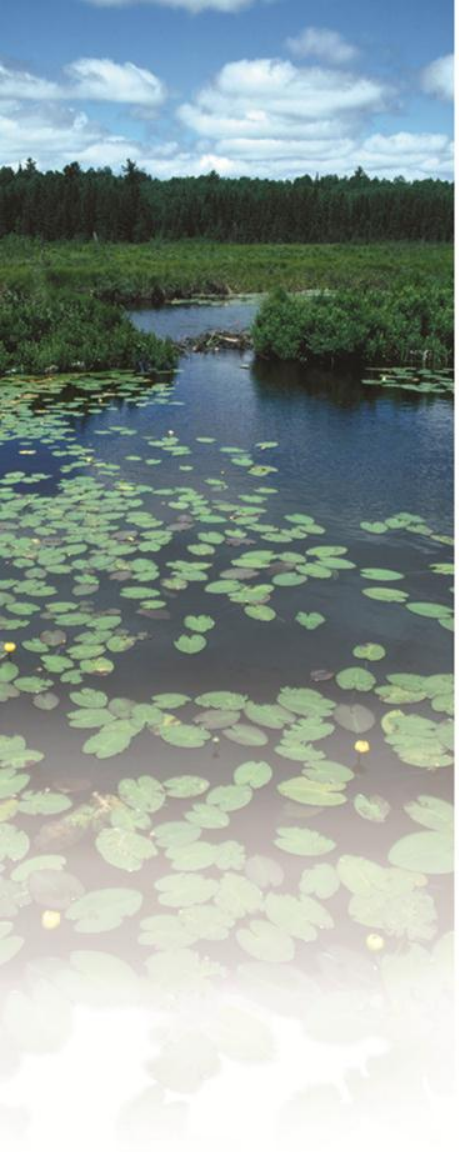


General Operational Considerations in Nutrient and Wet Weather Flow Management for Wastewater Treatment Facilities *Part III*

Samuel Jeyanayagam, PhD, PE, BCEE
Julian Sandino, PhD, PE, BCEE

CH2MHILL

Ohio WEA Plant Operations Workshop
September 28, 2011

Presentation Outline

- Why Remove Nutrients?
- Overview of Wastewater Treatment
- Nutrient Removal Fundamentals
  - Phosphorus Removal
  - Nitrogen Removal
- Sustainability Considerations
- Design & Operational Considerations
- Managing Wet Weather Flows in Nutrient Removal Facilities

Part I

Part II

Part III

Wet Weather Treatment Requires a Paradigm Shift…

Dry Weather	Wet Weather
• Environmental & public health driven	• Mainly public health driven
• Relatively constant flow & loads	• Highly variable flow & loads
• Stable performance	• Variable performance
• Year-round optimization	• Event optimization
• Capital & O&M Costs	• Mainly capital driven

Wet-Weather Treatment Requirements

- Visible floatables and gross solids
- Pathogens
- TSS
- BOD_5
- Toxic organics & metals
- Nutrients

What is the Most Critical Wet Weather Process Concern?

- cBOD removal generally not an issue
- Bio-P removal could potentially be impacted due to:
  - Reduced substrate (VFA) concentrations
  - Lower influent temperature
- Can be addressed by providing stand by chemical system

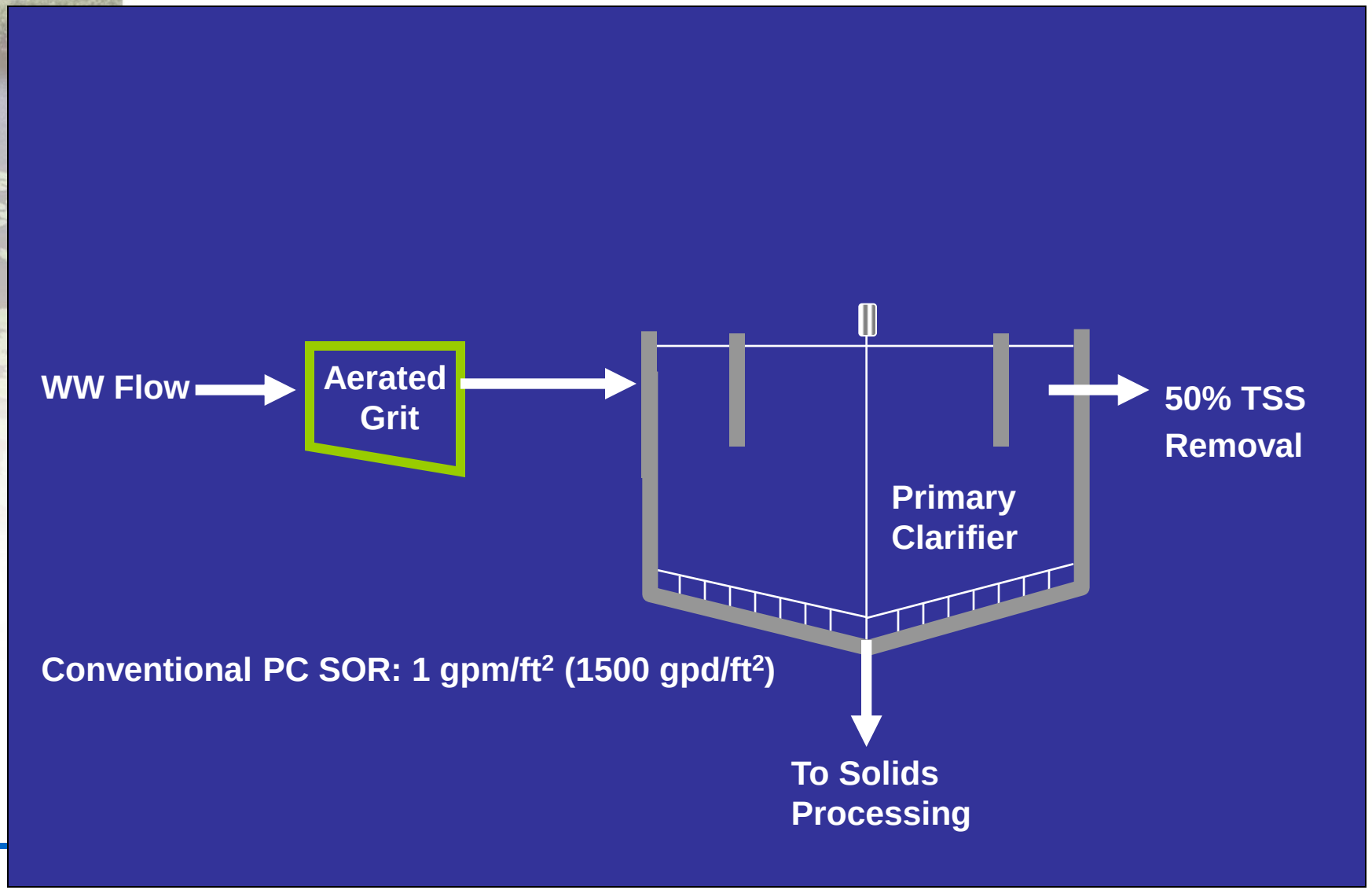
Nitrification is the Most Critical Wet Weather Process Issue

