Wastewater Instrumentation for Monitoring and Control

Shenandoah Valley

SHENANDOAH VALLEY
PURE H_2O
FORUM

Wastewater Treatment Plant Network

Hach, you know us?

67 years (started in 1946)

An American Company!

70+ Technical Sales Assoc nationwide

80+ Service specialists nationwide

PRICE LIST
November 1948

DRY CHEMICALS FOR SCHWARZENBACH DETERMINATION OF TOTAL HARDNESS

	5 g.	25 g.	100 g.	500 g.
Disodium Dihydrogen Versenate, Analytical Reagent			$ 3.50	$10.00
Indicator F241 (Eriochromeschwartz T)	$2.00	$6.00	15.00	
Calcium Carbonate, Analytical Reagent			.75	2.00

PREPARED SOLUTIONS FOR SCHWARZENBACH DETERMINATION OF TOTAL HARDNESS

	500 ml.	1 liter	4 liter
Standard Disodium Dihydrogen Versenate (titer adjusted so that 1.00 ml. is equivalent to 1.00 mg. $CaCO_3$)		$2.00	$6.00
Indicator F241 (2.00 g. per 500 ml. methanol)	$3.00	4.50	
Buffer Solution (a 1:5 mixture of 1 M NH_4Cl and 1 M NH_4OH)		2.00	4.00
Standard Calcium Chloride Solution (1.00 ml. equivalent to 1.00 mg. $CaCO_3$)		2.00	

ANALYTICAL REAGENTS

	1 g.	10 g.	100 g.	500 g.
Nioxime (1,2-Cyclohexanedionedioxime)	$1.00	$5.00	$25.00	$105.0
Tetraphenylarsonium Chloride	1.00	5.00	25.00	105.0
Tetraphenylphosphonium Chloride	1.00	5.00	25.00	105.0
Alpha Furildioxime	1.00	5.00	25.00	105.0
Copper Selenite (Kjeldahl Catalyst)			2.00	7.1

PRIMARY STANDARD MATERIALS

	100 g.	500 g.
Constant Boiling Hydrochloric Acid		$ 3.4
Sulfamic Acid	$1.40	4.4
Potassium Acid Iodate	9.25	37.5
Electrolytic Iron (Ignited in Hydrogen)	3.10	11.0
Ferrous Ethylenediamine Sulfate (Oesper's Salt)	1.80	5.0

ANALYZED SAMPLES

For analyzed samples for student analysis and standard sample work refer to price list of STANDARD SAMPLE COMPANY, Ames, Iowa. The samples currently available and the number of samples of each kind are: Barium Chloride (for H_2O, 30), Soluble Sulfate (SO_3, 20), Soluble Chloride (Cl, 25), Iron Ore (Vol. Fe, 20; Grav. Fe, 16), Sodium Carbonate (Na_2O, 25), Kjeldahl Nitrogen (N, 25), Limestone (SiO_2, R_2O_3, Fe_2O_3, Al_2O_3, P_2O_5, CaO, MgO, CO_2, 65), Brass (Sn, Cu, Pb, R_2O_3, Zn, Ni, 35), Copper Ore (Cu iodometric, 27), Lead Ore (Pb, 35).

HACH CHEMICAL AND OXYGEN COMPANY
Ames, Iowa

All prices are
f.o.b. Ames, Iowa
30 days net

Clifford Hach
Harvey Diehl

What's the Objective Today?

- Think about the appropriate instruments for different applications
- Workshop solutions to common problems
- Products/Ideas/Technologies that might help make your day easier
- Network with others in the room

Today's Training Agenda

- Types of Treatment Systems
- Overview of Process Steps
- Instrumentation and Control Applications
  - Nutrient Removal
  - Aeration
  - Suspended Solids
  - pH
  - Organics

Today's Training Agenda

- Making Your Data Meaningful
- Troubleshooting Mercoid Switches
- Hands-on instrument review

Why Do We Treat Wastewater?

To protect public health

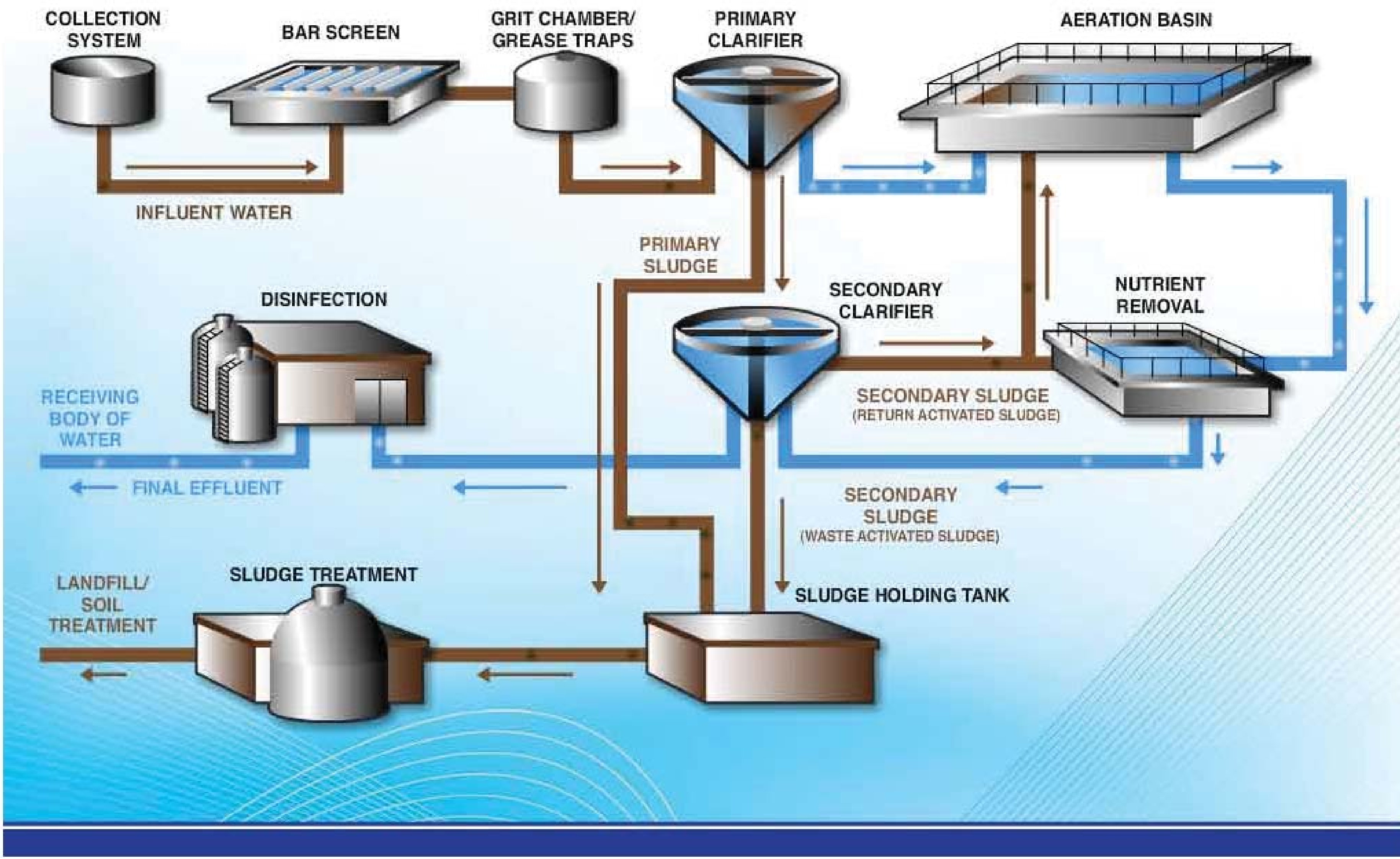
&

To protect the environment

How Do We Treat Wastewater?

Process Step Overview

Click on a Process Step to learn more.



Collection System

Wastewater flows into the collection system through a series of pipes and pumps. Flow measurements and influent sampling are required by NPDES permit and are needed to calculate loading rates on plant processes. Parameters such as pH and conductivity are often measured to determine maintenance needs and to monitor industrial dischargers.

Parameters Tested

BOD

COD

pH
Total Organic Carbon (TOC)

Total Suspended Solids (TSS)

Bar Screen

The bar screen is an inclined grid that is designed to remove large debris such as boards, branches, plastic, rags or any large item that may damage the equipment or plug pipes. The coarse solids collected at this step are taken to a landfill for disposal.

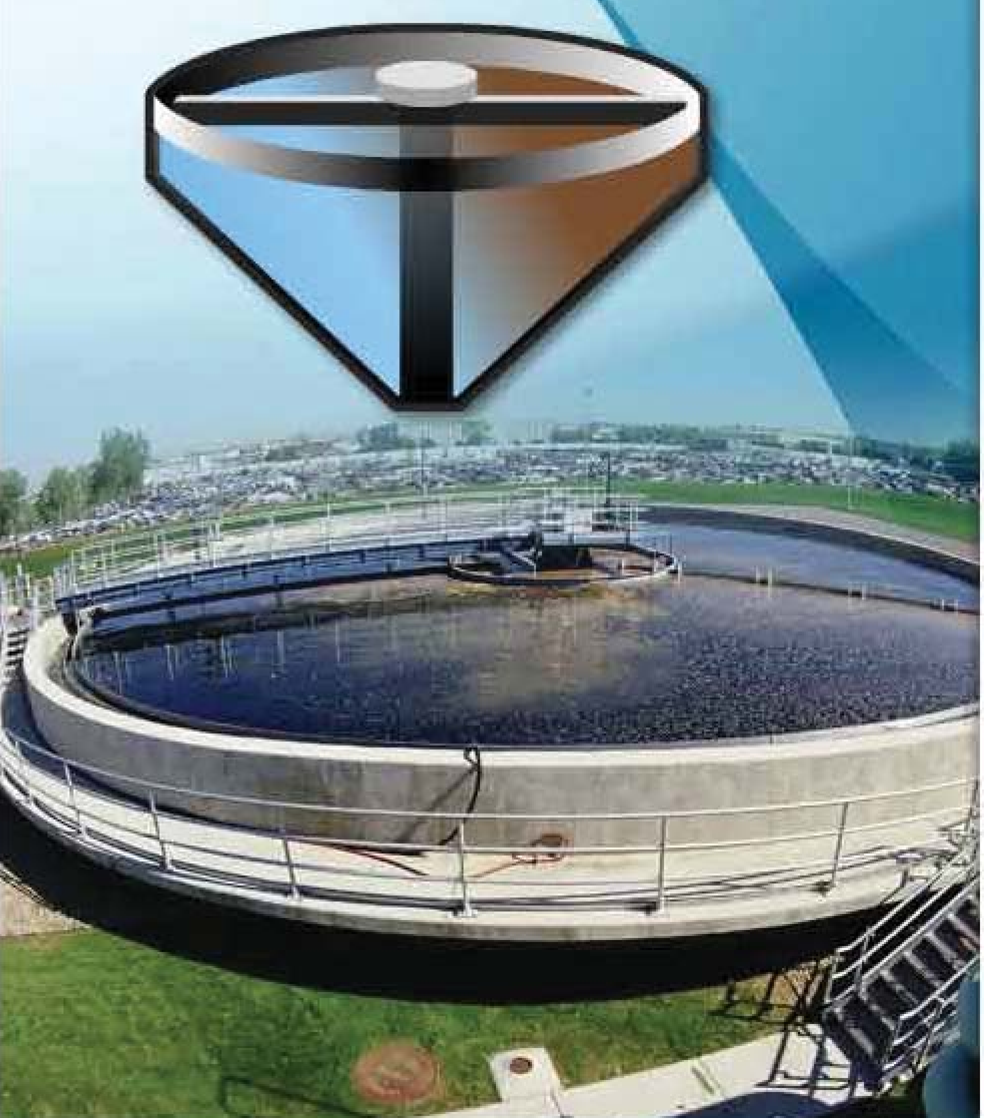
Measurements are generally not taken at this step.

Grit Chamber/ Grease Traps

The grit chamber removes particles larger than 0.2 millimeters in size through sedimentation. Inorganic solids like sand, cement, cinders, and eggshells as well as some dense organic materials like grains will settle in the grit basin. Air is bubbled through the water to help keep the organic material in suspension. The grit settles to the bottom where it is pumped, dewatered, and hauled to the landfill. Some grit chambers also contain grease traps.

Grease traps remove substances with a lower relative density, such as oils and fats, from kitchens, workshops and gasoline stations. The oils and grease rise to the surface and can be removed with the skimmer. Incineration and recycling are two of the available disposal methods for grease and oil sediment.

Primary Clarifier



Primary clarifiers remove 95% of the settable solids from the wastewater stream. A low flow rate of less than 1 ft/s in the primary clarifier allows heavier suspended solids to settle out and floatable material such as grease to rise to the top of the tank. Flights made of wood or fiberglass scrape the settled sludge on the bottom to a hopper where it is pumped out to the solids handling facility. Then the flights push the grease on the surface to a scum trough for disposal at a sanitary landfill.

Parameters Tested

Ammonia

Phosphate

Sludge Level

Total Suspended Solids (TSS)

CLOSE

Aeration Basin

Ammonia

BOD

COD

Dissolved Oxygen

Nitrate

Nitrite

ORP

pH

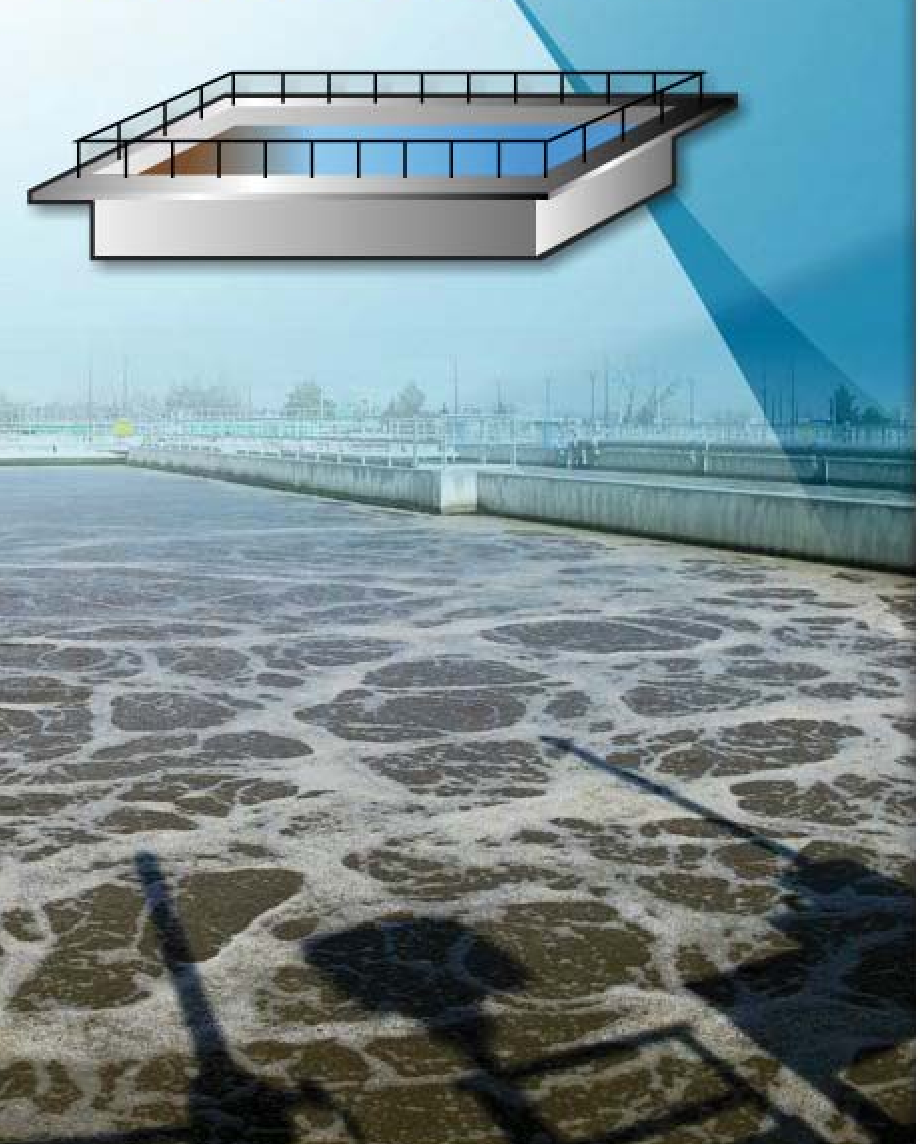
Phosphate

Total Suspended Solids (TSS)

The Activated Sludge Process is one of the most common secondary treatment processes in use today. This process uses Saprophytic bacteria to breakdown suspended solids and dissolved BOD that flow from the primary clarifier. To maintain an optimal environment for these bacteria, it is important that temperature, pH, oxygen,

CLOSE

Aeration Basin



As the bacteria or Mixed Liquor Suspended Solids (MLSS) in the aeration basin flows from the aeration basin to the secondary clarifier, the solids settle out. Some of these solids are returned (Return Activated Sludge) to the mix with the primary effluent to continuously treat the wastewater. A percentage of the settled solids are removed from the process by wasting (Waste Activated Sludge) to a handling facility. Solids and Oxygen concentrations are critical to the process.

