Can the POTW Treat Your Industrial Waste & Reduce Costs?

The Industry

- Here comes the City again.
- We hired a consultant for $45,000.00 and he said there's no way the problem is ours.
- What the hell is a TRE?
- Don't those people at the POTW know we hire about 200 people in the City? How would they like it if we just pack up and leave!
- We just can't discharge that stuff, our piping won't allow it.

The WWTP Says

- They dump on us in the middle of the night!
- I would just like to see them go away!
- You can’t believe a word they say!
- They just kill our plant.
- The bugs just die!
- The odor at the lift station will knock a buzzard off a gut wagon.
- This foam on the oxidation ditch only happens when they dump!
- We’ll just go talk to the Mayor!!

Usually they're both **Right** and **Wrong!**

- Pat Beamon – Process Tech, LLC
- Don Adams, Ph.D., P.E. Environmental Services Company, LLC. Ruston, Louisiana

EPA MODEL PRETREATMENT ORDINANCE

SECTION 1—GENERAL PROVISIONS

A. To prevent the introduction of pollutants into the POTW that will interfere with its operation;

B. To prevent the introduction of pollutants into the POTW that will pass through the POTW, inadequately treated, into receiving waters, or otherwise be incompatible with the POTW;

C. To protect both POTW personnel who may be affected by wastewater and sludge in the course of their employment and the general public;

D. To promote reuse and recycling of industrial wastewater and sludge from the POTW;

E. To provide for fees for the equitable distribution of the cost of operation, maintenance, and improvement of the POTW;

F. To enable [the City] to comply with its NPDES permit conditions, sludge use and disposal requirements, and any other Federal or State laws to which the POTW is subject.

This ordinance shall apply to all Users of the Publicly Owned Treatment Works……..

The POTW
Publicly Owned Treatment Works

Here's Our Outline

- Incoming Raw Sewage
- Kinds of Wastewater Processes
- What are the Bugs (microbes)?
- What makes the Bugs Tick?
- How is the POTW Designed?
- What is the biggest design Flaw?
- TRE Evaluation
- Case Studies

TYPICAL COMPOSITION OF UNTREATED DOMESTIC SEWAGE

Contaminant	Concentration, mg/L		
	Low	Med	High
TS	390	720	1230
TDS	270	500	860
TSS	120	210	400
BOD5	110	190	350
TOC	80	140	260
COD	250	430	800
NH3-N	15	25	45
P	4	7	12
Cl	30	50	90
FOG	50	90	100

C:N:P

Carbon	100 ppm
Nitrogen	5 ppm
Phosphorus	1 ppm

Carbon -Food

- Bacteria Need Carbon to Function
  - Organic Compounds such as;
    - Some Constituents in Raw Sewage
    - Fats, Oil and Greases
    - Some Agricultural Industrial Waste
    - Methanol
    - Ethanol

Nitrogen

- One of the Key Macronutrients needed for cell growth.
- Sources of Nitrogen
  - Anaerobic Digestion
  - Urea
  - Ammonia
  - Surfactants

Phosphorus

- Nutrient needed for cell growth.
- Sources of phosphorus
  - Orthophosphate
  - Some Surfactants
  - Cleaners

(This nutrient is usually not deficient in a POTW)

NUTRIENTS REQUIRED FOR CELLULAR GROWTH AND REPRODUCTION

Major Nutrients: Macro-Nutrients

C, Ca, Cl, H, K, N, Mg, Na, O, P, S

Minor Nutrients: Micro-Nutrients

B, Co, Cu, Cr, Fe, I, Mn, Mo, Ni, Se, Si, V, Zn

*<u>What do all these parameters have in common?</u>

Wastewater Processes

- Activated Sludge
- Trickling Filters
- Rotating Biological Contactors
- SBR’s (Sequencing Batch Reactors)

(These processes at the POTW are biological.)

What Makes the Bugs Tick?

- Oxygen
- Carbon
- Nitrogen
- Phosphorus
- Detention Time
- Temperature
- pH
- Micro and Macro Nutrients

Activated Sludge Inhibitions Threshold Levels

Parameter	Threshold Values
pH	6.5-8.5
Sulfides	25
Phenol	50
O & G	50
Chromium, +6	1
Mercury	0.1
Surfactants	100
Copper	1.0
Arsenic	0.1
Lead	1
Ni as Nickel chloride	1
Zn	0.3
Chlorides	8,000-15,000
NH_3	480
TDS	5,000

- Does your Industrial Waste Satisfy these requirements?
  - What about a carbon source?
  - What about a nitrogen source?
  - What about dilution?
  - What percentage of the POTW wastewater flow is the Industrial Discharge?

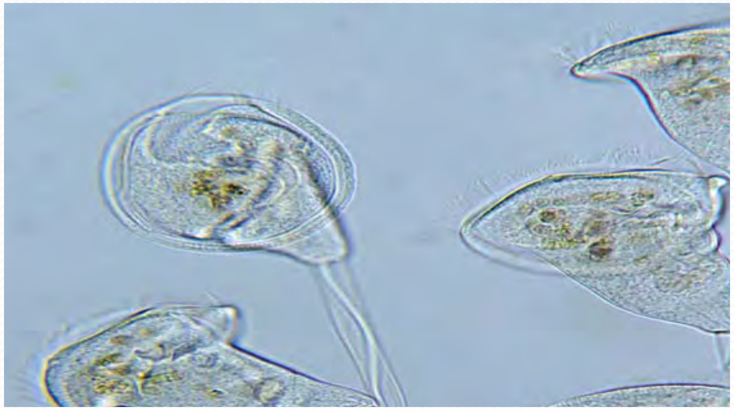
What Makes the Bugs Tick?

- Oxygen
- Carbon
- Nitrogen
- Phosphorus
- Detention Time
- Temperature
- pH
- Micro and Macro Nutrients

(This is how design at a POTW usually is performed)

What's the Biggest Design Flaw at the POTW?

- Not taking into consideration the Microbiology



In Other Words – Designing Around Hardware And Not Micro-Biology

Microbiology

- The microbes don’t lie.
- Request a microbiological test (on site).
- Get someone experienced.

What’s a TRE?

- A TRE is Toxic Reduction Evaluation.
  - It is sometimes required by Regulatory Agencies when effluent biomonitoring analysis fails.
  - What is Bio-monitoring?

