OWEA Annual Conference, Sandusky, OH, Wednesday, June 24, 3:00-3:45 PM

Masses at Massillon: IFAS for Industrial Loads and Nutrient Removal

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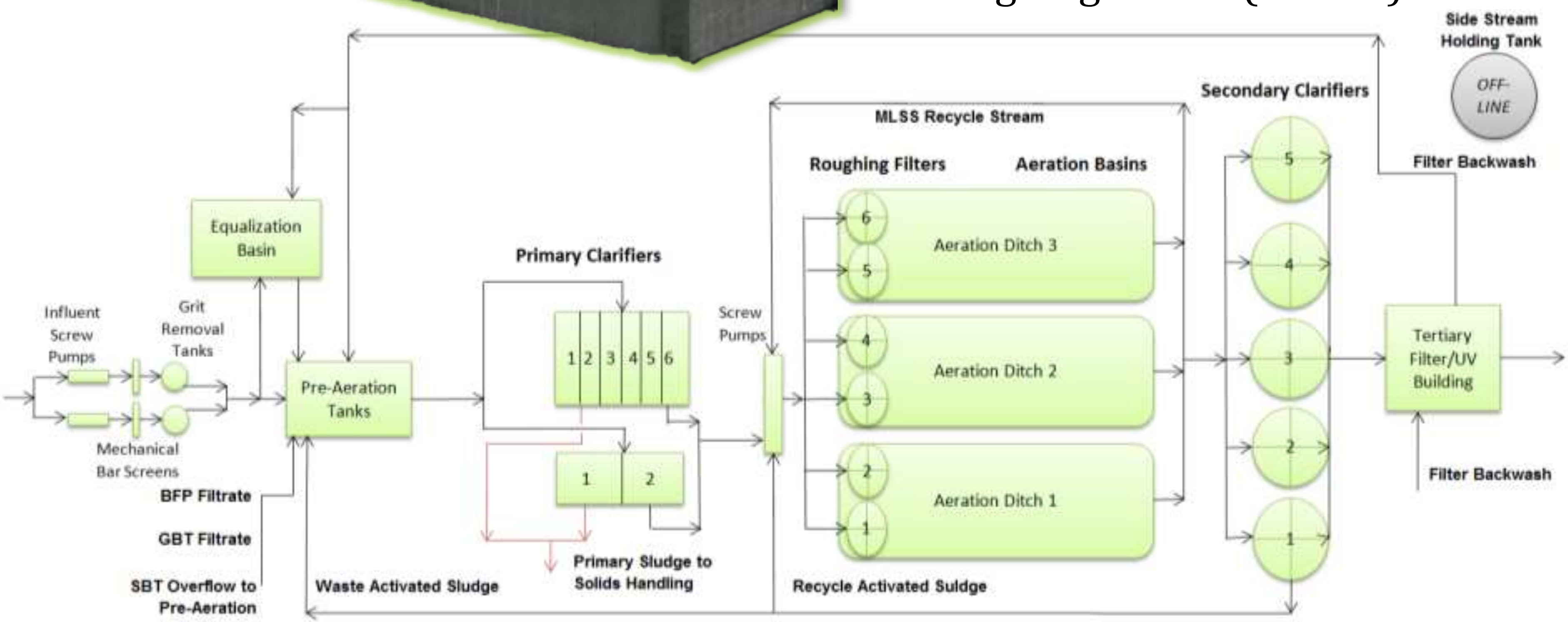
Joint Venture

Agenda

- Project Background
  - Ex. Plant
  - Future Limits
- Facilities Planning
  - TP Removal Study
- Transition from Study to Design
  - *Challenges Arise!*
- Industrial v. In Plant Solutions
- Final Design Challenges
- Summary & Questions

Massillon Ohio WWTP – Ex. Liquid Stream

- 15.8 MGD Design ADF
  - Secondary Biological Treatment
    - $CBOD_5$/Summer NH_3-N
  - Aeration Ditches
  - Roughing Filters (odors?)



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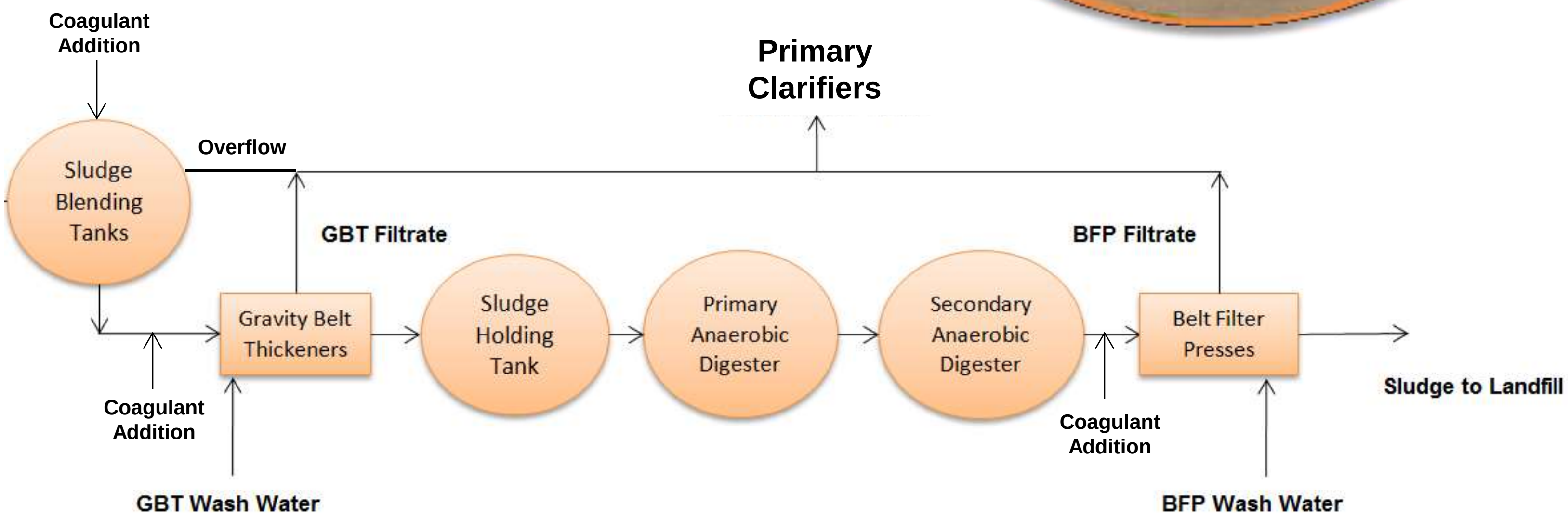
Massillon Ohio WWTP – Ex. Solids Treatment

- Stabilization - Anaerobic Digestion
  - Sludge Blending
  - Gravity Belt Thickening
  - Belt Filter Press Dewatering
  - Coagulant Feed for odor control



Massillon Ohio WWTP – Ex. NPDES Permit

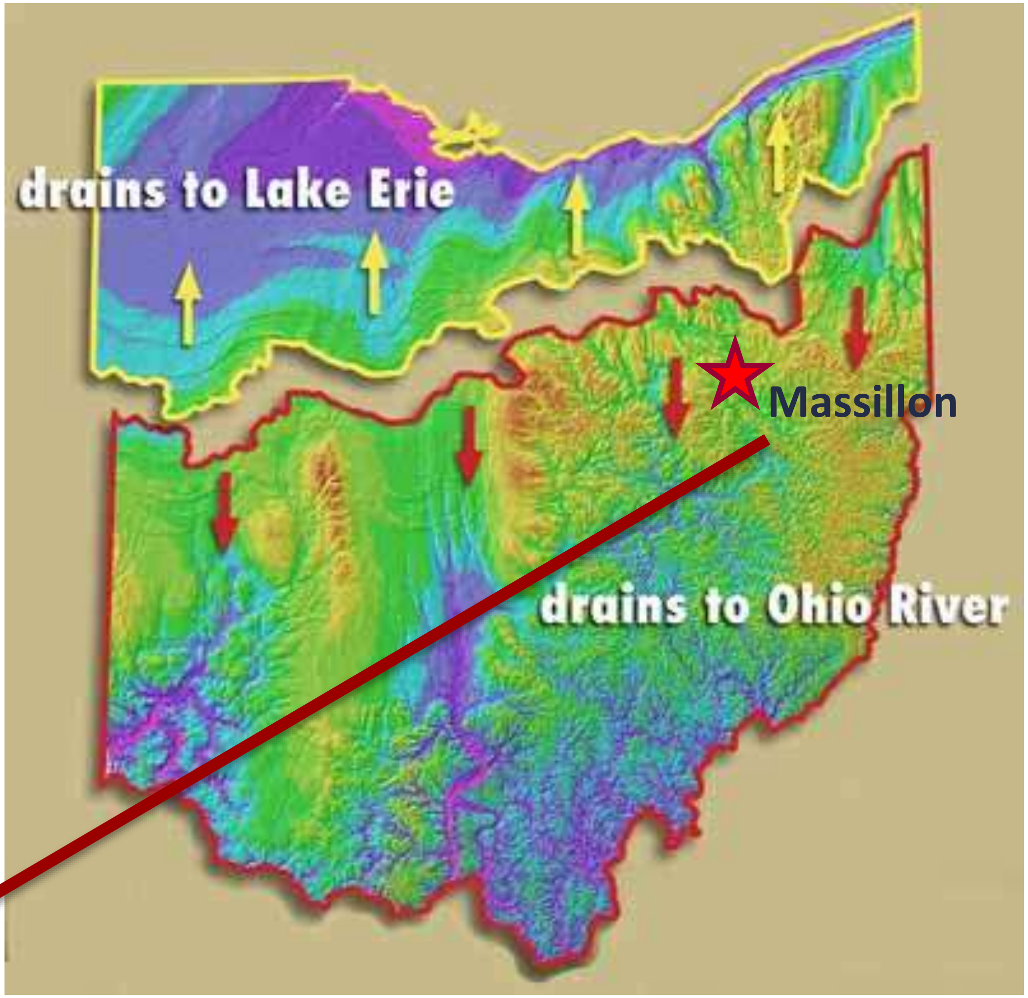
Ex. NPDES Discharge Permit Limitations			
Parameter:		**Concentrations- mg/L**	
		Weekly	**Monthly**
TSS		18	12
NH_3-N	Summer	2.1	1.4
$CBOD_5$	Summer	15	10
	Winter	33	22
TP*		1.5	1.0
**60 mo. after effective date (March 2016)*			