A number of methods are used to control the solids concentration in an aeration basin.

Sludge age is the average time (in days) that a bacterial cell stays in the biological system. It is calculated by determining the mass of solids in the aeration tank and dividing it by the mass of solids wasted from the system.

Mean Cell Residence Time (MCRT) is very similar to sludge age; however, the solids inventory from the blanket depth in the secondary clarifiers and the solids from the clarifier effluent account for a more accurate and complete solids inventory in the plant.

Using the sludge volume concentration from the aeration basin by performing a 30-minute settling test is another method of controlling the return rate. In addition, the Sludge Volume Index(SVI) concentration can be used to calculate the concentration of solids in the Return Activated Sludge (RAS) line. This value can later be used to calculate the return rate.

CLOSE

Nutrient Removal

Parameters Tested

Ammonia

BOD

COD

Dissolved Oxygen

Nitrate

Nitrite

ORP

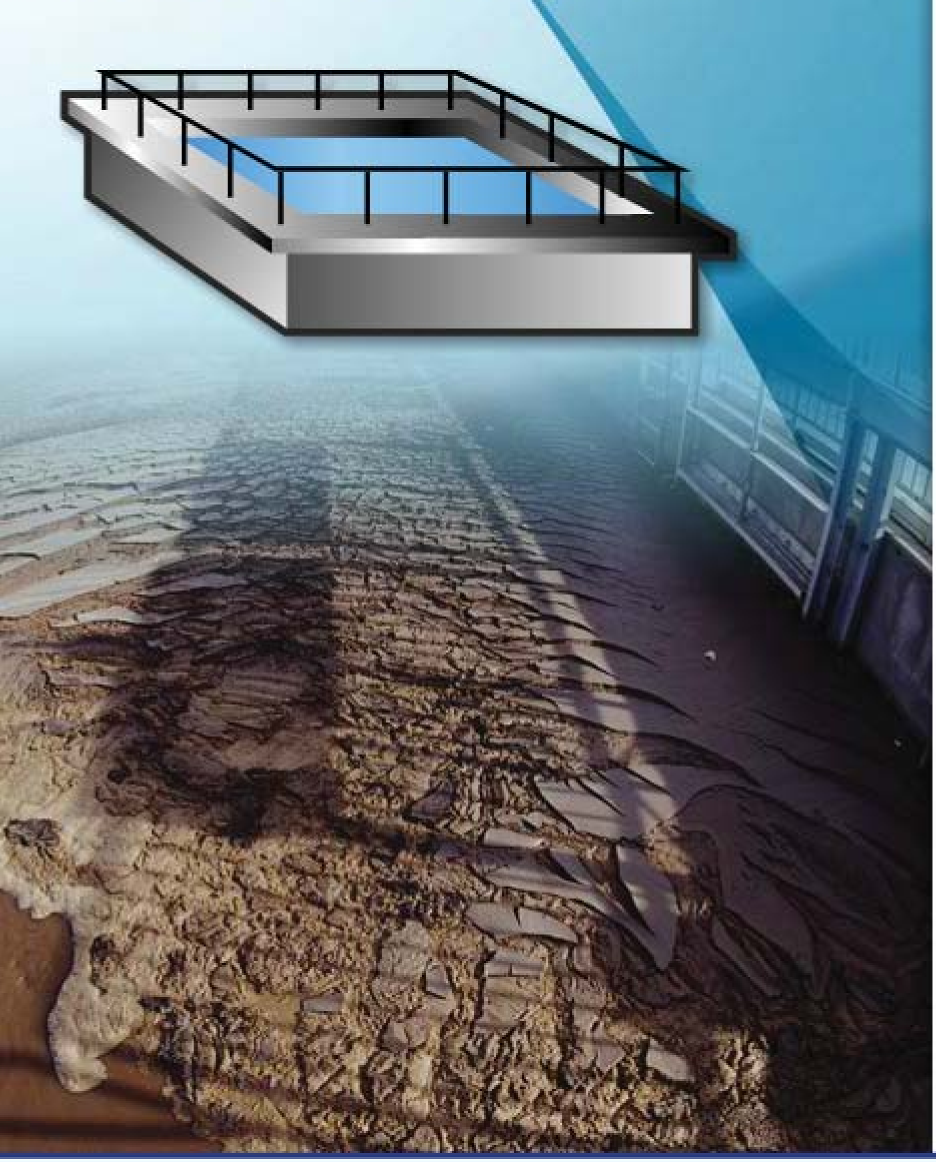
pH

Phosphorus

Total Suspended Solids (TSS)

Turbidity

Nutrient Removal



Nutrients are essential to the life of the bacteria in the aeration basin. Bacteria break down ammonium, nitrate and organic nitrogen compounds in the course of the metabolic processes involved in cell growth. If supply were to exceed demand, however, incomplete removal of nutrients would result in an effluent that would contribute to the pollution of environmental waters. Ammonium, Nitrate, and Phosphate are the key parameters for advanced nutrient elimination.

Nitrogen Removal

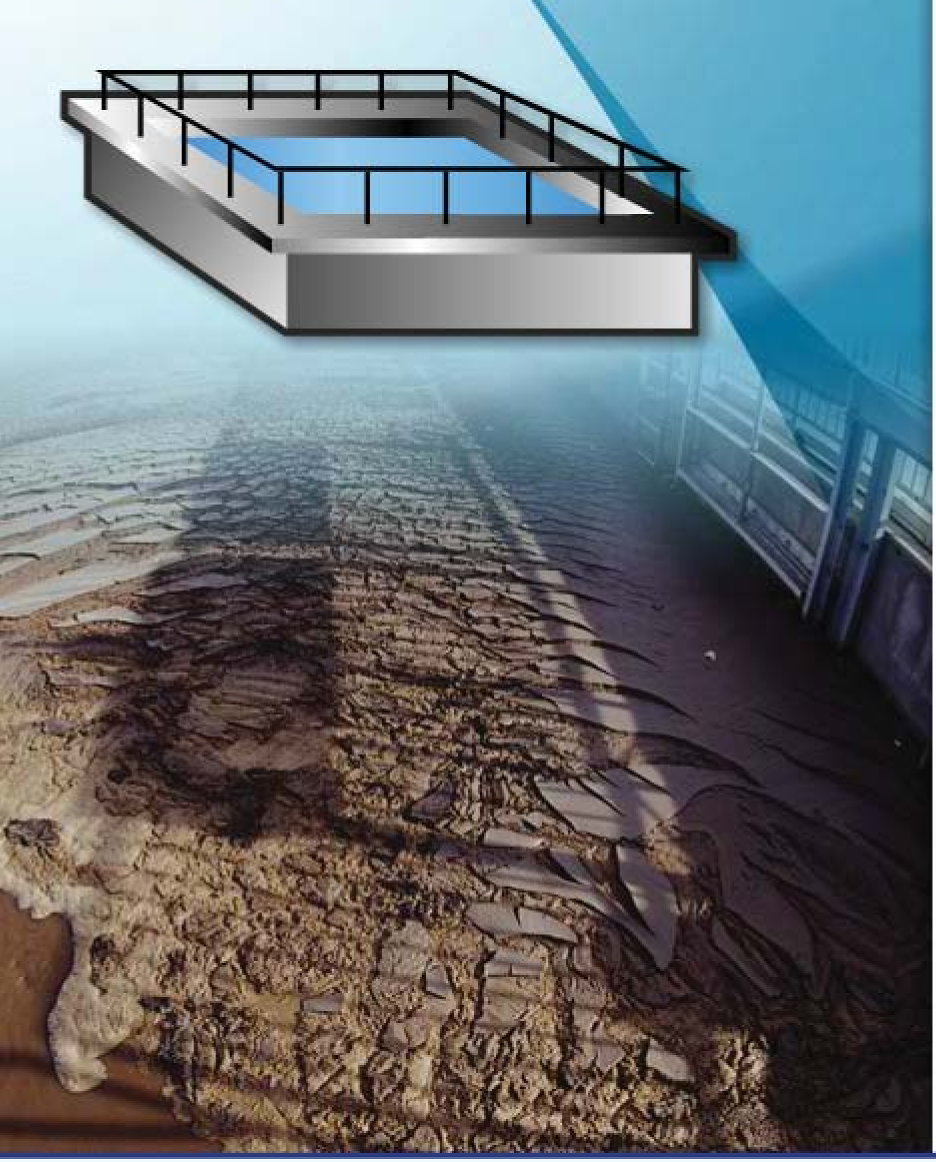
Nitrogen enters wastewater treatment plants as Ammonia and Organic Nitrogen and is typically removed biologically. Utilizing aeration, the nitrification stage utilizes aerobic bacteria to turn Ammonia into Nitrite and then Nitrate. Nitrogen removal happens in the denitrification stage as bacteria consume the Oxygen from Nitrate turning it into Nitrogen gas that escapes into the atmosphere.

Phosphorous Removal

Phosphorus does not have a gaseous form, so it must be converted from soluble form to particulate form for removal. Chemical Phosphorus removal uses Iron or Aluminum compounds to combine with and precipitate out Phosphate.

Biological Phosphorus removal utilizes Phosphate accumulating

Nutrient Removal



Phosphorus does not have a gaseous form, so it must be converted from soluble form to particulate form for removal. Chemical Phosphorus removal uses Iron or Aluminum compounds to combine with and precipitate out Phosphate.

Biological Phosphorus removal utilizes Phosphate accumulating organisms (PAOs). In the anaerobic environment, the PAOs consume volatile fatty acid compounds, while they release Phosphate into the water. In an aerobic environment, the PAOs consume more Phosphate than they can digest, which results in a net removal of Phosphorus from the wastewater. The PAOs settle in the secondary clarifier and are removed when the sludge is wasted.

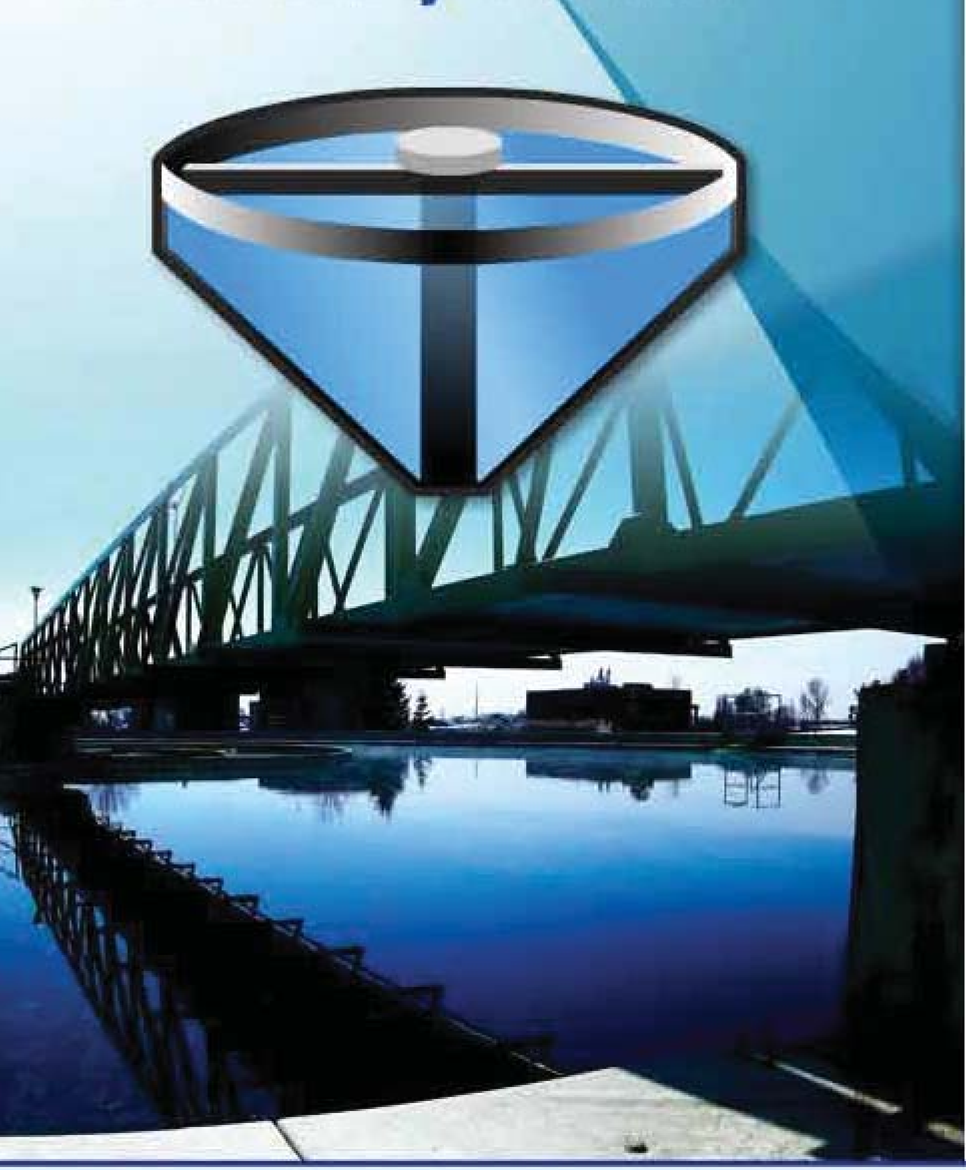
Chemical and Energy Savings

In biological nutrient removal, aeration can be 70% of a plant's budget because most wastewater treatment plants play it safe by running their blowers full speed 24 hours a day 7 days a week.

Monitoring your process in real-time is critical to save you money by knowing when to turn off the blowers.

Typically in chemical Phosphorus removal, the flow weighted average Phosphate is used to set a static dose. This will lead to over and under dosing which could waste money and cause a permit violation! Using real-time data to control dosing can significantly reduce the cost of chemical Phosphorus removal.

Secondary Clarifier



The treatment process in the secondary clarifier is similar to that of the primary clarifier. However, a percentage of the sludge that settles in the secondary clarifier is returned (Return Activated Sludge) to the aeration basin to replenish the microbial populations. Excess activated sludge (Waste Activated Sludge) is taken out of circulation by being pumped into the Sludge Treatment Process.

Parameters Tested

Ammonia

BOD

COD

Dissolved Oxygen

Nitrate

Nitrite

ORP

Phosphorus

Total Suspended Solids

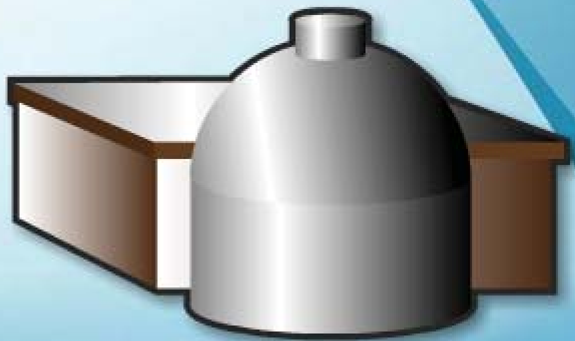
Sludge Level

Turbidity

Sludge Holding Tank

Sludge generated from both the primary and secondary clarifiers is sent to a sludge holding tank where it awaits further processing.

Sludge Treatment



Sludge with a solids content of about 0.1 to 1 percent is formed in the primary and final sedimentation tanks of biological sewage treatment plants. The sludge treatment process and subsequent disposal is one of the highest costs for a wastewater treatment plant often contributing up to one third of the total costs.

