IRON AND MANGANESE REMOVAL STUDY

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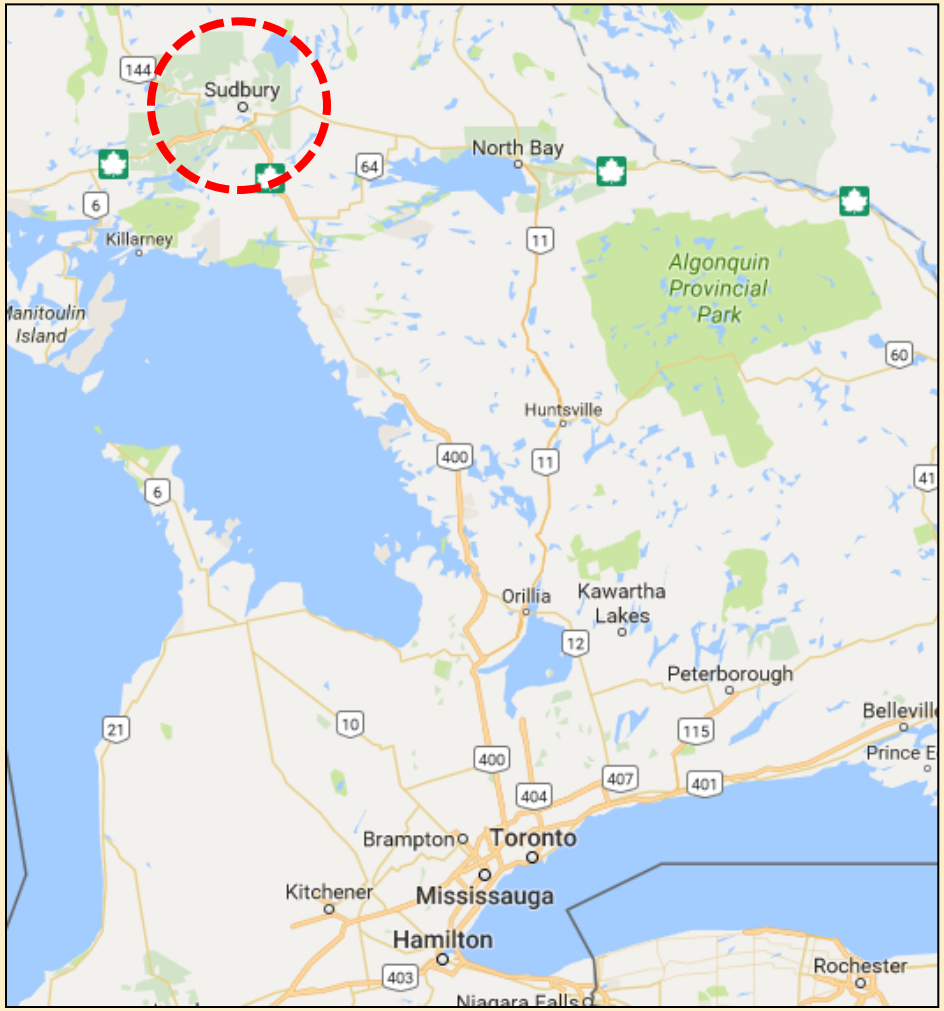
Environmental and Power Solutions Inc.

AGENDA

- Background
- Problem Statement
- Treatment Technology
- Experimental Set-up
- Experimental Results
- Future Plans