- Effective: March 2011
- Expiration: January 2015
  - Ex. Plant meets TSS, $CBOD_5$ and NH_3-N
  - ***Improvements required for TP removal – Other improvements?***

Ohio EPA
Ohio Environmental Protection Agency

Ohio EPA – Nutrient Removal Strategy

- State Wide Nutrient Reduction Strategy
- TMDLs, watershed plans
- Priority watersheds
- Phase in Effluent Phosphorus (P) limits
- Ohio River Watersheds
  - State Waters
  - *Gulf Hypoxia Program*



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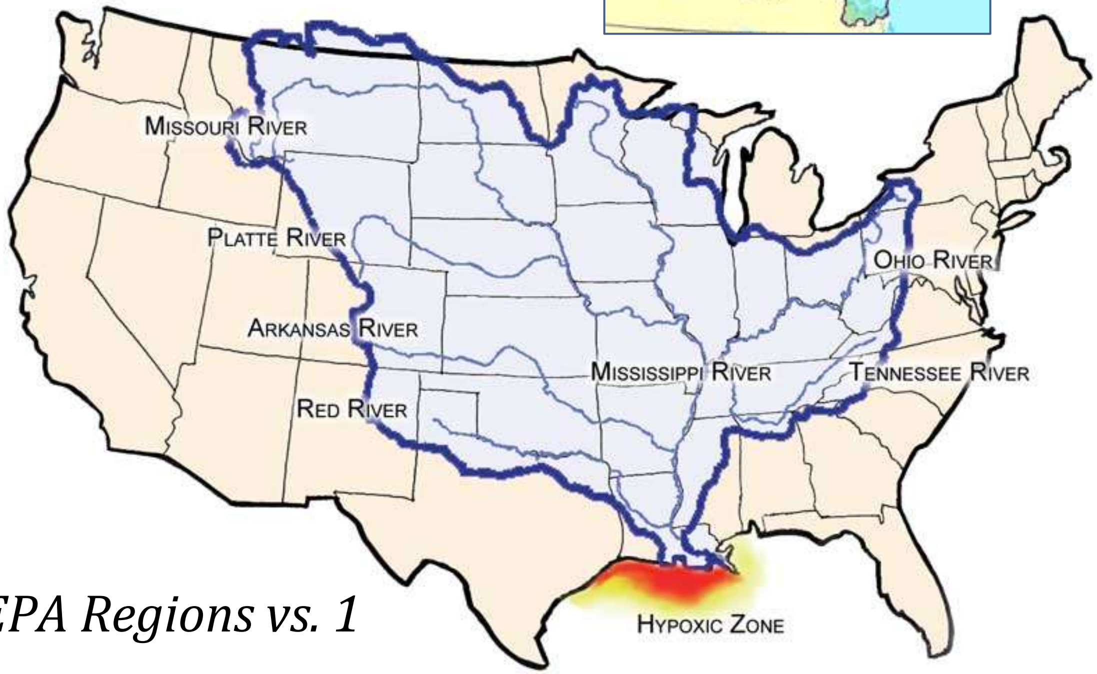
Gulf Hypoxia Program - may look a lot like Chesapeake Bay's

- Precedence
  - Science, Regulations
  - Performance Results
    - Point Source (TP, TN; Capital, O&M)
    - (Some) Non-Point Source
  - Trading
  - Integrated Planning
  - Nutrient Recovery
- Policies & Procedures
- Lessons Learned
  - Fairness
  - Funding?
  - Flexibility
  - *33 vs. 6 States, Multiple EPA Regions vs. 1*



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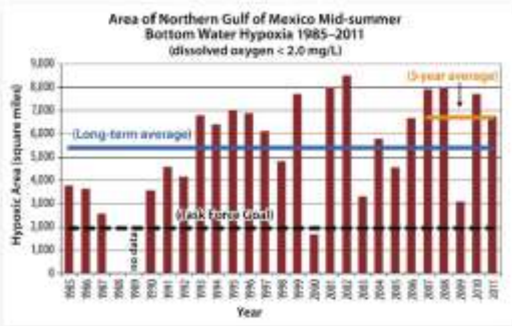
Gulf of Mexico Hypoxia & Pending Nutrient Removal Program



Nutrient Removal (NR) Levels (mg/L)

- Biological NR (BNR) – 8-10 TN, 1 TP
- Advanced NR (ANR) – 5 TN, 0.5 TP
- Enhanced NR (ENR) – 3 TN, 0.1-0.3 TP

Likely Future Effluent Limits?

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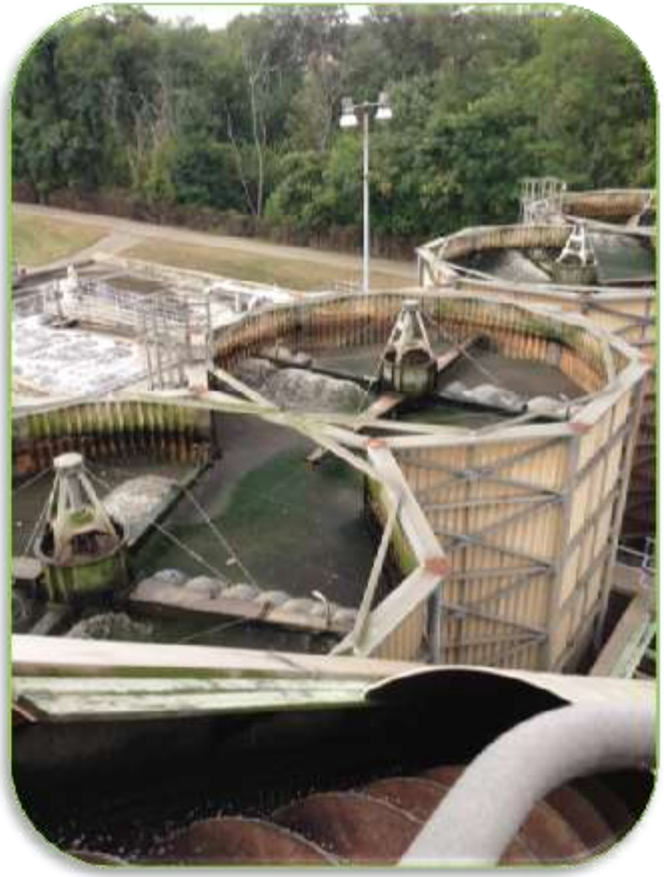
Massillon WWTP – Improvements Project Goals

- Expansion to 17 MGD
- Pending 1 mg/L TP
    - *Future 10 mg/L TN?*
        - Evaluate BNR
- Take roughing filters offline
    - Odor complaints
- Maintain Existing:
    - Tankage
    - Anaerobic Digestion
    - Industrial Pretreatment



- Facility Plan Update (CTI) and TP Removal Study (OBG)

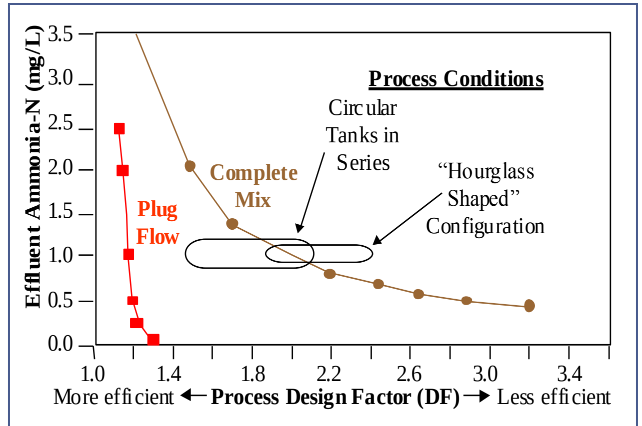
TP Removal Study – Establishing Design Loadings