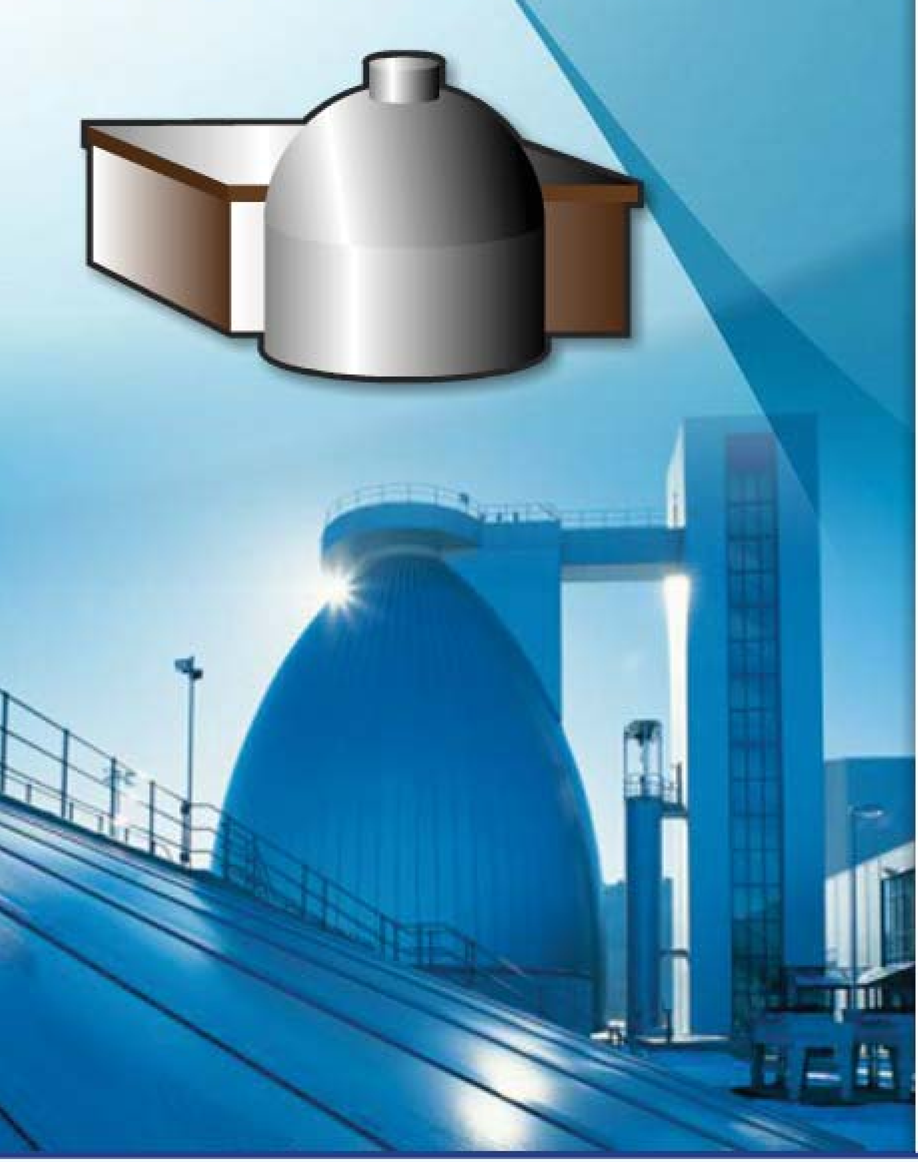
Sludge Digestion

Aerobic and anaerobic digestion is used to decompose organic matter and to reduce volume. Untreated sludge is approximately 97% water. The dewatering of sludge is a key process step in terms of minimizing the costs of landfill disposal or incineration. Water can be removed from the sludge by using dry beds, vacuum filters, filter presses, and centrifuges resulting in sludge between 50 to 80 percent water. The dehydrated sludge is called sludge cake.

Anaerobic Digestion

Sludge digestion is a highly sensitive process, requiring 20 to 30 days and at least three types of bacteria, each with its own enzyme system, to carry out completely different tasks. The first bacteria species must break down large molecules into alcohols and fatty acids. The next type of bacteria in the digester immediately converts the alcohols and fatty acids to hydrogen and acetic acid. The third group of bacteria converts acetic acid and hydrogen relatively quickly into methane. The sludge remains in the digester for 20 to 30 days. The physical structures used for this process step are large and dominate the external appearance of many sewage treatment plants.

Sludge Treatment



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Parameters Tested

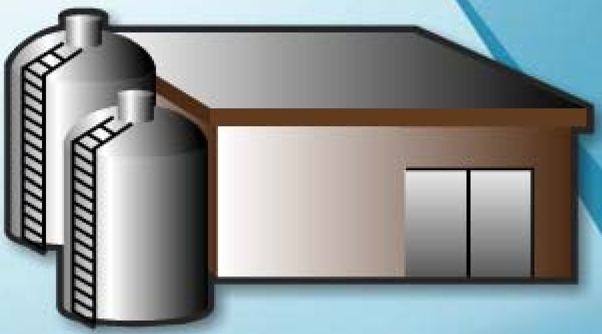
Dissolved Oxygen (aerobic digester)

ORP (anaerobic digester)

pH

Total Suspended Solids

Disinfection



The biological processes of a wastewater plant are unable to remove all bacteria. Consequently a disinfection step is necessary to ensure that regulated bacterial counts are kept within allowable levels before wastewater is discharged to the environment. While chlorine is most commonly used for disinfection, ozone, chlorine dioxide and ultraviolet light (UV) are becoming more common for wastewater treatment.

High levels of residual chlorine may be harmful to aquatic life in receiving streams. Allowable limits for chlorine release in the effluent are regulated by NPDES permit and may differ based on the receiving body of water. To maintain chlorine discharge within allowable limits, treatment systems often add a chlorine-neutralizing chemical such as sodium bisulfite or sulfur dioxide to the treated water before discharge.

Parameters Tested

TOC

Chlorine

UV% Transmittance

Process Step Overview

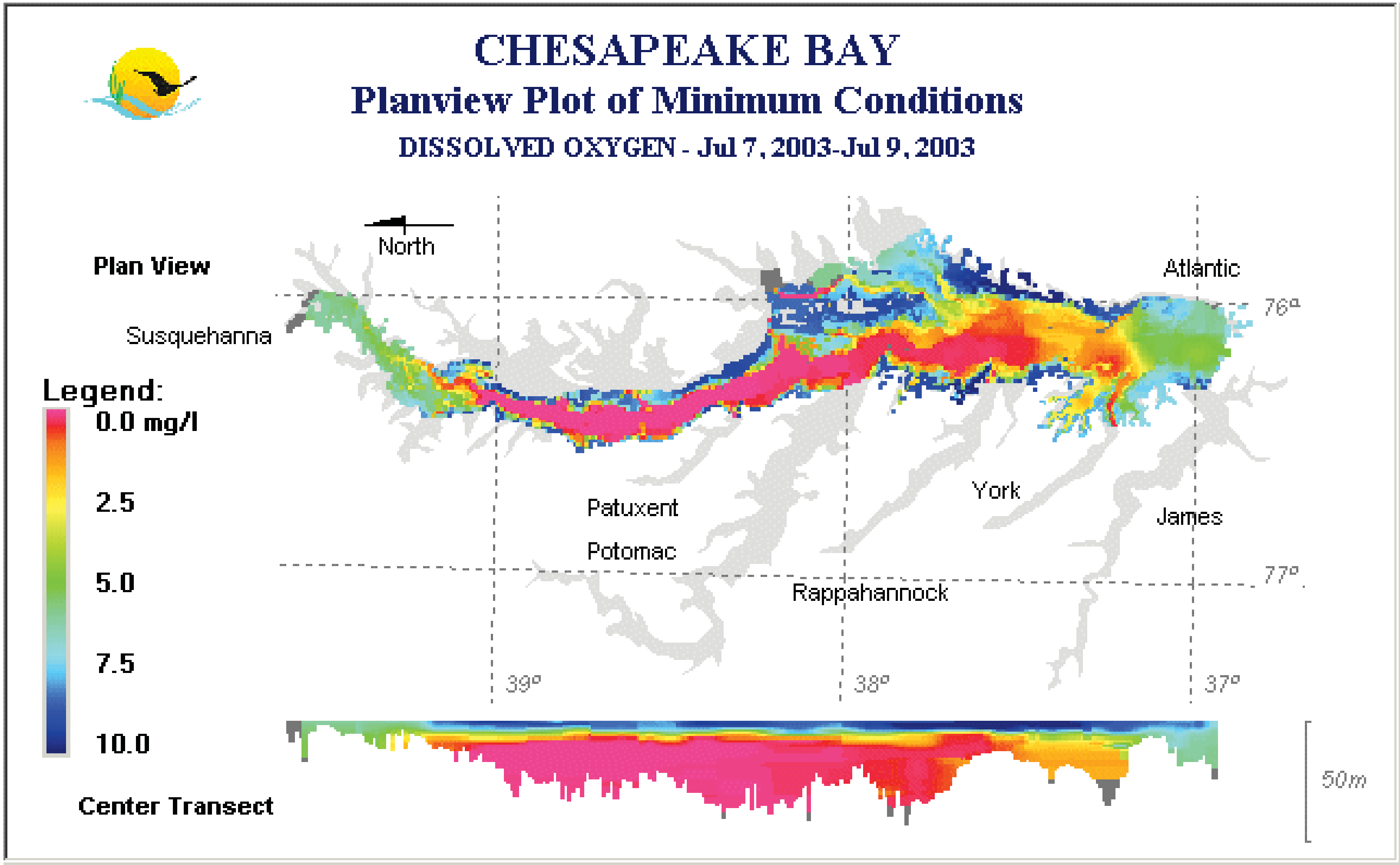
N U T R I E N T S

Nitrogen and Phosphorus in Wastewater Treatment

Introduction

- N & P discharged into Surface Waters
- Algae consume N & P and reproduce
- Bacteria eat algae and “breathe” O_2
- Low DO kills fish, shellfish, invertebrates


Effects of Eutrophication



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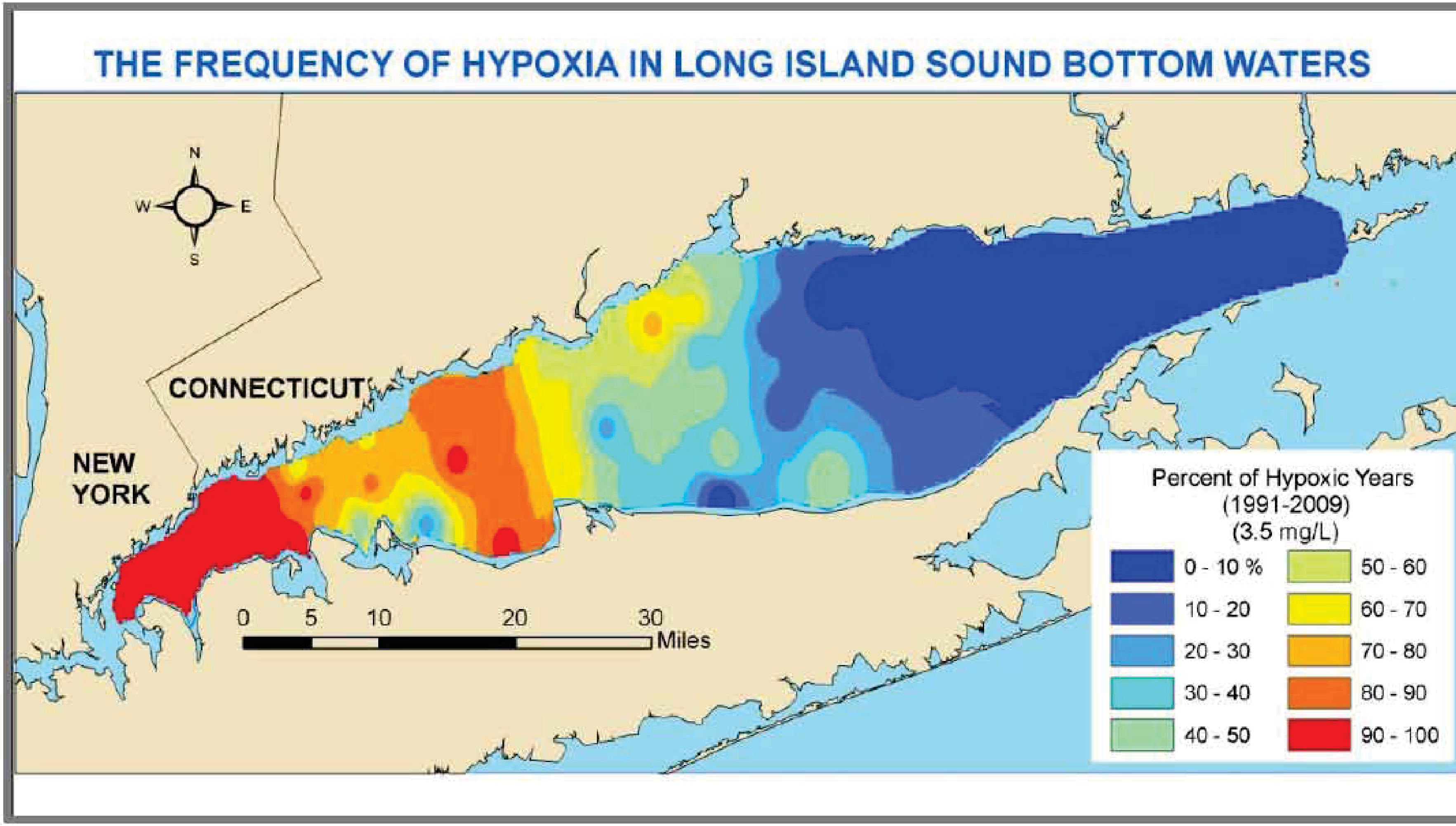


Impaired Waters

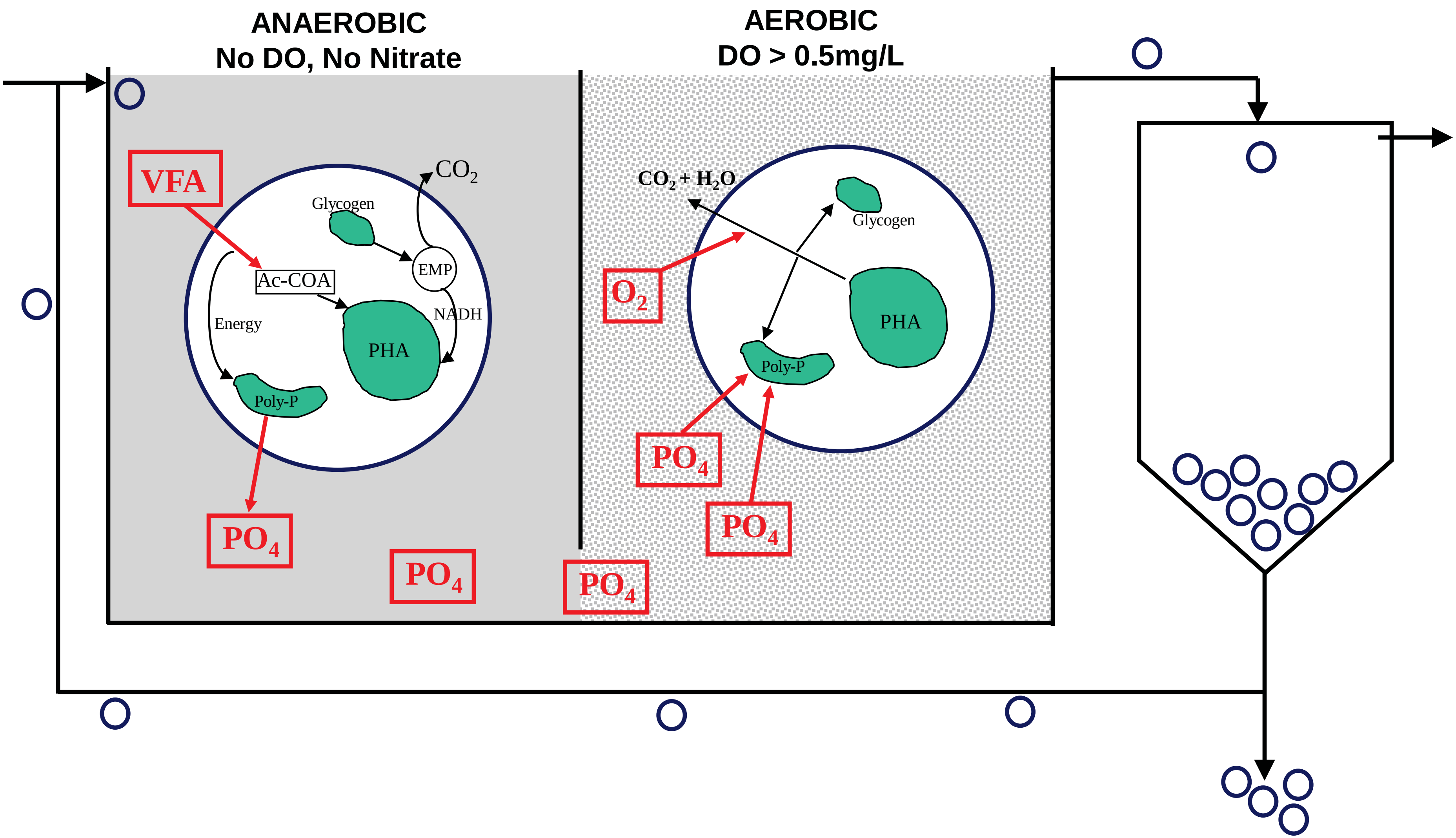
- EPA (2008)
  - 168 Hypoxic Areas in USA
  - 1200 Nitrate Effluent Violations at DW plants
  - Mandate: States to establish nutrient limits in surface waters

- States: Total Maximum Daily Load
  - Set TMDL for N & P in specific watersheds
  - New permits contain N & P limits

