

Treatment Facility Technologies and Costs for Phosphorus Removal

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Government Affairs Seminar
February 23, 2012

TOPICS COVERED

Technologies

- Disc Filtration
- Ballasted Setting
- Continuous BackWash Filter
- Membrane Bioreactors (MBR's)

Levels of Treatment

Costs

Sizing

PRESENTATION WILL NOT COVER

- ◉ Regulations
- ◉ Nutrient Trading
- ◉ Adaptive Management



DISC FILTER APPLICATIONS

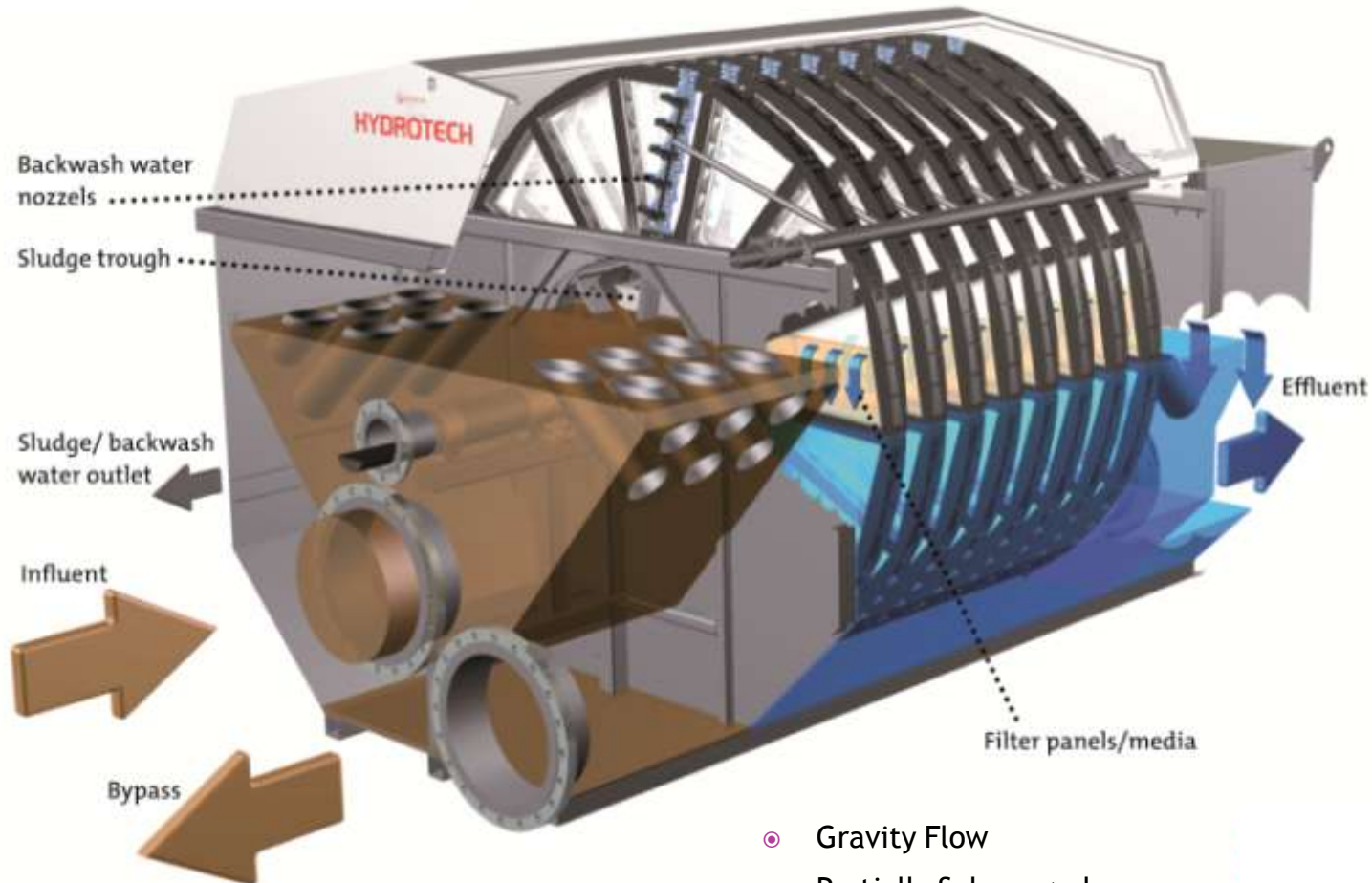


- Effluent Filtration
- Water Re-use

- Phosphorus Reduction
- CSO/SSO

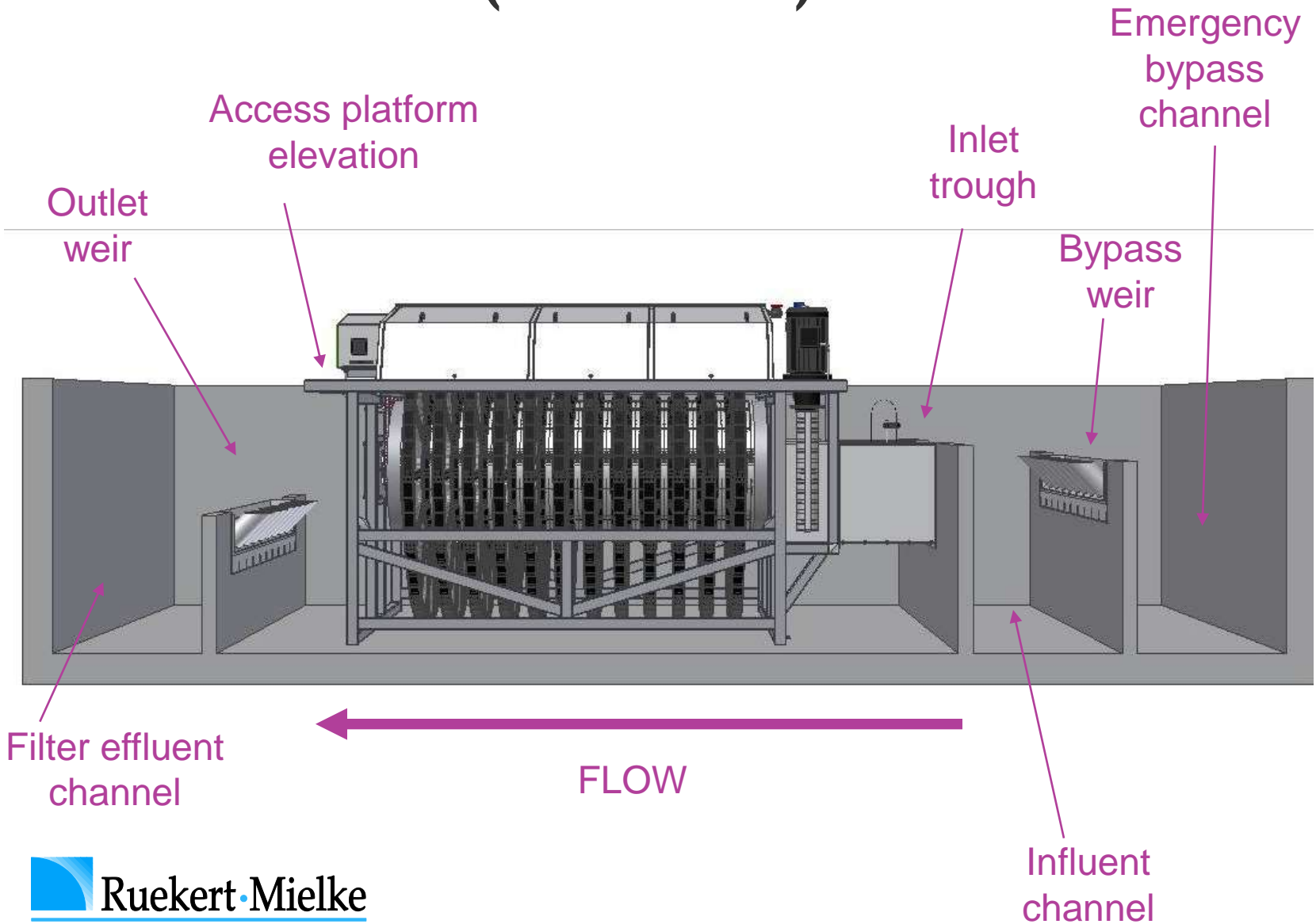


DISC FILTER OPERATION

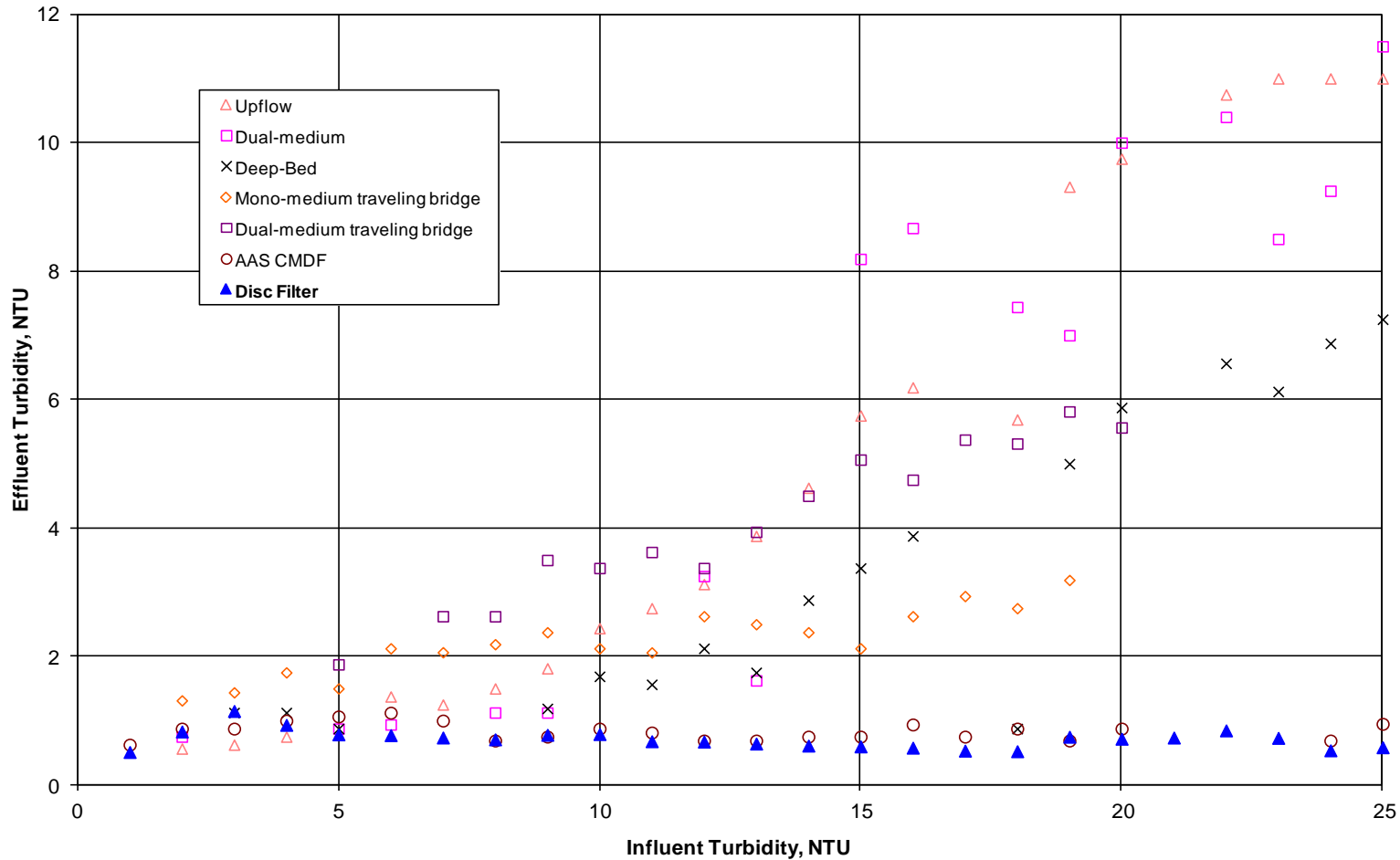


- Gravity Flow
- Partially Submerged
- Stationary Filter Discs
- Automatic Operation
- Continuous Operation