Current Data				
Parameters	Units	Industrial Load	Calculated Domestic	Measured Plant Influent (2007-2011)
Average Daily Flow	MGD	0.816	9.5	10.3
BOD_5	mg/L	787	155	205
TSS		309	149	162
Ortho-P		19	0.7	1.2
Total P		17	1.5	2.8
20 Year Prediction				
		Industrial Load	Calculated Domestic	Calculated Future Influent
Design Flow	MGD	2.185	14.8	17
BOD_5	mg/L	433	155	191
TSS		329	149	173
Ortho-P		19	0.7	1.6
Total P		18	1.5	3.6

- Four Significant Industrial Users (SIUs)
  - Reported current data, 20 year projections
- Design TP → 3.6 mg/L

TP Removal Study - Initial Design Ideas

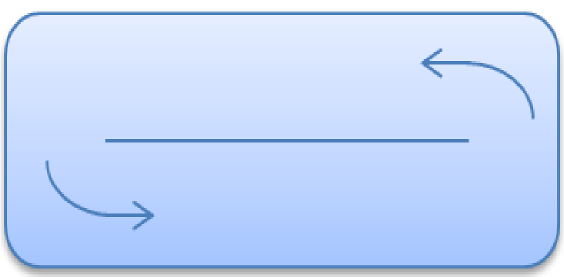
- Remove Roughing Filters
- Three Expansion Options:
  1. Keep Existing Ditch Operations
  2. Convert Ditches to Plug Flow
  3. Convert Ditches to Plug Flow and Add Media (IFAS)



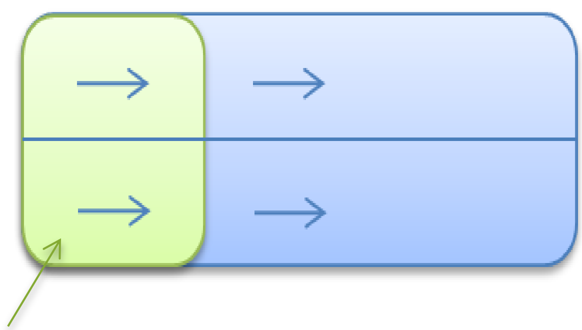
Effect of design factor on steady state effluent ammonia levels in complete mix and plug flow suspended growth reactors.


AnoxKaldnes K5 Media

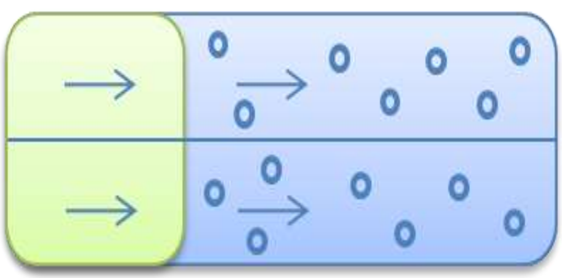
Existing Operations



Plug Flow



Plug Flow with IFAS



Anaerobic/Anoxic Zone

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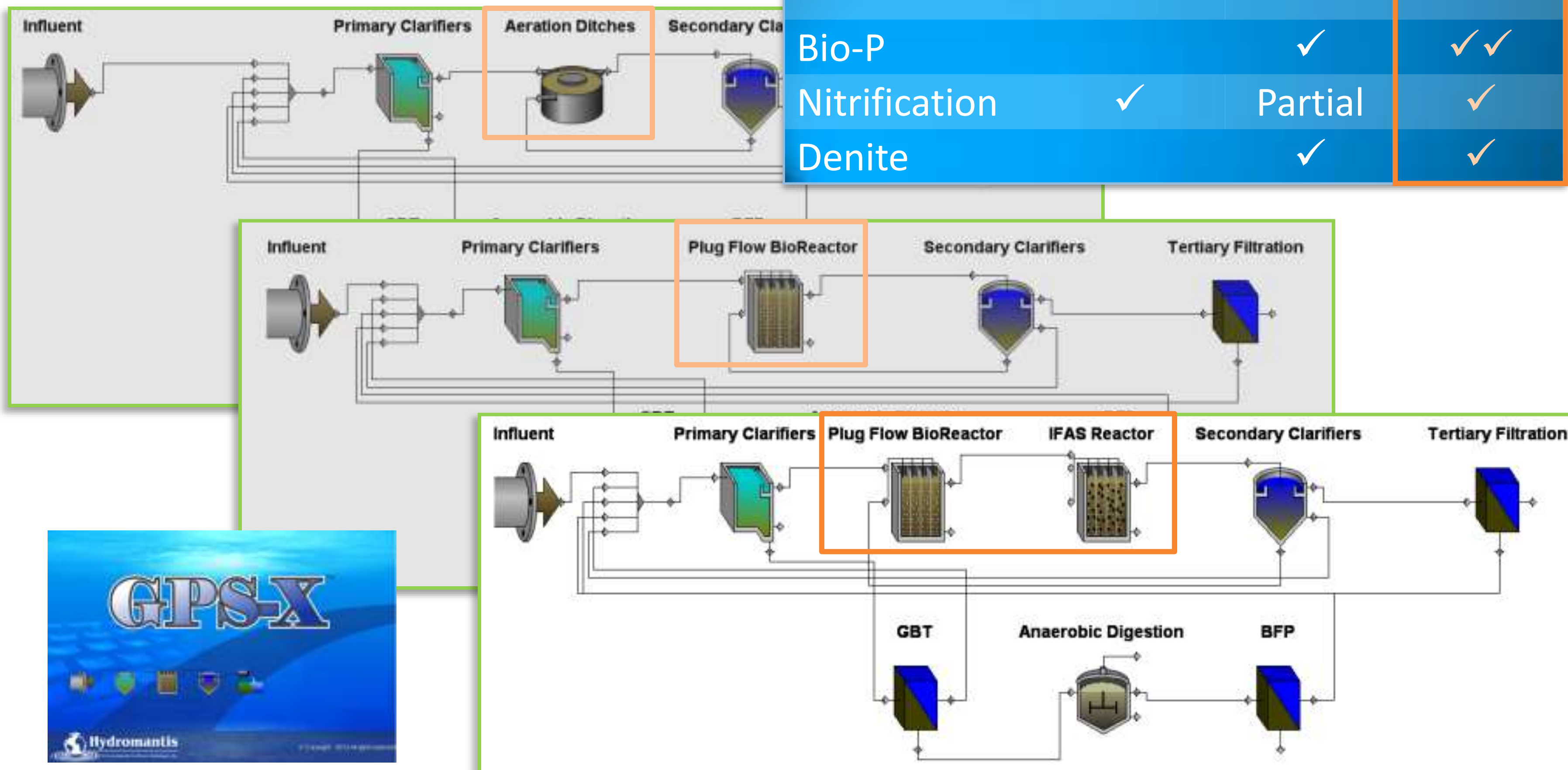
TP Removal Study - Initial Modeling Results

- Plug Flow + IFAS
  - Predicts best overall treatment

Treatment Achieved	Aeration Ditches	Plug Flow	Plug Flow + IFAS
BOD	✓	✓	✓
Bio-P		✓	✓✓
Nitrification	✓	Partial	✓
Denite		✓	✓



TP Removal Study - Recommendation

Plug Flow + IFAS

Capacity Expansion + Moderate BNR

- Bio-P primary design goal

O+M Savings

- Maintain existing footprint
- An/Ax Zone as selector:
  - Reduce aeration, filamentous growth
  - Improve settling

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Facilities Plan Update (& TP Study) - Recommendations

Headworks

- Odor control modifications
- Fine screening

Secondary Treatment

- Demo screw pumps (High DOs)
  - New VTSH Primary Effluent Pump Station (PEPS)
- Conversion of Ditches to Plug Flow + IFAS

Tertiary Treatment

- Replace Ex. Tertiary Filters

Ancillary Upgrades

- Power
- Replace Boilers

Estimated Cost: $21.6 Million

Transition from Study to Design Phase – *Challenges Arise*

Vendor Review - Limited An/Ax?

- Min Temp: TP *or* TN Removal – not both

City requests TN as Primary Goal

- $2 M for IR, Ax Volume – **$23.6 M New Total**

Time to detail scope and secure 0% loan

- 1-yr post study – is data different?