Biological P Removal

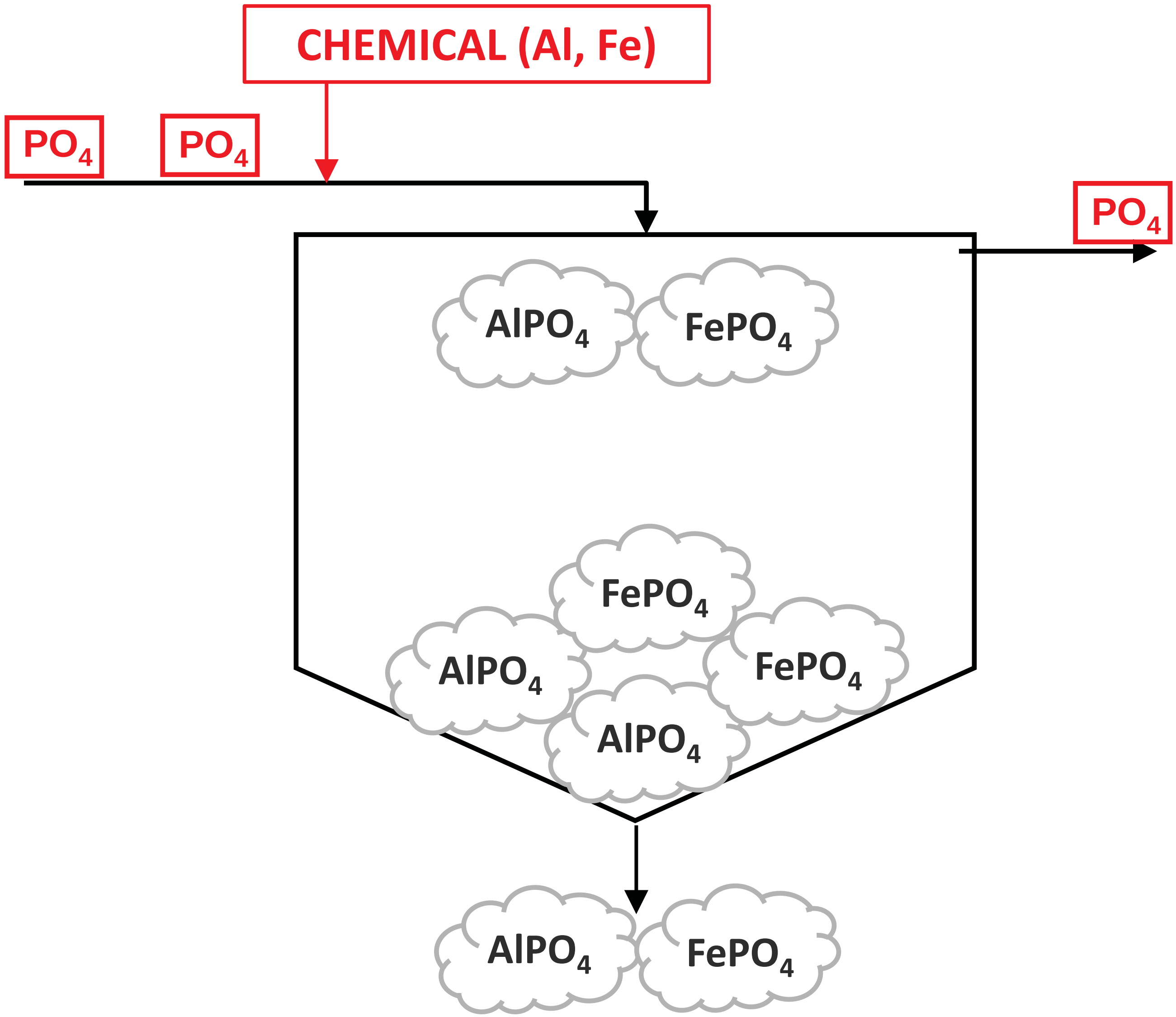
You can't control bacteria

You can only control their *environment*



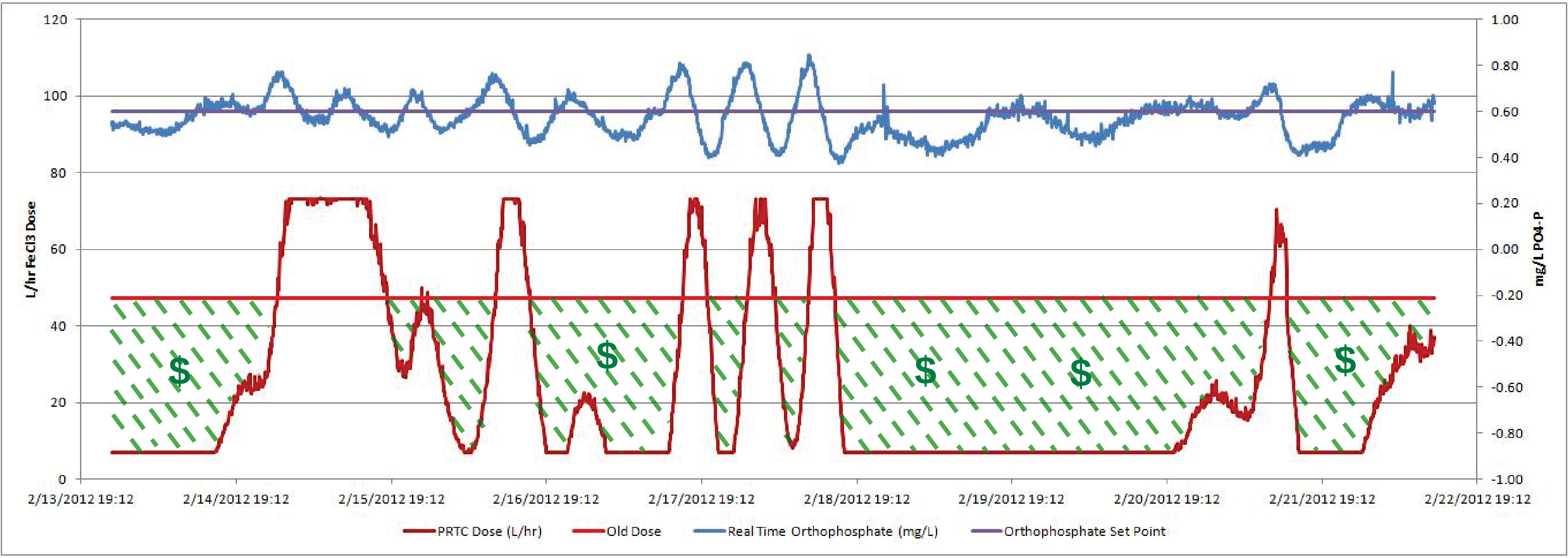

LANGE

Chemical P Removal




Phosphorus Real Time Controller

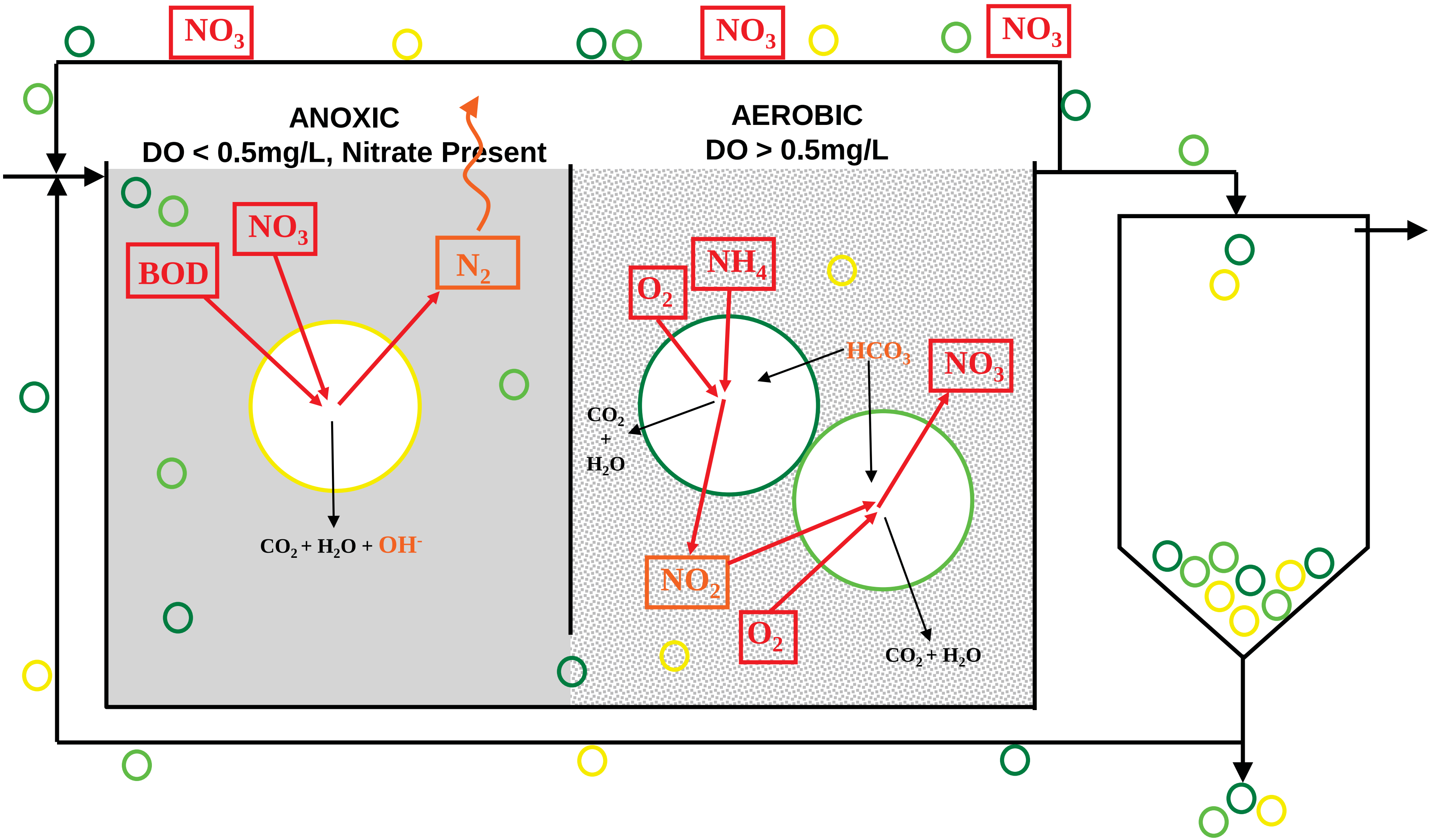
- Measuring Plant Effluent orthophosphate
- Measuring Plant Effluent flow
- Output exact dose to meet 0.60mg/L PO4-P setpoint
- **Saving 55% compared to previous static dose**



Biological N Removal

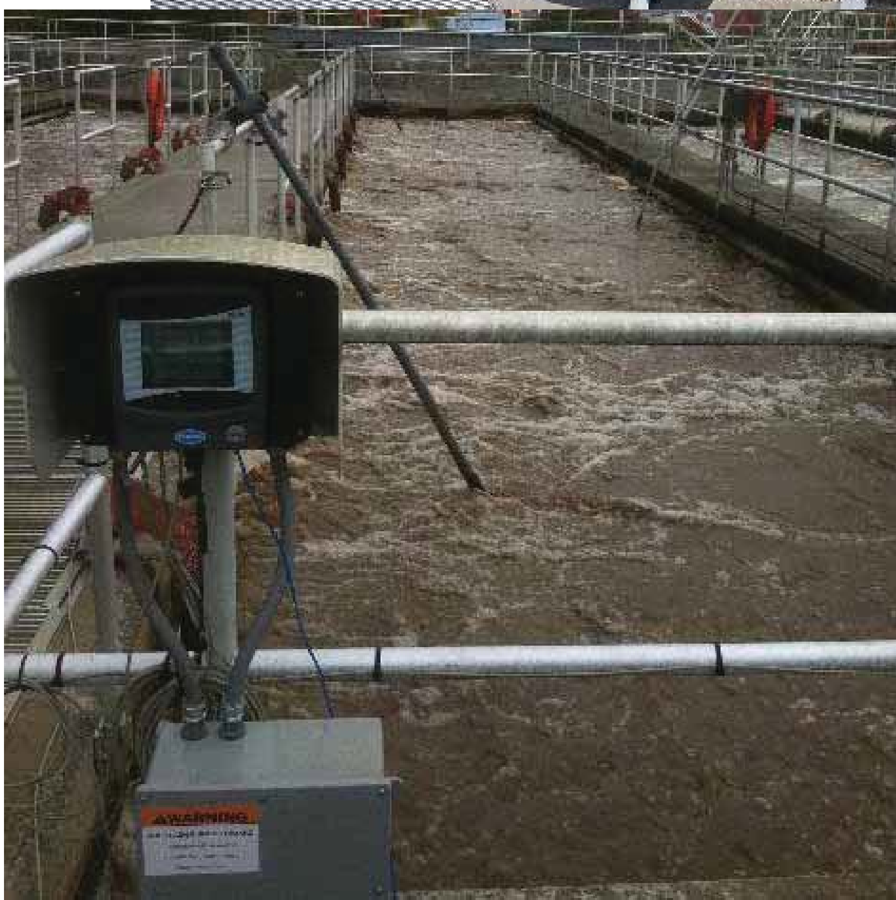
You can't control bacteria

You can only control their *environment*



Nitrification – Ammonia Removal

- Process Characteristics that can Impact Nitrification
  - MCRT (Sludge Age)
    - Generally > 10 day MCRT is needed for stable nitrification in extended air systems
    - Nitrifying bacteria grow very, very slooowly
  - pH
    - Nitrifiers are sensitive to changes in pH
    - Reported “optimum” pHs vary b/w 5.8 – 8.5…a wide range
  - Alkalinity
    - 7.1 mg of alk is consumed for every mg of Ammonia converted to Nitrate
  - BOD
    - 0.08 lb of inorganic carbon/ lb of Ammonia oxidized
  - DO
    - cBOD oxidation
      - 1.0 – 1.2 lbs of Oxygen for every lb of BOD
    - Ammonia Oxidation
      - 4.3 lbs Oxygen per lb of NH_3-N
      - 4.6 lbs Oxygen per lb of NH_4-N



WARNING


Denitrification – Total N Removal

- Other half of biological nitrogen removal
  - Nitrate converted to Nitrogen gas
- Consumes 2.86 grams of BOD per gram of Nitrate reduced
  - Why care: Not enough BOD = denitrification doesn't happen
    Alkalinity not recovered…possible chemical addition
- Forms ~0.5 grams of <u>new cells</u> per gram of Nitrate reduced
  - Why care: WAS = Solids Handling
- Possible problems if Nitrate to Clarifiers >6-8 mg/L
  - Floating Solids, Scum, effluent turbidity issues


Mallard Creek WRF (NC)

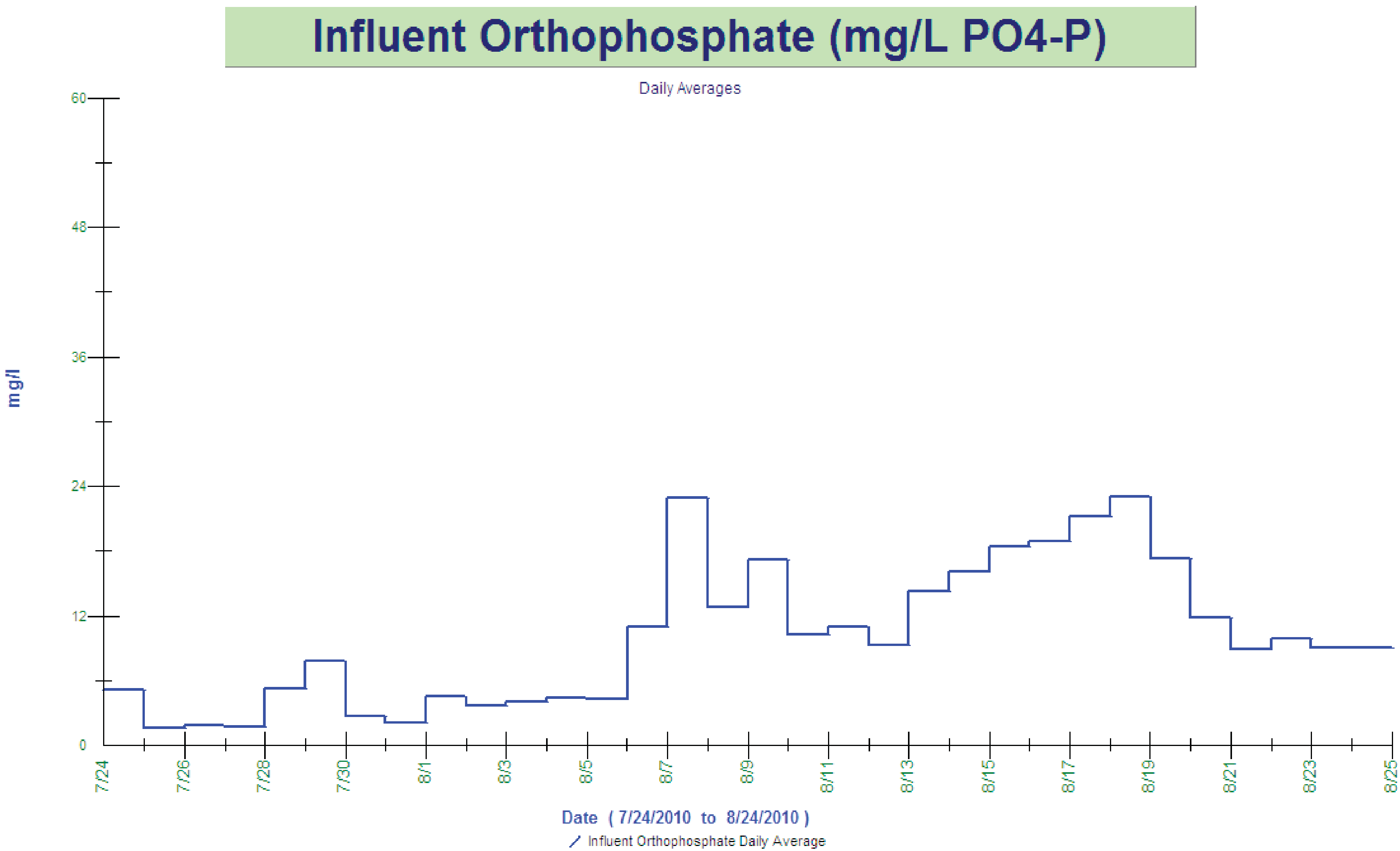
- 12 MGD, NH_4-N < 1.0 mg/L
- Modified Ludzack-Ettinger process
- Raw wastewater lacks enough alkalinity for complete nitrification
- Dose sodium hydroxide to supplement alkalinity
  - Flow proportional: $197,283
  - Real time load: $128,663
  - 34.8% savings

