

Operation – Minute by Minute Bio-Augmentation

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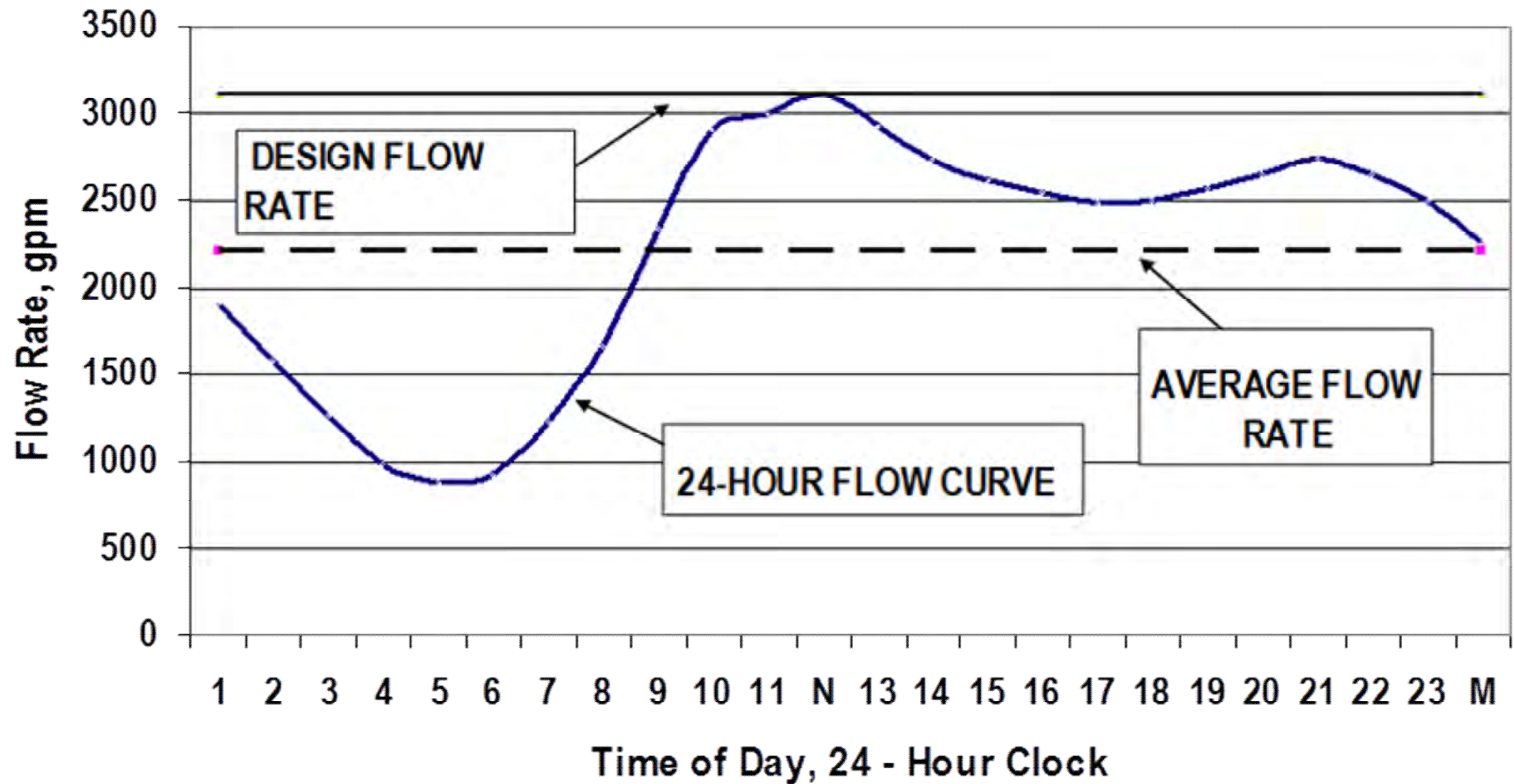
What We Are Going to Cover Today

- What the Wastewater Treatment Plant is doing on a minute by minute basis.
- Why the Wastewater Treatment Plant is doing what is doing on a minute by minute basis.
- Operational Strategies to deal with the minute by minute changes.
- Give Industry an idea what times are better than other depending on the parameters of the their discharge.