- High flows could potentially result in solids (bugs) washout
- Solids washout = unintentional wasting reduces SRT
- Following the rain event, considerable time would be required to reestablish the solids inventory
- The result: potential ammonia nitrogen violation

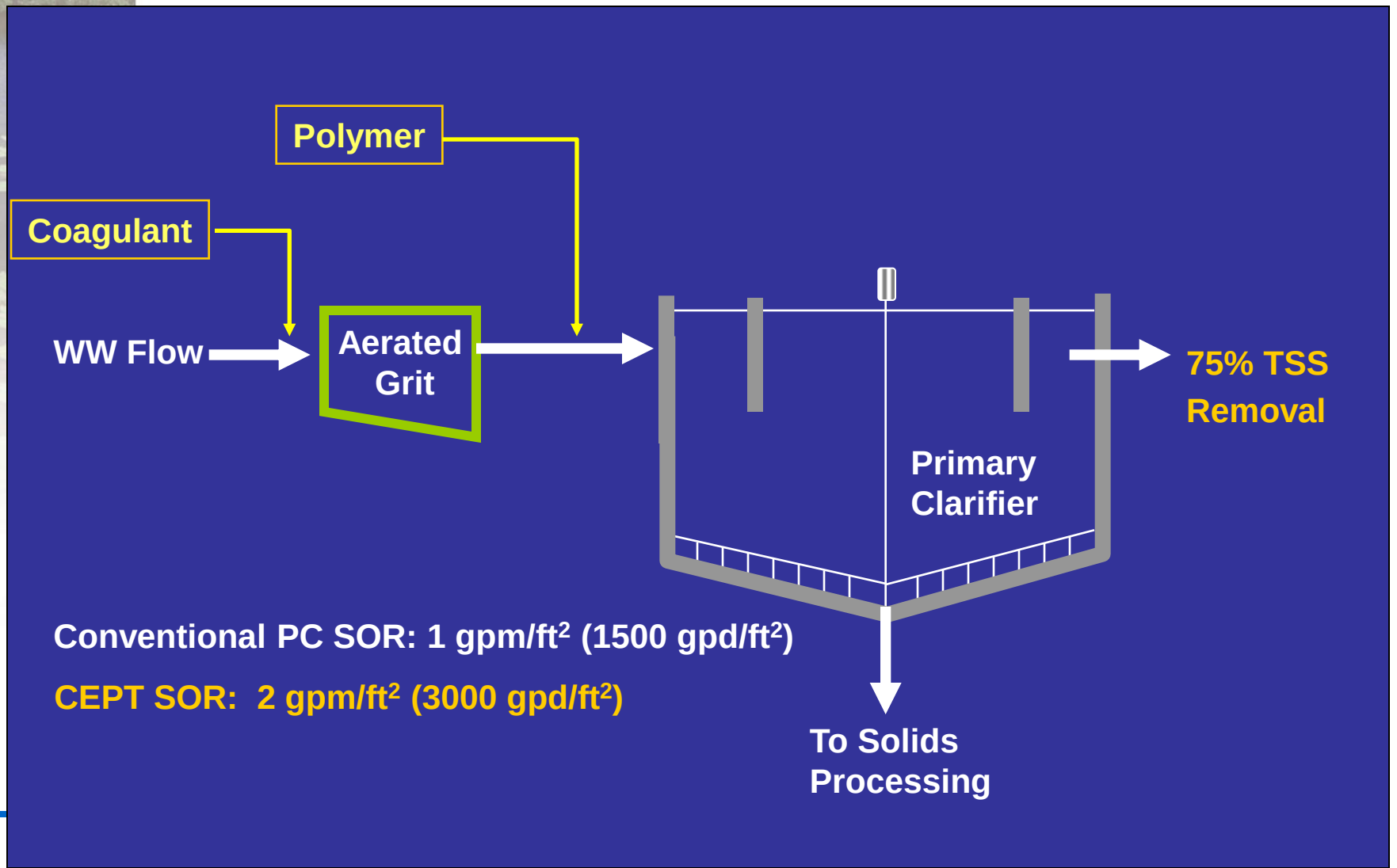
CEC Wet-Weather Flow Toolbox

- Chemically Enhanced Primary Treatment (CEPT)
- High Rate Clarification (HRC)
- Biological Enhanced High Rate Clarification (Bio HRC)

Conventional Primary Clarification



Chemically Enhanced Primary Treatment (CEPT)



Conventional PC SOR: 1 gpm/ft^2 (1500 gpd/ft^2)

CEPT SOR: 2 gpm/ft^2 (3000 gpd/ft^2)

Chemically Enhanced Primary Treatment (CEPT)

Recent evolution of a proven concept…

- Coagulants
  - Alum (30-70 ppm)
  - Fe salts (15-50 ppm; eliminates H_2S; affects UV disinfection)
- Flocculation aid
  - 0.3 - 2.0 ppm poly

