

Mishezula Lake Water System Improvement Project

Conceptual Design Phase: Update to the Community before selecting an option and moving to detailed design

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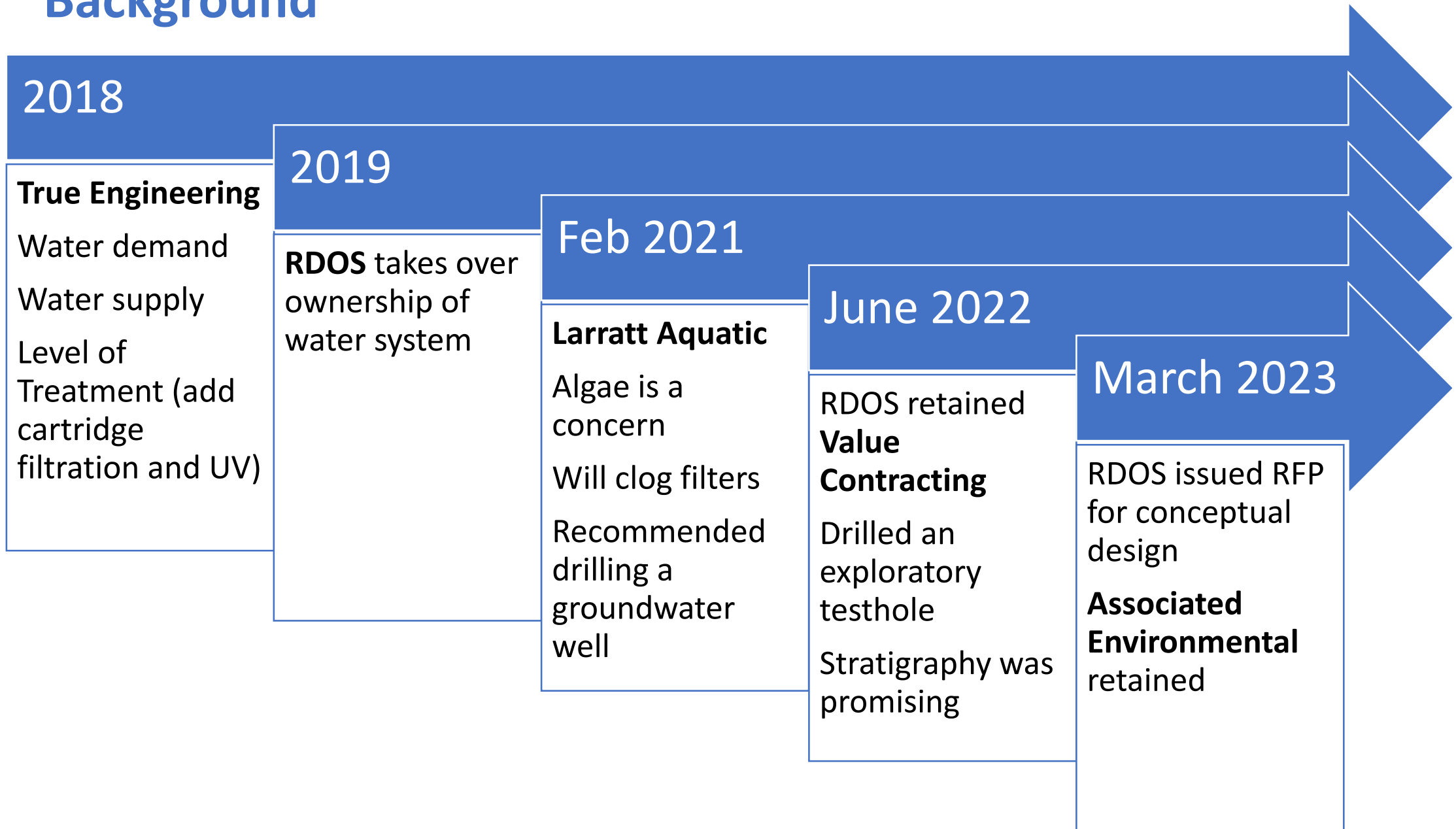


Presentation Outline

- Why the project (objective)
- What has been done to date
- Well drilling and pumping test results
- Treatment Options
- Recommendations
- Next steps



Background



Project Objectives: Water Source and Treatment

“What is the **best water source and treatment option** to meet Interior Health drinking water treatment objectives, knowing that we need to **address algae?**”

“How do we **incorporate treatment for algae into the successful funding grant and borrowing limits** as a constraint?”

Algae

- Larrat Aquatic (2021) described the lake ecosystem
- "High algae densities during the late summer and early fall ... increased raw water turbidity above 1 NTU"
- Blue-green algae (potential toxin-producers) are present, but not in concerning numbers
- Diatom algae can significantly reduce filtration efficiency, particularly during the spring bloom (June-July)

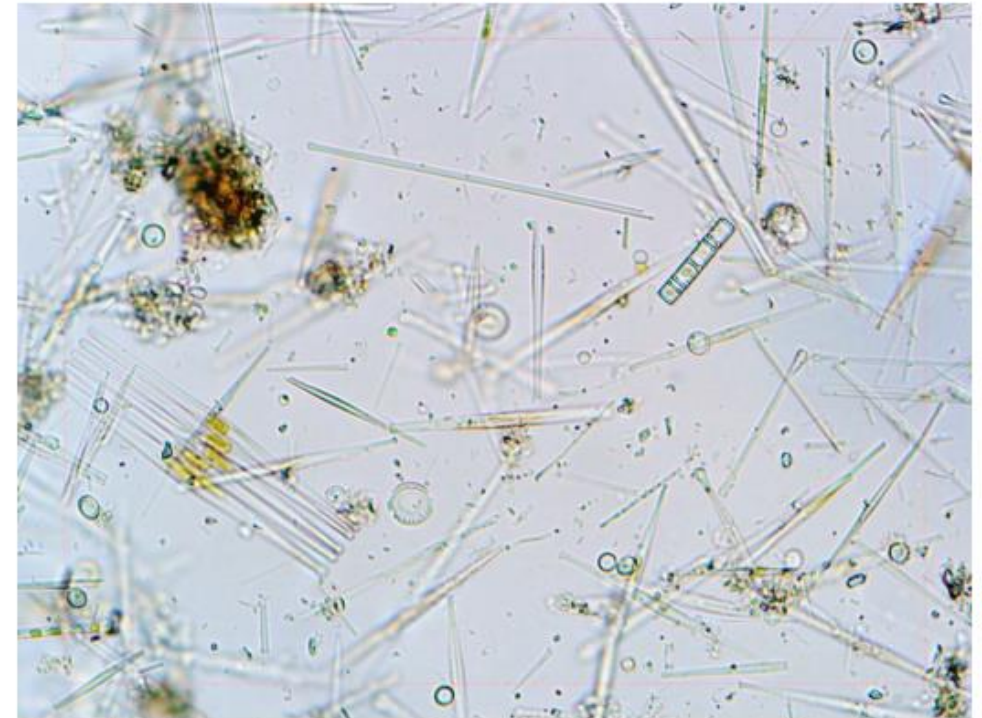


Figure 17: Diatom algae removed from clogged drinking water filter

Associated's Work to Date

Sept 19 2023

Attempted to sample from existing well – **pumped sand.**
Drilled a second well.

