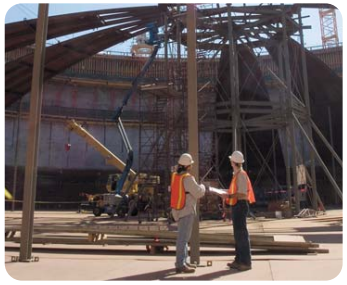
BUILDING A WORLD OF DIFFERENCE®

BLACK & VEATCH





KWEA & KsAWWA
Joint Annual Conference
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Planning For the Unknown

Isaac Crabtree, Black & Veatch

The Project

- Wastewater Treatment Plant Expansion Plan – Cedar Creek WWTP, Olathe, Kansas

- Expansion plan to address:
  - Current Regulations – Upgrade processes
  - Expected Growth – Plan for expanding capacity
  - Future Regulations – Accounting for more stringent limits in the future

The Plant

- Cedar Creek WWTP, Olathe, Kansas
- Current Rated Capacity: 3 MGD
- Preliminary Treatment:
  - Mechanical Screening
  - Aerated Grit Removal
- Liquid Treatment:
  - Oxidation basins – BOD removal
  - Final Clarification
  - UV Disinfection

The Plant

- Solids Treatment:
  - Gravity Thickening
  - Aerated Sludge Storage
  - Mechanical Dewatering
  - Composting Program

The Challenge

- Many design constraints and many unknowns…
- Working with:
  - Unknown NPDES permit limits – current and future expansions, negotiations ongoing
  - Anemic influent wastewater (fresh sewage, low VFA)
  - Limited site space
  - High wet-weather peaking factor
  - Complex plant hydraulics
  - Adjacent residential development

Process Selection

- First question is… *what?*
  - What facilities will be required through the life of the plant?
  - Look at capacity and regulatory needs
- Kansas Department of Health and Environment (KDHE) required the City to evaluate methods to meet BNR, ENR, and LOT limits
  - BNR – Biological Nutrient Removal = 8 mg/L TN & 1.5 mg/L TP
  - ENR – Enhanced Nutrient Removal = 5 mg/L TN & 0.5 mg/L TP
  - LOT – Limits of Technology = 3 mg/L TN & 0.3 mg/L TP