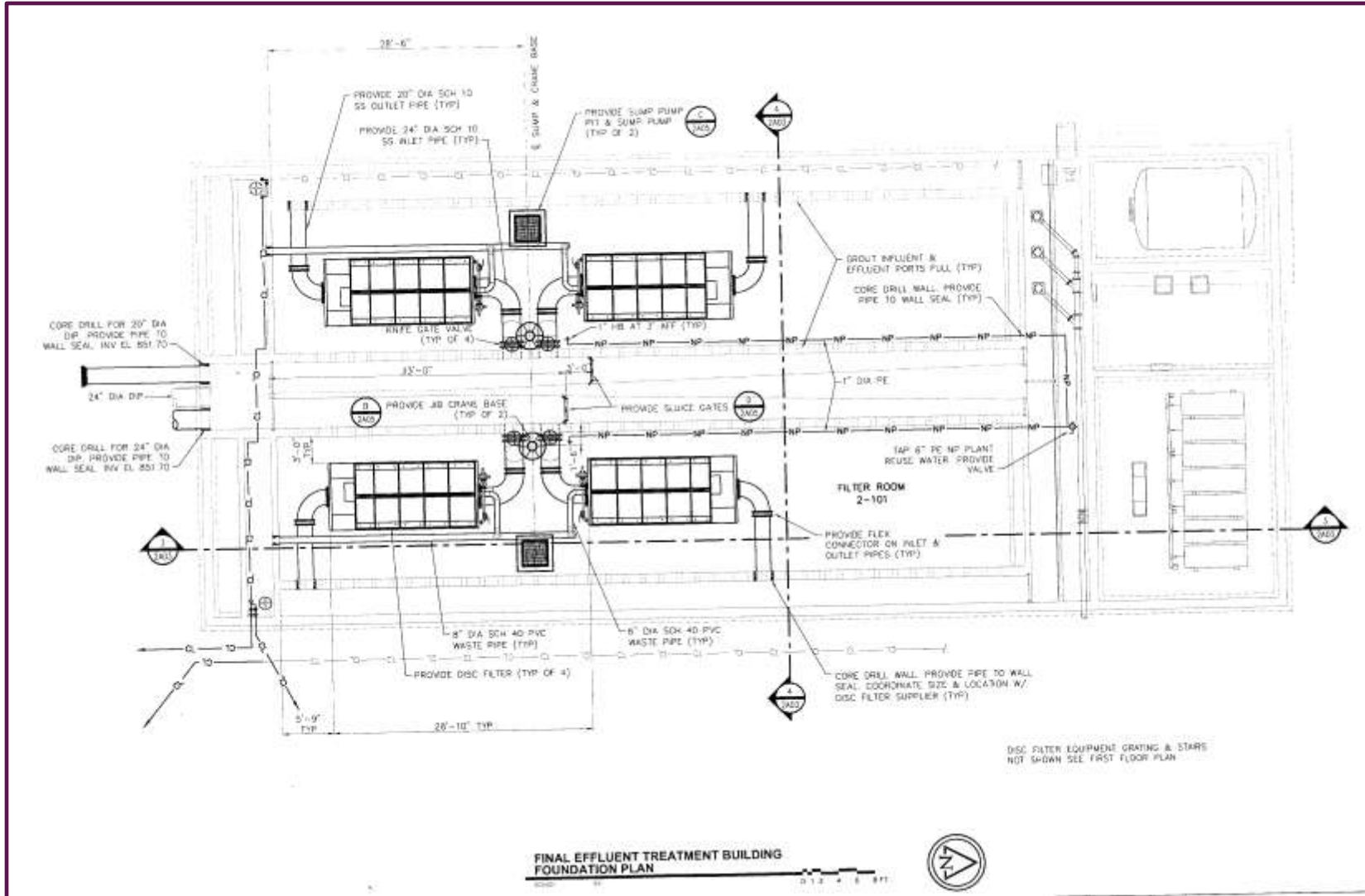
DISC FILTER INSTALLATION (Concrete)



DISC FILTER PERFORMANCE (Turbidity)



OCONOMOWOC, WI



OCONOMOWOC, WI TERTIARY POLISHING



OCONOMOWOC, WI TERTIARY POLISHING



OCONOMOWOC, WI TERTIARY POLISHING



PHOSPHORUS LEVELS & TECHNOLOGY

1.0 mg/l

- Coagulant

0.50 - 0.30 mg/l

- Multipoint coagulant addition
- Assisted with biological

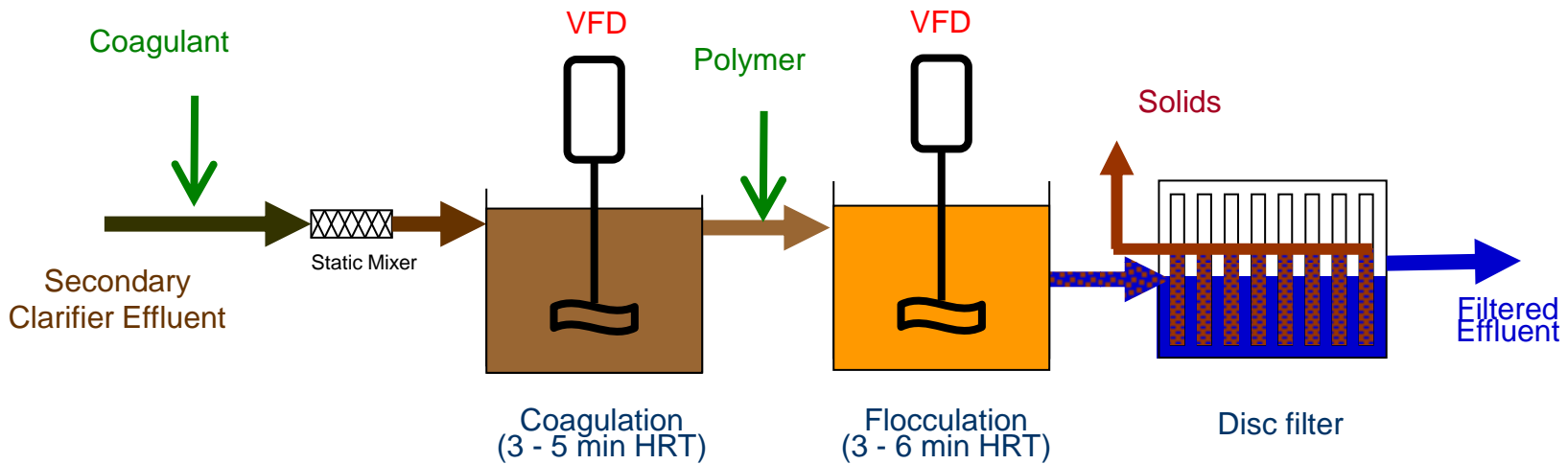
0.30 - 0.20 mg/l

- Coagulant
- Biological
- Coagulant and Polymer ?
- Disc Filter

< 0.20 mg/l

- Coagulant
- Biological
- Coagulant and Polymer
- Disc Filter

COAGULATION/FLOCCULATION PRIOR TO FILTRATION

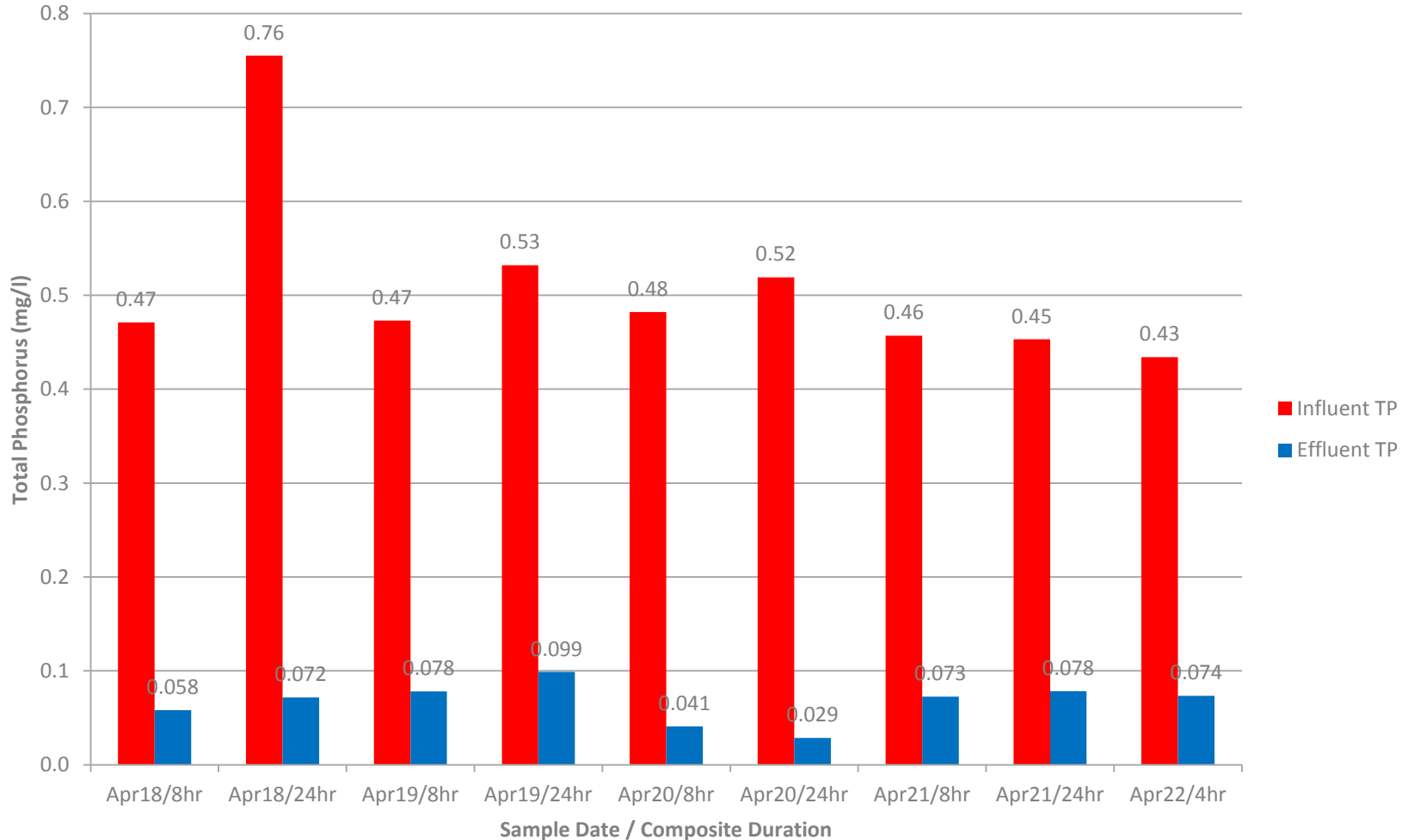


PILOT STUDY - CLINTON, MA (MARCH/APRIL 2011)

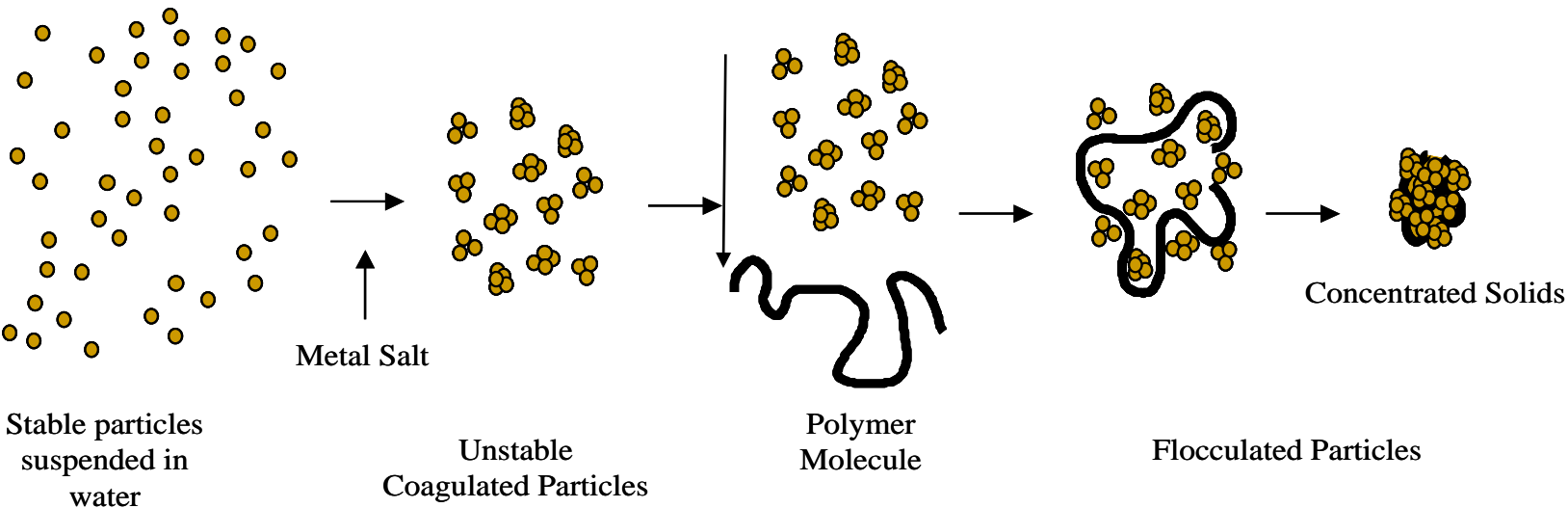
- Disc Filtration used for total Phosphorus removal - <0.10 mg/L
- Normal and Stressed Conditions
- Ferric Chloride and Aluminum Sulfate Used