The Ultimate Goal

- Energy Savings
- Chemical Savings
- Easy of Operation!!
 - Lets make life more simple on a daily basis

Diurnal Flow Curve



What's So Important

Carbon - BOD

Carbon - BOD

Carbon - BOD

COMPOSITION OF BACTERIAL CELLS

Parameter	%
Carbon	50
Oxygen	22
Nitrogen	12
Hydrogen	9
Phosphorus	2
Sulfur	1
Potassium	1
Sodium	1
Trace compounds	2

Biggest Problem(s) in Wastewater

- Too Little Carbon
- Too Much Aeration

Carbon-Nitrogen-Phosphorus

- 100 Carbon
- 5 Nitrogen
- 1 Phosphorus

Plant Loadings - Low

Kentucky Plant

Influent BOD = 50 – 80 mg/l

Influent TSS = 80 mg/l

Influent Ammonia = 12 – 15 mg/l

Influent Phosphorus = 3 – 5 mg/l

Plant Loadings - Low

Kentucky Plant

Effluent BOD = 2 mg/l

Effluent TSS = 2 mg/l

Effluent Ammonia = 0.5 mg/l

Effluent Phosphorus = 3 – 5 mg/l

Plant Loading – Medium to Heavy

Central Ohio Plant

Influent BOD = 200+ mg/l

Influent TSS = 200+ mg/l

Influent Ammonia = 20 – 30 mg/l

Influent Phosphorus = 9 mg/l

Plant Loading – Medium to Heavy

Central Ohio

Effluent BOD = 5 mg/l

Effluent TSS = 5 mg/l

Effluent Ammonia = 0.3 – 0.5 mg/l

Effluent Phosphorus = 1.5 mg/l (no chemicals)

Assimilation

- When the nutrients such as Ammonia and Phosphorus are taken up by the bacteria cells.
(also called carbon uptake)

Versus

- Nitrification – Ammonium is reduced to nitrites and nitrates by nitrifying bacteria.

Nitrifying bacteria as a component of MLVSS

- MLVSS or bacterial population
- Nitrifying bacteria approximately 10%
- Organotrophic bacteria approximately 90%

(An organotroph is an organism that obtains hydrogen or electrons from organic substrates.)

(Have you ever heard of the Anderson River Fish Kill)

Consider this;

What happens if you have a low MLVSS?

- You will have to rely on nitrifiers
 - Which are 10% of the bacterial population

What's the Moral of the Story

- Don't be stupid when enforcing Sewer Use Ordinances
- Have to find ways to save on the limited amount of BOD
- Use it (BOD) wisely in the wastewater plant