October 17 2023

Pumping test
Well yield **did not meet maximum day demand**
Groundwater quality **exceeded guidelines** for manganese and high TDS
Required a pivot to re-evaluate lake

November 2023

Brought in **engineering**
Contacted suppliers to **add DAF and switch from cartridge filters to a vessel filter**

April 2024

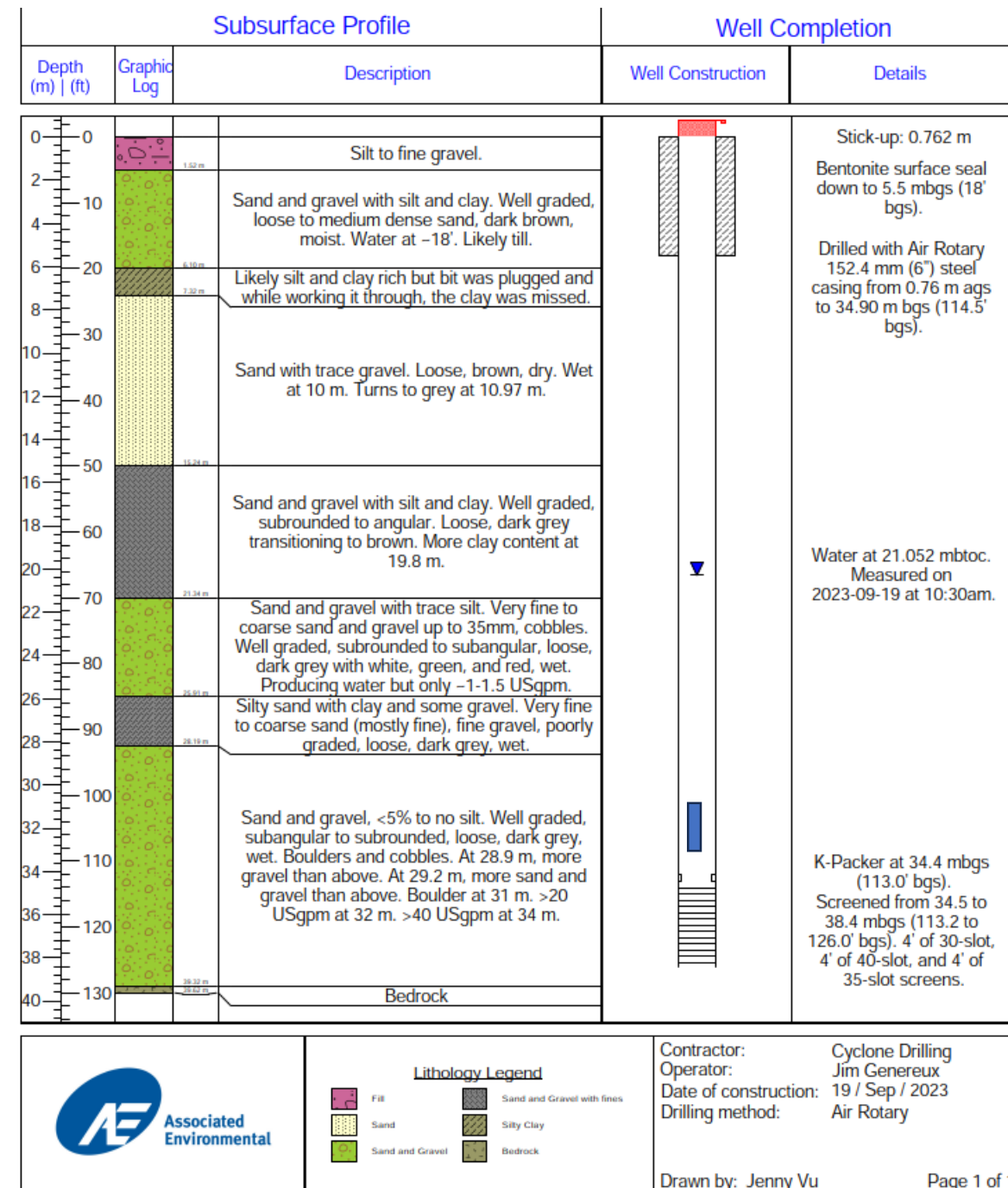
Budgets came in **really high \$5-6M!**
Went back to suppliers with a new adjusted “ask”:
“What volume can you flow through a package plant within budget constraint?”