CLINTON, MA

Clinton, MA Kruger Disc filter Pilot Study Week Four - April 18 to April 22

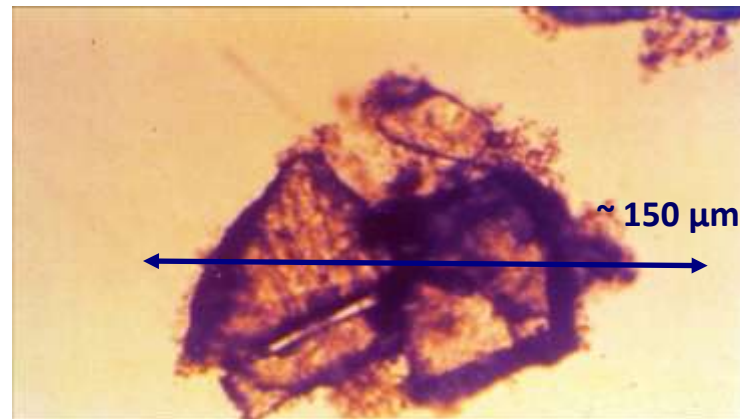
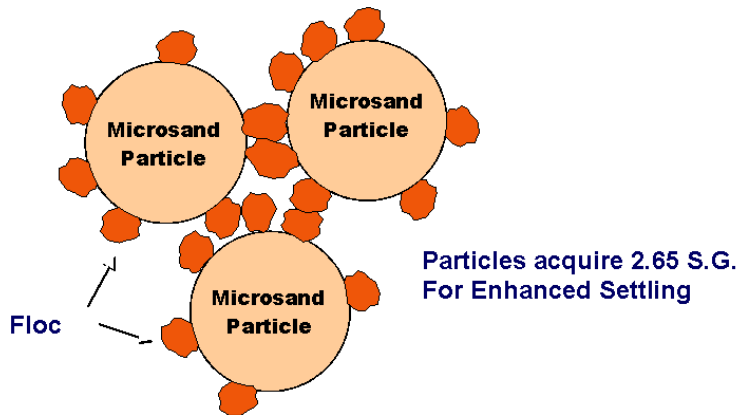


BALLASTED SETTLING - PROCESS CHEMISTRY

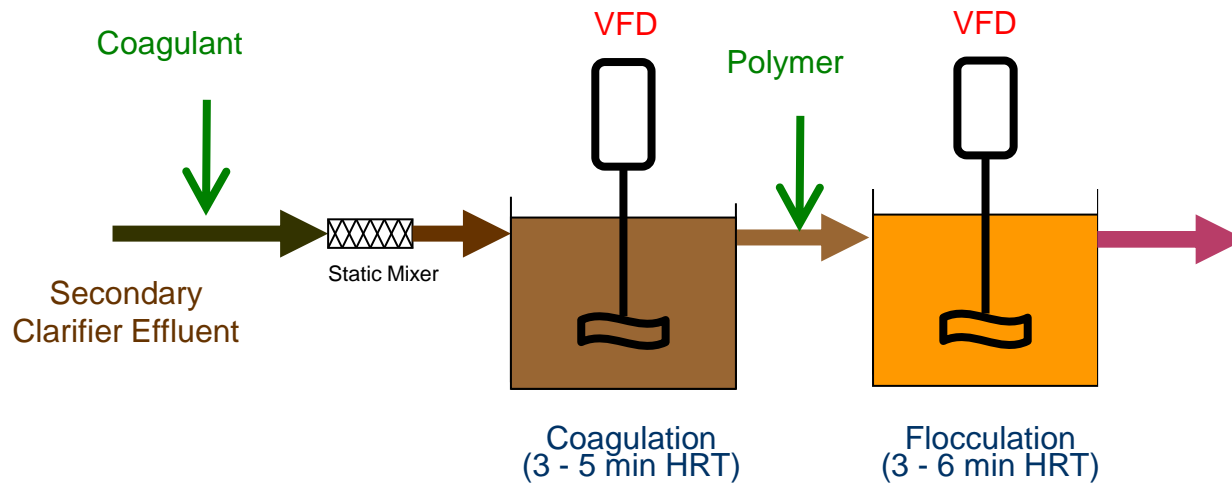


Polymer molecules bridge between suspended particles, “glue” them together as “flocs”, and concentrate the solids