PROJECT BACKGROUND



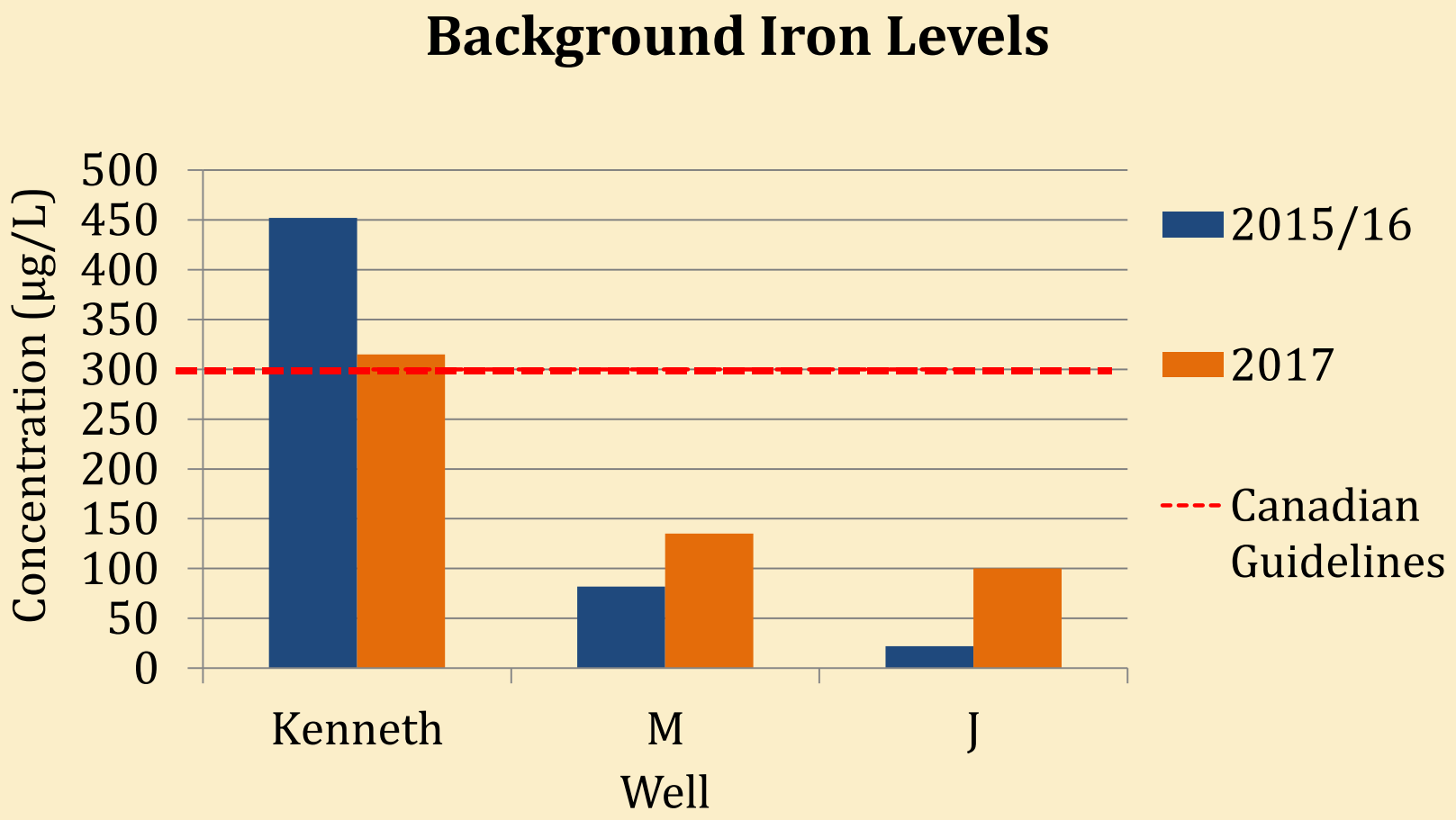
Location: City of Greater Sudbury

Capreol Wells J and M

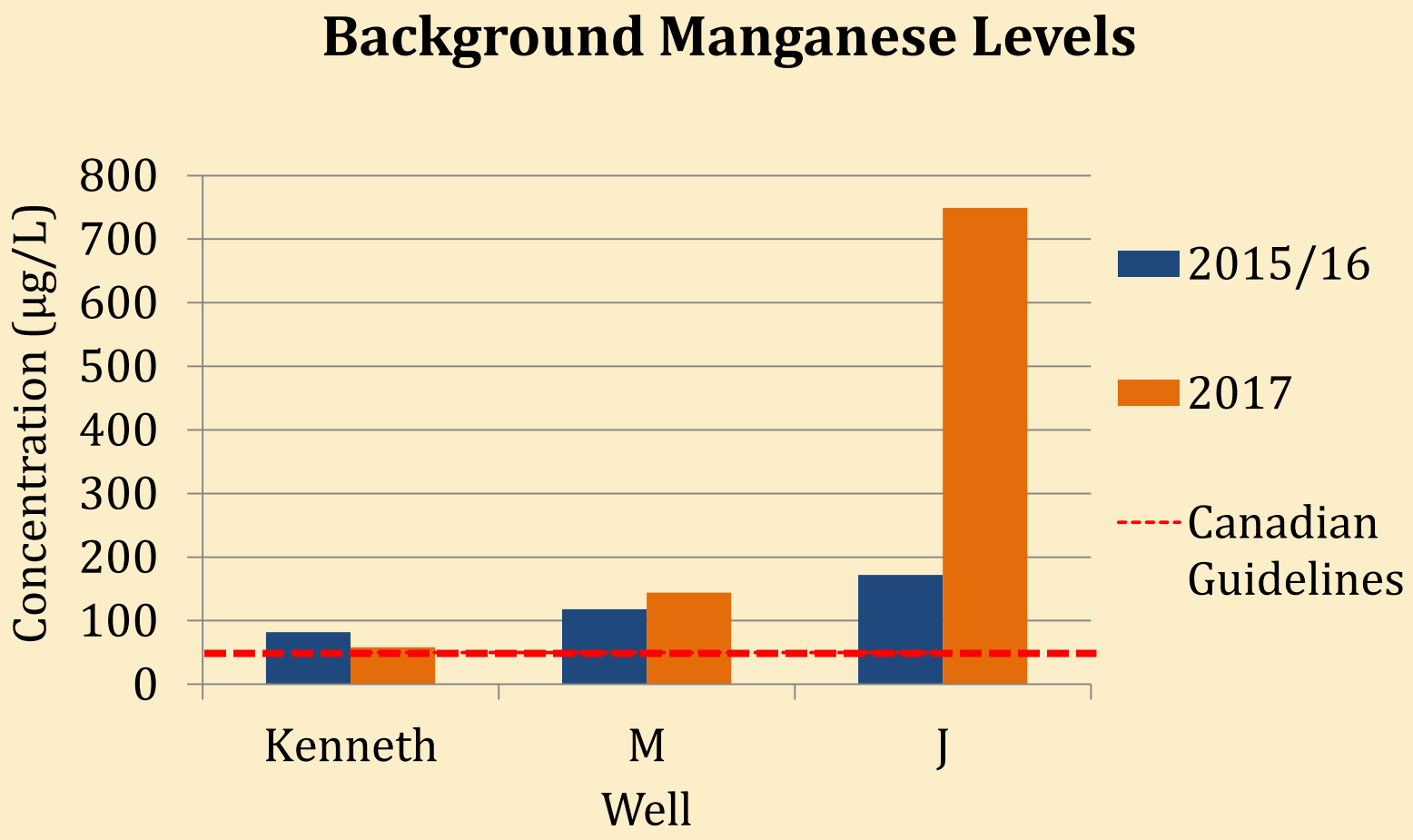
Blezard Valley "Kenneth" Well B

- Historical data and laboratory analysis indicates high levels of manganese in all three wells
- Kenneth Well B exhibits extremely high iron levels

PROJECT BACKGROUND (CONTINUED)



PROJECT BACKGROUND (CONTINUED)



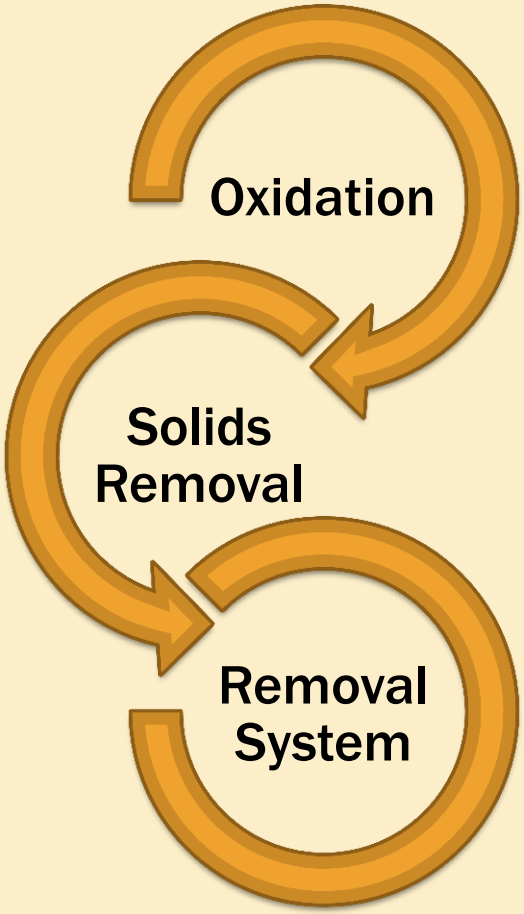
PROBLEM STATEMENT

Reduce elevated levels of iron and manganese to provide a better quality drinking water in the City of Greater Sudbury municipal water treatment and supply system

Iron Staining

Iron and Manganese Staining

TREATMENT TECHNOLOGY



Oxidation is used to transform soluble iron and manganese into insoluble metal oxides which precipitate out of the water.

Solids Removal is used to separate the oxidized iron and manganese particles out of the drinking water stream.

TREATMENT TECHNOLOGY (CONTINUED)

- Well
- Reservoir
- Creek/River

- Aeration
- Chlorine
- Potassium Permanganate
- Sodium Permanganate
- Chlorine Dioxide
- Ozone

- Conventional Sedimentation
- Solids Contact Clarification
- Plate Settlers
- Tube Settlers
- Ballasted Flocculation

