BIOLOGICAL PHOSPHORUS REMOVAL PLUS CHEMICAL POLISHING FOR LOW LEVEL COMPLIANCE

Nathan Cassity, Donohue

Lake Michigan District Regional Operators Meeting

May 21, 2015

DONOHUE

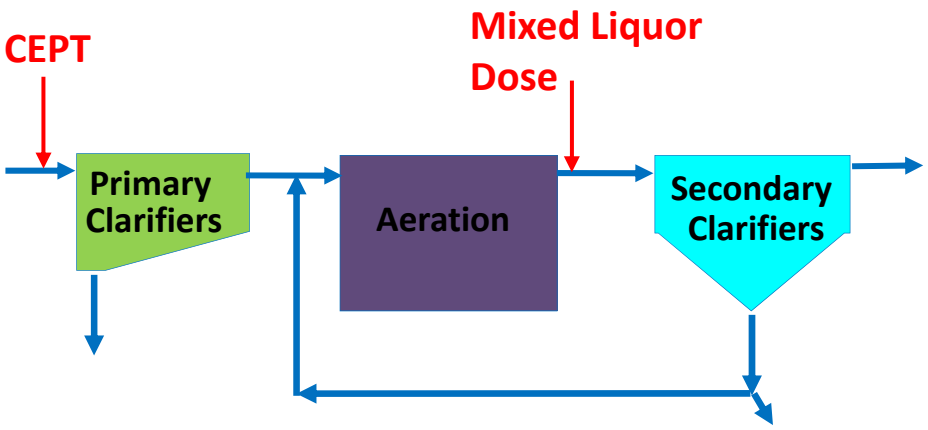
Presentation Outline

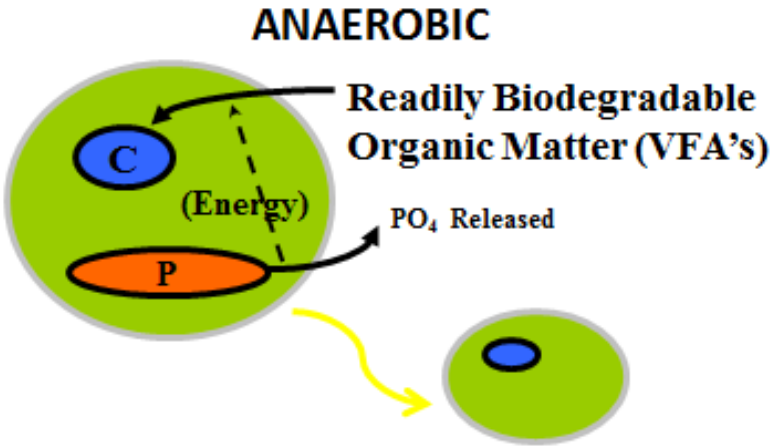
- Background
  - BPR + Coagulants
- Janesville Pilot Studies
- BPR + Supplemental Carbon
- Take-away points

Background

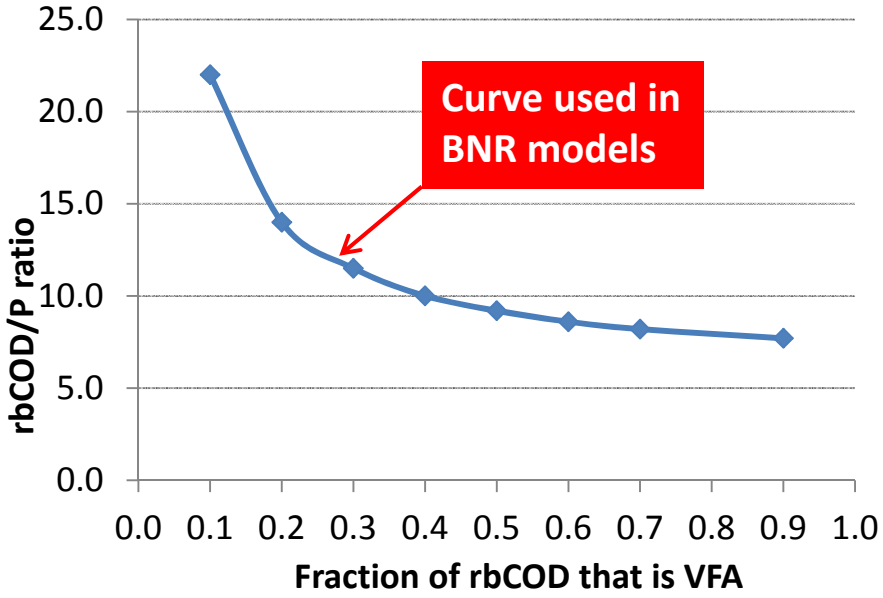
Background

- Focus of discussion:
  - BOD:P ratio
    - Importance to BPR
  - Chemical dosing ratio
    - Interactions / interrelationships when chemicals are added to a BPR process

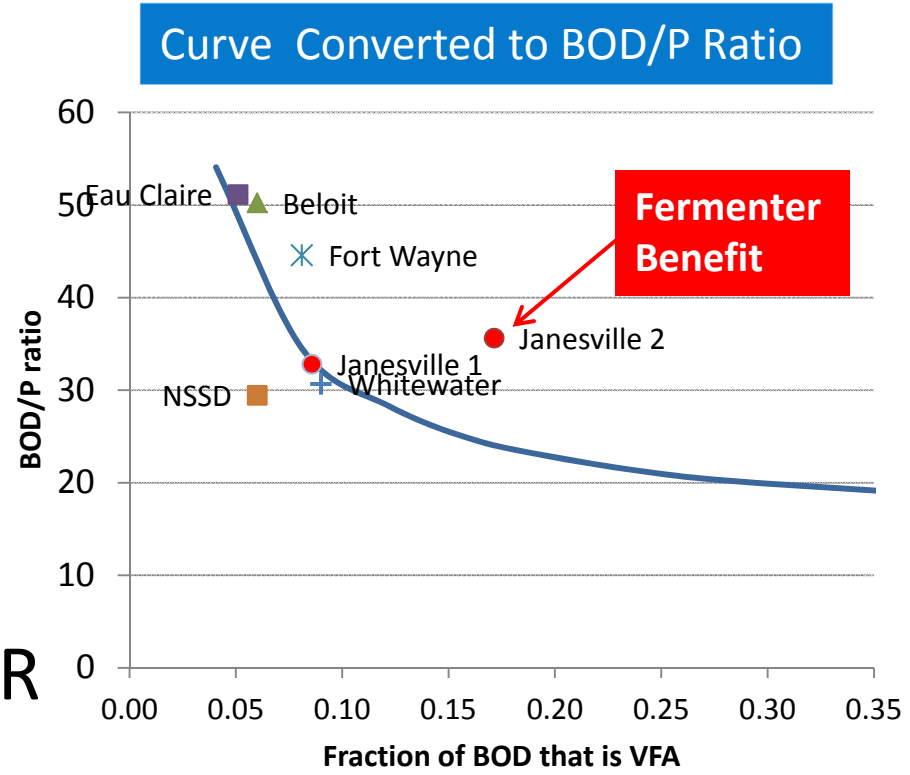




Background



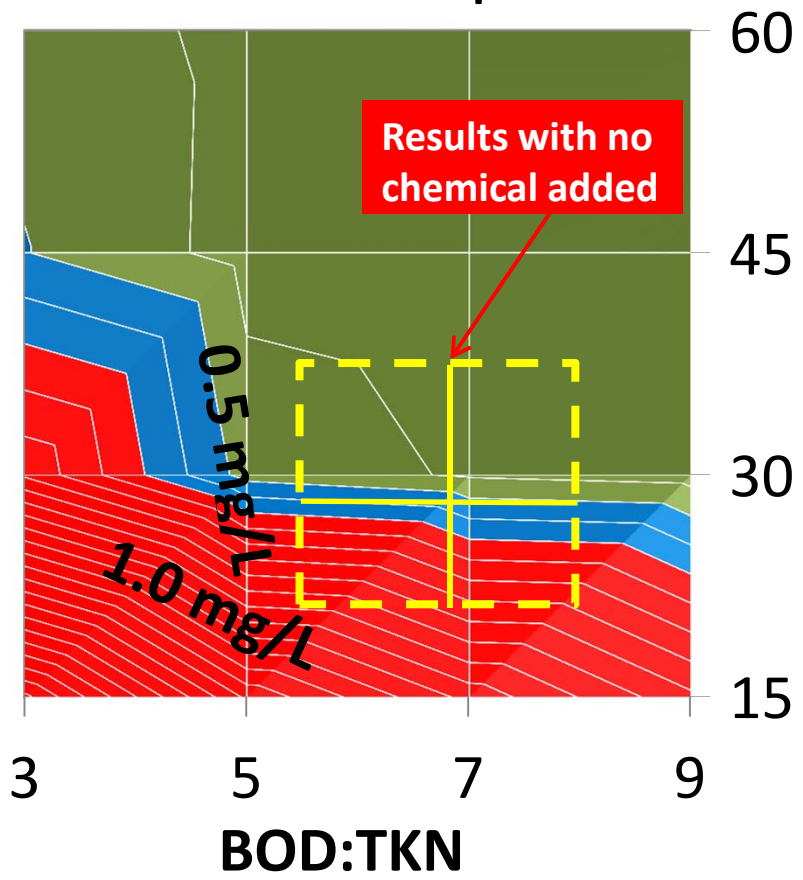
EBPR Curve (Barnard et al, WEFTEC 2005)



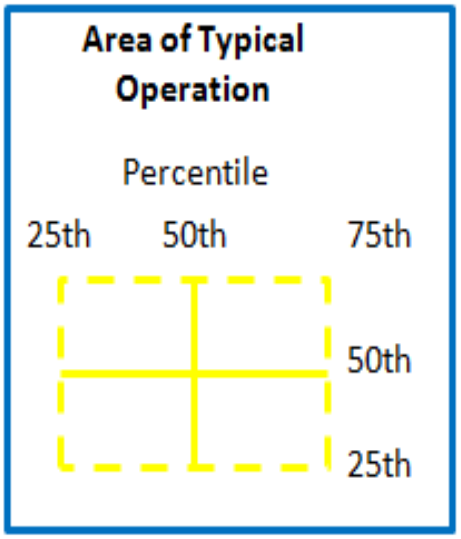
- BOD:P provides simple BPR performance gauge