What the POTW Expects From Industrial Dischargers

- Respect
- Professionalism
- Transparency
- Fairness
- Understanding

What the Industrial Dischargers expects From POTW

- Respect
- Professionalism
- Transparency
- Fairness
- Understanding

Steps to Discharge to a POTW

- Partner with the POTW
- Characterize Wastewater Discharge
- Determine if Waste is Catagorical
- Determine if Waste Meets Domestic Waste Quality
- Adjust Quality with Nutrients or Other Material
- Apply for Discharge Permit
- Monitor Waste Frequency
- Keep POTW Aware of any Changes
- Be Prepared to be the Bad Guy
- See No. 1

INDUSTRIAL PARAMETERS TO BE CONSIDERED

- TSS
- Temperature
- O&G
- BOD
- COD
- pH
- N
- P
- Industry specific metals
- Industry specific compounds such as salinity, TDS, conductivity
- Industry specific micro-organisms

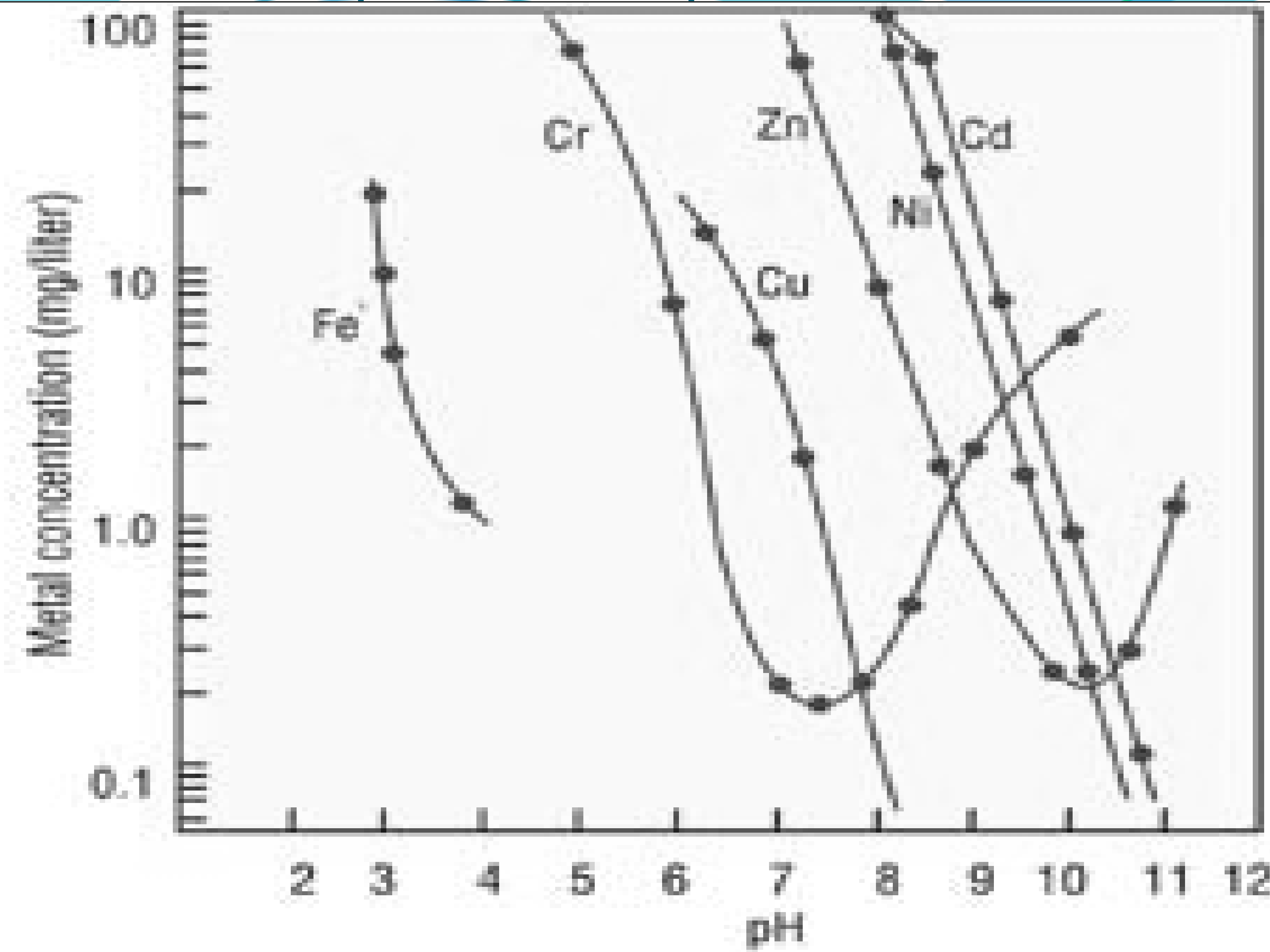
Comparison of Domestic vs. Wool Textile and Tomato Processing

Contaminant	Med Domestic	Wool Textile	Tomato Cannery
pH	6.5-8.5	5.9	7.2-8.0
TDS	500	-	480-640
TSS	210	93	270-760
BOD_5	190	91	460-1100
COD	430	529	-
NH_3-N	25	8	-
P	7	-	1.5-7.4
FOG	90	27	-
Temperature, ^oC	Ambient+	-	18-23

pH AT WHICH METALS PRECIPITATE

METAL	pH
Cadmium	11.0
Copper	8.1
Chromium	7.5
Nickel	10.8
Zinc	10.1

Metal Precipitation vs. pH



NUTRIENT-DEFICIENT INDUSTRIAL DISCHARGES

INDUSTRY	NITROGEN	PHOSPHORUS
Bakery	X	X
Beverage	X	X
Chemical	X	X
Coke Ovens	X	X
Dairy	X	X
Formaldehyde	X	X
Petroleum	X	X
Phenols	X	X
Textile	X	X

PARAMETERS FOR POTWs TO TEST

Arsenic	Nickel
Cadmium	Mercury
Chromium	Molybdenum
Copper	Selenium
Cyanide	Silver
Lead	Zinc
BOD5	TSS
Ammonia	POTW-specific POCs
CWA organic priority pollutants	TCLP

Stimulants and Inhibitors In Anaerobic Digesters

Parameter	Stimulatory (mg/L)	Moderately Inhibitory (mg/L)	Strongly Inhibitory (mg/L)
Na	100-200	3,500-5,500	8,000
K	200-400	2,500-4,500	12,000
Ca	100-200	2,500-4,500	8,000
Mg	75-100	1,00-4,500	3,000

Problem Solving Steps

- Client Contact
- 2 – Day Preliminary Investigation
  - Data
  - Personnel
  - On site tests
  - Flow diagrams
- Report
- In Depth Study
- Final Report
- Implementation

Case Studies

CASE STUDY – GREASE RENDING

PROBLEM:

NEITHER BIO-AUGMENTATION OR CHEMICALS WILL REDUCE THE VOLUME OF SLUDGE

CONDITIONS:

- APPROXIMATELY 3 ACRE LAGOON
- LAGOON FULL OF SLUDGE
- EXTREMELY HIGH AMMONIA
- EXTREMELY HIGH ALKALINITY
- pH Extremely High

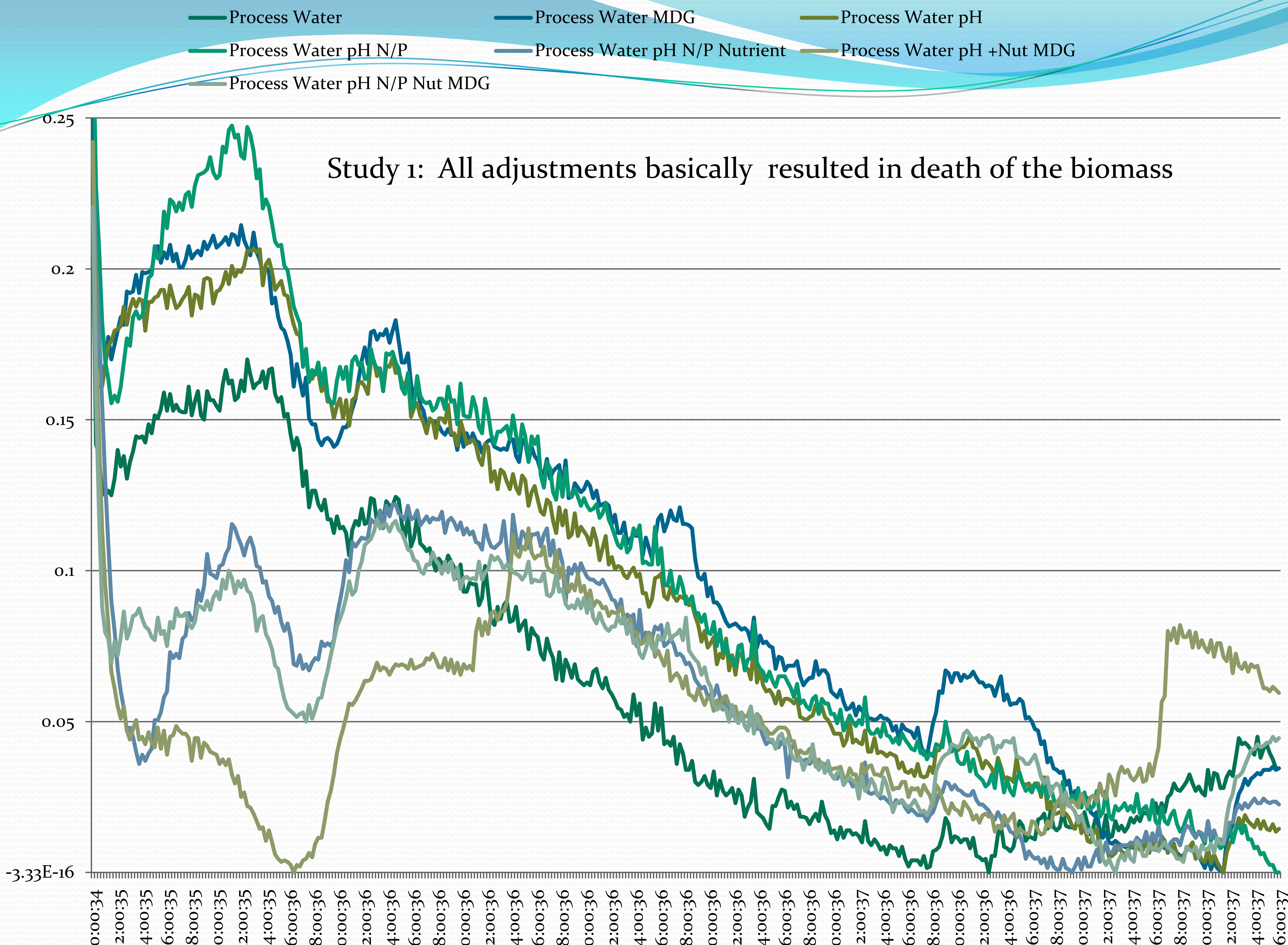
TREATMENT OBJECTIVE

DETERMINE WHAT COMBINATION OF WATER QUALITY MODIFICATIONS Will BE NECESSARY TO REDUCE THE AMOUNT OF SLUDGE IN THE LAGOON.

FIRST TREATMENT ATTEMPT

COMBINATIONS OF TREATMENTS:

- RAW PROCESS WATER ALONE
- pH ADJUSTMENT
- NUTRIENT ADDITION
- BIO-AUGMENTATION



Process Water
Process Water MDG
Process Water pH
Process Water pH N/P
Process Water pH N/P Nutrient
Process Water pH +Nut MDG
Process Water pH N/P Nut MDG
Study 1: All adjustments basically resulted in death of the biomass
0.25
0.2
0.15
0.1
0.05
-3.33E-16
0:00:34
2:00:35
4:00:35
6:00:35
8:00:35
10:00:35
12:00:35
14:00:35
16:00:36
18:00:36
20:00:36
22:00:36
24:00:36
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70:00:36
72:00:36
74:00:36
76:00:37
78:00:37
80:00:37
82:00:37
84:00:37
86:00:37
88:00:37
90:00:37
92:00:37
94:00:37
96:00:37

FIRST INVESTIGATION CONCLUSIONS

- Microbes died a rapid death regardless of materials added.
- Microbes showed some initial signs of growing but then died off rapidly.
- All treatment schemes ended with high pH

  8.5-8.75 and high ammonia.
- CNP ratio should be 100:5:1.
- High BOD may be organic nitrogen where the microbes must digest proteins to get to carbon.

SECOND INVESTIGATION

FACT:

C:N RATIO MUST BE AT LEAST 20:1.