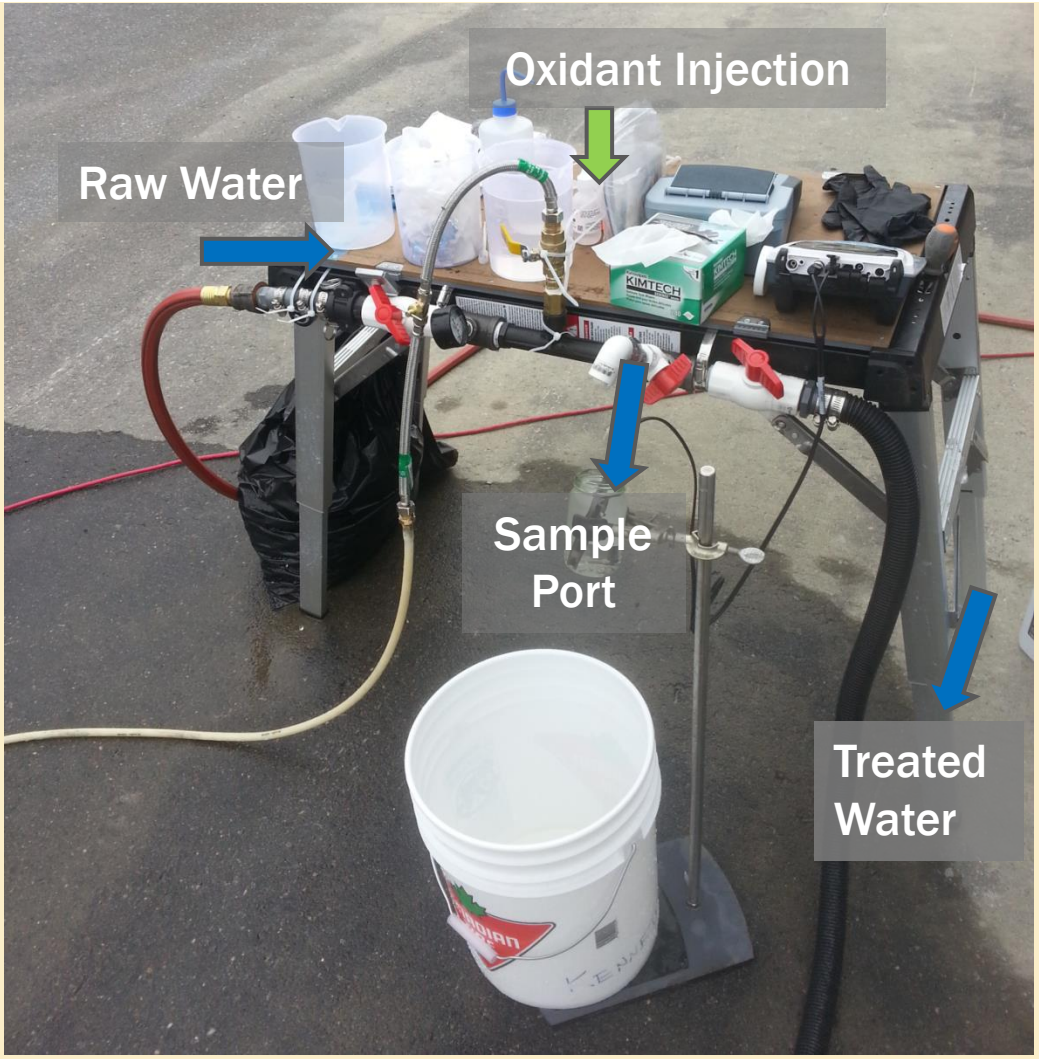
- Dual Media
- Greensand
- Ion Exchange
- MnO2 Coated Media
- MnO2 Ore
- Hollow-Fiber Membranes
- Spiral Membranes
- Ceramic Membranes
- Biological Filtration

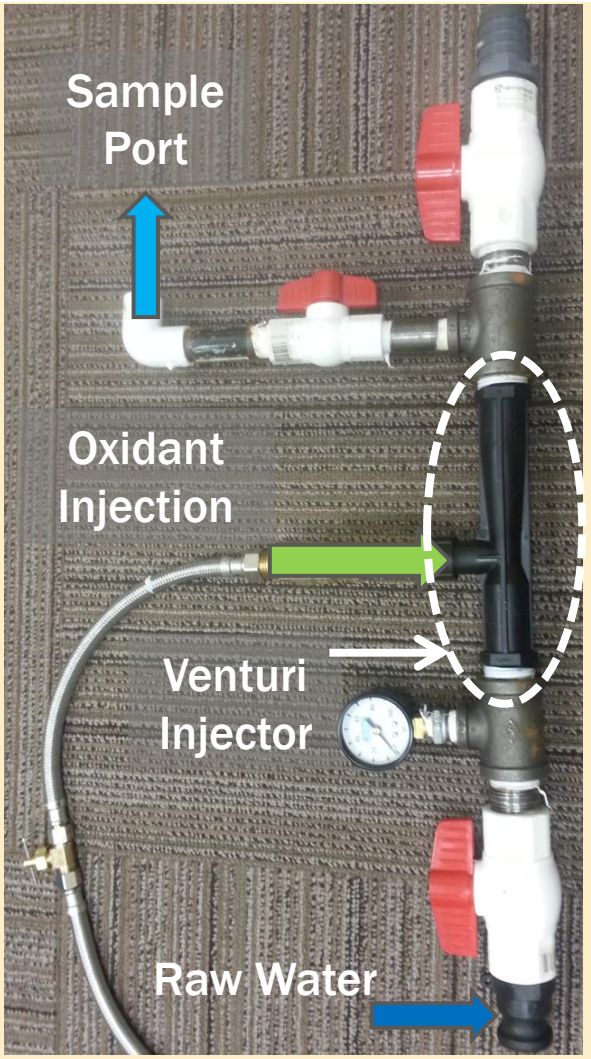
- Direct Discharge to Sewer
- Equalization and Sewer
- Lagoons and Sand Drying Beds
- Mechanical Dewatering

METHODOLOGY AND APPROACH

- **Task 1 – Background Information and Data Review**
- **Task 2 – Well Water Quality Evaluation**
- **Task 3 – Experimental Work Plan**
  - ***PHASE I – Oxidation Assessment***
  - ***PHASE II – Solids Removal***
  - ***PHASE III – Pilot-Scale Treatability Study***
  - ***PHASE IV – Preliminary Engineering Design***
    - Process Flow Diagram (PFD).
    - Unit process design criteria.
    - Process operating strategy for the proposed system.
    - Preliminary facility site plan.
    - Capital and operating cost estimates.
- **Task 4 – Project Report and Analysis**