Chemically Enhanced Primary Treatment (CEPT)

Increased performance over conventional process

- SOR's: 3,000 gpd/sf
- Removals
  - TSS: 70 - 80%
  - BOD_5: a function of suspended and colloidal fraction;
  - Time in hydro/pollutograph
- Sludge:
  - Additional raw solids
  - 15-20% chemical sludge

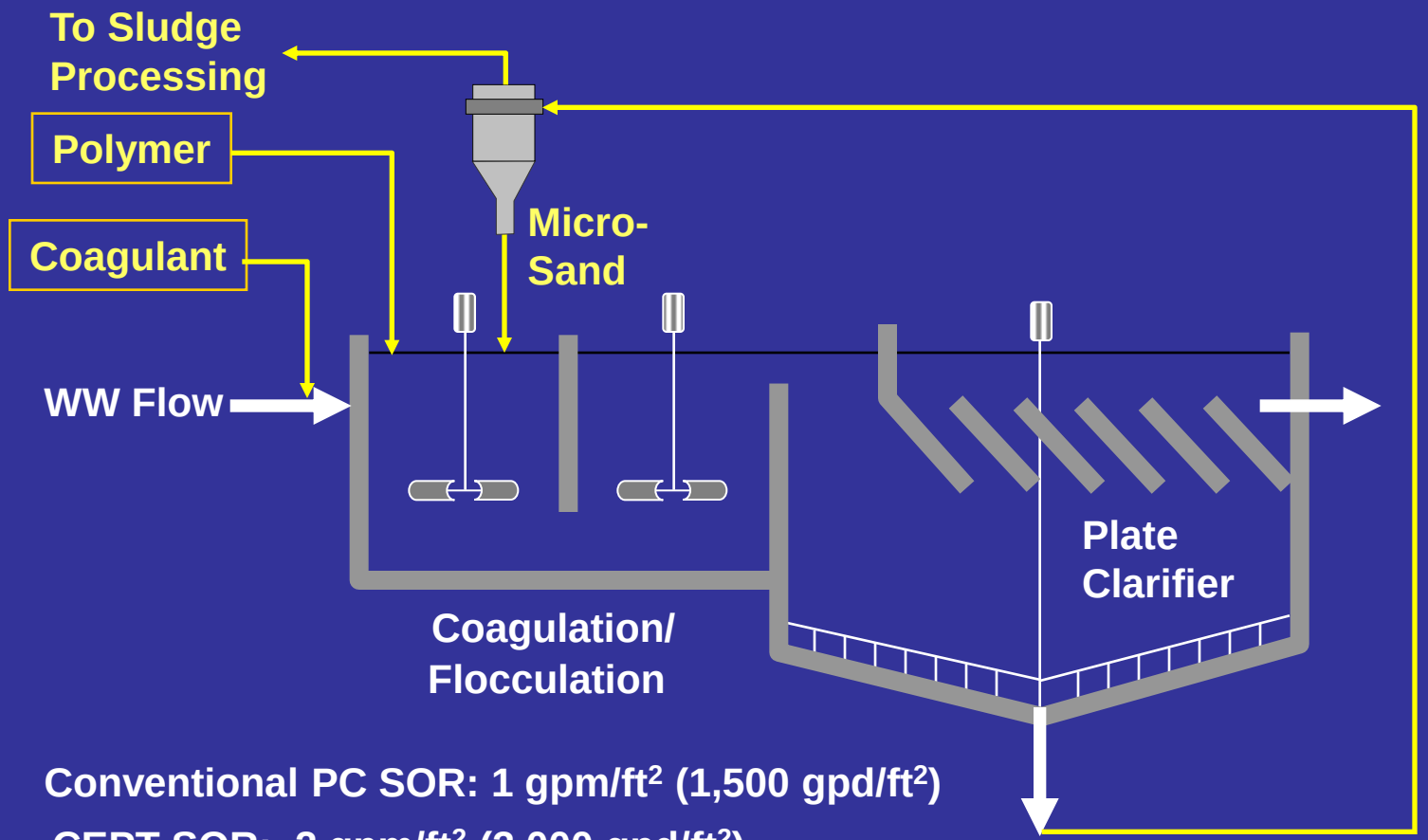
High Rate Clarification (HRC)

- Water treatment origin (Europe); successful "cross-over" to wet-weather applications
- Chemically assisted tube/plates clarification
- Extremely compact
  - SOR : 90 - 150 m/h (30-50 x's conventional PC)
  - HRT: 8 - 10 min

High Rate Clarification (HRC)

- Dosages
  - $FeCl_3$ (50 - 100 mg/l); Alum (70 -150 mg/l)
  - Polymer: 0.5 - 2.0 mg/l
- Removal efficiencies
  - TSS: 85 - 95%
  - BOD ~ 50%
  - TKN: 15 - 30 %
  - P: 50 - 90 % ~ f(dose)
  - Stable at variable influent (flows, loads)
  - Start-up ~ 15 - 30 min
  - Pilot testing still recommended

High Rate Clarification (HRC): ACTIFLO® (KRUGER)



