The Metropolitan

Water Reclamation District

of Greater Chicago

WELCOME

TO THE NOVEMBER EDITION

OF THE 2016

M&R SEMINAR SERIES

BEFORE WE BEGIN

- SAFETY PRECAUTIONS
  - PLEASE FOLLOW EXIT SIGN IN CASE OF EMERGENCY EVALUATION
  - AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE
- PLEASE SILENCE CELL PHONES OR SMART PHONES
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- PLEASE FILL EVALUATION FORM
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2016 Seminar Series)
- STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)

Heather M. Phillips, P.E., BCEE

Current: Wastewater Operations Manager, City of Olathe, Kansas,

Experience: Ms. Phillips has 15 years of experience in the wastewater industry, 11 as a design engineer and 4 in operations with the City of Olathe, Kansas.

At Olathe, she has managed the Industrial Pretreatment Program, the Fats, Oil & Grease program.

Education: B.S and M.S. in Civil Engineering from the Kansas State University

Professional: Professional Engineer registered in the State of Kansas
Class IV operator in Kansas
Board Certified Environmental Engineer by AAEES
Member of Water Environment Federation

Publication: MOP 31, An Introduction to Process Modeling for Designers
MOP 35, Biofilm Reactors
MOP 8 , Design of Municipal Wastewater Treatment Plants
The Nutrient Roadmap, WEF
Numerous journal and conference papers

Biological Phosphorus Removal at the Cedar Creek Wastewater Treatment Facility

by Operations Staff &

Heather M. Phillips, P.E., BCEE
Wastewater Operations Manager

#OlatheProud

OLATHE
KANSAS


CANADA
Lake Itasca
Yellowstone
Snake
Missouri
Minneapolis
ROCKY MTS.
Platte
Omaha
Colorado
UNITED STATES
Illinois
Ohio
APPALACHIAN MTS.
Louis
emphis
Cumberland
Mississippi
New rleans
MEXICO
Gulf of Mexico
Kansas
Nebraska
Missouri River
Missouri
Republican River
Atchison
Missouri River
Colby
Manhattan
Leavenworth
Kansas River
Missouri River
Hays
Salina
Topeka
Kansas City (Kansas)
Kansas City (Missouri)
Mt. Sunflower (4,039 ft)
Smoky Hill River
Colorado
Arkansas River
Great Bend
Emporia
Missouri
Hutchinson
Neosho River
N
W
E
S
Dodge City
Wichita
Flint Hills
Pittsburg
Key
State Capital
City
State boundary
©EnchantedLearning.com
Oklahoma
100 miles

Olathe, Kansas

"Setting the Standard for Excellence in Public Service"

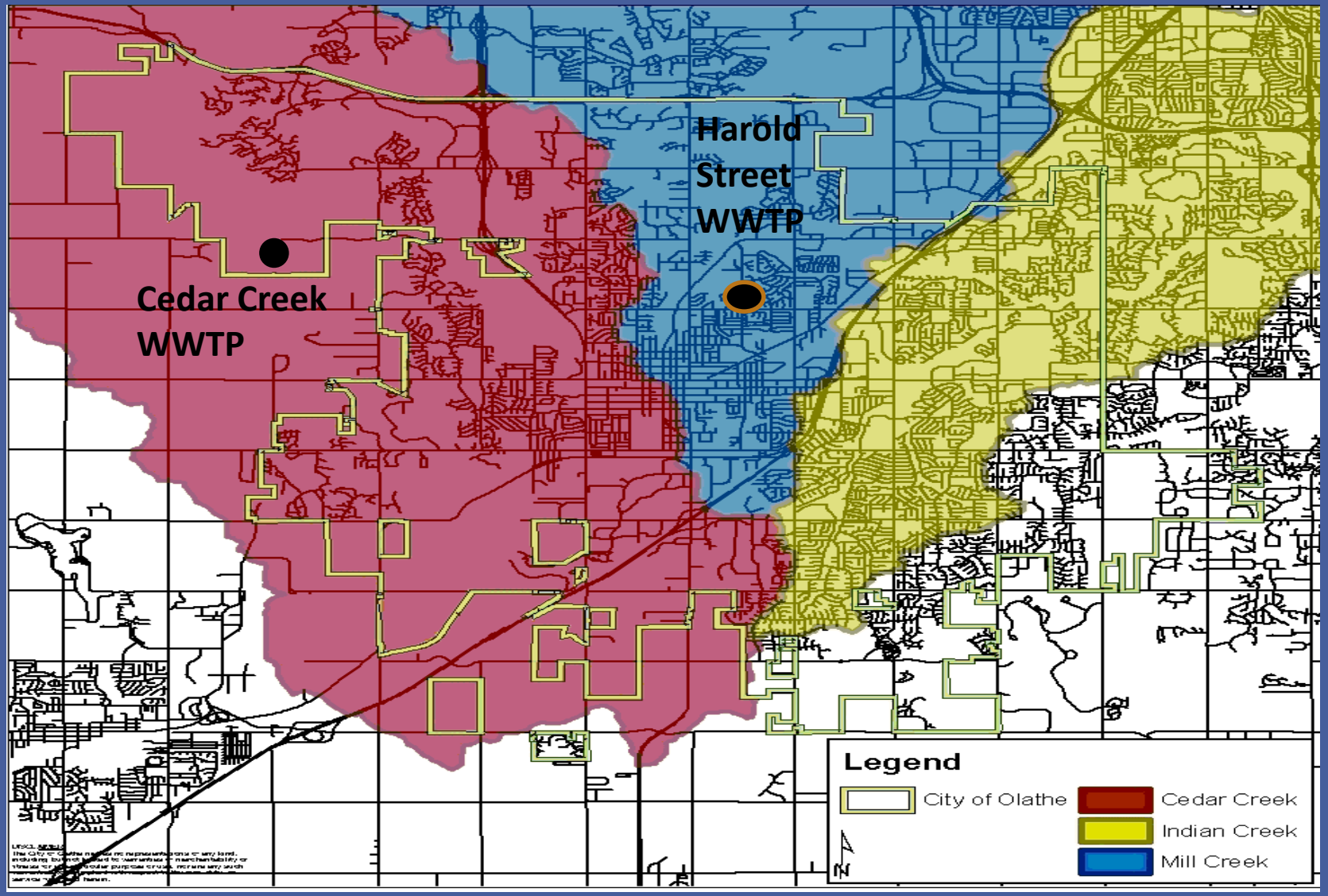
City Population – 129,241

428 Miles of Sanitary Sewers

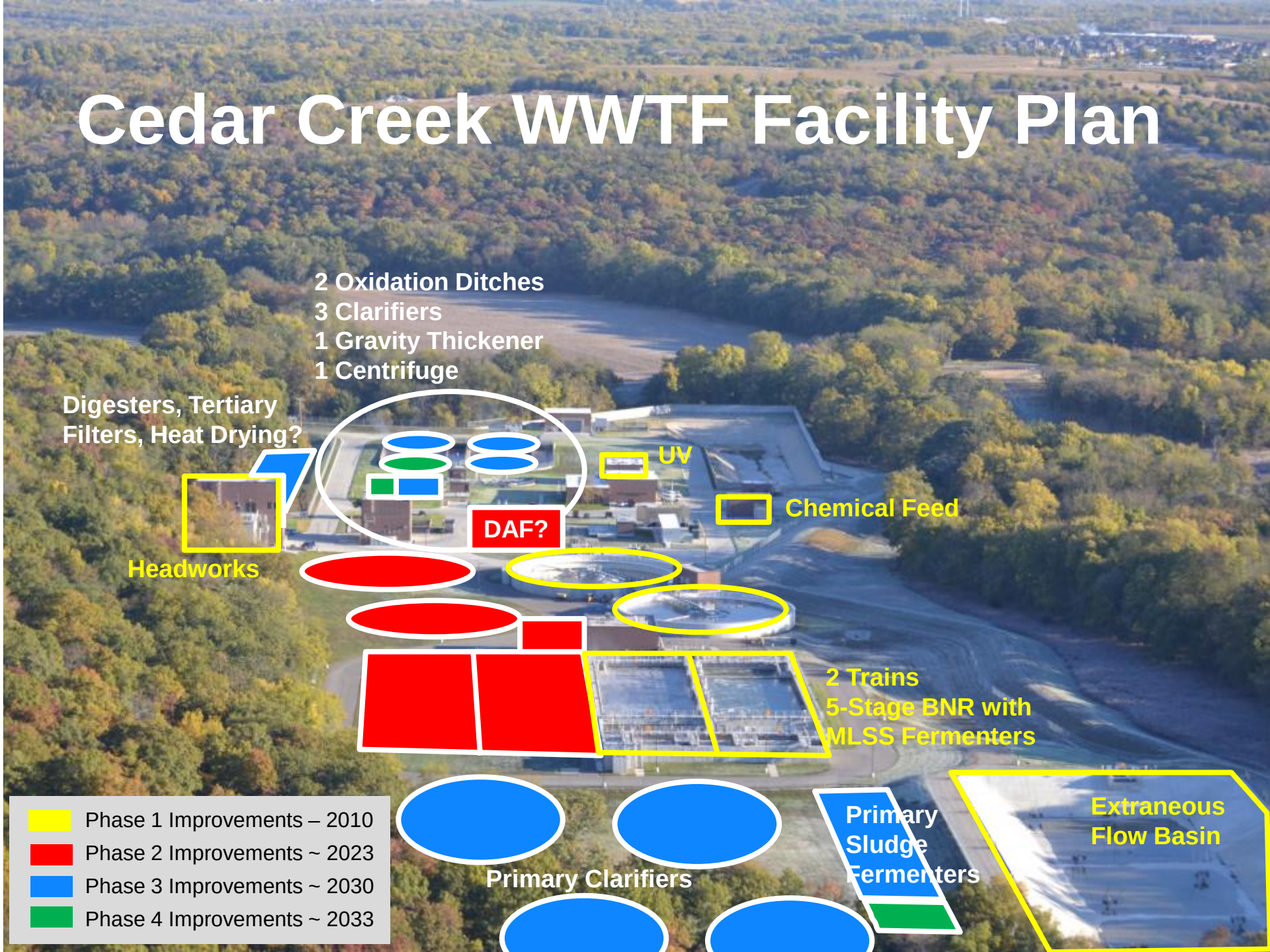
2 Wastewater Treatment Facilities & one non-discharging lagoon

Some parts of City served by Johnson County Wastewater

Wastewater Basins



Cedar Creek WWTF Facility Plan



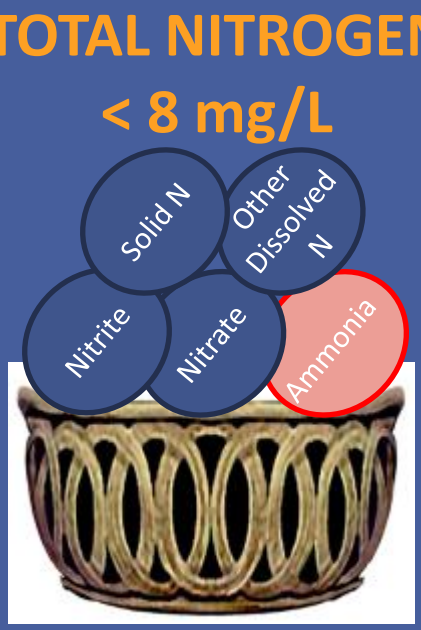
BNR Permit Limits

Monthly ammonia limits (varies 1.4 – 4.8 mg/L)

8.0 mg/L Total Nitrogen

1.5 mg/L Total Phosphorus

(both annual average)



#OlatheProud

EPA National Biosolids Award 2006

NACWA Peak Performance 2015, 2014, 2013, 2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2002, 2001….

Preliminary Treatment

1

INFLUENT PUMP STATION

2

PRELIMINARY TREATMENT

Screens
Remove large debris.

Vortex grit basins
Remove sand and abrasive material.

Throttling Gate to Avoid Cascades

Throttling gate at the aeration basin influent will back this water level up in the headworks to avoid cascade aeration (and destruction of carbon substrate)

Biological Treatment

3

BIOLOGICAL TREATMENT

Aeration Basins

Remove organic pollution and nutrients.