July 2024

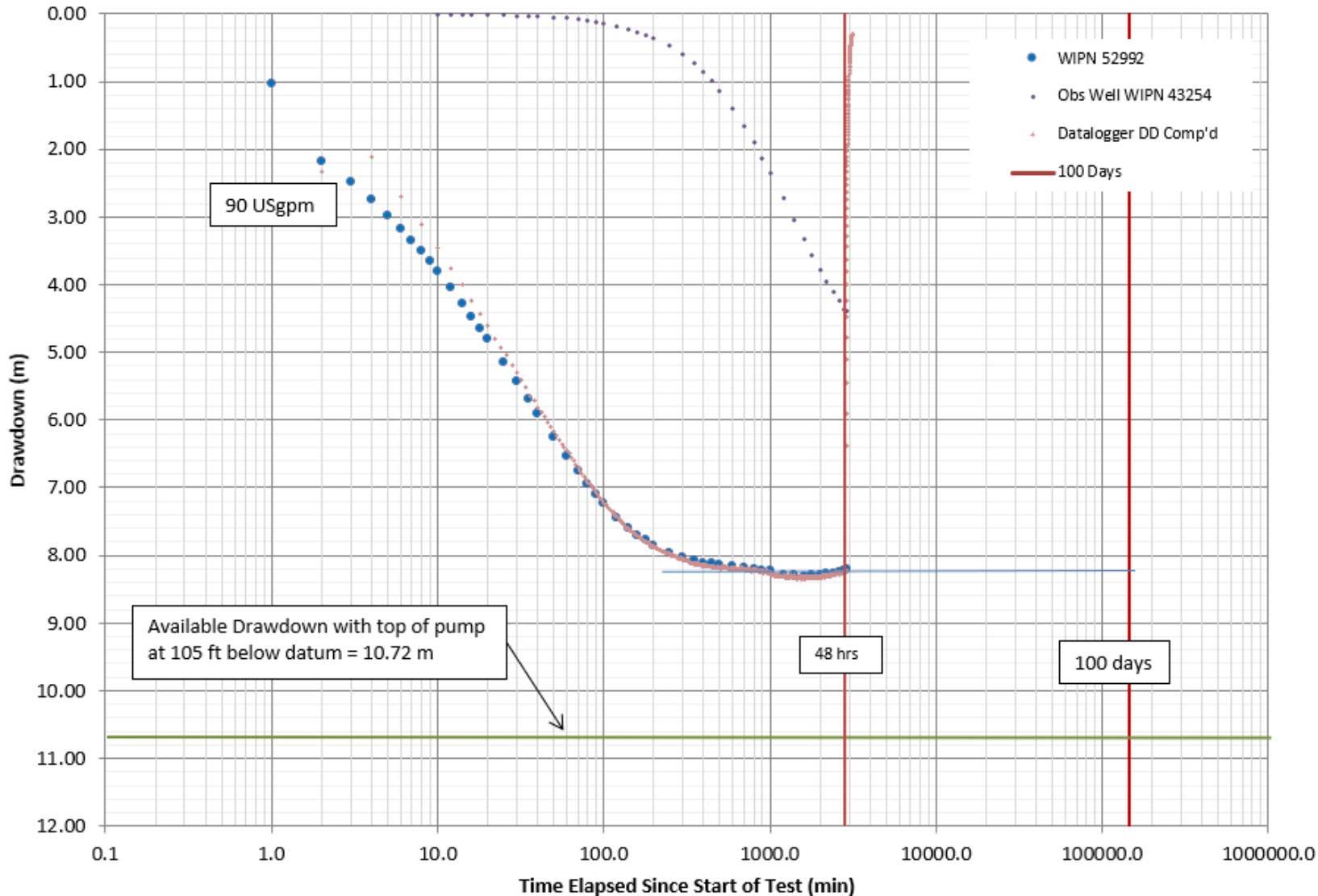
Residual management and dilution modeling
Reviewed other risks/project constraints
Summary of options

Groundwater Well Drilling and Testing Results

- Stratigraphy:
 - 0-26 m: SAND
 - 26.19-28.19m: Sand with silt and clay (aquitard)
 - 28.19-39.62m: SAND and GRAVEL AQUIFER (11.43 m thick)
 - 39m: Bedrock
- Screened from 113-126 ft (34.5-38.4 m) deep. Static water level: 20.63 mbgs. Available drawdown: 10.7m (with top of pump set at 31.3 m bgs)
- 4 m of screen: 30 and 40 slot, gives a theoretical screen transmitting capacity: 220-230 USgpm (13.9-14.5 L/s) but the driller's air lift test was at 90 USgpm (5.7 L/s)



