Troubleshooting Noncompliance at the Smallest Wastewater Treatment Plants

Part 1: Conversion

ACTIVATED SLUDGE PROCESS CONTROL

TROUBLESHOOTING CHART

Jon van Dommelen – Ohio EPA, Compliance Assistance Unit

THE COMPLIANCE ASSISTANCE UNIT

- Clean Water Act: Section 104(g)(1)
- In Ohio, the federal grant was used for equipment, supplies, travel and training
- Positions were funded through normal revenues
- Most importantly, the CAU had support of management

THE COMPLIANCE ASSISTANCE UNIT

Provide **on-site** technical assistance to communities

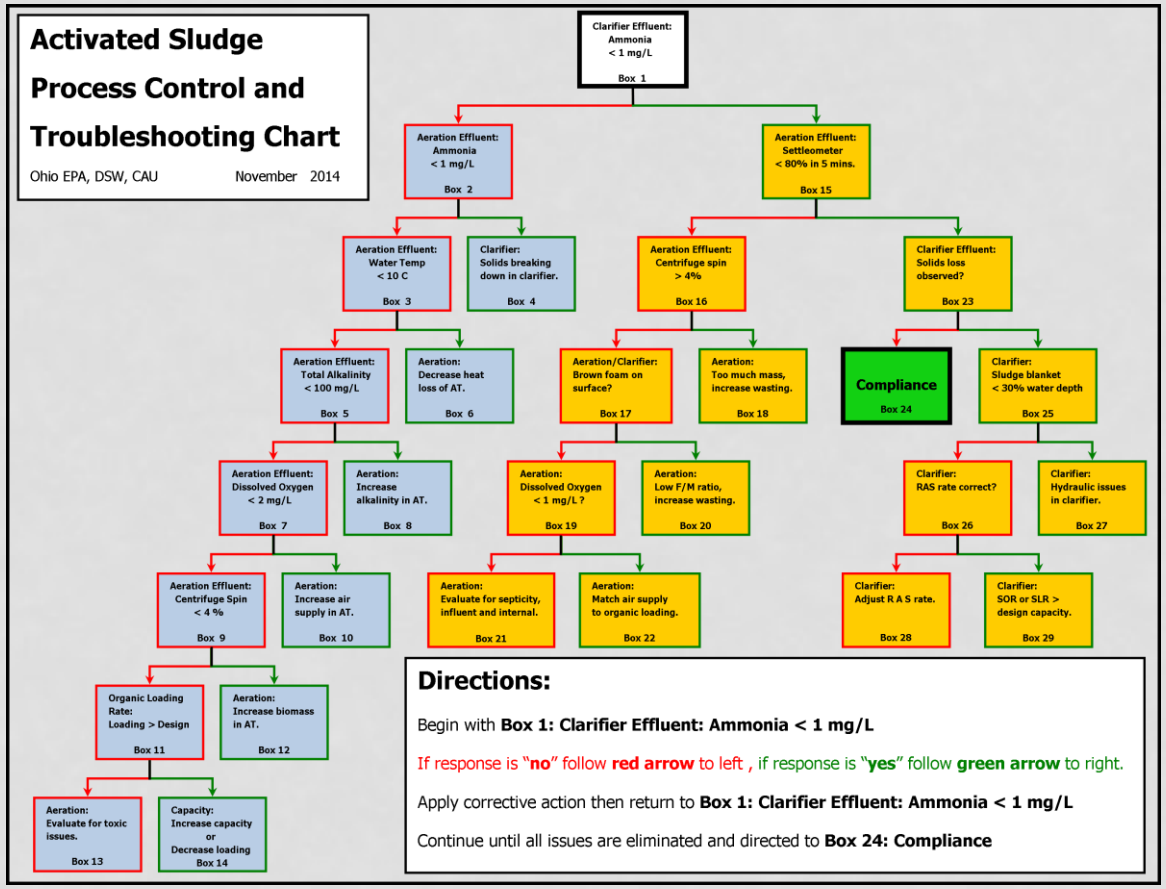
- Typically smaller communities (1500 gpd up to 15+ MGD)
- Help operators to overcome noncompliance with NPDES permits

THE COMPLIANCE ASSISTANCE UNIT

Provide **on-site** technical assistance to communities

- Troubleshooting all aspects of wastewater treatment
- Process optimization using cheap, easy, and effective process control tools

CAU created the Activated Sludge Process Control and Troubleshooting Manual and Flow Chart



Ohio Environmental Protection Agency

Activated Sludge Process Control and Troubleshooting

Training Manual

Division of Surface Water
Compliance Assistance Unit
March 2015

THE PACKAGE PLANT INITIATIVE

- Target SNC in Small WWTPs in Ohio
- Focus on Design Capacity less than 100,000 gpd
- Focus on mechanical systems (not lagoon systems)

THE PACKAGE PLANT INITIATIVE

Reason:

If we could get the operators to do **process control**, we believed we could solve **Significant Noncompliance** through process optimization

THE PACKAGE PLANT INITIATIVE

Reason:

If we could get the operators to do **process control**, we believed we could solve **Significant Noncompliance** through process optimization

THE PACKAGE PLANT INITIATIVE

Compliance Assistance Unit (CAU)

- View wastewater treatment as a biological process
- Measure the **physical** characteristics, the **visual** clues and the **chemica**l trails that bacteria leave behind as they convert the pollutants in wastewater into carbon dioxide, nitrate and more bacteria.

The Universe of Small Discharge Non-compliance

NPDES Permitted WWTPs < 100,000 gpd design
SNC at some time over 2 year period

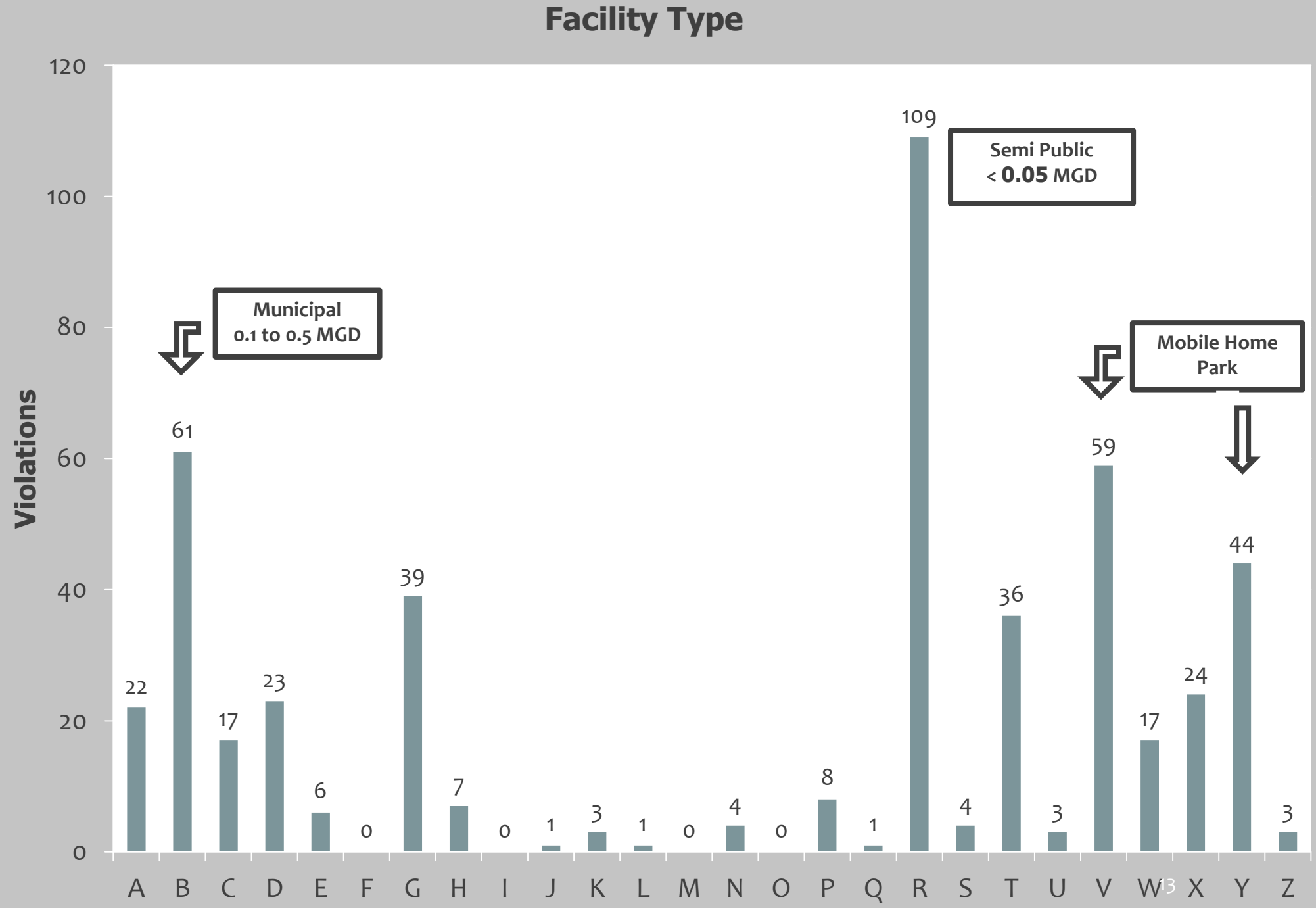
Central	153	37	24%
Private	44	12	
Public	41	11	
Semi-Public	16	3	
Specific	52	11	
Northeast	732	151	21%
Private	109	33	
Public	99	23	
Semi-Public	439	77	
Specific	85	18	
Northwest	389	78	20%
Private	72	19	
Public	105	20	
Semi-Public	178	34	
Specific	34	5	
Southeast	210	52	25%
Private	37	9	
Public	92	24	
Semi-Public	38	11	
Specific	43	8	
Southwest	233	28	12%
Private	75	14	
Public	41	5	
Semi-Public	14	9	
Specific	103	0	
Grand Total	1717	346	20%

Ohio NPDES Permit 1 P B 0 0 0 0 5 * A D

Letter	Public
A	Municipality – Under 0.1 MGD
B	Municipality – 0.1 to 0.5 MGD
C	Municipality – 0.5 to 1.0 MGD
D	Municipality – 1.0 to 10 MGD
E	Municipality – 10 to 50 MGD
F	Municipality – Greater than 50 MGD
G	County/Sewer District – Under 0.1 MGD
H	County/Sewer District – 0.1 to 0.5 MGD
I	Storm Water
J	County/Sewer District – 0.5 to 1.0 MGD
K	County/Sewer District – 1.0 to 10 MGD
L	County/Sewer District – 10 to 50 MGD
M	County/Sewer District – 50 MGD or more
N	Federal Facility
O	-
P	State Facility
Q	Regional Authority
R	Semi-Public – less than 0.05 MGD
S	Semi-Public – Greater than 0.05 MGD
T	Schools and Hospitals
U	PUCO
V	Mobile Home Parks
W	Subdivisions and Apartment Complexes
X	Miscellaneous
Y	Mobil Home Parks
Z	Extension of R's

Ohio NPDES Permit 1 P B 0 0 0 0 5 * A D

Letter	Public
A	Municipality – Under 0.1 MGD
B	Municipality – 0.1 to 0.5 MGD
C	Municipality – 0.5 to 1.0 MGD
D	Municipality – 1.0 to 10 MGD
E	Municipality – 10 to 50 MGD
F	Municipality – Greater than 50 MGD
G	County/Sewer District – Under 0.1 MGD
H	County/Sewer District – 0.1 to 0.5 MGD
I	Storm Water
J	County/Sewer District – 0.5 to 1.0 MGD
K	County/Sewer District – 1.0 to 10 MGD
L	County/Sewer District – 10 to 50 MGD
M	County/Sewer District – 50 MGD or more
N	Federal Facility
O	-
P	State Facility
Q	Regional Authority
R	Semi-Public – less than 0.05 MGD
S	Semi-Public – Greater than 0.05 MGD
T	Schools and Hospitals
U	PUCO
V	Mobile Home Parks
W	Subdivisions and Apartment Complexes
X	Miscellaneous
Y	Mobil Home Parks
Z	Extension of R's


Facility Type
Violations
120
100
80
60
40
20
0
Municipal
0.1 to 0.5 MGD
Semi Public
< 0.05 MGD
Mobile Home
Park
22
61
17
23
6
0
39
7
0
1
3
1
0
4
0
8
1
109
4
36
3
59
17
24
44
3
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z

STOP THE BLEEDING . . .