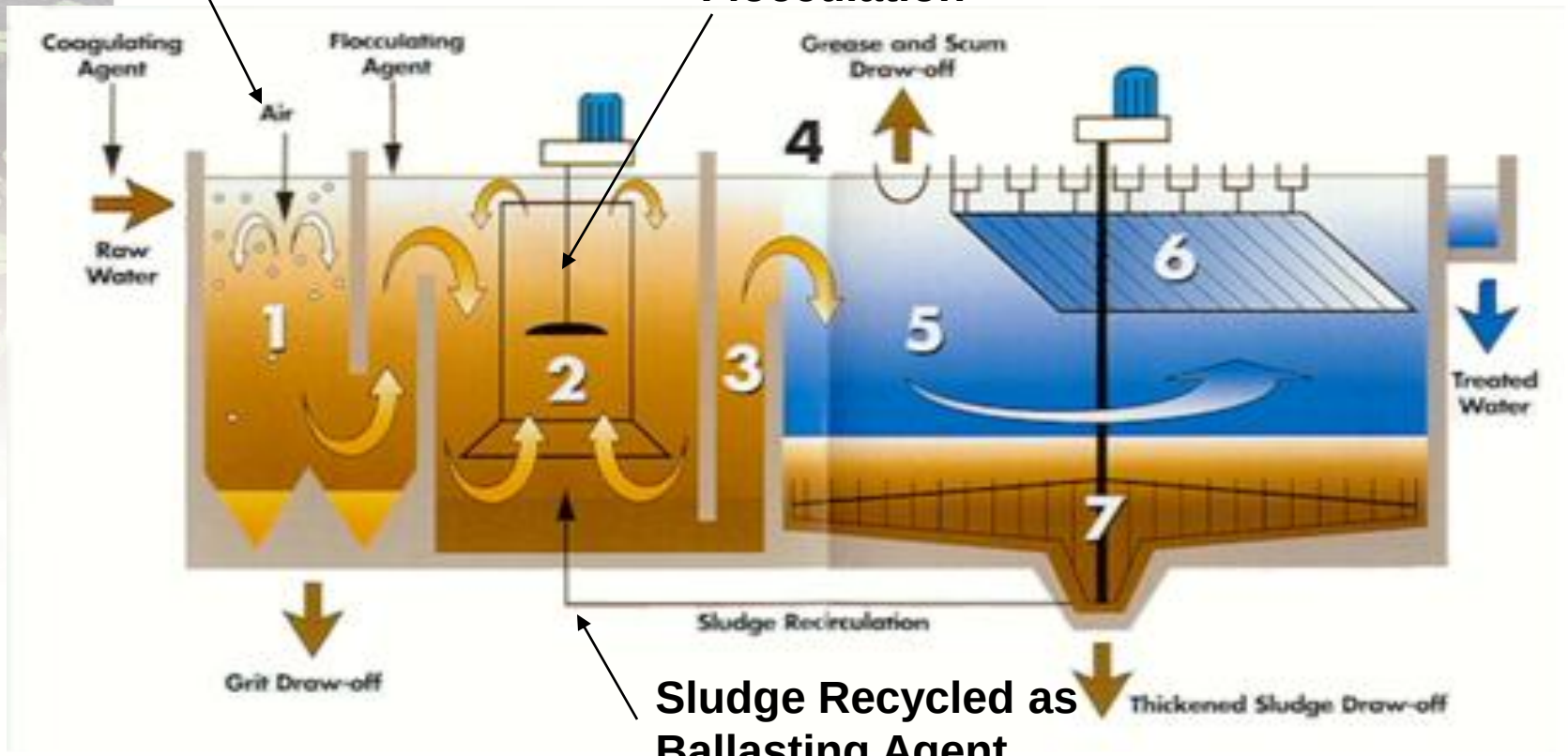
Conventional PC SOR: 1 gpm/ft^2 (1,500 gpd/ft^2)

CEPT SOR: 2 gpm/ft^2 (3,000 gpd/ft^2)

Lamella SOR: 5 gpm/ft^2 (7,000 gpd/ft^2)

Actiflo SOR: 50 gpm/ft^2 (72,000 gpd/ft^2)

High Rate Clarification (HRC): DensaDeg® 4D System (IDI)