Sewer Use Ordinances

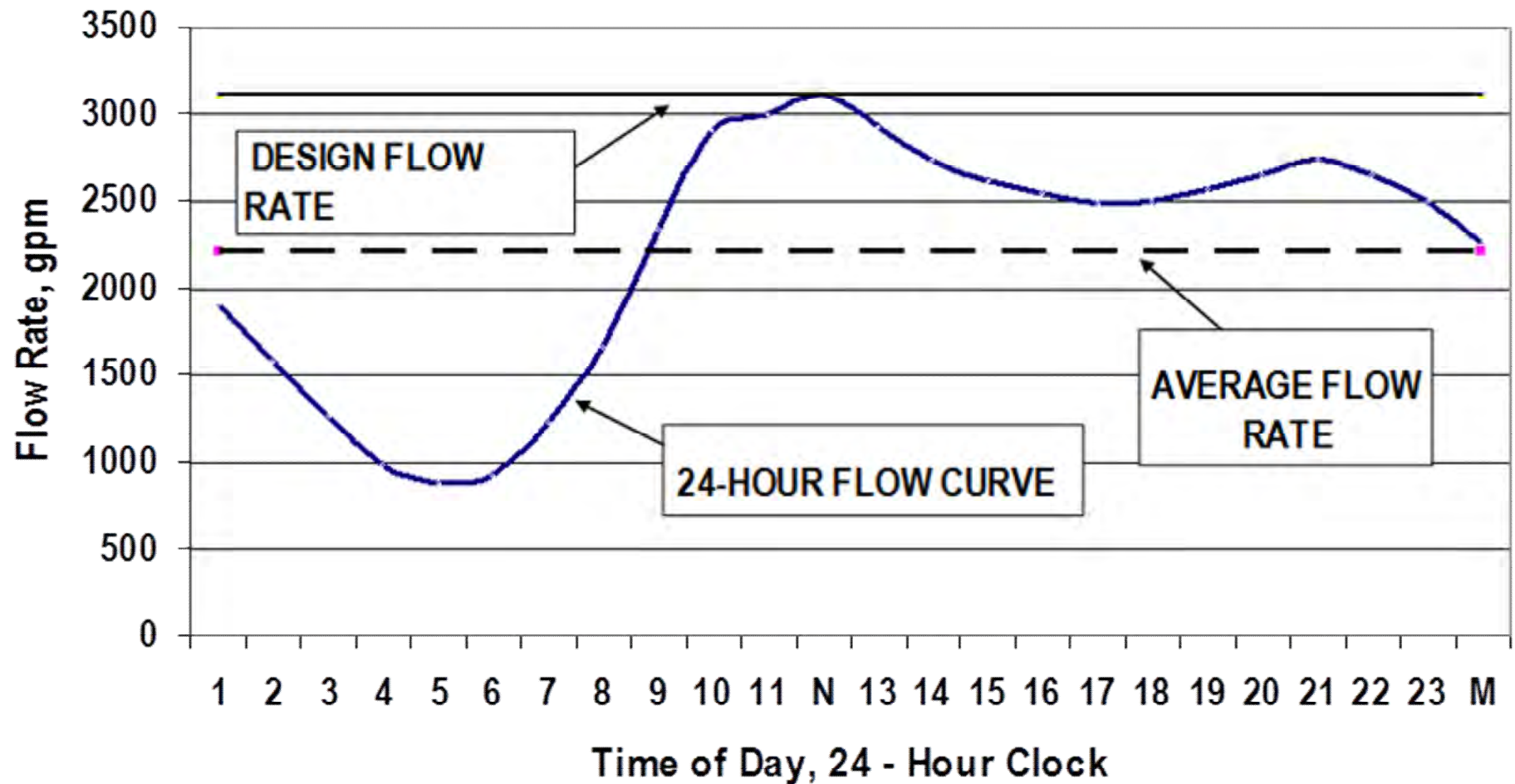
- Should we limit by ordinance the amount of BOD a SIU (significant industrial user) can send to the treatment plant.

Yes - No

Let's Set Limits

- 250 mg/l and Over is surcharged (CYA)
- 1000 mg/l is a violation Or not (CYA)
- What if you have a waste that is 15,000 BOD?

Diurnal Flow Curve



Ammonia

- We need 5 minimum at the plant
 - I like 10 to 15 ppm

Why?

- Get better solids removal.

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Sewer Use Ordinance - Ammonia

- Set Limit at 50 ppm – (CYA)
- Set Violation at 100 ppm (CYA)
 - If possible make it to where you let them go and take the money.
- Leachates?

Ammonia Caution

- It takes 1.55 pounds of oxygen to oxidize one pound of BOD
- It takes 4.6 pounds of oxygen to oxidize one pound of Ammonia
- It takes 6.5 pounds of oxygen to oxidize one pound of Urea or NH_2

Operation Minute by Minute

Lets divide the treatment plant into time zones

- Zone 1 – 5:30am to 10:00am
- Zone 2 – 10:00am to 4:00pm
- Zone 3 – 4:00pm to 10:30pm
- Zone 4 – 10:30pm to 5:30am

Zone 1 – 5:30am to 10:00am

- BOD Loading is highest of the day – Why
 - Everybody is starting their day at the same time!
- Ammonia is lowest of the day – Why
 - A lot of organic waste is assimilating it.
- Phosphorus is lowest – Why
 - A lot of organic waste is assimilating it.

Zone 1

- Most Operators don't see the transition from Zone 4 to Zone 1.

What happens to the Treatment Process – Zone 1

- Dissolved Oxygen goes down
- ORP (Oxidation Reduction Potential) goes down
- pH will drop
- TSS will increase

Dissolved Oxygen/ORP

- Dissolved Oxygen readings stink
- ORP is the only way to monitor

Dissolved Oxygen VS ORP

- Dissolved Oxygen is very temperature dependent
 - In the winter, DO may read artificially high
 - ORP will not

Algae will give you a false DO and ORP reading

(Winkler test will confirm)