Background

- Surface plot of BioWin modeling results provides "performance map"

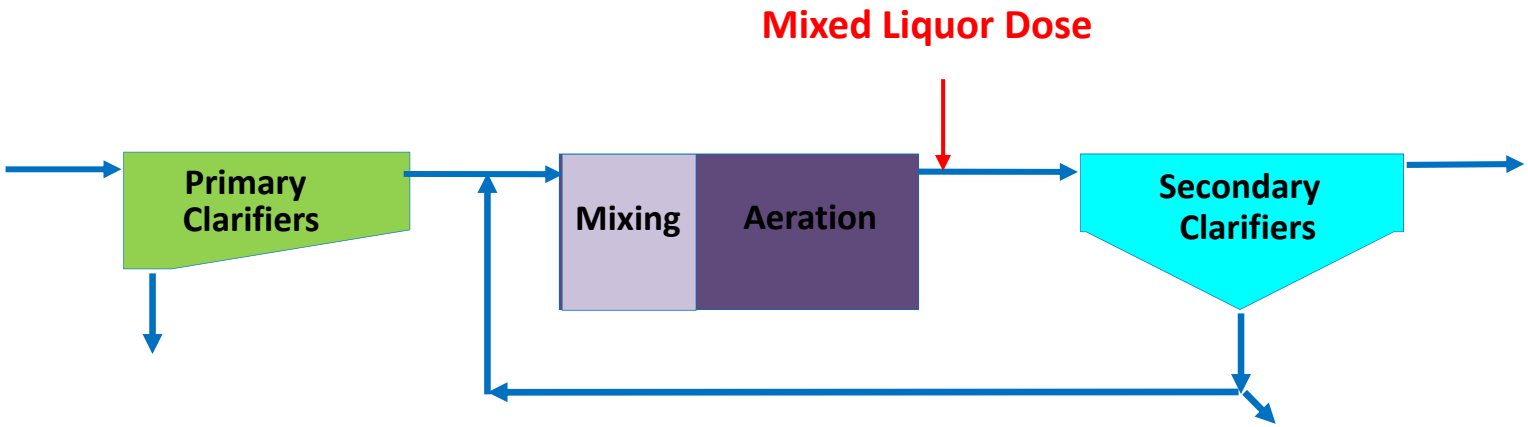


BioWin shows performance is highly dependent on BOD:P



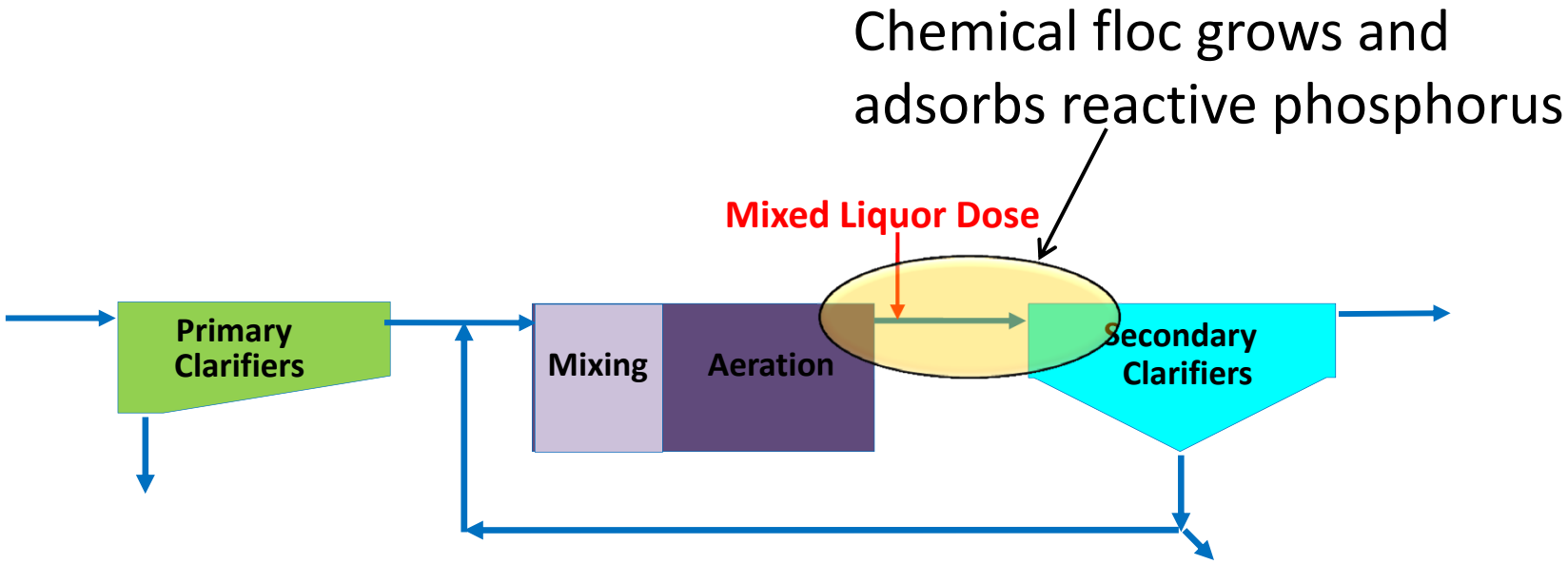
Background

- Chemical addition for polishing
  - BPR + chemical working together
  - How does this affect BOD:P ratio?
    - Focus on two areas of chemical interaction