Type "R" Semi Public < 0.05 MGD

Who are they?

4-H / FFA camps
Marinas
Small Manufacturing
Bars/Taverns
Restaurants
Schools
Motels
Churches

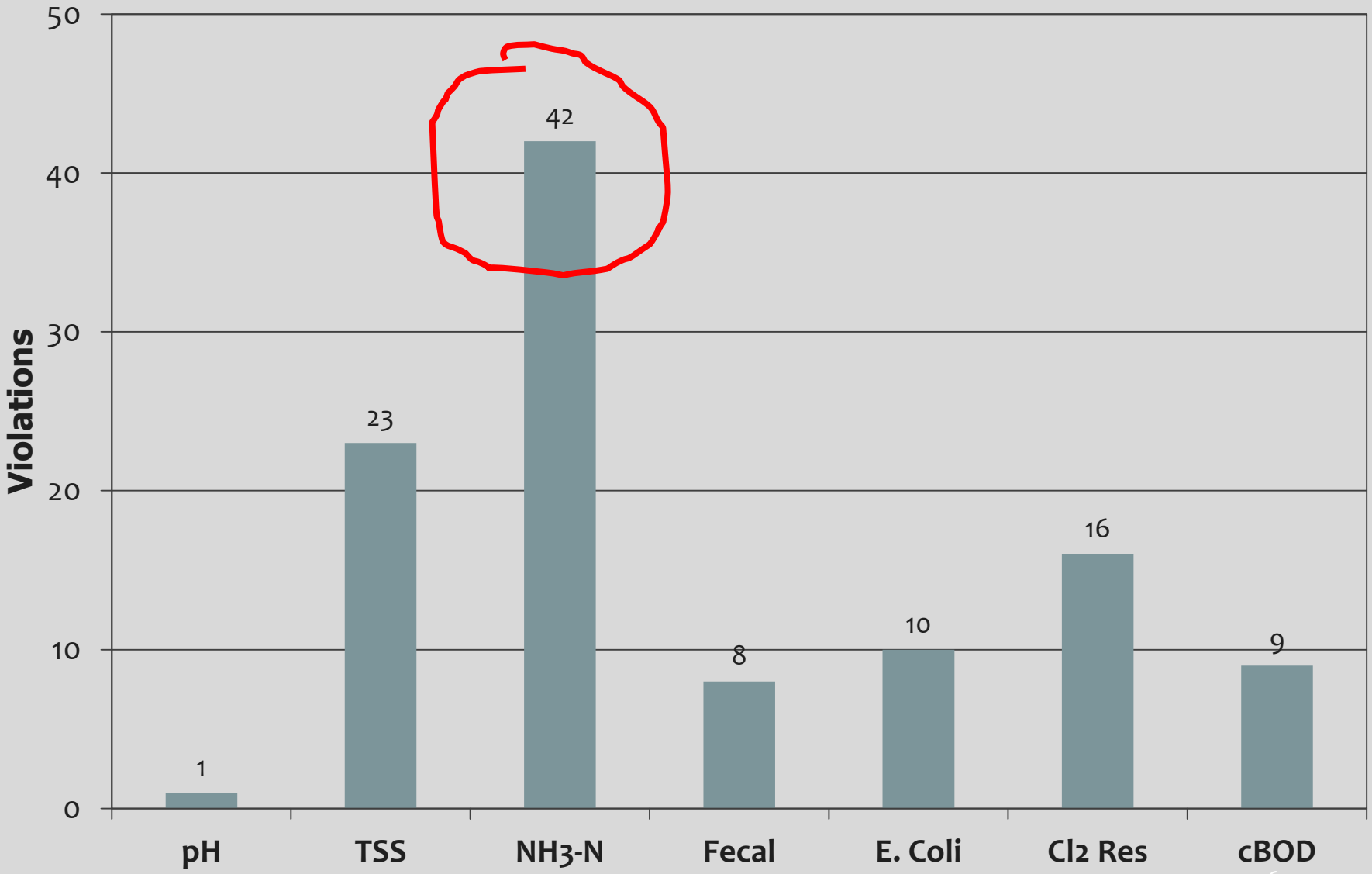
Their #1 business is not the #1 business.
Might require more "hand holding".

STOP THE BLEEDING . . .

Type "R" Semi Public < 0.05 MGD

What are their issues?

Semi Public < 0.05 MGD
(violations by parameter)

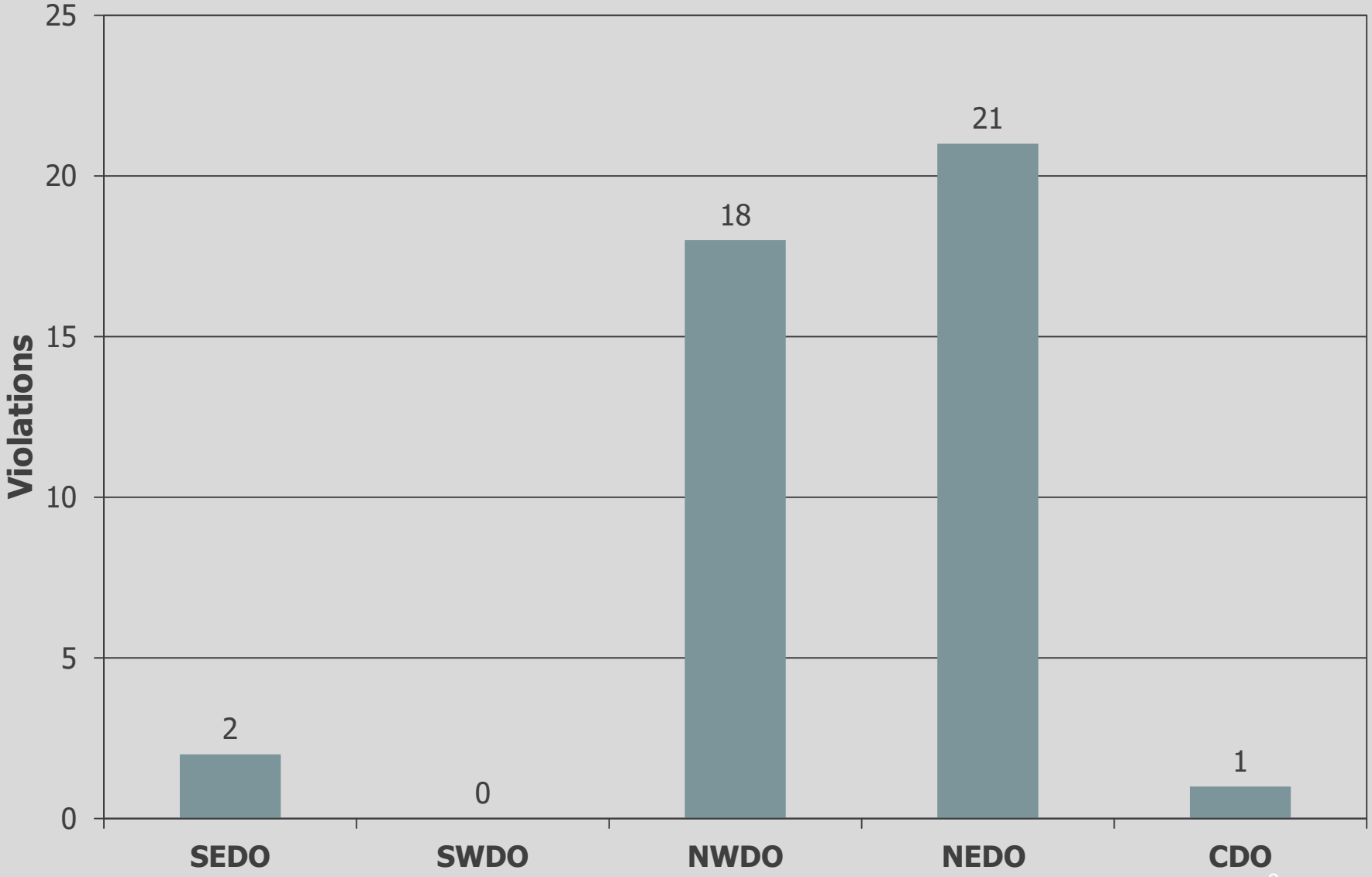


STOP THE BLEEDING . . .

Type "R" Semi Public < 0.05 MGD

Where are they?

Semi Public < 0.05 MGD
NH3-N violations by district



The World of Noncompliance – Causes and Fixes

- Operational Issues
  - Process control
  - Maintenance
- Design Issues
  - Increased process control
  - Work arounds
- Administrative Issues
  - Staffing
  - O, M, and R costs


Welcome to my world

Welcome to my world.

Welcome to my world


Welcome to my world.

Welcome to my world.


Welcome to my world

Welcome to my world.


Welcome to our world.


Welcome to my world.


Welcome to my world.

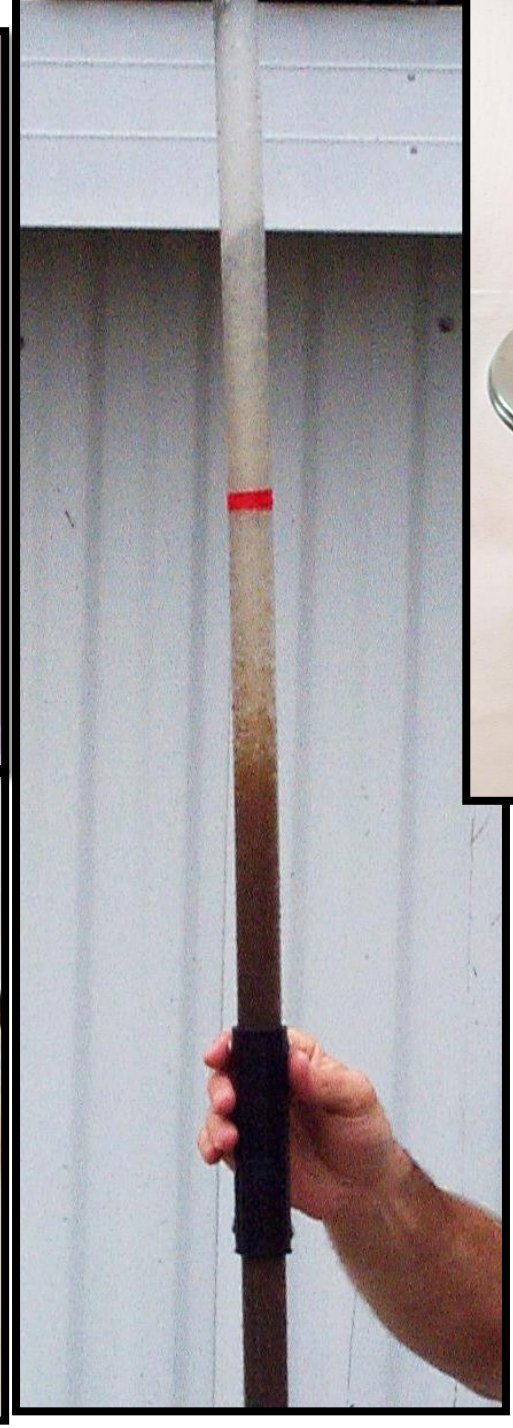

Welcome to my world.

Welcome to my world


Welcome to my world.


