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Offering Solutions

Water treatment principles and technologies for treating unconventional waters

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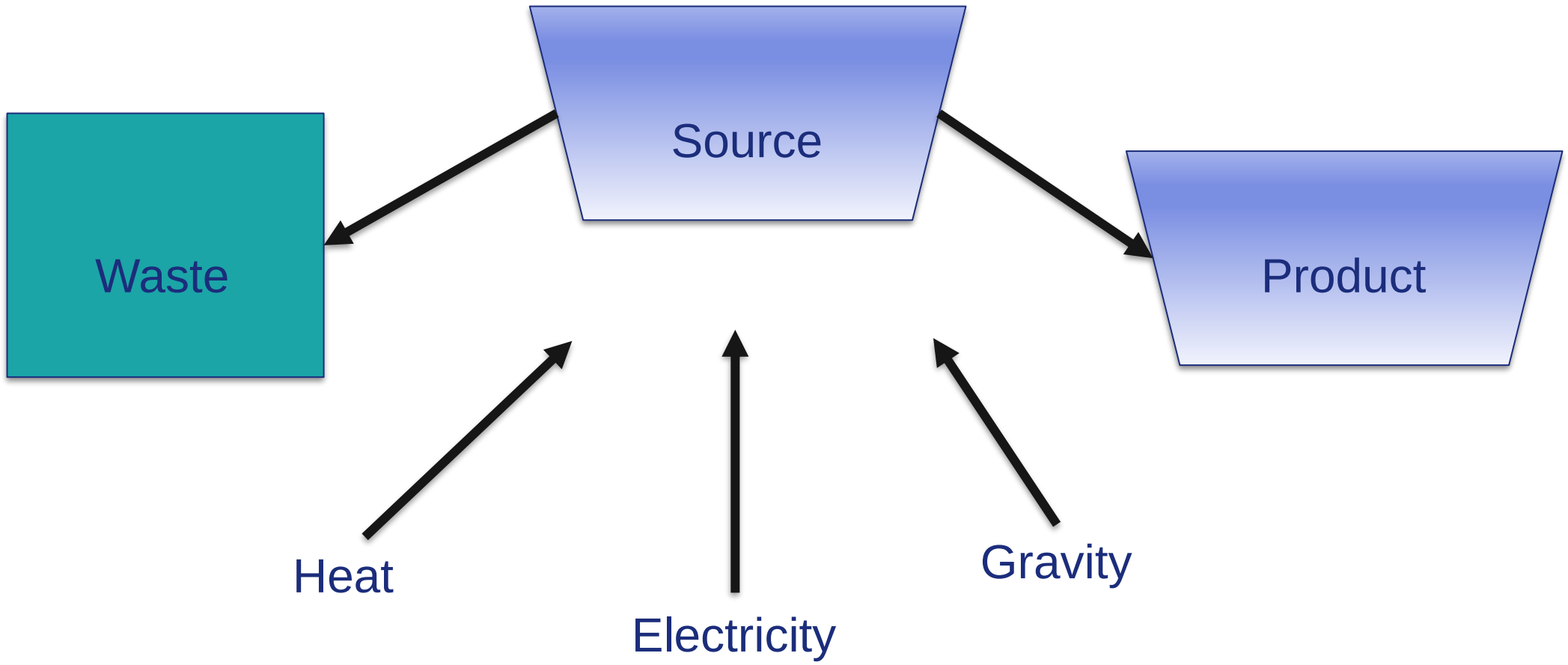
New Water for New Mexico



Water treatment is a Separations Process

There is no free lunch……

- Water treatment follows the laws of physics
- Chemistry must be understood and controlled
- Energy must be added to the system
- Wastes must be removed from the system
- Few original ideas, but,
- Plenty of room for improvement and sustainability