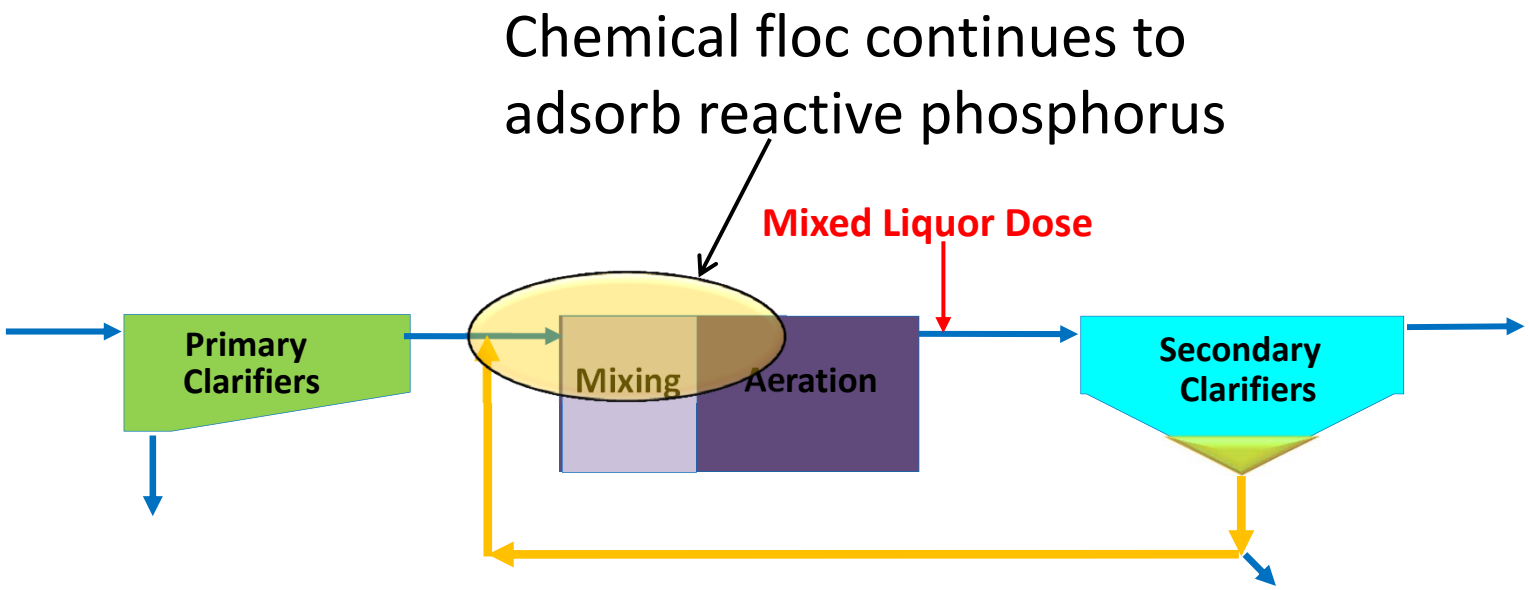
Background

- Dose point interaction



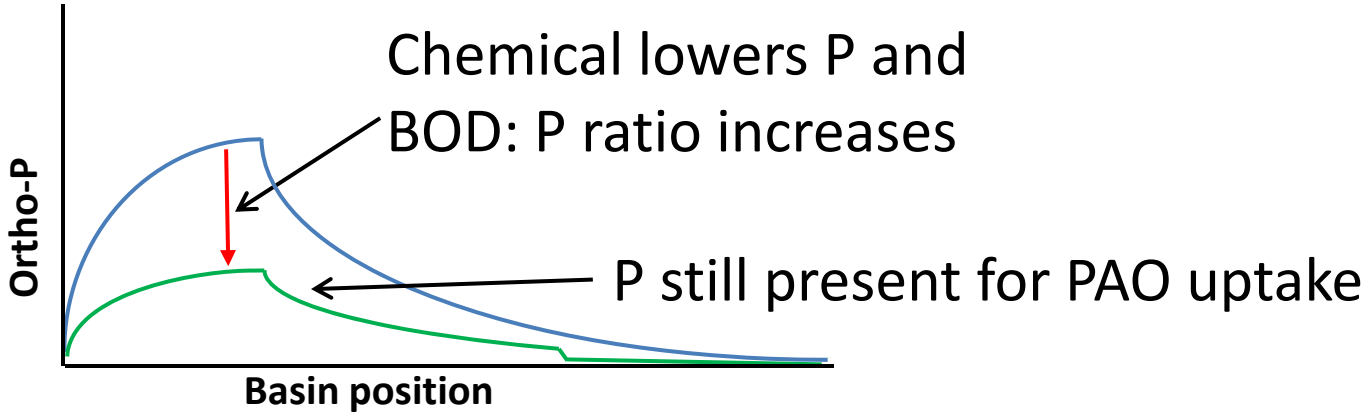
Background

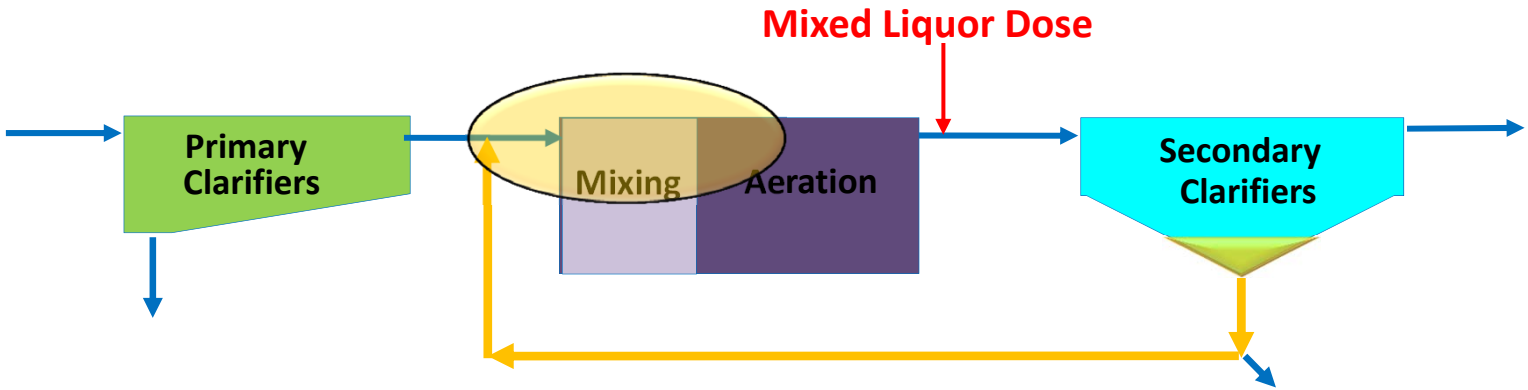
- In-basin interaction



Background

- BPR interaction





PAOs continue to have an advantage – BPR stays healthy

Background

- Chemical addition for polishing
  - Chemical interaction

    Low level treatment requires high dosing ratios

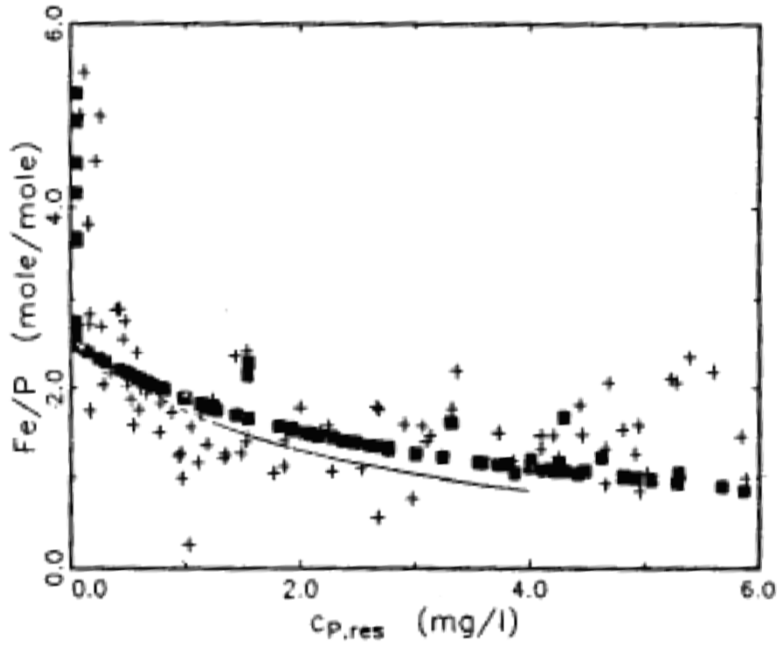
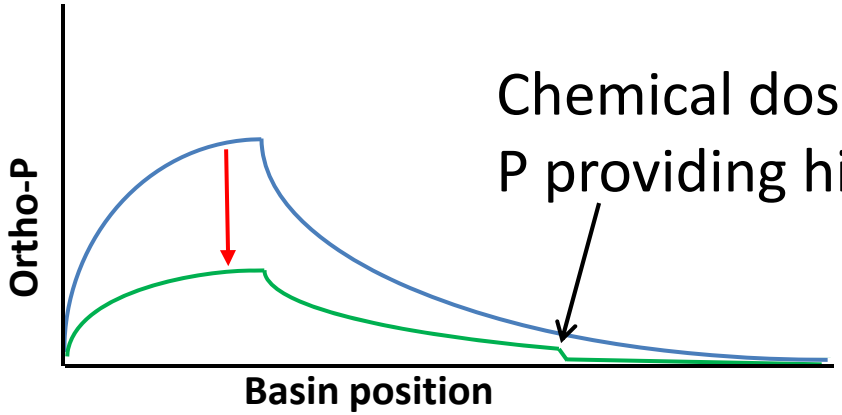


Fig. 6. Observed and calculated values of Fe/P ratios for pH=7.2
(+ observed, • calculated, solid and broken lines: estimation of r)

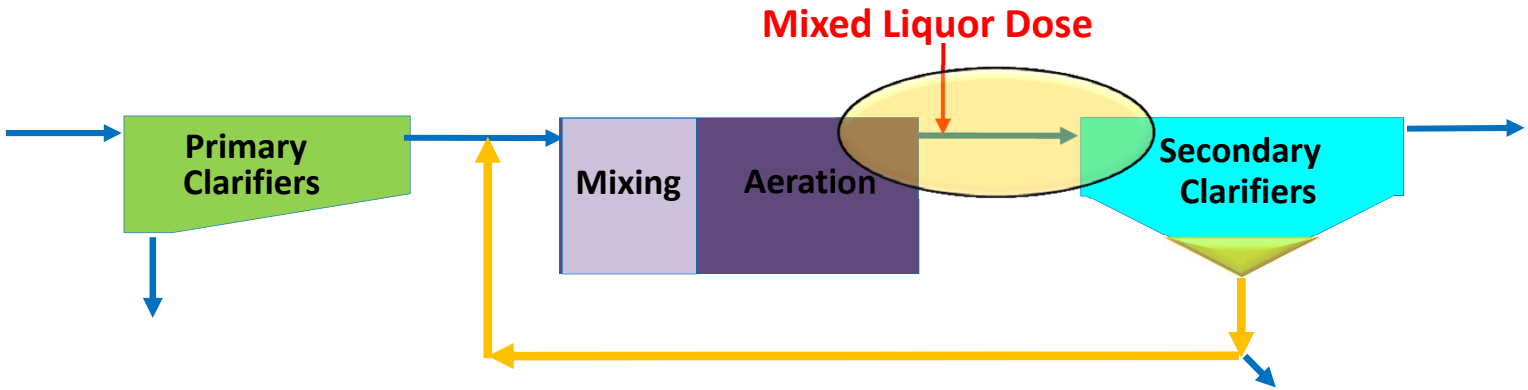
"Precipitation of Ferric Phosphate in Activated Sludge: A Chemical Model and Its Verification," Luedecke et al, Water Science and Technology, Vol. 21, pp 325-337, 1989.

Background

- Chemical interaction



Chemical dosing occurs at low P providing high dosing ratio

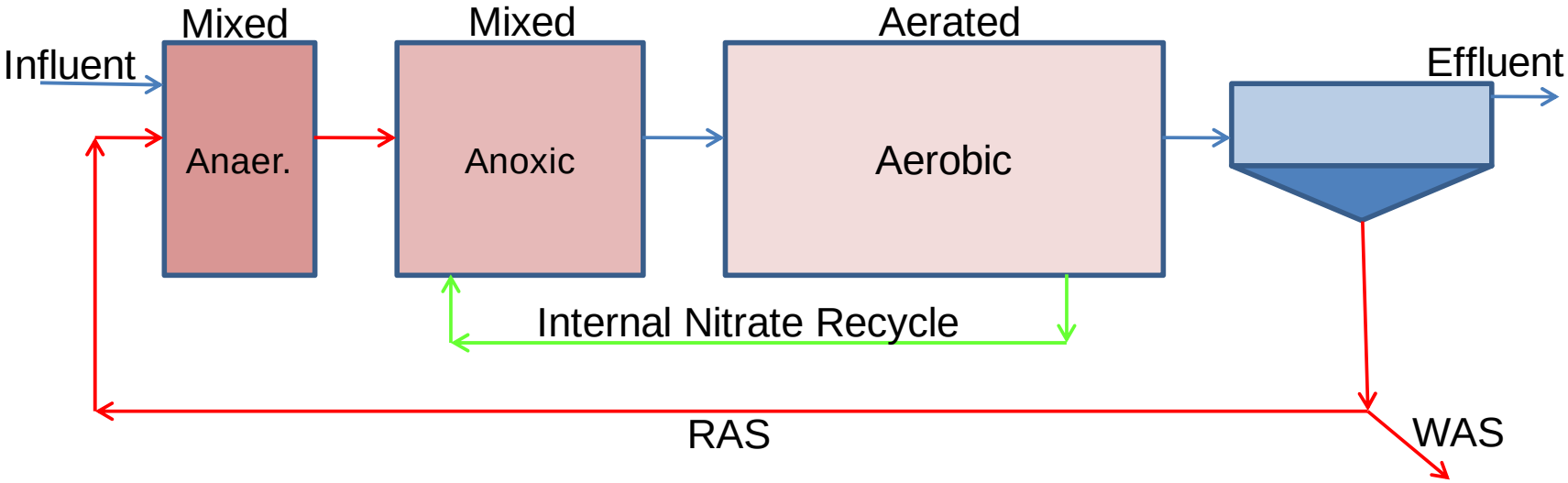


Chemical dose point provides best opportunity for low level treatment

Janesville Case Study

Janesville Background

- Current flow of 14 mgd
- A^2O process configuration
- Effluent P goal between 0.3 mg/L and 0.5 mg/L