DI
H2O


HACH

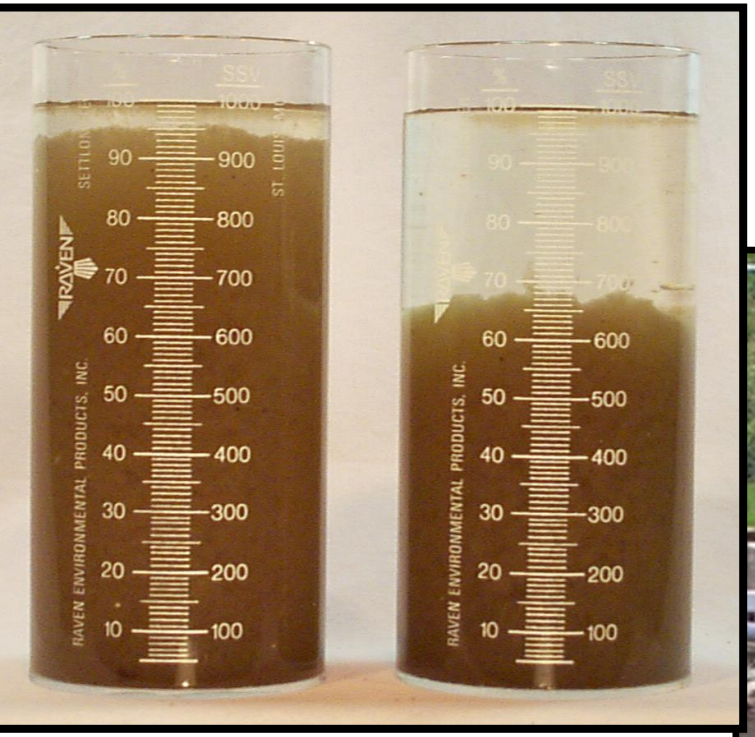



TWC #4

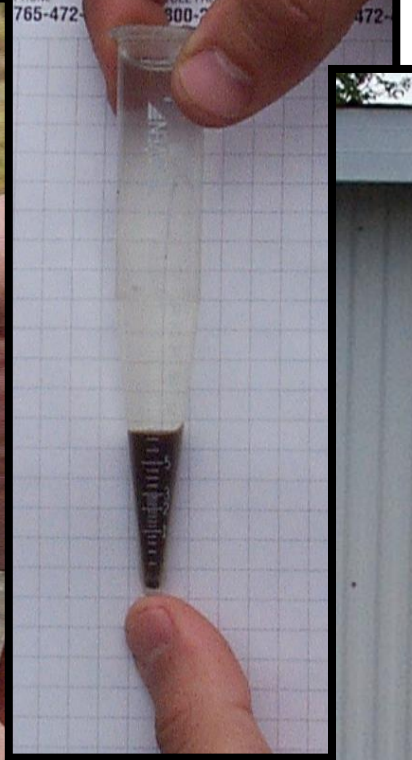

API
AMMONIA
NH3/NH4+
TEST KIT
FRESH WATER / SALT WATER
EAU DOUCE / EAU DE MER
Monitor ammonia to help prevent fish loss
Surveillez le taux d'ammoniaque pour éviter la perte de poissons


YSI
55
ON/OFF
LIGHT
MODE
ENTER


RAVEN
RAVEN ENVIRONMENTAL PRODUCTS, INC.
RAVEN ENVIRONMENTAL PRODUCTS, INC.


RAVEN ENVIRONMENTAL PRODUCTS, INC.
RAVEN ENVIRONMENTAL PRODUCTS, INC.

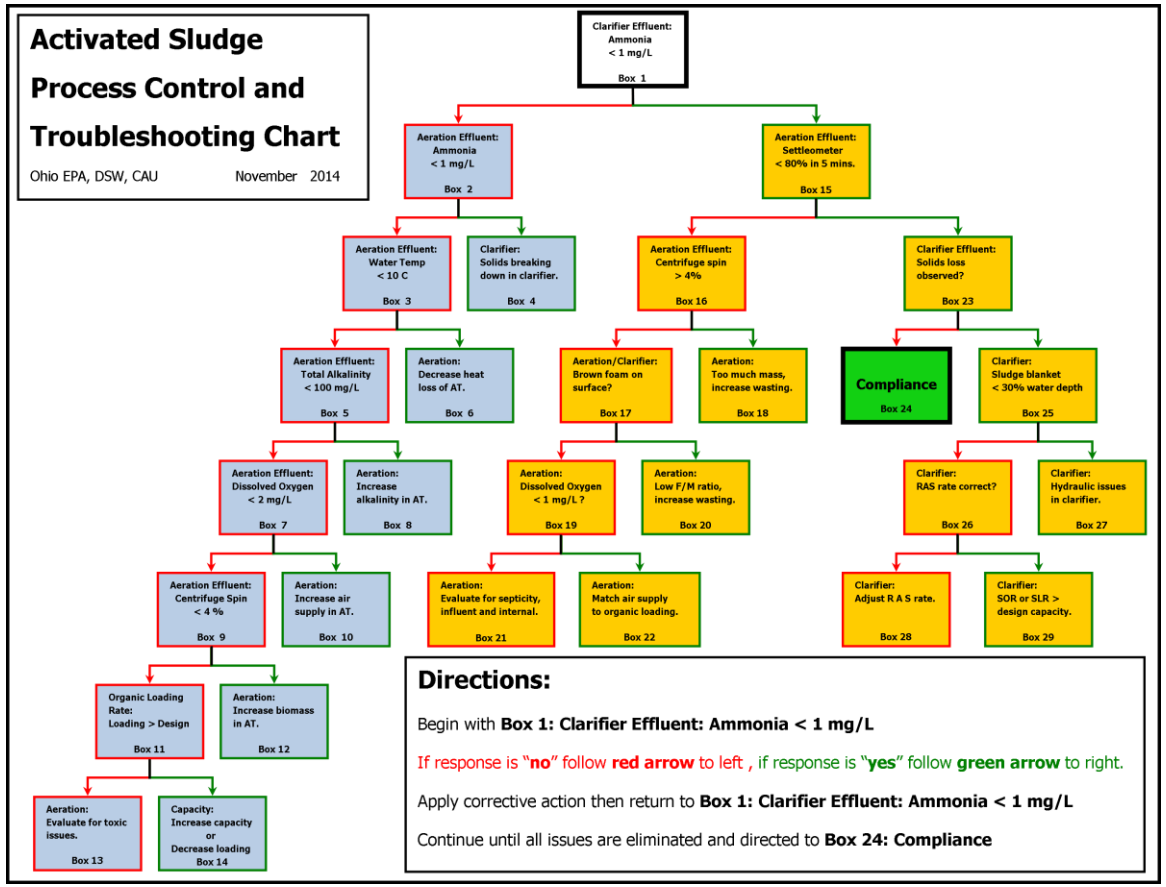

RAVEN




AMMONIA
0.20
mg/L NH3-N
ZERO
READ
HACH
Pocket Colorimeter

The Solution…

The CAU training material:



Ohio Environmental Protection Agency

Activated Sludge Process Control and Troubleshooting

Training Manual

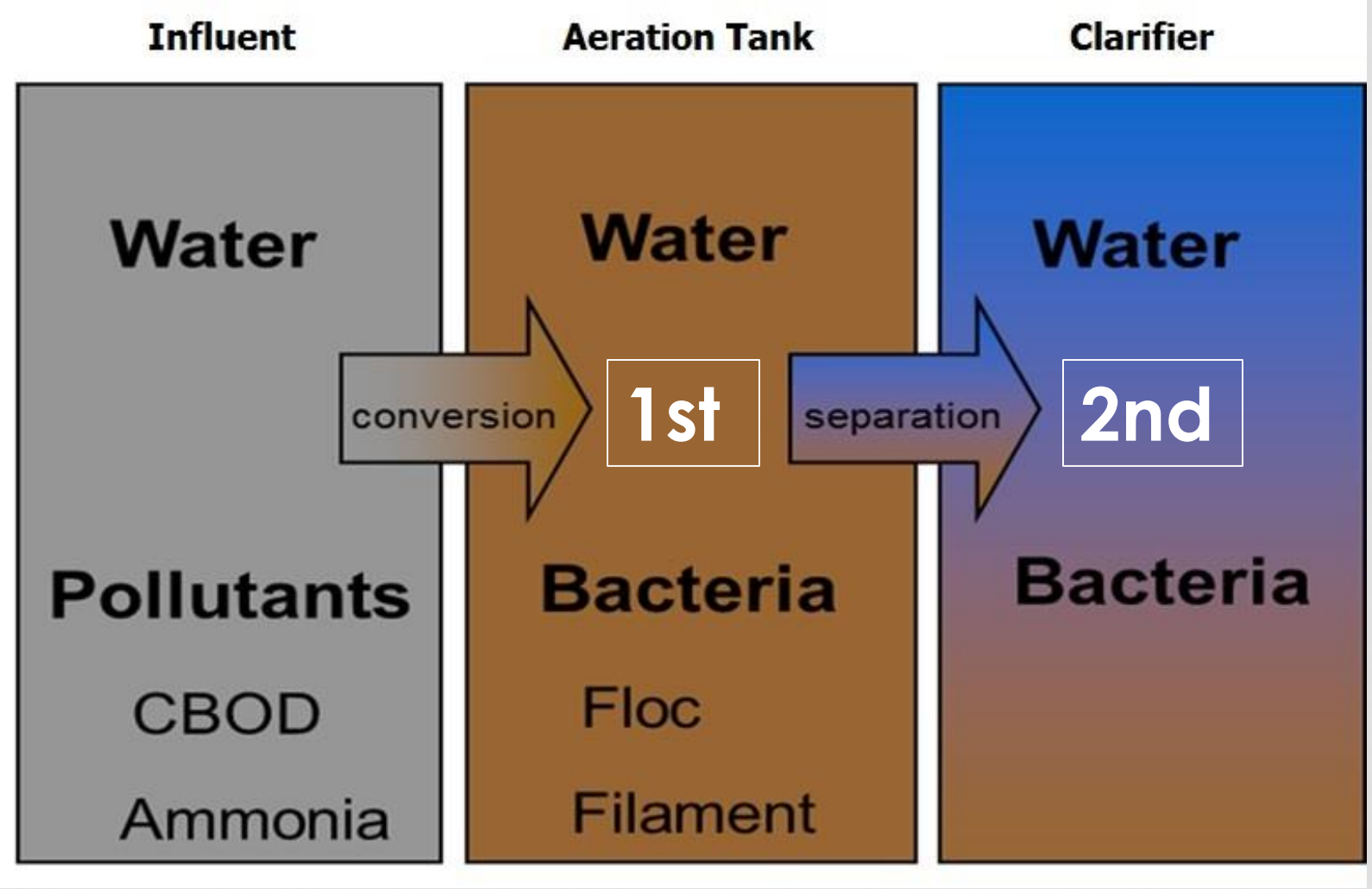
Division of Surface Water
Compliance Assistance Unit
March 2015