Path forth:

- **Request Permit Extension, Evaluate Data, An/Ax Volume**

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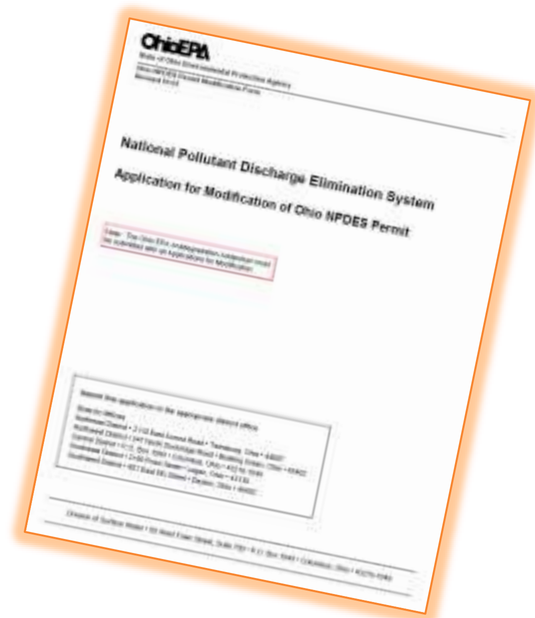
NPDES Permit Schedule Modification Request

- Additional Time Required to:
  1. Apply and Receive Loan
     - Water Pollution Control Loan Fund (WPCLF)
       - 0% Interest Loan, $6 M Savings
  2. Establish Agreement with Stark County
  3. Develop and Detail Scope
     - Comprehensive plant-wide upgrades
       - Want to best utilize high capital budget



- Requested Extension to NPDES Schedule
  - Extended 60 to 94 Months
  - **Meet 1 mg/L TP January 2019**

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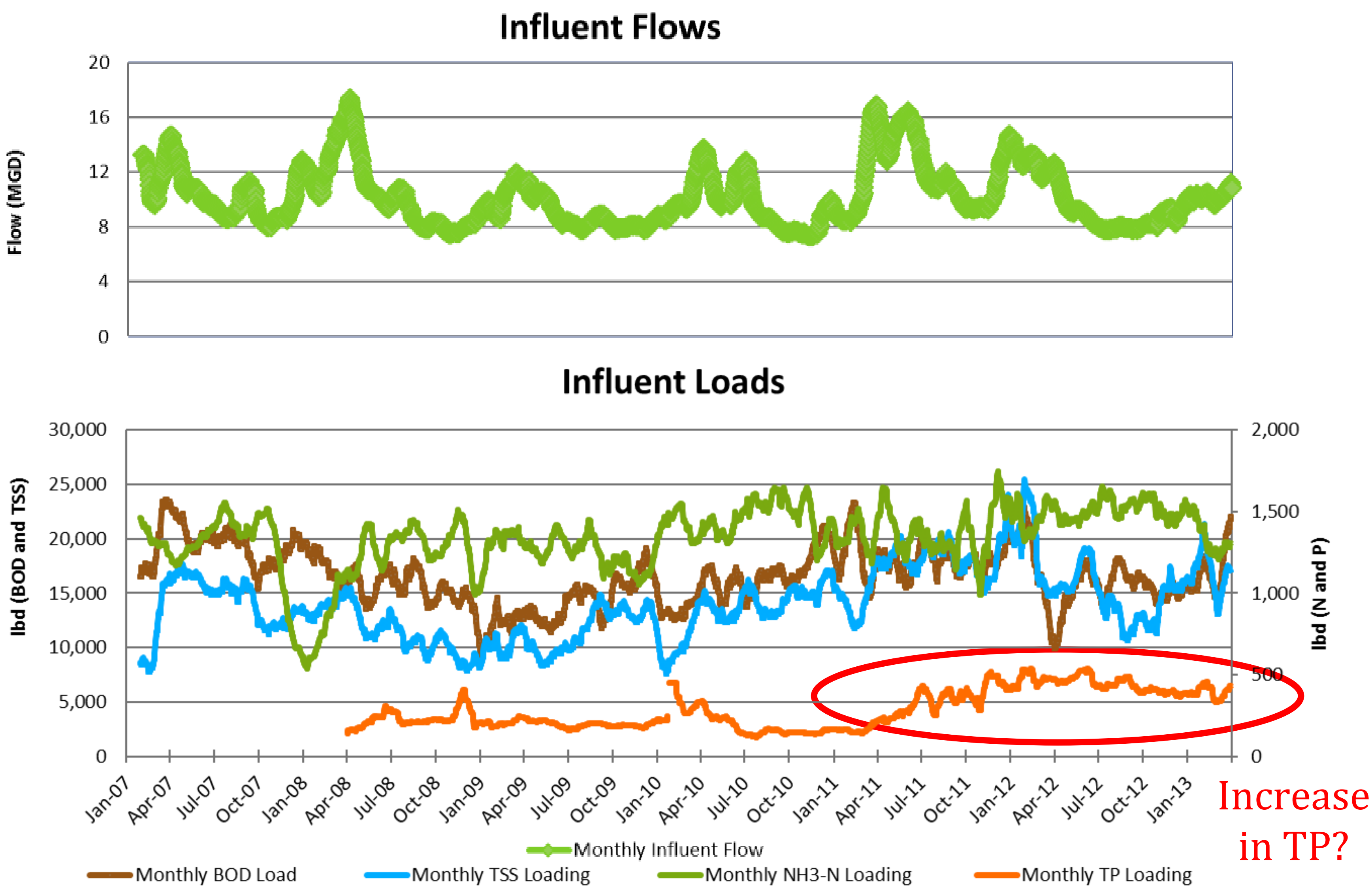
Evaluation of New Data – Influent Flows and Loads



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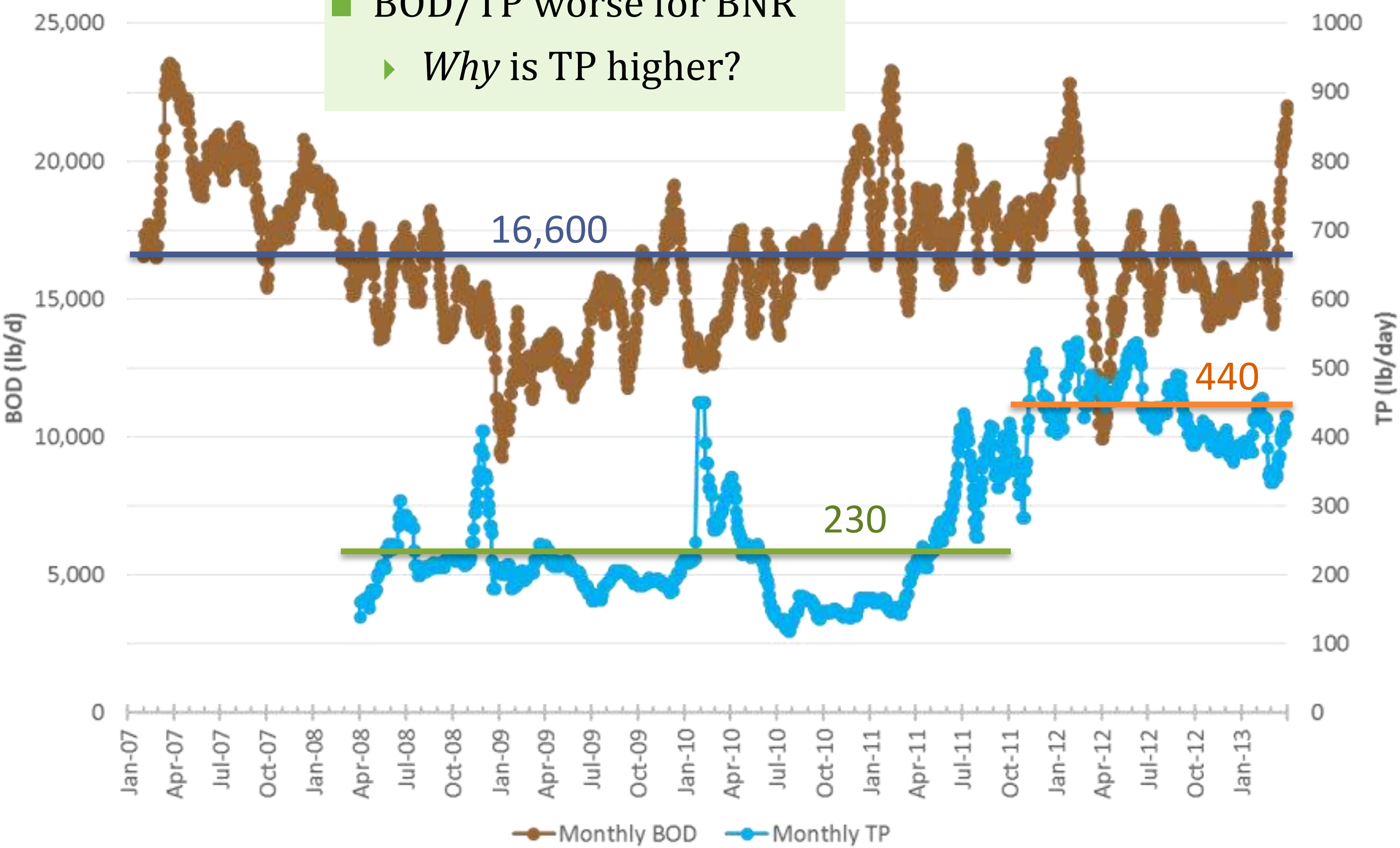
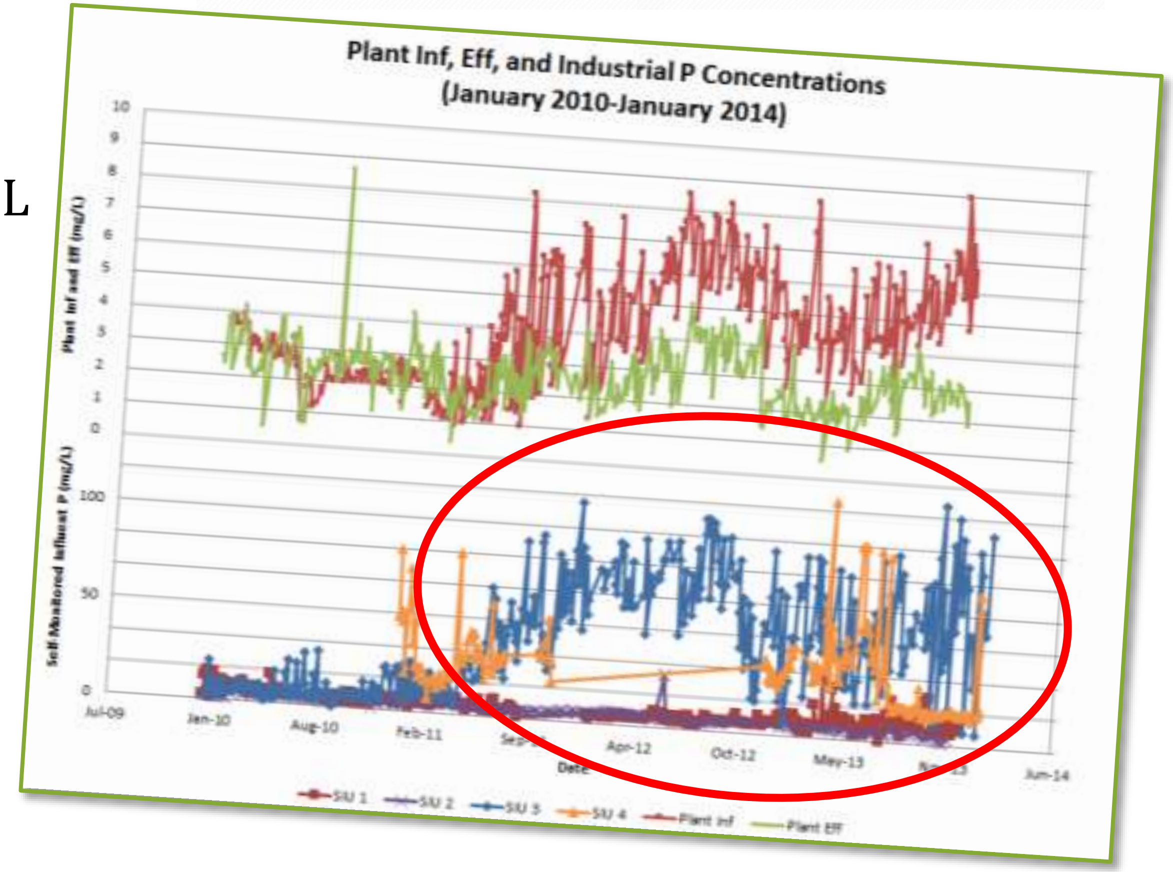
Evaluation of New Data –TP Loads Increased