BALLASTED SETTLING - FLOC PARTICLE

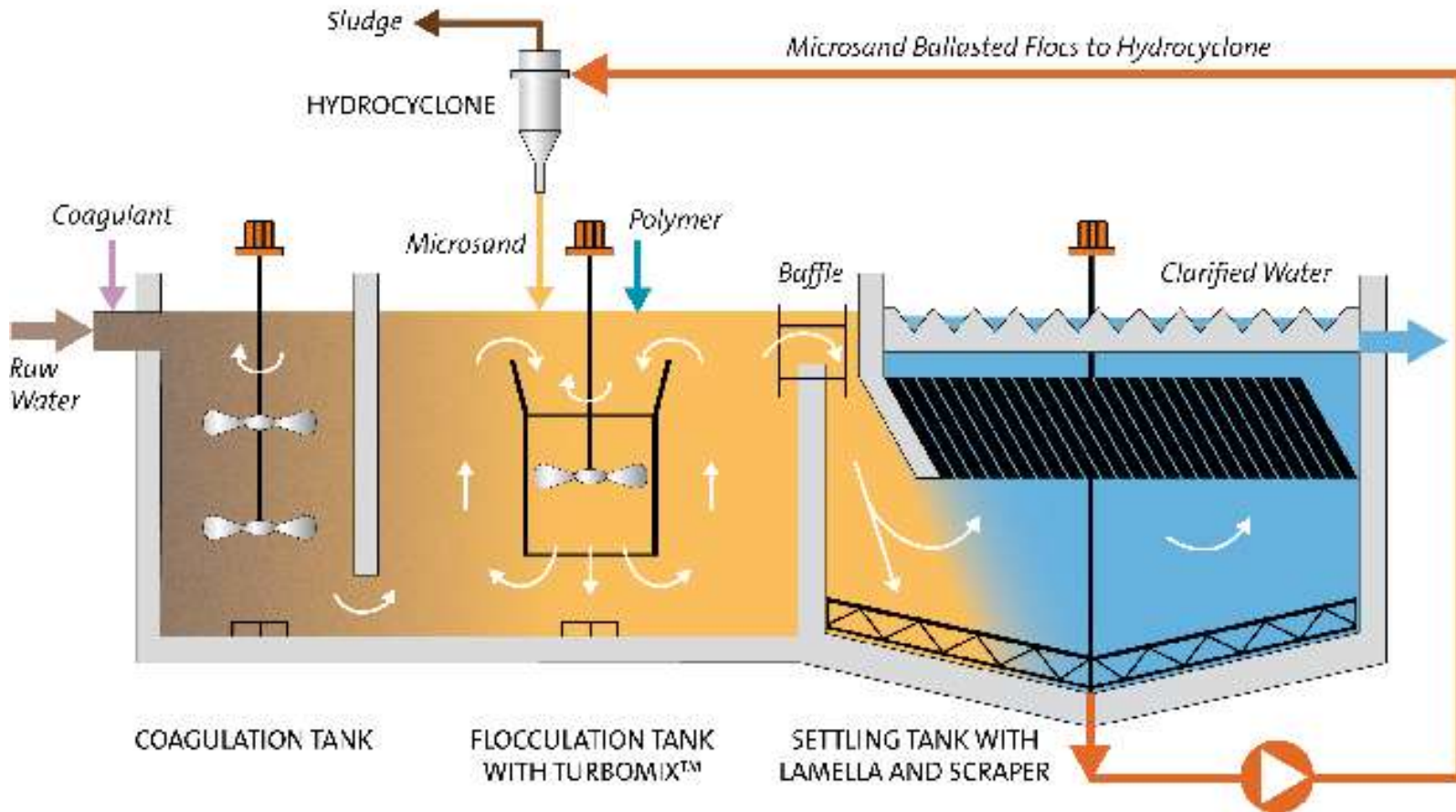


BALLASTED SETTLING - COAGULATION/FLOCCULATION

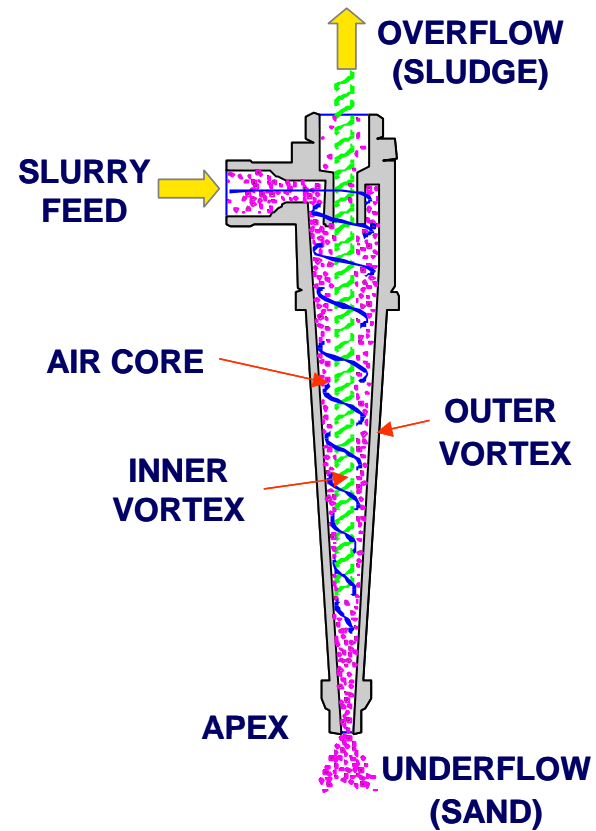


BALLASTED SETTLING - PROCESS SCHEMATIC

- High Rate Clarifier, 30-50 gpm/ft²

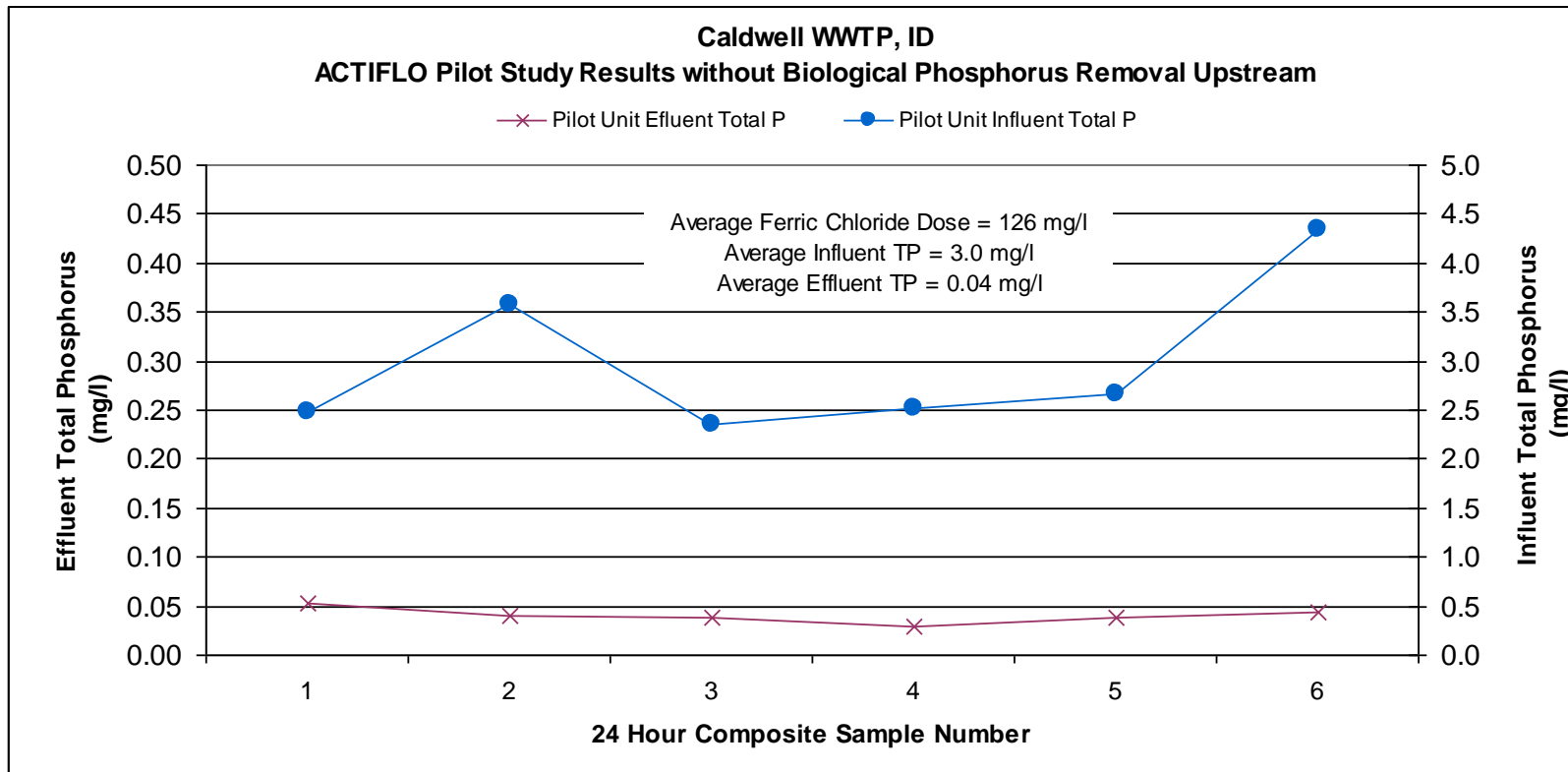


BALLASTED SETTLING - HYDRO CYCLONE SLUDGE SEPARATION



BALLASTED SETTLING - CALDWELL, ID PILOT STUDY RESULTS EXTENDED RUN WITH FERRIC CHLORIDE

- Bio-P Selector Bypassed
- Influent Total Phosphorus Increased from 0.3 mg/l to 3mg/l
- Achieve 70 ppb Effluent Total Phosphorus

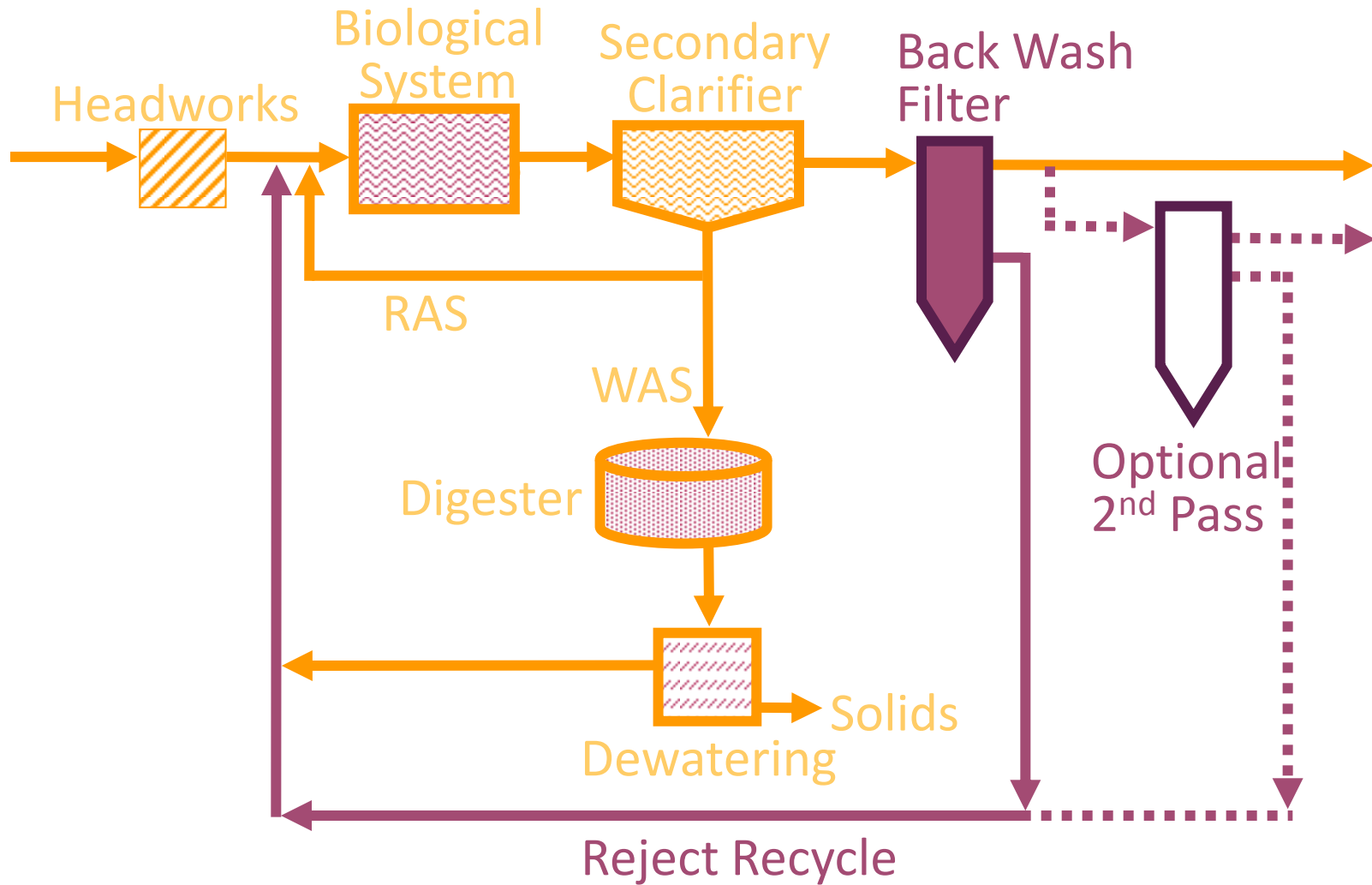


CONTINUOUS BACKWASH FILTER

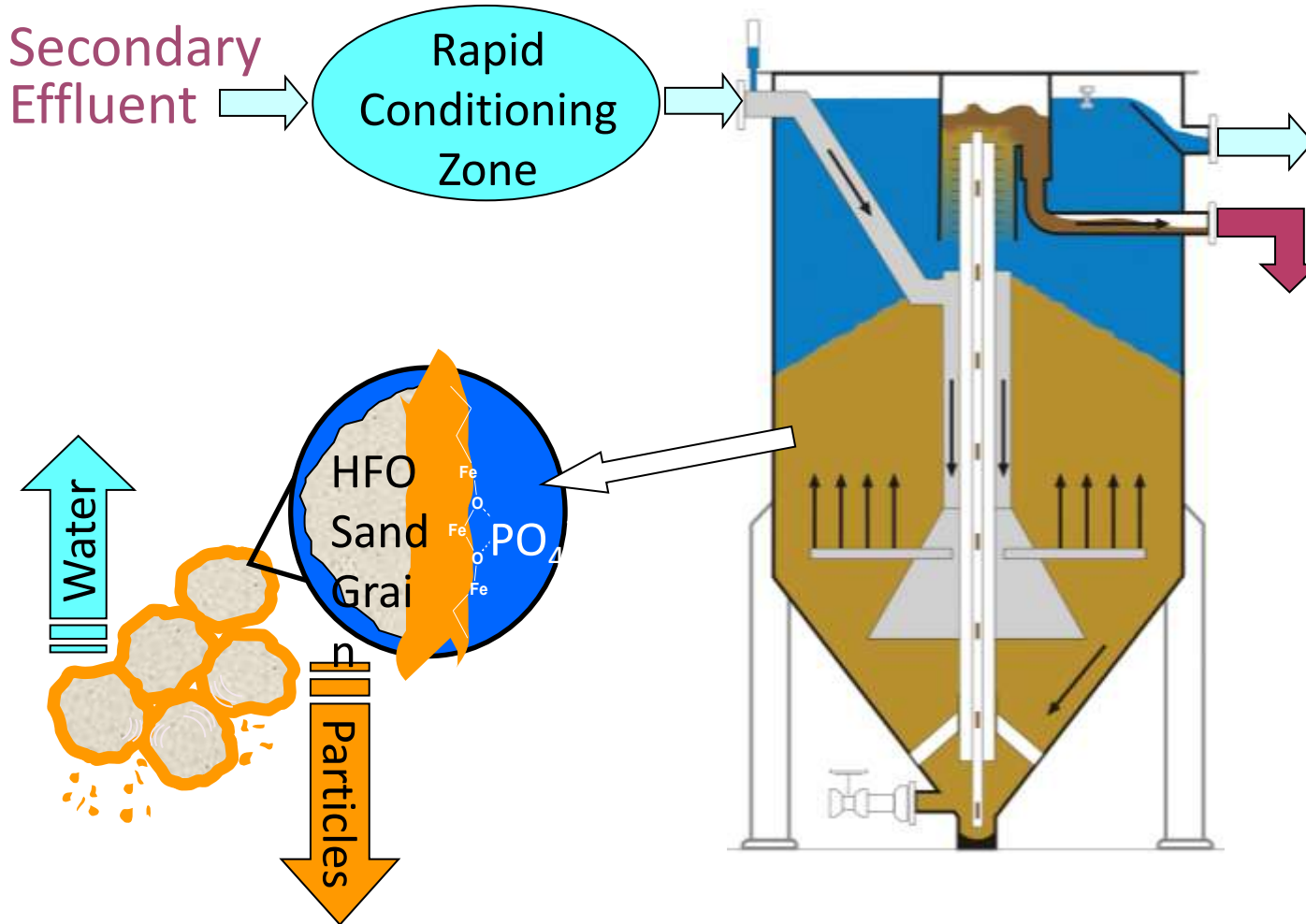
- ◉ Regenerative Adsorptive Column
- ◉ Coagulant Ferric Sulfate or Ferric Chloride



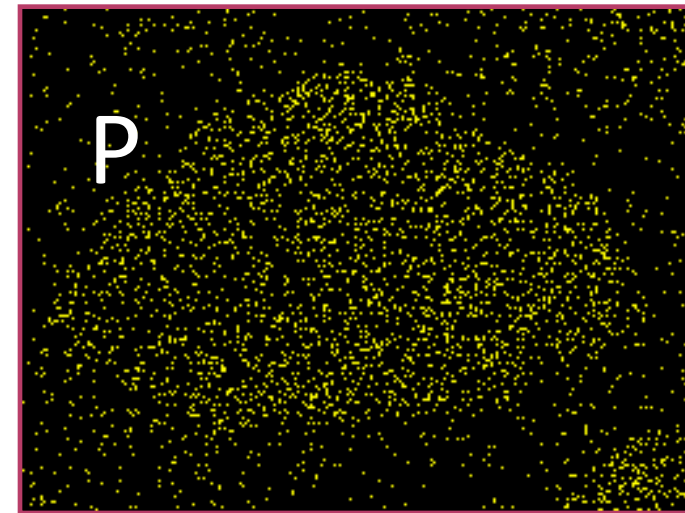
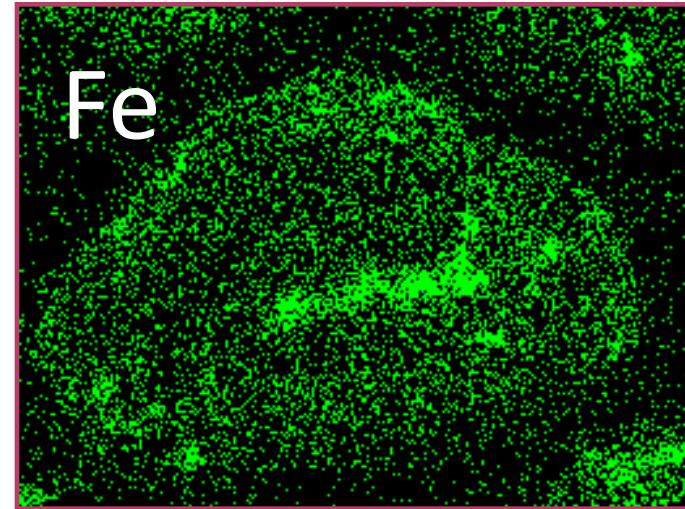
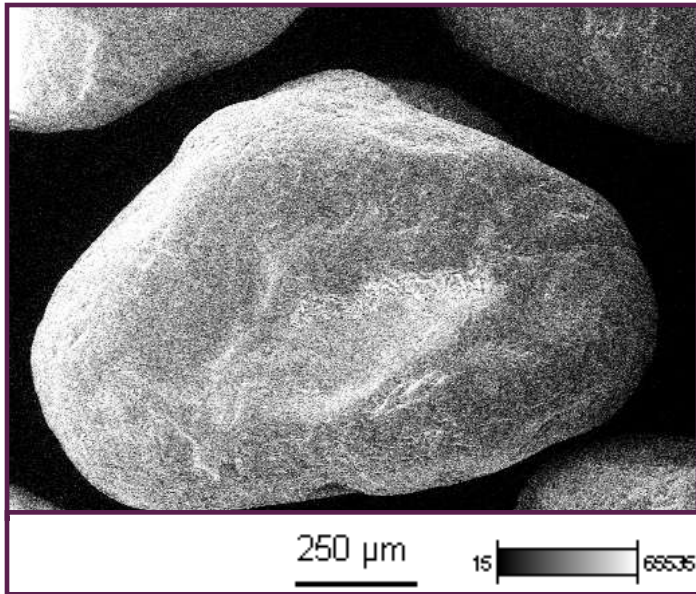
CONTINUOUS BACKWASH FILTER



