



Water New Zealand Conference & Expo 2019  
18 September 2019

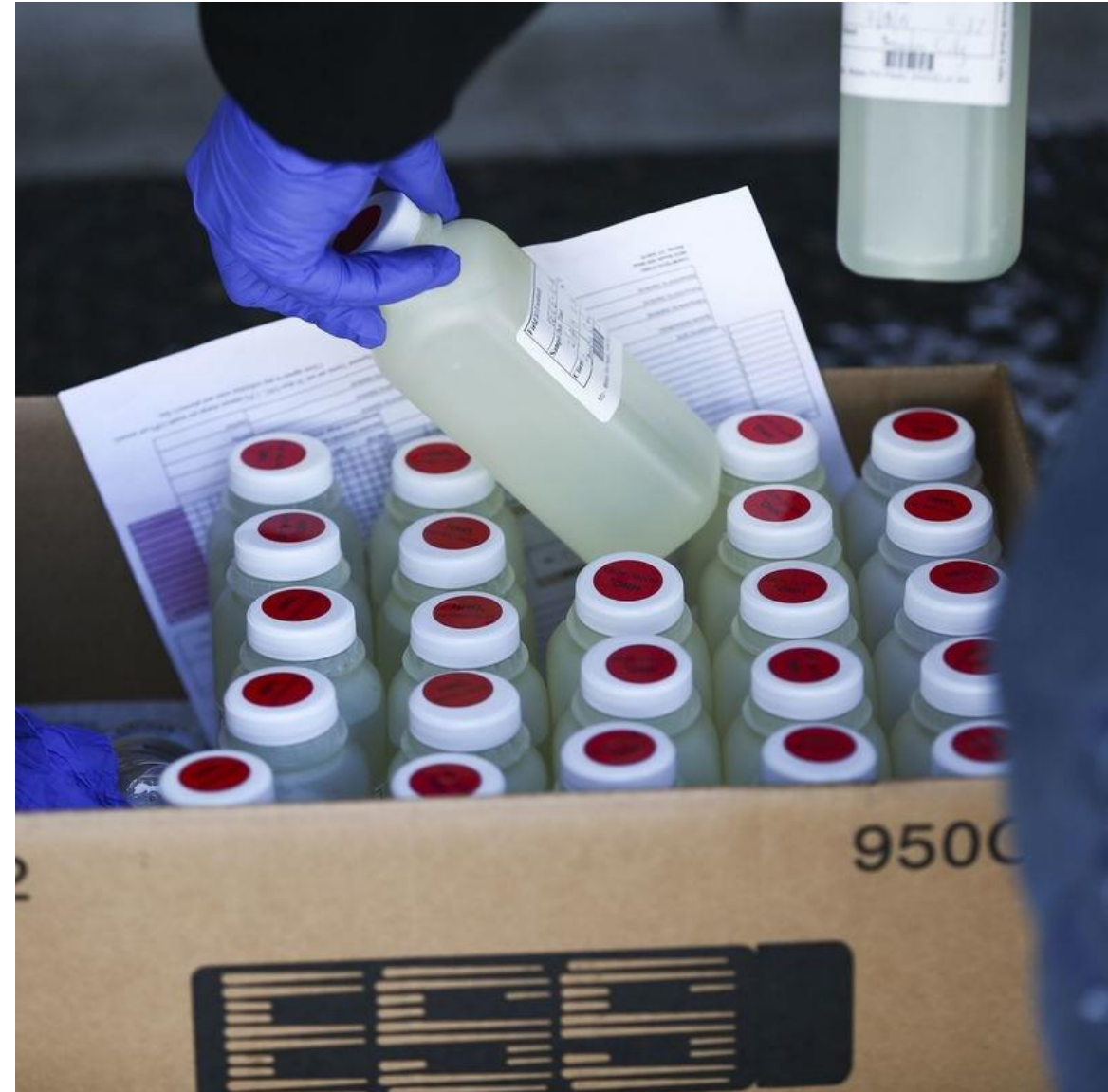
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# Intelligent Water Treatment Process Selection



# Monitoring Programme

- Water quality data is the basis for treatment targets and process selection
- Multi-season programme recommended
  - Snow melt, algal blooms, Fe/Mn
  - Storm events
- Review historical water quality and operational data
  - Identify seasonal trends
  - Parameters of importance