- BOD/TP worse for BNR
  - *Why* is TP higher?



Increases from Industry

- Industrial TP Increases
  - Current data
  - 20 year projections
    - New expansion
- Design TP
  - 3.6 mg/L → 4.7 mg/L
  - +160 lbd @ 17 MGD
- Design BOD/TP
  - Reduced 24%



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Brainstorming Solutions to Address TP Load

Industrial

- Limit TP
- Increase BOD

In Plant

- Increase An/Ax
- Side-stream loads

Evaluating Industrial TP Solutions

Industrial

~~Limit TP~~

~~Increase BOD~~

- Industrial Limits - Hard Politically
  - Industry brings jobs, $
    - Example Expansion
  - Rather not limit TP further

- Models suggest 270 mg/L Inf BOD required for adequate NR
  - 1.5x Current (180 mg/L)
  - Another Political issue
    - Hard to enforce
  - Hard to ensure consistency

Evaluating In Plant TP Solutions

In Plant

- Increase An/Ax
- Side-stream loads

- City prefers In Plant Solutions
- Evaluating Options:
  - How and Where?
  - Maintain Project Goals?
    - (Ex. Footprint)
  - Minimize Budget Increases?
    - (Above the $2 M for TN)

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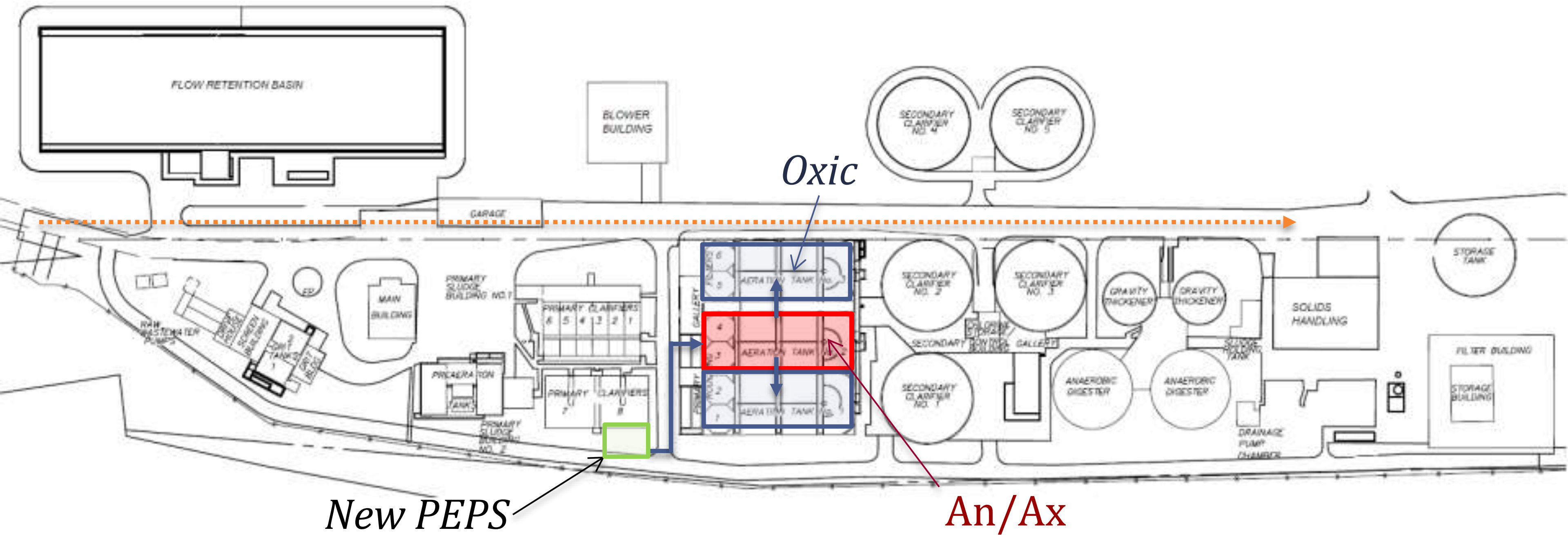
Increase An/Ax – How and Where?

- Maintain Existing
  - Footprint?
    - An/Ax Plug Flow + IFAS was within Aeration Ditches
      - 2.5 MGD total volume
  - Truck access to solids?
  - PC Effluent – flow path?