CONTINUOUS BACKWASH FILTER

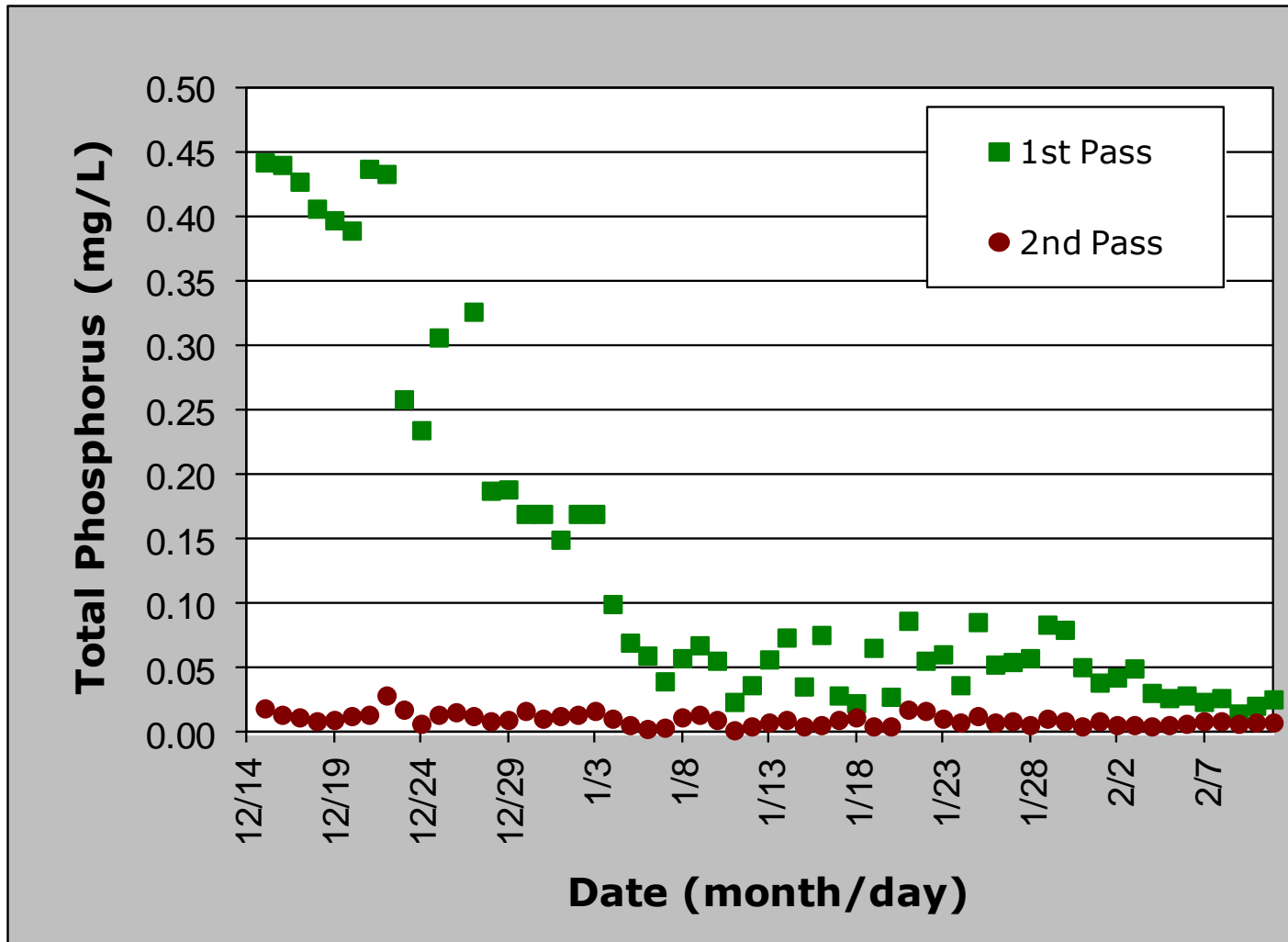


CONTINUOUS BACKWASH FILTER

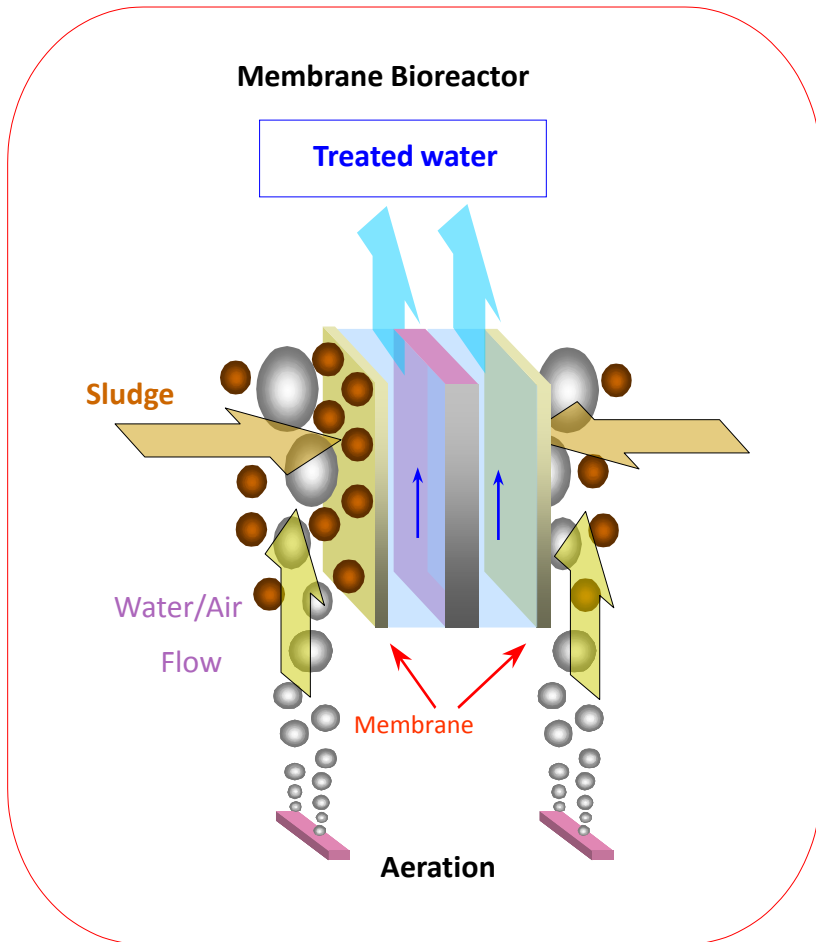


- Hydrous Ferric Oxide-Coated Sand
 - Images from scanning electron microscopy
- X-ray Fluorescence