# General Testing

- Turbidity (NTU)
  - Quantifies “cloudiness”
  - Aggregate measure of light scattering and absorption
- Colour (TCU, HU)
  - Aggregate measure of suspended and dissolved matter
- Temperature (°C)
  - Track seasonal changes and anticipate changes in water quality
- pH
  - Acidic / basic properties of water
  - Aesthetic guideline: 7.0-8.5
- Alkalinity / Hardness
  - Stability / corrosivity



Thermo Scientific



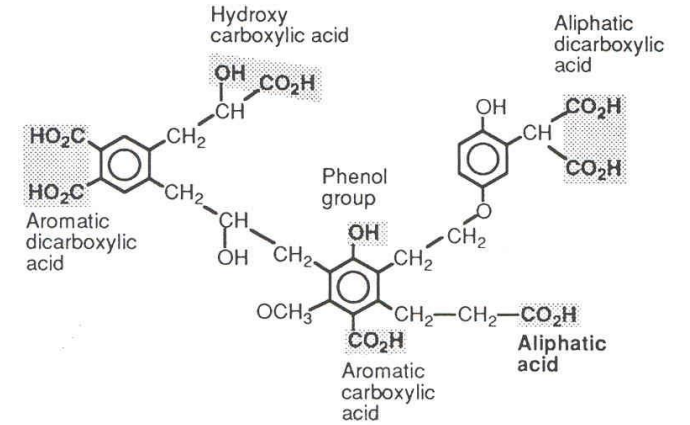
Hach

# Organics

- Natural Organic Matter (NOM)
  - Surface water impacted sources
  - Coagulant demand, DBP control, biological stability
- Total (TOC) and Dissolved Organic Carbon (DOC)
  - High DBP yield DOC < 2 mg/L
  - Low DBP yield DOC < 4 mg/L
- Specific Ultraviolet Absorbance (SUVA)

$$SUVA = \frac{UVA_{254} (cm^{-1})}{DOC (mg/L)} \times 100$$

SUVA Value	Description
< 2	Low chlorine demand / low Cl <sub>2</sub> DBPFP
2-4	Higher chlorine demand / higher Cl <sub>2</sub> DBPFP
>4	High chlorine demand / high Cl <sub>2</sub> DBPFP



# Metals

- Cursory full suite total and dissolved metals
- Identify metals that:
  - $\geq 50\%$  the MAV, aesthetic Guideline Values
  - Exert chlorine demand
  - Foul downstream equipment and distribution system

- Iron

	New Zealand	Canada
Aesthetic Objective	0.2 mg/L	0.3 mg/L

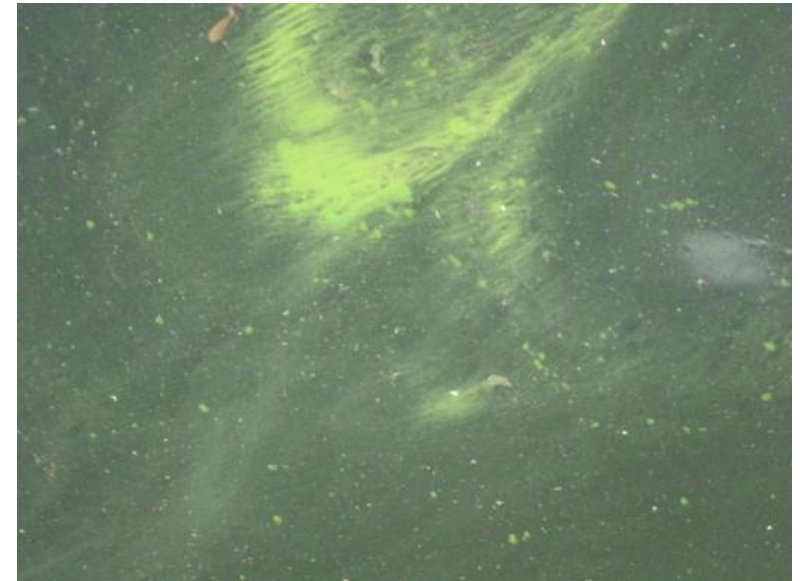
- Manganese

	New Zealand	Canada (2019)
Aesthetic Objective	0.04 mg/L	0.02 mg/L
MAV	0.40 mg/L	0.12 mg/L