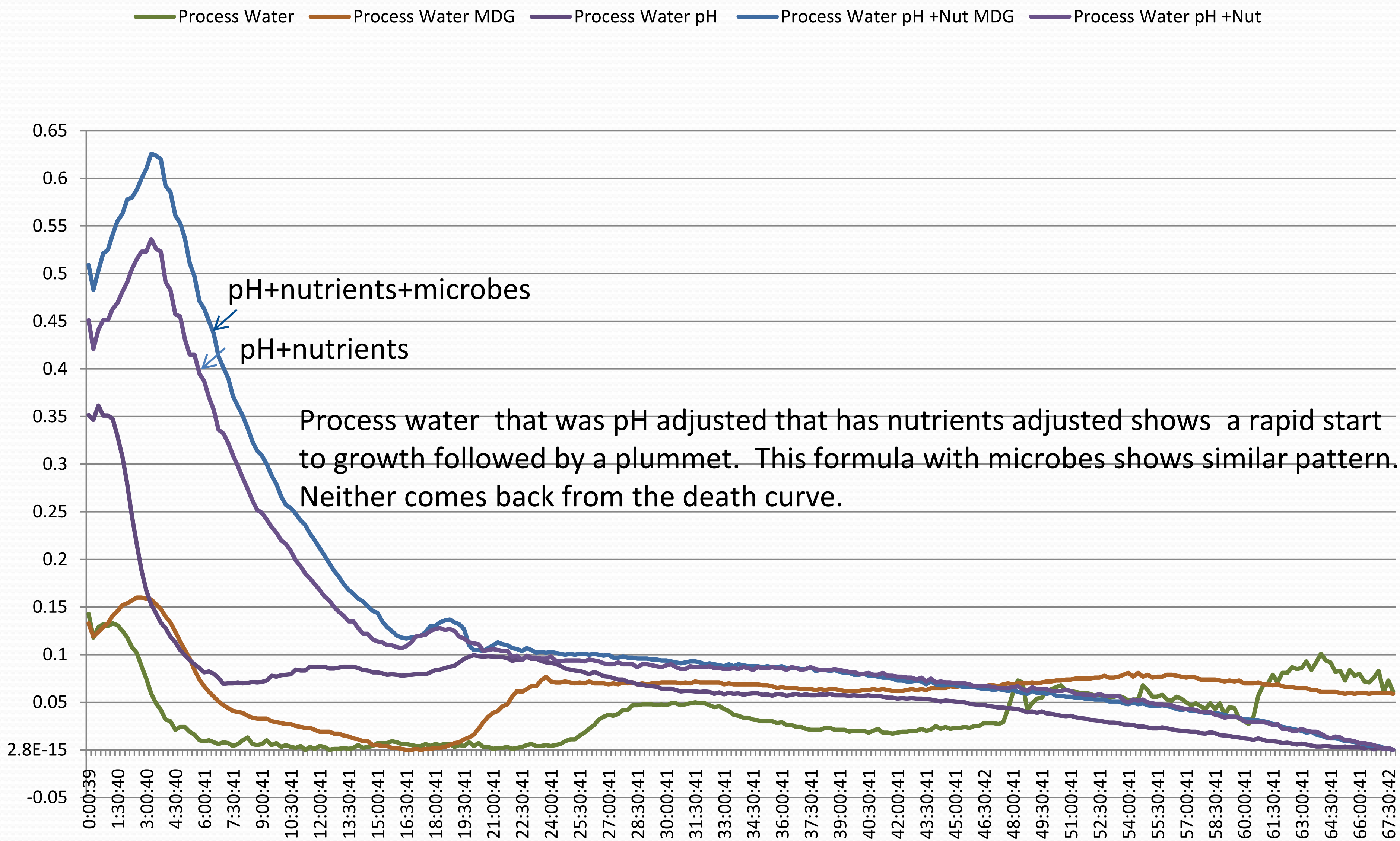
HYPOTHESIS:

- CARBON IS NOT READILY AVAILABLE TO THE MICROBES.
- CARBON IS COMPLEXED AS PART OF THE NITROGEN COMPOUNDS.

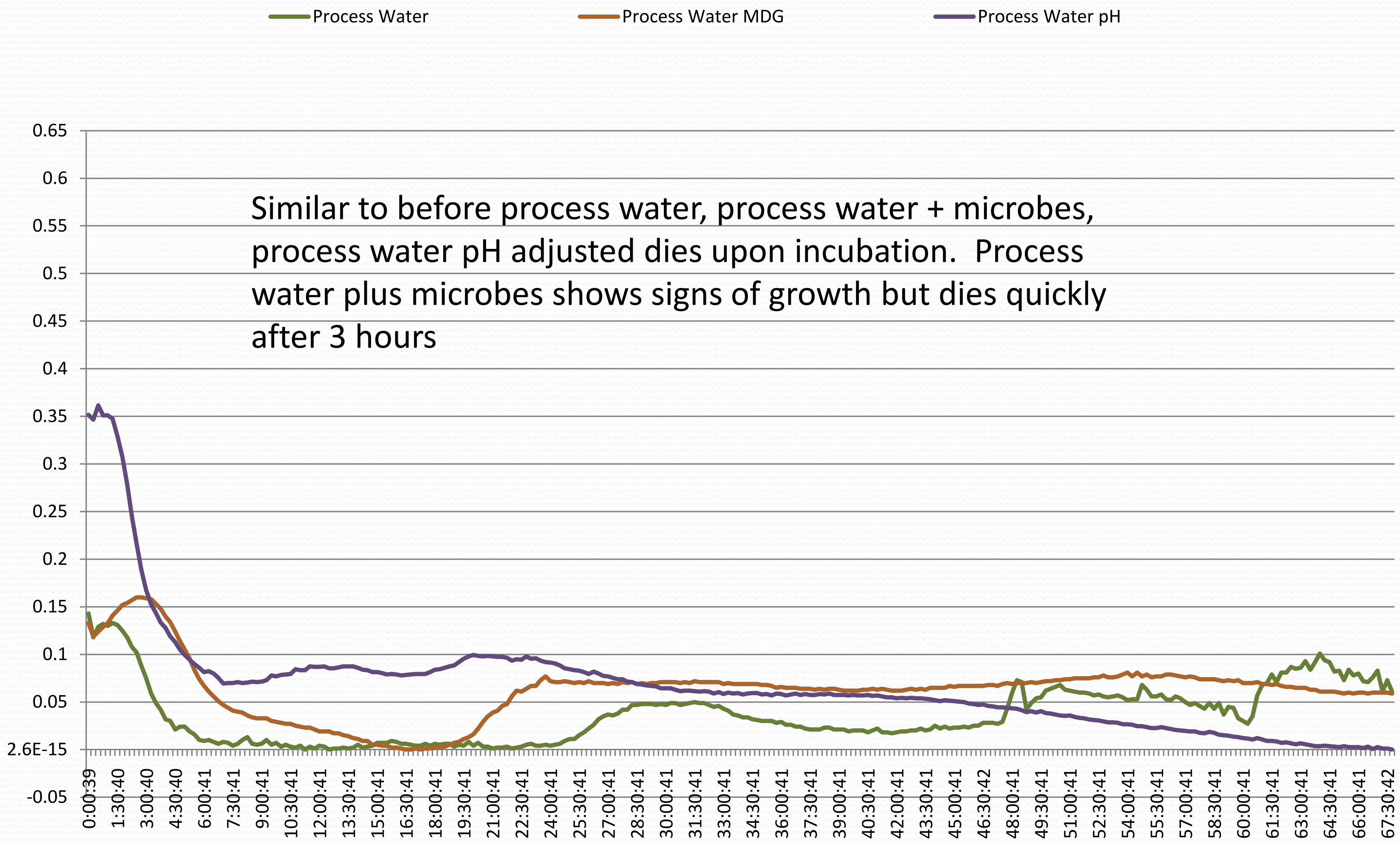
PLAN OF ACTION:

USE VARIOUS C:N RATIOS IN COMBINATION WITH THE OTHER VARIABLES.