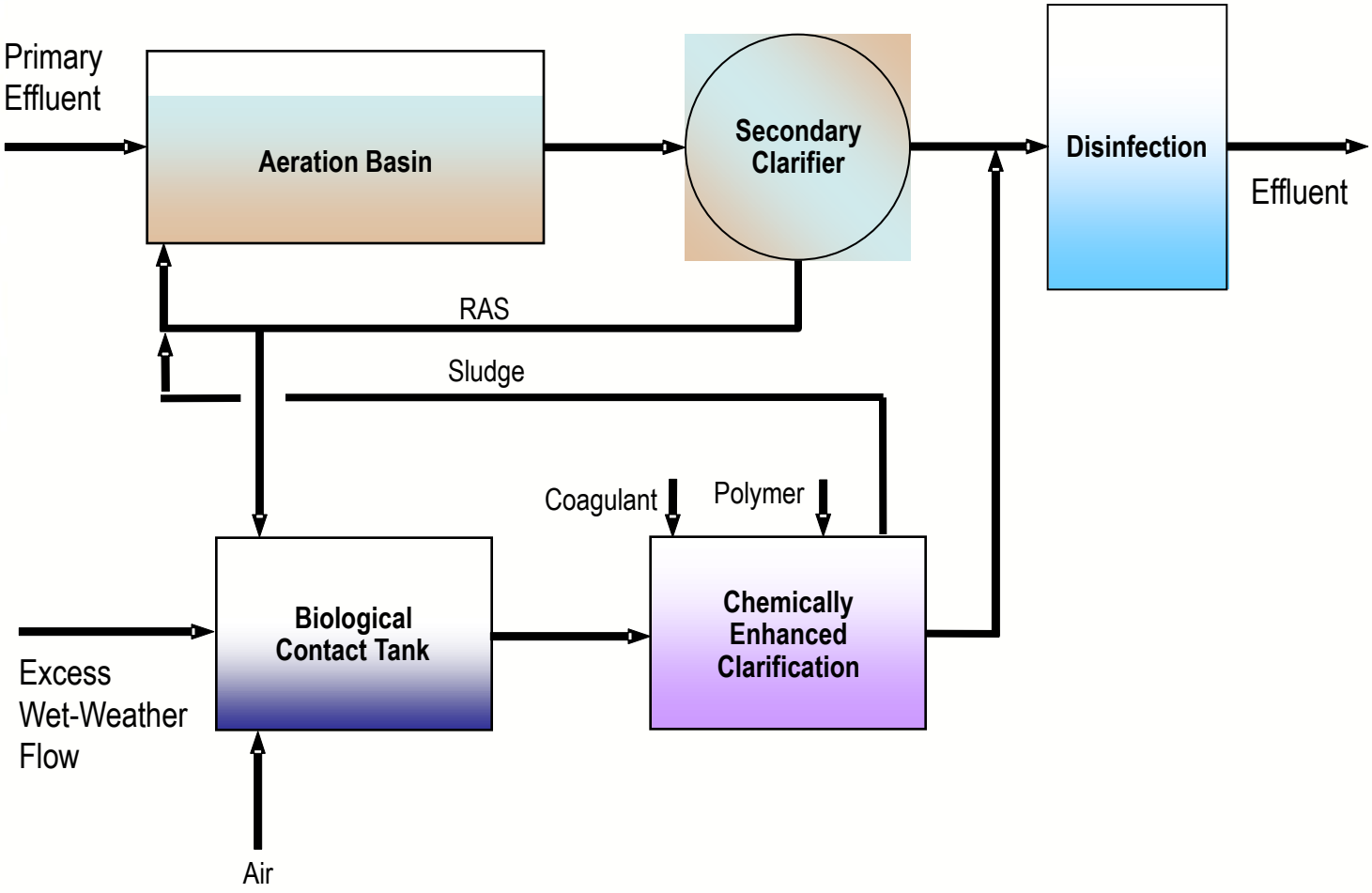


A Newer Concept: Biologically Enhanced High Rate Clarification

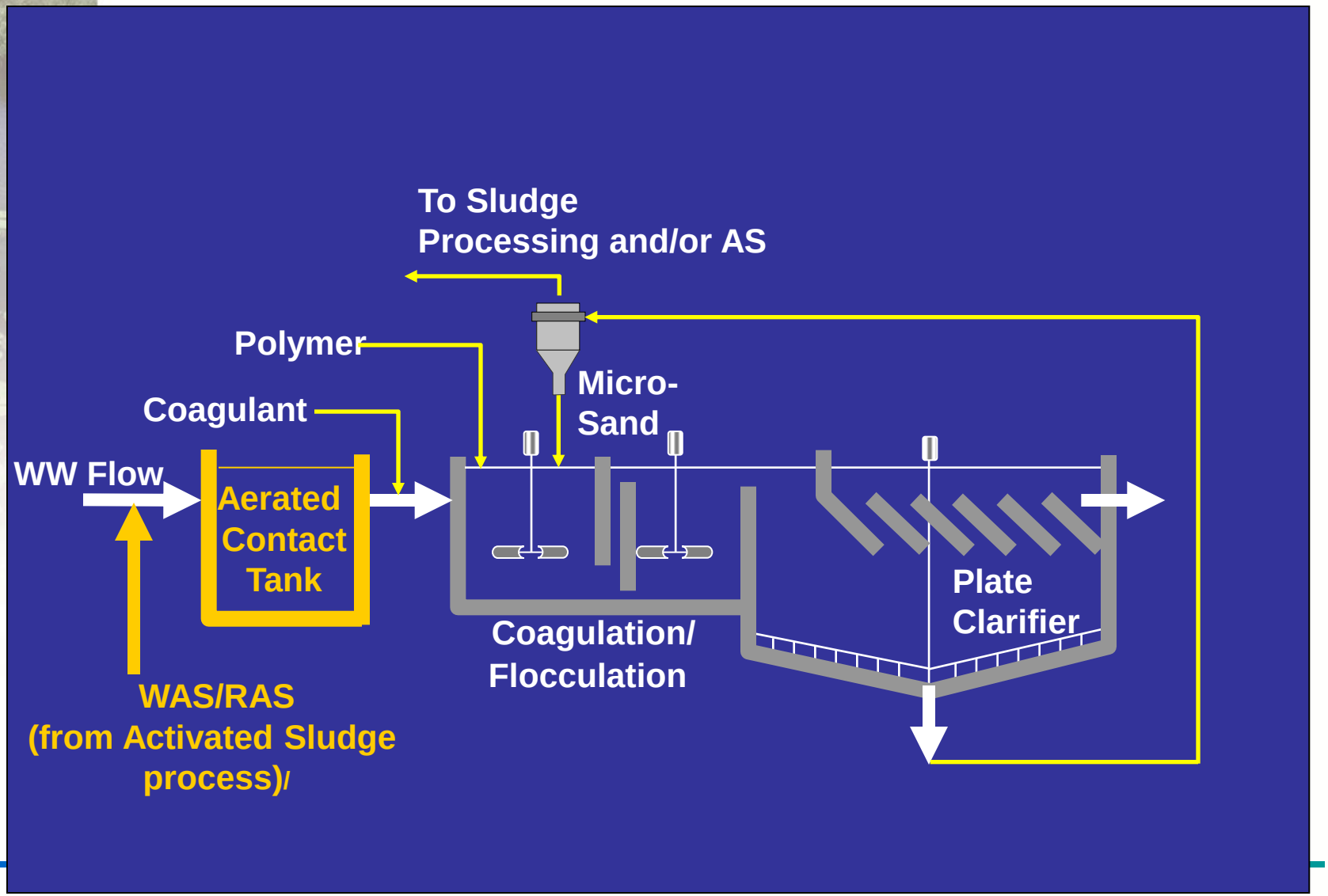
Incorporating a Biomass Contact Step Ahead of Clarification

- Short (5-10 min) of WAS/RAS contact
- Several Benefits:
  - *Soluble BOD uptake*
  - *Bioadsorption of colloidal and particulate matter*
  - *Potential reduction of HRC chemical requirements*
  - *Lower foaming potential*
  - *Higher UV Transmittance*
  - *Tertiary treatment (P < 0.1 ppm)*

A Newer Concept: Biologically and Chemically Enhanced Clarification (BioCEC)