ACTIVATED SLUDGE PROCESS CONTROL

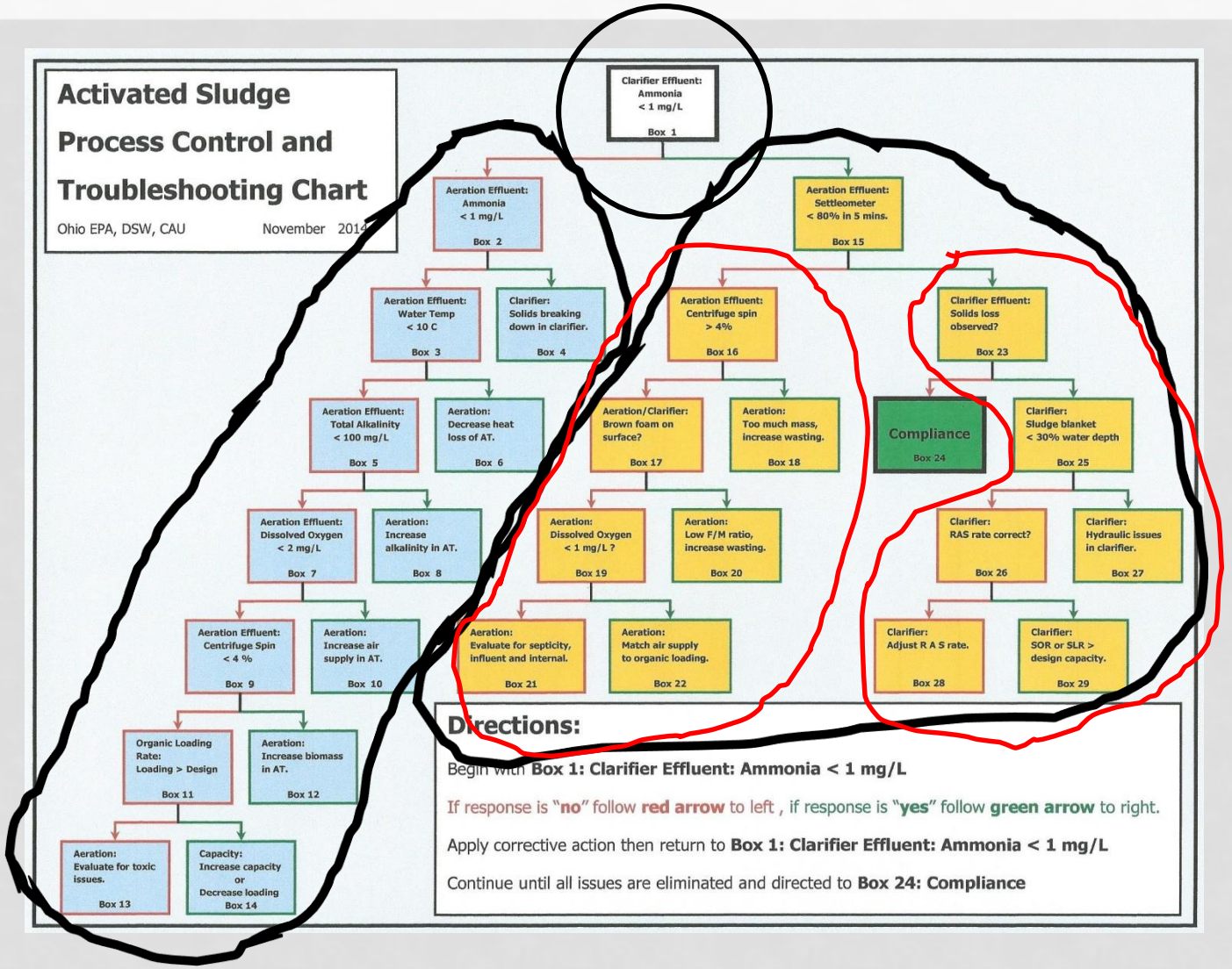
TROUBLESHOOTING CHART

Part One: Conversion

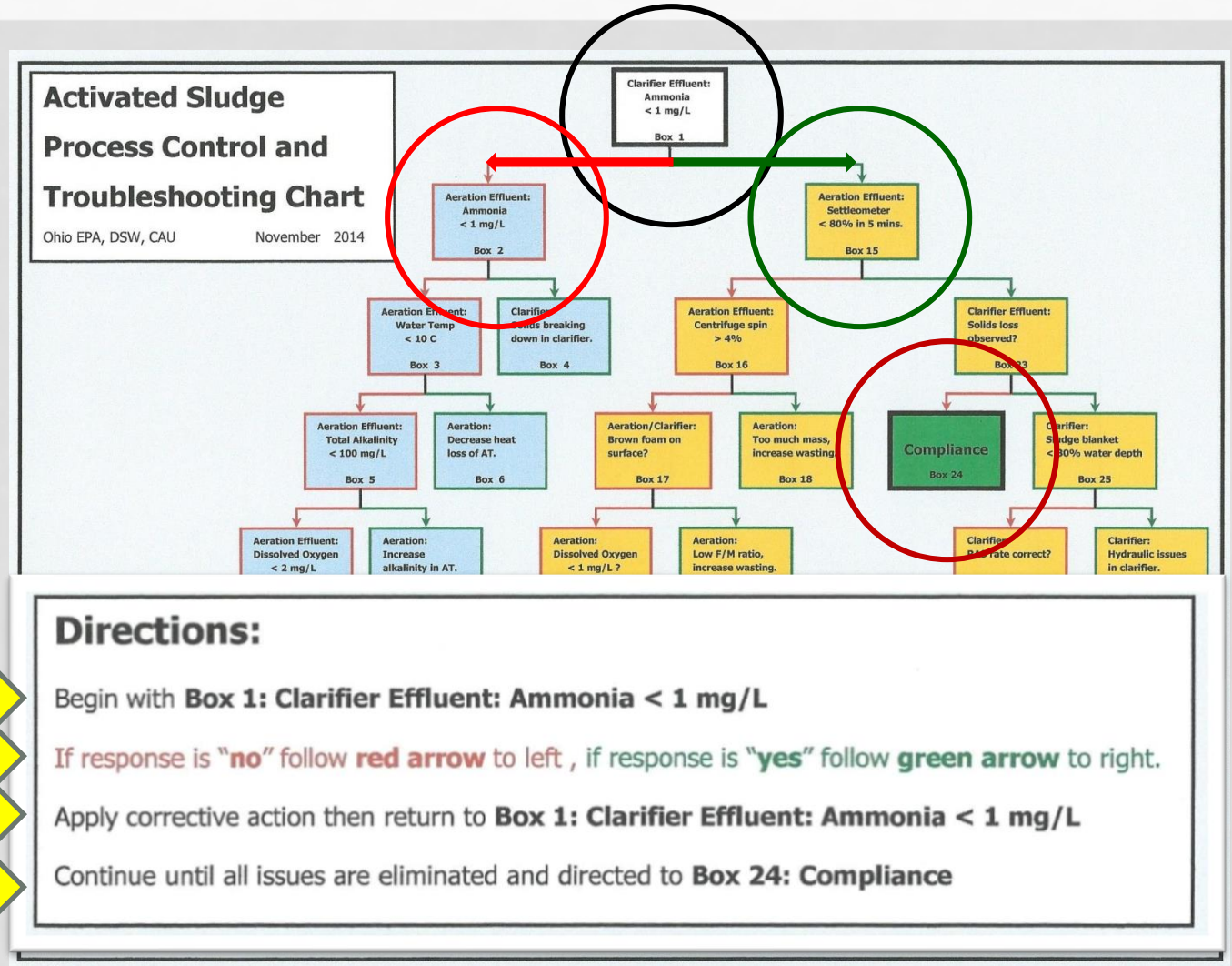
BASIC CONCEPTS



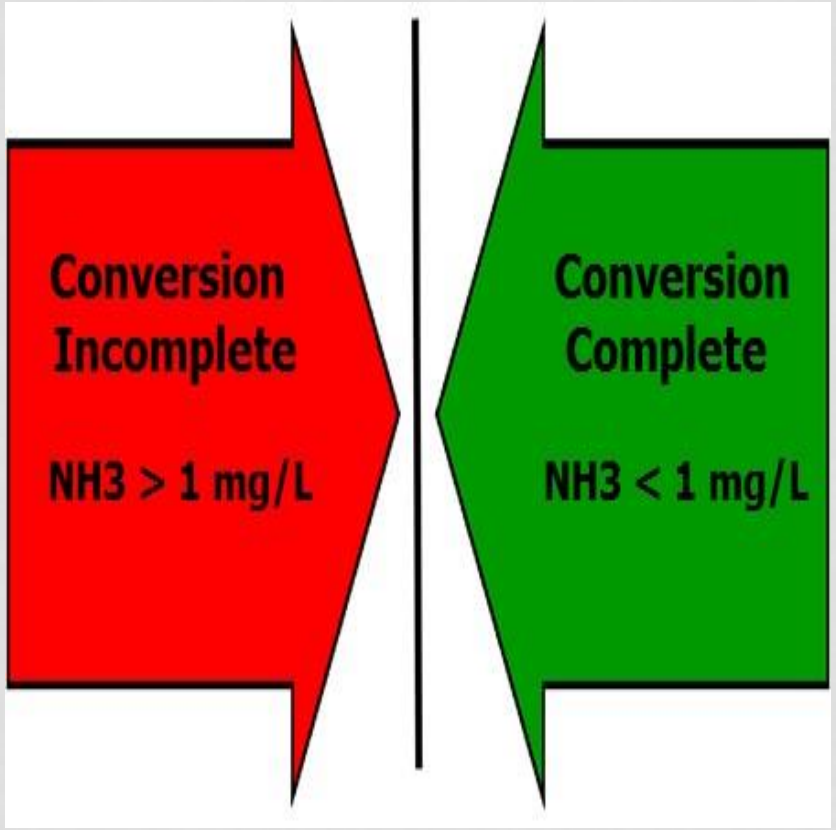
ACTIVATED SLUDGE PROCESS CONTROL



Each box will either request more data or identify the issue.

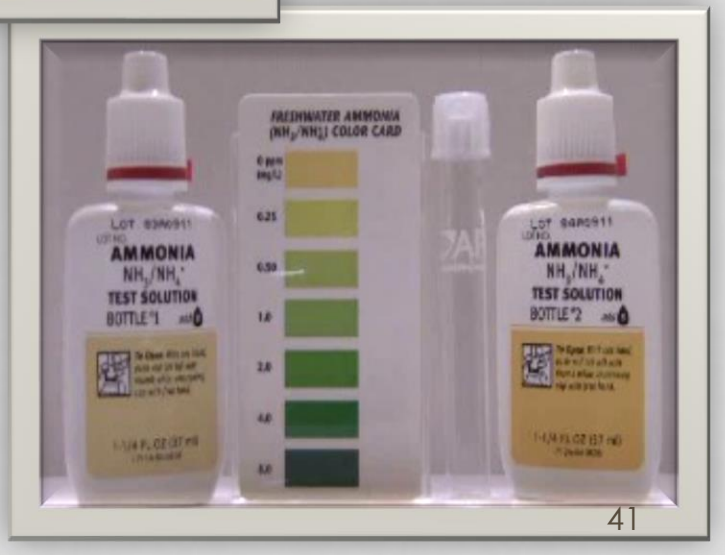


BOX # 1 CLARIFIER EFFLUENT: AMMONIA < 1 MG/L

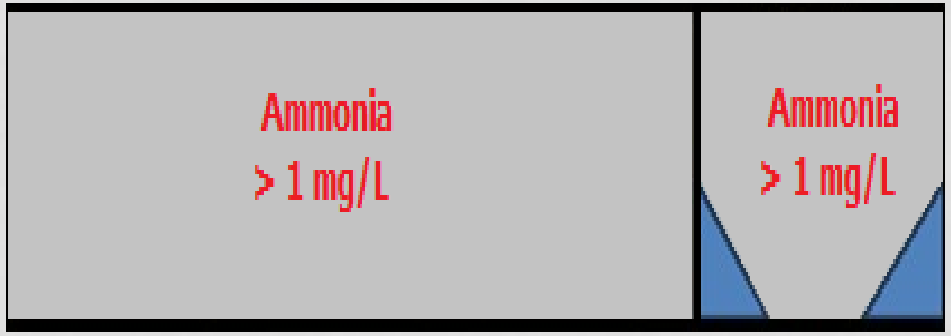


- Conversion Process
  - CBOD & NH3
- Ammonia Indicator
  - "sensitive"
    - Early warning
  - < 1 mg/L NH3
    - Conversion Complete
  - > 1 mg/L
    - Conversion problem

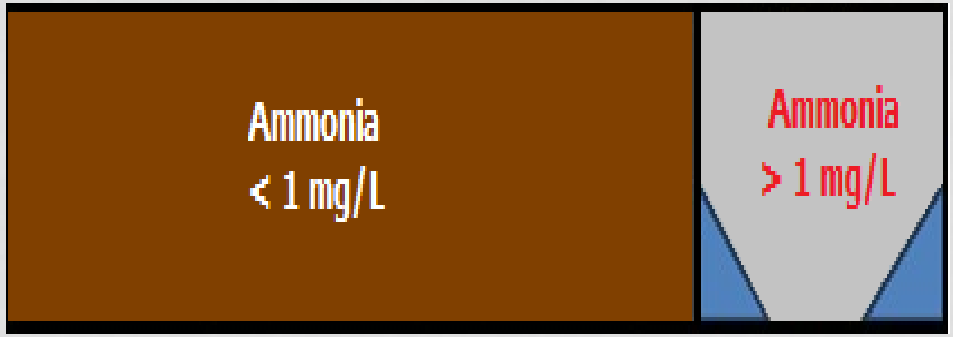
BOX # 1 CLARIFIER EFFLUENT: AMMONIA < 1 MG/L