# Algae and Cyanobacteria

- Algal blooms
  - Taste & Odour events – Geosmin/MIB
  - Algal toxins
  - Impede clarification processes
  - Clog filters and membranes
  - Algae count / speciation, algal biomass (mg/L)
- Cyanobacteria and Toxins
  - Microcystin – Hepatotoxin (liver)
  - Saxitoxin – Neurotoxin (nerve, synapses)
  - Cylindrospermopsin – Cytotoxin (liver kidneys)



# Cartridge Filtration

- Uses:
  - Ultrapure water, industrial, in-home use, small WTP
- DWSNZ – Typically 2-log protozoa credits
- Applicability:
  - High quality groundwater
  - Turbidity < 1 NTU
  - Low colloids / fine clays (1 nm - 1  $\mu$ m)
  - Piloting – assess change out freq. (single use)
  - Pathogen reduction only – no dissolved species



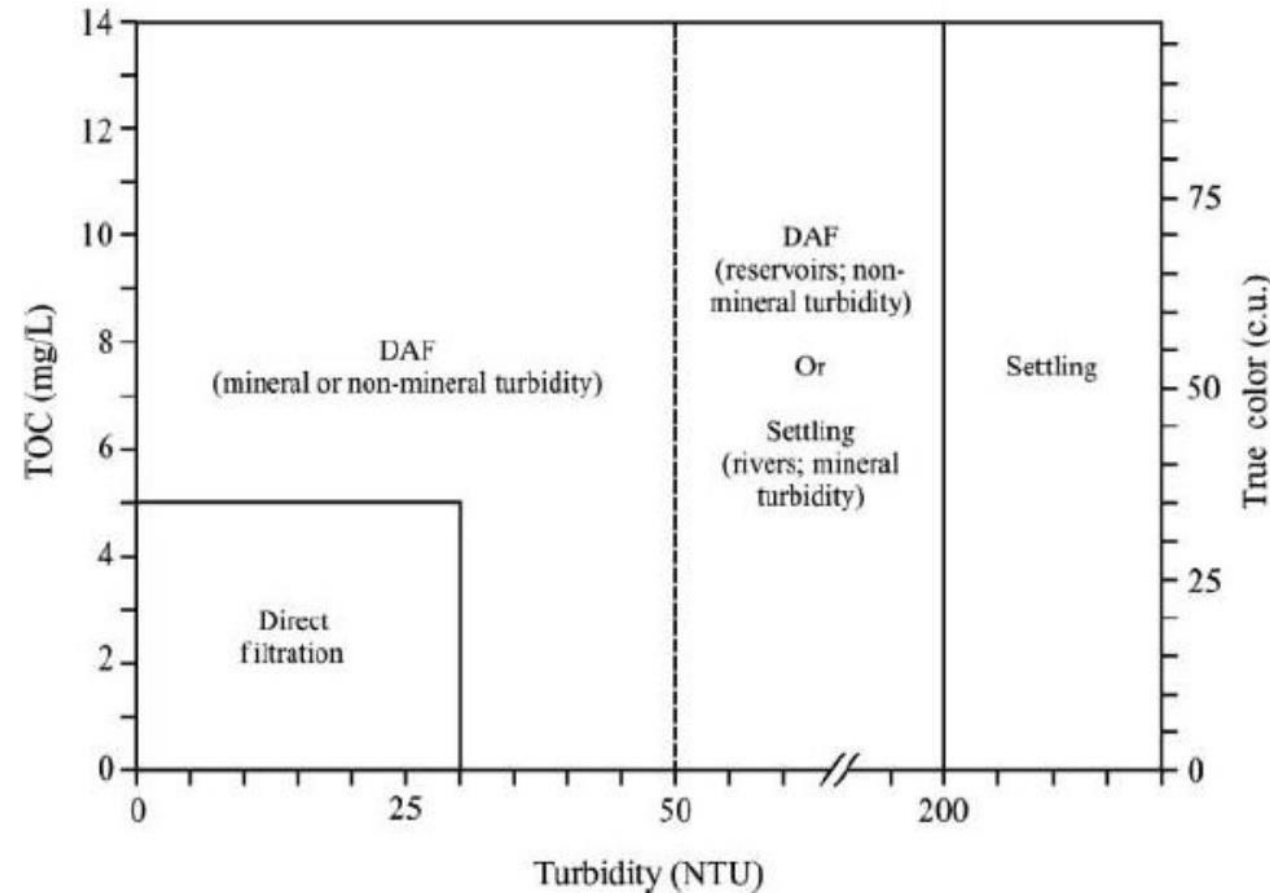
Industrial Process Technologies, 2016



Commercial Filtration Supply, 2019

# Coagulation Processes

- Surface / surface impacted sources
- Requires more time & expertise to operate and optimise but more robust
- DWSNZ – filtration req'd for log credits
- Key target constituents:
  - Suspended solids / precipitates
  - Microorganisms / pathogens
  - Algae / cyanobacteria
  - Dissolved NOM
  - Colloids