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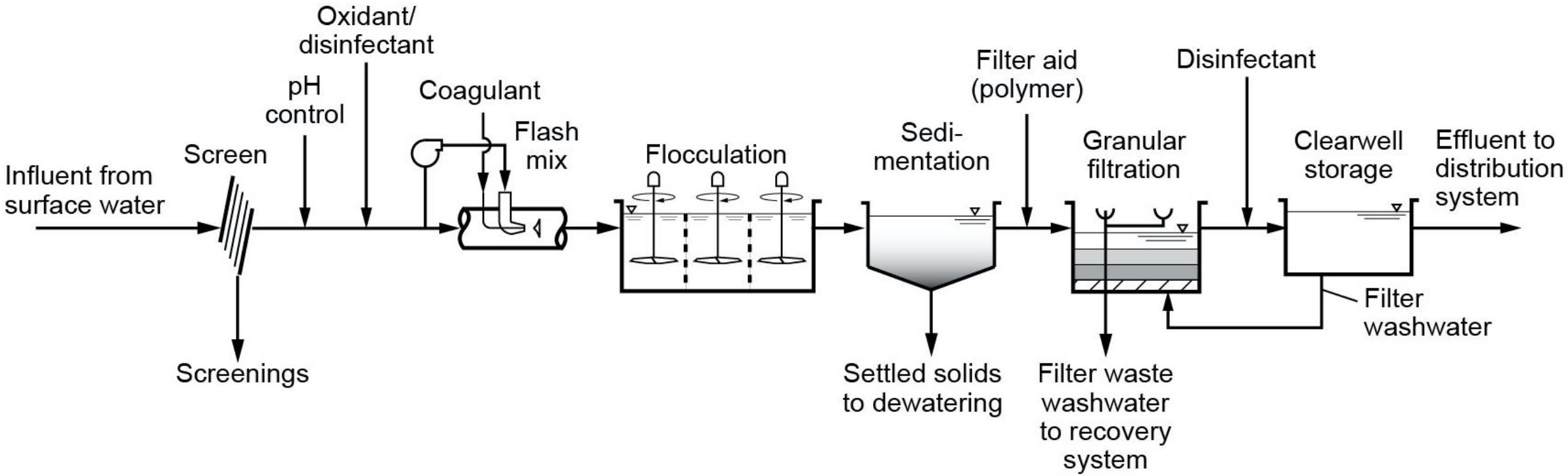
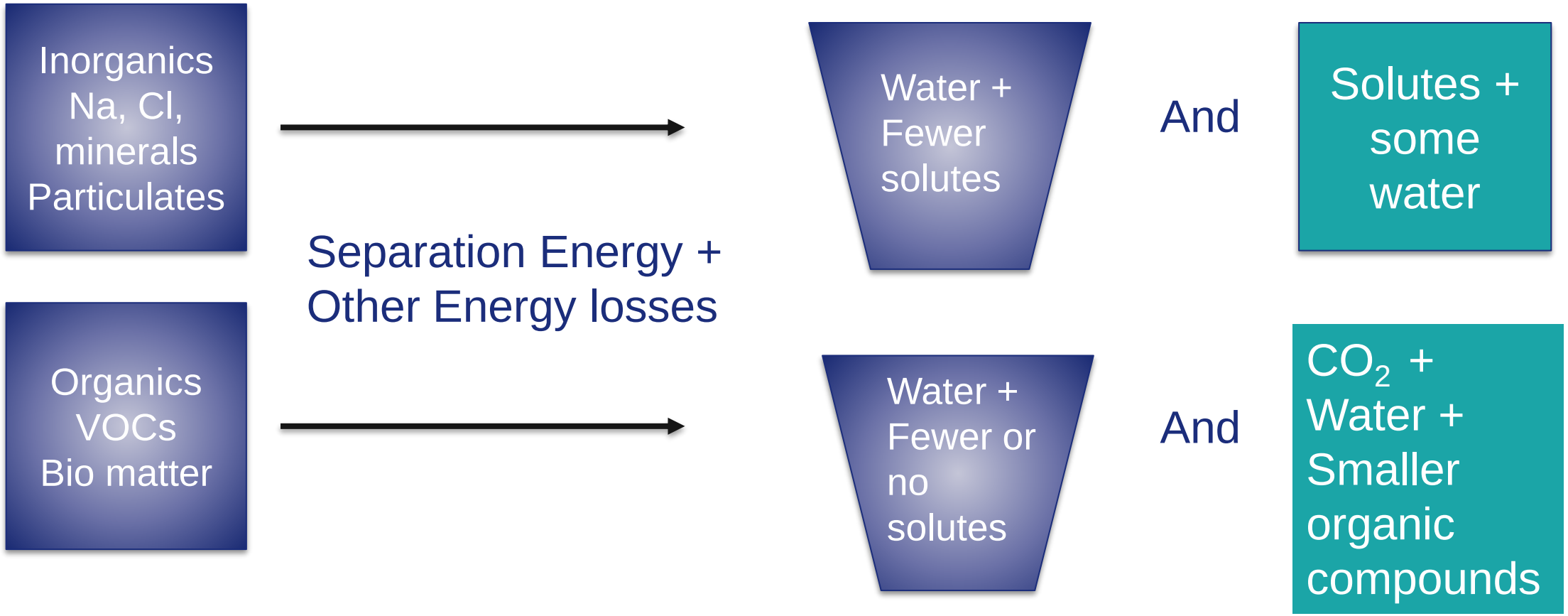