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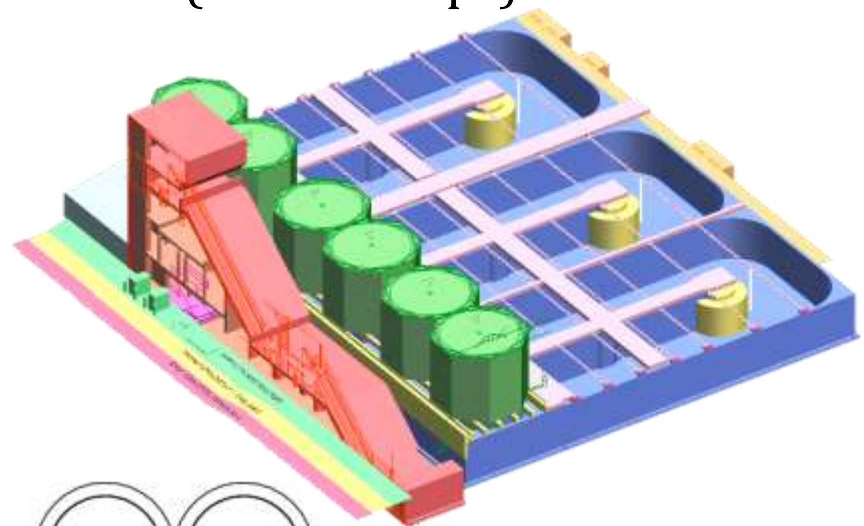
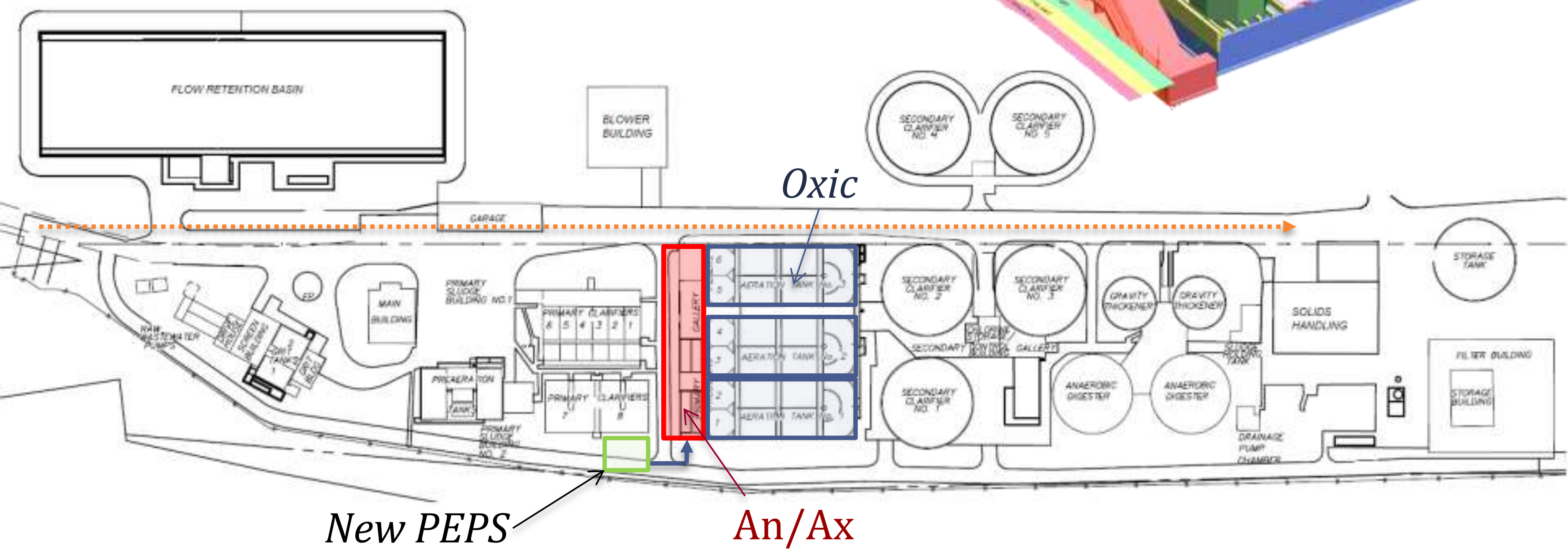
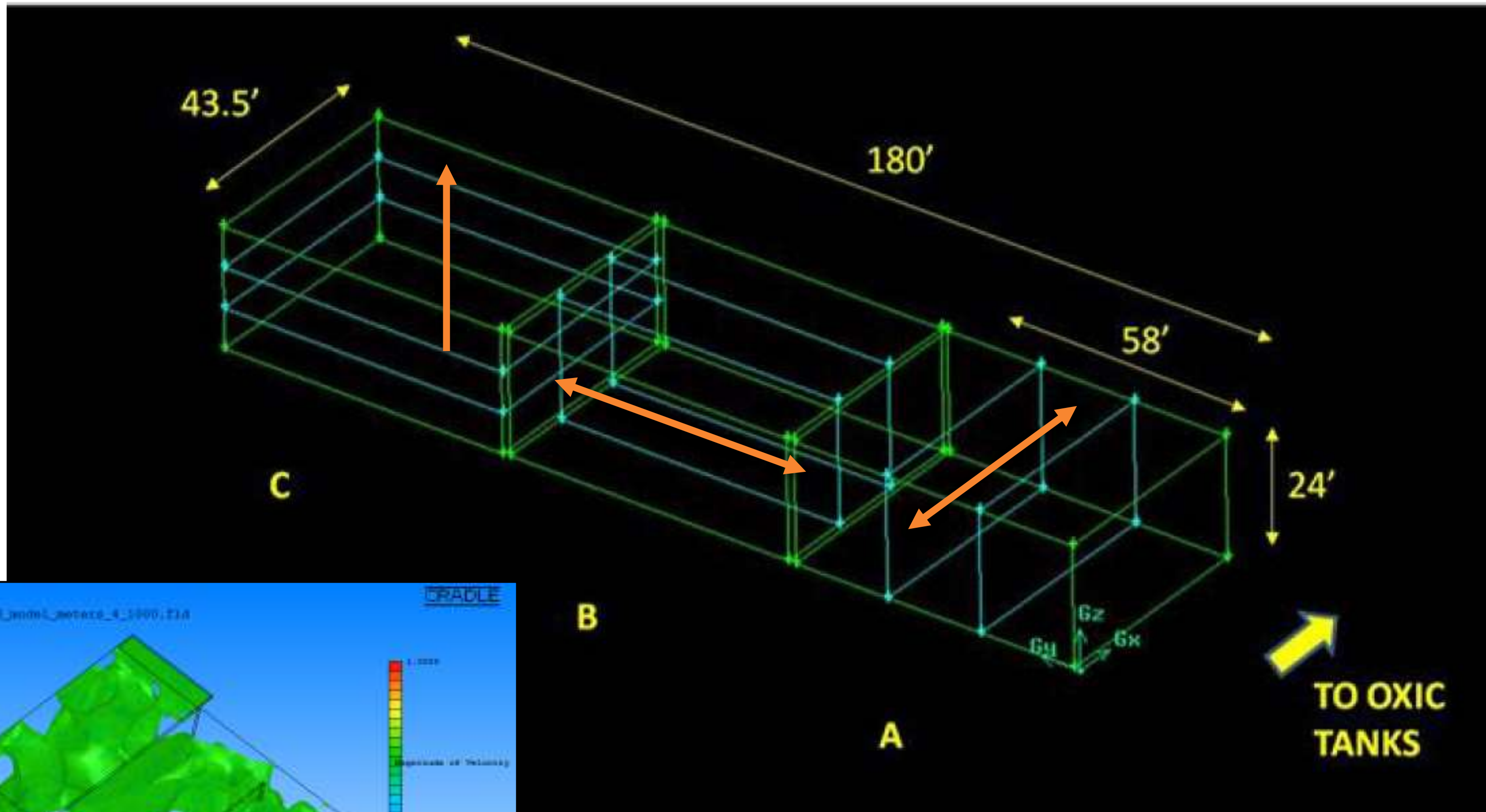
Increase An/Ax – "Chimney"

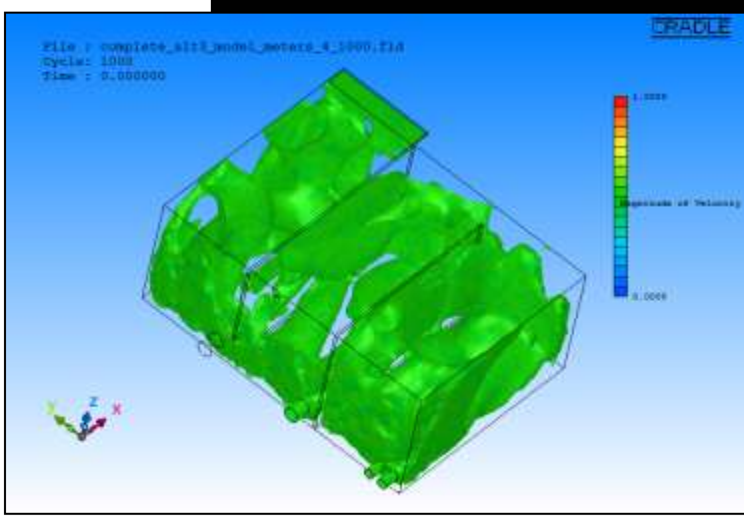
- Demolishing screw pumps→ New smaller PEPS (VTSH Pumps)
  - Deep An/Ax tanks before Oxic
    - 24 ft SWD
      - CFD Model Flow Path