Janesville Background

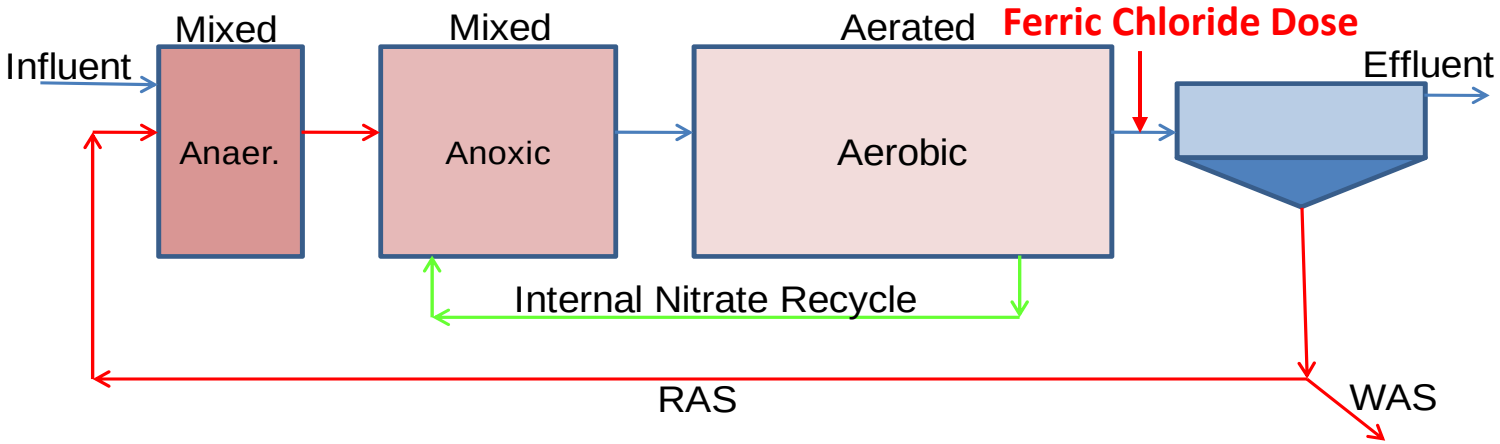
- TMDL Implementation for Rock River
  - Janesville has new TMDL permit
  - Monthly mass allocations necessitate effluent P concentrations at or below 0.1 mg/L
  - Compliance schedule of 9 years

Ferric Dosing Pilot

- First pilot testing period
  - September 3 to October 5, 2013 (5 weeks)
    - Low flow period
    - 35 mg/L ferric dose (300 gpd ferric, Q = 12 MGD)

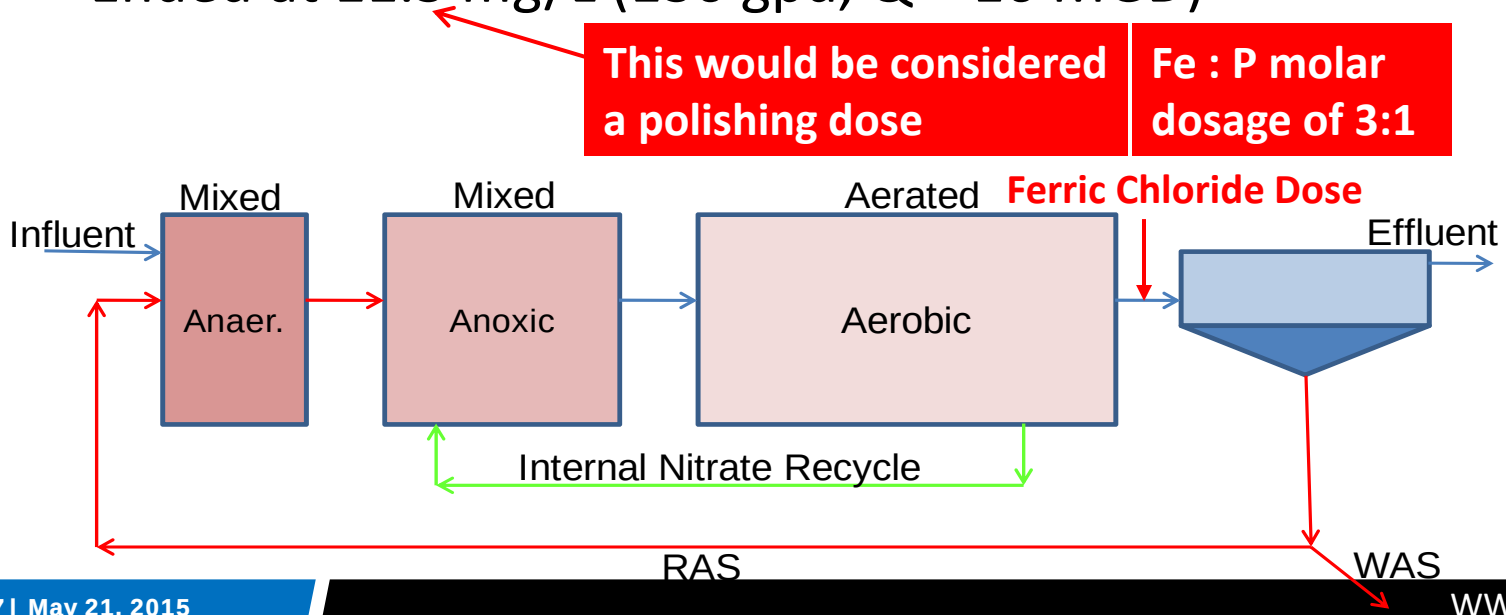
This dose is likely too high to be considered polishing

Fe : P molar dosage of 7:1



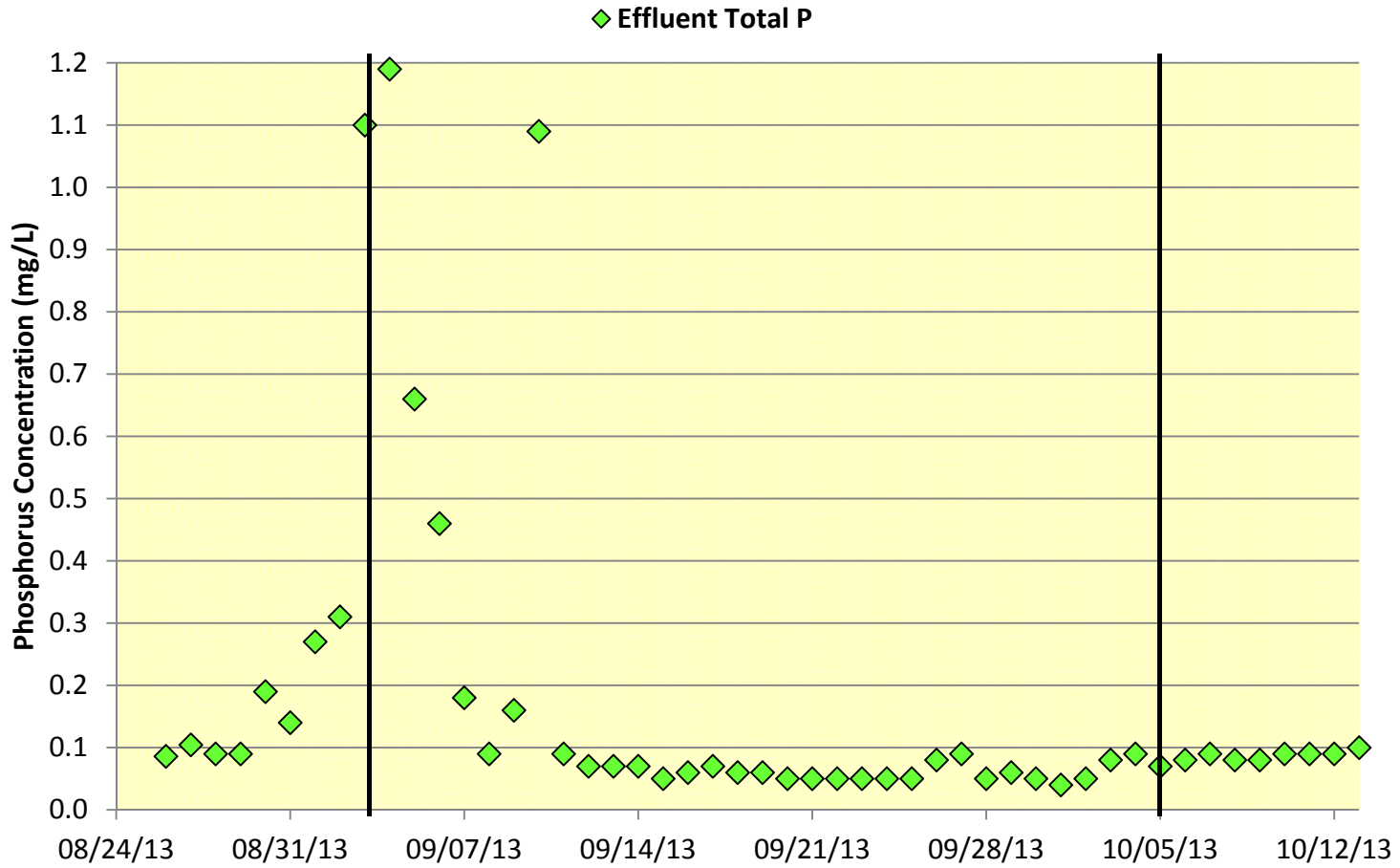
Ferric Dosing Pilot

- Second pilot testing period
  - June 2 to August 10, 2014 (10 weeks)
    - High flow period
    - Initial ferric dose of 19 mg/L (200 gpd ferric, Q = 15 MGD)
    - Ended at 11.5 mg/L (130 gpd, Q = 16 MGD)