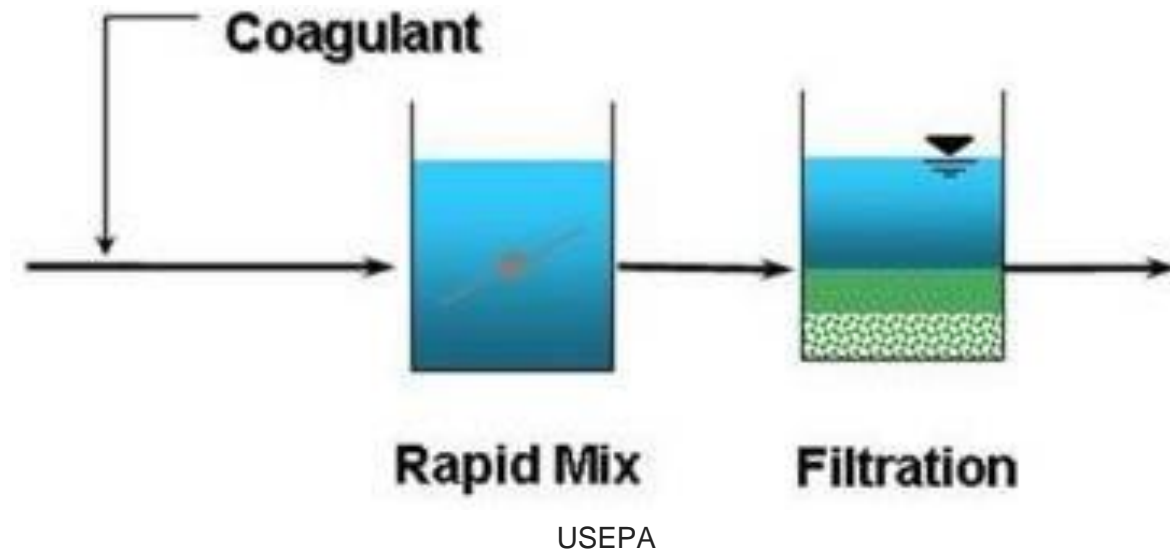


Valade, et al., 2009



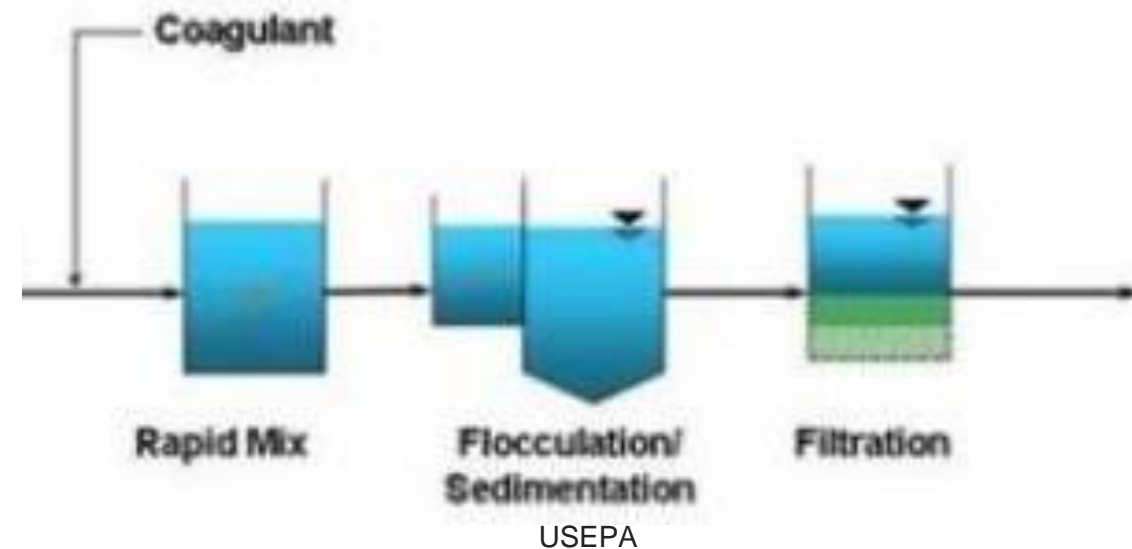
# Direct Filtration

- Chemical coagulation followed by filtration
- Low coagulant doses and fine (pin) floc
- DWSNZ – 2.5-log protozoa credits
- Applicability
  - Good quality surface water
  - Turbidity: Typically 1-5 NTU
  - Medium NOM, colour
  - Low algae, iron, manganese



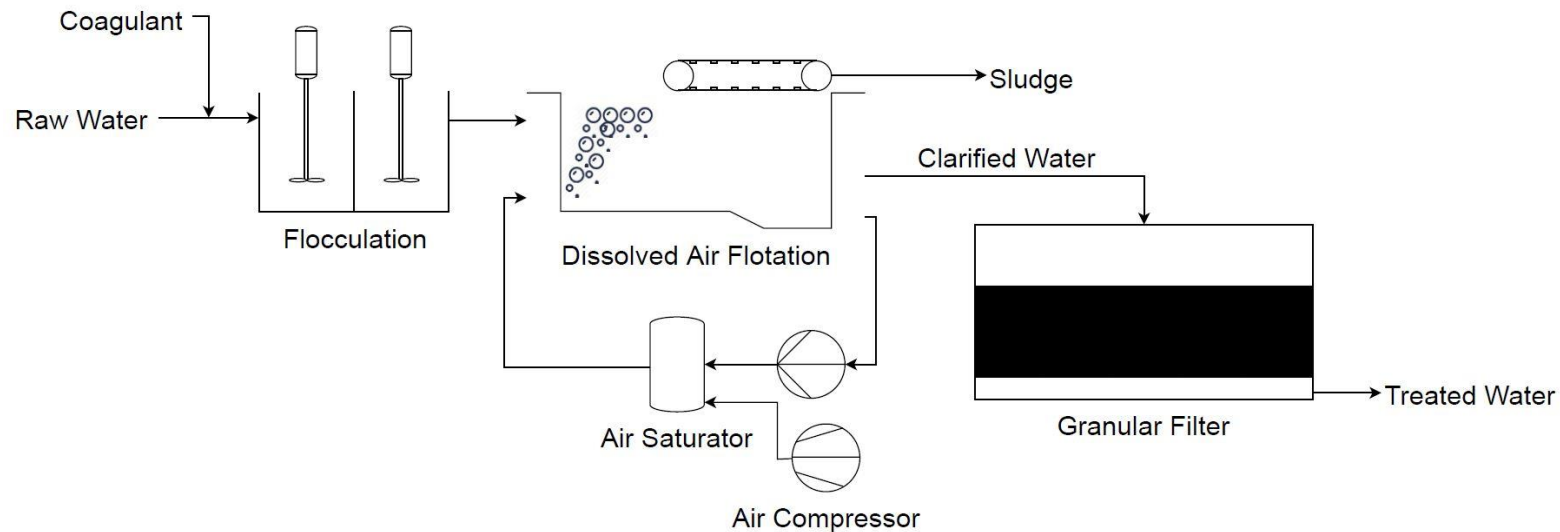
# Conventional Treatment

- Coagulation, flocculation, sedimentation, filtration
- DWSNZ – 3.0-log protozoa credits
- Applicability
  - Turbidity: Typically < 50 NTU
  - High NOM, colour, suspended solids
  - Challenged by algal / cyanobacteria blooms



# Dissolved Air Flotation (DAF)

- Coagulation, flocculation, floatation, filtration
- DWSNZ – 3.0-log protozoa credits
- Applicability:
  - Turbidity: Typically < 30 NTU
  - High NOM, colour
  - Algal / cyanobacteria blooms