Clarifiers

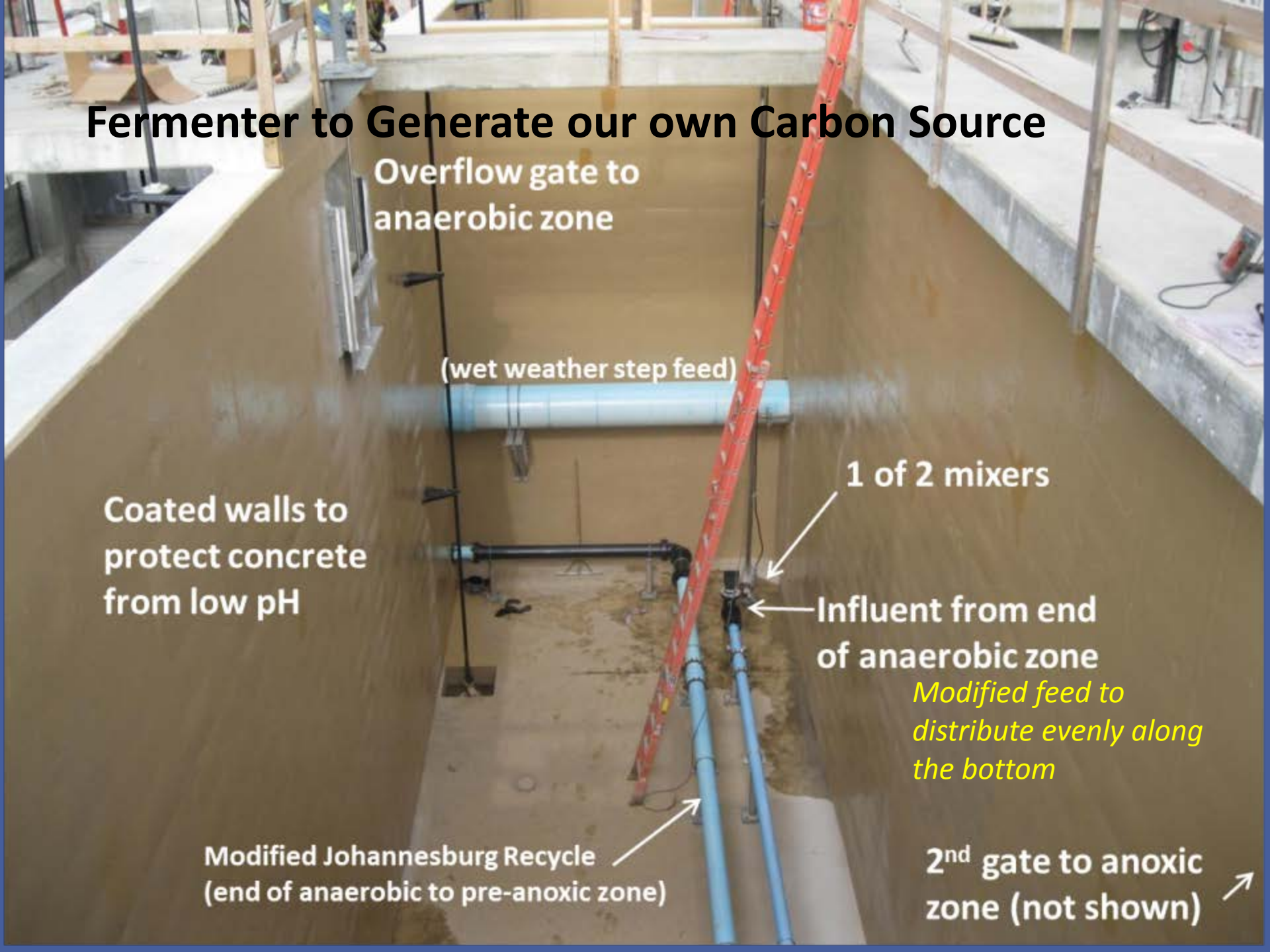
Remove solids.

Submerged Baffle Walls

Prevent short-circuiting and allow scum to pass.

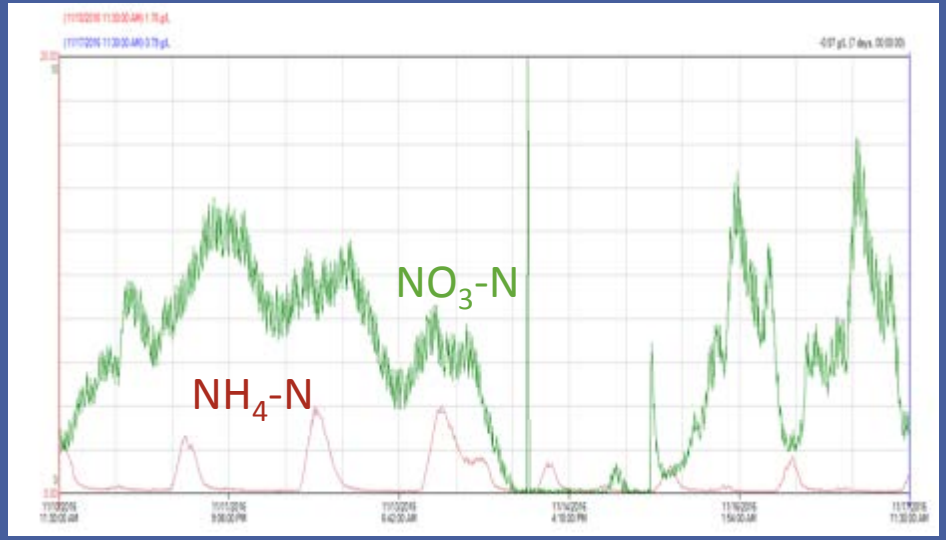
(photos taken 10 days before startup, with clean water)

Fermenter to Generate our own Carbon Source



Online Instruments

- Ammonia
  - End of First Oxic
  - End of Second Oxic
- Nitrate
  - End of First Anoxic
  - End of Second Anoxic
- Phosphate
  - End of Anaerobic
  - Final Clarifier Effluent
- MLSS
- Dissolved Oxygen
- ORP

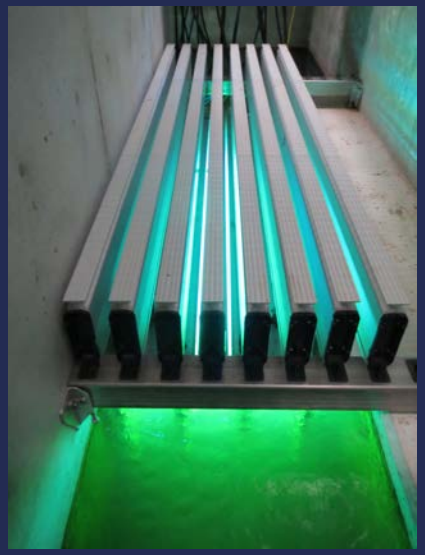


Our I&C Department has full-time maintenance techs and SCADA programmers.

Disinfection & Re-aeration

4

DISINFECTION



Ultraviolet Lamps

Sterilize pathogens.

REAERATION

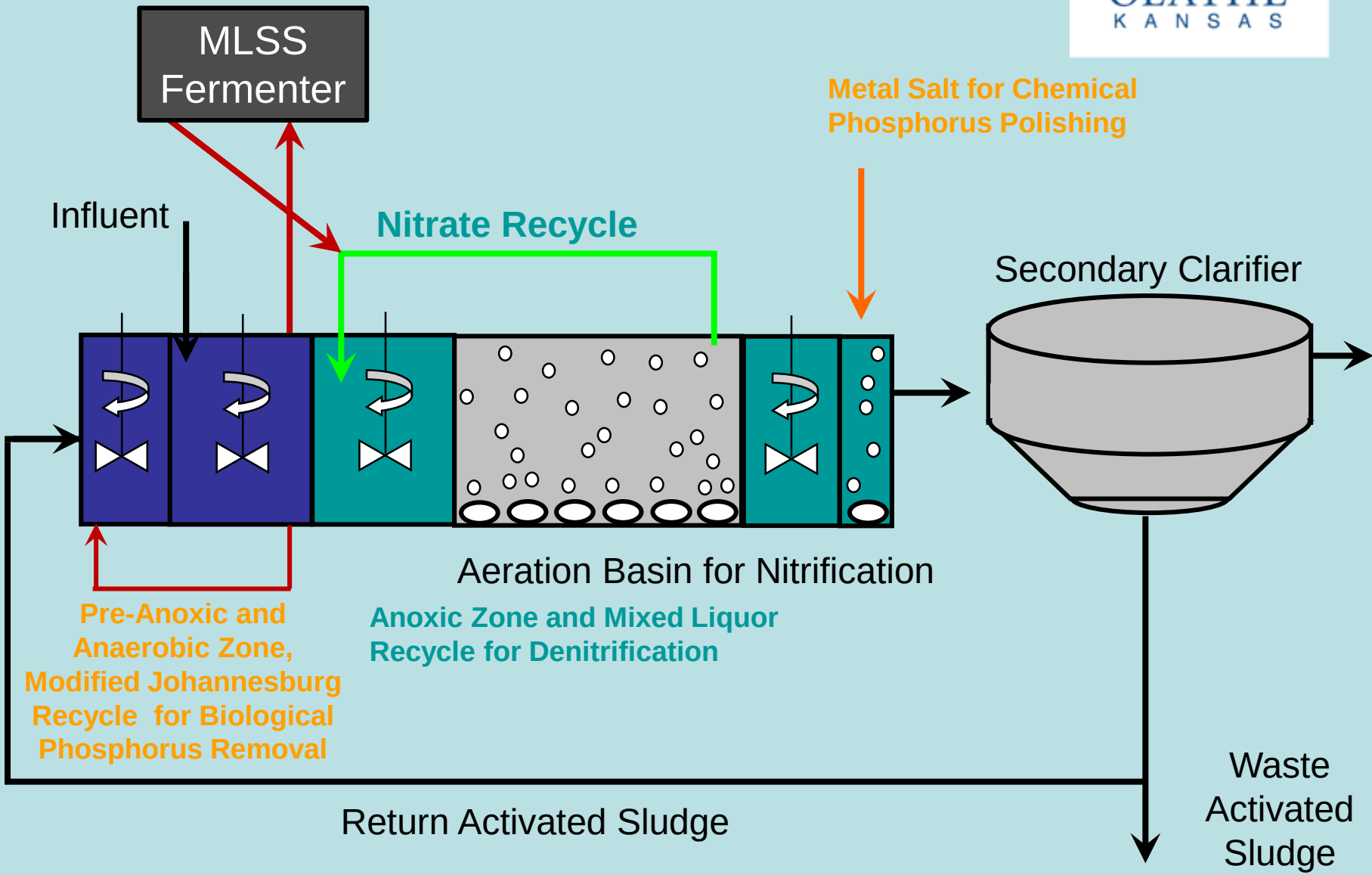
Diffusers

Add air.

#OlathePround

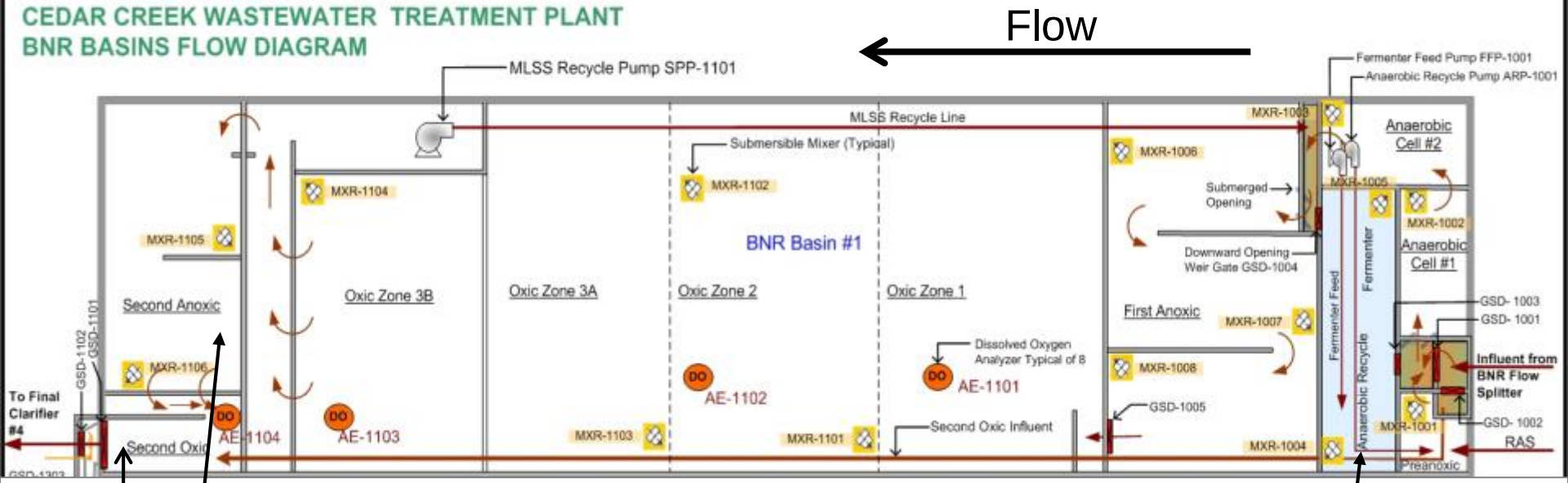
to compost and reuse our biosolids from the Harold Street Facility.