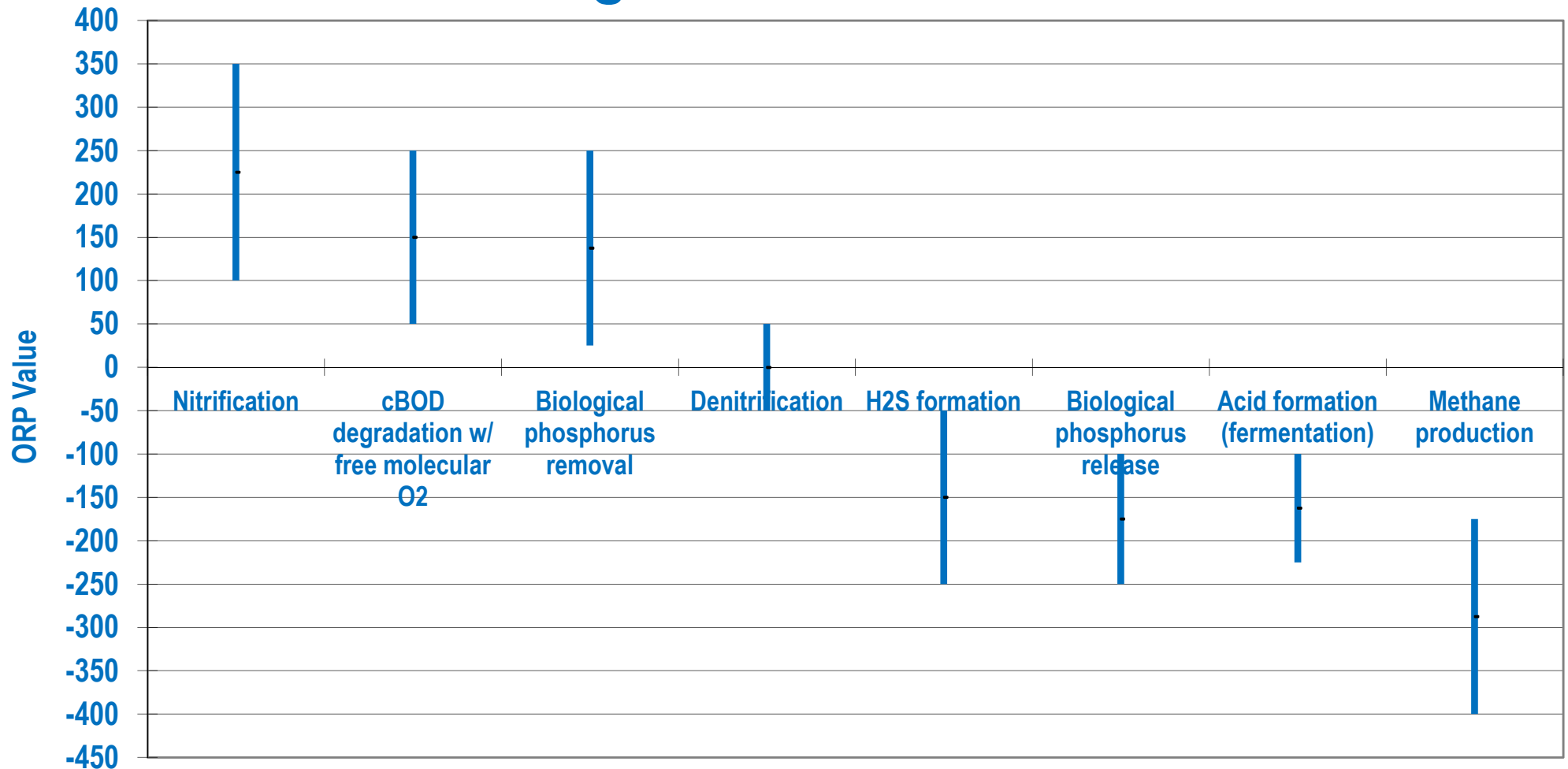
ORP

Oxidation Reduction Potential

(MV – Like on a pH meter)

(Tell whether or not the water is oxidized)

Range of ORP Values



ORP Actuals

Biochemical Reaction	ORP (Mv)
Nit	+100 to +135
cBOD oxidation	+50 to +80
Biological P uptake	+100 to +150
De-nit	+50 to -100
Sulfate reduction	-50 to -250
Biological P release	-150 to -250
Acid formation	-100 to -175
Methane production	-300 to -400

Oxidation Reduction Potential

- Tells you precisely where the wastewater process tank is operating at.
- Tells you when to stop aerating and when to increase aeration
- Tells you when nitrification is complete
- Tells you when carbonaceous is complete
- Tells you when phosphorus uptake has occurred.