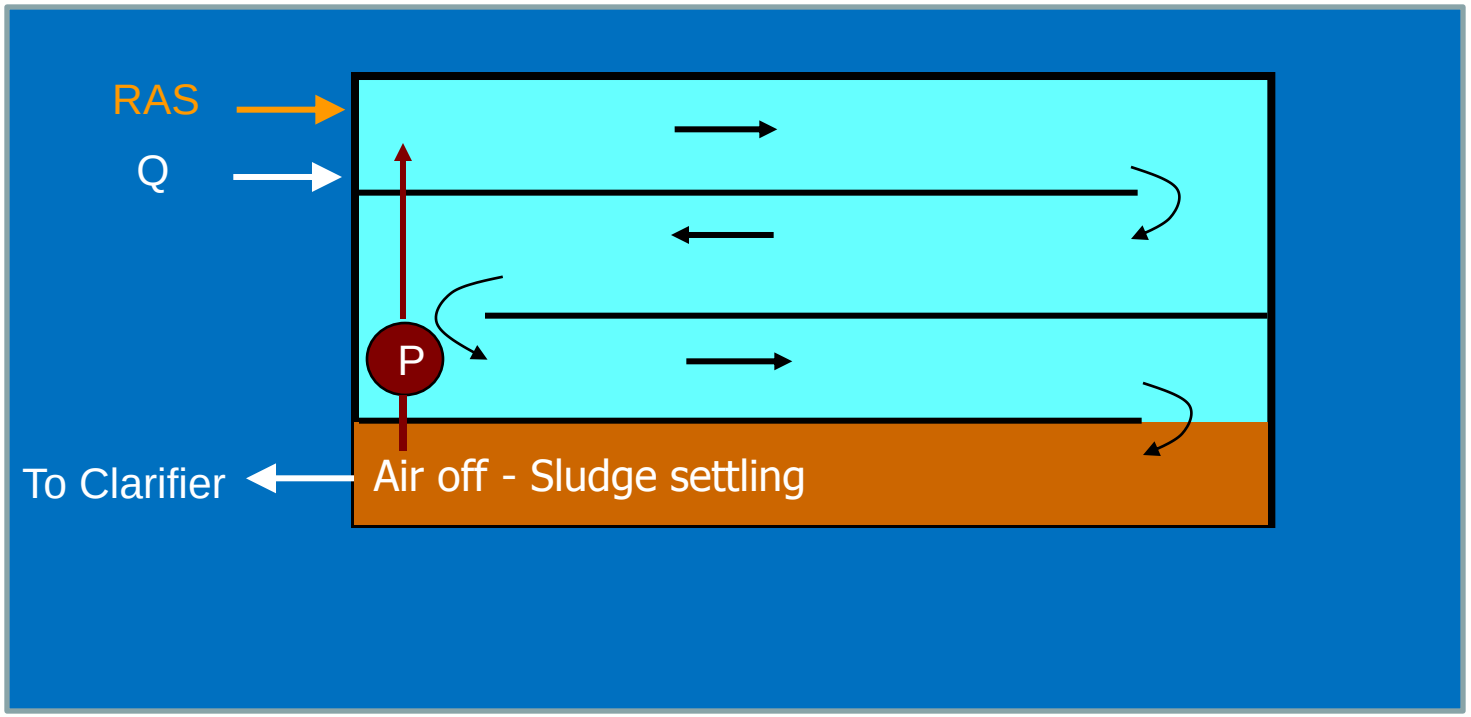
Biologically Enhanced High Rate Clarification (Bio HRC)



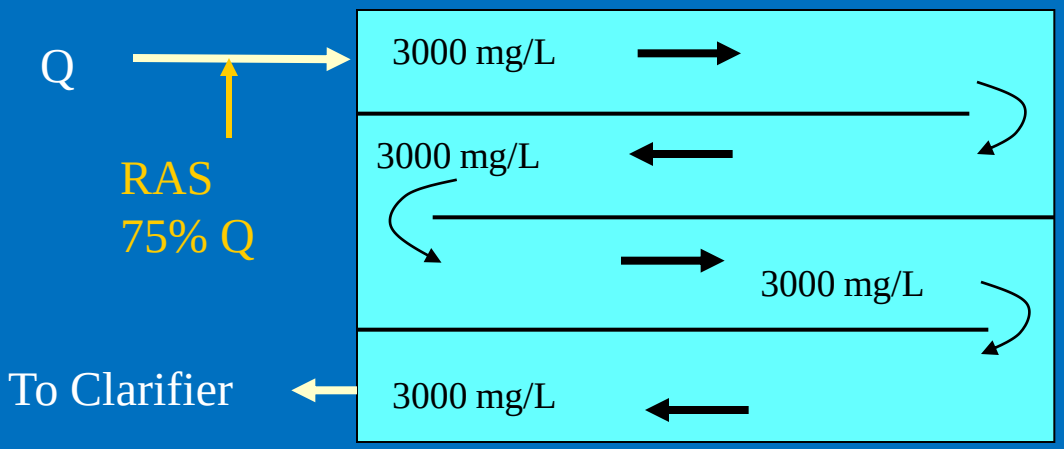
Handling Wet Weather Flows Through Biological Secondary Processes

- Hydraulic surges increase mass loading to secondary clarifiers in activated sludge
  - Disruptive currents
  - High sludge blankets
  - TSS lost over effluent weir
  - Potential for biomass washout
  - $Q_{peak} \sim 2\ Q_{avg}$
- Potential Solutions
  - Hydraulic improvements to clarifiers
  - “Hide” the bugs
  - “Anchor” the bugs