BOX # 2 **AERATION EFFLUENT: AMMONIA < 1 MG/L**



- Aeration Effluent
  - Problem: Conversion
  - Location: Aeration



- Clarifier Effluent
  - Problem: Re-release
  - Location: Clarifier

BOX # 4

CLARIFIER:
SOLIDS BREAKING DOWN IN CLARIFIER

- Sources:
  - Scum Baffle
  - Clarifier Surface
  - Clarifier Sludge Blanket

BOX # 4

CLARIFIER:
SOLIDS BREAKING DOWN IN CLARIFIER

- Sources:
  - Scum Baffle
  - Clarifier Surface
  - Clarifier Sludge Blanket

BOX # 4

CLARIFIER:
SOLIDS BREAKING DOWN IN CLARIFIER

- Sources:
  - Scum Baffle
  - Clarifier Surface
  - Clarifier Sludge Blanket

BOX # 4

CLARIFIER:
SOLIDS BREAKING DOWN IN CLARIFIER

Sources:

- Scum Baffle
- Clarifier Surface
- Clarifier Sludge Blanket

BOX # 4

CLARIFIER:
SOLIDS BREAKING DOWN IN CLARIFIER

Sources:

- Scum Baffle
- Clarifier Surface
- Clarifier Sludge Blanket

BOX # 3

AERATION EFFLUENT: WATER TEMPERATURE < 10 C

- WATER temperature impacts growth rate
  - slower growth = slower removal rates
- Measure AT effluent water temperature

BOX # 3

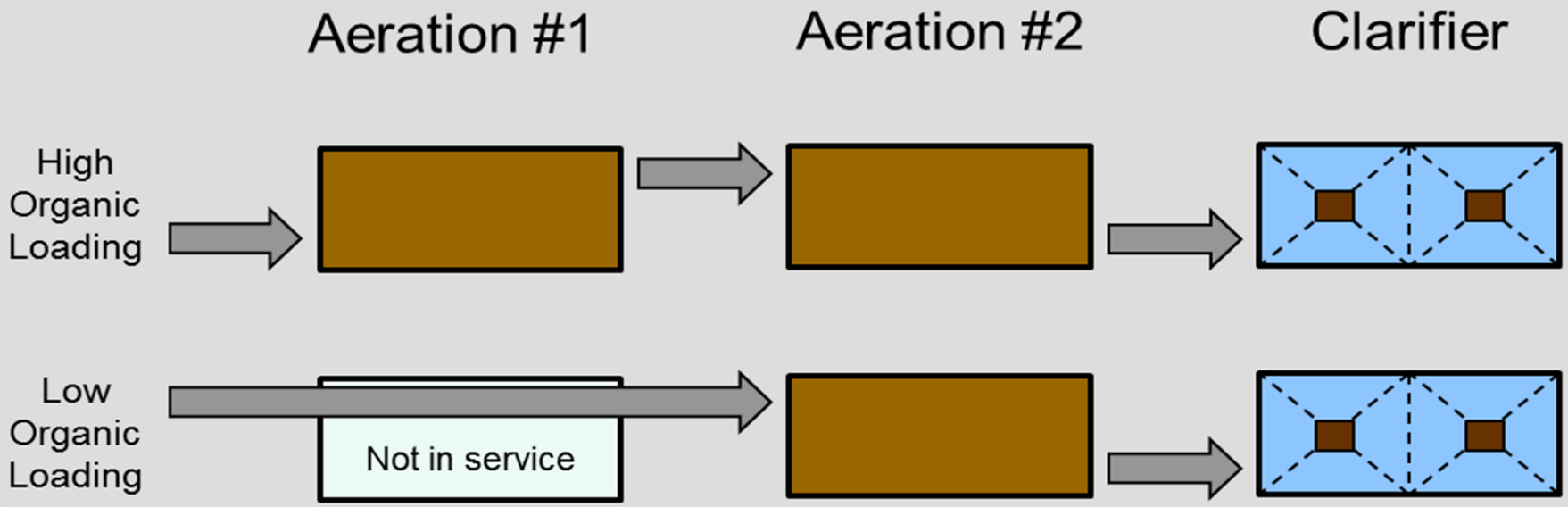
AERATION EFFLUENT: WATER TEMPERATURE < 10 C

- WATER temperature impacts growth rate
  - slower growth = slower removal rates
- Measure AT effluent water temperature

BOX # 6

AERATION:
DECREASE HEAT LOSS OF AERATION TANK

- Reduce Heat Loss
  - Aeration Capacity



BOX # 6

AERATION:
DECREASE HEAT LOSS OF AERATION TANK

- Reduce Heat Loss
  - Aeration Capacity
  - Reduce Blower Timers
    - Match supply to load
  - Reduce Loss
    - Cover AT, EQ, clarifiers

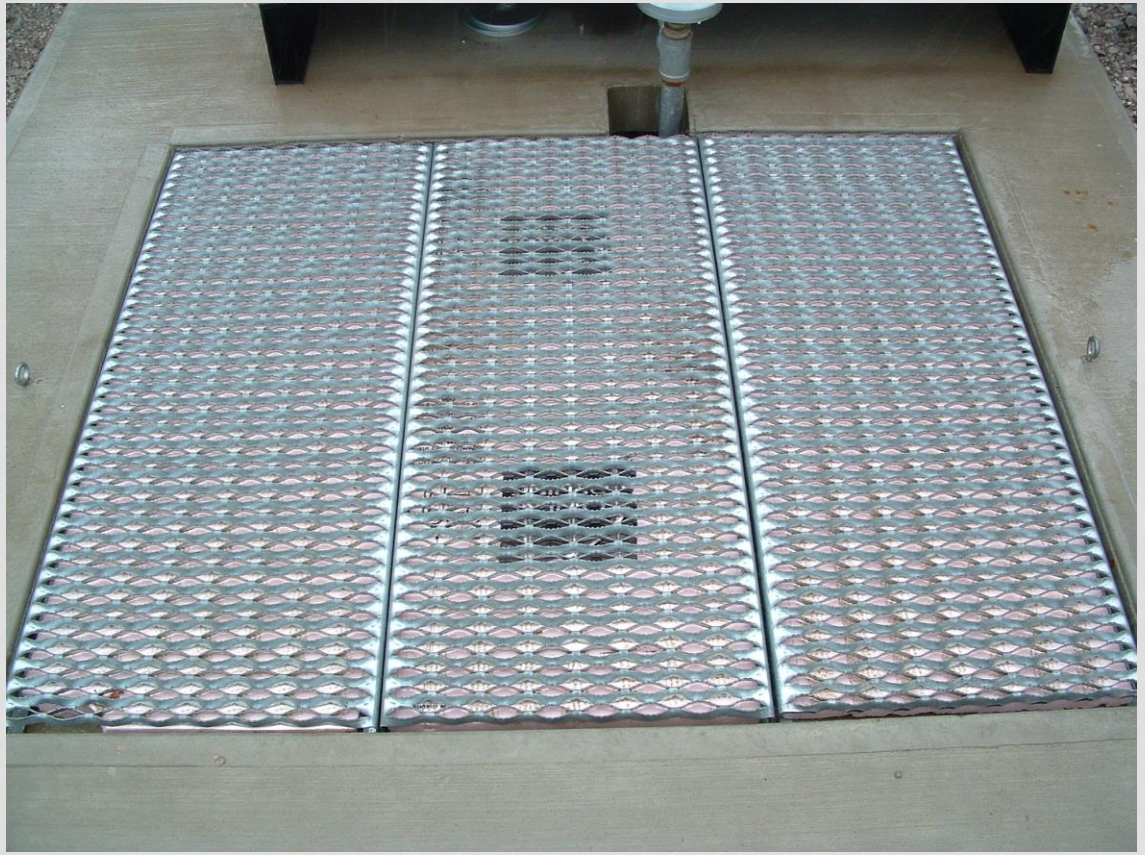
BOX # 6

AERATION:
DECREASE HEAT LOSS OF AERATION TANK

- Reduce Heat Loss
  - Aeration Capacity
  - Reduce Blower Timers
    - Match supply to load
  - Reduce Loss
    - Cover AT, EQ, clarifiers

BOX # 6

AERATION:
DECREASE HEAT LOSS OF AERATION TANK



BOX # 5

AERATION EFFLUENT:
TOTAL ALKALINITY < 100 MG/L

- Nitrification
  - Consumes alkalinity
    - 7.14 mg/L alkalinity
  - No Alkalinity,
    No Buffer
  - pH "post mortem"
    - Drops like a rock

BOX # 5

AERATION EFFLUENT:
TOTAL ALKALINITY < 100 MG/L

- Nitrification
- Consumes alkalinity
  - 7.14 mg/L alkalinity
- No Alkalinity,
  No Buffer
- pH "post mortem"
  - Drops like a rock

BOX # 5

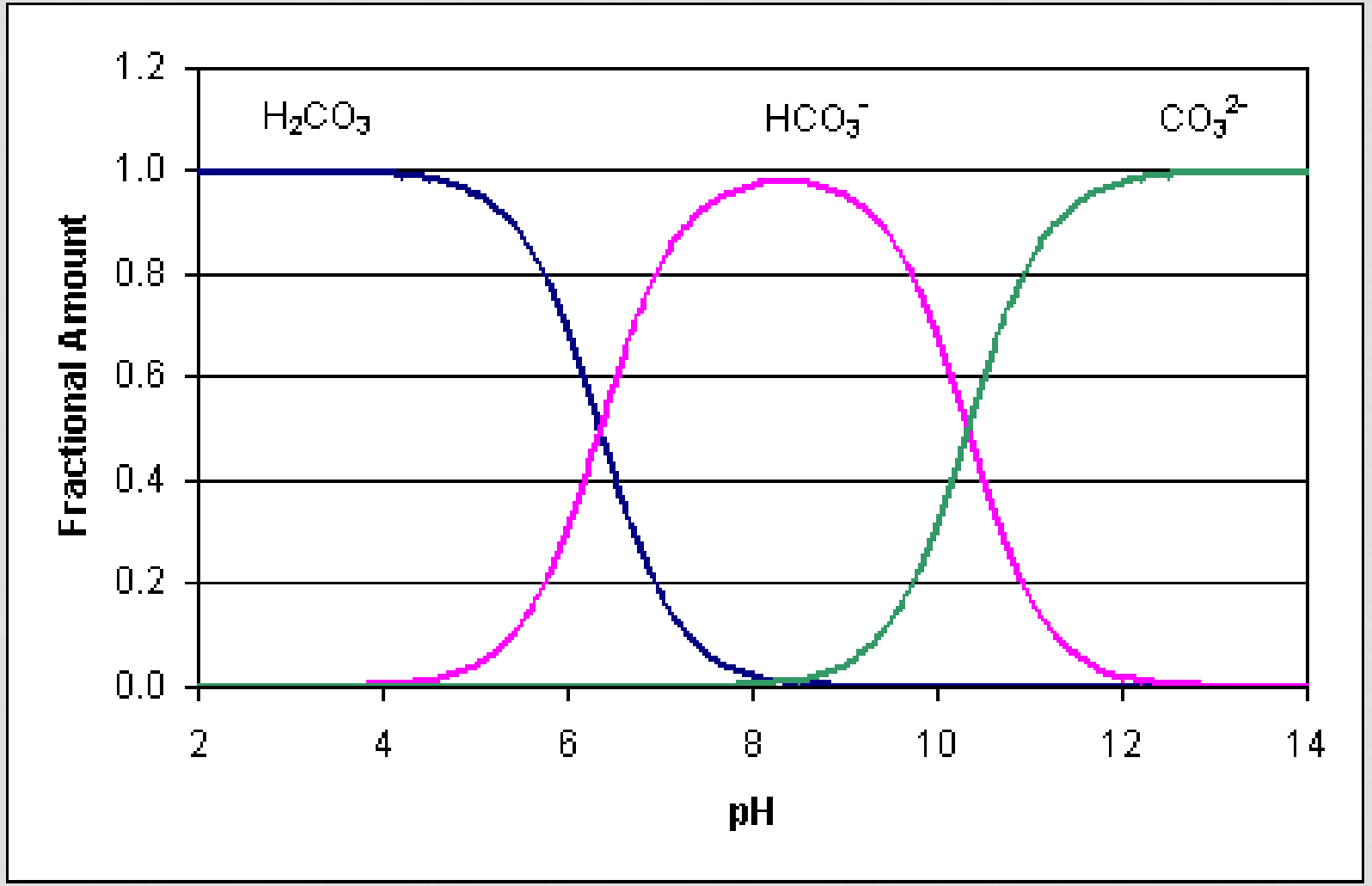
AERATION EFFLUENT: TOTAL ALKALINITY < 100 MG/L