CEDAR CREEK PROCESS



Name 6 things that kill BNR…

CITY OF OF OLATHE, KS
CEDAR CREEK WASTEWATER TREATMENT PLANT
BNR BASINS FLOW DIAGRAM



Second Anoxic Zone
DO = 0 mg/L
ORP: -100 to 0 mV
NO_3N < 5 mg/L
NH_3N < 1 mg/L
PO_4P < 1 mg/L

Oxic Zones 3a and 3b
DO = 1.5 mg/L
ORP > 100 mV
NO_3N > 5 mg/L
NH_3N < 1 mg/L
PO_4P < 1 mg/L

Oxic Zone 2
DO = 2 mg/L
ORP > 100 mV
NO_3N > 5 mg/L
NH_3N < 2 mg/L
PO_4P < 2 mg/L

Oxic Zone 1
DO = 2 mg/L
ORP > 100 mV
NO_3N > 2 mg/L
NH_3N < 5 mg/L
PO_4P < 5 mg/L

First Anoxic Zone
DO = 0 mg/L
ORP: -100 to 0 mV
NO_3N < 2 mg/L
NH_3N < 5 mg/L
PO_4P > 5 mg/L

Anaerobic Zone
DO = 0 mg/L
ORP < -200 mV
NO_3N = 0 mg/L
NH_3N < 15 mg/L
PO_4P > 15 mg/L

Second Oxic Zone
DO = 2 mg/L
ORP > 100 mV
NO_3N < 5 mg/L
NH_3N < 1 mg/L
PO_4P < 1 mg/L

Secondary Effluent Limits:
TN < 8 mg/L
TP < 1.5 mg/L

Fermenter
DO = 0 mg/L
ORP < -200 mV
NO_3N = 0 mg/L
NH_3N > 5 mg/L
PO_4P > 15 mg/L
sCOD > 200 mg/L

Phosphorus Accumulating Organisms

Anaerobic Conditions:

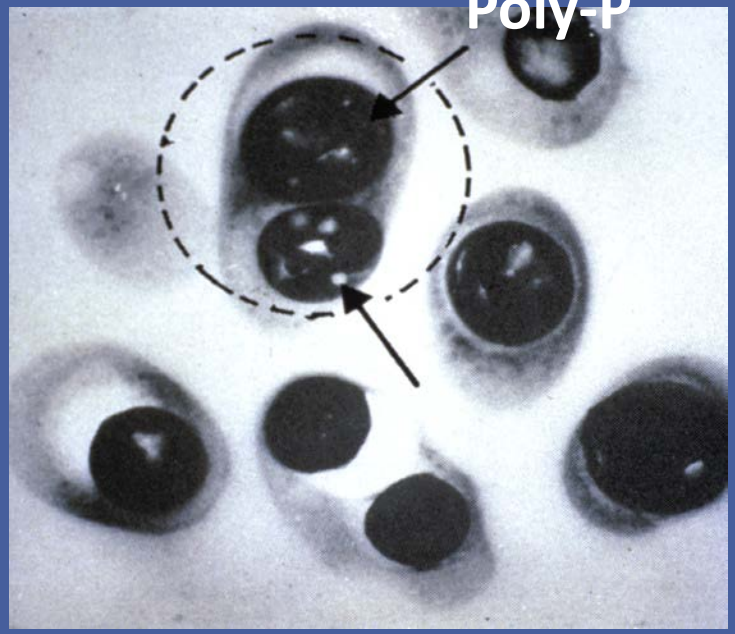
-VFA must be present.

-Phosphate is released.

-PAOs survive by storing PHB.

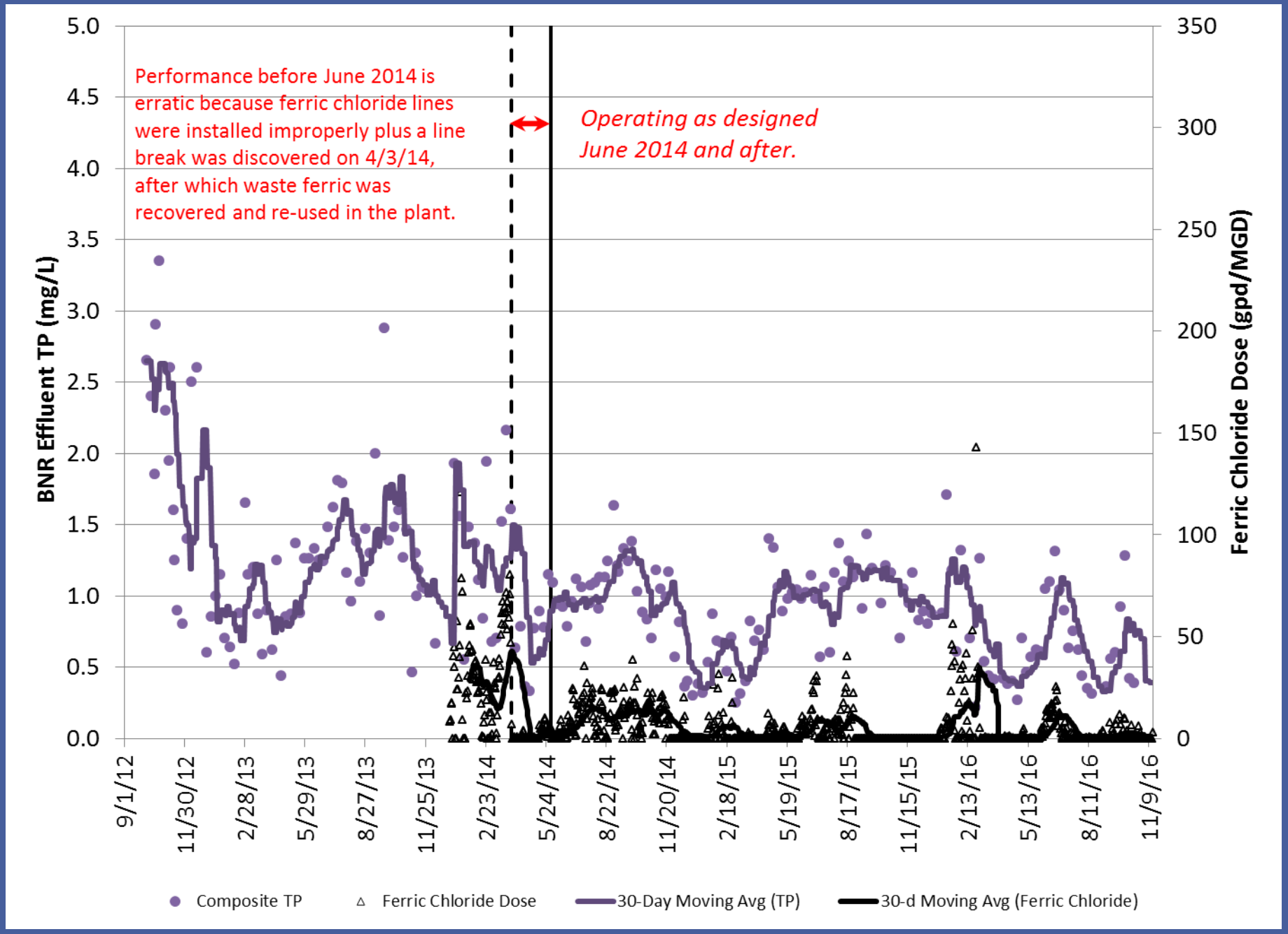
Aerobic Conditions:

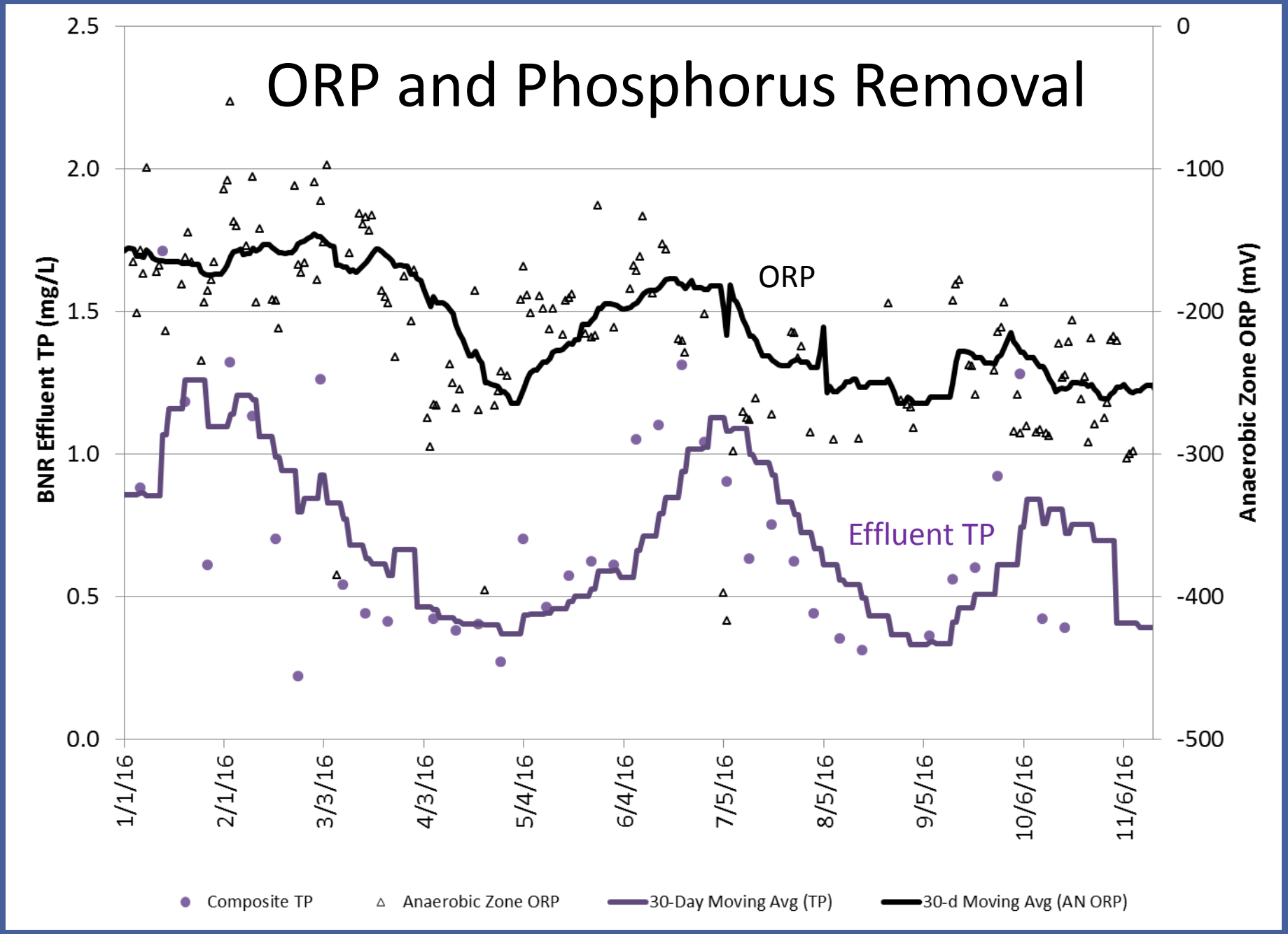
-Luxury phosphorus uptake.