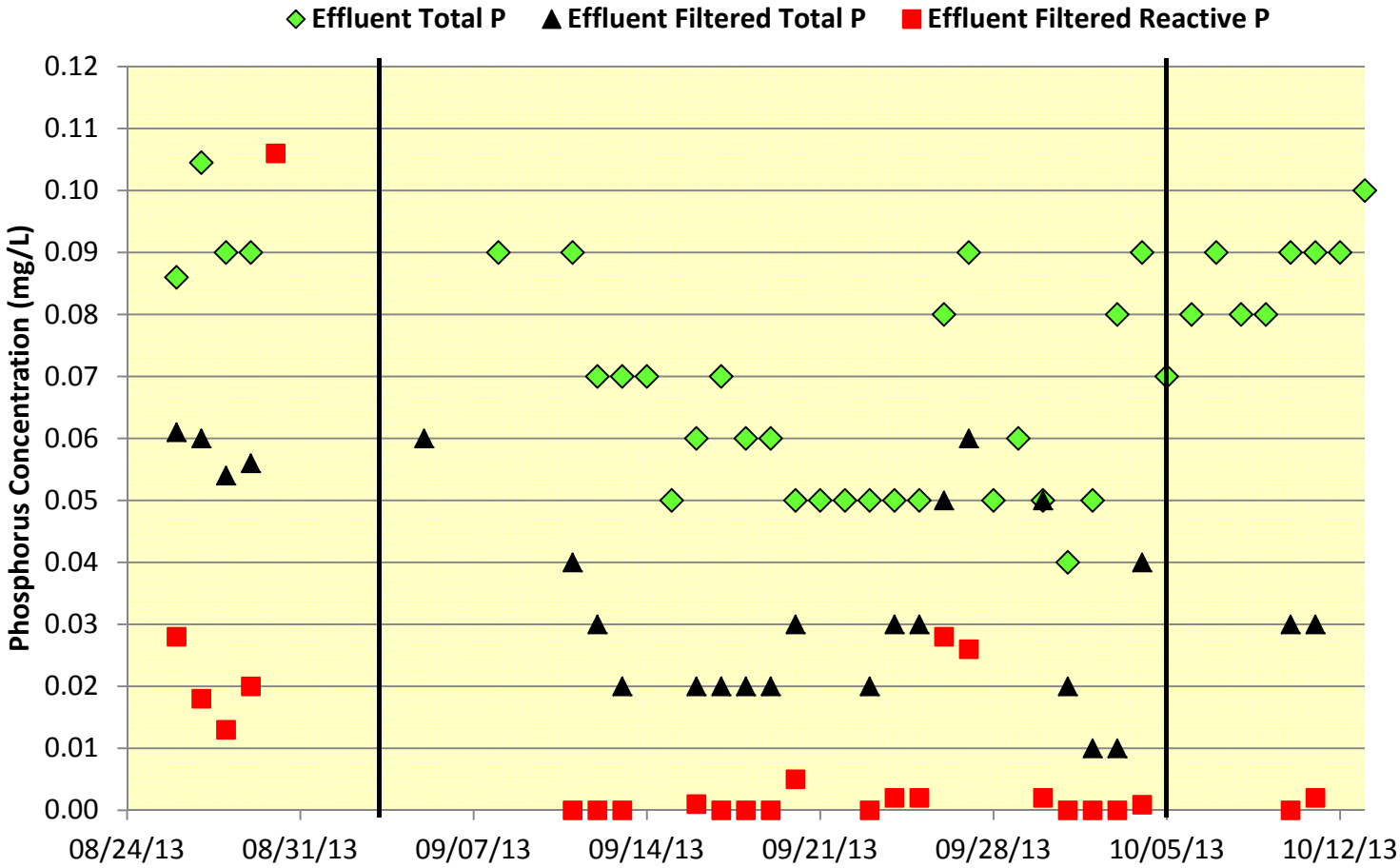
2013 Pilot Results

- Effluent total P



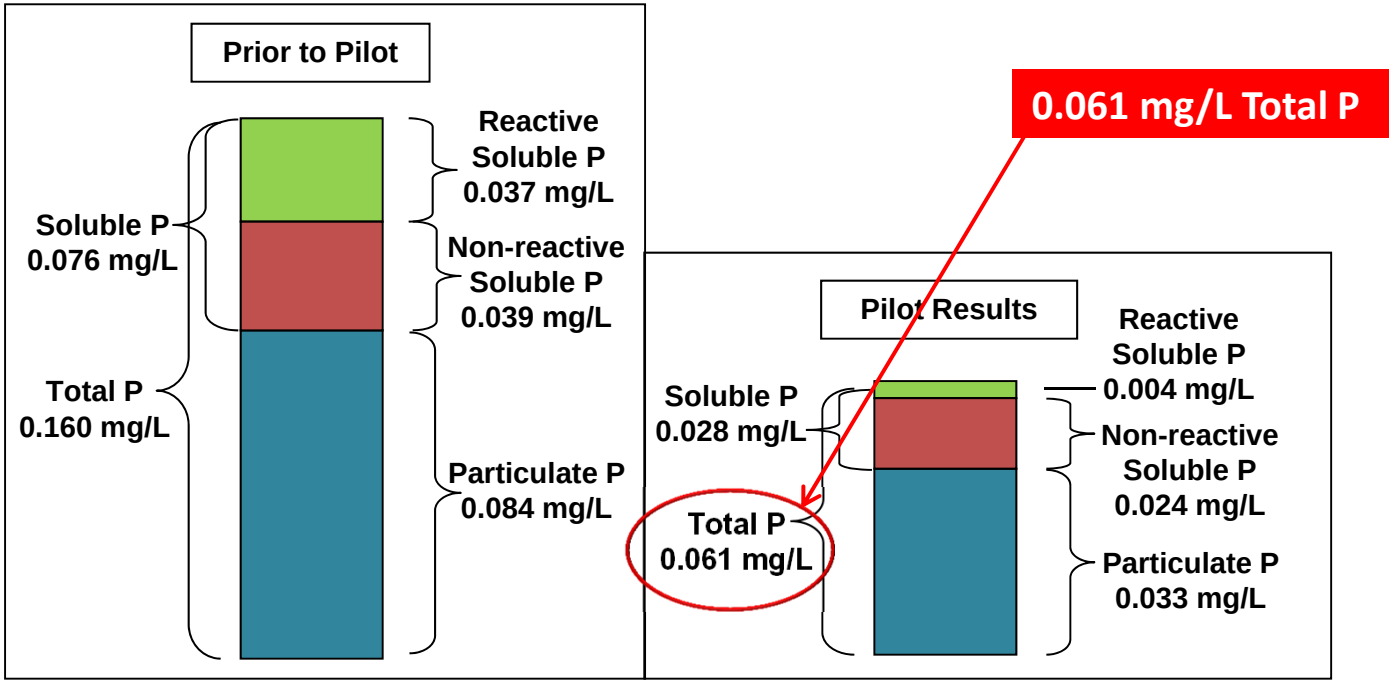
2013 Pilot Results

- Effluent P speciation data



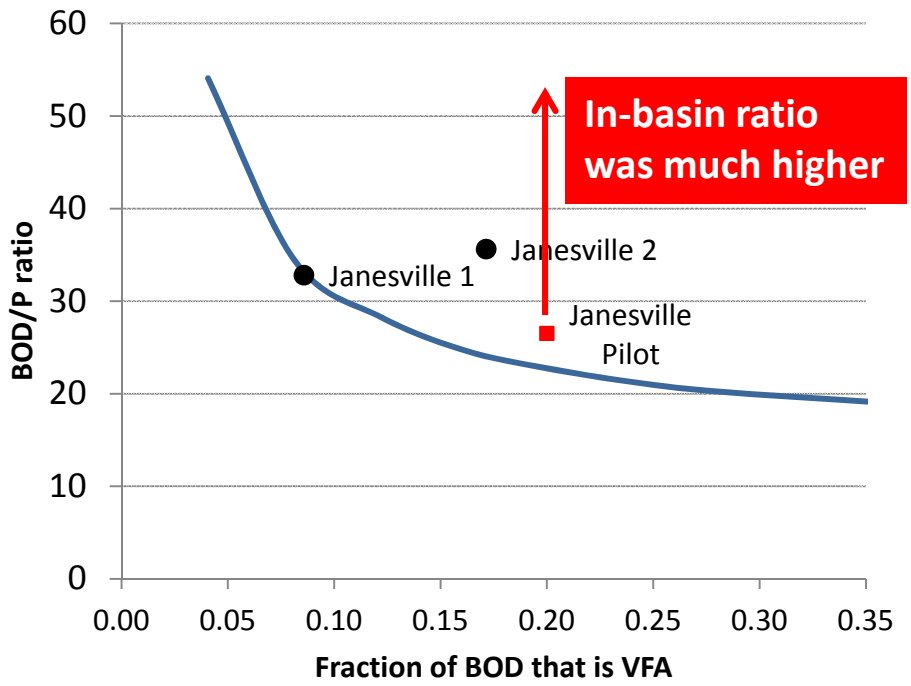
2013 Pilot Results

- Effluent phosphorus speciation – average values
  - Note: Ortho P is part of reactive P