Ammonia Measurement

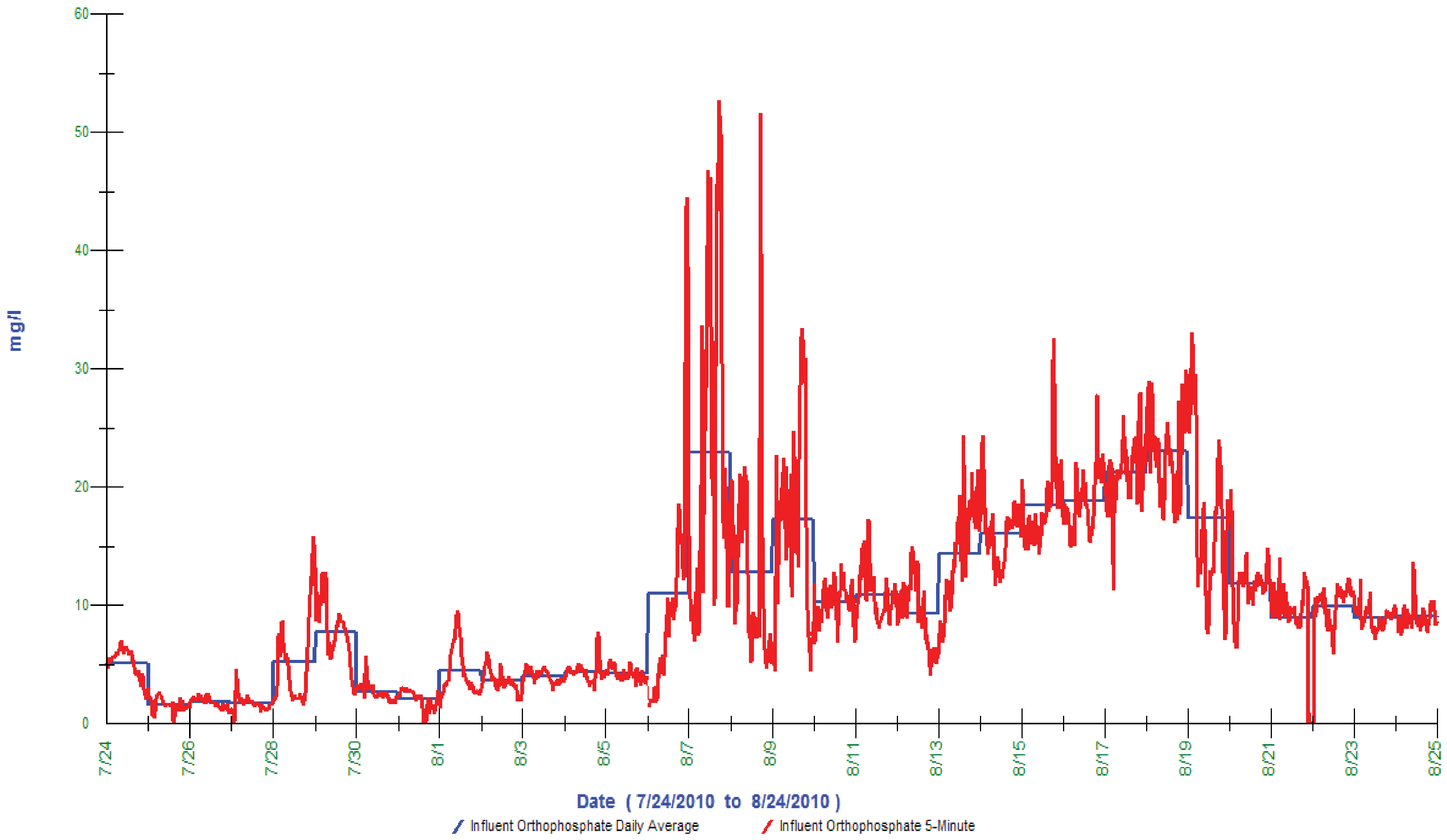
- Ammonia Nitrogen
  - Ion Selective Electrode
  - Gas Sensing Electrode

Hutchinson WWTP

- 2.4 MGD, TP < 1.0mg/L monthly average
- 2 Plants
  - Oxidation Ditch & Clarifier
  - Membrane Bioreactor with anoxic selector
- Chemical precipitation with ferric sulfate
- Composite samples & flow proportional dosing were not meeting the effluent limit


Influent Orthophosphate (mg/L PO4-P)
Daily Averages
mg/l
60
48
36
24
12
0
7/24
7/26
7/28
7/30
8/1
8/3
8/5
8/7
8/9
8/11
8/13
8/15
8/17
8/19
8/21
8/23
8/25
Date (7/24/2010 to 8/24/2010)
Influent Orthophosphate Daily Average

Influent Orthophosphate (mg/L PO4-P)



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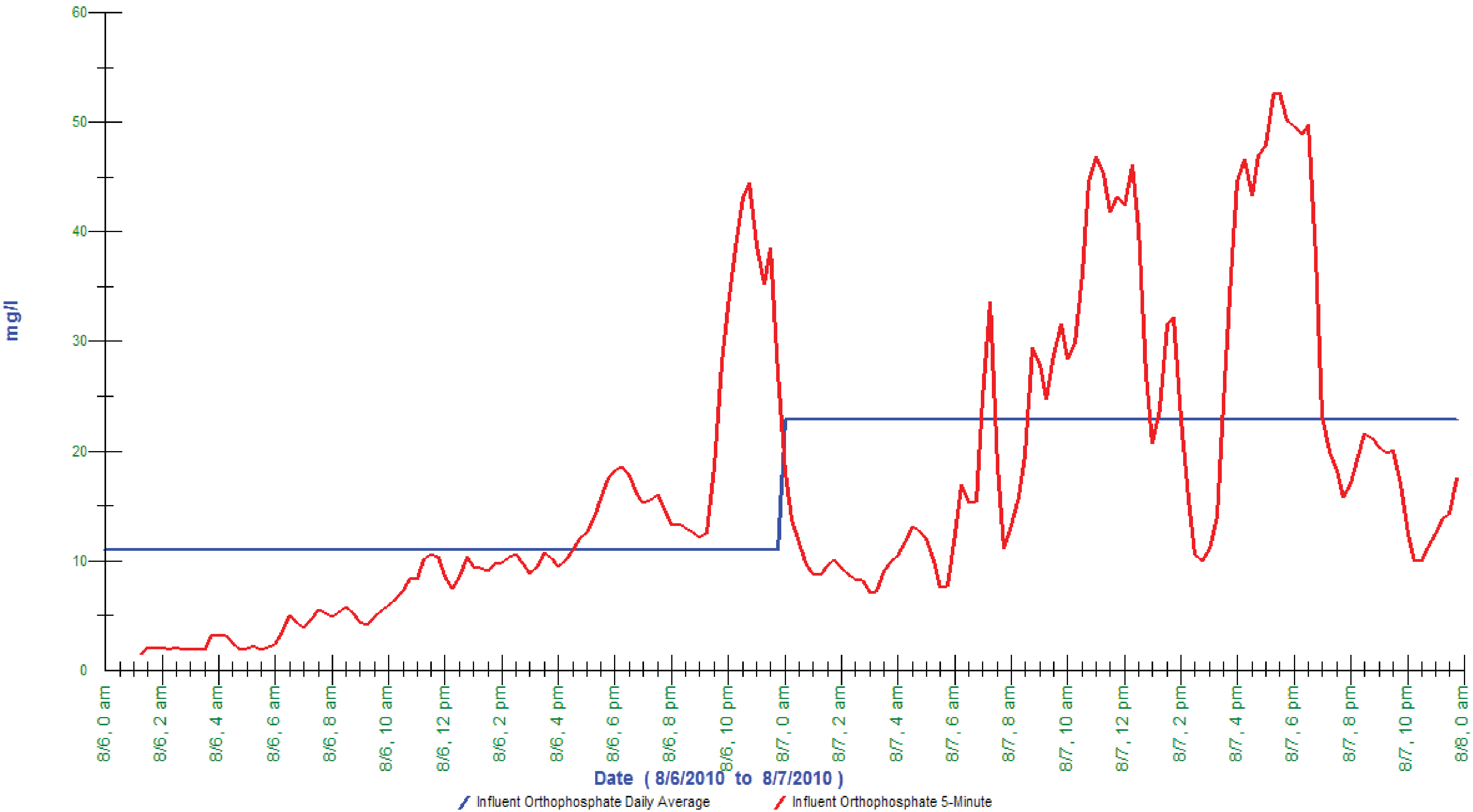
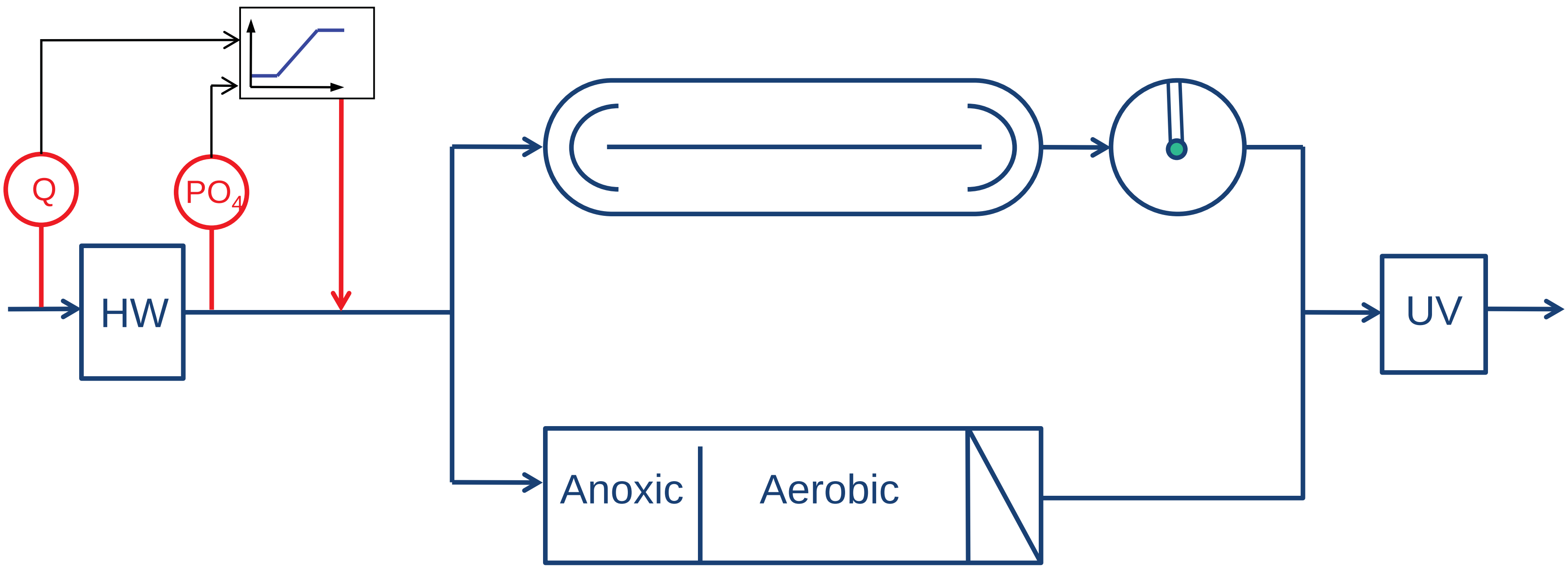


Hutchinson WWTP



Phosphate Analyzer

- Orthophosphate
  - Molybdovanadate
    - “Yellow method”
  - 0.05 – 15.0 mg/L PO_4-P
  - +/- 2% accuracy
  - Self Filtering

Pinery Water & Wastewater
Parker, CO

- 2 MGD, TP < 0.05 mg/L
- 5 Stage System with alum addition and mixed media filters
- Instrumentation:
  - 4 ORP Sensors
  - 5 pH Sensors
  - 4 LDO Sensors
  - 2 Phosphate Analyzers
  - 2 Turbidimeters

Stamford WPCF (CT)

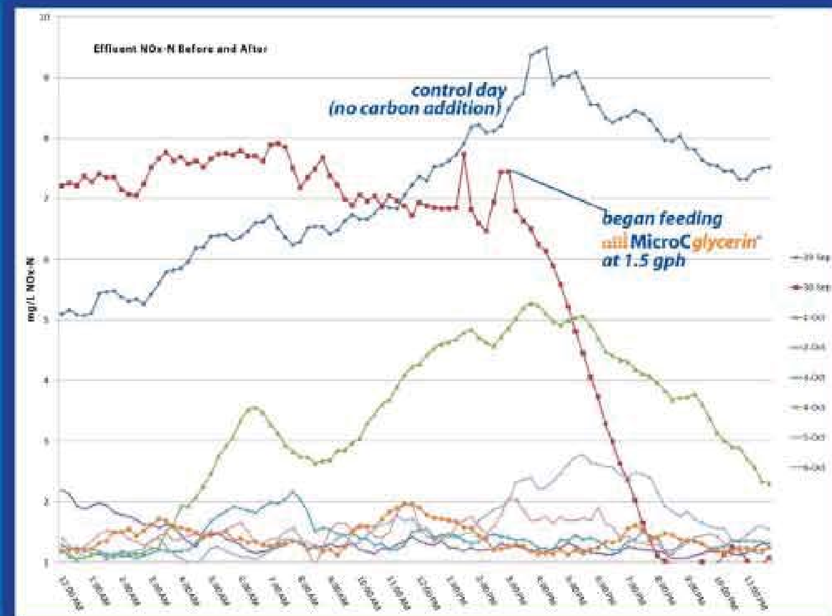
- 24 MGD, TN 1057lbs/day
- 4 Stage System with methanol feed and UV disinfection
- Instrumentation:
  - 4 Ammonia analyzers
  - 1 Ammonia sensor
  - 6 Nitrate/Nitrite sensors
  - 1 MLSS sensor
  - 4 LDO sensor
  - 2 Sludge Blanket sensors
- 2009: Earned $961,118 with credits

The West Haven Water Pollution Control Facility is a 12 mgd facility located on the Long Island Sound in Connecticut and is required to reduce nitrogen as part of the Long Island Sound TMDL. The facility utilizes an MLE activated sludge process with six separate process trains, each with a pre-anoxic zone. Nitrate is returned in each process train with individual nitrate recycle pumps. The facility is presently upgrading to a 4 stage Bardenpho process utilizing plastic IFAS media in the aerobic zone with carbon addition to the 2nd anoxic zone. The upgraded facilities will not be fully operational for three years.

In 2008 the facility discharged over the nitrogen permit and was required to purchase $346,000 in nitrogen credits as part of the Connecticut Nitrogen Trading Program. Their 2009 mass based permit is 415 pounds of total nitrogen per day or 7 mg/l at an average flow of 7 mgd.

To reduce costly credit purchases during the construction period, the facility began pilot testing MicroCglycerin™ on September 30, 2009, adding it to the front end of a 1.15 mgd process train, at a flow of 1.5 gph. Within an 5 hour acclimation period effluent nitrate levels were reduced by 4 mg/l, and within 48 hours a stable process was achieved. Nitrates were further reduced by 5.7 mg/l from the control day on September 29th. An online nitrate analyzer provided 24 hour monitoring of anoxic zone nitrate levels.

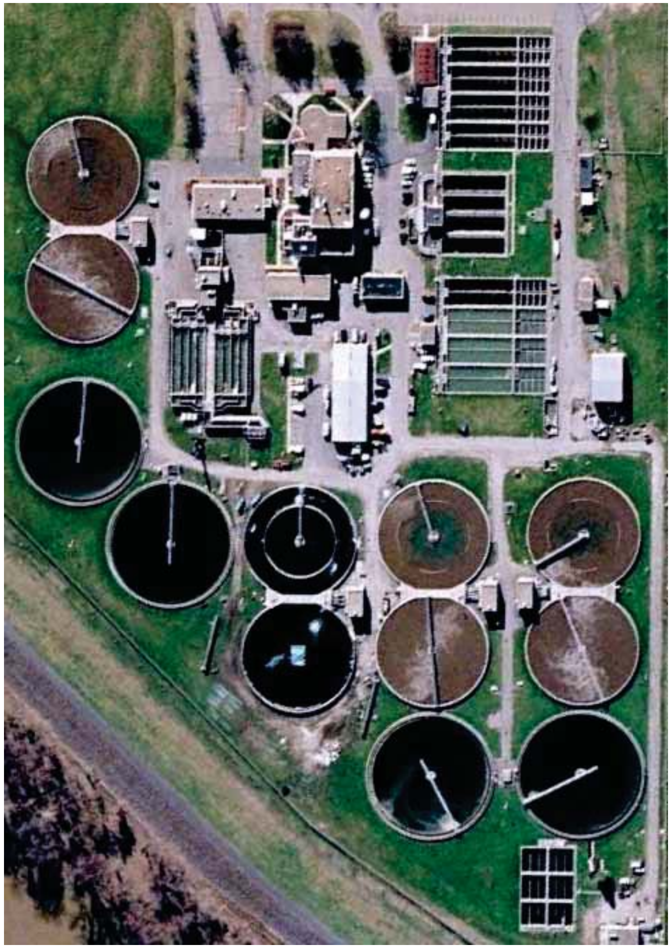
Acknowledgements: Environmental Operating Solutions, Inc. would like to thank Bill Norton and Abdul Quadir from the City of West Haven, CT, and Kevin Dahl, Facility Manager for OMI, for their participation in this project.