Increase An/Ax – “Chimney” – CFD Results

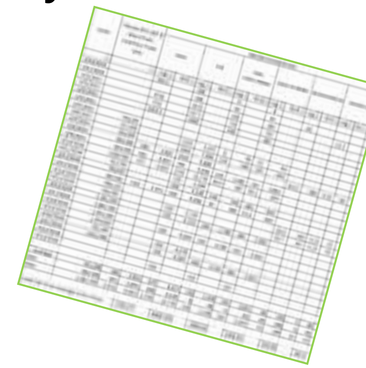


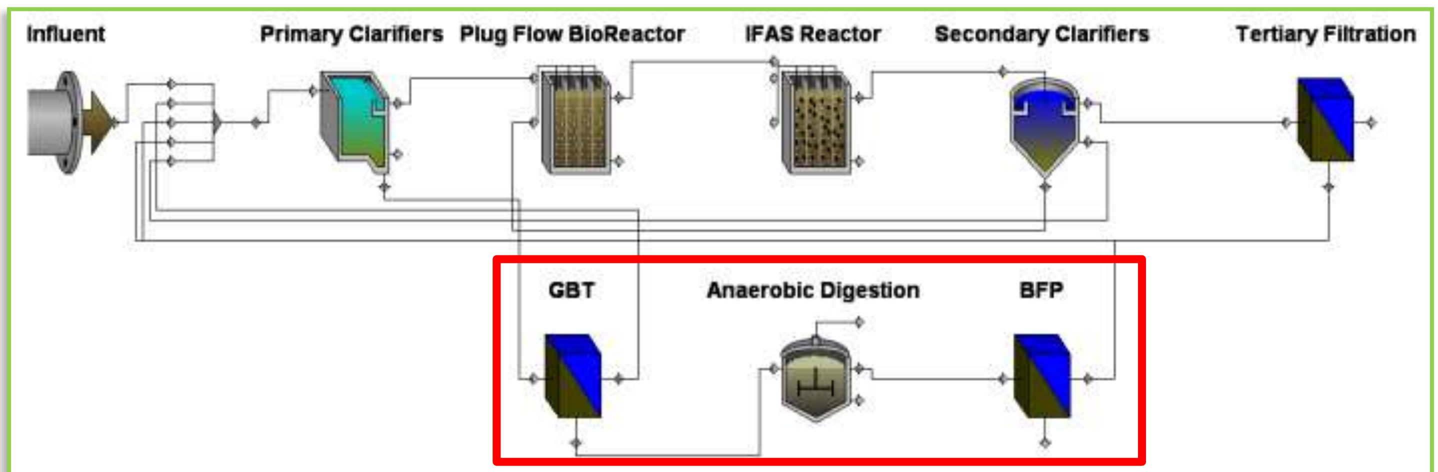


- 3 Trains, Split to 3 Zones
  - An – An/Ax Swing - Ax
- 3 Options: “A” predicted best mixing

Side-stream Loads – How and Where?

- Model results suggest high nutrient loads in solids handling recycles
  - 1,200 mg/L OP - Real?
- Initial Filtrate Special Sampling Results:
  - Concentrations lower than expected
    - (Combined 10-20 mg/L OP)
  - However, total load (300 lbd) 2x Increase in Influent TP (160 lbd)
    - *Could side-stream removal significantly reduce TP load to IFAS?*





Side-stream Loads – How and Where?

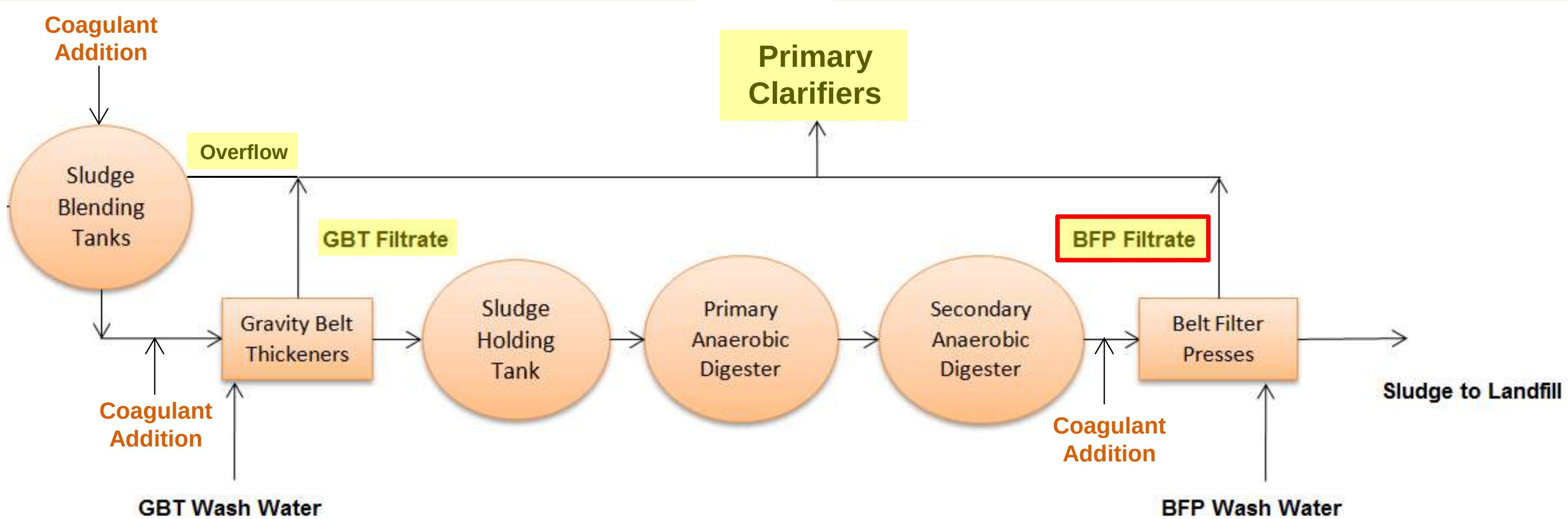
- Limited budget for side-stream treatments (Ostara, Anita Mox)
  - Coagulant addition? Ex. Ferric Feed System (odors)

1-2 Dedicated Primary Clarifiers?

- Treat side-streams together
- But, limited SOR
- Primary Activation

Addition Direct to Source?

- System Already in Place
- BFP Most Concentrated (post – AD)
- Perform full scale test?



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Side-stream Loads – 2nd Special Sampling and Testing

- Second Round of Sampling to:

1. **Test Increasing Ferric Feed**
   - To BFPs to evaluate side-stream OP removal
2. **Further Evaluate Influent and Sidestream Characterization**
   - Confirm high nutrient loads (NH_3-N, OP)
3. **(Bonus!) Evaluate Struvite ($MgNH_4PO_4 \cdot 6H_20$)**
   - City had mentioned struvite issue on GBT and BFP belts
   - Struvite scale typical post-digestion
     - 2 constituents are nutrients of interest
     - Could coagulant addition affect production?

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Side-stream Loads – 2nd Special Sampling Procedure

- **Basic Procedure:**
  - Sample nutrients and struvite parameters for baseline (3x)
  - Ramp up Ferric feed to BFPs
- **Streams to test**
  - Plant Influent
  - GBT Influent*
  - BFP Influent*
- **Parameters to Test (3x)**

Filtered (soluble):	Ortho-Phosphorus (OP)	Ammonia (NH3-N)	Dissolved Magnesium (Mg)
Unfiltered (total):	Phosphorus (TP)	Nitrogen (TN)	Magnesium (Mg)
Specific Conductance			

**Filtrates were tested in the first round of sampling*

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Side-stream Loads – 2nd Special Sampling – Ferric Feed Test

- Following the third baseline sample:
  - While dewatering (8 hours)
  - Increase Ferric feed every two hours
    - to ~10x current feed rate
  - Sample OP in Filtrate every two hours

Hour of Test	Ferric Feed Rate (gpm)
1	10
3	40
5	70
7	96

Side-stream Loads – 2nd Special Sampling - Average Results

Flow Stream	TP	OP	NH_3-N	TKN as N	Magnesium	Dissolved Magnesium	Conductivity
	mg/L						uS/cm
Plant Inf	4.66	1.51			23.9	18.9	1047
GBT Inf	323	127	218	2375	43.0	6.9	2249
BFP Inf	977	361	1782	2440	122	28.4	4367

- Average Plant Influent TP around estimated design value (4.7 mg/L)
  - Range 3.4 – 5.4 mg/L
- Inf GBT, BFP OP >> than previous Filtrate sampling (Combined 10-20 mg/L)
  - Suggests existing ferric feed operations already removing OP

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Side-stream Loads – 2nd Special Sampling -Struvite Analysis

Struvite Tool Results						
	Flow	Struvite Predicted?	Struvite Produced	Total Mg	NH_3-N	OP
Flow Stream	m3/day	% of 4 Tests	kg/day		mg/L	
Inf GBT	940	25%	16	43	218	127
Inf BFP	195	100%	225	8	1716	215

*Note pH and Temp Estimated at 7 and 25 deg C

- Calculating Struvite Precipitation Potential
  - Sacramento State - Office of Water Programs Tool ($75)
    - Excel Based Software
- Input Measured Influent Data (Mg, NH_3-N, OP, Specific Conductance, Flow)
  - Following Expectations:
    - BFPs have larger Precipitation Potential
    - OP Decreases with Struvite Production (361→ 215 mg/L in BFP)

- California WEA Presentation "Dealing with Struvite" (Buhrmaster and Abraham 2011)
  - http://www.owp.csus.edu/courses/additional/struvite-precipitation-potential-calculation-tool.php