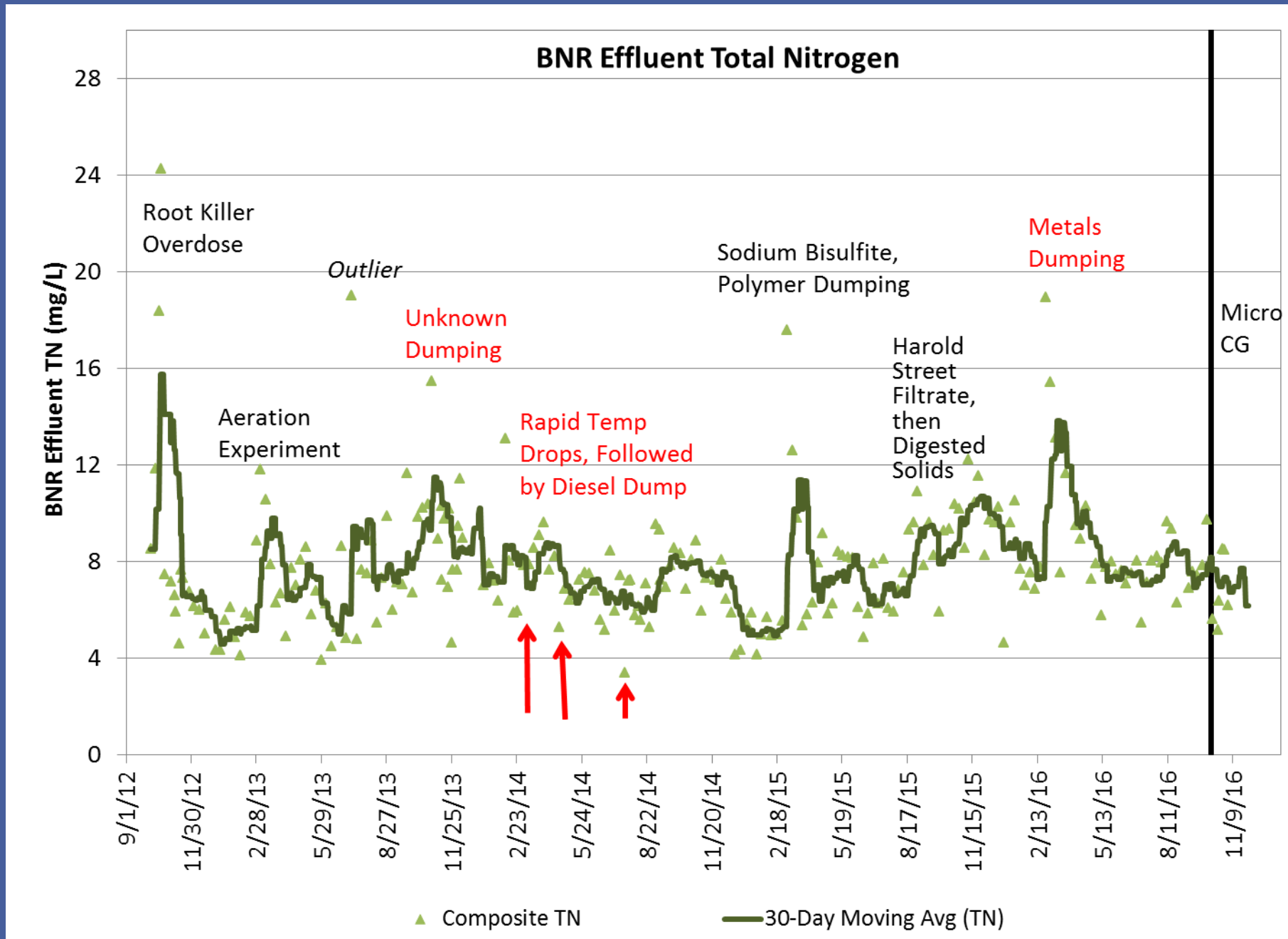


Slide credit: Dr. James Barnard, Black & Veatch

Mechanism: Fuchs & Chen 1975


Performance before June 2014 is erratic because ferric chloride lines were installed improperly plus a line break was discovered on 4/3/14, after which waste ferric was recovered and re-used in the plant.
Operating as designed June 2014 and after.
BNR Effluent TP (mg/L)
Ferric Chloride Dose (gpd/MGD)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
350
300
250
200
150
100
50
0
9/1/12
11/30/12
2/28/13
5/29/13
8/27/13
11/25/13
2/23/14
5/24/14
8/22/14
11/20/14
2/18/15
5/19/15
8/17/15
11/15/15
2/13/16
5/13/16
8/11/16
11/9/16
Composite TP
Ferric Chloride Dose
30-Day Moving Avg (TP)
30-d Moving Avg (Ferric Chloride)


ORP and Phosphorus Removal
BNR Effluent TP (mg/L)
Anaerobic Zone ORP (mV)
2.5
2.0
1.5
1.0
0.5
0.0
0
-100
-200
-300
-400
-500
ORP
Effluent TP
1/1/16
2/1/16
3/3/16
4/3/16
5/4/16
6/4/16
7/5/16
8/5/16
9/5/16
10/6/16
11/6/16
Composite TP
Anaerobic Zone ORP
30-Day Moving Avg (TP)
30-d Moving Avg (AN ORP)


BNR Effluent Total Nitrogen
BNR Effluent TN (mg/L)
28
24
20
16
12
8
4
0
Root Killer Overdose
Outlier
Unknown Dumping
Aeration Experiment
Rapid Temp Drops, Followed by Diesel Dump
Sodium Bisulfite, Polymer Dumping
Harold Street Filtrate, then Digested Solids
Metals Dumping
Micro CG
9/1/12
11/30/12
2/28/13
5/29/13
8/27/13
11/25/13
2/23/14
5/24/14
8/22/14
11/20/14
2/18/15
5/19/15
8/17/15
11/15/15
2/13/16
5/13/16
8/11/16
11/9/16
Composite TN
30-Day Moving Avg (TN)

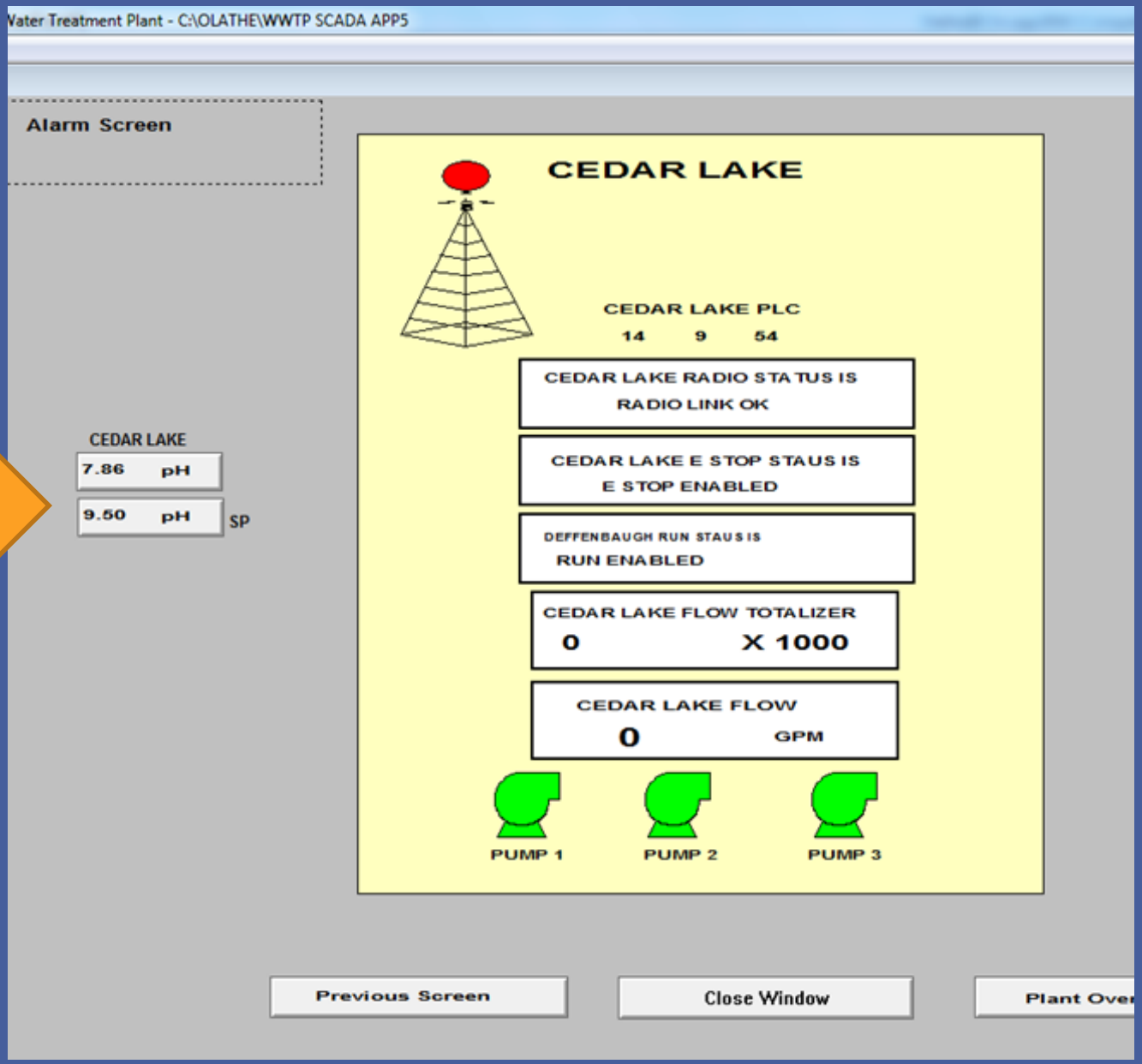
Weekend operator smelled something in the entire plant, and nitrification was lost by Monday.

Exactly 3 months later, operators smelled the same odor, quickly diverted flow, and saved the process.

Exactly 2 months later, it happened again.


07/24/2014

pH Meters in Lift Stations will Call Out as Early Warning



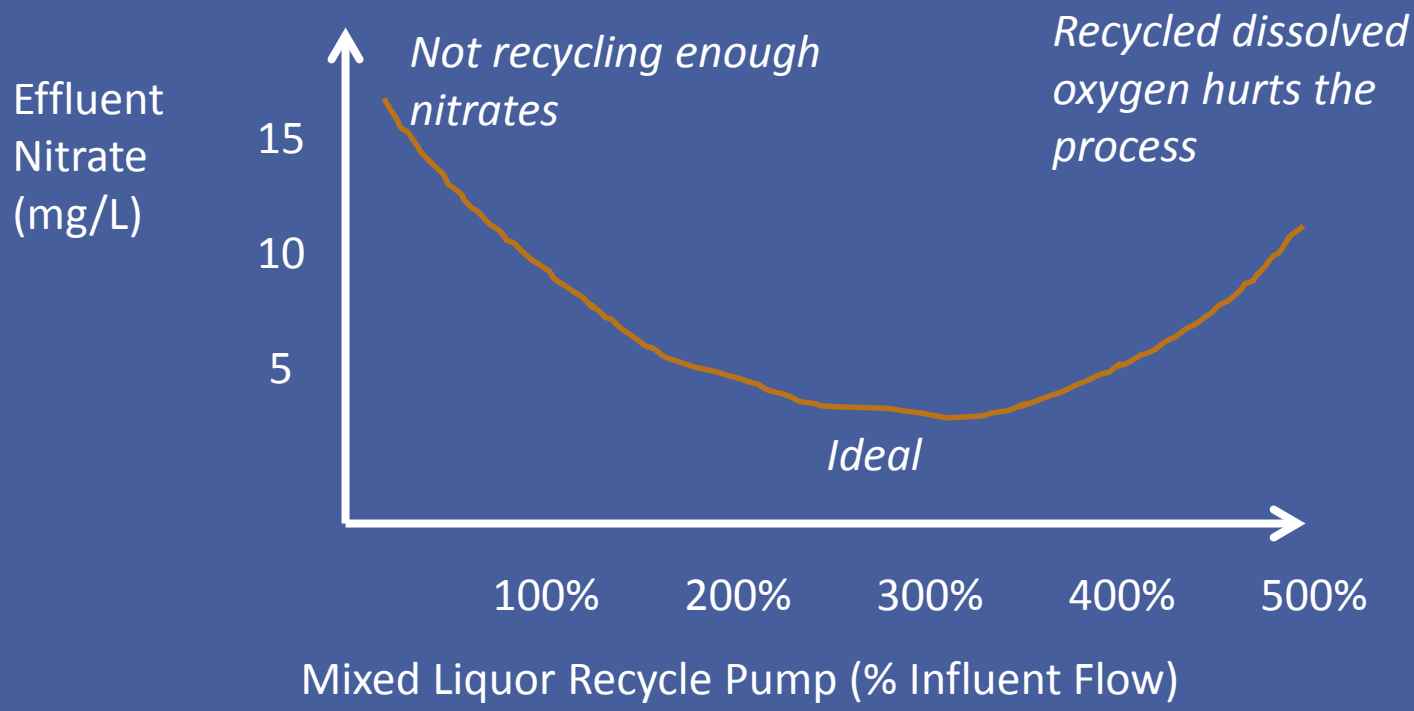
pH Loggers – Deploy in Manholes Outside Industries