Nitrate Sensors

- Nitrate Nitrogen
  - Reagentless
  - UV absorbance
  - Ion Selective Electrode

Wyoming Valley San. Auth. (PA)



- 32 MGD, Load Limits
  - TN limit: 584,000 lbs/yr
  - TP limit: 77,000 lbs/yr
- Schreiber™ System
- Pilot Test: control aeration
  - Ammonia Sensors
  - Nitrate Sensors
  - LDO sensors
- Meets new limits, $20M upgrade unnecessary

Online Methods for Analysis

- **Total** Nitrogen
  - Digestion with Ozone and Hydroxyl Radical
    - Oxidizes everything to nitrate
    - Measured with UV absorbance
    - 0.3 – 100,000mg/L N
    - < 8 min. cycle time
    - +/- 3% Accuracy

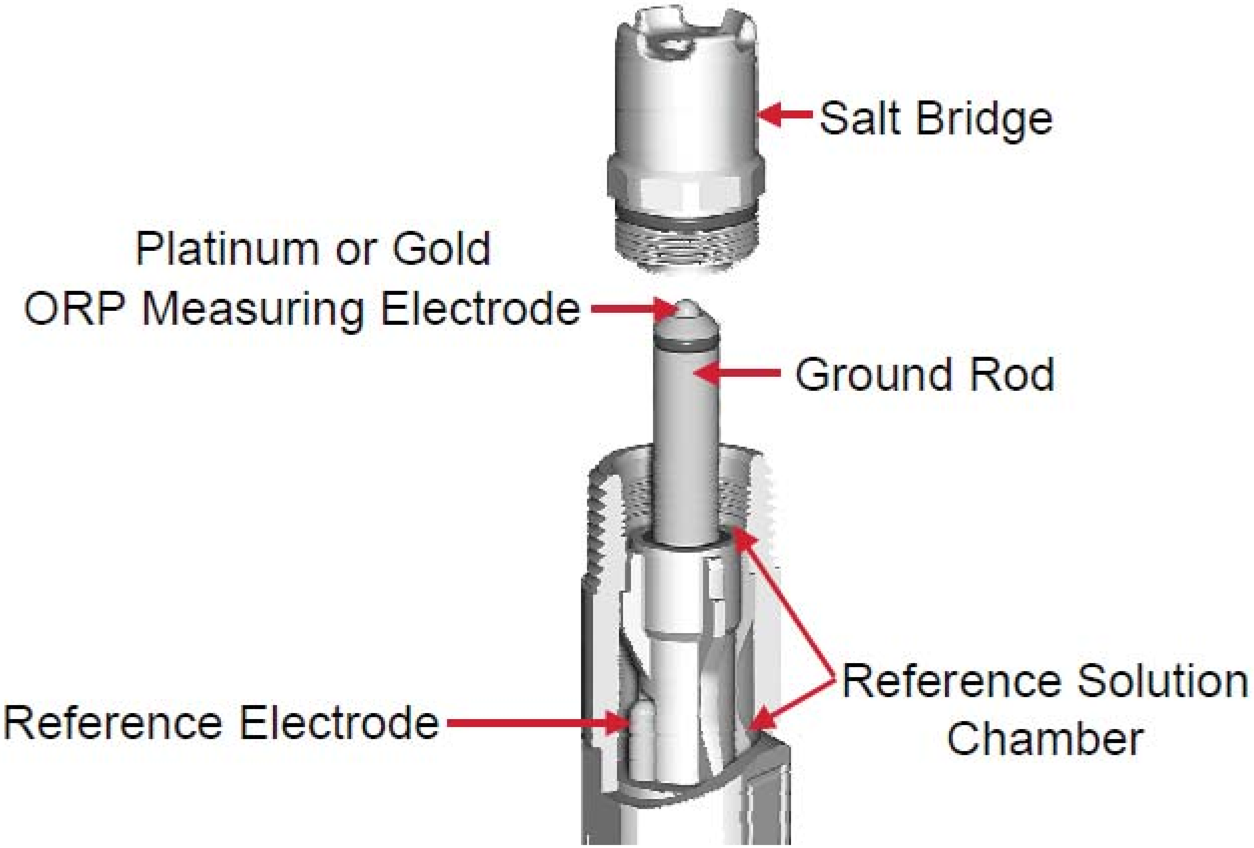
Online Methods for Analysis

- **Total** Phosphorus
  - Digestion with Ozone and Hydroxyl Radical
    - Oxidizes everything to phosphate
    - Measured with molybdovanadate reagent
    - 0.3 – 100,000mg/L P
    - < 20 min. cycle time
    - +/- 3% Accuracy

Other Valuable Tests

- Dissolved Oxygen
- Oxidation – Reduction Potential (ORP)
- Total Suspended Solids
- Volatile Fatty Acids
- pH
- Alkalinity
- COD

ORP Sensor



Salt Bridge
Platinum or Gold
ORP Measuring Electrode
Ground Rod
Reference Solution
Chamber
Reference Electrode

ORP

- Anaerobic:
  - No oxygen, no nitrate
  - Sulfate present
- Anoxic
  - No oxygen
  - Nitrate Present
- Aerobic
  - Oxygen present

Electron Acceptors

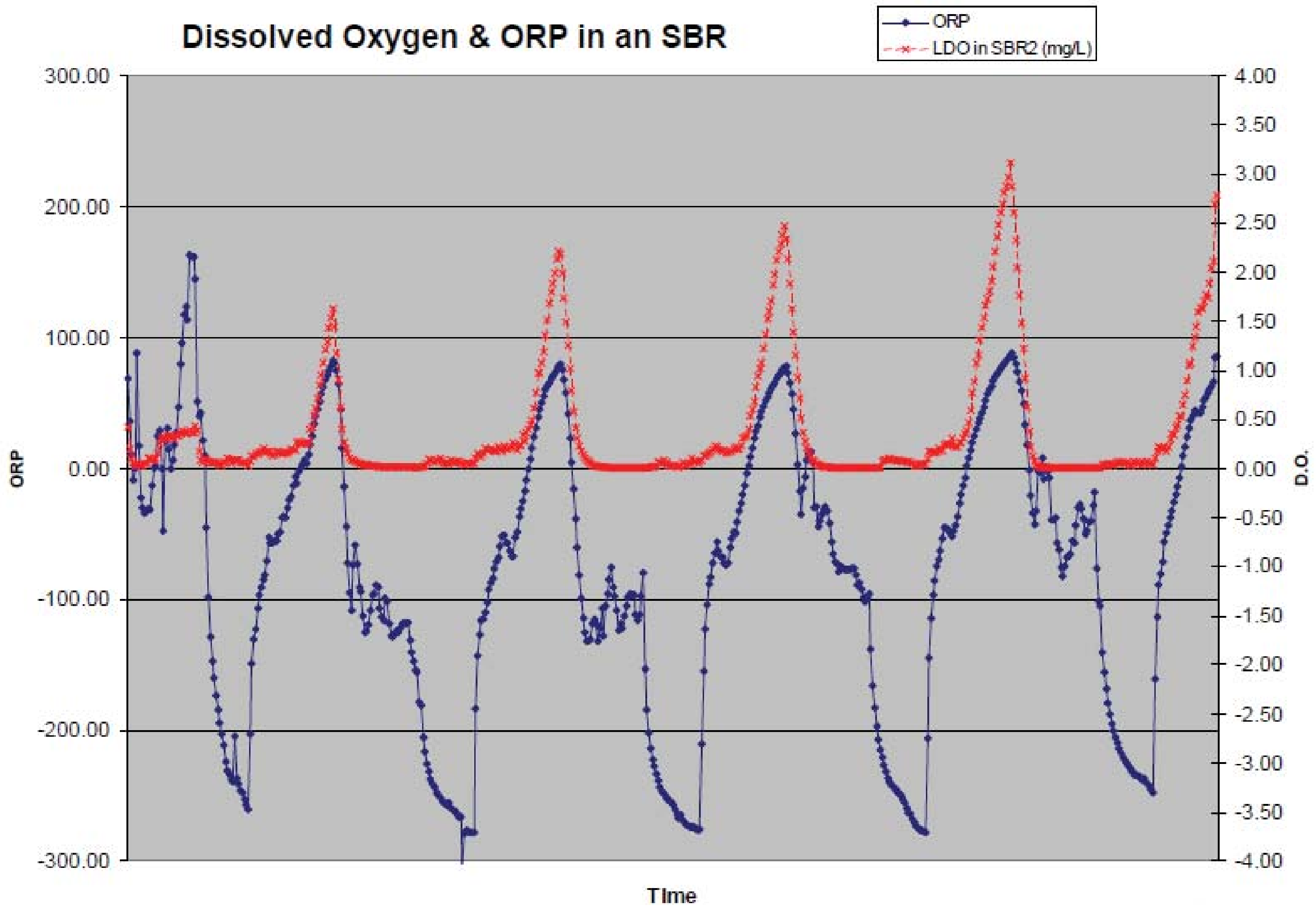
Aerobic zone: DO and ORP (DO: 1.5-3mg/L; ORP: >100mV)

Anoxic zone: ORP between –100mV and +100mV

ORP will respond to subtle changes in the anaerobic zone

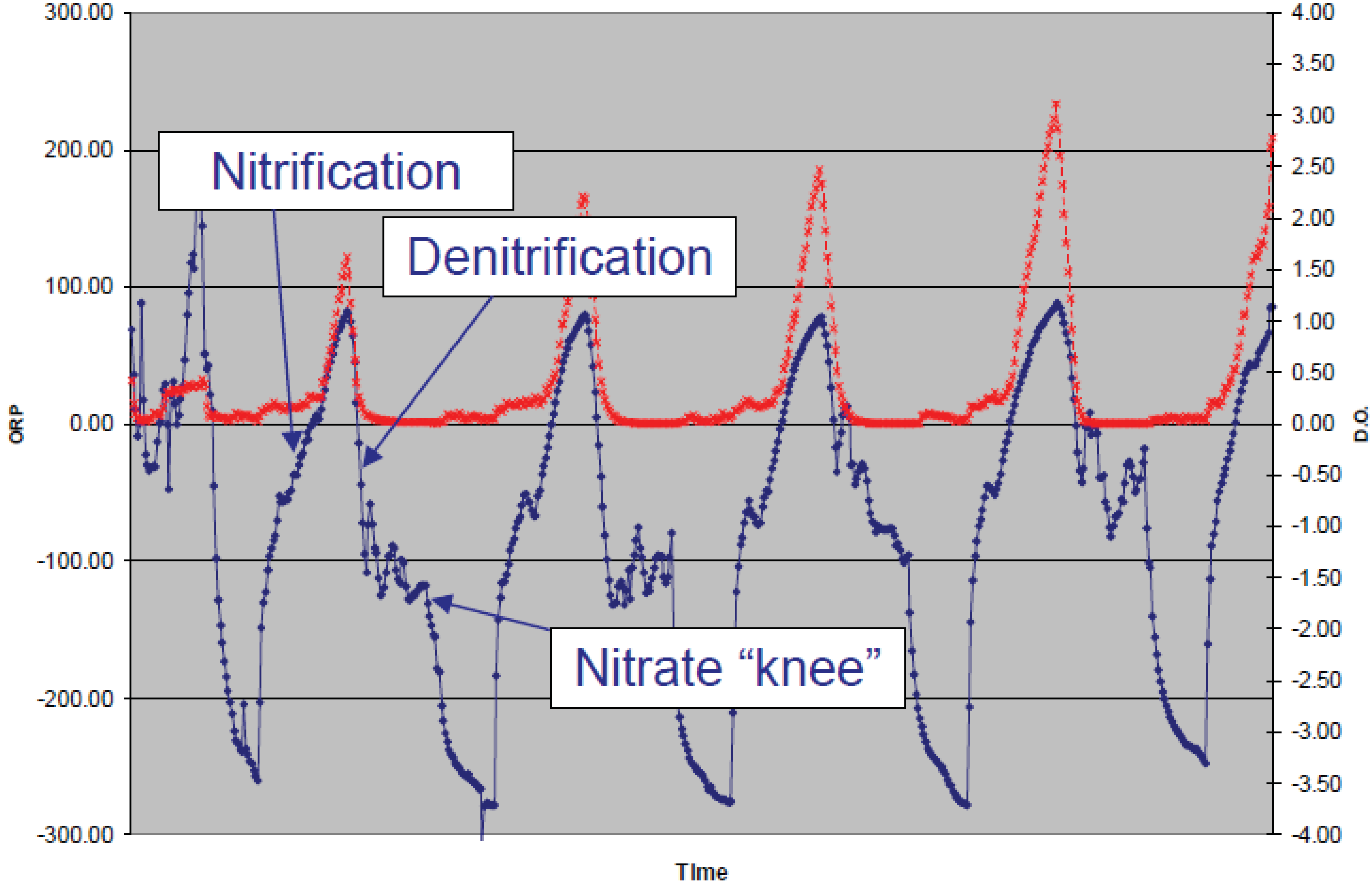
Should see values < -100mV

ORP in SBR



Dissolved Oxygen & ORP in an SBR
ORP
LDO in SBR2 (mg/L)
300.00
200.00
100.00
0.00
-100.00
-200.00
-300.00
ORP
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
-4.00
D.O.
Time

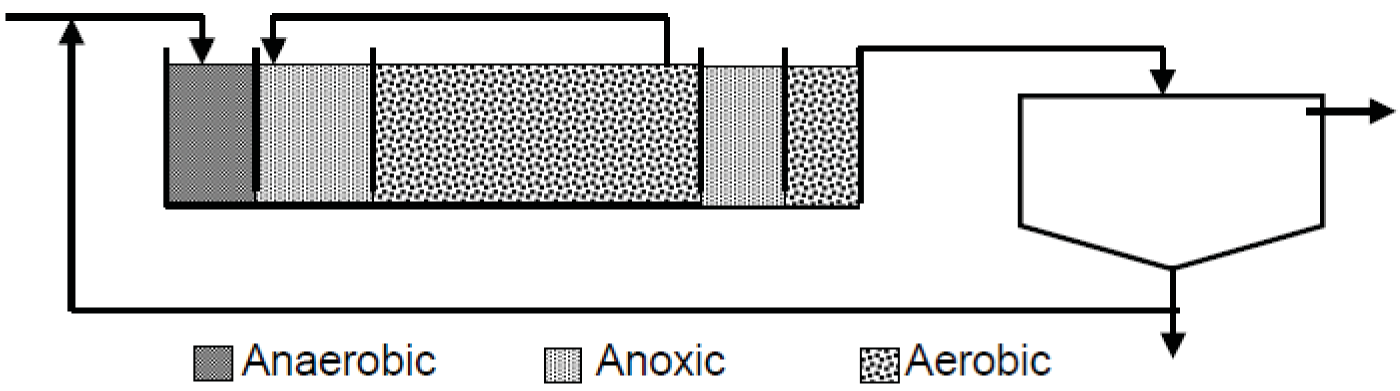
ORP in SBR



300.00
200.00
100.00
0.00
-100.00
-200.00
-300.00
ORP
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
-4.00
D.O.
Time
Nitrification
Denitrification
Nitrate “knee”

ORP in BNR

Five Stage Bardenpho



Pinery WWTP (Near Parker, CO: 2mgd, TP<0.05, TN<5.0)

Controlling first aeration at 80mV

Controlling first anoxic at -80mV

Monitoring anaerobic at -250mV

Take Home Messages

- Nutrient regulations are expanding
- Pioneers have paved the road
- Baseline data is critical for design & operation