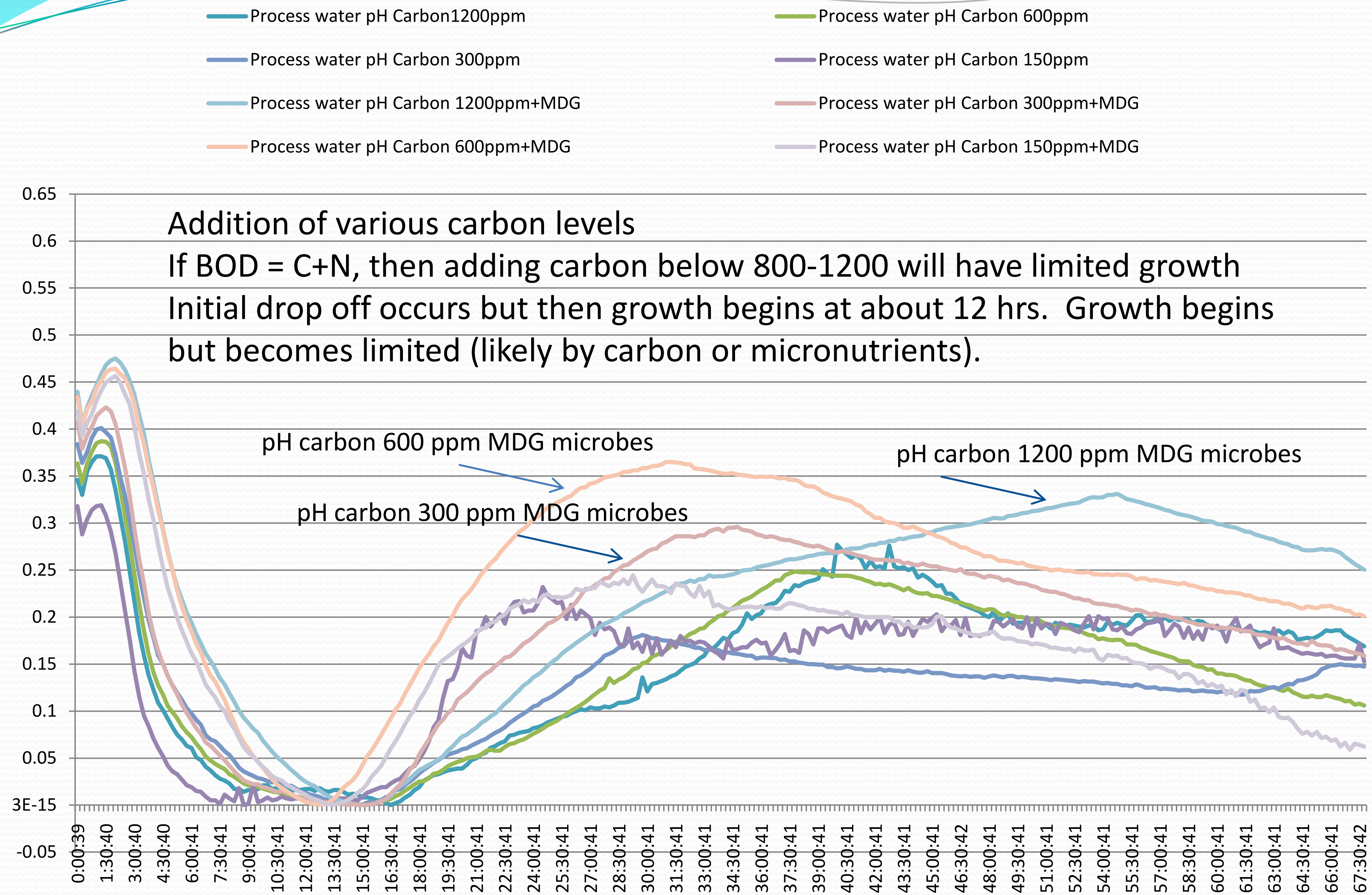
Process Technologies Carbon Source Study