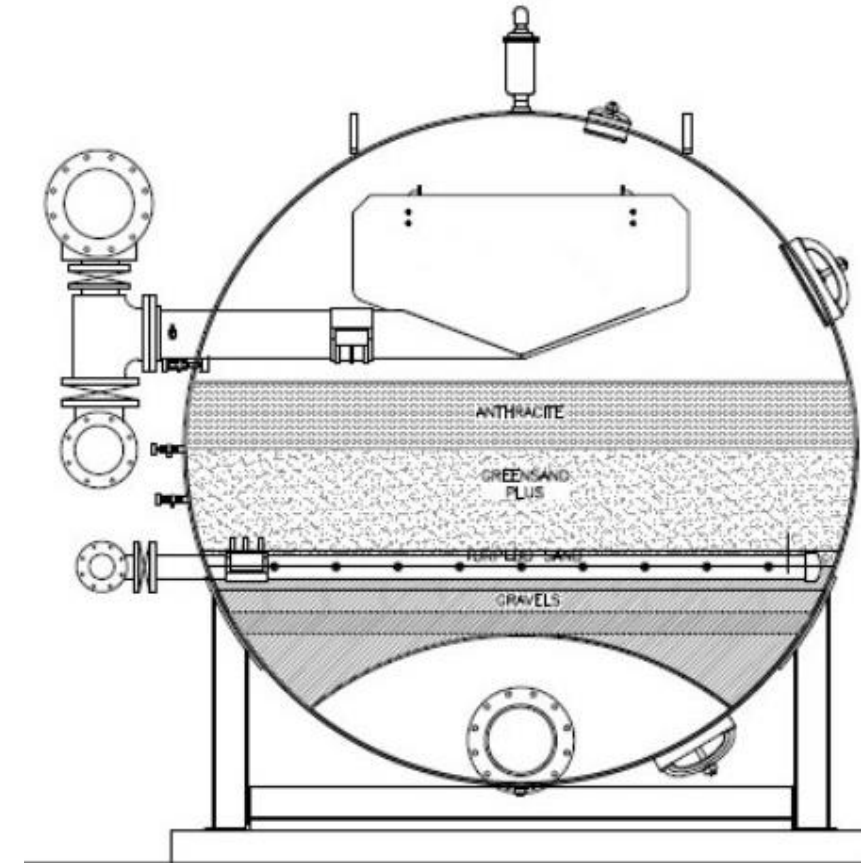
# Membrane Filtration

- Microfiltration
  - Pore size: 0.1-5.0  $\mu\text{m}$
- Ultrafiltration
  - Pore size: 0.02-0.10  $\mu\text{m}$
- Cost competitive for small/medium WTPs
- DWSNZ – Typically 4.0-log protozoa credits
- Pre-treatment often used
  - NOM, metals