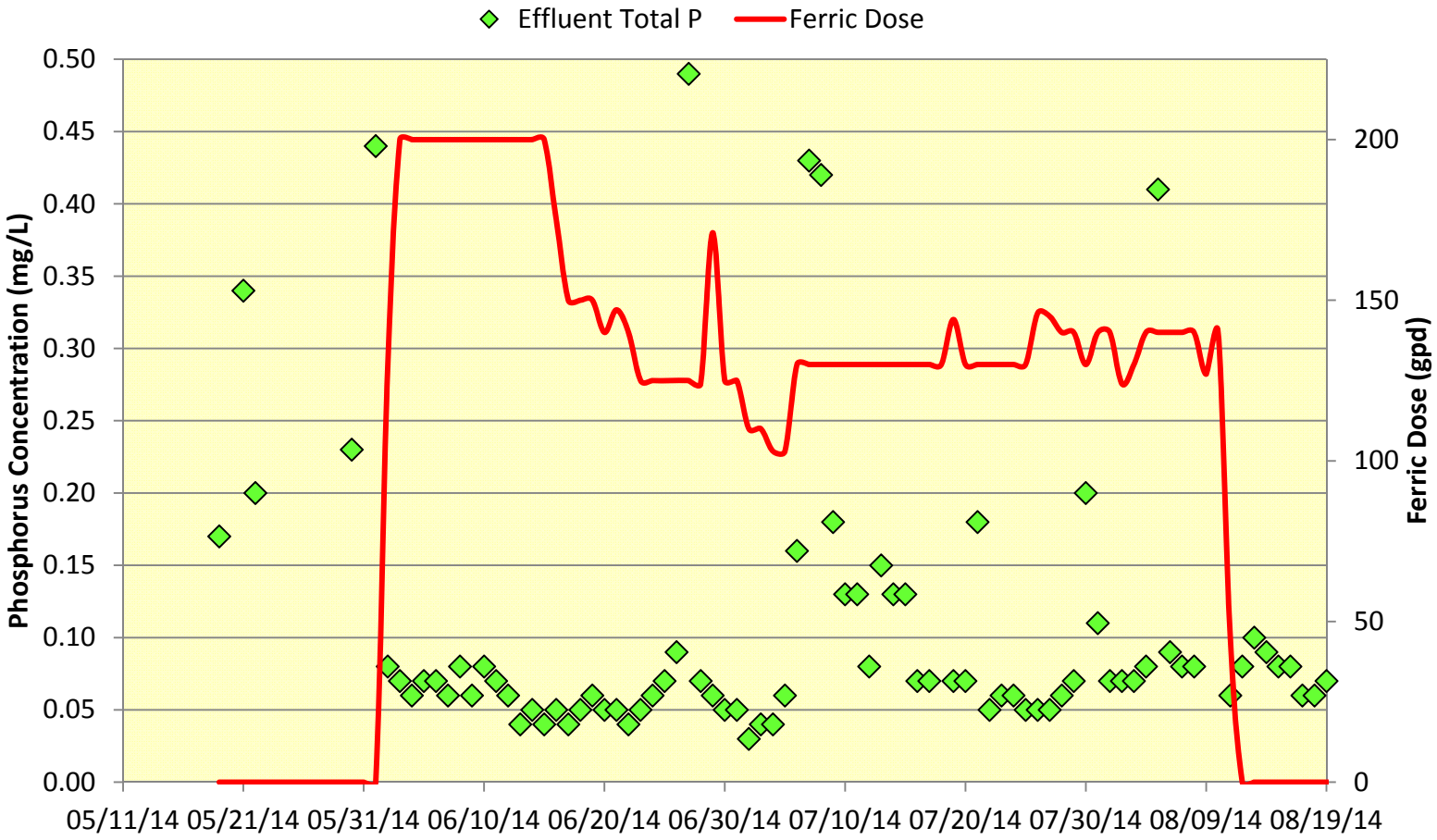
2013 Pilot Results

- Observations
  - BOD:P ratio 26.5
  - Target P was 0.1 mg/L
  - 0.06 mg/L result suggested over-dose
  - BPR was not affected
    - Following month P of 0.10 mg/L



2014 Pilot Results

- Effluent total P versus ferric dose



2014 Pilot Results

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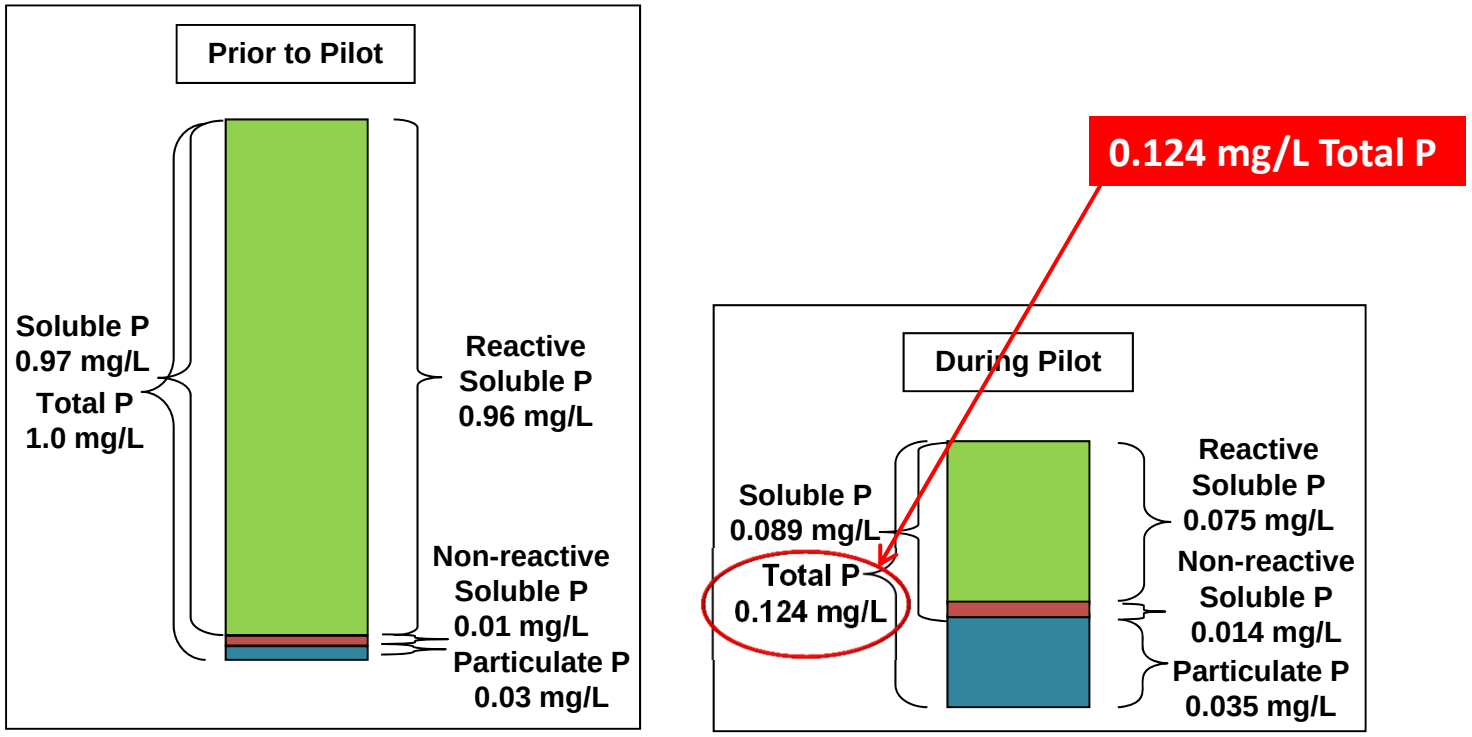
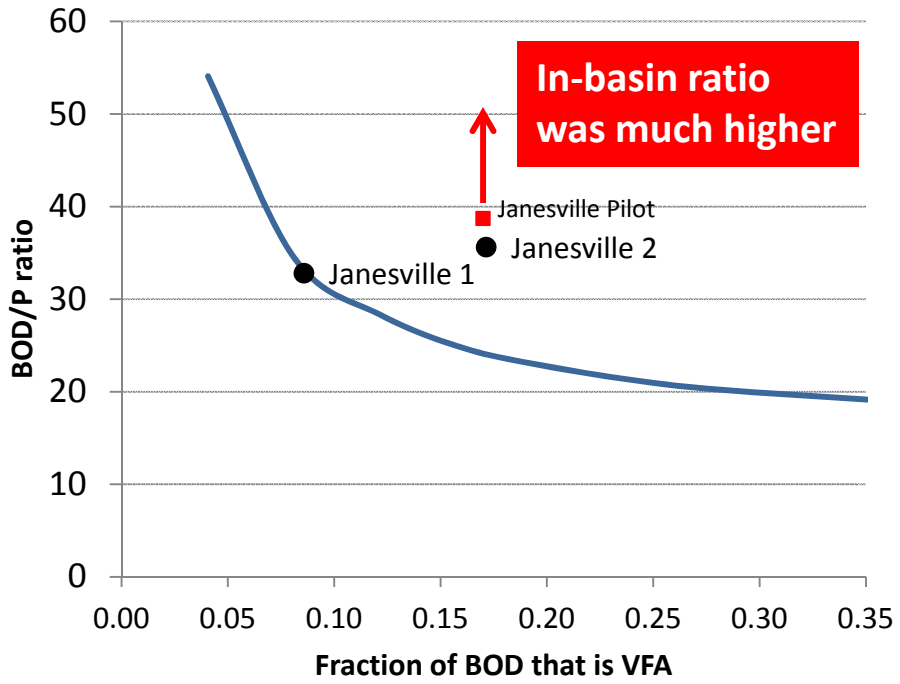