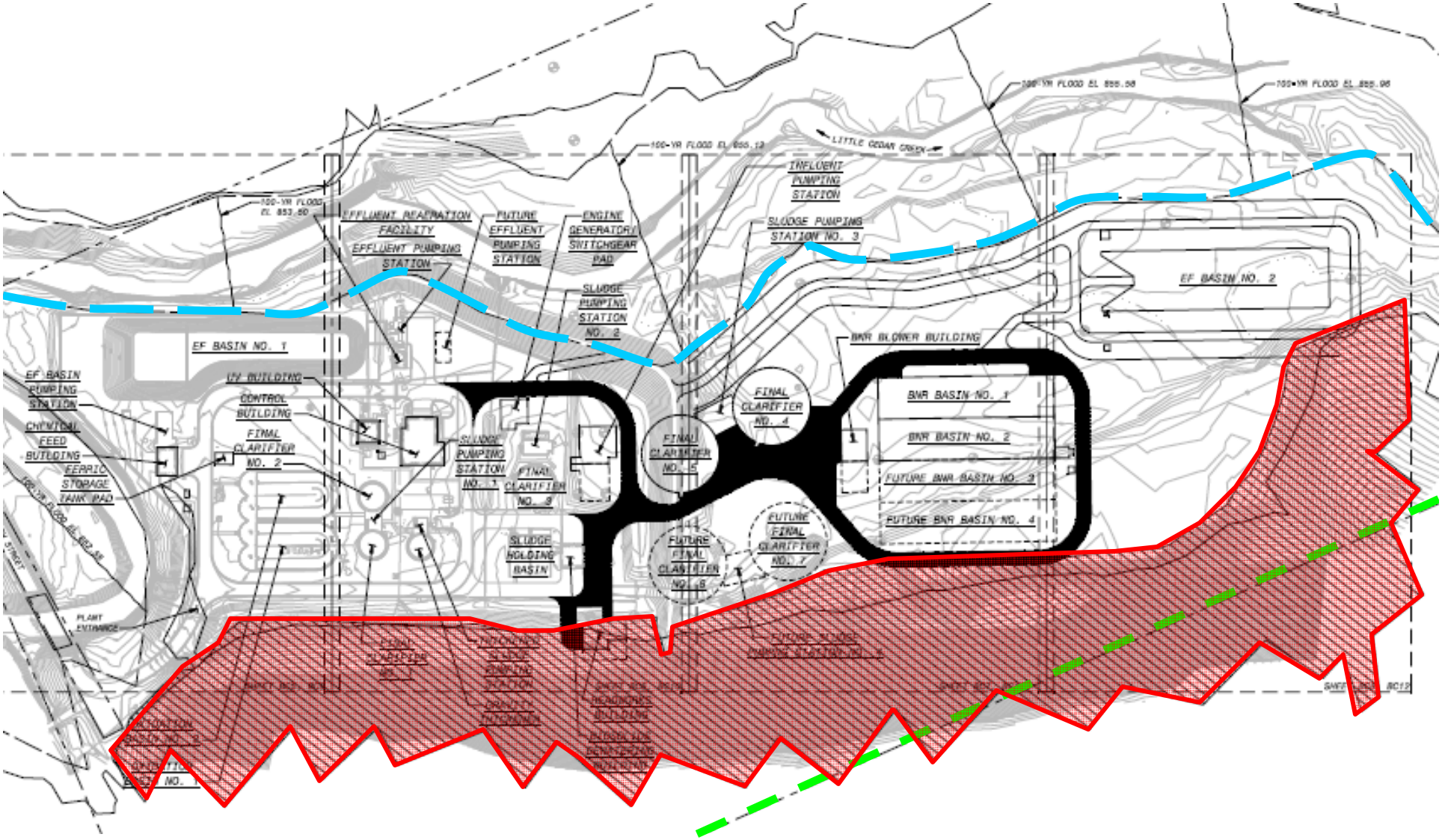
Process Selection

- BNR – Biological Nutrient Removal
  - 5-Stage Bardenpho Process for biological phosphorus removal (BPR), nitrification, and denitrification
- ENR – Enhanced Nutrient Removal
  - 5-Stage Bardenpho Process for BPR, nitrification, and denitrification
  - Effluent filtration
- LOT – Limits of Technology
  - 5-Stage Bardenpho Process for BPR, nitrification, and denitrification
  - Effluent filtration
  - Carbon addition