Aeration Tank Settling

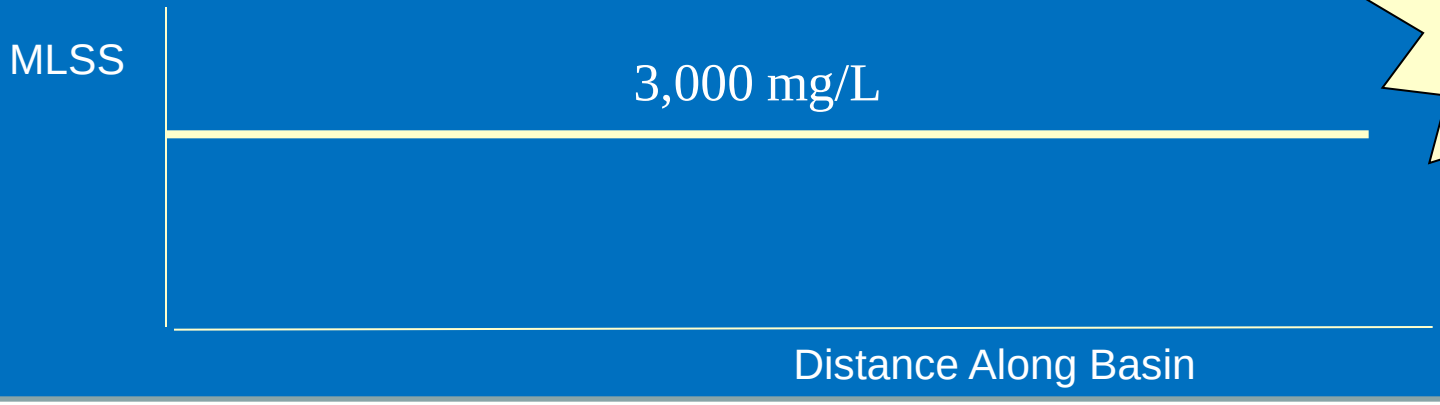


Step Feed

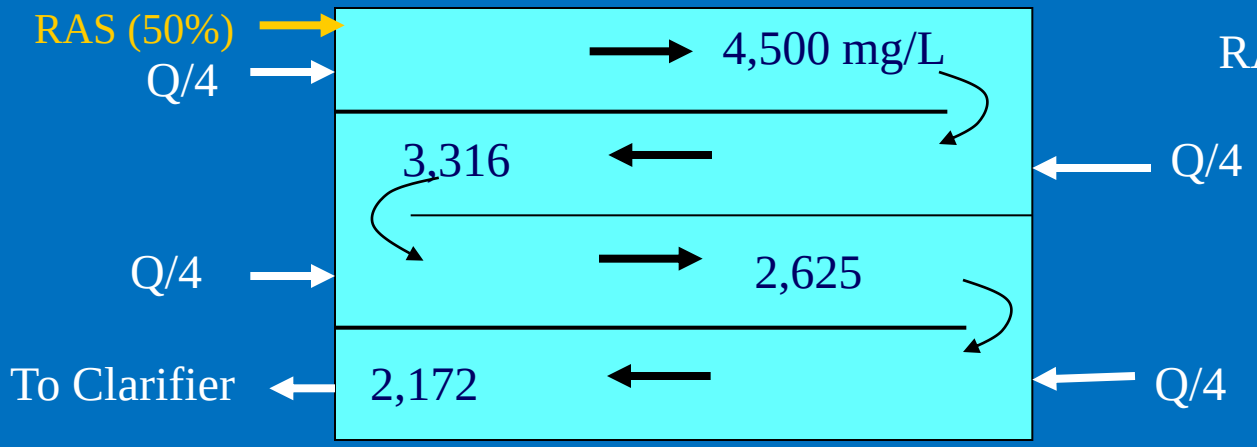


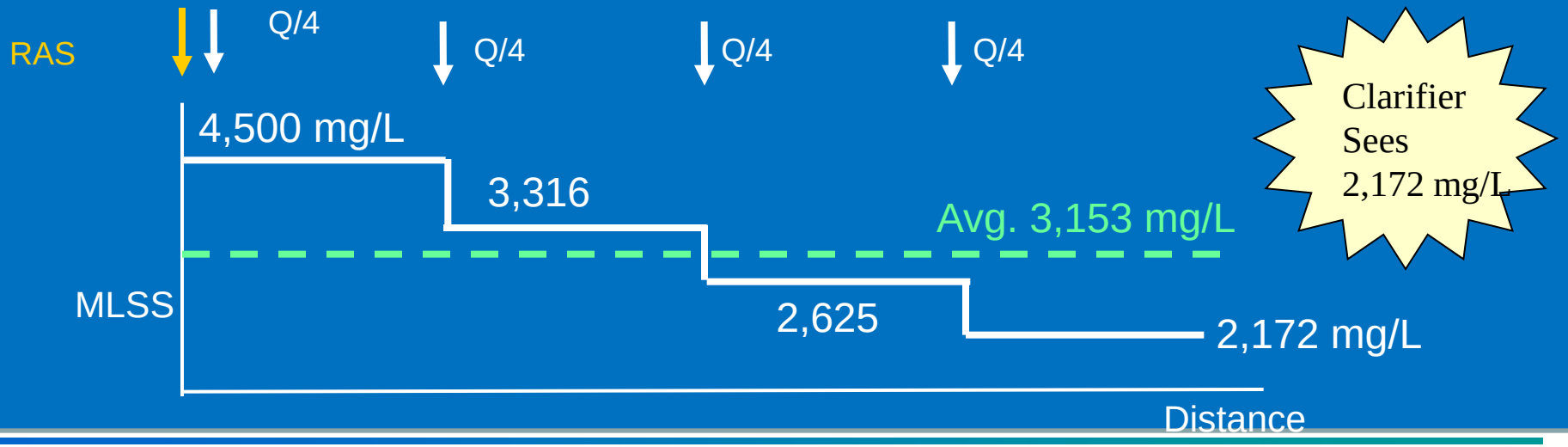
RAS Solids: 7000 mg/L

Clarifier Sees
3,000 mg/L



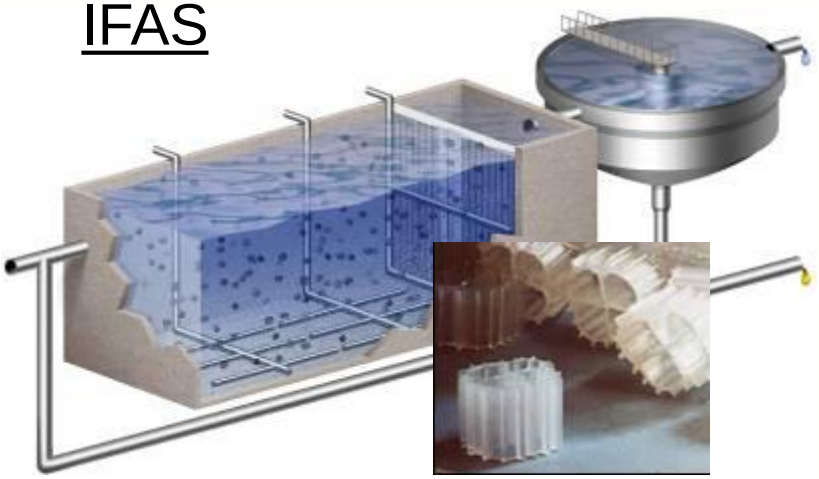
Convert to Step Feed





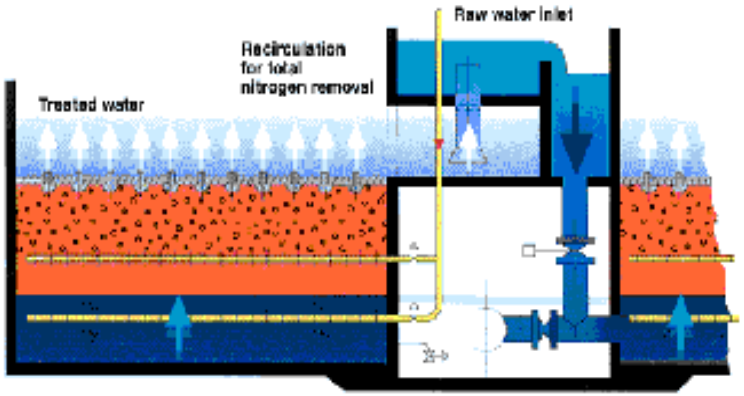
Potential Secondary Treatment Improvements: "Anchor" the Bugs…

IFAS



MBR

Biological Aerated Filter



Wet Weather Flow Disinfection

Options

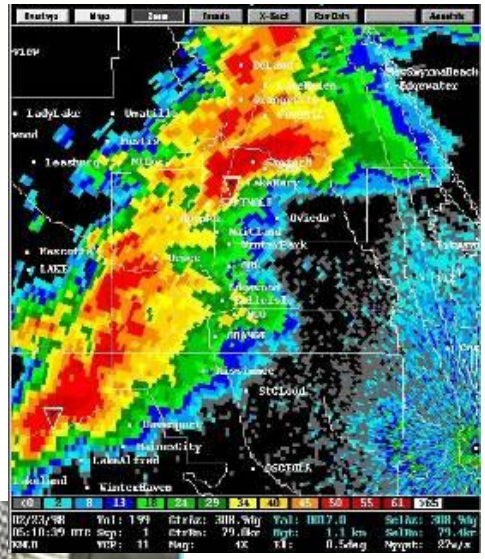
- Hypochlorite/bisulfite
- Peracetic acid
- Ozone
- UV light
- Hybrid system
  - UV for dry wetaher flow
  - Chemical for excess flows

Challenges

- Storage, handling & shelf life (chemical)
- Power quality & emergency power (UV)
- Variable effluent quality
  - Ammonia-Nitrogen
  - UVT
  - TSS
- Process control strategy

Additional Wet-Weather Improvement Components

- Advance warning systems
- Real-time control
  - Storage/pumping coordination
  - Placing facilities on-line
  - Chemical feed
- Automation