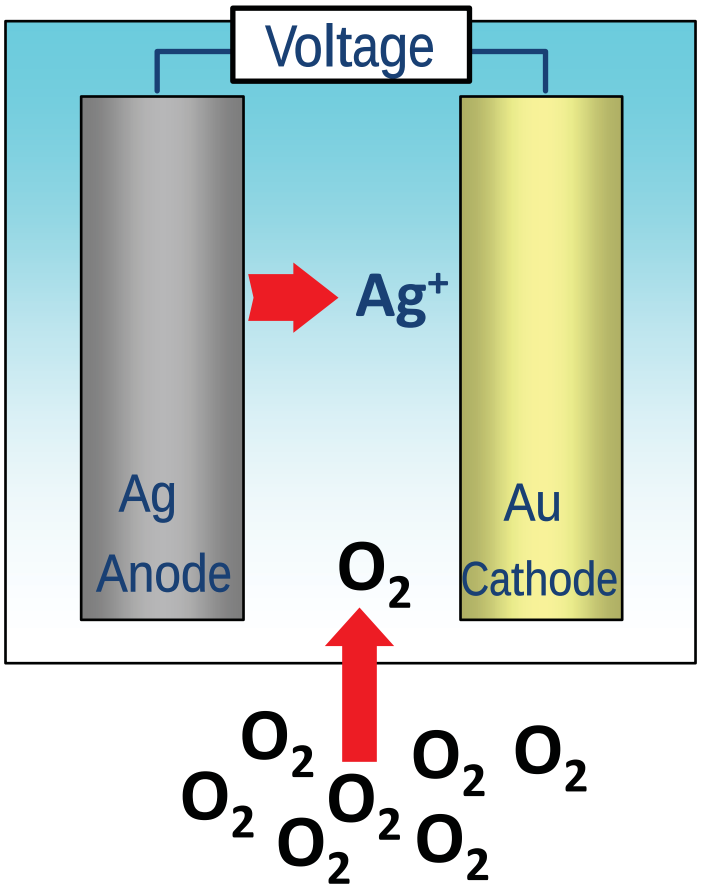
Aeration

Introduction

- Do we need to have air in the basin?
  - Aerobic Zones- **Aeration Present**
    - Dissolved Oxygen > 0.5 ppm
  - Anoxic Zones- **Oxygen depletion /except chemically bound**
    - Dissolved Oxygen < 0.5 ppm
    - Nitrate present –bugs at work!
  - Anaerobic Zones- **Atmospheric/ Dissolved oxygen not present**
    - Dissolved Oxygen < 0.5 ppm
    - No Nitrate present

Polarographic Method

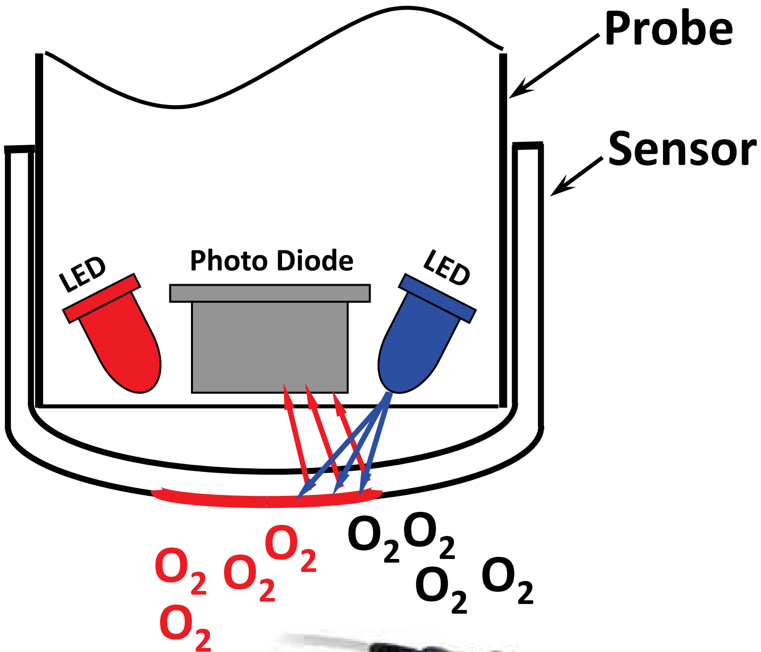
- As oxygen permeates the membrane, it is reduced at the cathode
- The current (amperage) created is directly proportional to the dissolved oxygen concentration



Steps used to combat the problem

- Began by chlorinating the RAS (common solution to deal with filaments)
  - $3,000/month
- Manually controlled blowers (increased DO)
  - 14,000 scfm
  - Twice daily DO testing with portable (old) unit.

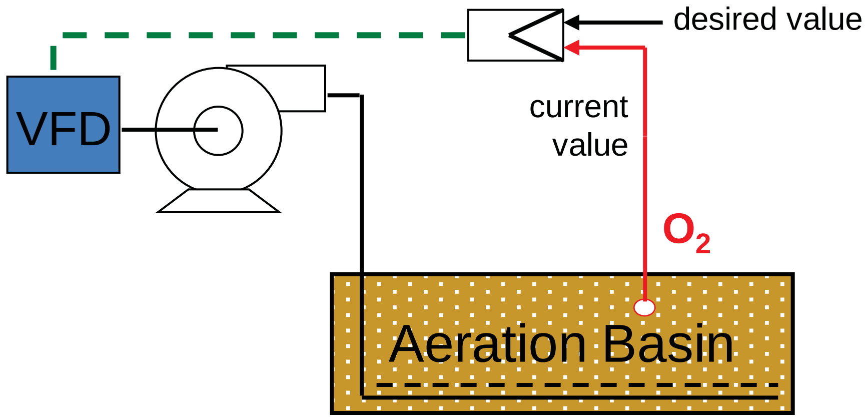
Luminescent Dissolved Oxygen



- The sensor is coated with luminescent material
- Blue light from an LED excites the material
- The excited material emits red light
- Oxygen 'steals' energy from the luminescent material
- The time it takes for the material to stop emitting light directly relates to the amount of dissolved oxygen present in the sample

Aeration Control

- Solution – Long Term
  - Automated Blower Control with online luminescent dissolved oxygen sensors (LDO)



****RESULTS****

Accurate Dissolved Oxygen Sensors

- Stopped chlorinating the RAS
- Eliminated twice per day manual testing
- Reduced blower output from 14000 to 12000 scfm
- Eliminated sensor maintenance 3x/week

= $70,000 annual savings[1]

[1] Kiser, Phil "Advances in Online Dissolved Oxygen Measurement Using Luminescent Technology". Presented at 2006 ISA Automation Week Conference

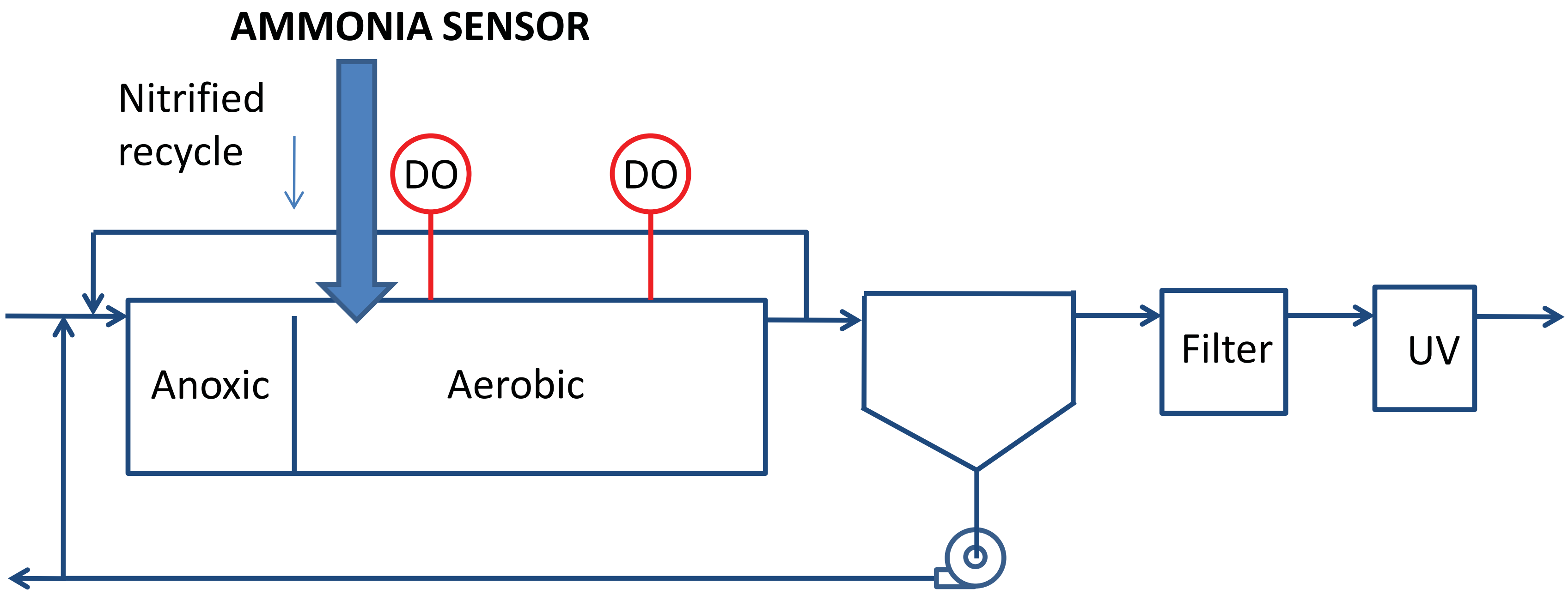
Verify online readings with a portable

.43
74.6F

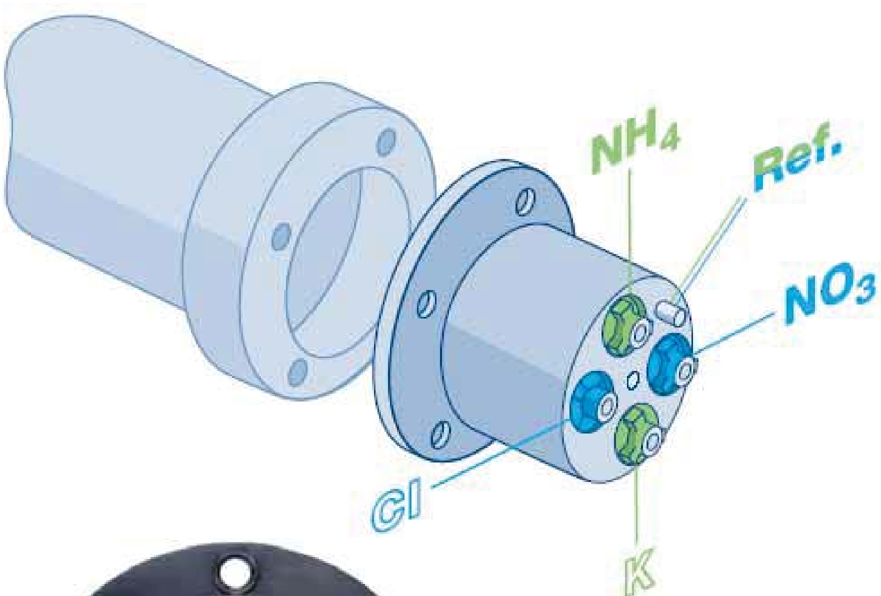
.39
75.3F

Problem

- Larger WWTP with 10mg/L TN Limit (Total Nitrogen)
- Poor Effluent Quality Forcing Construction
  - Additional Clarifier and Filter
- Have LDO sensors & use for Aeration Control
  - Ammonia sensor was faulty—repairs in Europe
- No budget for additional capital construction
- Operational budget cut by $50,000


AMMONIA SENSOR
Nitrified
recycle
DO
DO
Anoxic
Aerobic
Filter
UV

Ammonium Probe



- Ion Selective Electrodes
- Direct in basin measurement
- High Range
- Medium Precision
- Change cartridge every 3 – 6 mo

Ammonia Analyzer

- Low Range, High precision applications
- Sample Prep & Delivery:
  - Filter probe for mixed liquor
  - Filtrax for Primary Effluent
- Gasification Method
- Change reagents 3 – 6 mo

Results

- Controlling Aeration by Ammonia
- From 9,500 – 12,000 to 8,000 – 9,000 kwh/d
- $90,000/yr Energy Savings
- ROI: 2.8 Months
- Sludge Quality Improved
  - No need for additional Clarifier & Filter
  - Estimated at $3,200,000

Aeration

Suspended Solids

What are Suspended Solids?

Total Suspended Solids or TSS is defined as - the amount of filterable solids in a water sample

Why Measure Suspended Solids

- Determine the Mixed Liquor Suspended Solids
- <u>Calculate</u> the Return Activated Sludge (RAS)
- <u>Calculate</u> the Waste Activated Sludge (WAS)
- <u>Calculate</u> the Sludge Retention time (SRT)
- <u>Calculate</u> Mean Cell Residence Time (MCRT or Sludge Age)
- Determine the depth/height of the Sludge Blanket
- Determine the efficiency of the dewatering mechanics
- Solids interfere with disinfection

Control of Solids Inventory- Can:

- Allow additional capacity to be realized in individual unit processes;
- Potentially allow nitrification to be achieved without the construction of additional biological treatment capacity;
- Reduce the energy use & costs associated with aeration in biological processes
- Reduce biosolids mgnt costs by reducing the quantity of solids requiring processing
- Improve the settling characteristics of the biomass
- Improve the ease and stability of plants operations
- Result in an overall improvement in effluent quality.

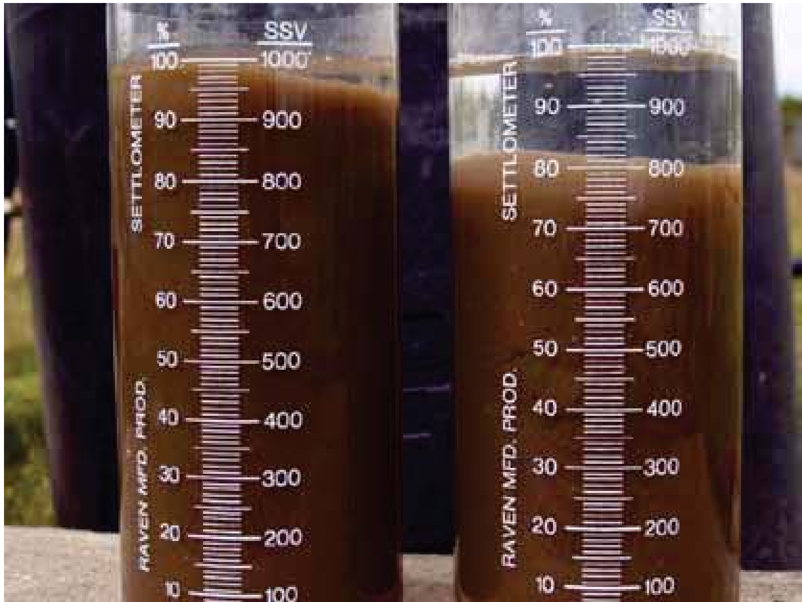
Solids Inventory Control for Wastewater Treatment Plant Optimization
Issue No. 1.0
Publication Date: March 2004
2004 Federation of Canadian Municipalities and National Research Council
SBN 1–897094–60–4

Where do you Measure Suspended Solids?

- Aeration Basin
- Influent
- Effluent
- Centrate/Filtrate
- Clarifier Effluent
- Digester Feed
- ???

Mixed Liquor Suspended Solids

- How do you currently test for it?
- How long does it take to receive your results?
- What can happen between grab samples?
- How would a real time trend of MLSS help you?
- Do you ever have settleability problems?
- Why do they happen?



Food

- Organics (BOD) in the sewage are the food for the bacteria
  - Typically more than enough food present
  - Typically cannot control quantity of food
- Need to have the right amount of food per bug
  - Food to Microorganism Ratio:

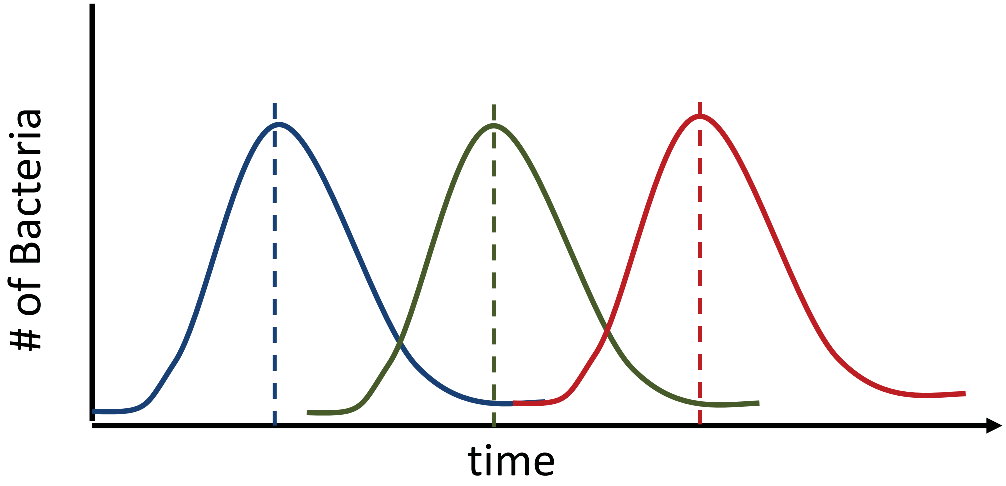
$$\frac{\text{Pounds BOD in Sewage}}{\text{Pounds of MLSS}} = \frac{\text{BOD Conc (mg/L)} \times \text{Flow (MGD)} \times 8.34}{\text{MLSS Conc (mg/L)} \times \text{Volume (M gal)} \times 8.34}$$

F:M Ratio

- Typically this is used to determine the Mixed Liquor Suspended Solids concentration (MLSS)
- Then the amount of return sludge is determined
  - Typically as % of influent flow
- The wrong F:M for your plant can lead to settleability issues
- Grab samples are usually sufficient here

Sludge Age

- The time (days) that an average bacterial cell stays in the biological system
  - "Young": < 4 days
  - "Middle age": 4 and 15 days
  - "Old": > 15 days



Sludge Age

- The right sludge age for your system means:
  - The bacteria will remove pollutants
  - The sludge will settle

- How important do you think sludge age is??!!