EXPERIMENTAL SET-UP





EXPERIMENTAL RESULTS

Oxidant Testing

Well: Kenneth		Reduction (%)	
		Iron	Manganese
Oxidant	Dosing Rate	Background: 315 µg/L	Background: 82 µg/L
Ozone	Low Flow	98	53
	5 SCFM	95	58
	15 SCFM	92	55
Chlorine Dioxide	0.5 ppm	10	6
	1 ppm	43	4
	2 ppm	13	5
	4 ppm	-	-

EXPERIMENTAL RESULTS (CONTINUED)

Oxidant Testing

Well: M		Reduction (%)	
		Iron	Manganese
Oxidant	Dosing Rate	Background: 135 µg/L	Background: 144 µg/L
Ozone	Low Flow	37	53
	5 SCFM	37	58
	15 SCFM	63	35
Chlorine Dioxide	0.5 ppm	-	-
	1 ppm	15	2
	2 ppm	7	10
	4 ppm	-	-

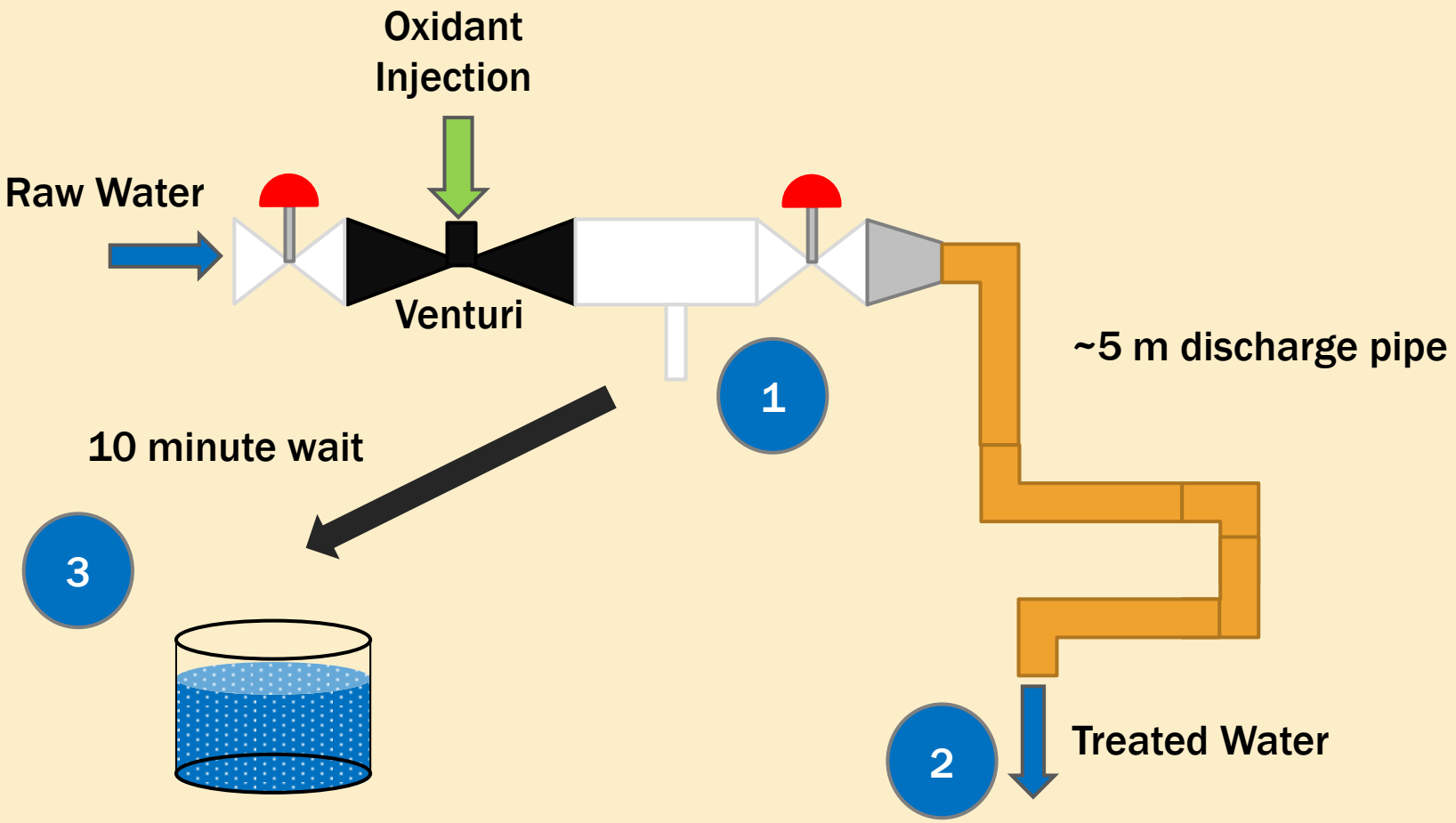
EXPERIMENTAL RESULTS (CONTINUED)

Oxidant Testing

Well: J		Reduction (%)	
		Iron	Manganese
Oxidant	Dosing Rate	Background: 100 µg/L	Background: 749 µg/L
Ozone	Low Flow	-	-
	5 SCFM	-	-
	15 SCFM	100	72
Chlorine Dioxide	0.5 ppm	-	-
	1 ppm	-	-
	2 ppm	-	-
	4 ppm	0	34