2014 Pilot Results

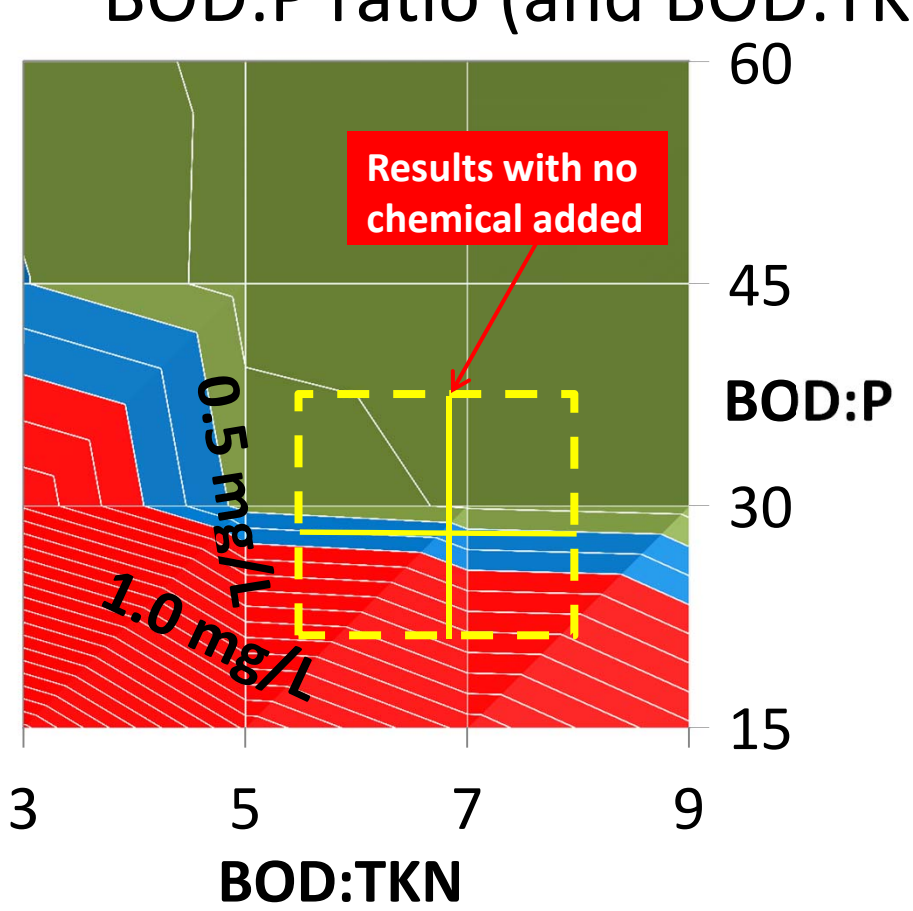
- Observations
  - BOD:P ratio 38.7
  - Target P was 0.1 mg/L
  - 0.12 mg/L result suggested under-dose
  - BPR was not affected
    - Following month P of 0.12 mg/L

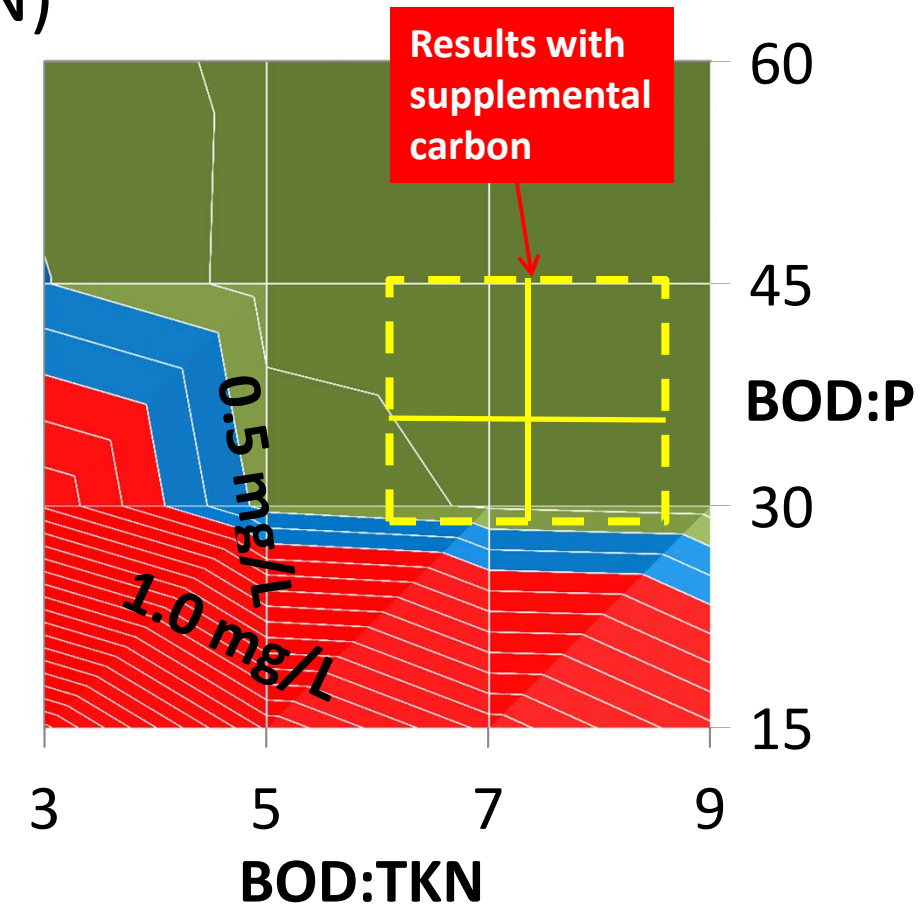


BPR + Supplemental Carbon

BPR + Supplemental Carbon

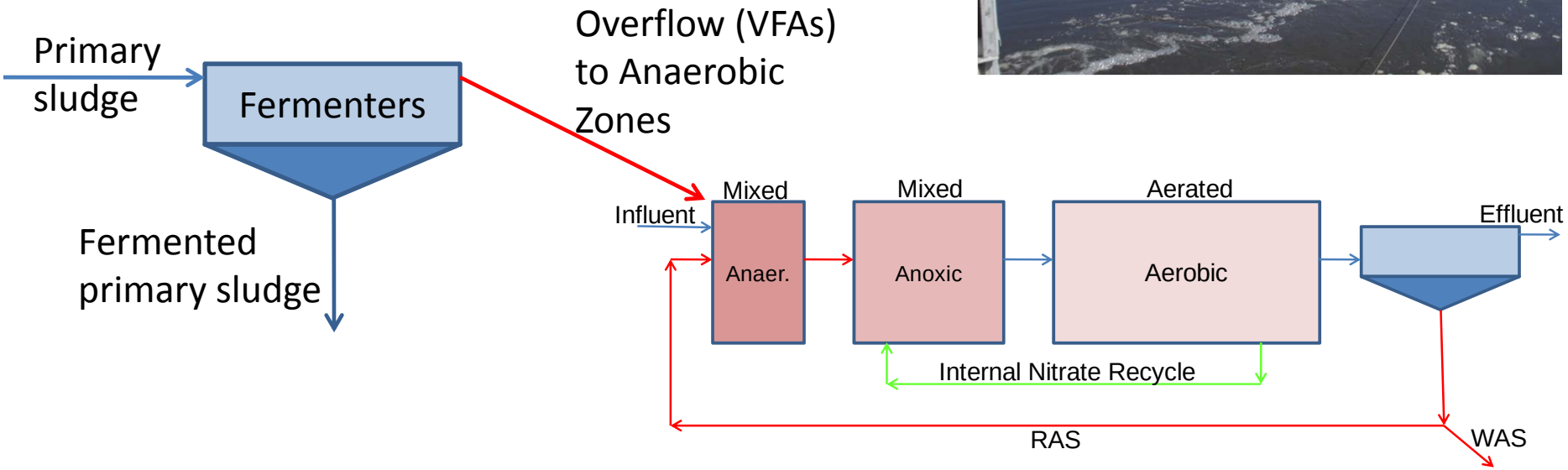
- Supplemental carbon can be added to increase BOD:P ratio (and BOD:TKN)





BPR + Supplemental Carbon

- Overflow from fermenters provides additional VFA for BPR
- The remaining VFA flows into the anoxic zone for biological nitrogen removal



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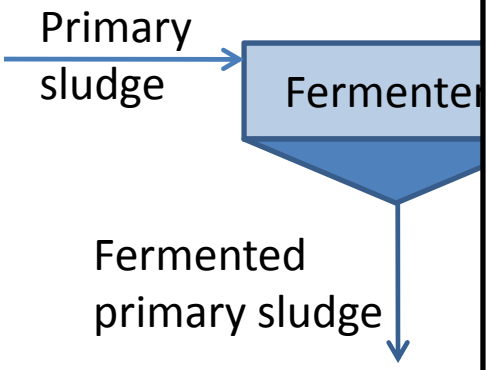
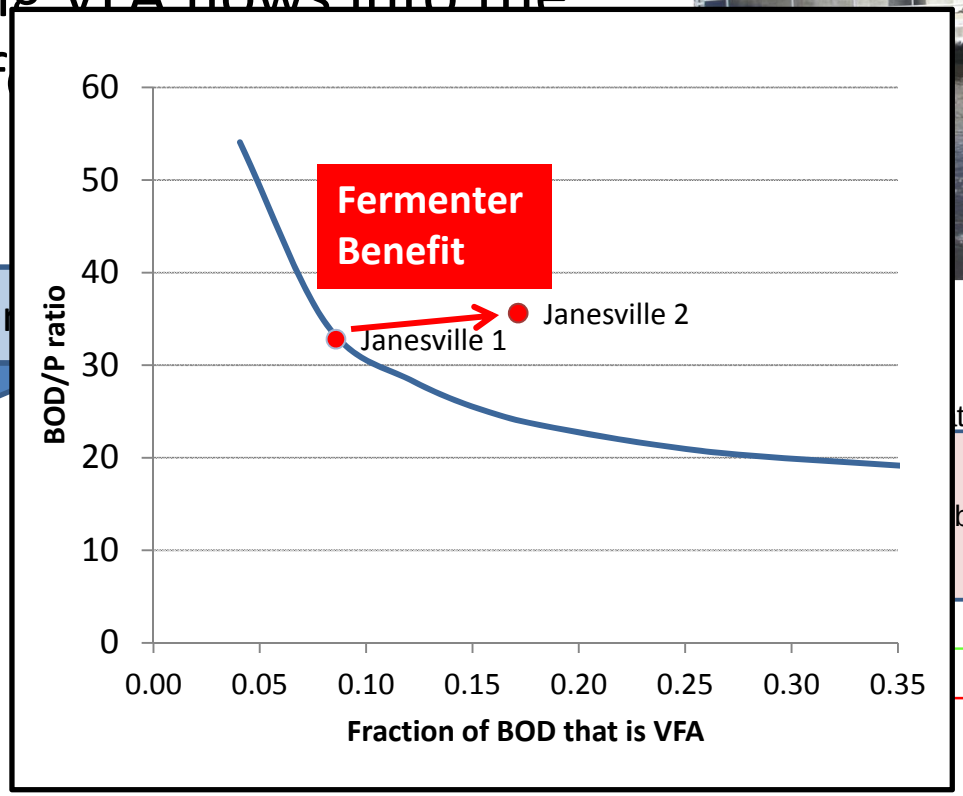
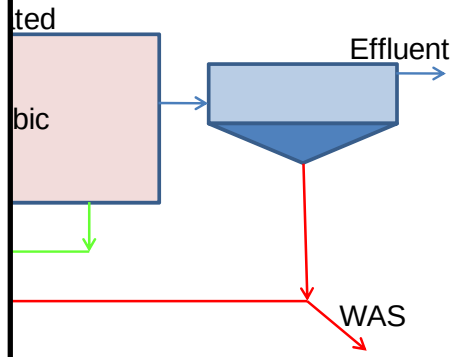