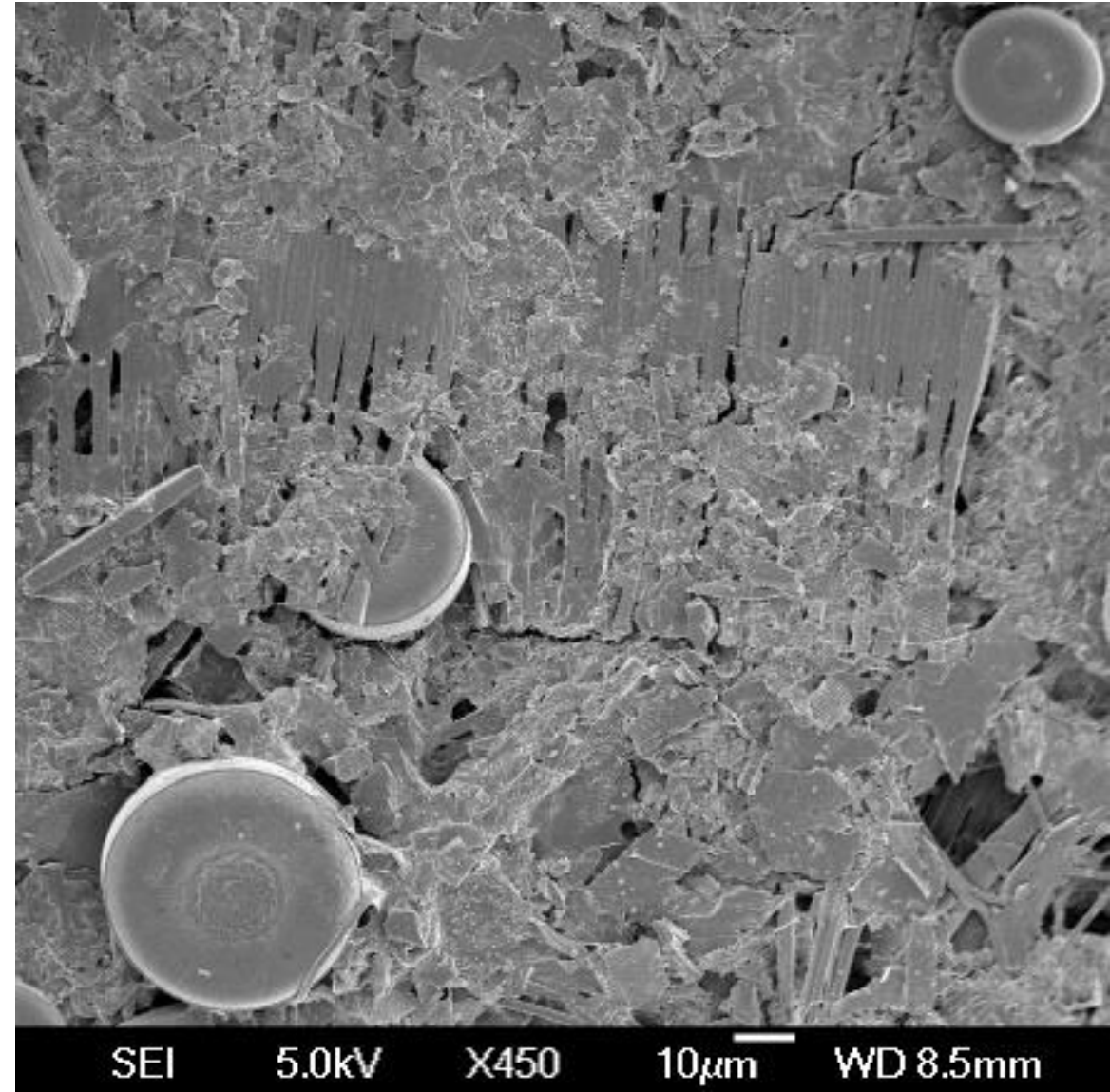
# Iron / Manganese Removal

- Iron and manganese removal
  - Oxidation – Fe/Mn floc
  - Greensand filtration ( $\text{MnO}_2$ ) – floc removal and adsorption
  - Mn oxidation:  $\text{pH} > 8$ , warm water, low NOM
- Oxidants:
  - $\text{NaOCl}$ ,  $\text{KMnO}_4$ ,  $\text{ClO}_2$ ,  $\text{O}_3$
- DWSNZ – zero protozoa credits



# Cartridge Filter Pilot Study

- Bore water / river bank
  - Concept design: Cartridge filtration / UV
  - Design flow rate: 18 MLD
  - 4-log protozoa target
- Raw Water Quality:
  - Turbidity < 0.5 NTU
  - Fe: 0.02-0.30 mg/L
  - Mn: 0.003-0.034 mg/L
  - Low hardness / alkalinity
- Pilot Study
  - 1 micron cartridge filter
  - Runtime: 12 hours – 5 days
  - PSD below detection TSS low
  - Clogging due to colloidal material
  - Cartridge filters not appropriate



# Coagulation Optimization

- Conventional surface WTP
  - 72 MLD
  - Coagulant: polyaluminum chloride
  - Polymer: LT22S
  - Sludge accumulation on plate settler
  - Shorter filter run times at warm temp.
- Bench scale jar testing:
  - Zeta potential – electrostatic particle charge
  - Coagulant-polymer dose optimisation
  - Alternative low MW polymer



# Iron and Manganese Treatment Pilot Study

- Ground water source
  - 10 bores
  - Design capacity: 250 L/s
  - Fe = 0.2-0.8 mg/L (AO = 0.3 mg/L)
  - Mn = 0.1-0.15 mg/L (MAV = 0.12 mg/L)
- Pilot Study
  - Greensand with NaOCl
  - Confirmed loading rate: 12 m/h
  - Filter run time > 70 hours
  - Mn < 0.02 mg/L