Typical fresh drinking water treatment “train”

Figure courtesy Kerry Howe, Principles of Water Treatment, 2012

What’s missing?

Key Principle of Chemistry in treatment: Conservation of mass



Comprehensive analytical analysis is KEY

There is ALWAYS a waste product

Key Principle of Chemistry in treatment: Separations require Energy

Inorganics
Na+
Cl-

Process Energy INCREASES with increasing concentration

Organics
VOCs

Process Energy Plateaus with increasing concentration
(but other factors may change, like time)

Corollary 1: We can be smart about how we apply and use energy
Corollary 2: We can model this to improve efficiency

Three ways to remove salt

- Membranes
  - Principle: solute size differentiation
- Thermal methods
  - Principle: evaporating water (but being smart)
- Electrochemical methods
  - Principle: moving molecules with electric charge

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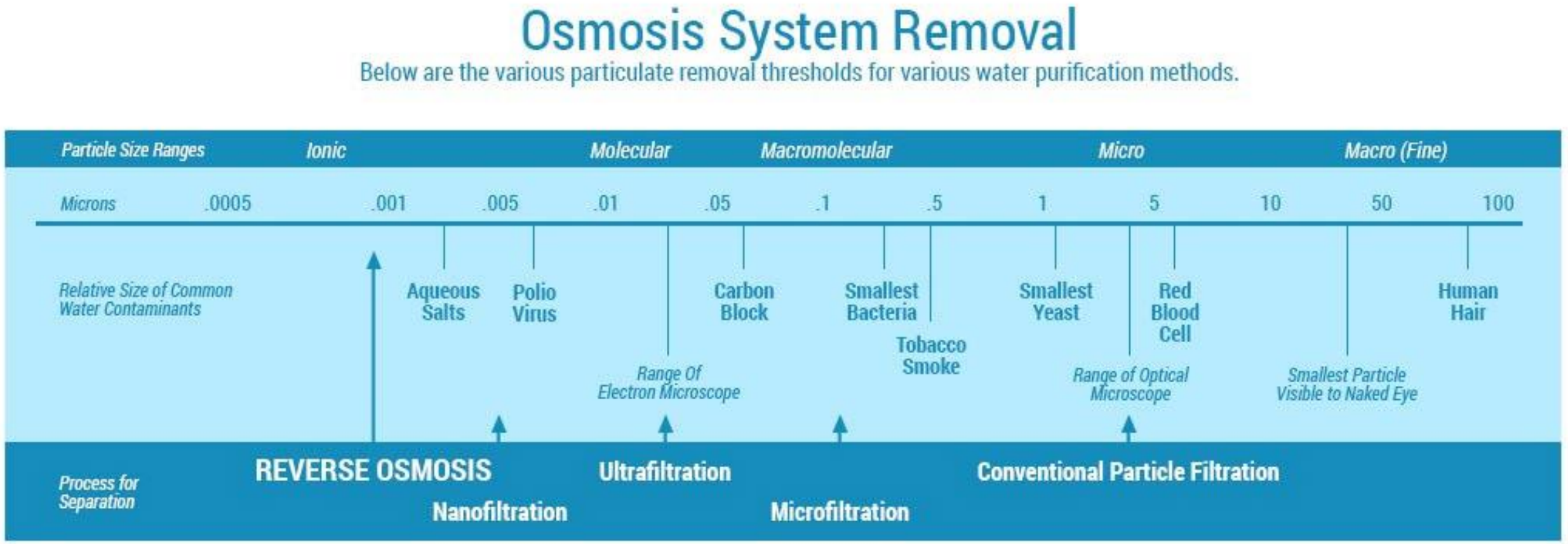
Membrane systems– effective for many constituents