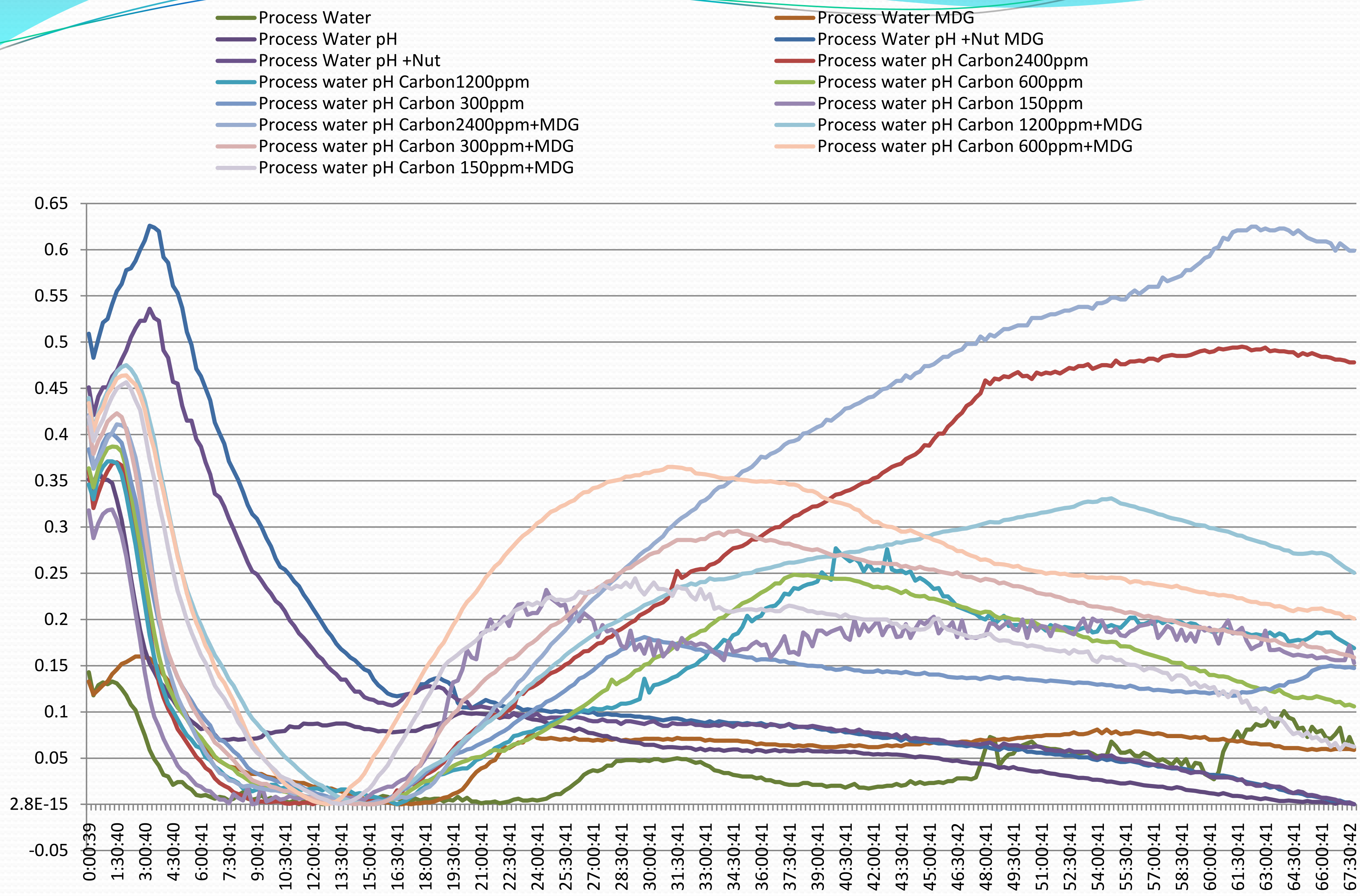
Process Technologies Carbon Source Study



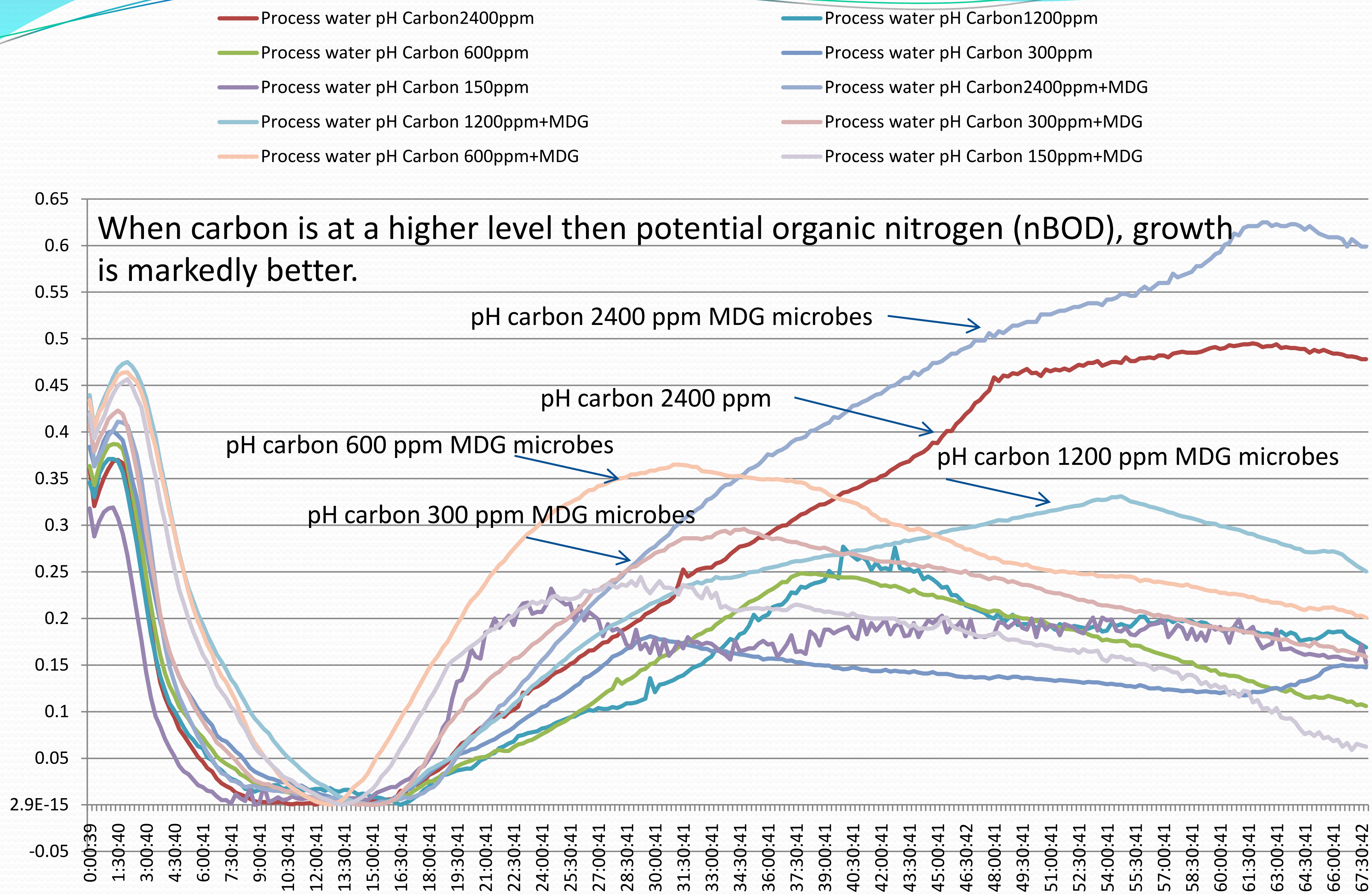
Process Technologies Carbon Source Study



Process Technologies Carbon Source Study (Study 2)