- Nitrification

- Consumes alkalinity
  - 7.14 mg/L alkalinity
- No Alkalinity, No Buffer
- pH "post mortem"
  - Drops like a rock

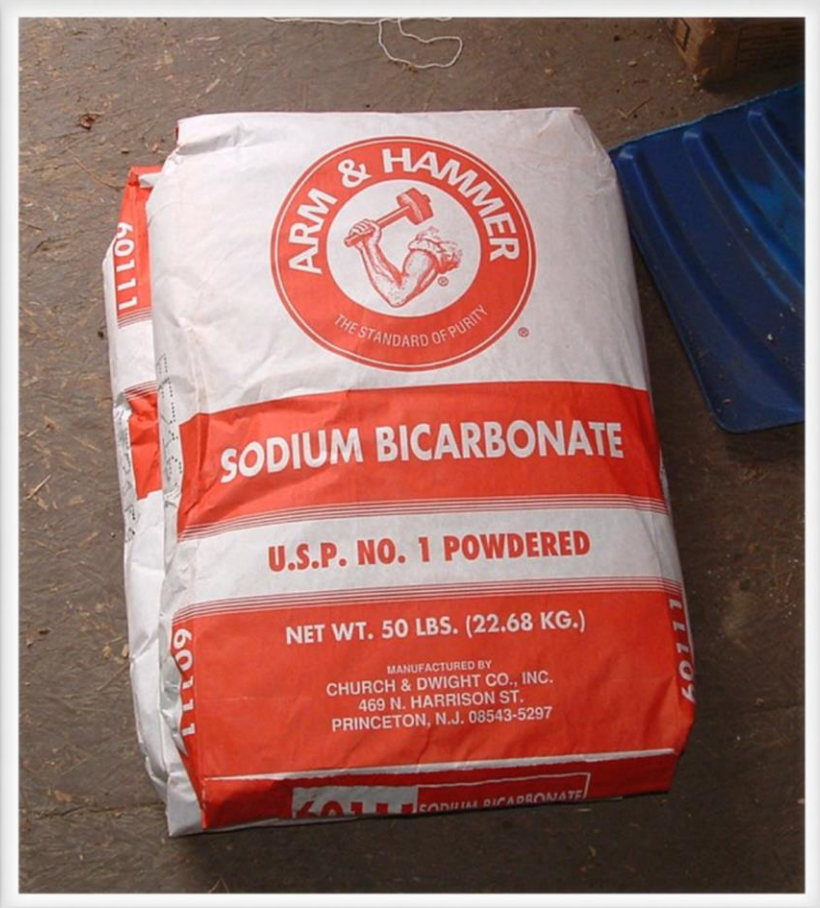
BOX # 5

AERATION EFFLUENT:
TOTAL ALKALINITY < 100 MG/L



BOX # 8

AERATION:
INCREASE ALKALINITY IN AERATION TANK

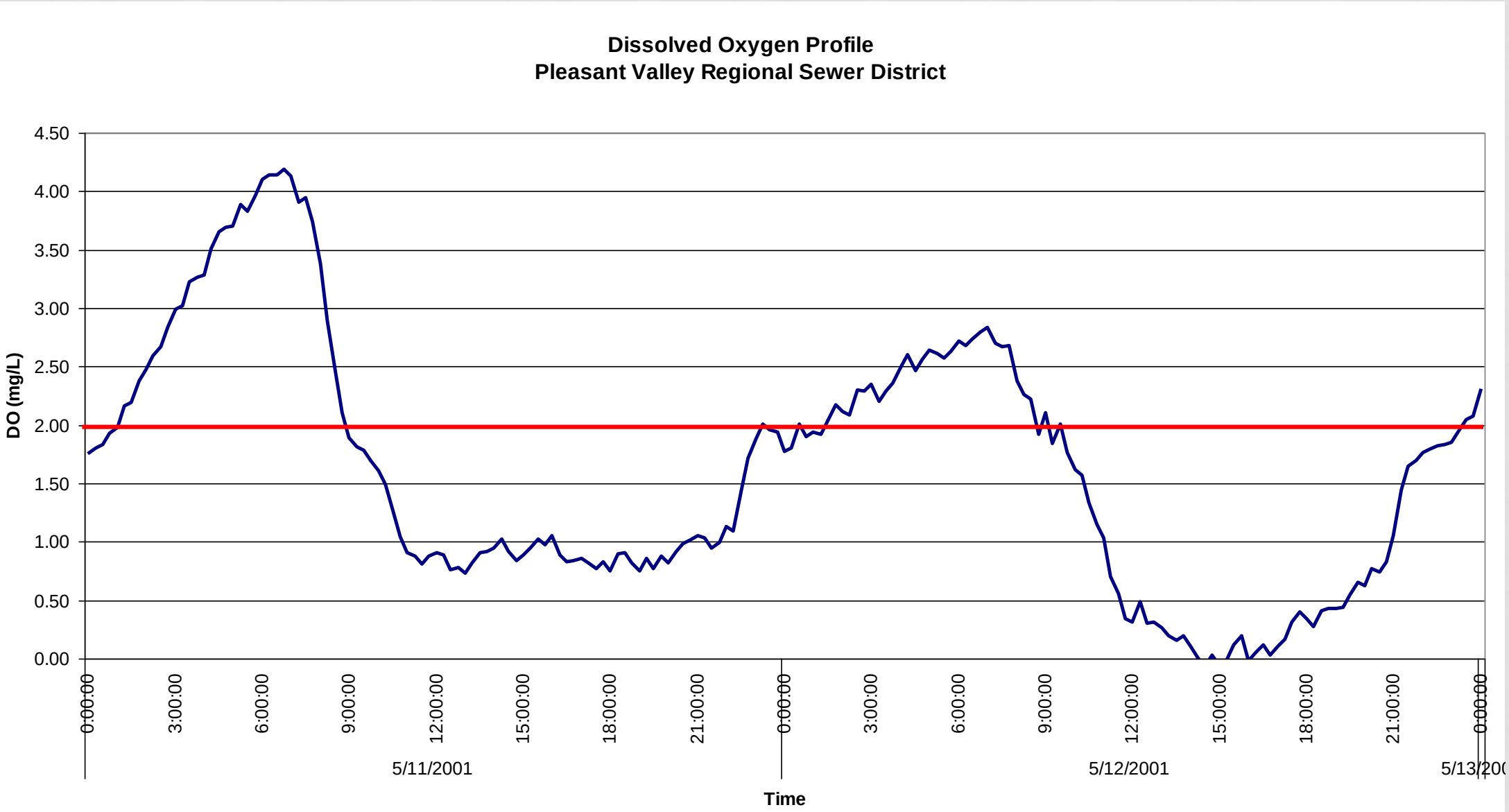


- Bicarb is best for an upset reactor
  - Safer to use in AT
  - Safer to use by operator
- Measure and know
  - Need 100 mg/L residual AND NH3 < 1 mg/L in AT

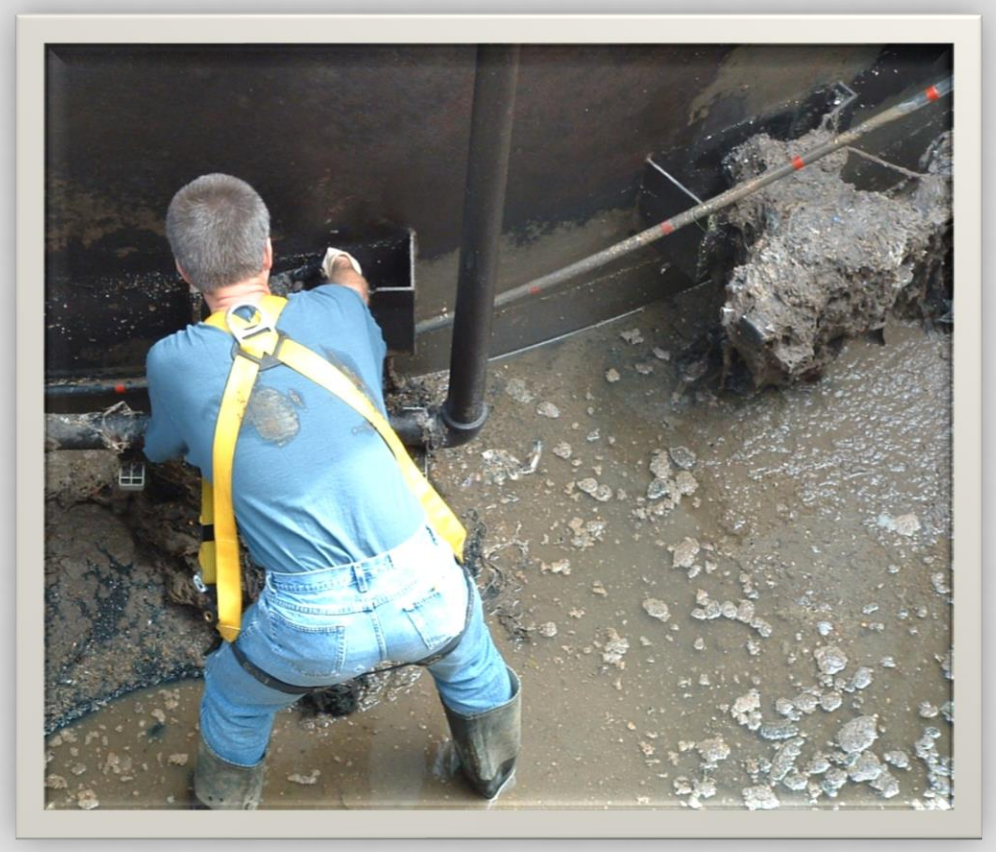
BOX # 7

AERATION EFFLUENT:
DISSOLVED OXYGEN < 2 MG/L

- DO Concentration
  - Aeration Tank Effluent
  - Photo vs Video
  - Multiple tanks
    - Parallel = equal value
    - Series = increasing value