Membrane Pore Size decrease

Macrofiltration-rejects particulates

Ultrafiltration-rejects macromolecules (usually organics)

Nanofiltration-rejects divalent ions (Ca^{2+})

Reverse osmosis-rejects monovalent ions (Na^{+}) up to ~95%

Membranes: simple RO example train

Principle: We pump/push water through membranes with different sized pores

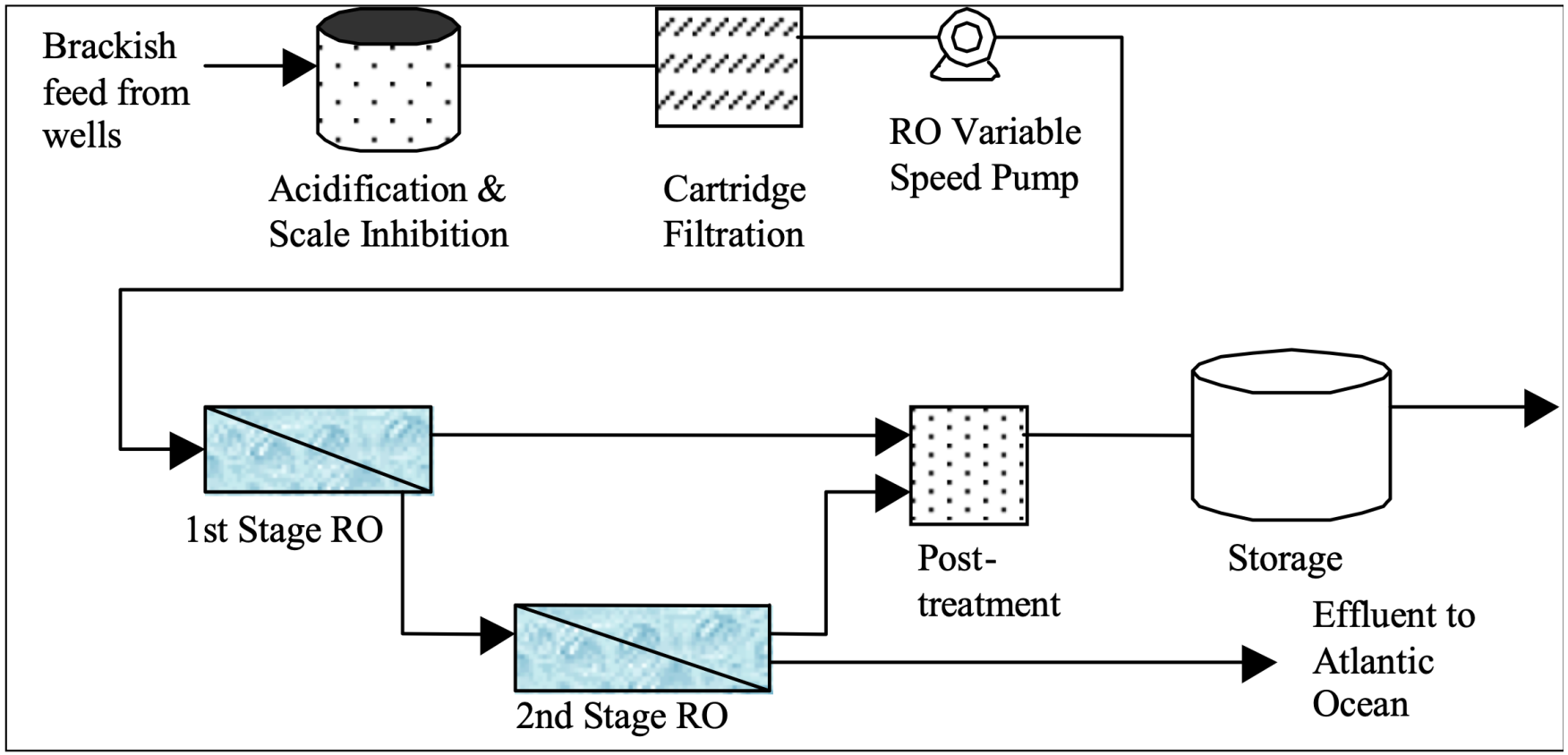


Figure 2-3 Process flow diagram for the Dare County, North Carolina, North RO plant