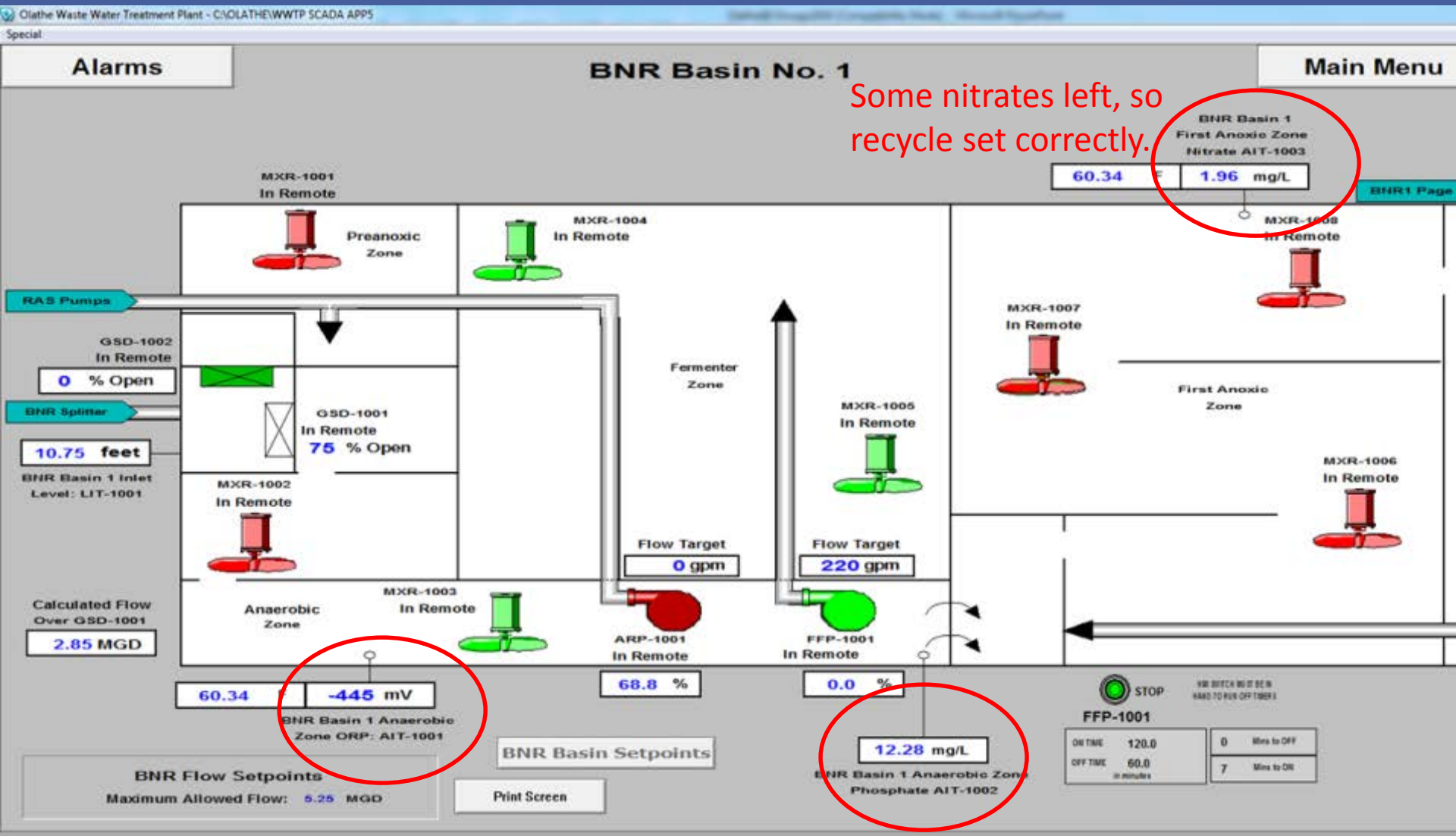
Denitrification

The solution to pollution is...

Mixed Liquor Recycle

- Recycles nitrates
- Also recycles dissolved oxygen

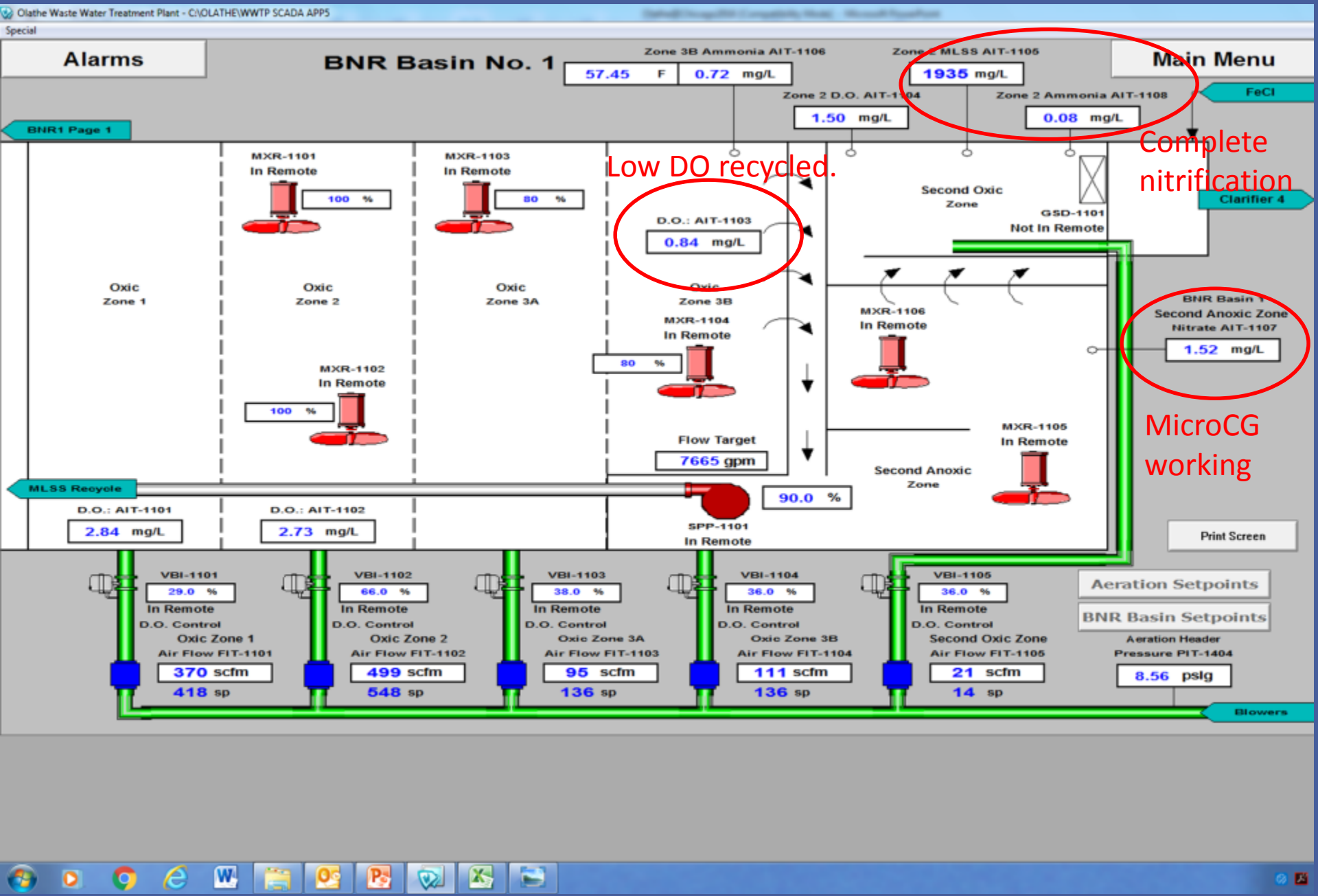


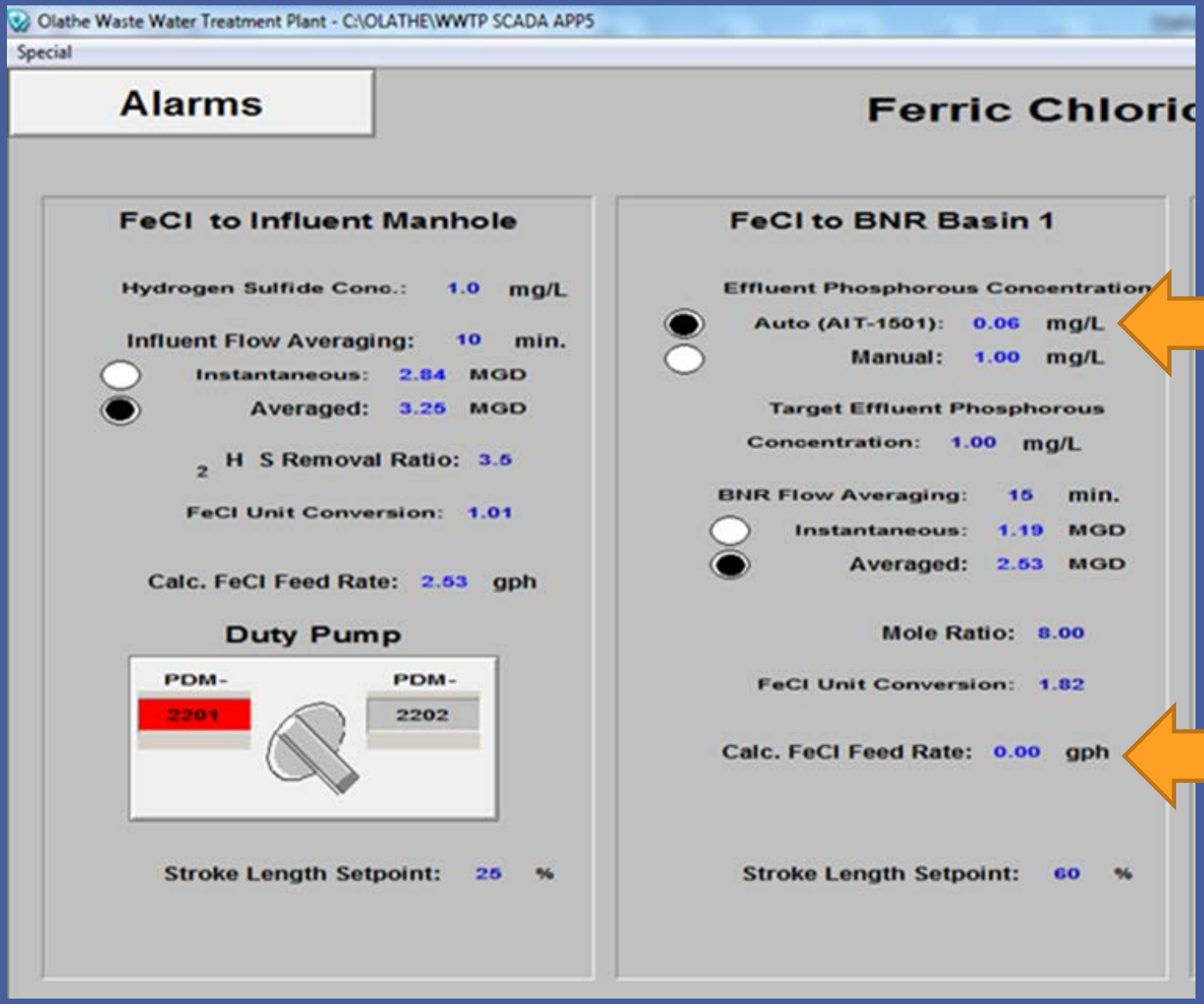


Good anaerobic conditions.

Good phosphorus release.

Membrane Diffusers – can turn off


Olathe Waste Water Treatment Plant - C:\OLATHE\WWTP SCADA APPS
Special
Alarms
BNR Basin No. 1
Zone 3B Ammonia AIT-1106
57.45 F
0.72 mg/L
Zone 2 MLSS AIT-1105
1935 mg/L
Main Menu
Zone 2 D.O. AIT-1104
1.50 mg/L
Zone 2 Ammonia AIT-1108
0.08 mg/L
FeCl
BNR1 Page 1
Low DO recycled.
Complete nitrification
Clarifier 4
MXR-1101
In Remote
100 %
MXR-1103
In Remote
80 %
D.O.: AIT-1103
0.84 mg/L
Second Oxic Zone
GSD-1101
Not In Remote
Oxic Zone 1
Oxic Zone 2
Oxic Zone 3A
Oxic Zone 3B
MXR-1104
In Remote
80 %
MXR-1106
In Remote
BNR Basin 1
Second Anoxic Zone
Nitrate AIT-1107
1.52 mg/L
MXR-1102
In Remote
100 %
MicroCG working
Flow Target
7665 gpm
MXR-1105
In Remote
Second Anoxic Zone
MLSS Recycle
90.0 %
D.O.: AIT-1101
2.84 mg/L
D.O.: AIT-1102
2.73 mg/L
SPP-1101
In Remote
Print Screen
VBI-1101
29.0 %
In Remote
D.O. Control
Oxic Zone 1
Air Flow FIT-1101
370 scfm
418 sp
VBI-1102
66.0 %
In Remote
D.O. Control
Oxic Zone 2
Air Flow FIT-1102
499 scfm
548 sp
VBI-1103
38.0 %
In Remote
D.O. Control
Oxic Zone 3A
Air Flow FIT-1103
95 scfm
136 sp
VBI-1104
36.0 %
In Remote
D.O. Control
Oxic Zone 3B
Air Flow FIT-1104
111 scfm
136 sp
VBI-1105
36.0 %
In Remote
D.O. Control
Second Oxic Zone
Air Flow FIT-1105
21 scfm
14 sp
Aeration Setpoints
BNR Basin Setpoints
Aeration Header
Pressure PIT-1404
8.56 psig
Blowers