Groundwater Quantity – Pumping Test

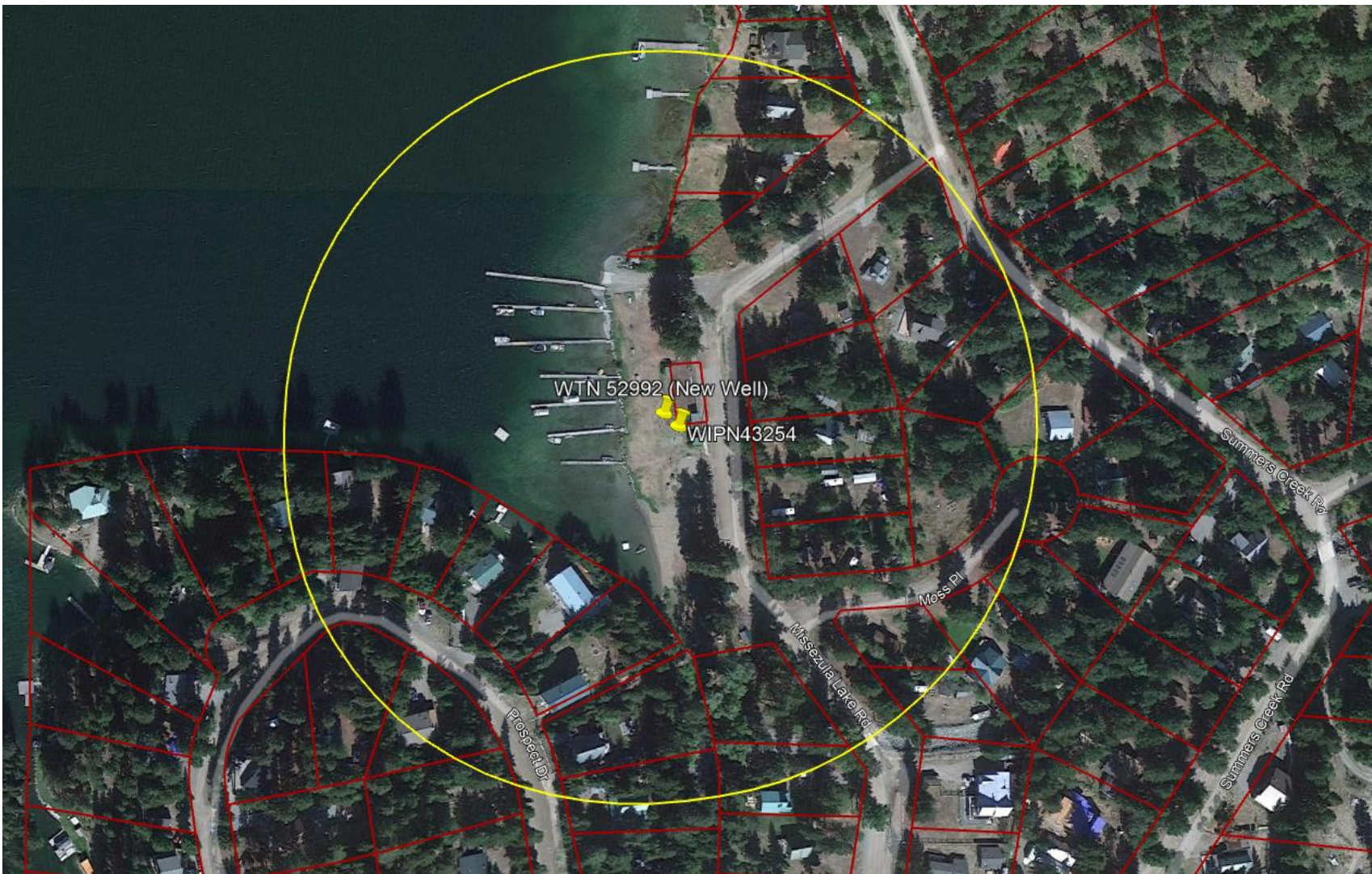


- Test pumping rate: 90 USgpm (5.7 L/s)
- Water level stabilizes (flat lines) indicating recharge to the aquifer
- Response indicates a leaky aquifer, i.e., recharge is from an upper aquifer
- Limited available drawdown (10.7m) due to low static water level and thin aquifer
- Sustainable well yield calculated to be 81.5 USgpm (5.1 L/s) with 30% safety factor

Well yield (groundwater availability) compared to Demand

Unit	m³/d	USgpd	USgpm	L/s	Notes
Water Demand					
ADD	284	75,000	52.1	3.29	From True 2018 report page 11.
MDD	776	205,000	142.4	8.98	From True 2018 report page 11. This is what you aim for wells to achieve. Based on 190 lots x 4 persons/lot x 350 lpcd, plus some allowance for water loss and outdoor watering.
PHD	1080	285,300	198.1	12.50	From True 2018 report page 11.
2023-07-31 Actual flow	950	250,964	174.3	11.00	From RDOS records. RDOS looking into the reason for high flow the summer of 2023.
1.5 times MDD	1164	307,500	213.5	13.5	Industry standard for pumping tests (from ISC guideline - probably best guideline on this topic in BC)
Water Supply/Groundwater Availability					
Water licence	444.379	117,393	81.5	5.14	This is averaged over the whole year, so reasonable to assume the community will stay under this volume since only a dozen homes or so in winter.
New well yield	441.482	116,640	81.0	5.10	The newly drilled well sustainable well yield with 30% safety factor. A second well with similar yield, would be needed to meet MDD (combined would be 162 USgpm, or 10.20 L/s), but no room for a second well.

Groundwater Quantity – Well Interference and Second Well Location



- Estimated well interference from pumping test to determine where a second well could be placed
- Location about 150 m away estimated to have 2.5 m drawdown
- If second well constructed here (assuming identical aquifer) nearly all available drawdown used if both wells pumping

Groundwater Quantity – Second Well Location

Limited options to north due to lake and distance to aquifer boundary



Raw Water Quality

Parameter	Surface Water Samples	Groundwater Samples	GCDWQ Objective
Turbidity	0.61 – 1.07 (Ave 0.84)	0.88 – 1.21 (Ave 1.045)	< 1.0
Hardness (mg/L as CaCO ₃)	133 – 146 (Ave 140)	464 – 583 (Ave 527)	See note
Algae	Present in summer	-	-
Total Iron (mg/L)	< 0.01	0.19 – 0.20 (Ave 0.19)	≤0.3
Total Manganese (mg/L)	0.001 – 0.002 (Ave 0.002)	0.13 – 0.16 (Ave 0.15)	≤ 0.02 (AO) ≤ 0.12 (MAC)
Total Dissolved Solids (TDS; mg/L)	165 – 187 (Ave 176)	708	≤500

AO = aesthetic based standard, not health-based

MAC = health-based standard

Note: Not official limit for hardness, though hardness > 500 is considered very hard