Process Technologies Carbon Source Study

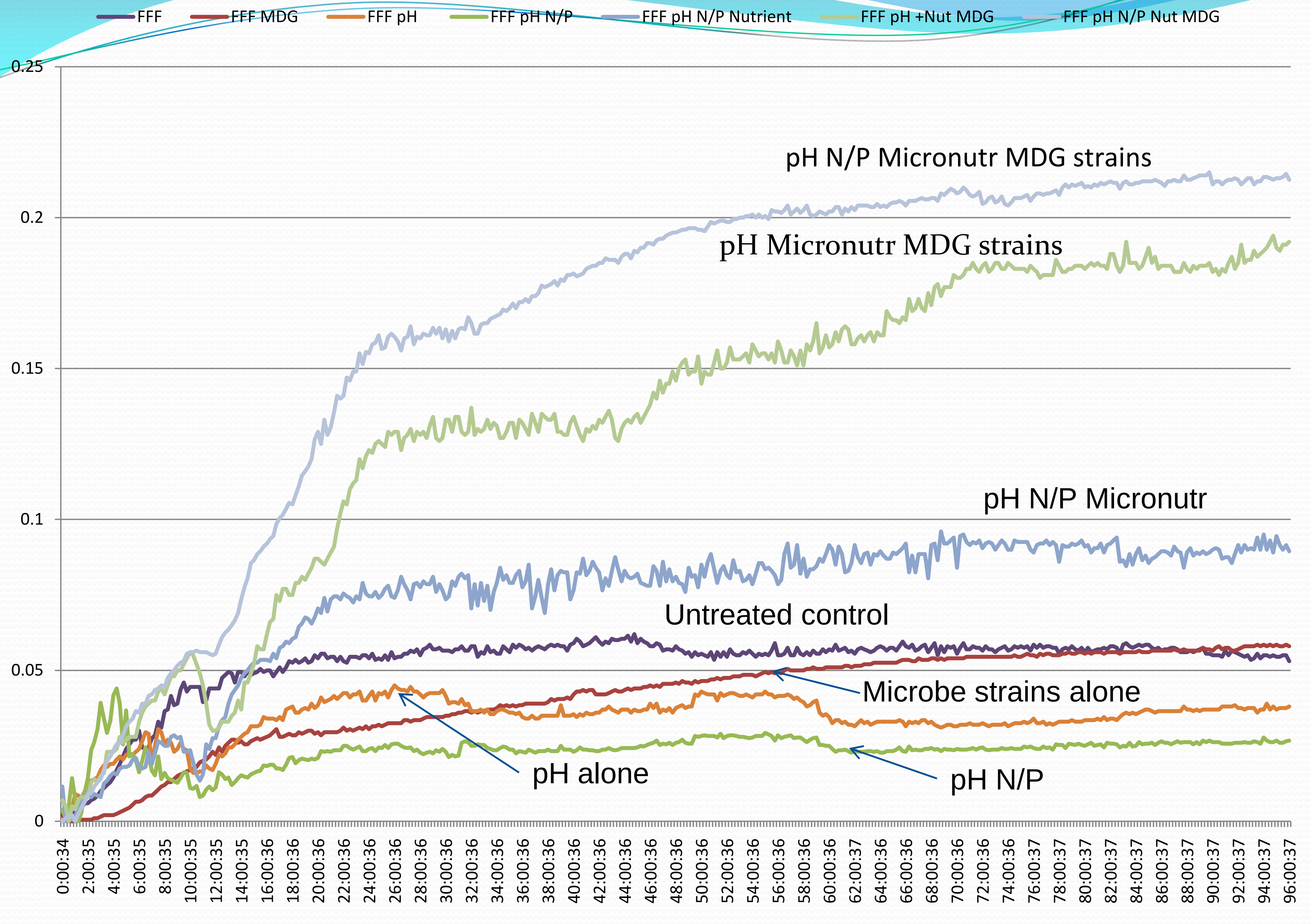


SUMMARY

- BOD IS LIKELY COMPLEXED WITH ORGANIC NITROGEN.
- ADDITION OF CARBON APPEARS TO PROVIDE A MEANS OF LOWERING pH DURING FERMENTATION.
- HIGH DOSES OF CARBON CREATED RAPID GROWTH.
- MORE TESTING IS NECESSARY TO FURTHER DEFINE THE NEED FOR MODIFICATIONS TO THE WASTEWATER.

Poultry Processing Plant Case Study

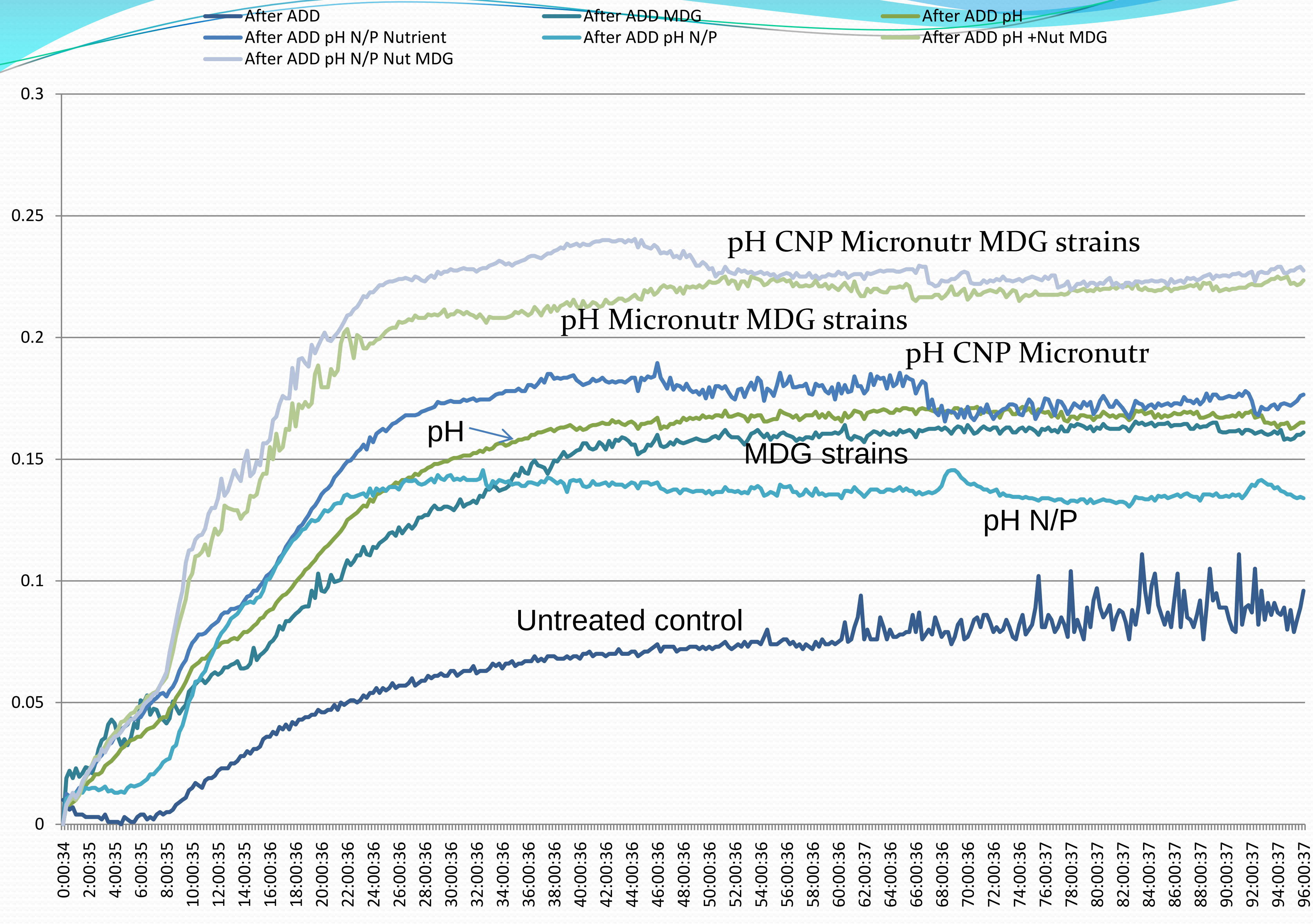
Environmental Services Co. EFF Waste Sample