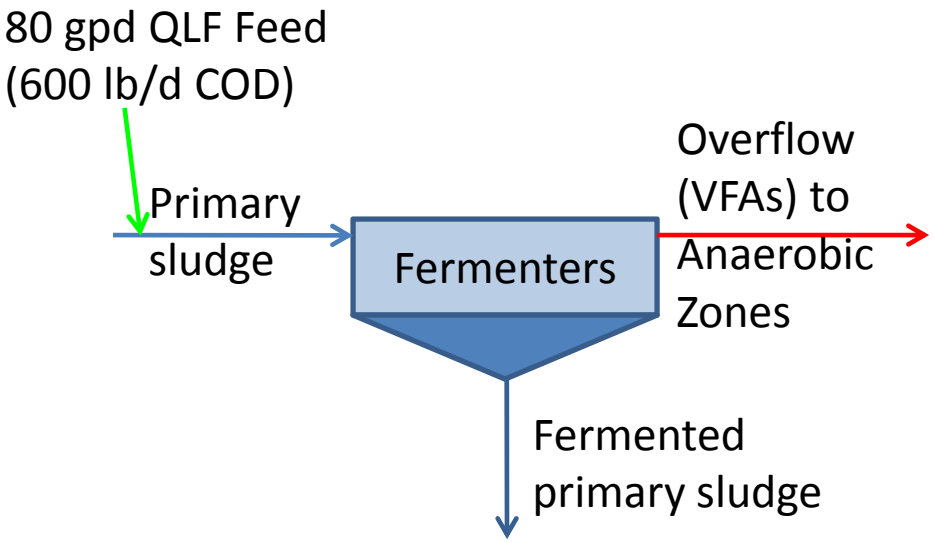


Supplemental Carbon Pilot

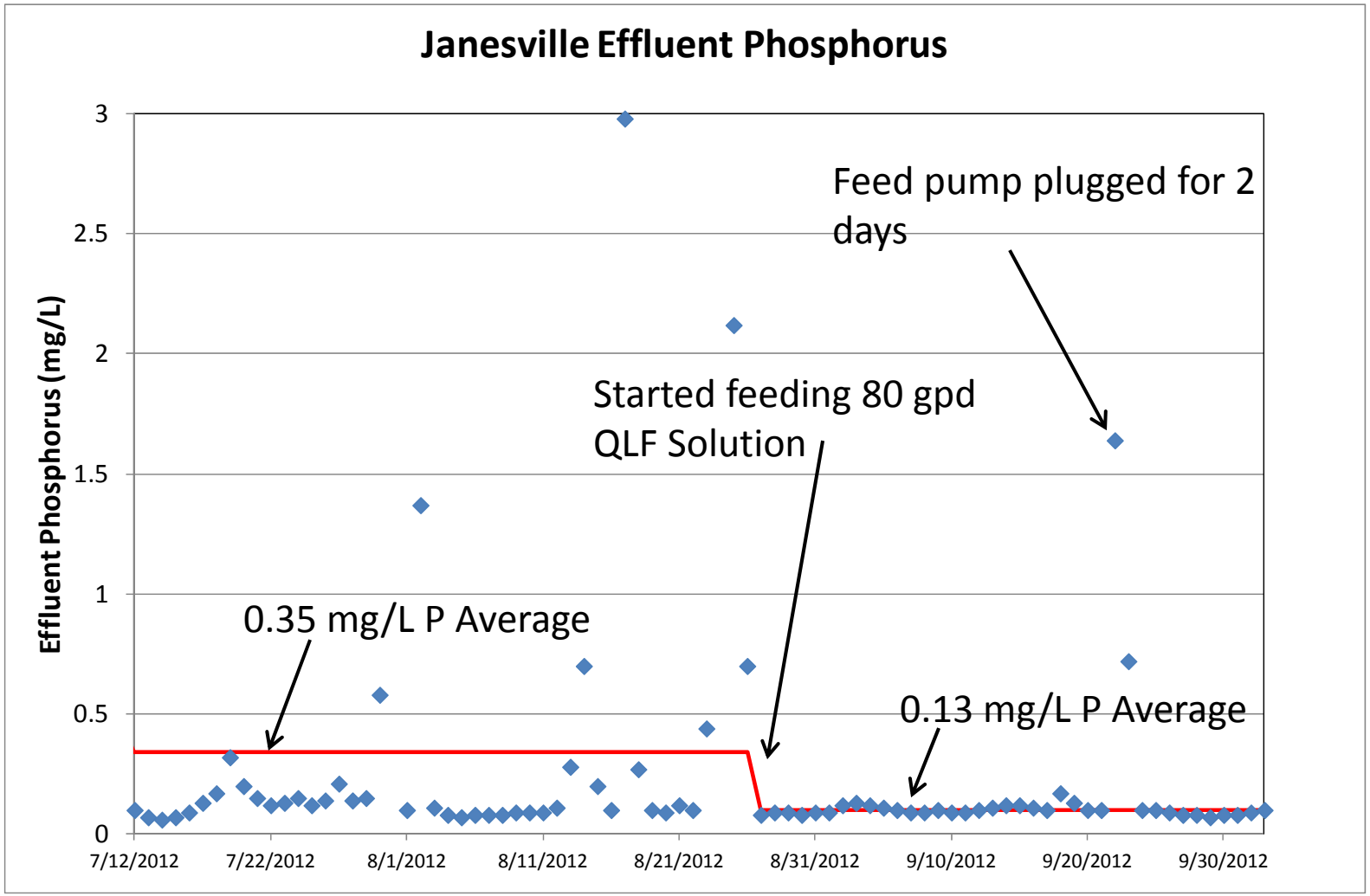
- Evaluate feeding supplemental carbon from QLF Specialty Products
  - Liquid molasses blend product
  - 7.3 lbs COD per gallon (875,000 mg/L)
- Pilot Goal
  - Stabilize BPR performance near 0.10 mg/L effluent total-P **(no filters and no ferric chloride)**

Supplemental Carbon Pilot

- QLF product fed into fermenters
  - Fermenters convert product to VFA's
  - VFA loading in fermenter overflow increased

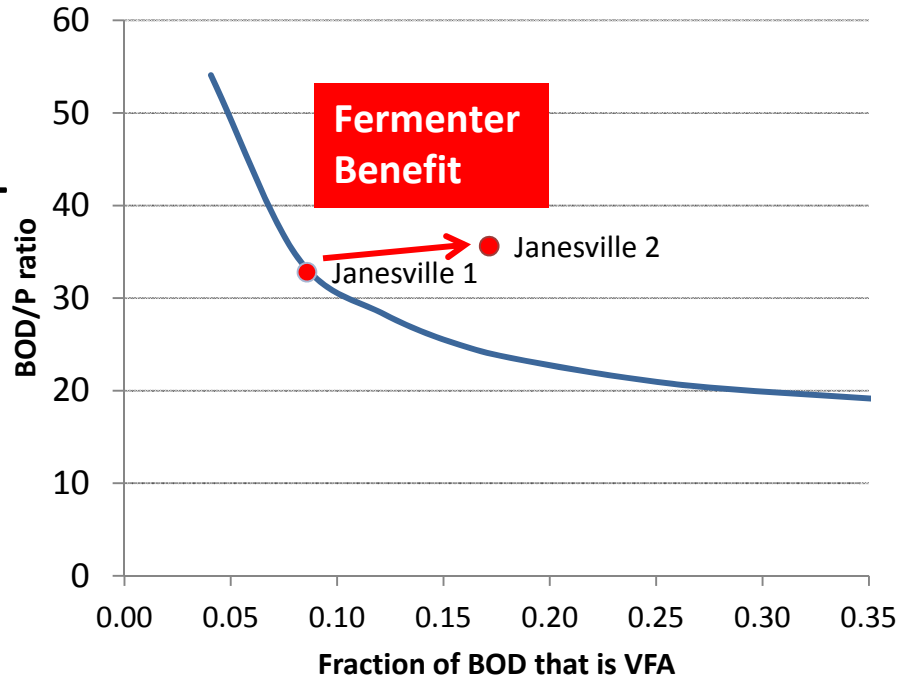


Supplemental Carbon Pilot



Supplemental Carbon Pilot

- Observations
  - Target P was 0.1 mg/L
  - Supplemental carbon dose achieved 0.13 mg/L
  - Ortho-P was stable at 0.06 mg/L
    - Limit for BPR?
  - Another “tool in the tool box”



Take-Away Points

- Foundation of the process is BPR
  - Focus on keeping BPR happy
- Use of chemicals does not hurt BPR process
- Combination of BPR + chemicals:
  - Can produce low level performance
  - Can improve stability
  - May be more cost effective than chemical alone
- Supplemental carbon is another option
  - Improves both P removal and N removal

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