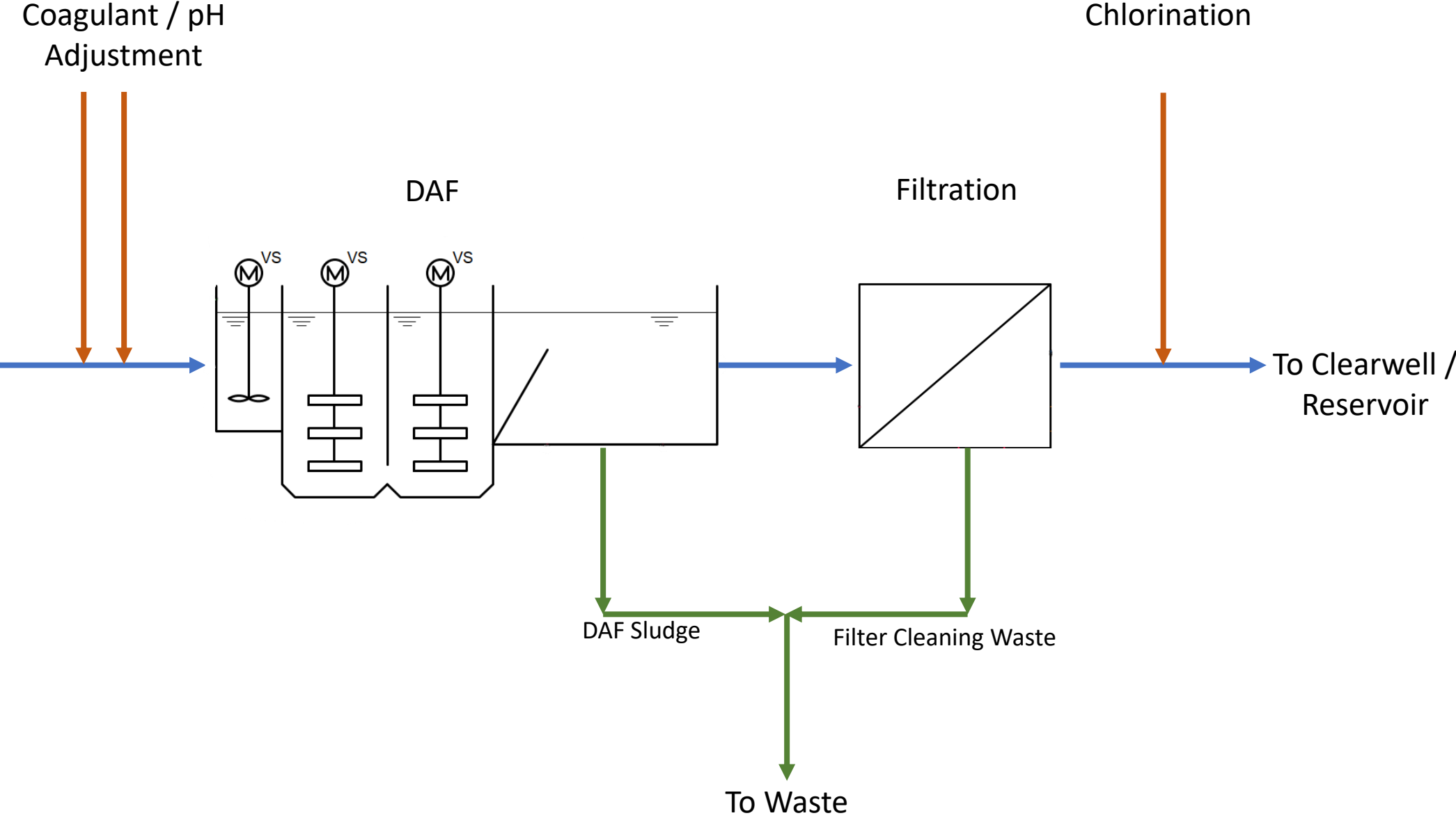
Treatment Objectives

Option	Surface Water	Groundwater
Treatment for Microorganisms	<i>Cryptosporidium</i> <i>Giardia</i> Viruses	Viruses
Treatment for Physical / Chemical Parameters	Turbidity Algae	Manganese
Other Physical / Chemical Parameters	-	Hardness TDS

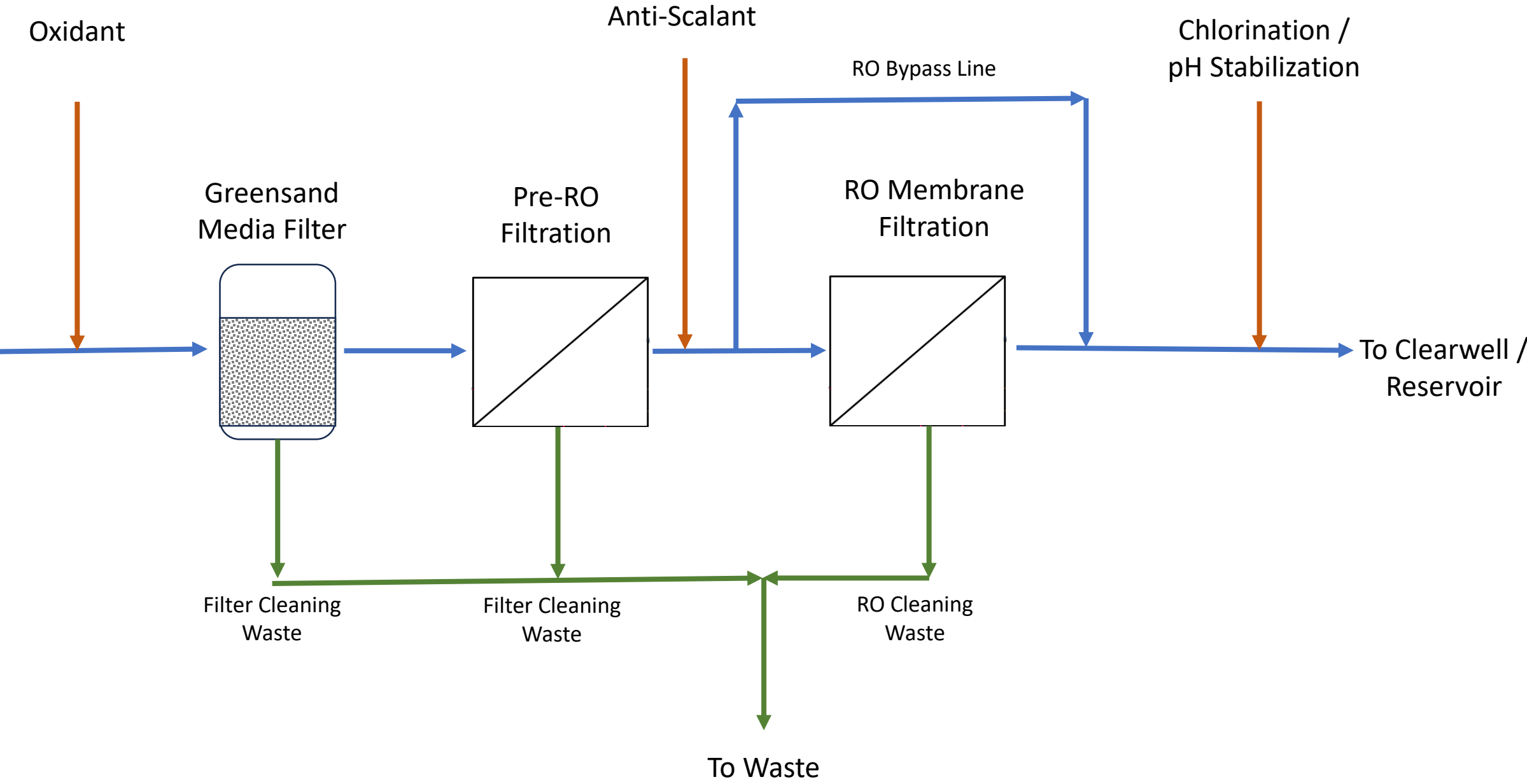
Hardness and TDS

- Hardness: 527 mg/L as CaCO₃ (Health Canada 1979)
 - Over 500 mg/L is considered very hard. 17 out of 525 cities in Canada had hardness above 500 mg/L (Ont and Sask)
 - No aesthetic or health-based guideline but guidelines states “Those in excess of 500 mg/L are unacceptable for most domestic purposes”
 - Leads to scaling of hot water pipes, boilers and other household appliances
 - Increases soap consumption
 - Water softener can be used to reduce hardness but due to sodium a separate unsoftened supply is recommended for drinking and cooking purposes
- TDS: 708 mg/L (Health Canada 1991)
 - Aesthetic objective is 500 mg/L.
 - Above that can cause scaling and can change taste and odour
 - <600 mg/L considered to be “good” palatability, >1200 mg/L “unpalatable” to most