Wet Weather Flow Management Operations Requirements

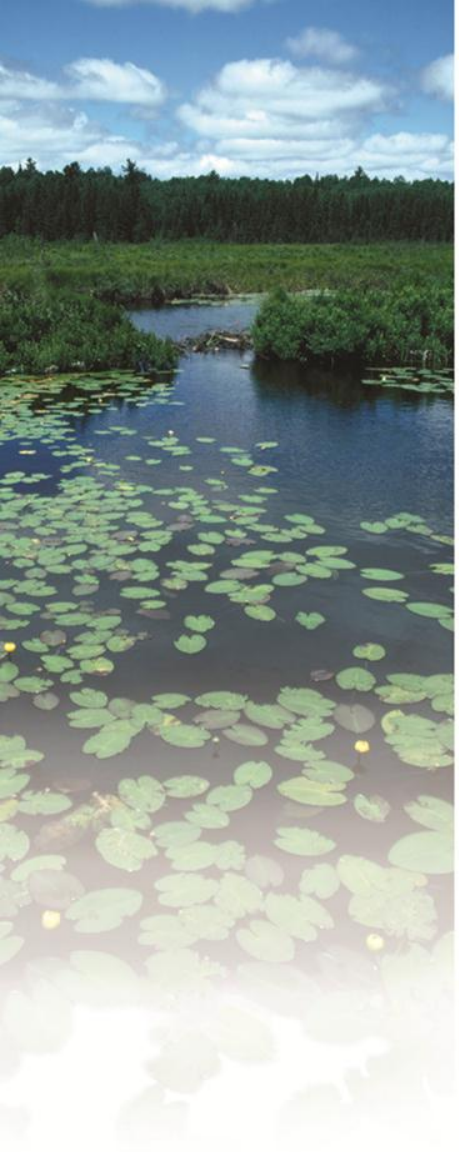
- Link collection system operations with plant operations
- Start-up & shut-down
- Winterization & freeze protection
- Chemical feed optimization
- Additional labor: sampling, lab, process control, clean-up
- Staffing and level of process automation
- Residuals management – quantity & quality
- Aesthetics: odor control; foam control; traffic

What Will the Ideal Plant of the Future Look Like?

Characteristics of the ideal plant of the future:

1. Nitrogen & phosphorus removal
2. Energy neutral
3. Resource recovery (P recovery)
4. Wet weather flow processing
5. Effluent reuse
6. Reduce greenhouse gas emissions
7. Reduce microconstituents
8. Decentralized vs. centralized treatment

If you are still awake, Thank you!



General Operational Considerations in Nutrient and Wet Weather Flow Management for Wastewater Treatment Facilities *Part III*

Samuel Jeyanayagam, PhD, PE, BCEE
Julian Sandino, PhD, PE, BCEE

CH2MHILL

Ohio WEA Plant Operations Workshop
September 28, 2011