EXPERIMENTAL RESULTS (CONTINUED)

Effects of Contact Time



EXPERIMENTAL RESULTS (CONTINUED)

Effects of Contact Time

Well J			
Sample Locations	After Venturi 1	Outlet Pipe End 2	After 10 min 3
Oxidant: Ozone			
Percent Reduction (%)			
Fe	100	100	100
Mn	72.3	79.2	80.7
Oxidant: Chlorine Dioxide			
Percent Reduction (%)			
Fe	0.0	0.0	94.7
Mn	35.7	73.4	93.4

EXPERIMENTAL RESULTS (CONTINUED)

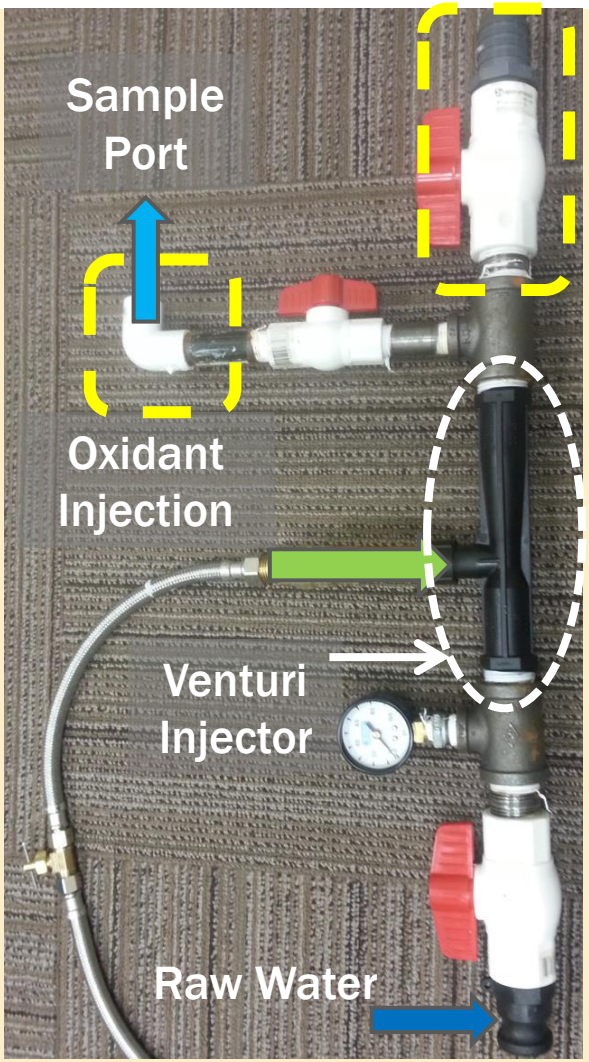
Batch Testing

Well J	10 minutes of Ozone	10 minutes of Ozone, 7 minutes rest, 10 minutes of Ozone
Percent Reduction (%)		
Fe	100	68.4
Mn	79.4	95.0

Well J	2 ppm, Rest for 10 minutes	2 ppm, Rest for 20 minutes
Percent Reduction (%)		
Mn	24.7	11.0