# Summary

- Key raw water quality parameters
  - NTU, colour, temperature, pH, Alk
  - TOC, DOC, UVT/UVA<sub>254</sub>
  - algae, cyanobacteria
  - Iron / Manganese
- Cartridge filtration (2.0-log)
  - Small supplies and high water quality
  - Piloting confirm clogging / change out frequency (colloids / clays)
- Chemical Coagulation (2.5-3.0-log with filtration)
  - More time / expertise
  - NOM, pathogens, algae
- Membrane filtration (typically 4-log)
  - Small/medium supplies
  - pre-treatment – often coagulation, may need oxidation
- Greensand filtration
  - Fe/Mn removal
  - Greensand only – protozoa barriers required

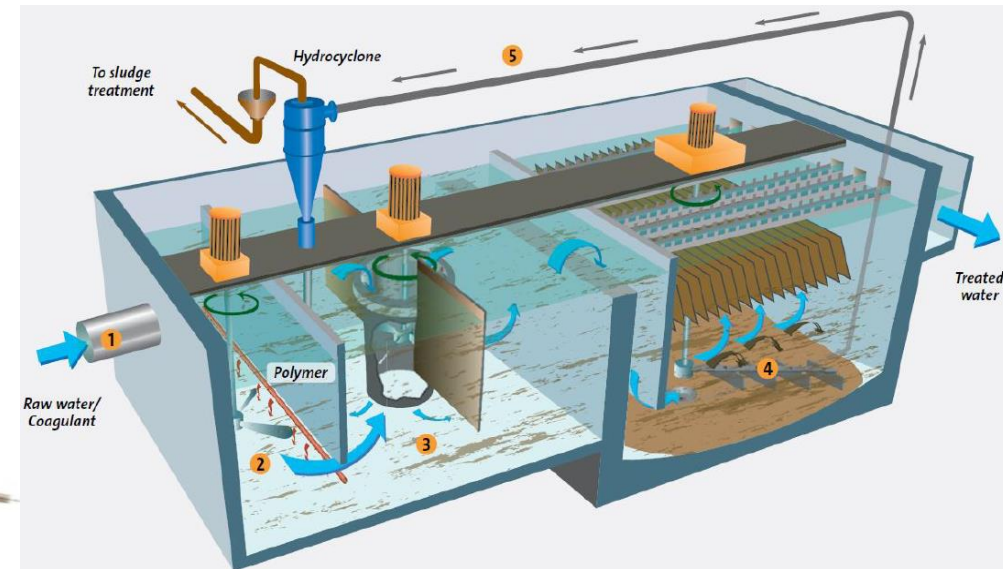
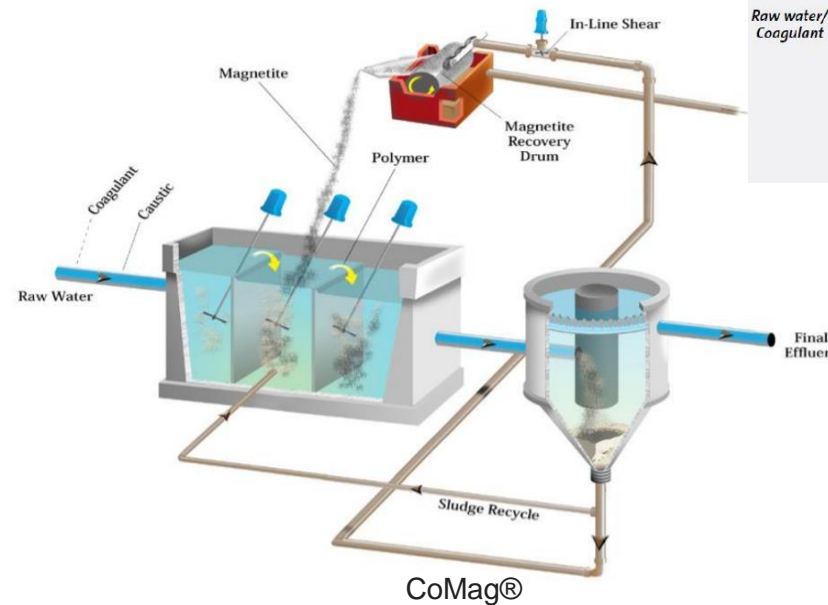


Thank You

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# Ballasted Clarification

- Addition of high-density particles improve floc settling
- Smaller footprint
- DWSNZ – 3.0-log protozoa credits
- Actiflo®
  - Silica microsand
  - Hydrocyclone
- CoMag®
  - Magnetite particles
  - Magnetic drum



Veolia Actiflo®