Most compatible with salinities of 3,000-35,000 mg/L

Recovery of 30-80% of feed depends on salinity and staging

Can use energy recovery devices and concentrate recycling systems

Source: USBR Desalting Handbook for Planners 2003

Thermal processes: MED, MSF, VC

Principle: We heat/cool water and cause distillation (but we are smart about it…)

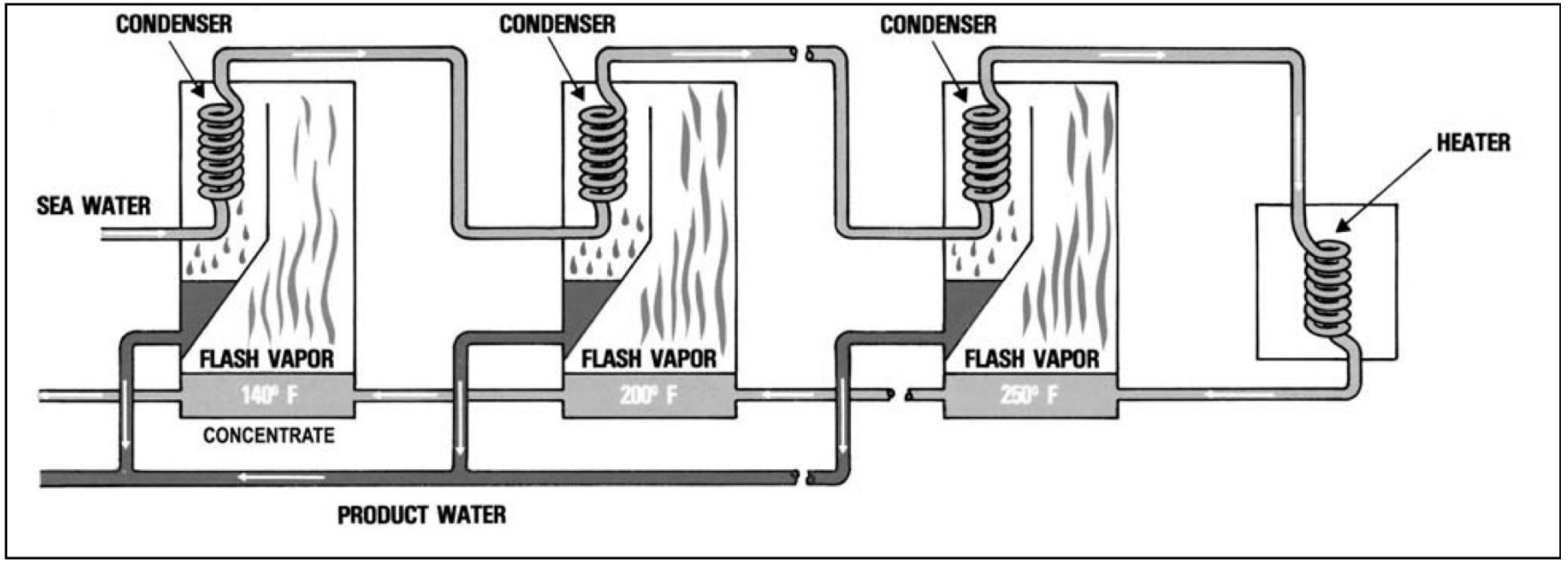


Figure 4-15 MSF arrangement

Works well for seawater and higher salinity (30,000 mg/L +)
Uses stages for heating, uses cold seawater for cooling
We use heat from the concentrate and condensers in stages
VC has higher recovery rates (>50%)

Source: USBR Desalting Handbook for Planners 2003

Electrochemical processes: ED/EDR

Principle: We use charge differences to attract ions from water and then sort and remove those ions through semipermeable membranes

Works best for brackish water salinities (500-3,000 mg/L)

Uses stages for removal of cations and anions

Not compatible with organic constituents (usually)

Recovery rates vary based on desired effluent salinity (>25-60% of salinity per stage)