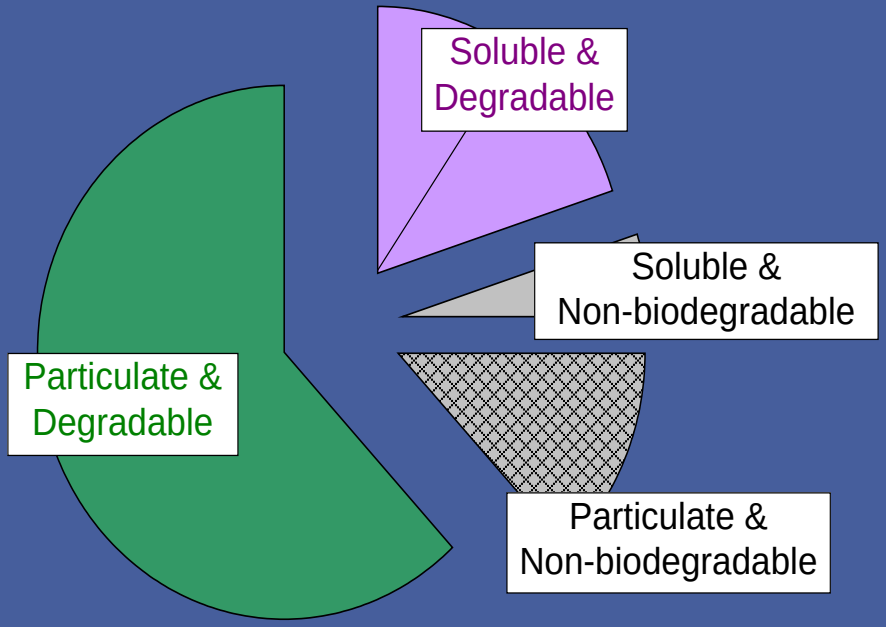


Limit of Technology

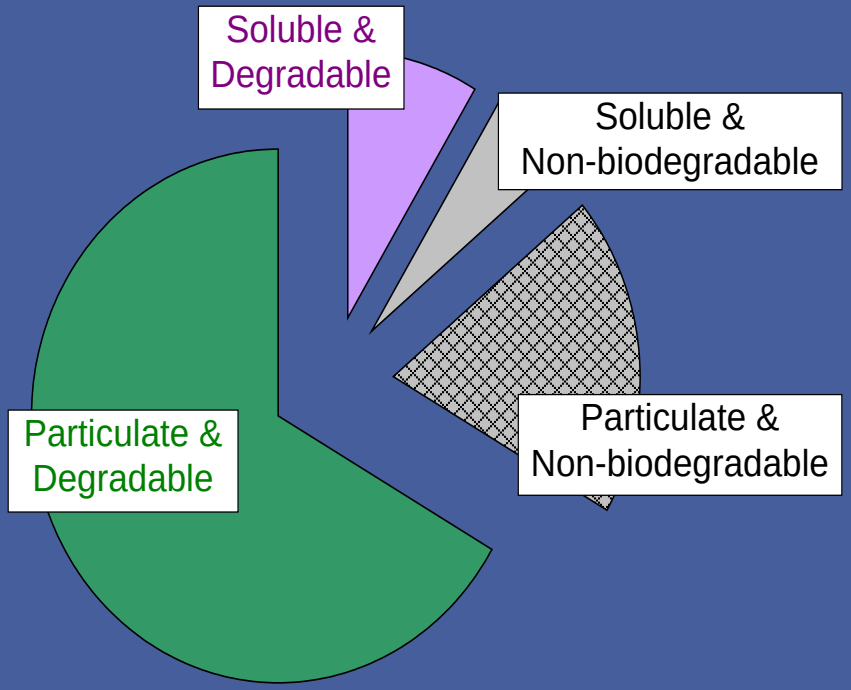
Ferric OFF

Why a Fermenter?

BNR will work.



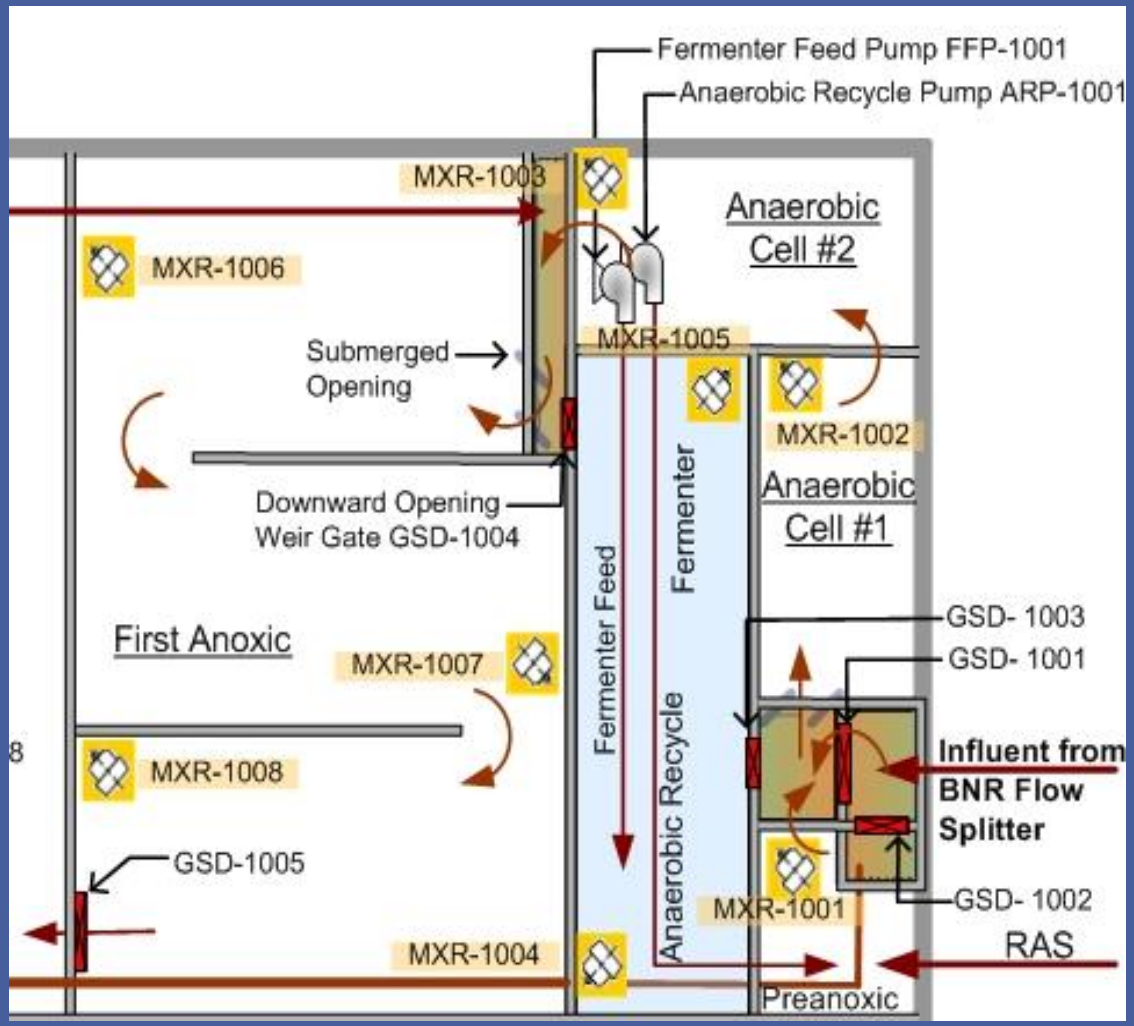
BNR will not work. Chemicals or a fermenter required.



Wastewater Chemical Oxygen Demand

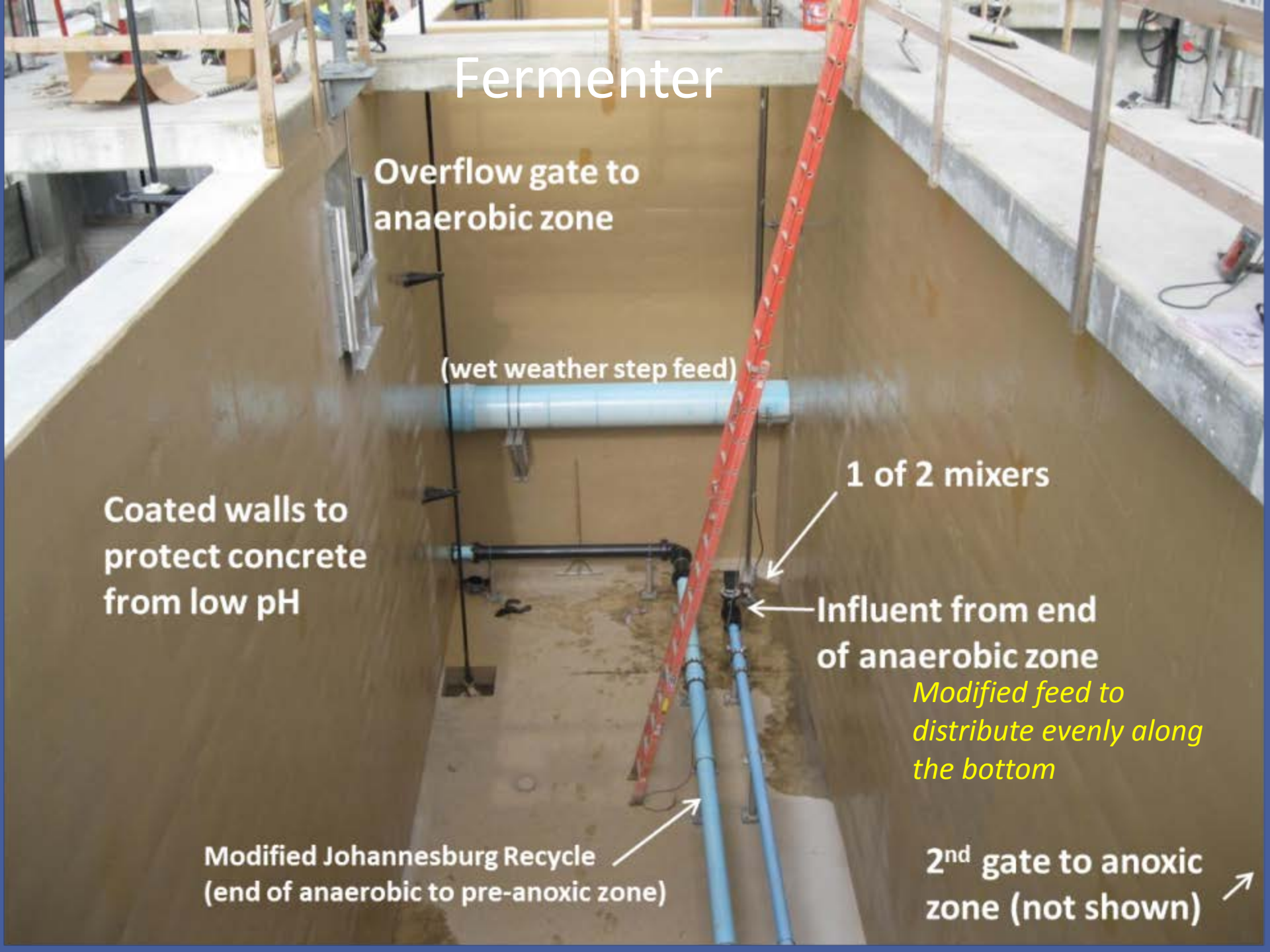
Methods for Wastewater Characterization in Activated Sludge Modeling (Melcer *et al.*, 2003)

Fermenter Flow Path

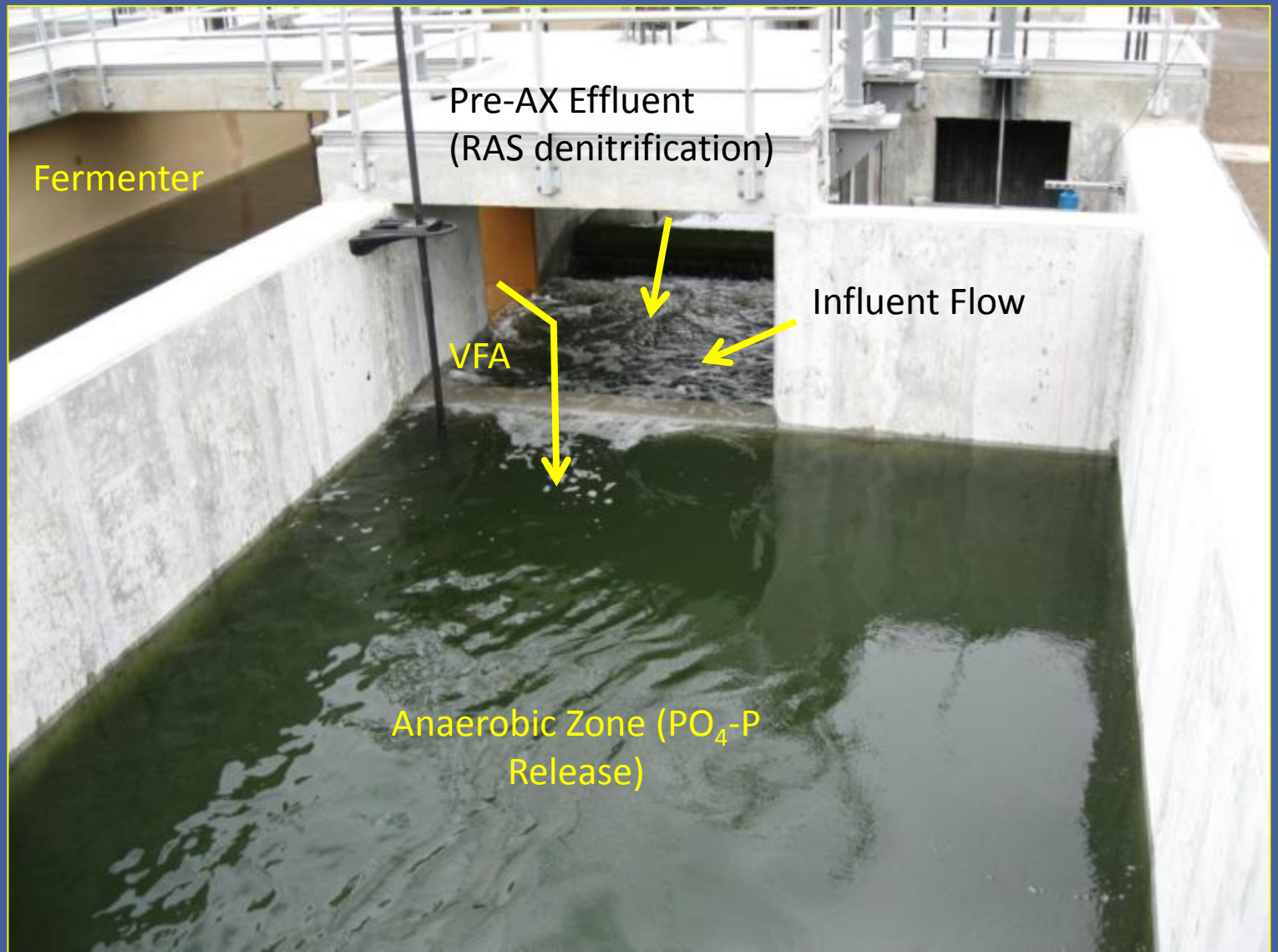


- Pump into Fermenter (from end of AN zone)
- Intermittent mixing
- Overflow out of Fermenter
  - To AN Zone
  - Or AX Zone