ORP – Main Reason

- Don't go to far after the waste is treated –
Why
 - Burn up nutrients
 - Burn up trace minerals
 - Rupture the cells – Basil Respirometry

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Zone 1 - TSS

- TSS will increase
 - Due to higher organic loading converted to TSS

Zone 1 - pH

- pH will drop in Zone 1
 - Higher BOD will drop the pH

Carbon – Nitrogen - Phosphorus

- 100 Carbon (PH Low)
- 5 Nitrogen (pH High)
- 1 Phosphorus (pH Slightly higher)

Zone 2 – 10:00am to 4:00pm

- Lunch Load
 - BOD coming down
 - TSS maintains
 - ORP is coming up
 - pH is coming up

Not everybody is on the same clock at Zone 2.

Zone 2 – Operational Strategy

- May need to turn aerators down or off
 - Make sure the design of a new system is good for aeration control
- Wasting will be less
- Turn up chemicals for phosphorus removal
 - Less assimilation
- Grab Sampling

Zone 3 – 4:00pm to 10:30pm

- ORP will probably go down some
 - It will take short ups and downs – Why?
- TSS will remain steady to climbing
- pH will stay steady to falling slightly

(nobody has the same schedule)

Zone 3 – Operational Strategy

- Zone 3 will resemble Zone 1 in that the loading will be higher, but not that high.
- Aeration will have to be monitored closely
 - BOD loading will fluctuate wildly
 - Automatic controls will have to be installed
 - Nobody at the plant
- Phosphorus precipitation chemical monitored with automatic controls.

Zone 4 – 10:30am to 5:30am

- BOD is nothing
 - The sidewalks are rolled up
- pH will raise during the night
- TSS will fall sharply
- Aeration will need to be almost completely turned off.

(Kentucky Plant Lessons)

Zone 4 – Operational Strategy

- Phosphorus removal will be almost all chemical dependent
- Aeration will need to be almost completely turned off.

Zone 4 – The Damage

- Over Aeration will kill a plant in Zone 4
 - Trace and micro nutrients will be used up with no loading
 - Bacteria cells will be damaged due to over aeration
 - You will get massive sludge production

Continuous Monitoring and Control

- It allows the operator more control than meets the eye
- Saves on electricity
- Saves on Chemical Cost
- Reduces the amount of sludge being produced
- Makes life easier
- YOU WILL KNOW