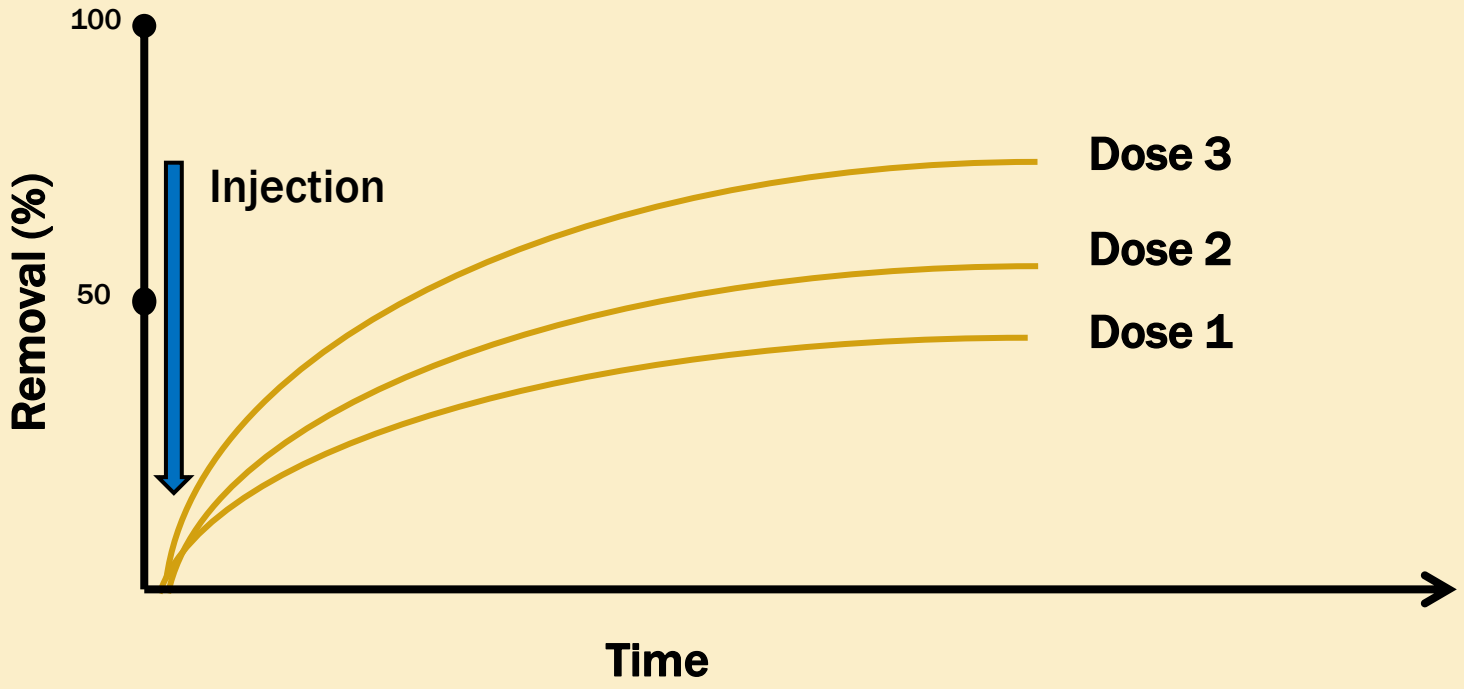
FATE OF SOLIDS

- It is important to determine where solids are settling out
- Solid film was observed directly after the venturi injector



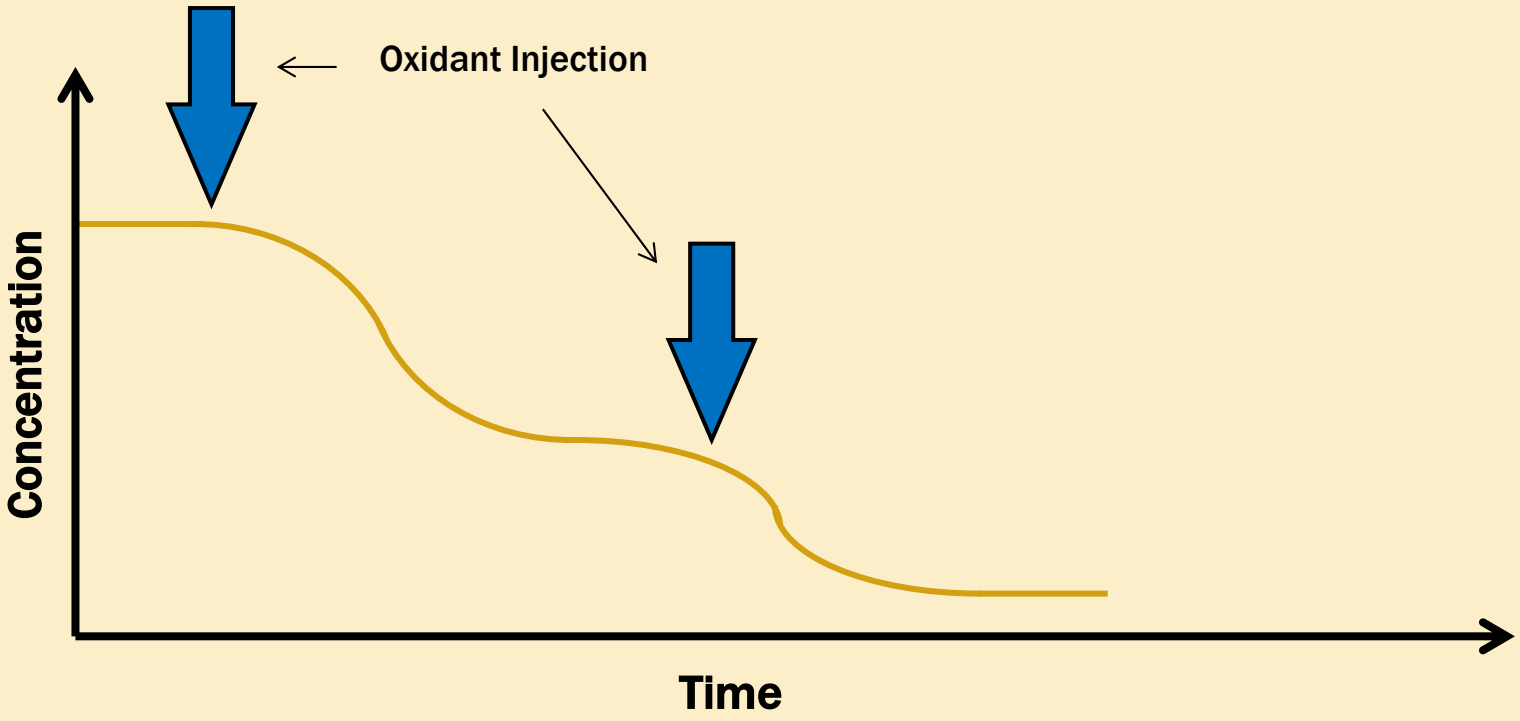
FUTURE PLANS

- Pulse Verses Continuous Injection
- Time-Concentration curves
  - How does the removal efficiency improve with increased injection time?