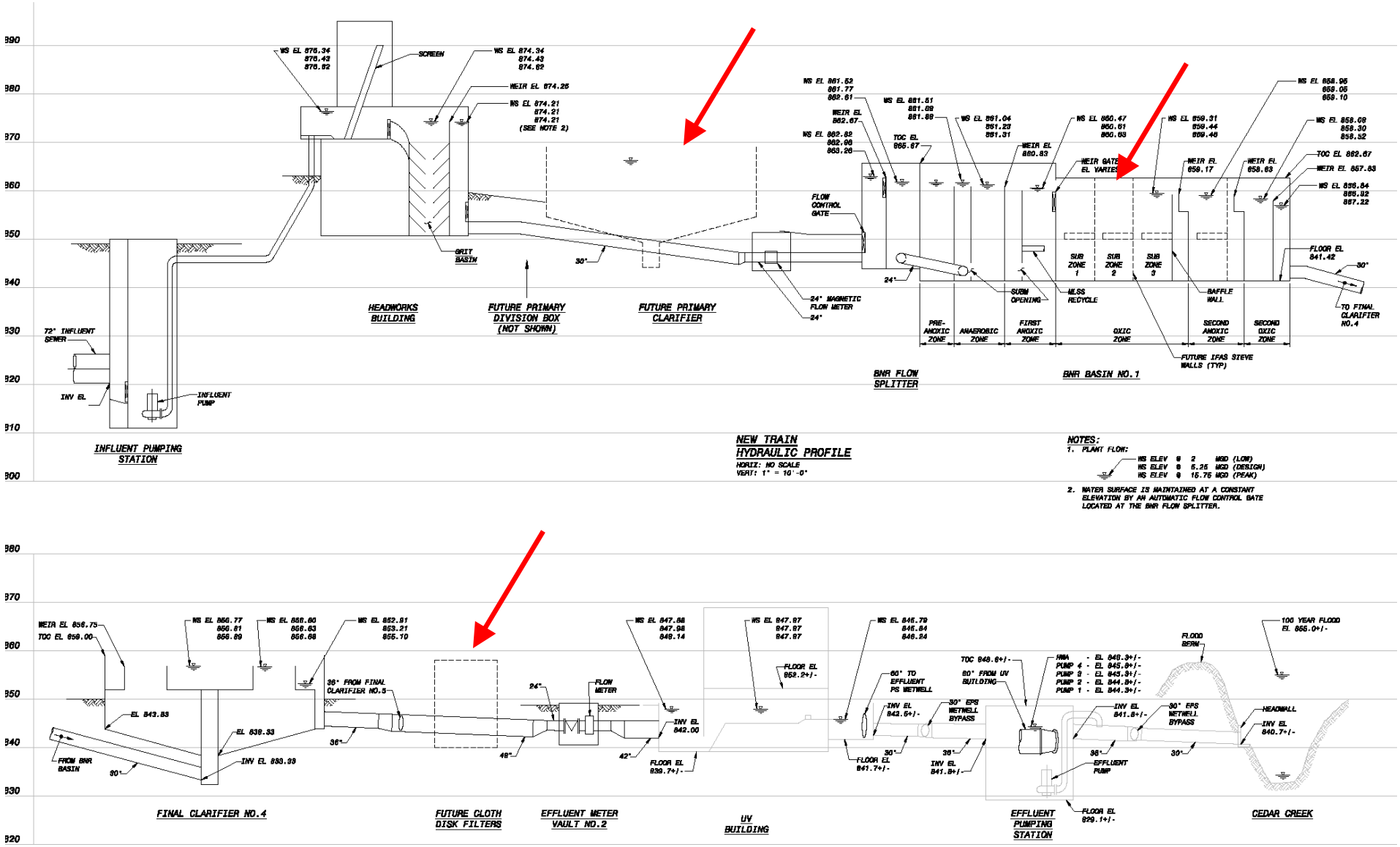
Beginning with the End…

- With finite space, you must begin with the end
- Determine which facilities will be needed through the life of the plant
  - Allocate space
    - Physically
    - Hydraulically
    - Economically

Site Plan


100-YR FLOOD EL 853.50
100-YR FLOOD EL 855.12
LITTLE CEDAR CREEK
INFLUENT PUMPING STATION
SLUDGE PUMPING STATION NO. 3
EFFLUENT REAERATION FACILITY
EFFLUENT PUMPING STATION
FUTURE EFFLUENT PUMPING STATION
ENGINE GENERATOR/ SWITCHGEAR PAD
SLUDGE PUMPING STATION NO. 2
EF BASIN NO. 2
EF BASIN NO. 1
BNR BLOWER BUILDING
EF BASIN PUMPING STATION
UV BUILDING
CONTROL BUILDING
FINAL CLARIFIER NO. 2
CHEMICAL FEED BUILDING
FERRIC STORAGE TANK PAD
SLUDGE PUMPING STATION NO. 1
FINAL CLARIFIER NO. 3
FINAL CLARIFIER NO. 5
FINAL CLARIFIER NO. 4
BNR BASIN NO. 1
BNR BASIN NO. 2
FUTURE BNR BASIN NO. 3
FUTURE BNR BASIN NO. 4
SLUDGE HOLDING BASIN
FUTURE FINAL CLARIFIER NO. 6
FUTURE FINAL CLARIFIER NO. 7
PLANT ENTRANCE

Hydraulic Profile



Timing is Everything

- Next concern is… *when?*
- Develop phasing plan
  - 8 mg/L TN and 1.5 mg/L TP anticipated for next phase – goal or a limit?
  - When will the limits become more stringent?
- Goal is to match up growth of service area with expectations of future limits
- Add flexibility – limits may tighten sooner than anticipated

Making it Work – Where Engineering and Science meet

- The last question is… *how?*
- Some questions we had to address
  - How do you set up the plant for expandability? Add more treatment trains, or increase the capacity of each train?
  - How do you provide the operator the flexibility to optimize BNR process?
  - How do you design the facility to accommodate more stringent limits if they come sooner than anticipated?

Example – BNR Basins

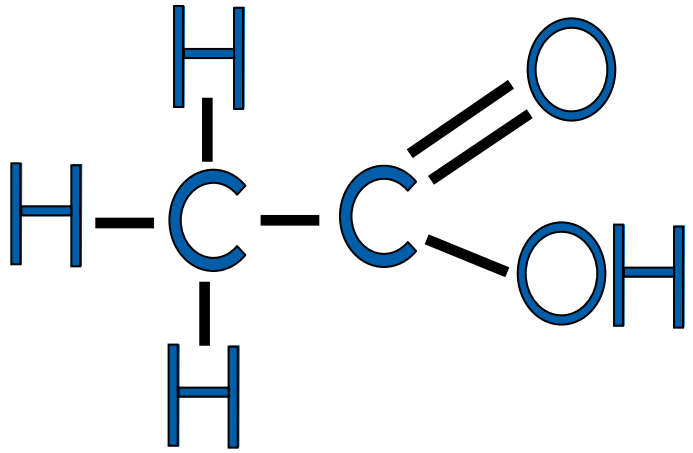
- Some design considerations…
  - Appreciate the importance of carbon – if we do not have enough, we need to make it (or add it)
  - Provide as much dissolved oxygen (DO) control as possible – too much air causes BNR failure
  - Design basin to accept integrated, fixed-film activated sludge (IFAS) media in the future

Appreciating the Importance of Carbon

- Just as your car needs gas… biological phosphorus removal needs volatile fatty acids (VFA)
- VFA is essentially the fuel that drives the BPR engine
- If BPR doesn't work, the process is not broken, it is just out of fuel

What are Volatile Fatty Acids?