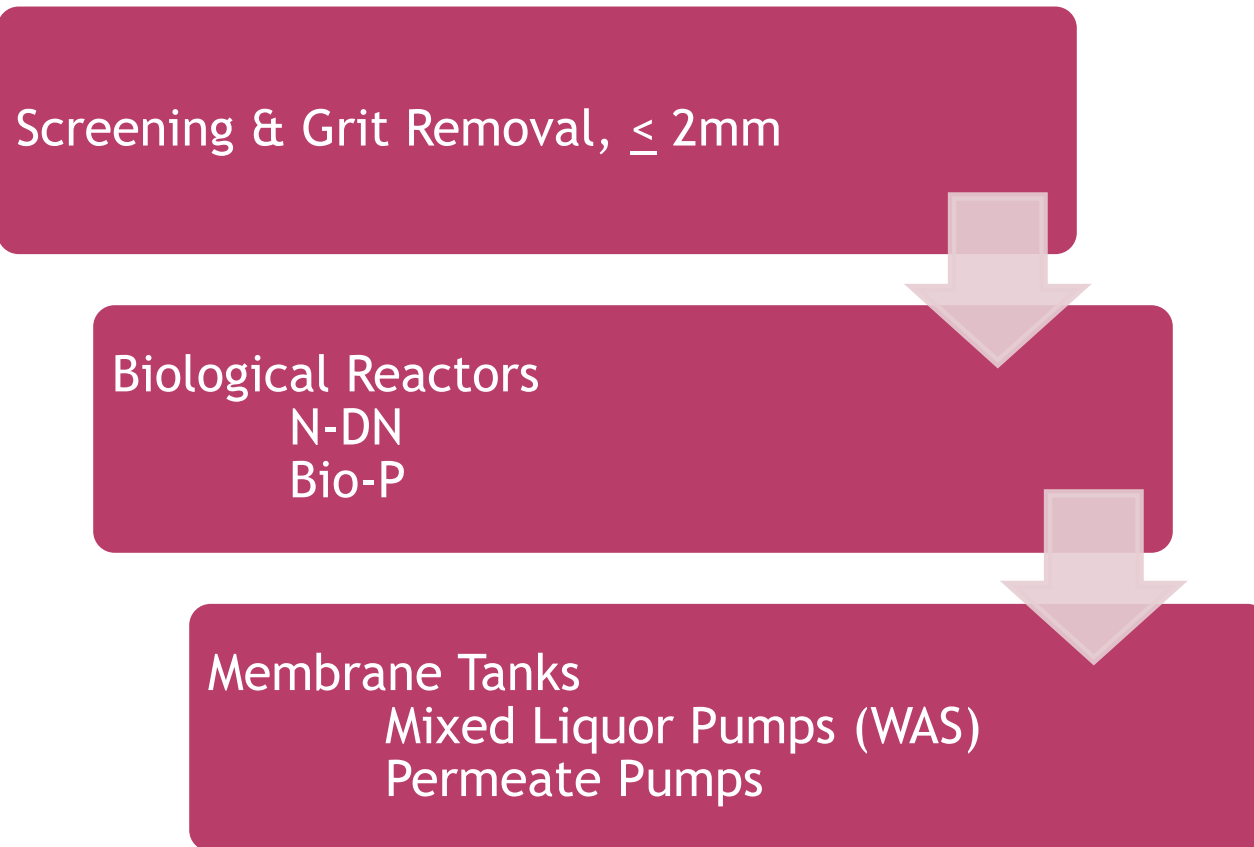
CONTINUOUS BACKWASH FILTER



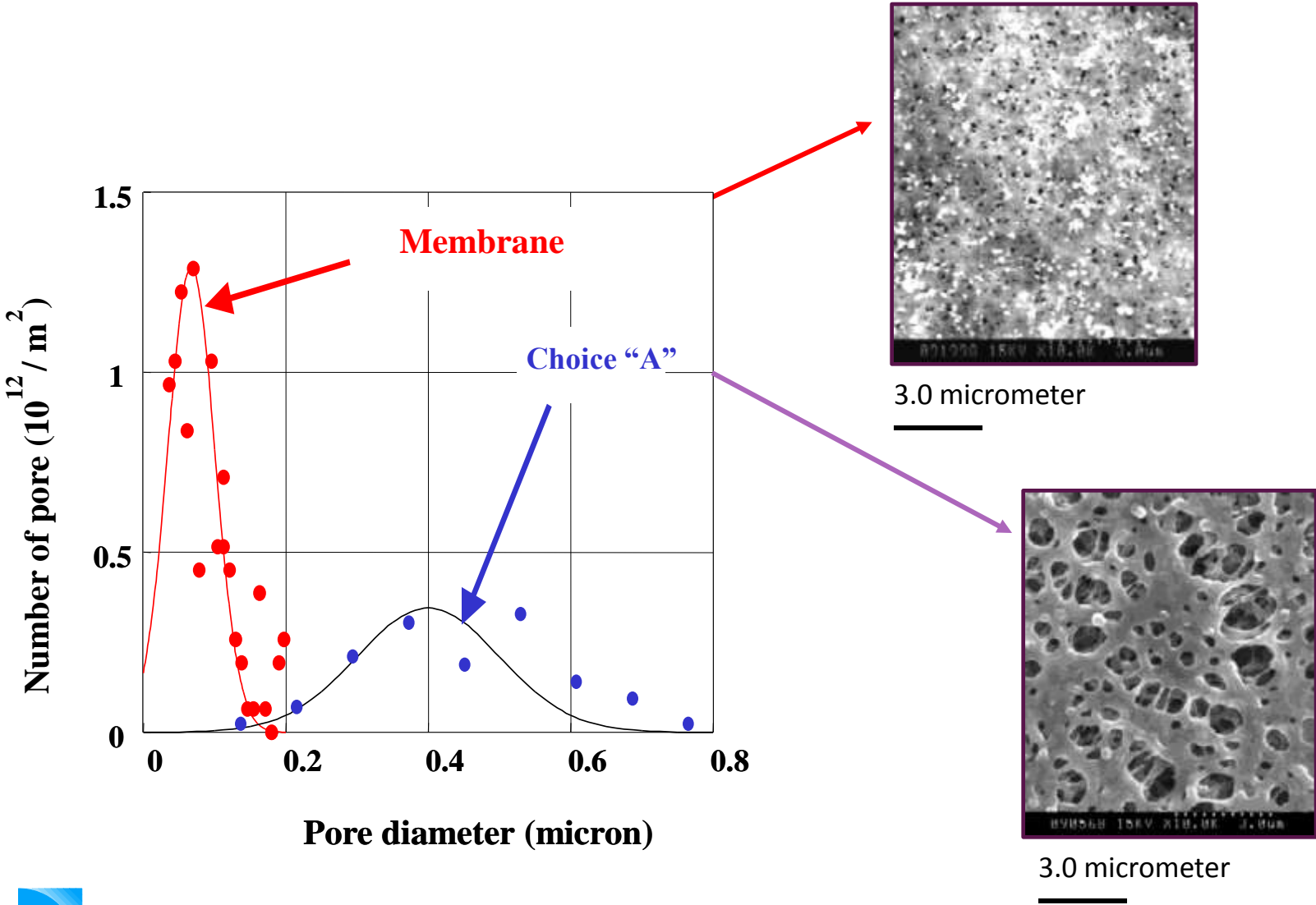
MBR



MBR PROCESS

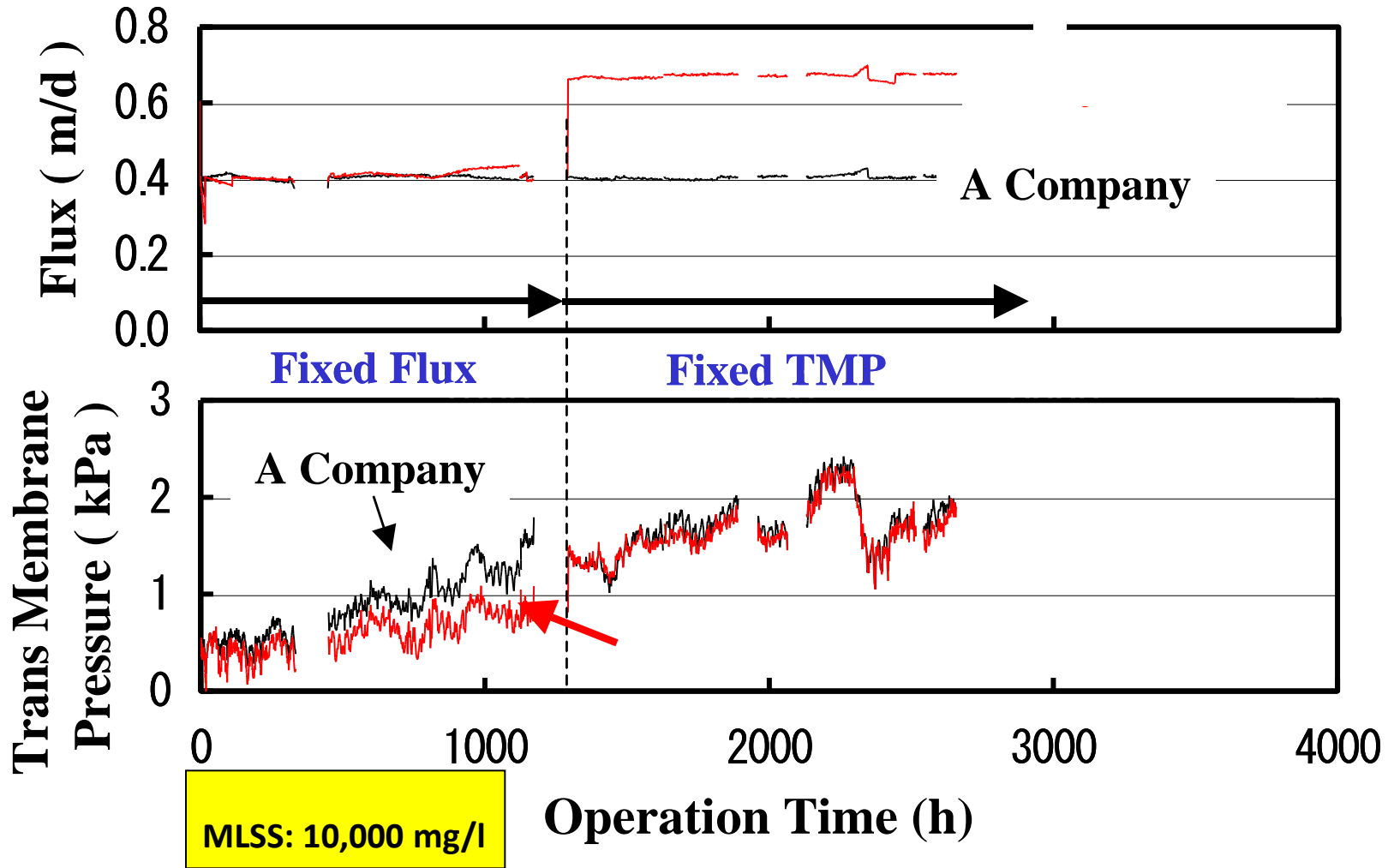


MBR - MEMBRANES



MBR FLUX & PRESSURE

Comparison of Immersed Membrane Modules

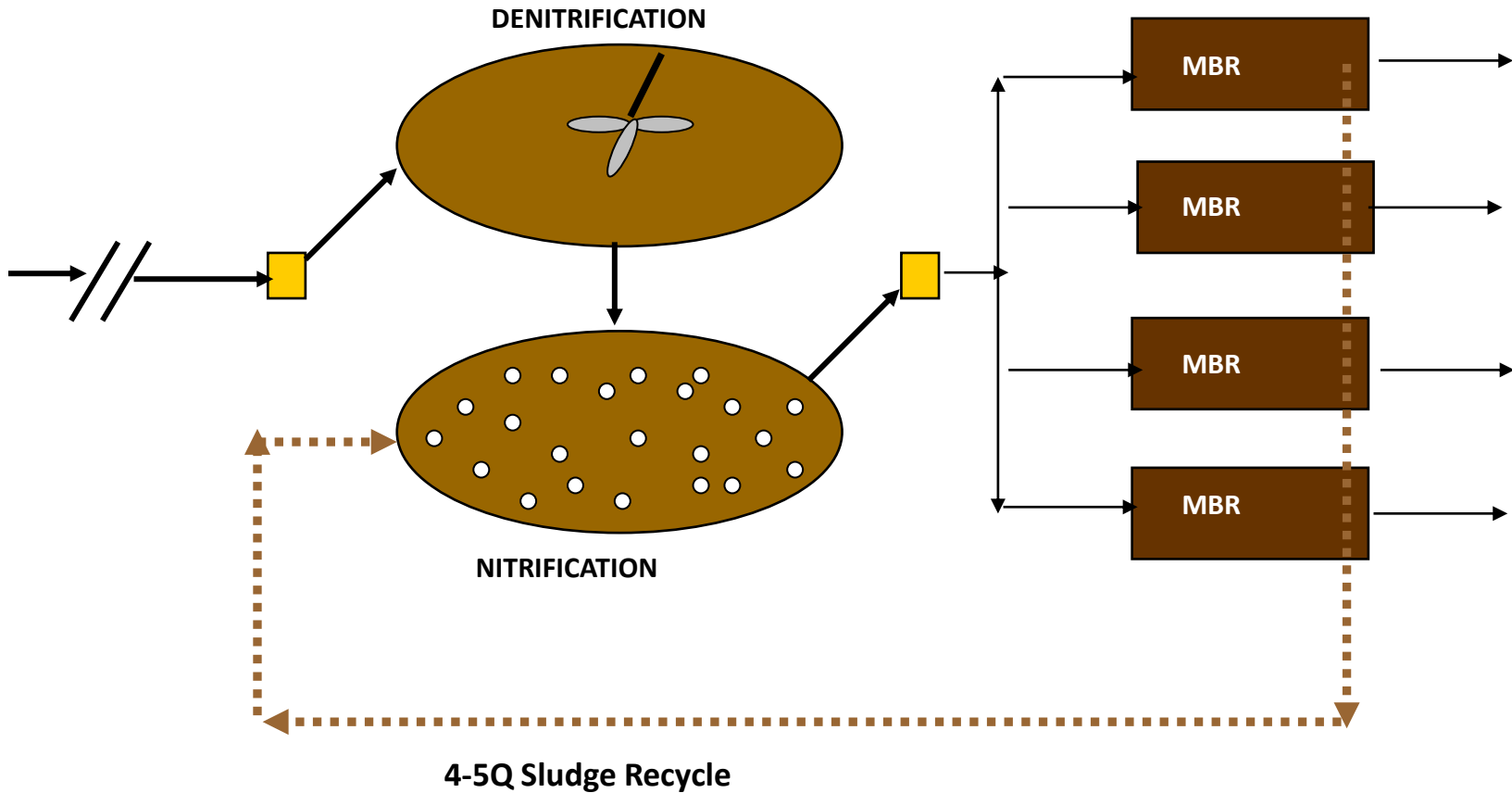


FLAT SHEET MEMBRANE

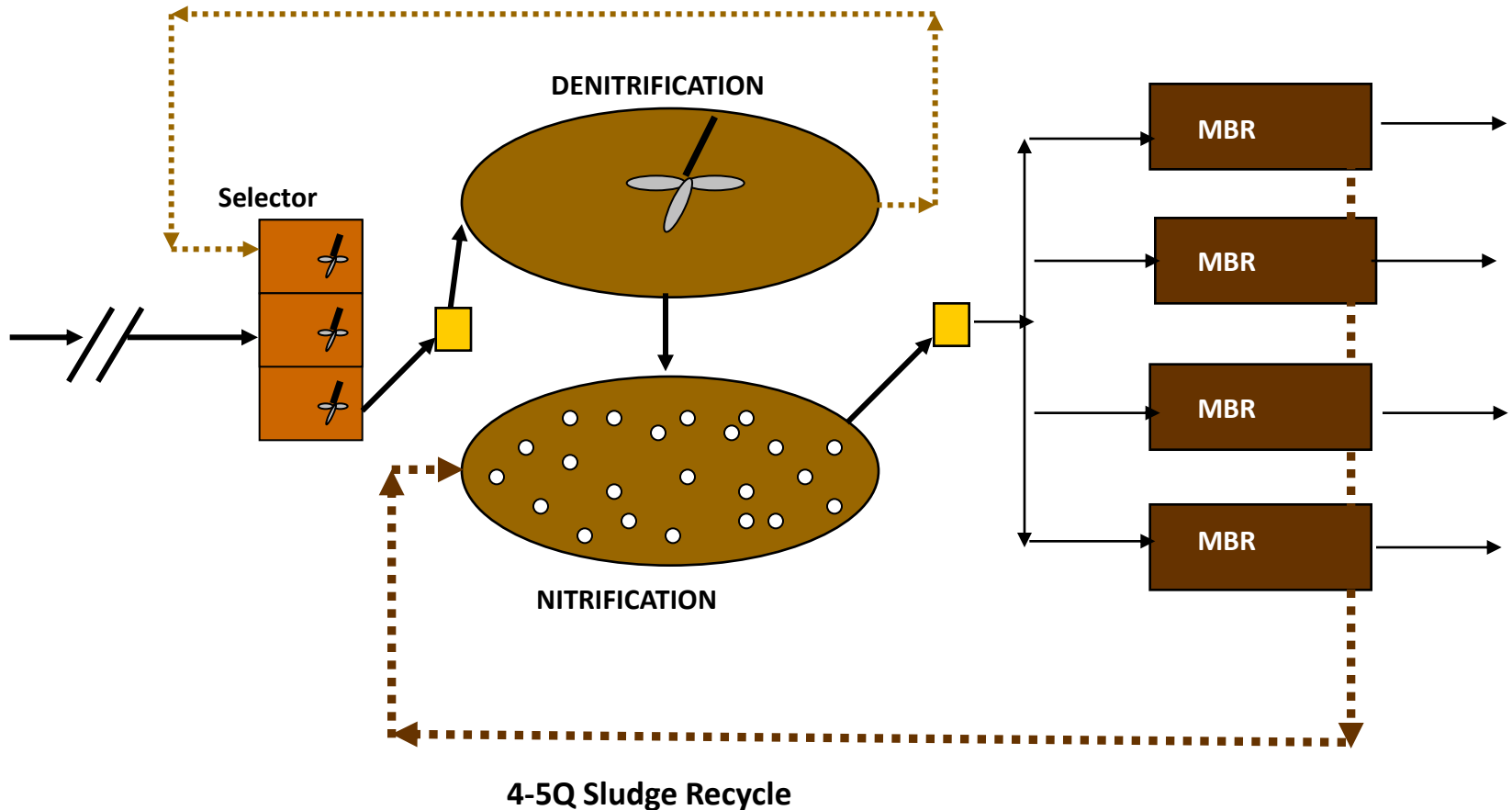


- 0.08 μm nominal pore size
- ~15 ft^2 (~1.4 m^2) per element
- 5.3' High x 1.7' Wide x 0.04' Thick

PHASED MBR - N-DN PROCESS



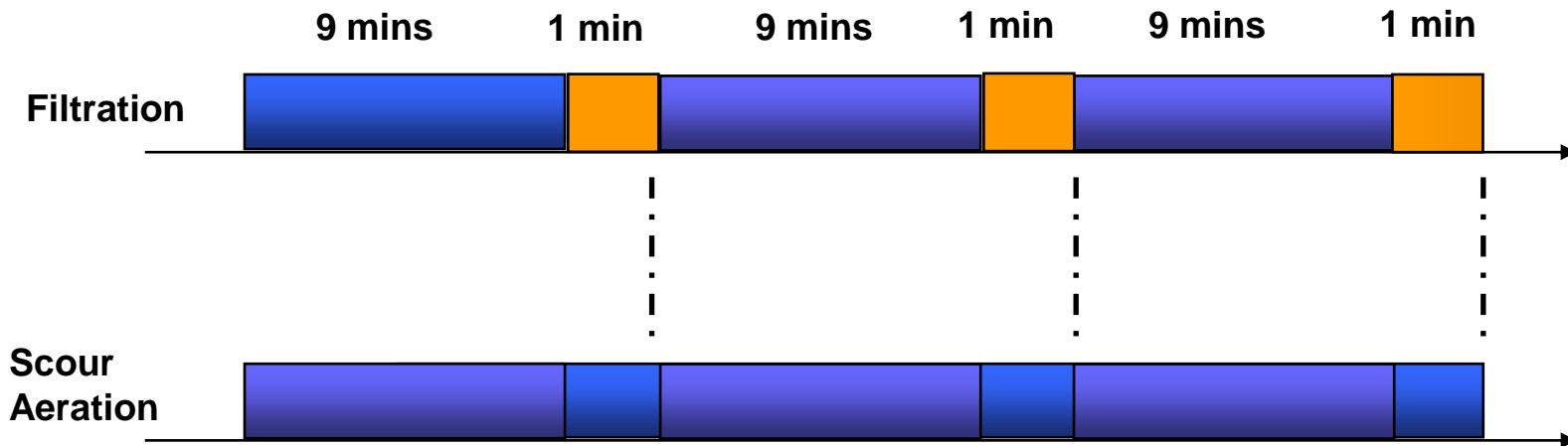
PHASED MBR - WITH BIO P REMOVAL



MBR OPERATING MODES: FILTRATION AND RELAXATION MODE