EFF Sample

- Some supplements help only a little.
  - Microbes alone work poorly
  - pH and pH NP adjustments work poorly
  - Some moderate improvement from pH N/P and micronutrient additions are combined
- Combinations of microbes plus pH, and micronutrients (+/- NP adjustments) demonstrated a dramatic synergy

Environmental Services Co. MLSS Sample

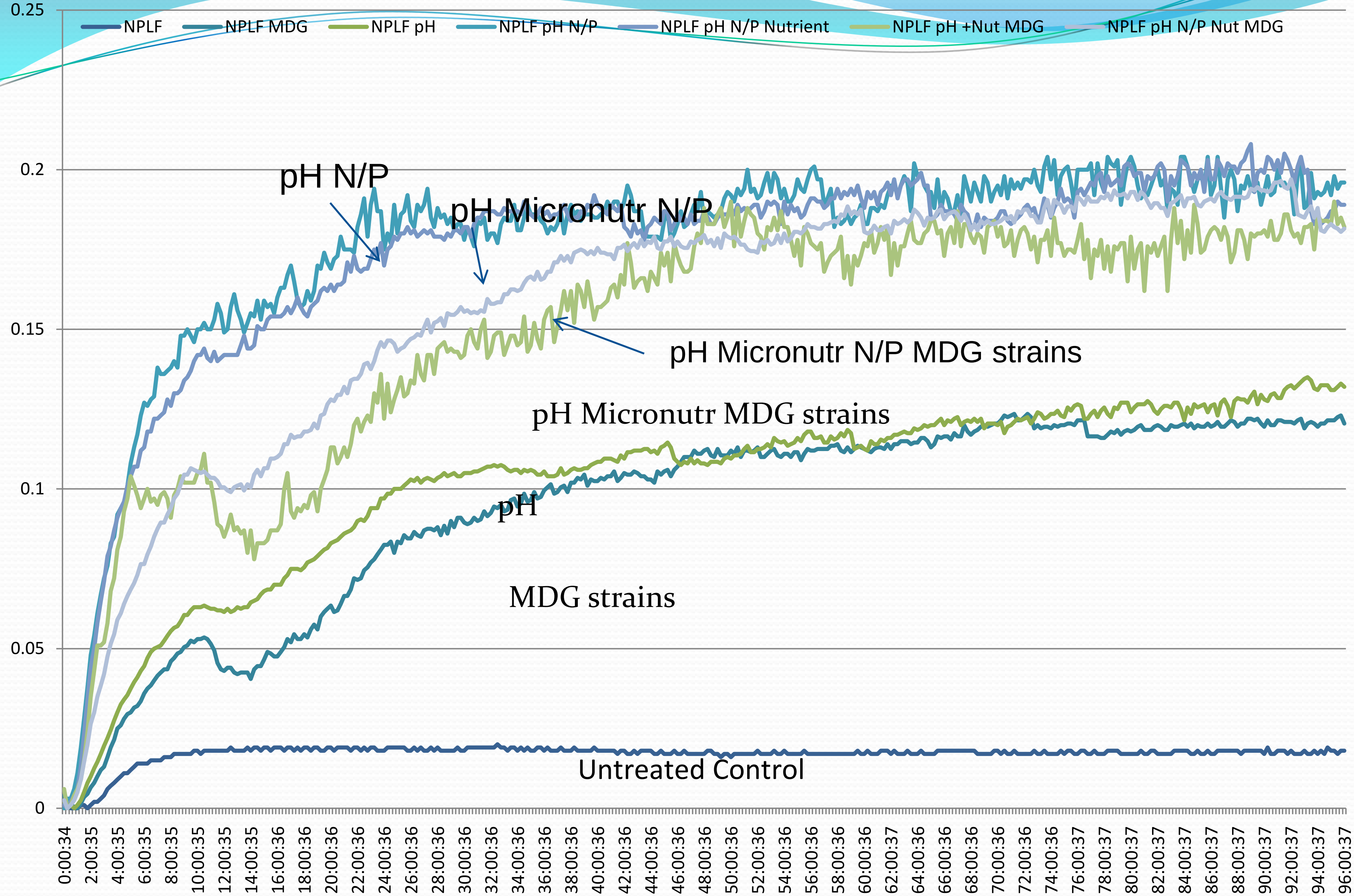


MLSS Sample

- Untreated control grows very poorly
- Individual component additions are helpful
- Microbes + pH and micronutrients with or without NP adjustments proved the most effective

Land Fill Leachate Treatment Case Study

Environmental Services Co. WPLF Sample



WPLF

- Aeration was added prior to treatment with no noticeable improvement
- Untreated control grows very poorly
- The microbes provide a positive effect by themselves but the best biomass growth was seen without microbes
- Best overall biomass growth was seen with pH and NP adjustments

Chloride Treatment

SAMPLE	CHLORIDES (mg/L)	Chlorides (mg/l)
	BEFORE	AFTER
Sample #1	582	46
Sample #2	586	40

Summary

- These studies show the importance of performing studies in advance to characterize the waste
- These tests further demonstrate that microbes are an important but small piece of the puzzle and may not provide the best results
- In two of the samples, microbes worked synergistically with pH, NP, and micronutrient combinations
- The waste alone produced very weak biomass growth in most cases
- In the WPLF sample it does not appear that microbe supplementation is necessary

What Have We Learned?

- POTW Requirements For Industrial Treatment
- Industrial Requirement for POTW
- How “Bugs Work”
- POTW Design Flaw
- TRE Evaluation
- Procedure for Solving Treatment Problems

Questions?