, and chemical dosing
- Should be completed for greenfield facilities, possible capital cost savings versus pilot testing is high

Closing updates on the projects:

- Middleton WS treatment upgrades design to start in 2024
- Shingletown Wells treatment upgrades design to start in 2026
- New Dundee WS treatment upgrades design to start in 2030

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Questions?

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