Option 1 – Surface Water: Typical Treatment



Option 2 – Groundwater: Typical Treatment

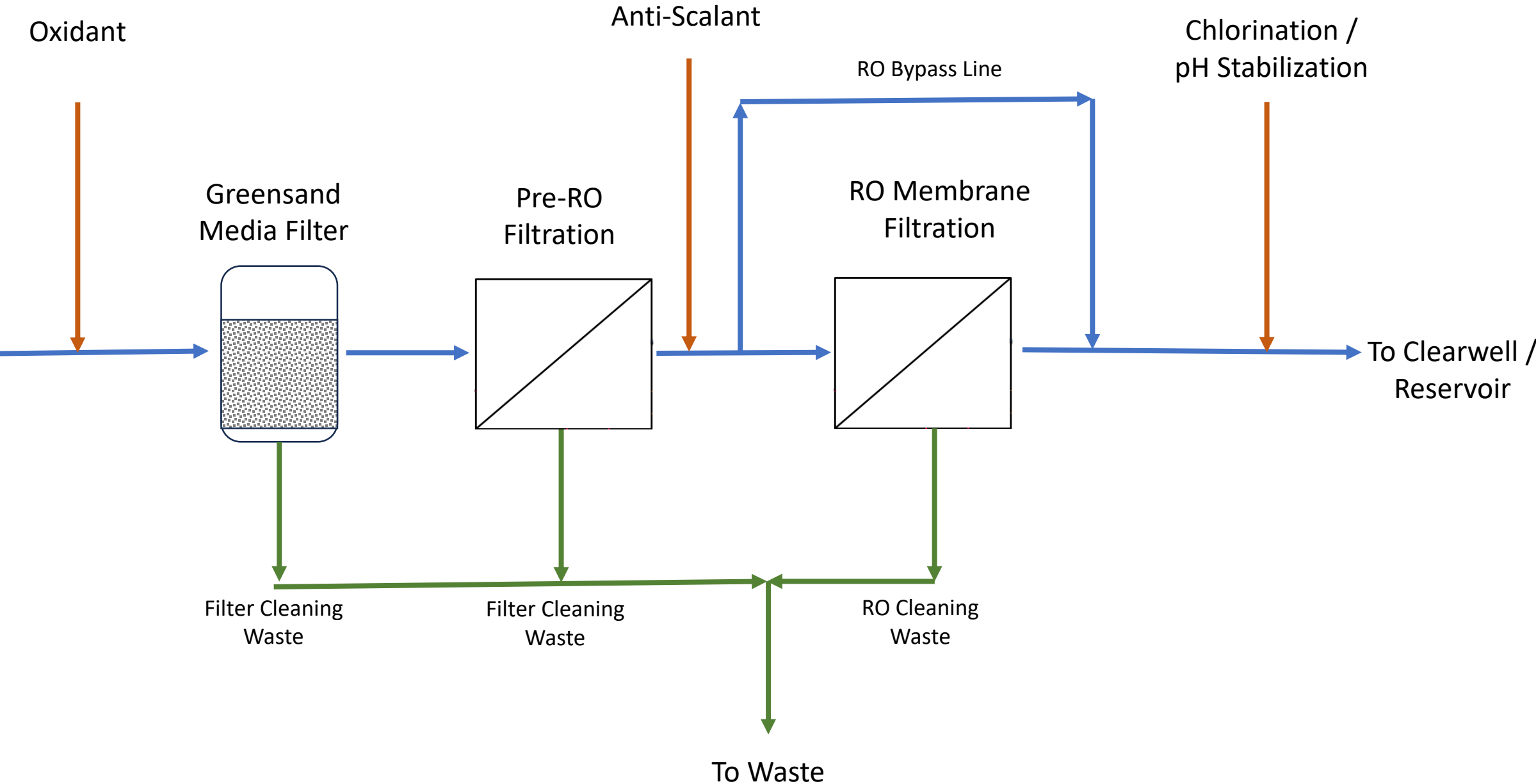


Capital Cost Constraints (WTP only)

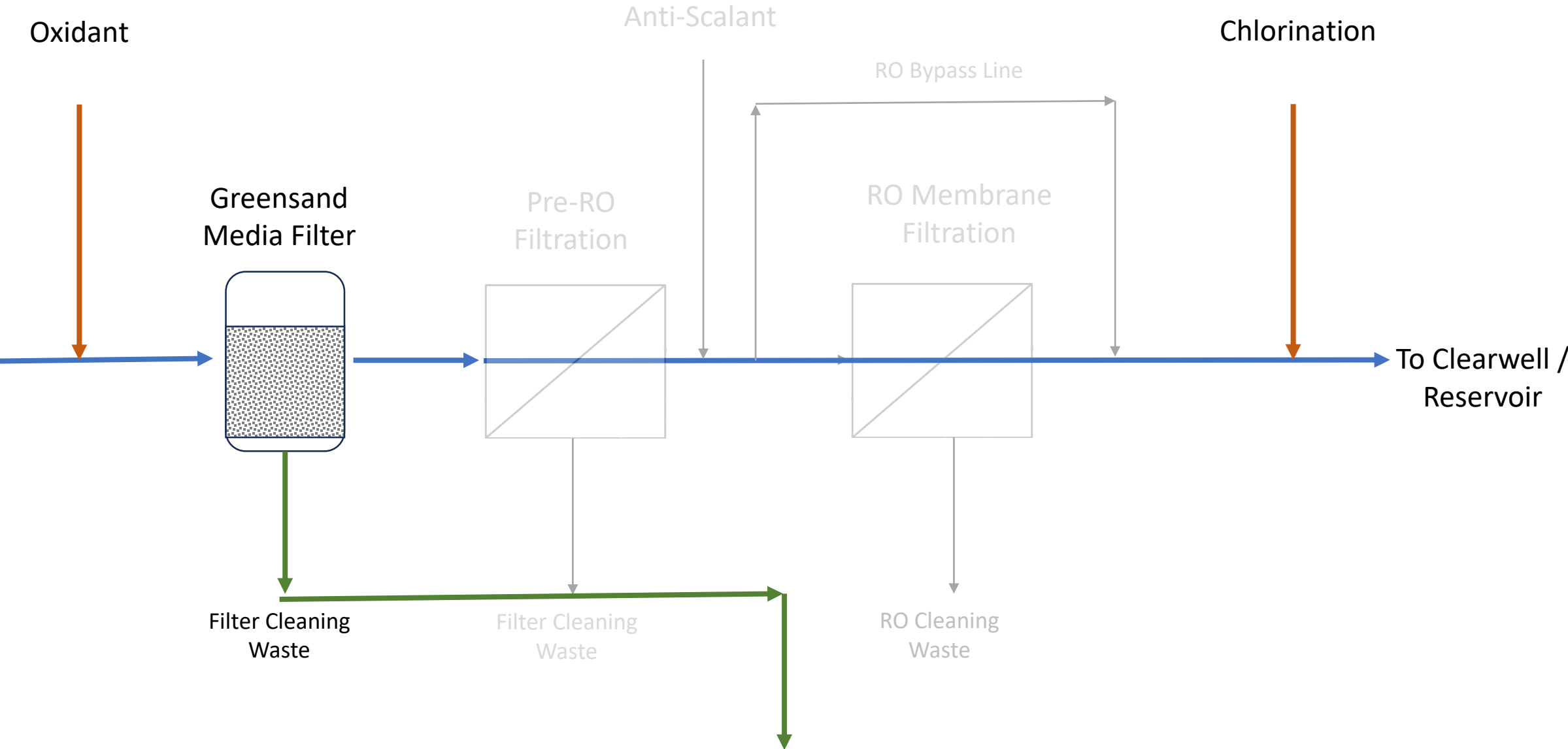
Water Source	Option 1 – Surface Water	Option 2 - Groundwater
Design Flowrate	11 L/s	11 L/s
Housing	New building, built on site	New building, built on site
Redundancy	N+1 for all equipment	N+1 for all equipment
Capital Cost (OPC – Class “D”)	\$4.8 m	\$5.0 m
30% Engineering & Contingency	\$ 1.4 m	\$1.5 m
Total Estimate	\$6.2 m	\$6.5 m
Cost per Flow (\$ per L/s)	\$564,000 / L/s	\$591,000 / L/s