Relaxation (Intermittent Filtration)

10 minute cycle: 9 minutes filtration followed by 1 minute relaxation and suspension of permeate (aeration is continuous)



MBR - MEMBRANE TANKS



MBR - BERMUDA

- Operating since Oct 2009
- 0.25 MGD
- Gravity Flow Permeate
- Membrane Thickening



MBR - MEMBRANE TANKS

- Two tanks - Five modules each
- Membrane thickening: One tank, one module

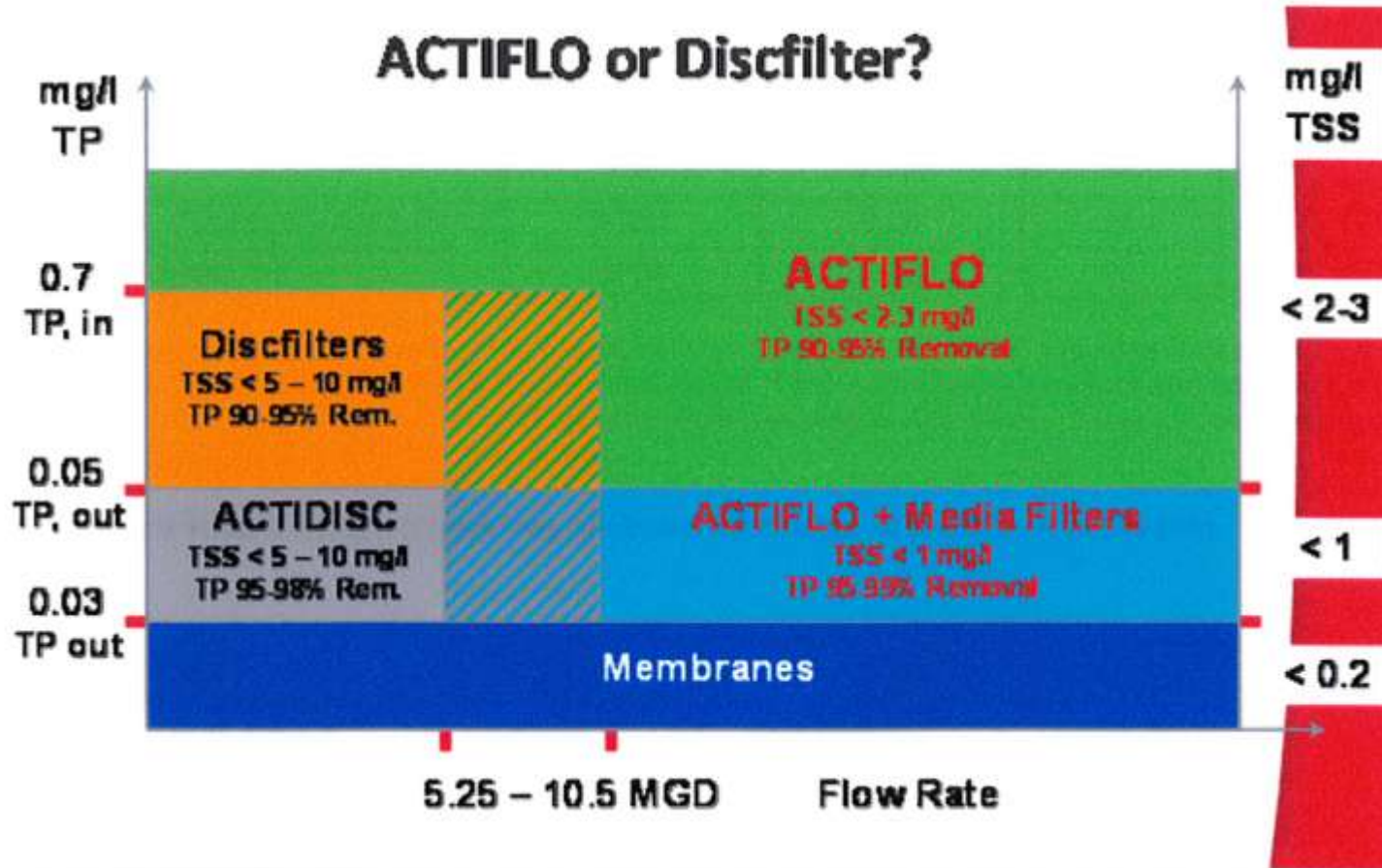


LEVELS OF TREATMENT

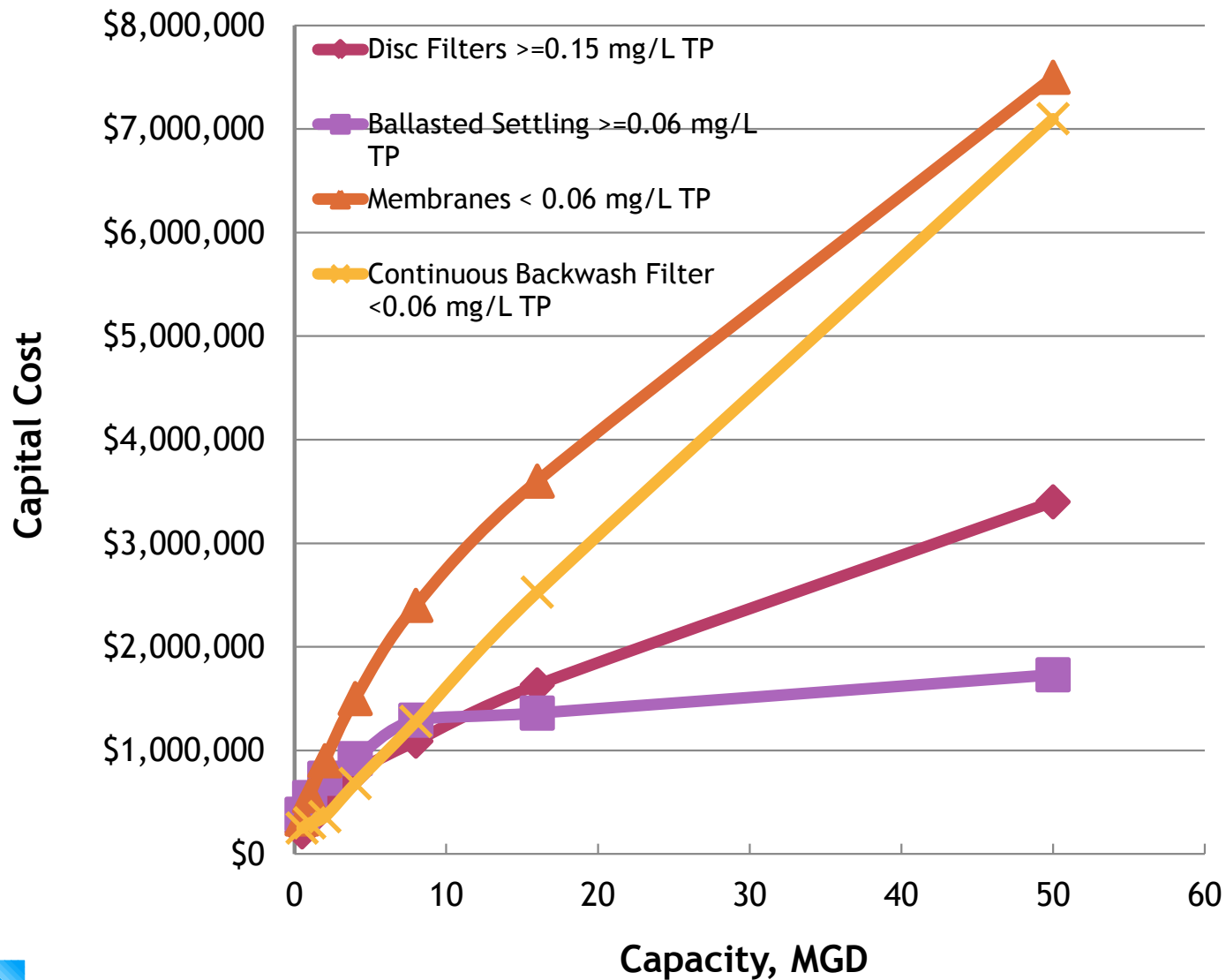
Approximate

- Disc Filtration ≥ 0.15 mg/L TP
- Ballasted Settling ≥ 0.06 mg/L TP
- Continuous Back Wash Filter < 0.06 mg/L TP
- MBR < 0.06 mg/L TP