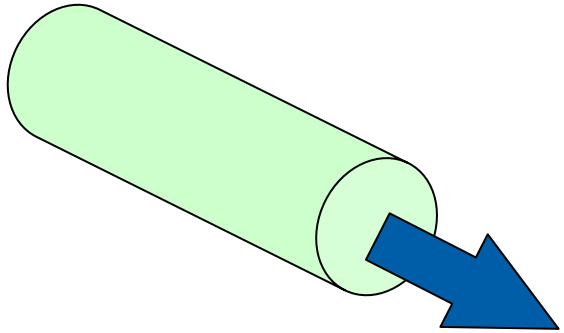
- Acetic Acid CH_3COOH
- Propionic Acid CH_3CH_2COOH
- Butyric Acid $CH_3CH_2CH_2COOH$
- And Other short chain fatty acids



Key Issue:

VFA are readily biodegradable materials

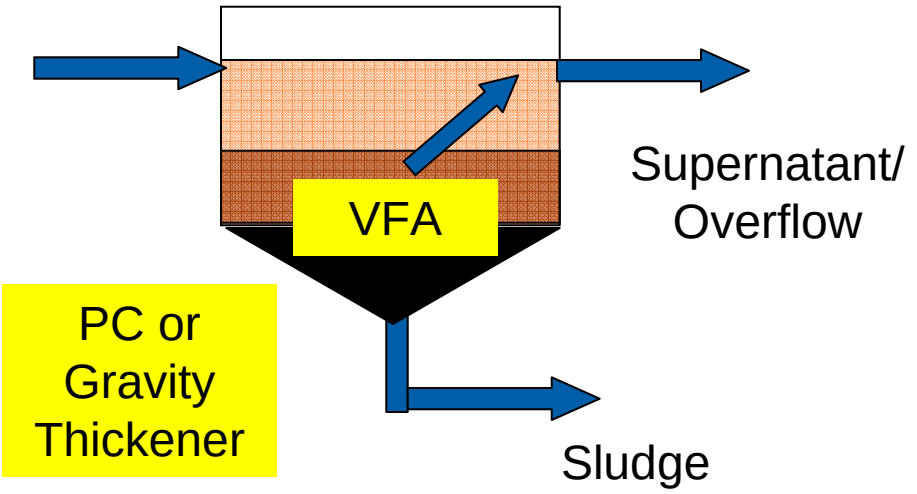
Where are VFA Formed? – Primary Sources



- **Underground Small Diameter Anaerobic Tubular Reactor**

- Most commonly called a **Sewer**
- Slime grows on sewer walls and make VFA
- H2S formed as a byproduct

- Sludge goes anaerobic and makes VFA
- H2S formed as a byproduct



Biological Phosphorus Removal Theory

Anaerobic Zone

Fluid o-PO_4-P concentration > 15 mg/L

VFA →

PO_4-P Released

Stored Phosphorus Compounds are Released

Aerobic Zone

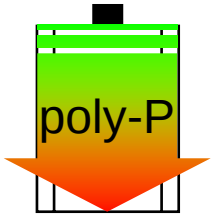
PO_4-P taken in →

Fluid o-PO_4-P concentration < 0.5 mg/L

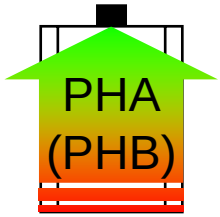
Released Phosphorus Compounds are Stored

Grow more Bio-P Microbes (PAOs)