Note: Class “D” Opinion of Probable Cost accurate to +/- 50%

Option 2 – Groundwater: Typical Treatment



Option 3 – Groundwater (Simplified)
(TDS and hardness not addressed)



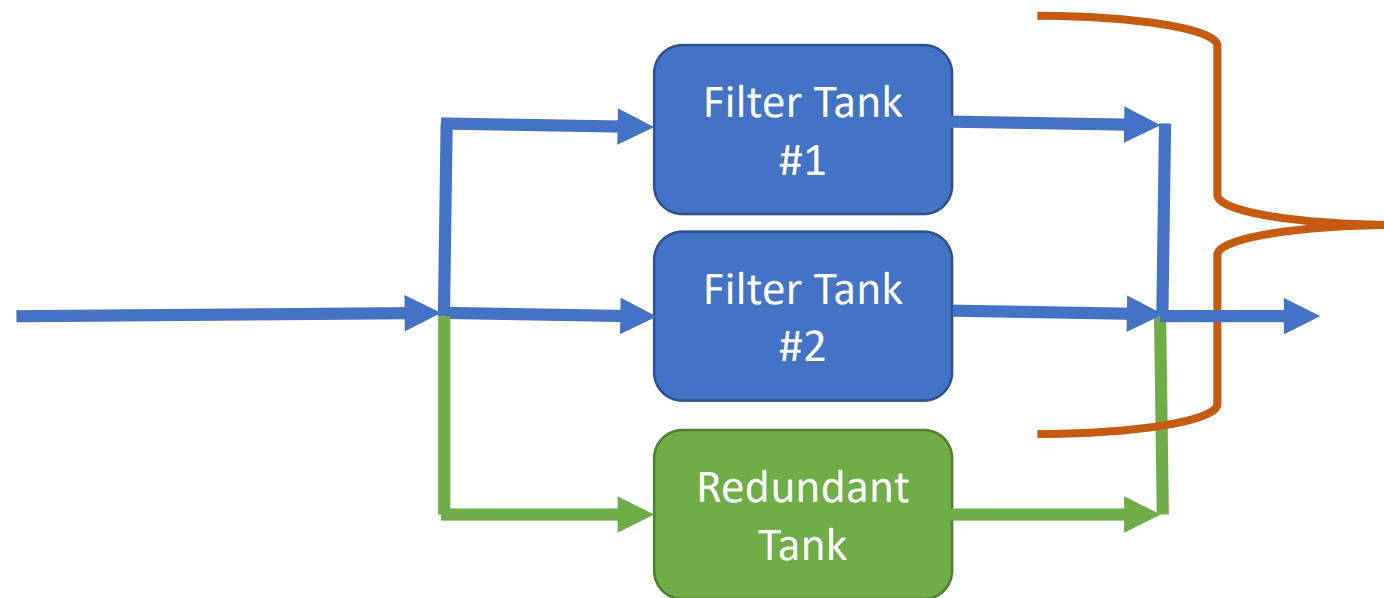
What can we do?

Water Source	Revised Option 1 – Surface Water	Revised Option 2 – Groundwater	Revised Option 3 – Groundwater (Simplified)
Design Flowrate	~~11 L/s~~ 7.6	~~11 L/s~~ 8.6 (Well restricted to 5.1 L/s)	11 L/s (Well restricted to 5.1 L/s)
Housing	~~New building, built on site~~ Prefab structure	~~New building, built on site~~ Prefab structure	Prefab structure
Redundancy	~~N+1 for all equipment~~ No redundant DAF / filters	~~N+1 for all equipment~~ No redundant filters / RO units	N+1 for all equipment
WTP Capital Cost (OPC – Class “D”)	\$1.6 m	\$1.6 m	\$1.4 m
30% Engineering & Contingency	\$0.5 m	\$0.5 m	\$0.4
Total Estimate	\$2.1m	\$2.1 m	\$1.8

Note: Class “D” OPC accurate to +/- 50%

What “no redundancy” means

- Redundant (i.e. backup) treatment equipment is industry best practice and recommended in the “Design Guidelines for Drinking Water Systems in BC”
- Options 1 & 2 have no redundant treatment processes (for budgetary reasons)
- Option 3 we can fit “n+1” redundancy within the target budget
 - i.e. we are including one additional filter vessel and chemical pump more than what is needed



- In this example, two tanks are needed to treat flow
- A third tank is installed as redundancy / back-up

Redundancy for Missezula treatment options

- The filter systems will need downtime for cleaning, around 1 hr/day
 - For Option 3, the redundant/extra filter vessel will come online while one vessel is being cleaned.
 - Max flow through the WTP can be maintained at all times.
 - Options 1 and 2 will have reduced flow or have to pause operation when filters are being cleaned
- Need storage to supply treated water during that downtime
 - Option 1 = 36 m³ of storage for 1 hr of max WTP flow
 - Option 2 = 31 m³ of storage for 1 hr of max WTP flow
 - Option 3 – no storage needed because redundant processes turn on when the main equipment is offline for cleaning. Max flow through WTP can be maintained at all times.