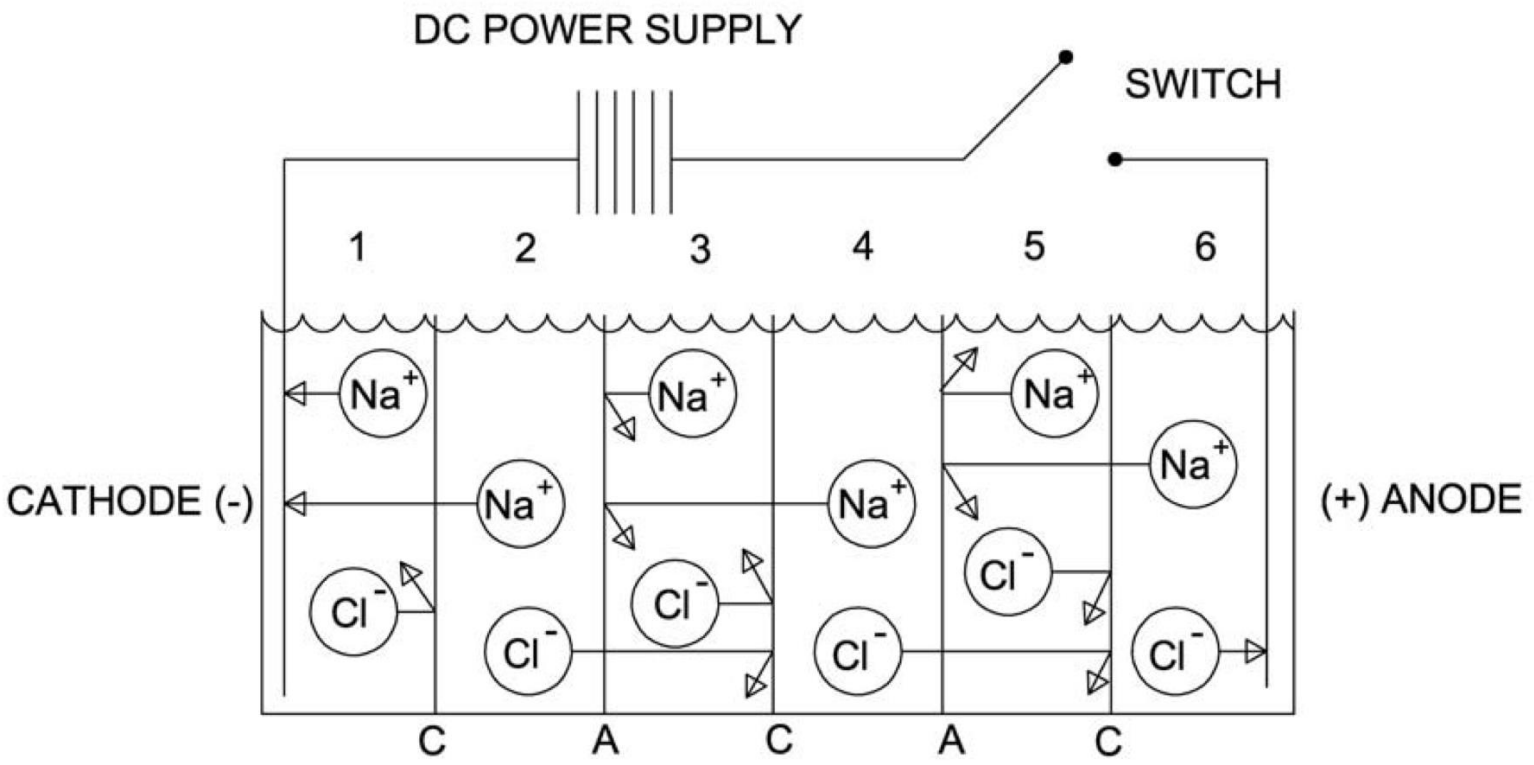
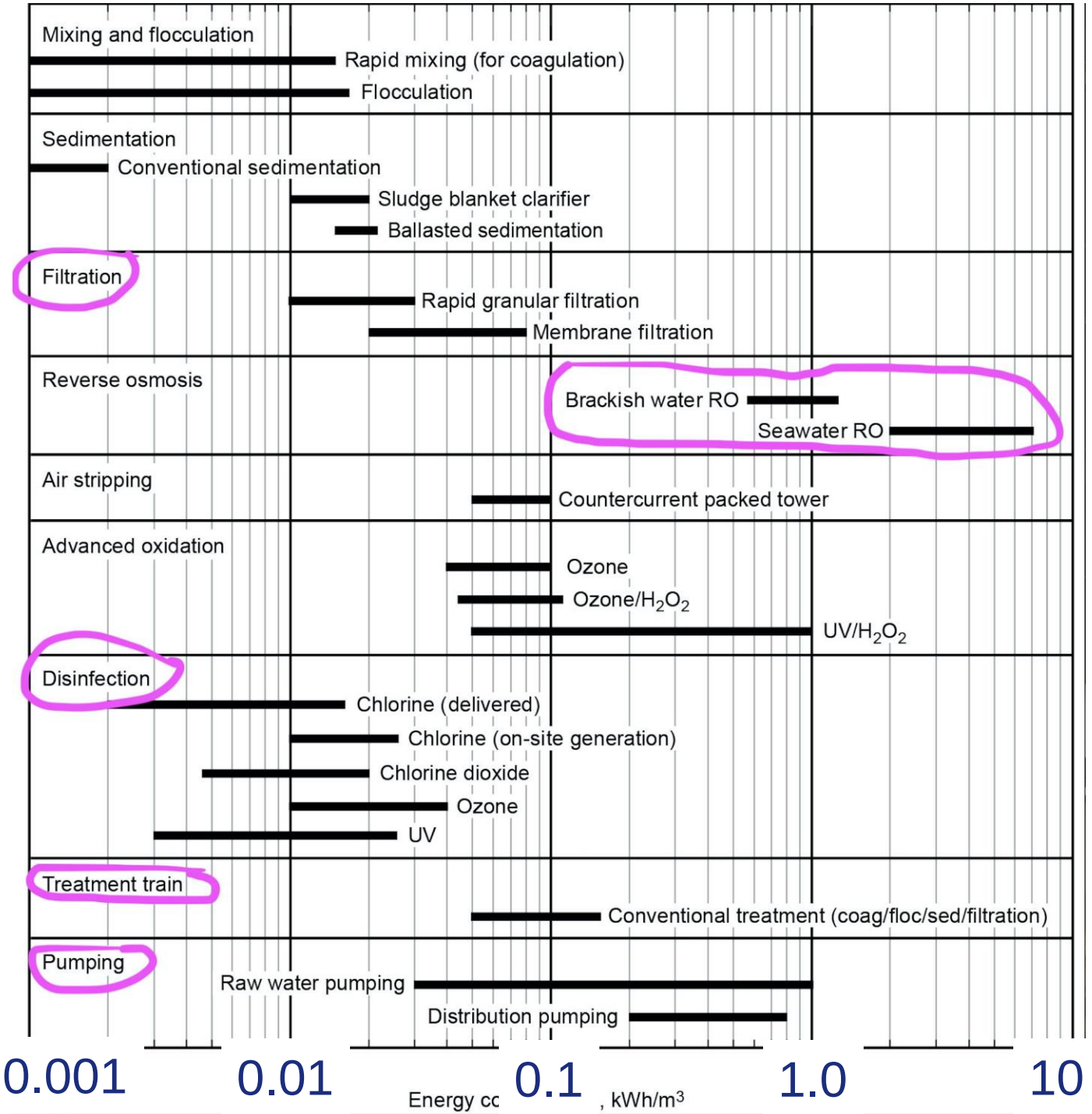


Figure 4-25 ED schematic

Everything costs Energy



Energy to boil water = >86 KWh/m^3

Thermal >> range

ED/ED ~ midrange

Log scale! Energy consumption in kWh/m^3

Figure courtesy of Kerry Howe, Principles of Water Treatment, 2012

Ways to increase efficiency and sustainability- Research

- Continue to push the boundaries of physics
- Better modeling systems with more sophisticated handling of physicochemical processes
- Better electronic system monitoring, process mechanisms, and energy recovery (“free energy”)

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Ways to increase efficiency and sustainability- Data

- Collect more physical and chemical information from wells in brackish and saline formations- sources & waste disposal locations
- Collect more complete process analytical data
- Collect more data about resource locations v/v user locations and needs

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Ways to increase efficiency and sustainability- Human Factors and $$$

- Collect data and analyze human responses to using treated water for municipal and agriculture
- Increase recruitment and training for system operators, engineering and chemistry students
- Increase funding for systems development focused on regions of greatest need

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