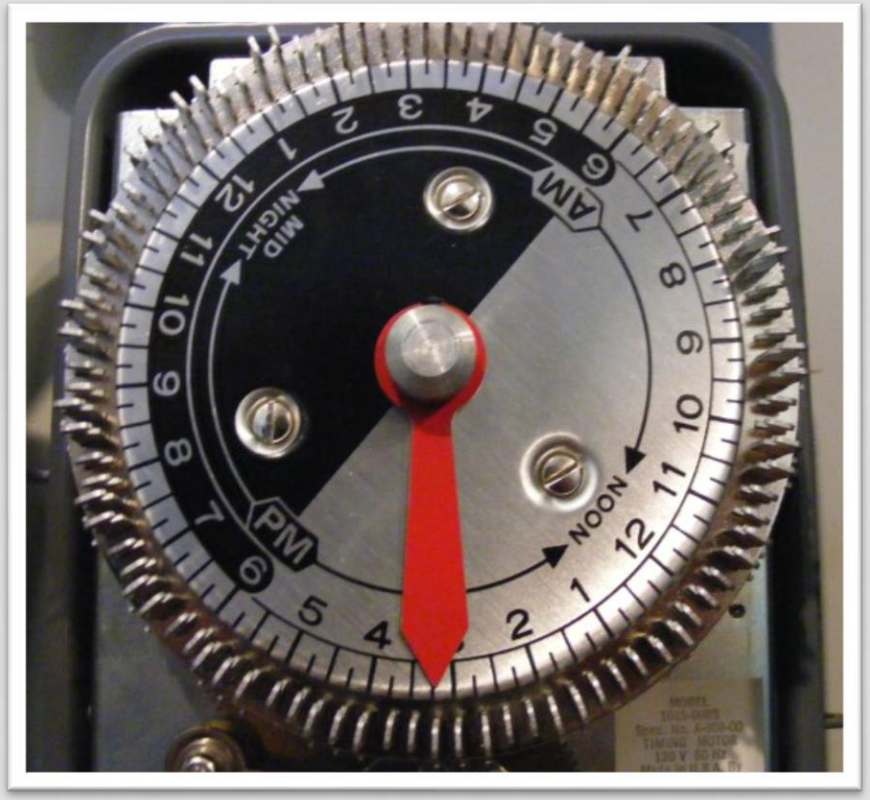

Dissolved Oxygen Profile
Pleasant Valley Regional Sewer District
DO (mg/L)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00:00
3:00:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
0:00:00
3:00:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
0:00:00
5/11/2001
5/12/2001
5/13/200
Time

BOX # 10 AERATION: INCREASE AIR SUPPLY IN AERATION TANK



- Operational Issue
  - Blower run time
  - System Loading
- Mechanical Issue
  - Blower
  - Motor
  - Air Distribution

BOX # 10 **AERATION: INCREASE AIR SUPPLY IN AERATION TANK**



- Operational Issue
  - Blower run time
  - System Loading
- Mechanical Issue
  - Blower
  - Motor
  - Air Distribution

BOX # 9 **AERATION EFFLUENT: CENTRIFUGE SPIN < 4%**

- Need bacteria in AT to convert NH3
  - Hiding in clarifier?
- Estimate amount in 15 minutes
- Typical range 2-4% by volume

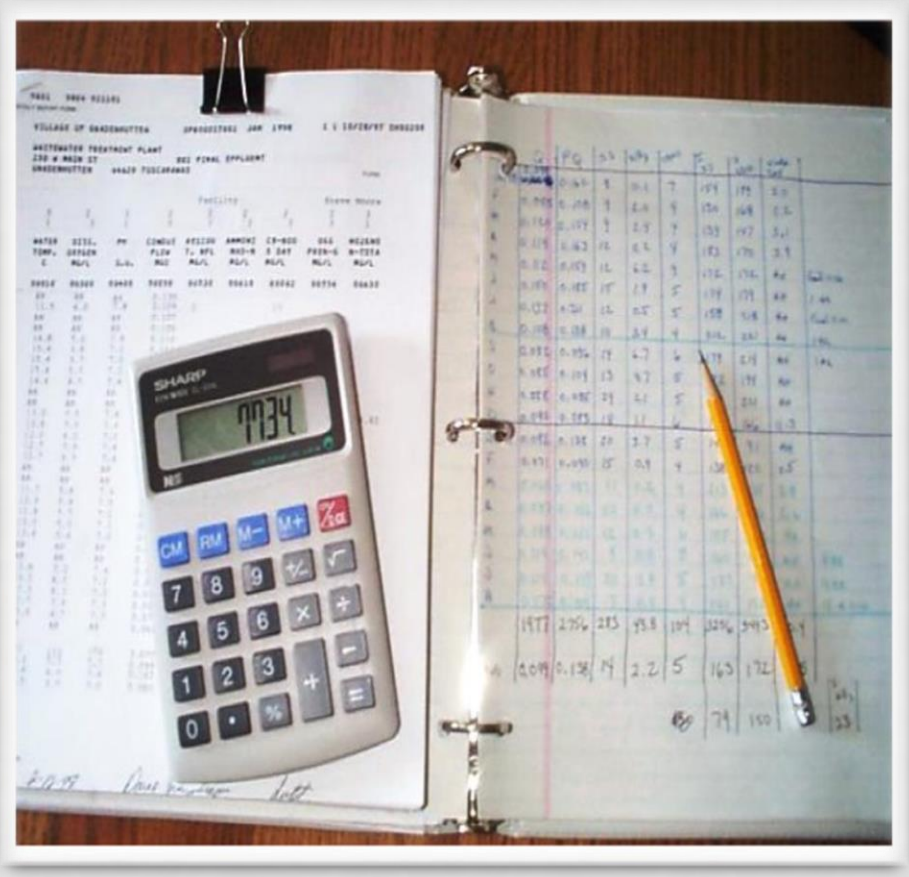
BOX # 9 **AERATION EFFLUENT: CENTRIFUGE SPIN < 4%**

- Need bacteria in AT to convert NH3
  - Hiding in clarifier?
- Estimate amount in 15 minutes
- Typical range 2-4% by volume

BOX # 12 AERATION: INCREASE BIOMASS IN AERATION TANK

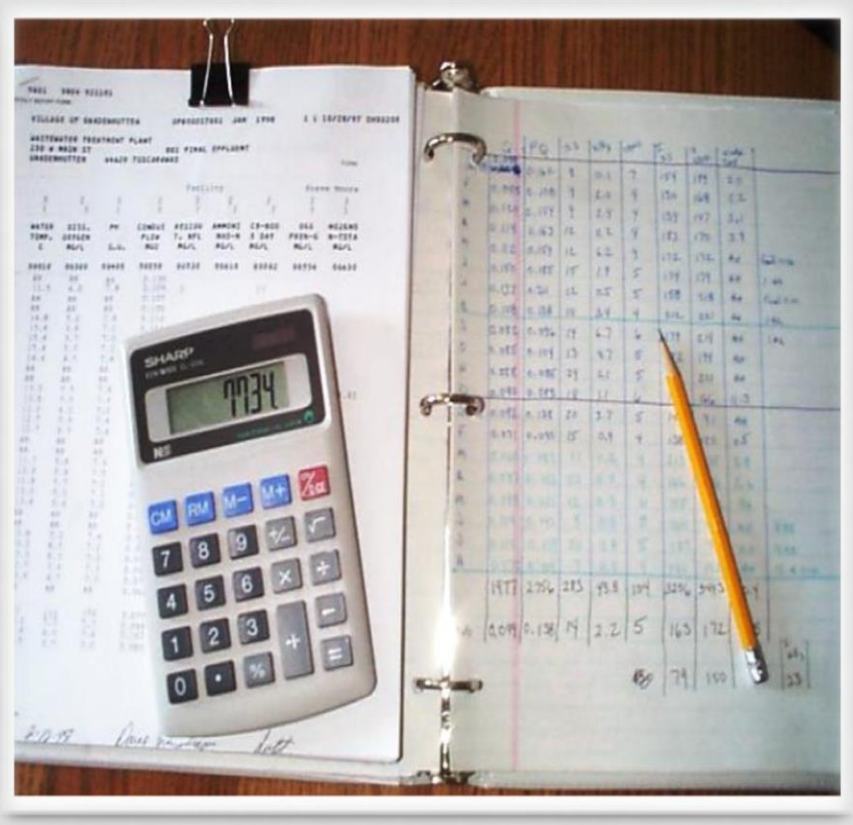
- Aeration Tank
  - 2% to 4% concentration
  - Decrease wasting to increase biomass
  - Colder temps require more biomass
  - Increased loadings require more mass

BOX # 11 **ORGANIC LOADING RATE: LOADING > DESIGN**



- **lbs./day/1,000 ft^3**
- (BOD)(MGD)(8.34)
- $\frac{\text{(length x width x wd)}}{\text{1,000 ft}^3}$
- <15 lbs./d/1,000 ft^3

BOX # 11 **ORGANIC LOADING RATE: LOADING > DESIGN**



Typical Design
15 lbs./d/1,000 ft^3

- lbs./day/1,000 ft^3

AT Dimensions
=2[56'x 12'x 15' w.d.}

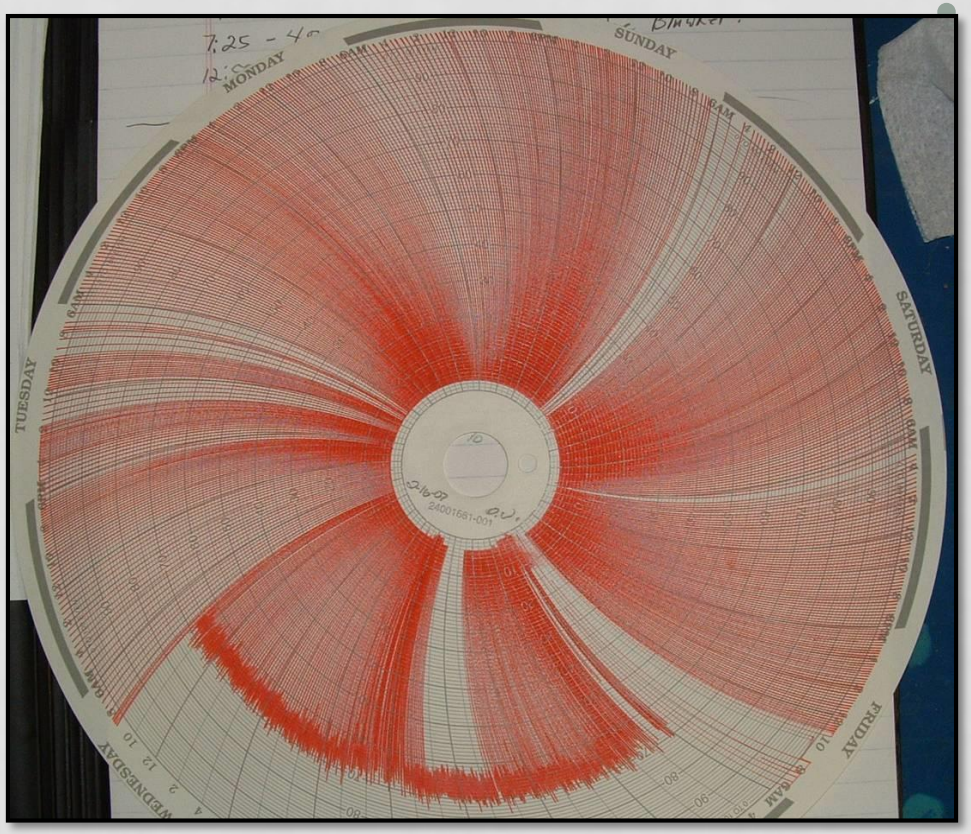
AT Environment
= 0.135 MGD
= 218 mg/L BOD_5

lbs./day/BOD
= 8.34 x 0.135 MGD x 218 mg/L
= 245 lbs./d/ BOD_5

1,000ft3
= (2x56x12x15)/1,000
= 20.1 AT capacity in 1,000 ft^3

lbs./d/1,000 ft^3
= 245/20.1
= 12.2 lbs./d/1,000 ft^3

BOX # 14 CAPACITY: INCREASE CAPACITY OR DECREASE LOADING



- Equalize Flows
  - Avg. Daily Flow vs. Pumping Rate
  - Flow EQ Design
  - Evidence of Problem
    - "the block"
- Add more capacity