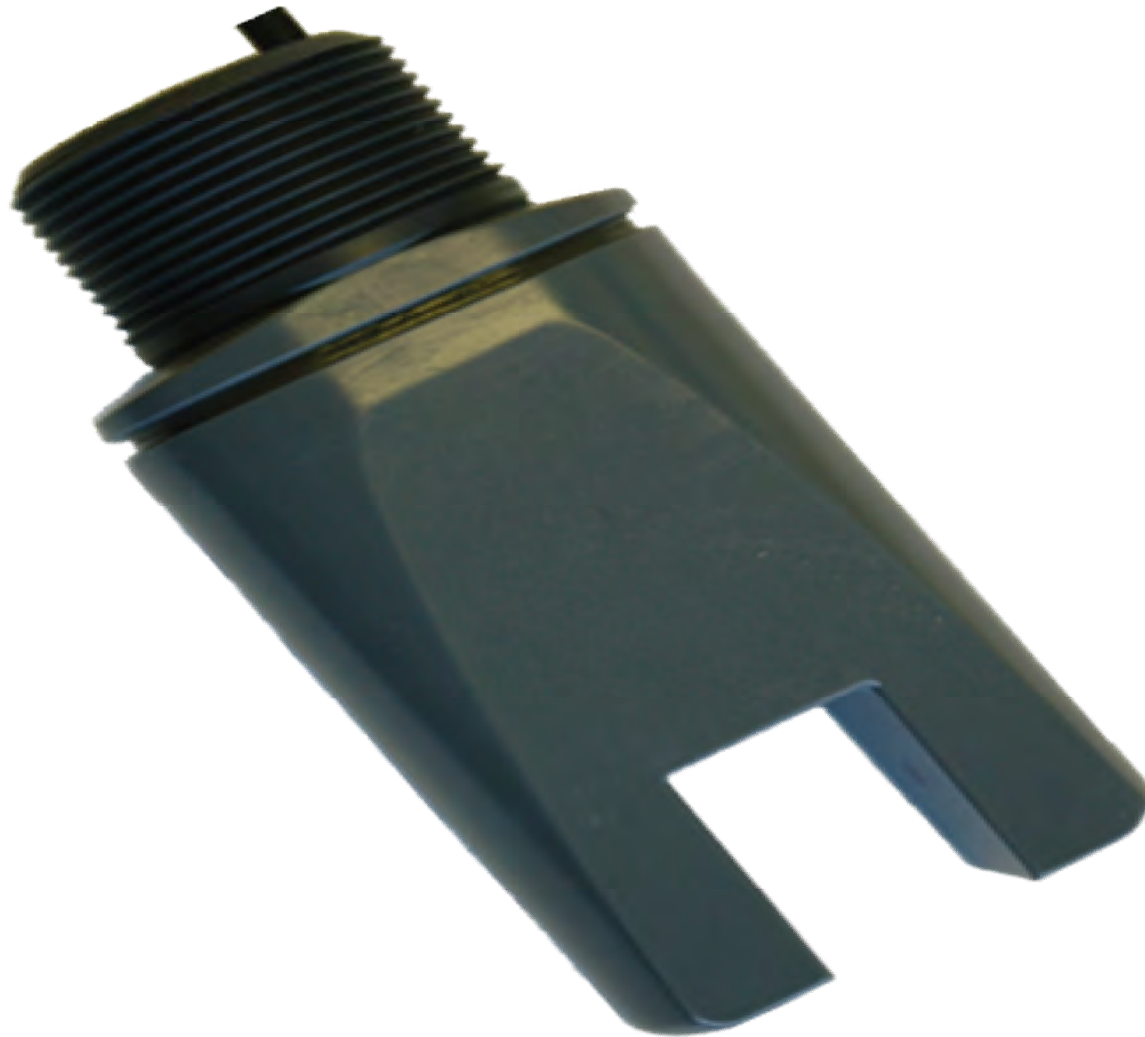
pH/ORP Sensor



TSS Sensor – High Range



TSS Sensor – Low Range



DO Sensor

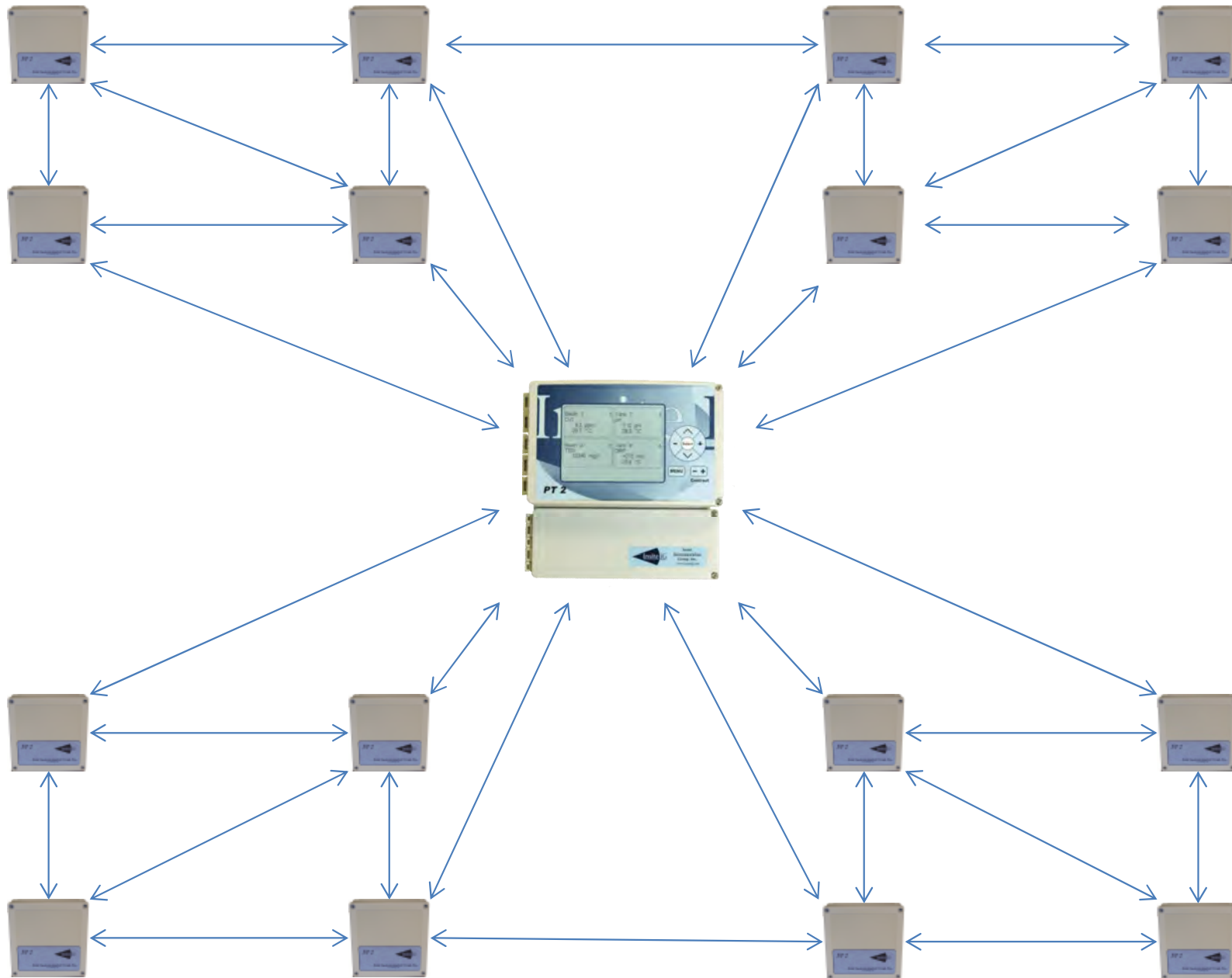




Wireless Communication

- Wireless communication allows:
- Reduction in installation cost
- Conduit can cost \$10 a foot to run
- One 200 foot run can cost up to \$2K
- Maximum flexibility
- Sensor placement based on process requirements, not wiring limitations
- Moving a sensor is quick and easy

Self-Healing Wireless Mesh Network



Aeration

- What kind of aeration do you have?
 - Oxidation Ditch
 - Vertical Loop Reactor
 - Complete Mix
 - Mechanical Aeration

Aeration – Is it Controllable

- Oxidation Ditch & Vertical Loop Reactors
 - Control the speed of the rotors
 - Hard to completely turn on or off
 - Solids not mixed is a problem
 - May need an inline mixer
 - Short Circuiting will occur if you turn it off



Complete Mix

- Hard to Control
 - Either on or off
 - Off cycle is good for De-Nitrification
 - Diffusers may need a certain pressure to open.



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Imagery Date: 9/22/2013 37°55'25.15" N 87°54'35.49" W elev 385 ft eye alt 700 ft

Mechanical Aeration

- Is easily controlled
 - VFD
 - On or Off



Turning Aeration Off

- De-nitrification can occur
- Stop Algae Growth on effluent weirs
- Gets you tough bugs