Redundancy and “the unexpected”

- Redundant units also give you backup equipment in case the unexpected shuts down the primary equipment
- For Option 3, if something goes offline, the redundant equipment comes on line.
 - This buys the operator time to respond and resolve the issue
- For Options 1 & 2, if something goes offline, no redundant equipment is available to pick up the slack.
 - An immediate response by the operator is required to restore full flow through the WTP

Residual Waste Considerations

Description	Option 1 – Surface Water	Option 2 – Groundwater	Option 3- Groundwater (Simplified)
Waste Generated	• DAF sludge • Filter backwash waste	• Greensand media backwash waste • RO hydraulic cleaning waste • RO chemical cleaning waste (neutralized) • Spent cartridge filters	• Greensand media backwash waste
Waste Flows	• 0.4 L/s	• 2.3 L/s	• 0.1 L/s

Residuals Discharge to Receiving Environment (Summer Creek)

	Option 1 – Surface Water	Option 2 – Groundwater	Option 3 – Groundwater (Simplified)
Main limitation	Aluminum exceedance	Insufficient dilution	None
Dilution (rule: >40 min)	155 x	27 x	620 x
Residuals Flow	0.4 L/s	2.3 L/s	0.1 L/s
Creek Flow	EFN* (62 L/s)	EFN* (62 L/s)	EFN* (62 L/s)
Downstream water quality assessment	Aluminum guideline exceeded	Guidelines met	Guidelines met
Regulatory Implications (Effluent Discharge Application to Ministry of Environment)	Approval unlikely without adding residuals management (settling lagoon/box) – not modeled yet	Approval only possible if no other options are available (dilution low)	Approval likely

*EFN = Environmental Flow Needs. Actual creek flows may be lower in drought years or for several day if debris accumulates and stops flow before weir gate is fixed/maintained and debris removed. Recommend during detailed design to further assess alternative disposal options whenever flow is less than the EFN.

Surface Water – How do we get the alum out of the waste?



- Separate into sludge and water
- Aluminum trapped in sludge
- Examples:
 - Lagoons
 - Drying beds
 - Geotubes
 - Gravity thickeners



Revised Capital Costs (WTP only)

Water Source	Option 1 – Surface Water	Option 2 - Groundwater	Option 3 – Groundwater (simplified treatment)
Design Flowrate	7.6 L/s	8.6 L/s (5 L/s ¹)	11 L/s (5 L/s ¹)
WTP Capital Cost (OPC – Class “D”)	\$1.6 m	\$1.6 m	\$1.4 m
Extra Storage for Redundancy	\$85,000	\$65,000	-
Residuals Management	\$200,000	??	-
Subtotal	\$1.9 m	> \$1.6 m	\$1.4 m
30% Engineering & Contingency	\$0.6 m	> \$0.5 m	\$0.4 m
Total Estimate²	\$2.5 m	> \$2.1 m	\$1.8 m
Cost per Flow (\$ per L/s)	\$329,000 / L/s	> \$244,000 / L/s	\$164,000 / L/s

Note 1: Pricing is based on 11 L/s, but the well yield is 5 L/s and a second well at a similar well yield is not likely to be successful. As a result, costs will be lower than these estimates.

Note 2: Class “D” OPC accurate to +/- 50%

O&M Considerations

Water Source	Option 1 – Surface Water	Option 2 – Groundwater	Option 3 – Groundwater (Simplified)
O&M Considerations			
Labour	Visit 1-2 times/week	- Visit 1-2 times/week - Prefiltration maintenance	Visit 1-2 times/week
Power Consumption	- Lights and heating - Process chemical pumps - DAF mixers - DAF sludge skimmer - DAF compressor - DAF recycle pump - DAF sludge pump - Filter backwash pumps	- Lights and heating - Process chemical pumps - Filter backwash pumps - Membrane permeate pumps - Membrane hydraulic cleaning pumps - Membrane chemical circulation pumps - Membrane chemical cleaning dosing pumps	- Lights and heating - Process chemical pumps - Filter backwash pumps - Waste recycle pumps
Chemicals	- Sodium hypochlorite - Soda ash - Polymer - Chlorine waste neutralizer	- Sodium hypochlorite - Anti-scalant - Membrane cleans (chlorine) - Membrane cleans (acid) - Chlorine waste neutralizer - Acid waste neutralizer	Sodium hypochlorite

* QUANTIFYING CHEMICAL AND ENERGY COSTS WILL DEPEND ON WHAT WE SET AS THE “AVERAGE” FLOW

Pros & Cons

Description	Option 1 – Surface Water	Option 2 – Groundwater	Option 3 – Groundwater (Simplified Treatment)
Pros	• Already have licenses for surface water use.	• Treatment also removes hardness from water.	• Includes redundant treatment equipment. • Lowest operational complexity.
Cons	• Budget does not allow any redundancy in treatment equipment. • Additional treatment needed for waste management – sludge disposal offsite will be needed. • Waste discharge permit required. • Lake pumping upgrades will be required.	• Budget does not allow any redundancy in treatment equipment. • High volume of waste – difficult to dispose of. • Waste discharge permit required. • Potentially frequent replacement of spent cartridge filters needed. • Will require the community to reduce consumption by half	• Water hardness not treated. Water softeners hard on septic fields • Waste discharge permit required. • Will require the community to reduce consumption by half

Recommendations (depends on priorities)

1. Abundant, softer water, higher cost

= Option 1: Lake source, with DAF, media filtration, chlorination

- Investigate redundancy (storage of treated water) for “the unexpected”
- Investigate waste stream for aluminum (add lagoon/drying beds and recalculate dilution in Summer Creek)

2. Limited quantity (half current use), hard water, and lower cost

= Option 3: Groundwater Source with filtration to remove manganese and chlorination to remove viruses (but no hardness or TDS removal)

- Water auditing and water conservation planning
- Water Licence Amendment application to switch from surface water to groundwater

Next Steps

1. Present results to date to community (this presentation)
2. Complete Draft Report
3. RDOS to finalize option selection
4. Complete Final Conceptual Design Report
5. Complete detailed design, tendering and construction



Questions/Comments?



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Manager, RDOS