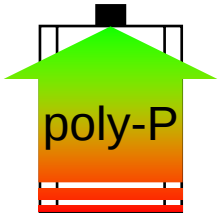
Analogy



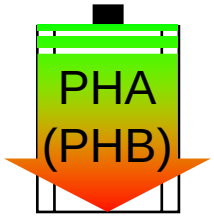
Use backup battery



Charge main energy source



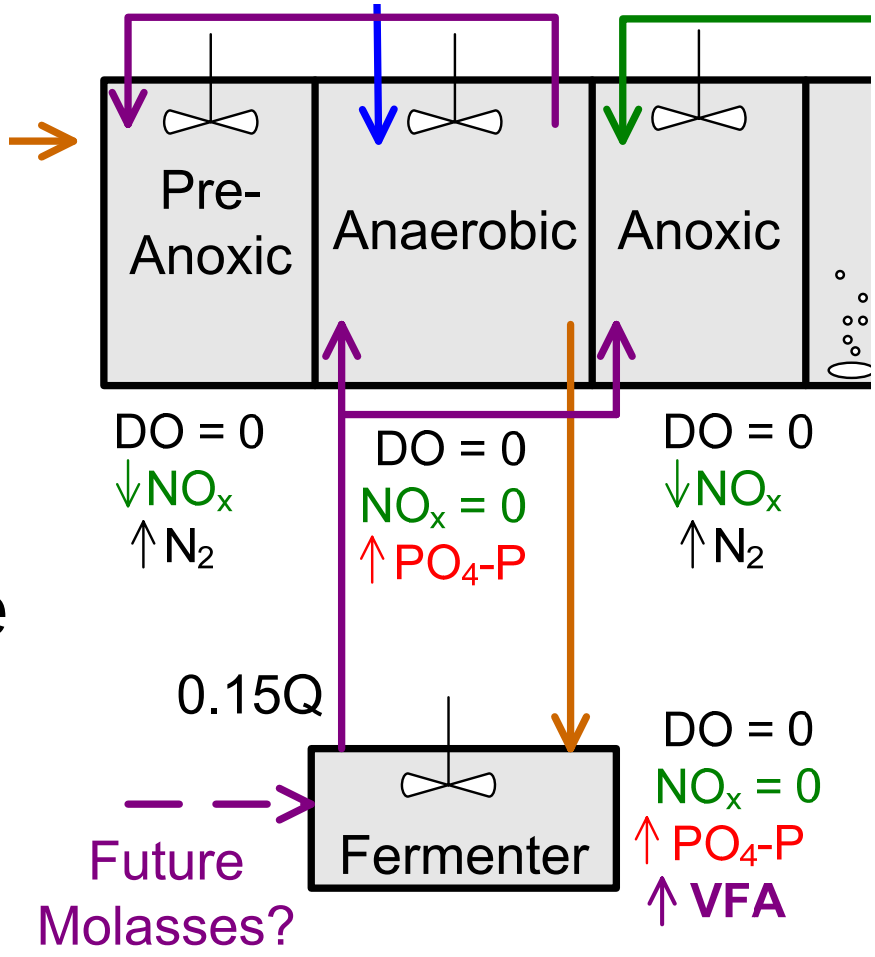
Charge backup battery



Use main energy source to grow more bugs

Not Enough VFA? Create Your Own!

- Low influent VFA at Cedar Creek
- Some fermentation will occur in anaerobic zone
- Need fermenter for more complex fermentation to occur
- SRT of 4 to 5 days

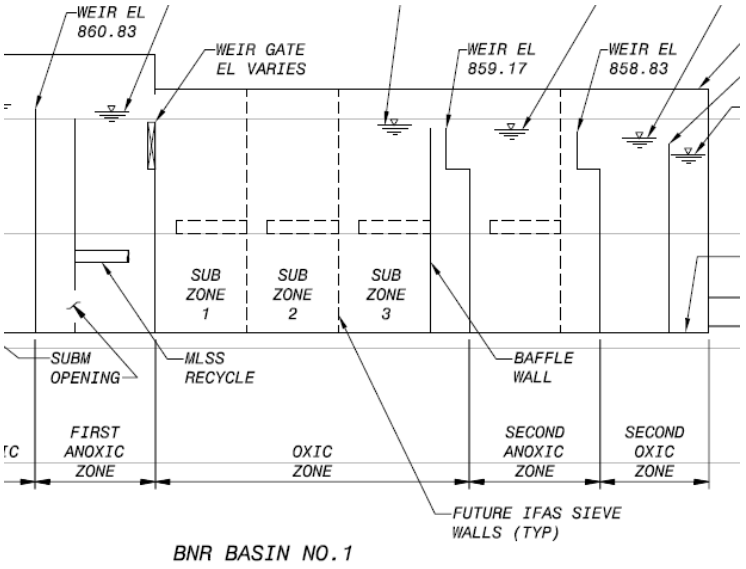


DO Control

- Minimize free fall over weirs
- Size blowers carefully
  - Concern is with turndown
  - May need to blow off excess air
- Provide tapered aeration
- Add supplemental mixing
- Pre-Anoxic and de-ox zones

Make Room for the Future

- As TN limits go down, may need IFAS for further denitrification
- IFAS requires sieve walls, 2 to 3 inches HL per wall



Questions?

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