- Removes some of the Total Nitrogen
- May remove some phosphorus
- It will reduce the sludge production

Aerobic Digesters

- Do we need to automate the digesters?
 - Maybe for a short time to learn about the oxidation of the wasting.
- Think about installing a mixer!

Biomass Enhancement

* What is biomass enhancement?

- Component of biomass enhancement may consist of any or all of the following:
 - Addition of microbial cultures
 - Addition of oxygen scavengers
 - Addition of humate (humic acid)
 - Addition of micronutrients (trace elements)

* Addition of microbial cultures

- Microbial cultures
 - Archaea
 - Bacteria
 - Fungi

* Addition of oxygen scavengers

* Oxygen scavengers

- * Biological

- * Chemical

* Purposes of oxygen scavenger

- * Lower ORP (oxidation-reduction potential)

- * Remove free chlorine residual, if potable water is used

- * Humate

- * Sequestering agent

- * Ligand or chelating agent

*** Addition of humate (humic acid)**

Addition of micronutrients (trace elements)

- Numerous trace elements needed as additives or activators of enzymes or enzyme systems
- Some elements are unique needs for some microbes and include:
 - Selenium
 - Tungsten
 - Anaerobic microbes
 - Co, Fe, Ni, and S

Heating of microbial cultures

- * Heating to mesophilic range
 - * Stimulates mesophilic growth
 - * Stimulates mesophilic production of metabolites