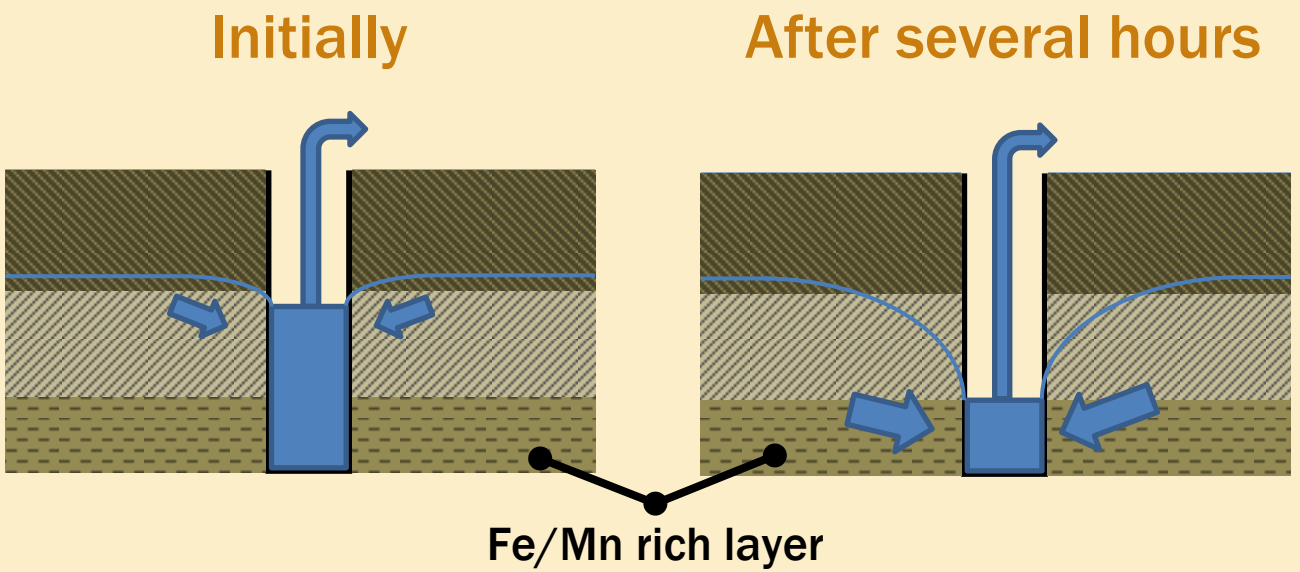
FUTURE PLANS (CONTINUED)

- What are the effects of multiple injections?



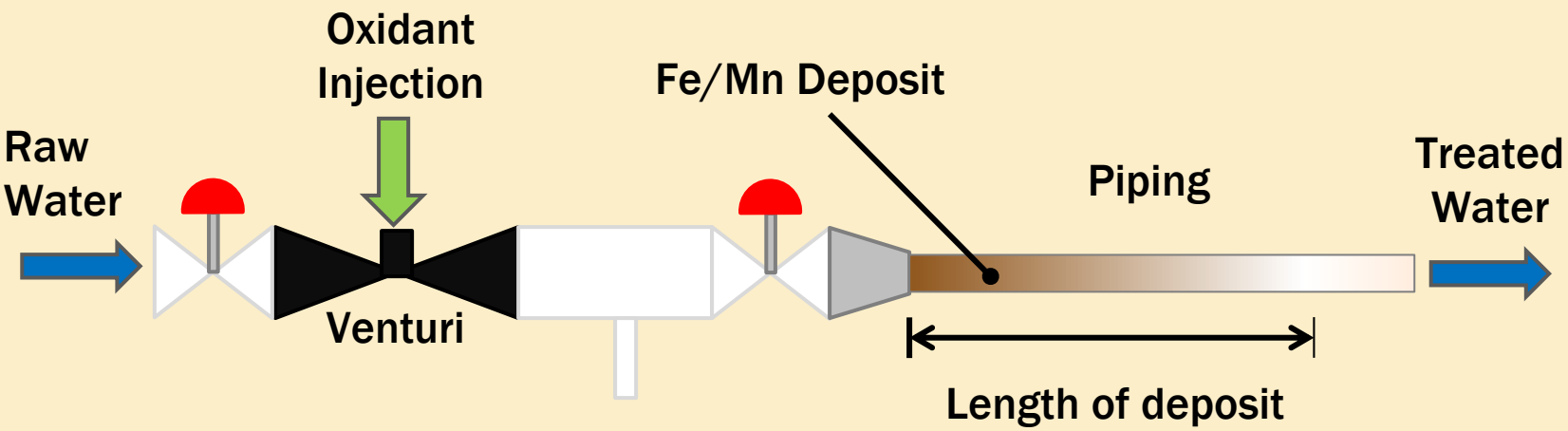
FUTURE PLANS (CONTINUED)

- How do the iron and manganese levels change with well level and flowrate?



FUTURE PLANS (CONTINUED)

- Where are the solids settling out and is there a need for a filter at a particular position?



THANK YOU!

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