Fermenter


Overflow gate to anaerobic zone
(wet weather step feed)
1 of 2 mixers
Coated walls to protect concrete from low pH
Influent from end of anaerobic zone
Modified feed to distribute evenly along the bottom
Modified Johannesburg Recycle (end of anaerobic to pre-anoxic zone)
2nd gate to anoxic zone (not shown)

BNR Influent

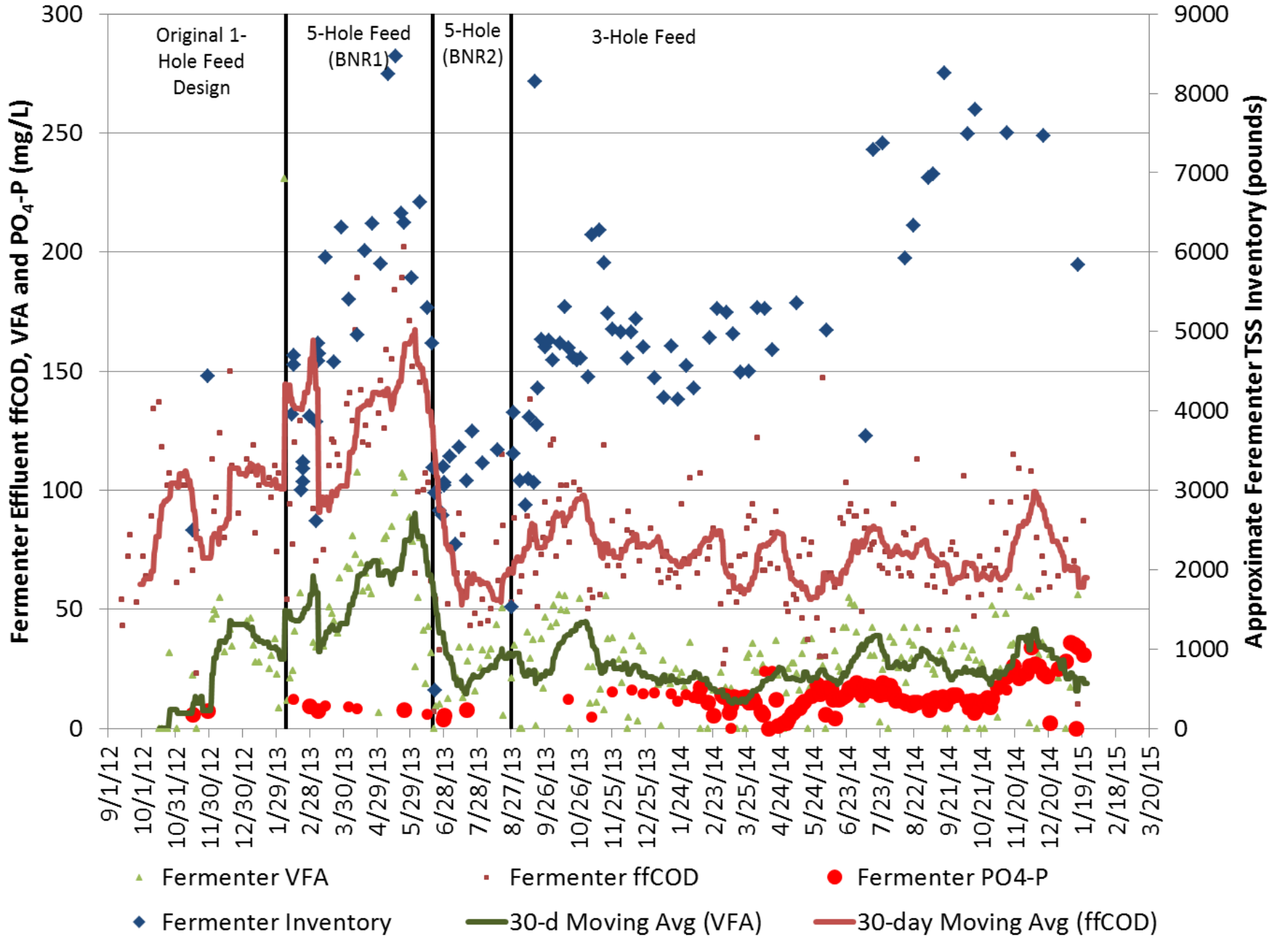


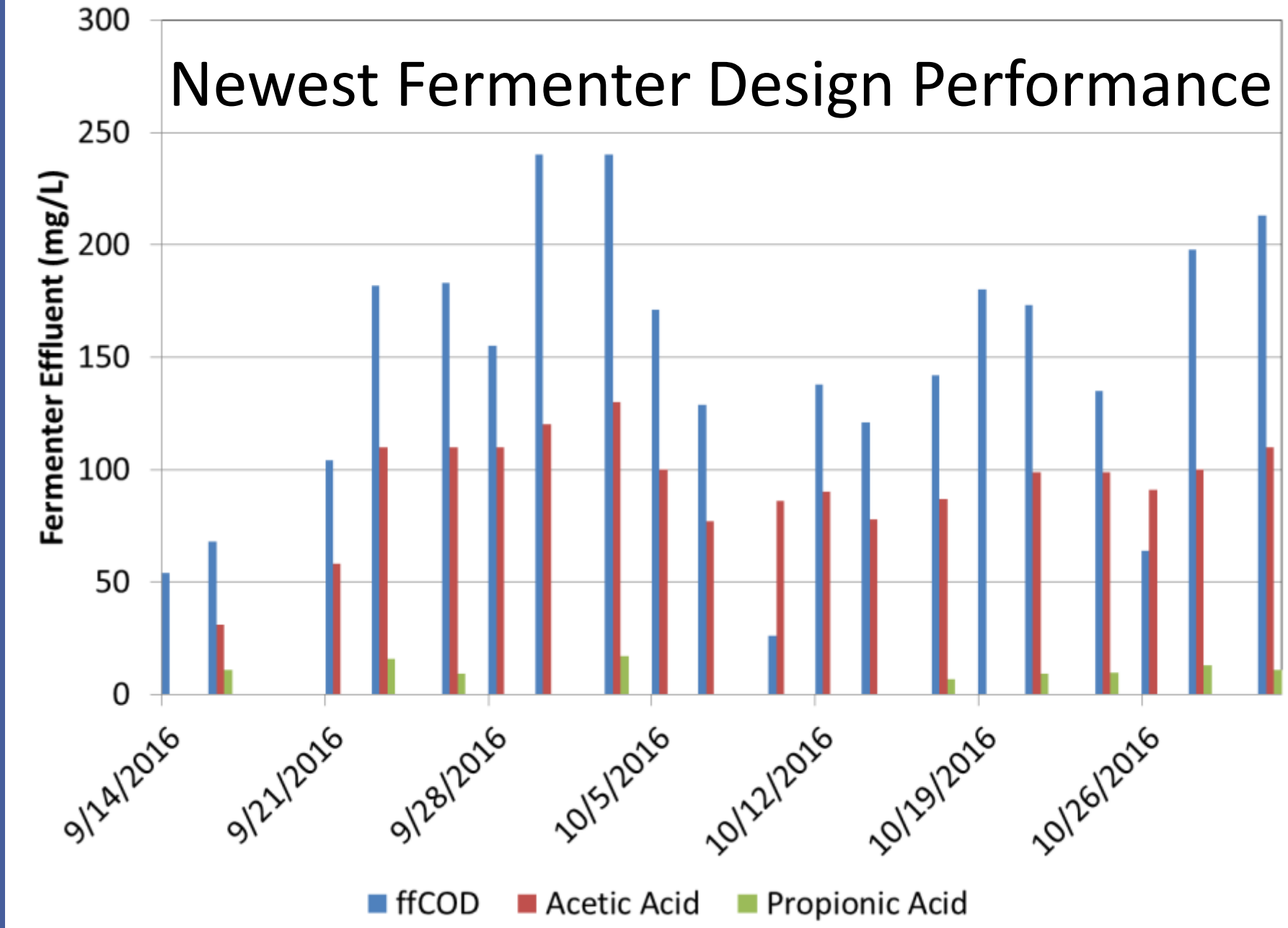
Fermenter Operations

- Feed Pump
  - On 2 hours, off 1 hour to prevent washout.
  - Average HRT Approximately 14 hours.
- Mixers
  - On 2 times per day for 1 min.
  - 2 mixers offset by about 1 hour.
- TSS Inventory (Manual Grab Samples)
  - Top, Middle, Bottom – both sides.
  - Feed, Effluent.
  - Target 2 to 5 days SRT but control is difficult.

Fermenter Sampling

- ORP (manual) – 5x per week
- Fermenter effluent grab – 3 x per week
  - ffCOD, acetic acid, propionic acid, butyric acid
  - PO_4-P, SO_4^{2-}, NO_3-N, NO_2-N, Cl^-, Fl^-
- Solids profiling – 2x per week
- pH profiling – 2x per week
- Microscope as needed
- Batch testing as necessary