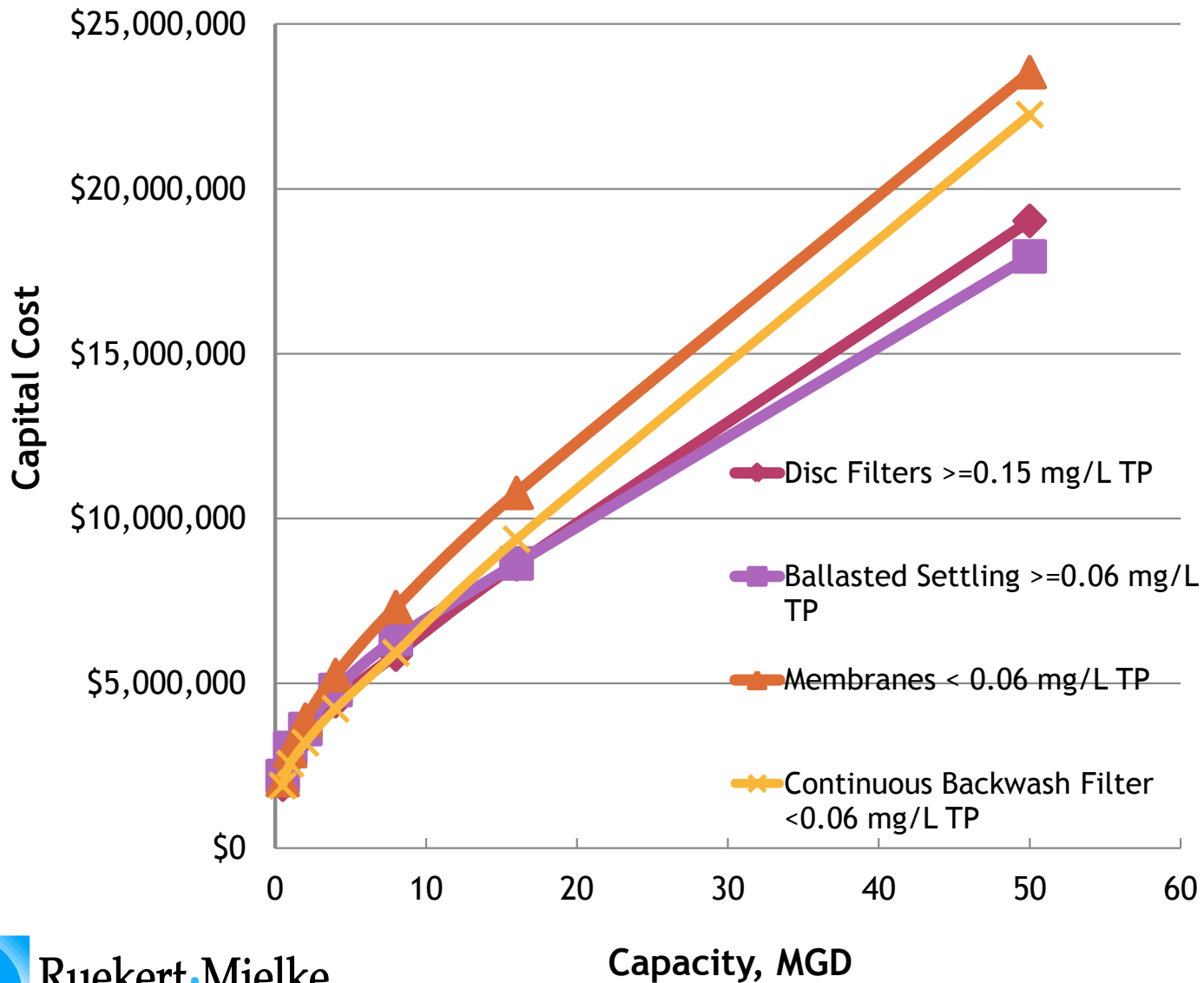
WHICH TECHNOLOGY?



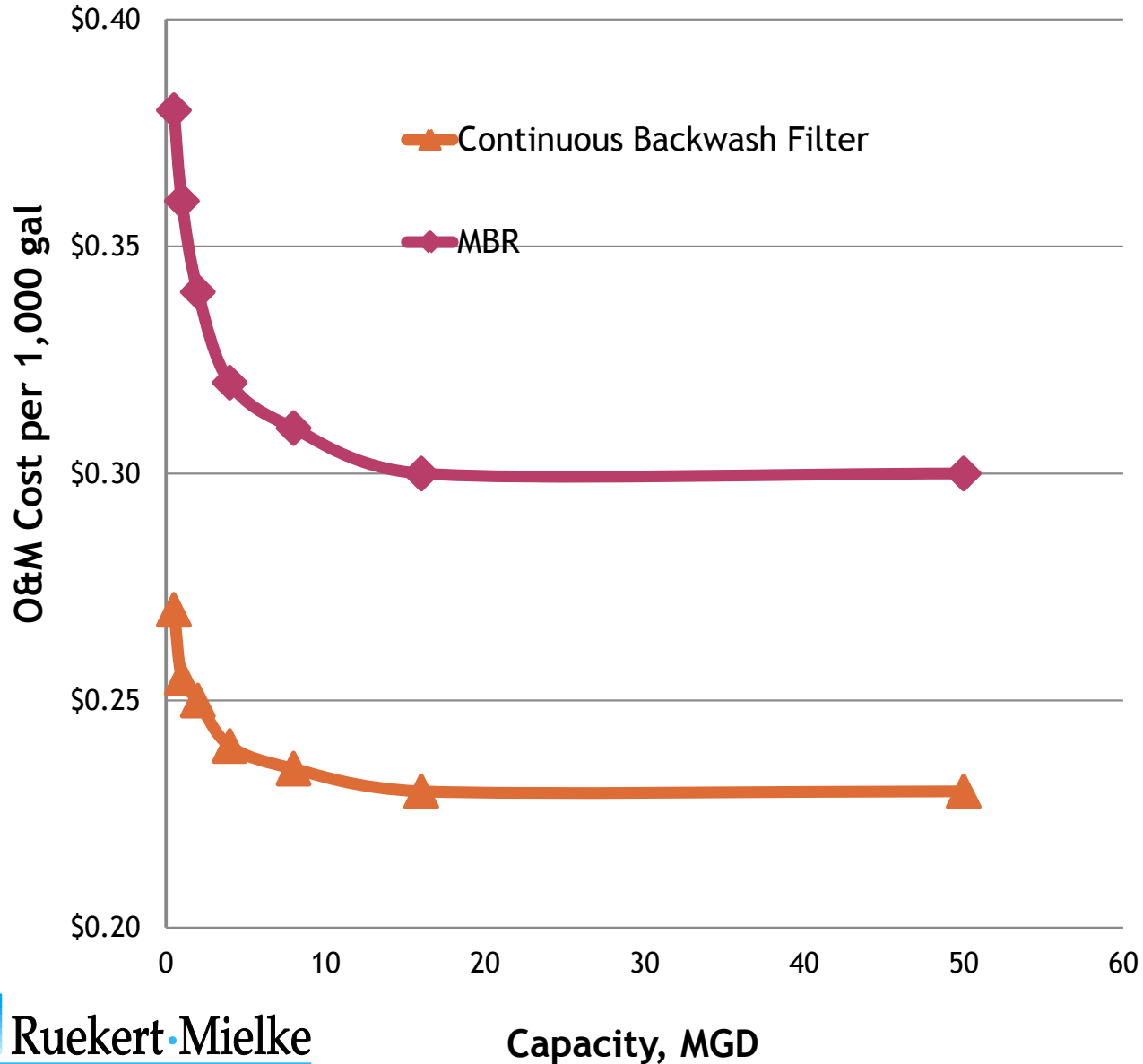
EQUIPMENT COSTS FOR PHOSPHORUS REMOVAL



WWTF FACILITY UPGRADE COSTS FOR PHOSPHORUS REMOVAL



O & M COSTS



EQUIPMENT SIZING

- ⦿ Not always peak hour flow
- ⦿ 365 Day Average, Total P Limit
- ⦿ Blending Potential

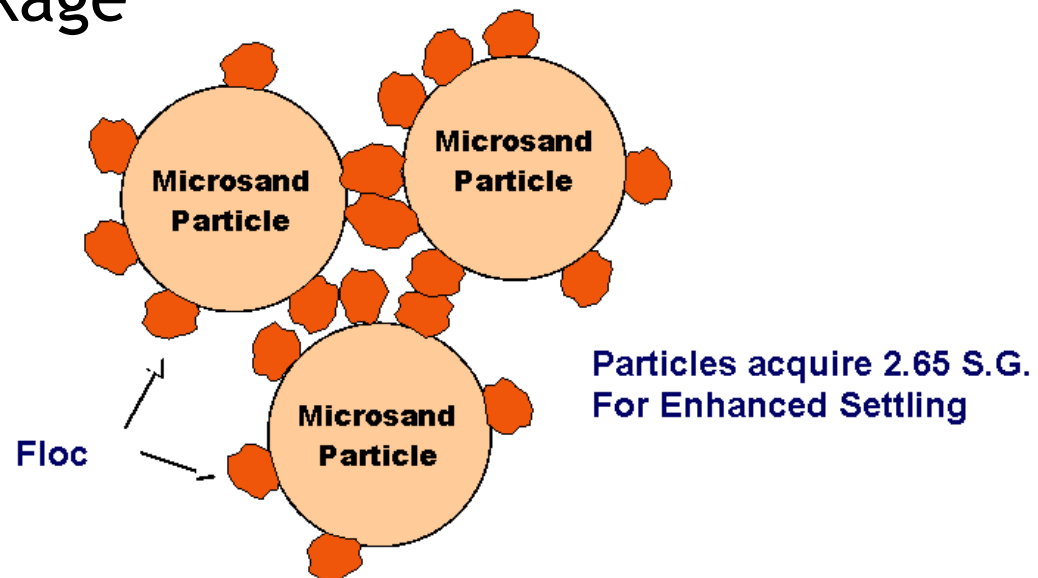
DISC FILTRATION - TAKE AWAYS

- Tertiary Polishing \neq Phosphorus Treatment
- Phosphorus Reduction - Need Coagulation or Flocculation
 - In-pipe dosing not sufficient
 - Mixing, energy critical
- Floc needs structural integrity
- Use existing tankage (if possible)



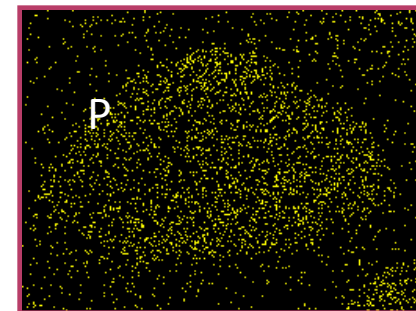
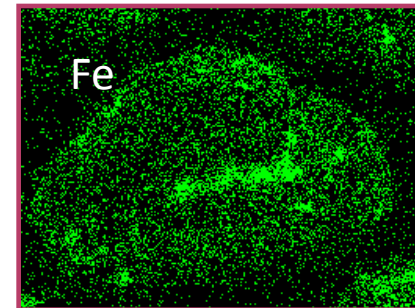
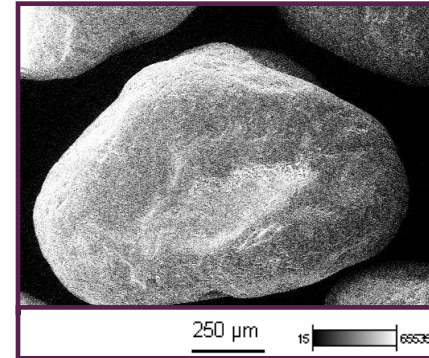
BALLASTED SETTLING - TAKEAWAYS

- Enhanced Floc Formation
- Shorter HRT → Higher Loading Rate
- Mixing energy critical
- Use existing tankage
(if possible)



CONTINUOUS BACKWASH FILTERS - TAKEAWAYS

- Regenerative Adsorption Process
- Hydrous Ferric Oxide-Coated Sand
- Multiple Passes for Additional Treatment
- Lower Coagulant Dose
- Reject Stream
 - Possible Re-use



MBR - TAKEAWAYS

- High level of treatment
 - P
 - Water reuse
 - Micropollutants
- Energy intensive
- High Capital Cost
- Compact footprint
- Membrane fouling critical
 - Aeration
 - Intermittent relaxation
 - Backwashing
 - Citric Acid



QUESTIONS?