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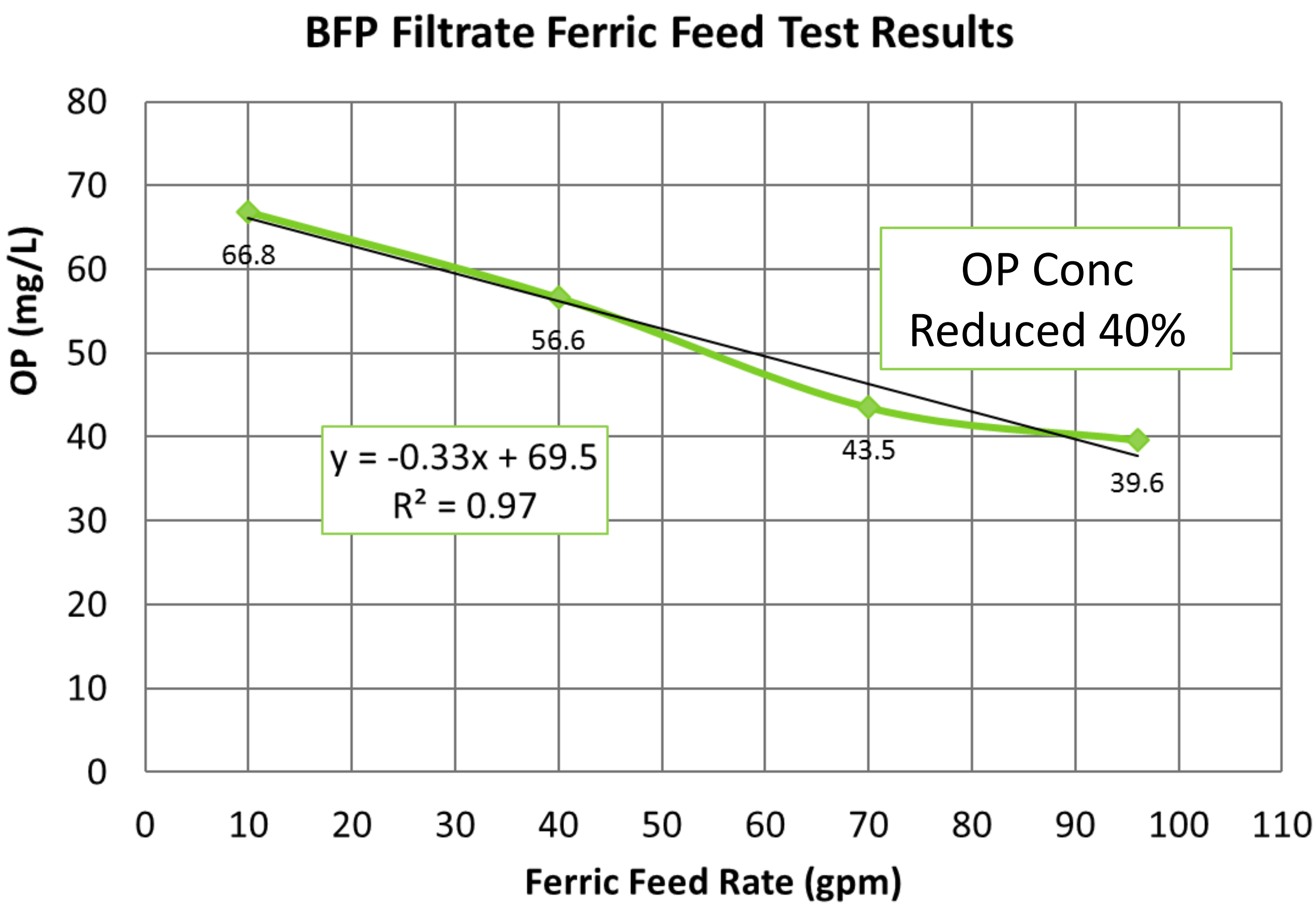
Side-stream Loads – 2nd Special Sampling- Ferric Test Results



- Strong linear response – OP decreases with Ferric feed
  - *No visual changes to struvite production*

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Side-stream Loads - Summary and Assumptions for Final Design

- Summary of Special Sampling
  - Nutrient loads confirmed
    - Inf BFP and GBT OP >> than Filtrate (1st Round)
      - Ferric feed already reducing OP?
  - Increased Ferric feed can decrease Filtrate OP
    - By 40% with ex. pump max
  - BFP more struvite potential
    - but no noticed change during test

- For Final Design:
  - Assume 50% removal of OP in BFP Filtrate with increased Ferric
    - 5% at other side-streams
  - City already planning to upgrade Ferric feed pumps
    - Will acquire larger pump

Additional Final Design Assumptions and Challenges

At 30% Design:

An/Ax Volumes Increased
- Minimal Additional Footprint

Side-stream Treatment
- Minimal Additional Project Budget

Industry not affected
- Ex. Industrial Limits Remain

New Challenge:

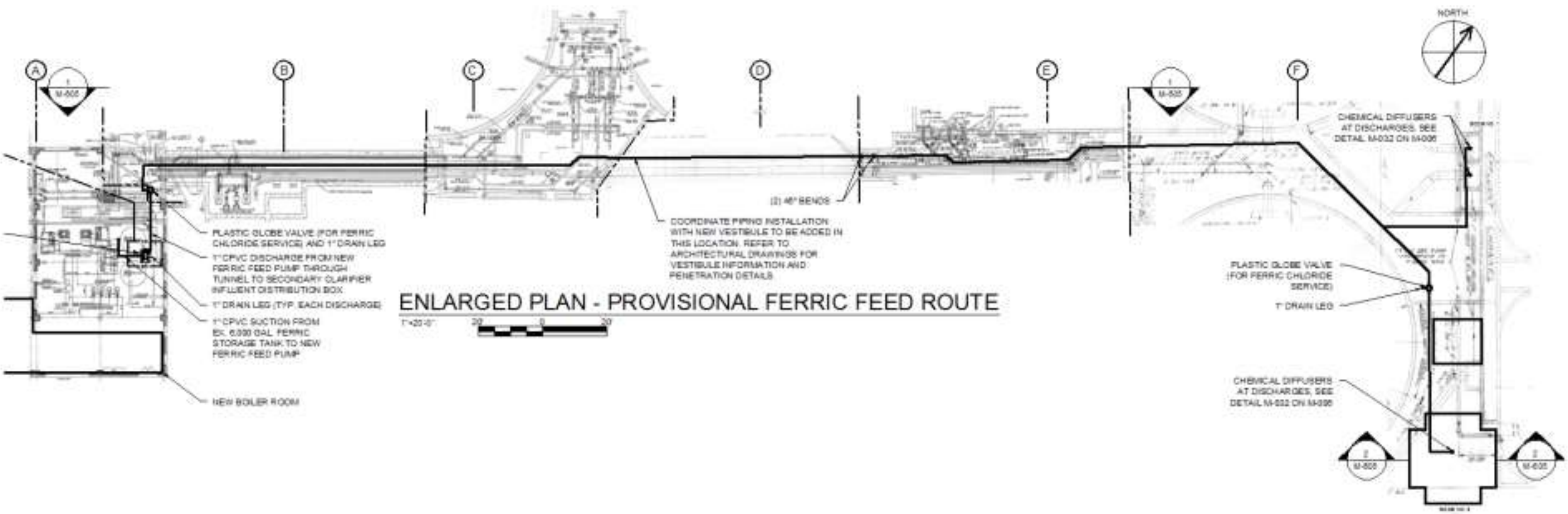
Tertiary Filter Vendors:

Performance Guarantee?

Concerned with Filter Inf TP

Tertiary Filter TP Concerns – Add Provisional feed

- Goal for all Bio-P (Normal Operations)
- Need to Link Bio + Tertiary Performance Guarantees
  - Ensure Permit Compliance
- Add provisional chemical feed to Secondary Clarifier Influent



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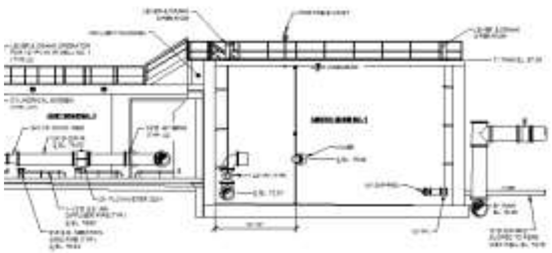
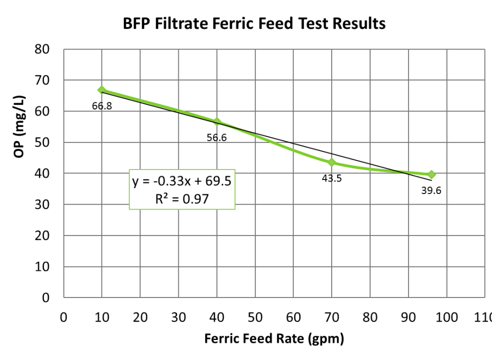
Summary of Challenges and Solutions

- Challenges to accommodating Industrial Nutrient Loads:
  - Potential Future Limits
    - Acknowledging pending OEPA NR Strategies
  - Potential Changes in Loads
    - New expansions could increase loads, worsen ratios
  - Political Boundaries
    - Industry brings revenue to City
  - Budgetary Constraints



- Navigating Solutions
  - Balancing act for both N and P in limited footprint
  - Evaluate available resources
    - Non-traditional tank geometry to fit into site
    - Existing Ferric feed system
    - *Minimal additional footprint & budget required*



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THANK YOU

  

  

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QUESTIONS?

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