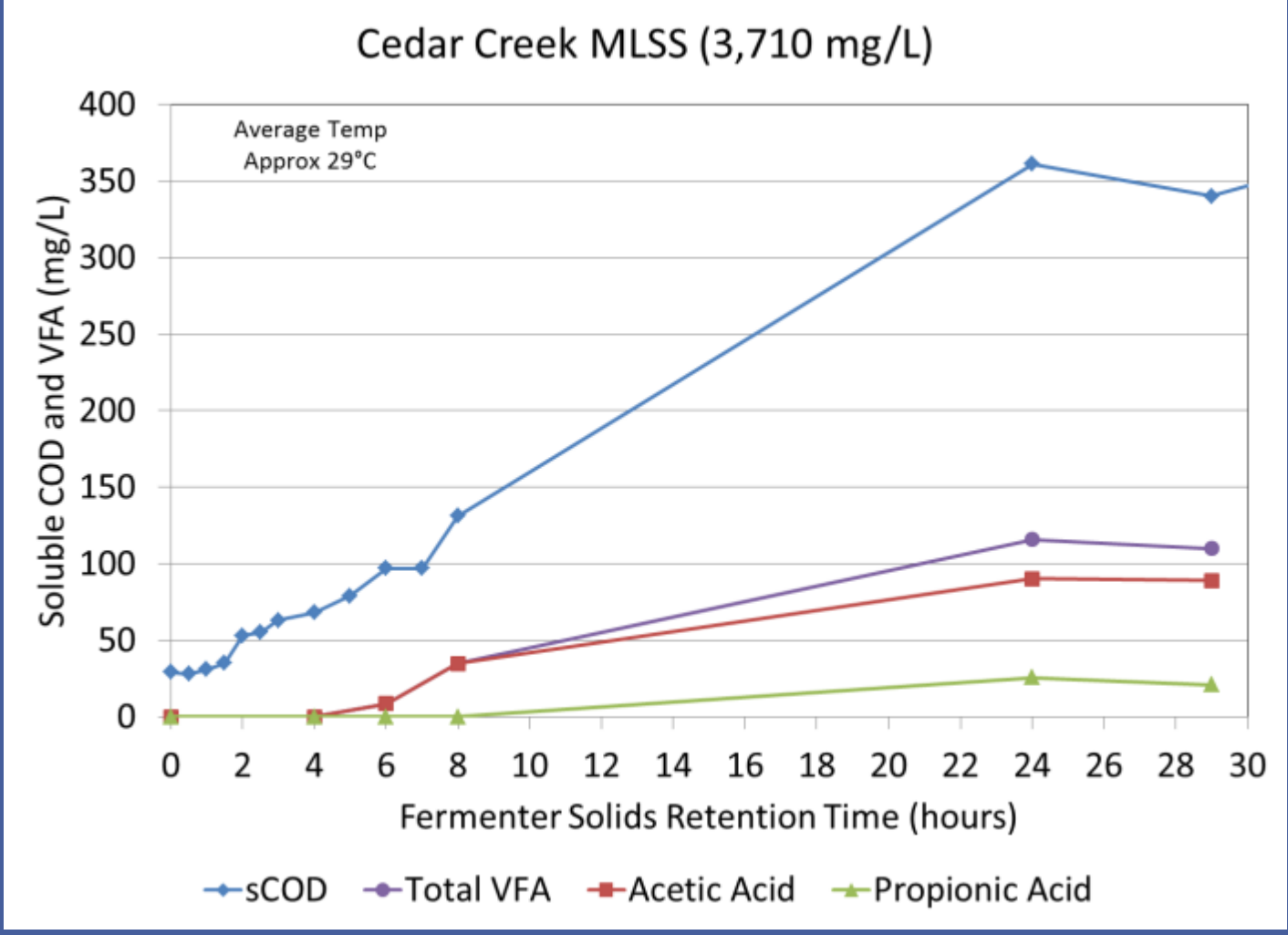

Original 1-Hole Feed Design
5-Hole Feed (BNR1)
5-Hole (BNR2)
3-Hole Feed
Fermenter Effluent ffCOD, VFA and PO4-P (mg/L)
Approximate Ferementer TSS Inventory (pounds)
300
250
200
150
100
50
0
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
9/1/12
10/1/12
10/31/12
11/30/12
12/30/12
1/29/13
2/28/13
3/30/13
4/29/13
5/29/13
6/28/13
7/28/13
8/27/13
9/26/13
10/26/13
11/25/13
12/25/13
1/24/14
2/23/14
3/25/14
4/24/14
5/24/14
6/23/14
7/23/14
8/22/14
9/21/14
10/21/14
11/20/14
12/20/14
1/19/15
2/18/15
3/20/15
Fermenter VFA
Fermenter ffCOD
Fermenter PO4-P
Fermenter Inventory
30-d Moving Avg (VFA)
30-day Moving Avg (ffCOD)


Newest Fermenter Design Performance
Fermenter Effluent (mg/L)
300
250
200
150
100
50
0
9/14/2016
9/21/2016
9/28/2016
10/5/2016
10/12/2016
10/19/2016
10/26/2016
ffCOD
Acetic Acid
Propionic Acid

Batch Fermentation Tests

Summer 29°C
TSS = 3710 mg/L
after 24 hours,

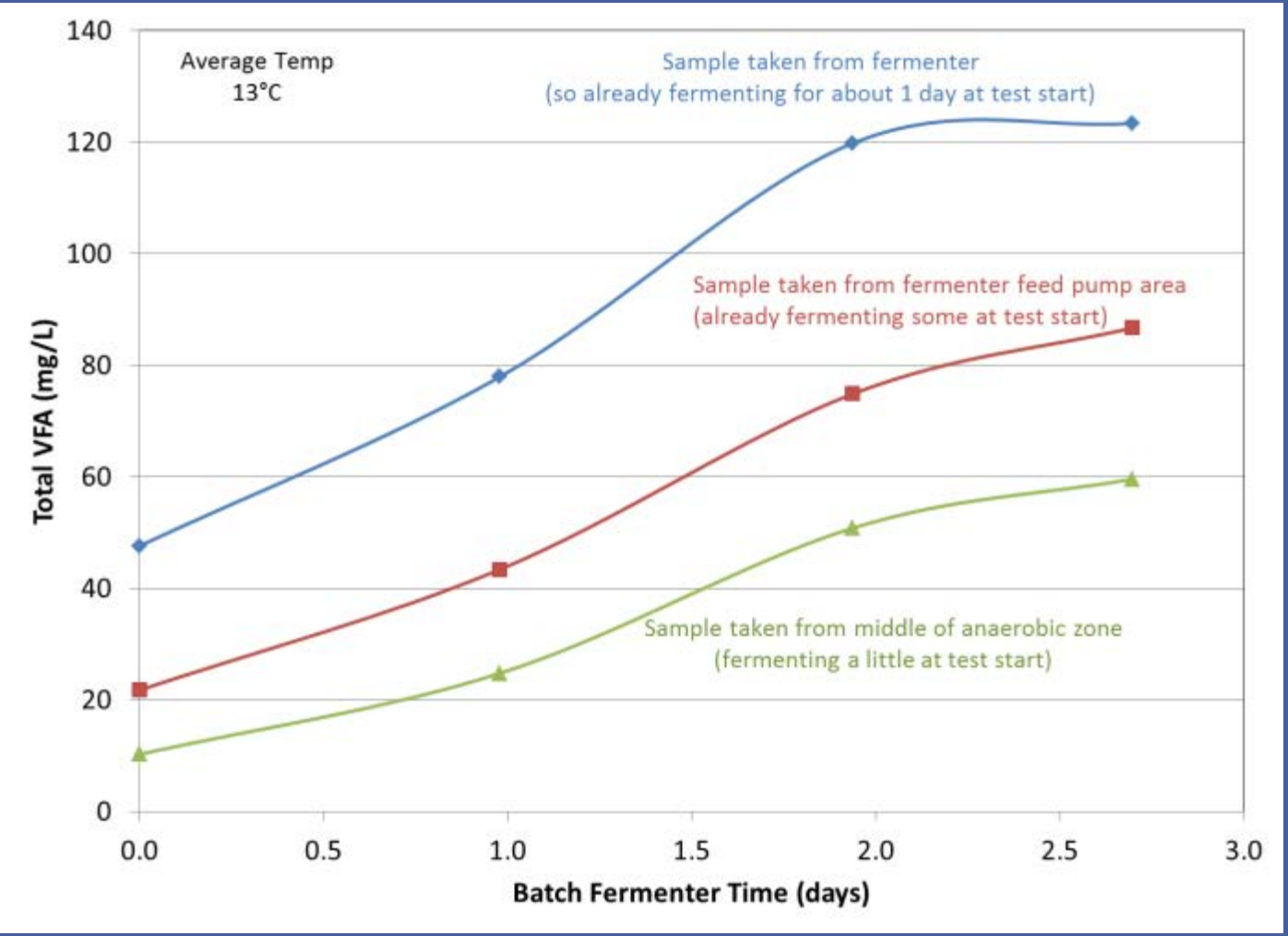
VFA = 116 mg/L
NH_3-N = 20 mg/L
PO_4-P = 22 mg/L
pH = 6.5



Batch Fermentation Tests

Winter 13°C
(tests done seasonally to optimize)

VFA = 60-123 mg/L
NH_3-N = 15-20 mg/L
PO_4-P = 20-27 mg/L
pH = 6.2 – 6.5



WERF Study - ongoing

- Led by Northeastern University (Dr. April Gu)
- City of Henderson, Nevada
- City of Naperville, Illinois
- City of Olathe, Kansas
- Clean Water Services - Hillsboro, Oregon
- Hampton Roads Sanitation District – Virginia Beach, Virginia
- Lake County Illinois
- Metro Wastewater Reclamation District – Chicago
- Metro Wastewater Reclamation District – Denver
- Black & Veatch
- AECOM
- Dynamita (Imre Takacs)
- Woodard Curran

WERF
Water Environment Research Foundation

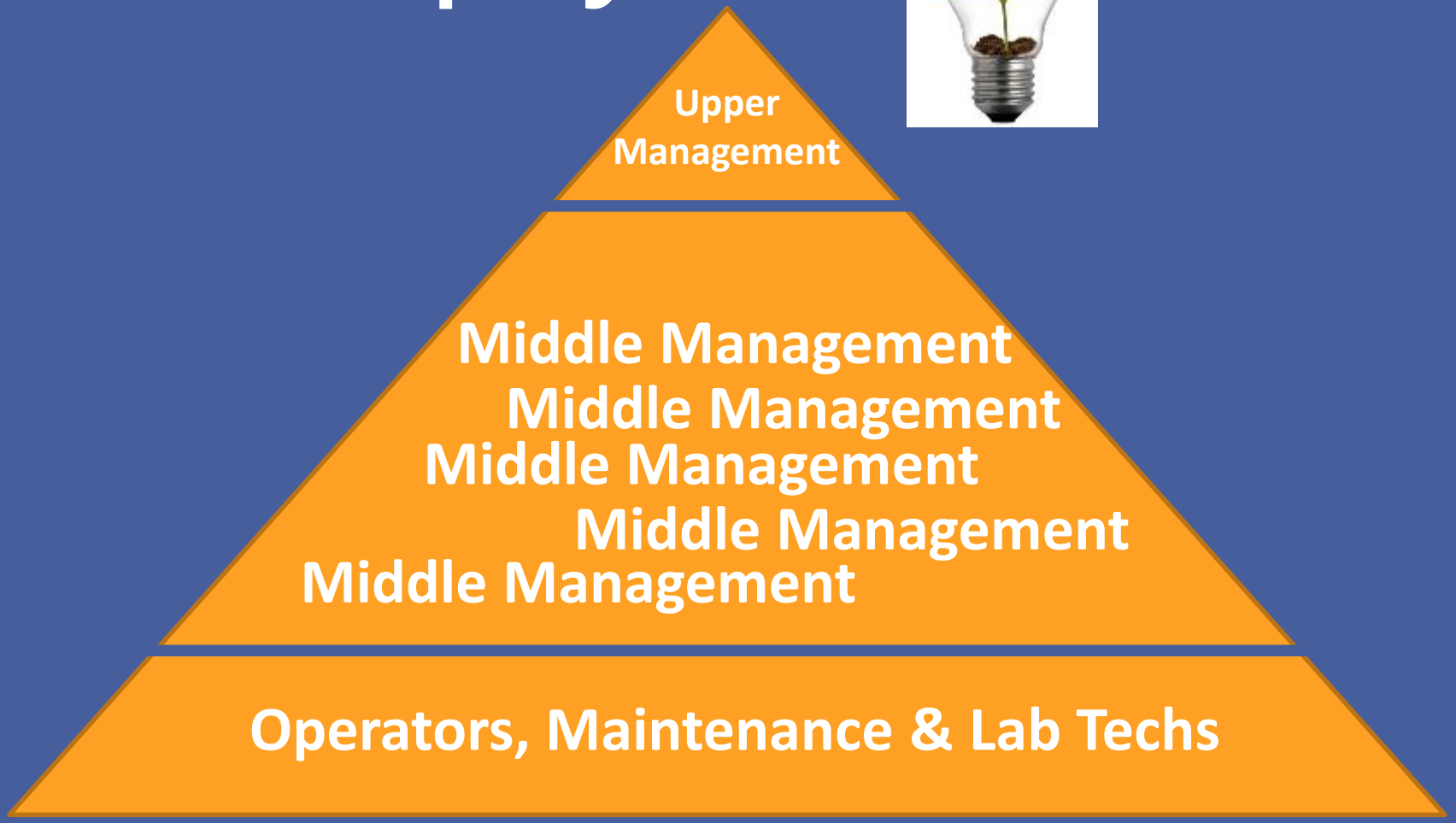
June 2015 On-Site Testing:
Nick Tooker, Yuqi Wang – Northeastern
Jenny Warren – City Intern, KU undergrad
Katie Jaegar – City Intern, KSU undergrad

Imported Nutrients

Centrate Management

Cedar Creek WWTF's "Temporary" Centrate EQ Line

Typical Leadership Philosophy



Olathe's Leadership Philosophy

Operators, Maintenance & Lab Techs

Front-Line Supervisors

Middle Management

Upper Management

ACKNOWLEDGMENTS

Kansas Department of Health & Environment
Environmental Protection Agency, Region 7
Black & Veatch
Grimm Construction

City of Olathe:
Operators: Daniel Marez II, Frank Moreno, Patrick Karashin, Kenny Deeter, Greg Breault, Les Newton, Carl Cook, Tony Kurkowski, Colin Smysor
Supervisors: Joe Foster, Richard Jones, Tim Whorton, Tim Kurkowski
Maintenance: Floyd Koder, Roman Rodriguez III, Scott Gibson, Steven McNolty II, Nate Volle, Doug Courtney, Mark Higgs, Bart Rehagen, Brad Beemer, Byron Anderson, Chad Jones, Chris Rosauer, Roman Rodriguez, Tito Mwela, Chris James
Laboratory: DeWayne McAllister, Bill Crandall, Dan Laneville, Darla Geary, Jennifer Bauman, Melissa Krayca, Ed Turner

Interns! Jenny Warren, Katie Jaeger, Alison Cioffi, Krista Long, Levi Hogan

#OlatheProud

EPA National Biosolids Award 2006

NACWA Peak Performance 2015, 2014, 2013, 2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2002, 2001….