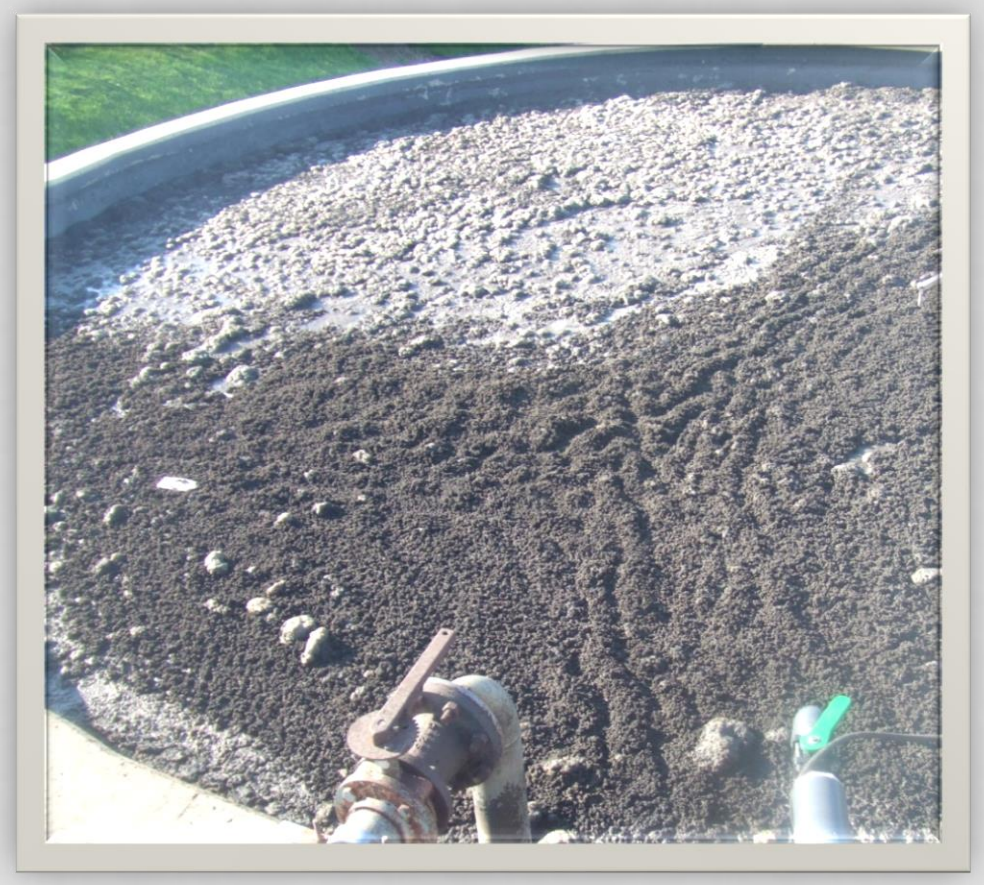
BOX # 14 CAPACITY: INCREASE CAPACITY OR DECREASE LOADING

- Equalize Flows
  - Avg. Daily Flow vs. Pumping Rate
  - Flow EQ Design
  - Evidence of Problem
    - "the block"
- Add more capacity

BOX # 14 CAPACITY: INCREASE CAPACITY OR DECREASE LOADING

- Equalize Flows
  - Avg. Daily Flow vs. Pumping Rate
  - Flow EQ Design
  - Evidence of Problem
    - "the block"
- Add more capacity

BOX # 13 AERATION: EVALUATE FOR TOXIC ISSUES.

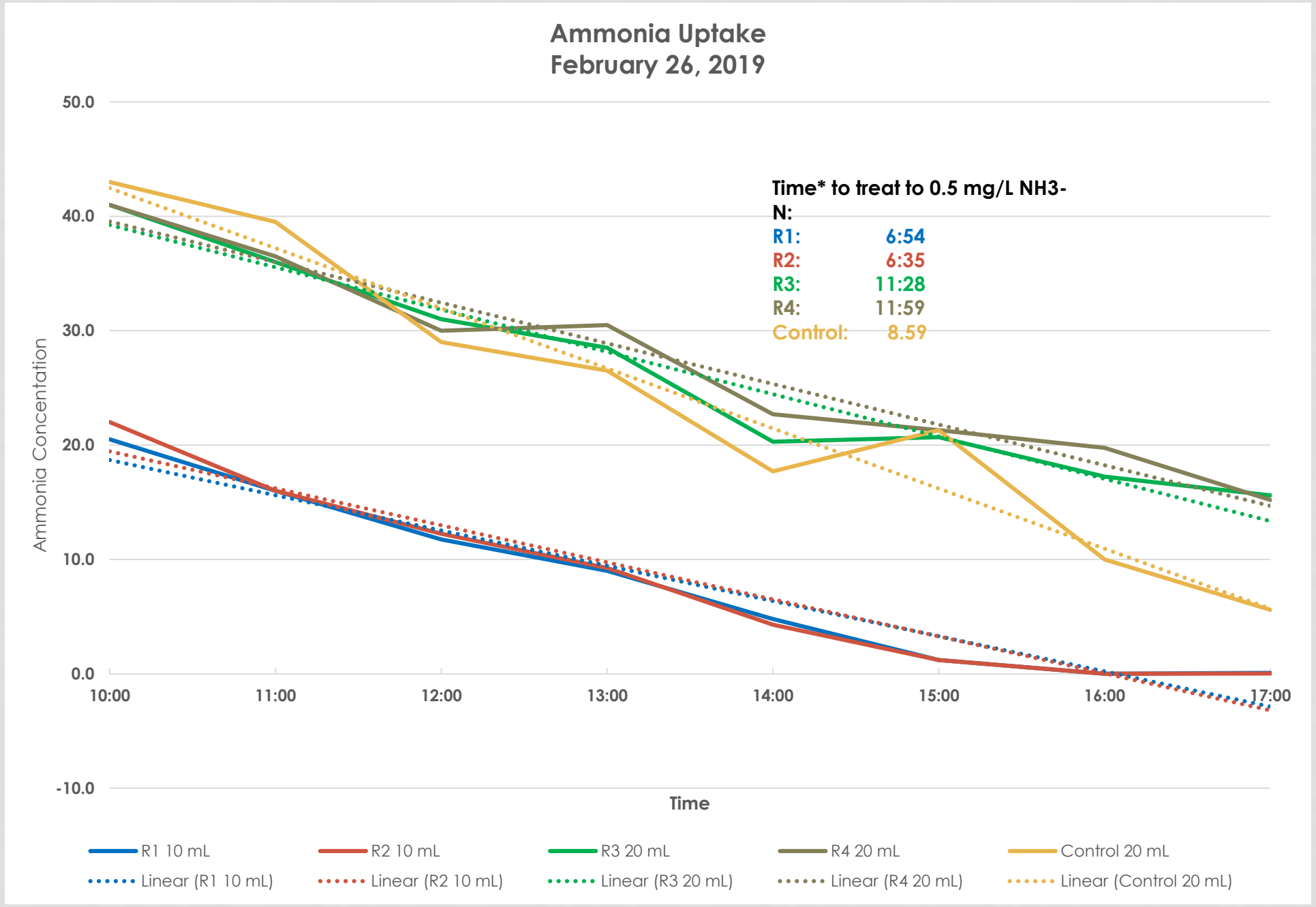


- Common sources
  - Internal
  - Digester Supernatant
  - Other side streams
- Other sources
  - External
  - Force Mains
  - Septage Receiving
  - Color, corrosion, odor

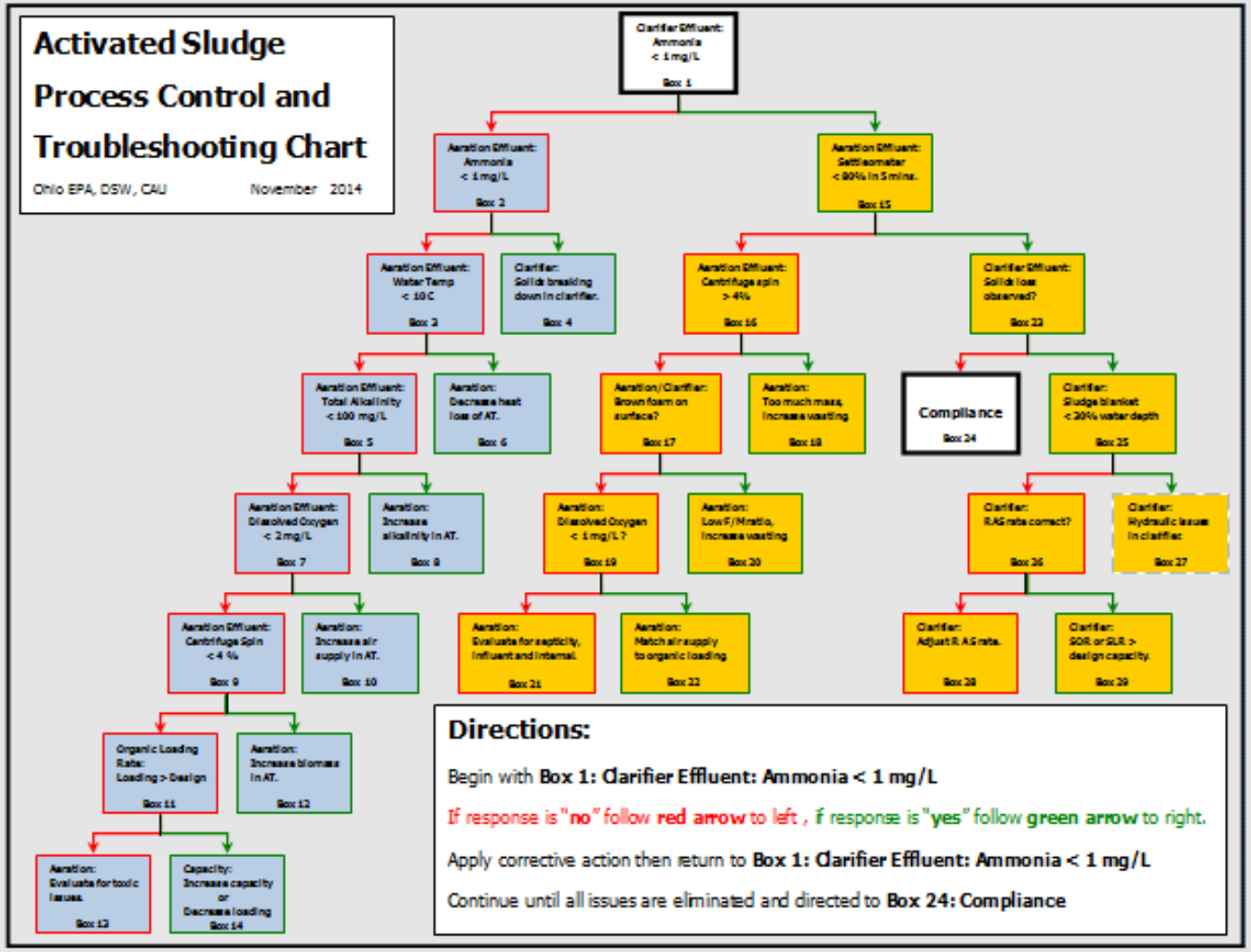
BOX # 13 AERATION: EVALUATE FOR TOXIC ISSUES.

- Common sources
  - Internal
  - Digester Supernatant
  - Other side streams
- Other sources
  - External
  - Force Mains
  - Septage Receiving
  - Color, corrosion, odor


8.2
26.4
ThermoOrion
500 mL
2
3
4


Ammonia Uptake
February 26, 2019
Time* to treat to 0.5 mg/L NH3-N:
R1: 6:54
R2: 6:35
R3: 11:28
R4: 11:59
Control: 8.59
Ammonia Concentation
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
Time
R1 10 mL
R2 10 mL
R3 20 mL
R4 20 mL
Control 20 mL
Linear (R1 10 mL)
Linear (R2 10 mL)
Linear (R3 20 mL)
Linear (R4 20 mL)
Linear (Control 20 mL)

ACTIVATED SLUDGE PROCESS CONTROL



http://epa.ohio.gov

Divisions and Offices

Environmental and Financial Assistance

Wastewater Treatment Plants:

Get Free Technical Assistance to Improve Compliance

Technical Resources

Activated Sludge Process Control and Troubleshooting Chart and Manual

Or email me at: jon.vandommelen@epa.ohio.gov