Sludge Age

- Calculation:

$$\frac{\text{Pounds of Solids in Aeration Basin}}{\text{Pounds of Solids Wasted in a Day}}$$

$$\frac{\text{Concentration (mg/L) x Volume (M gal) x 8.34}}{\text{Concentration (mg/L) x Flow (MGD) x 8.34}}$$

To calculate this, most wastewater plants take one grab sample from the aeration tank and one grab sample from the WAS once a day. They calculate today's sludge age from yesterday's data.

Is that good enough?

Mean Cell Residency Time

- Calculation:

$$\frac{\text{Aeration Solids (lb)} + \text{Clarifier Solids (lb)}}{\text{Wasted Solids (lb/d)} + \text{Effluent Solids (lb/d)}}$$

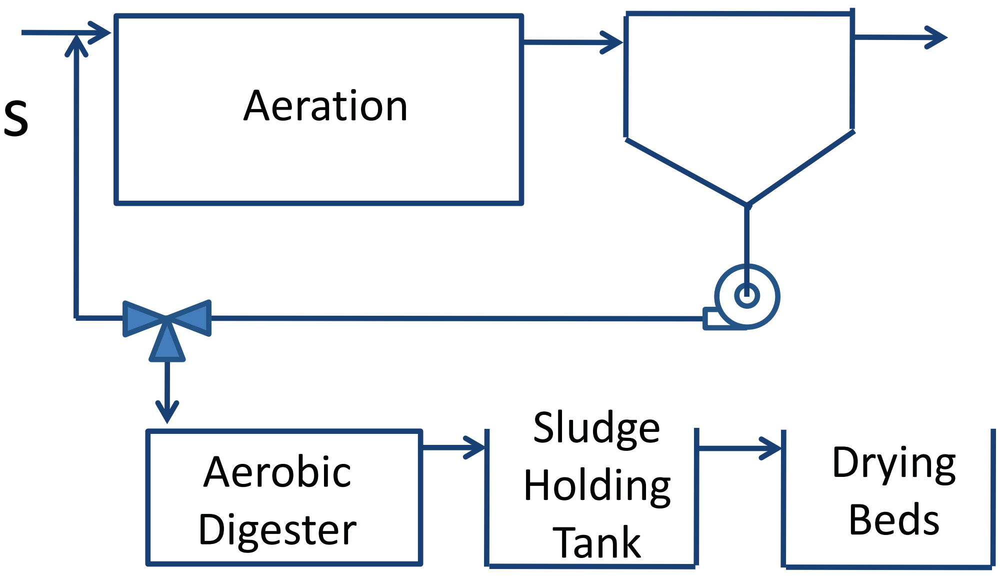
- How accurate do you want this number to be?
- In a perfect world, how soon would you like your Sludge Age/MCRT results?
- Would it save you time/money/sanity if your system did the wasting for you?

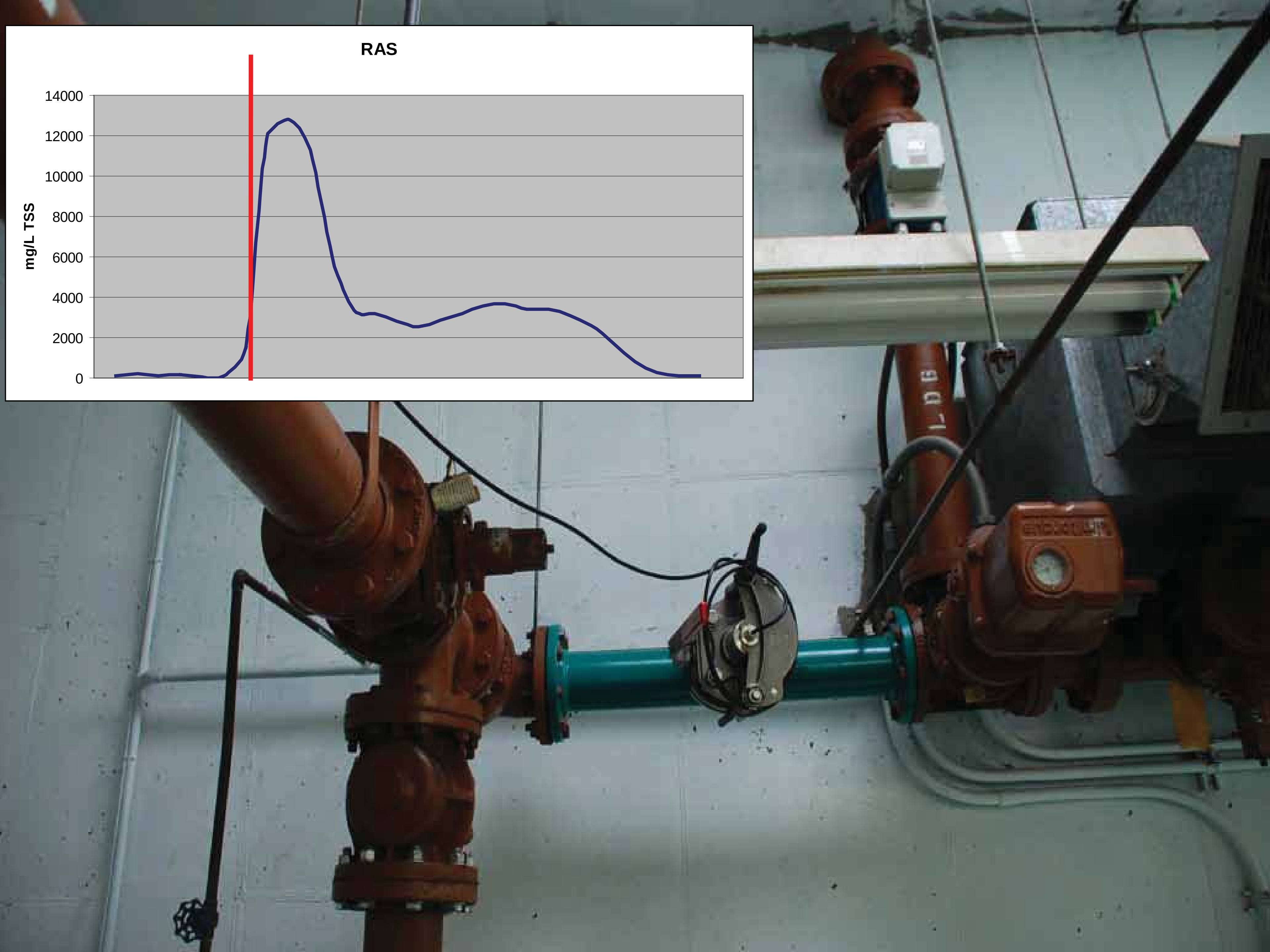
Why Measure Suspended Solids

- Determine the Mixed Liquor Suspended Solids
- Calculate The Return Activated Sludge (RAS)
- Calculate The Waste Activated Sludge (WAS)
- Calculate The Sludge Retention time (SRT) *Case Study*
- Determine the depth/height of the Sludge Blanket
- Determine the efficiency of the dewatering mechanics *Case Study*

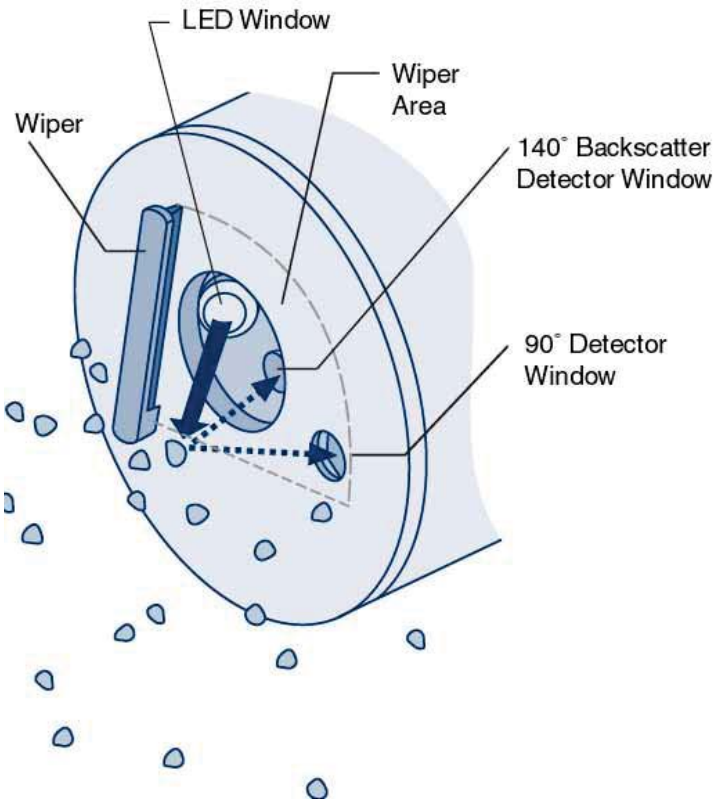
Morrison WWTP

- 100,000 gallon per day
- Extended Aeration Activated Sludge
- One Operator
- Problems with:
  - Oversized RAS pumps
    - “Off” 8 min
    - “On” 2 min
  - Aerobic Digester
    - Clear water in WAS



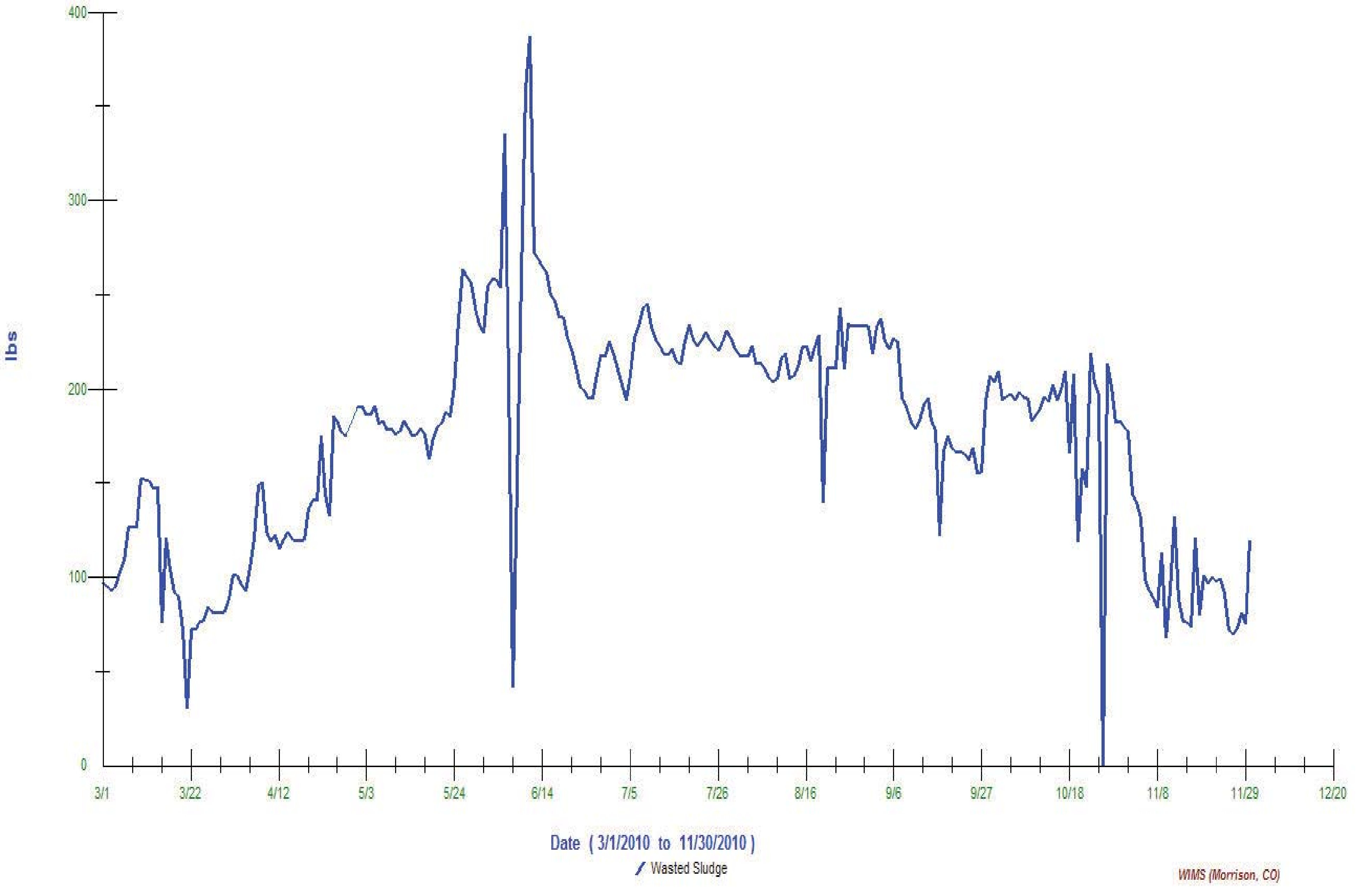

RAS
mg/L TSS
14000
12000
10000
8000
6000
4000
2000
0

TSS Sensors

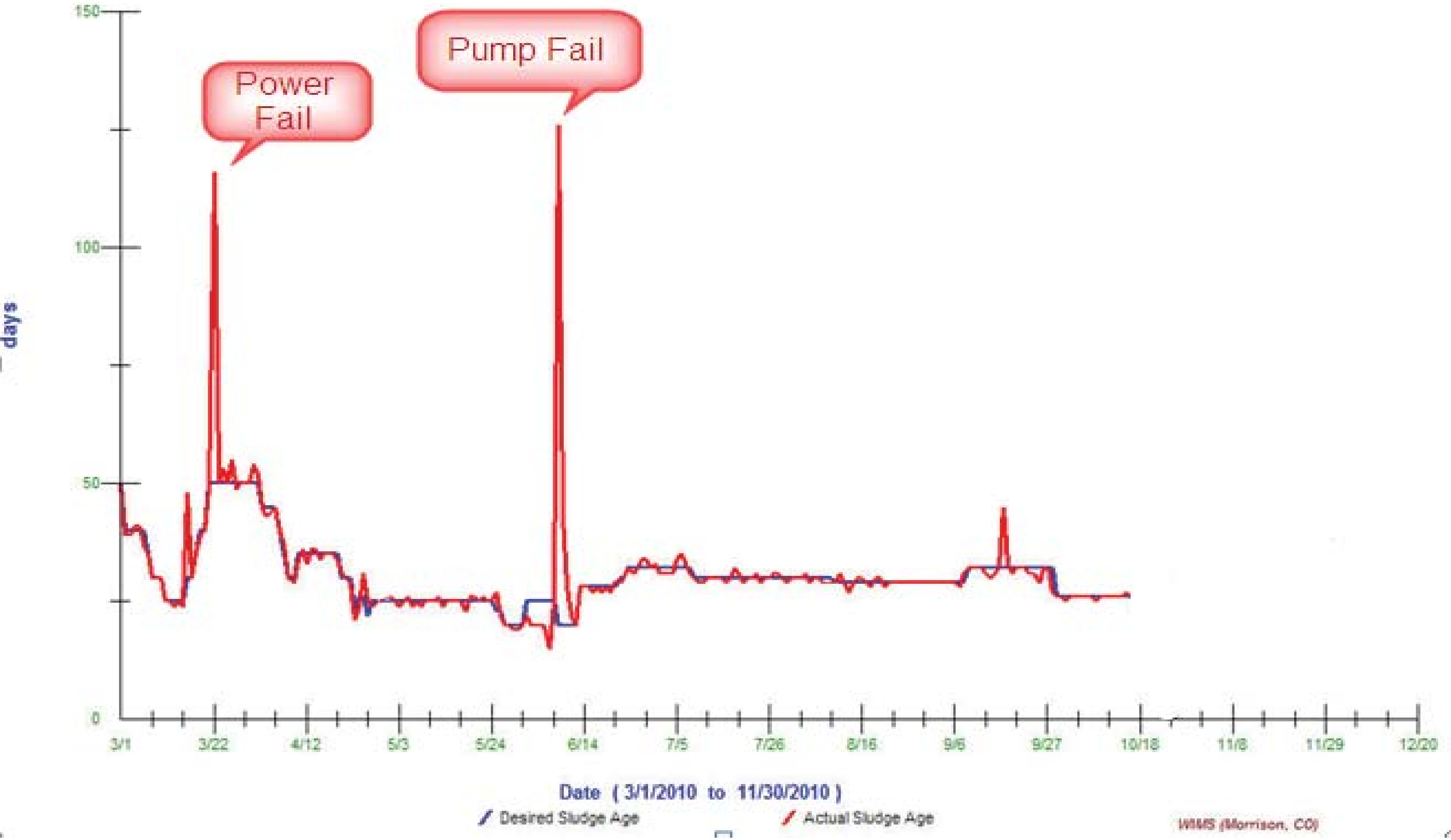


- Emit an infrared 860nm light
- 90° detector for turbidity
- 90° and the 140° detectors for Suspended Solids
- Color does not interfere
- Compensates for particle size & shape
- Range: 0.1mg/L – 15%+
- +/- 5% Accuracy

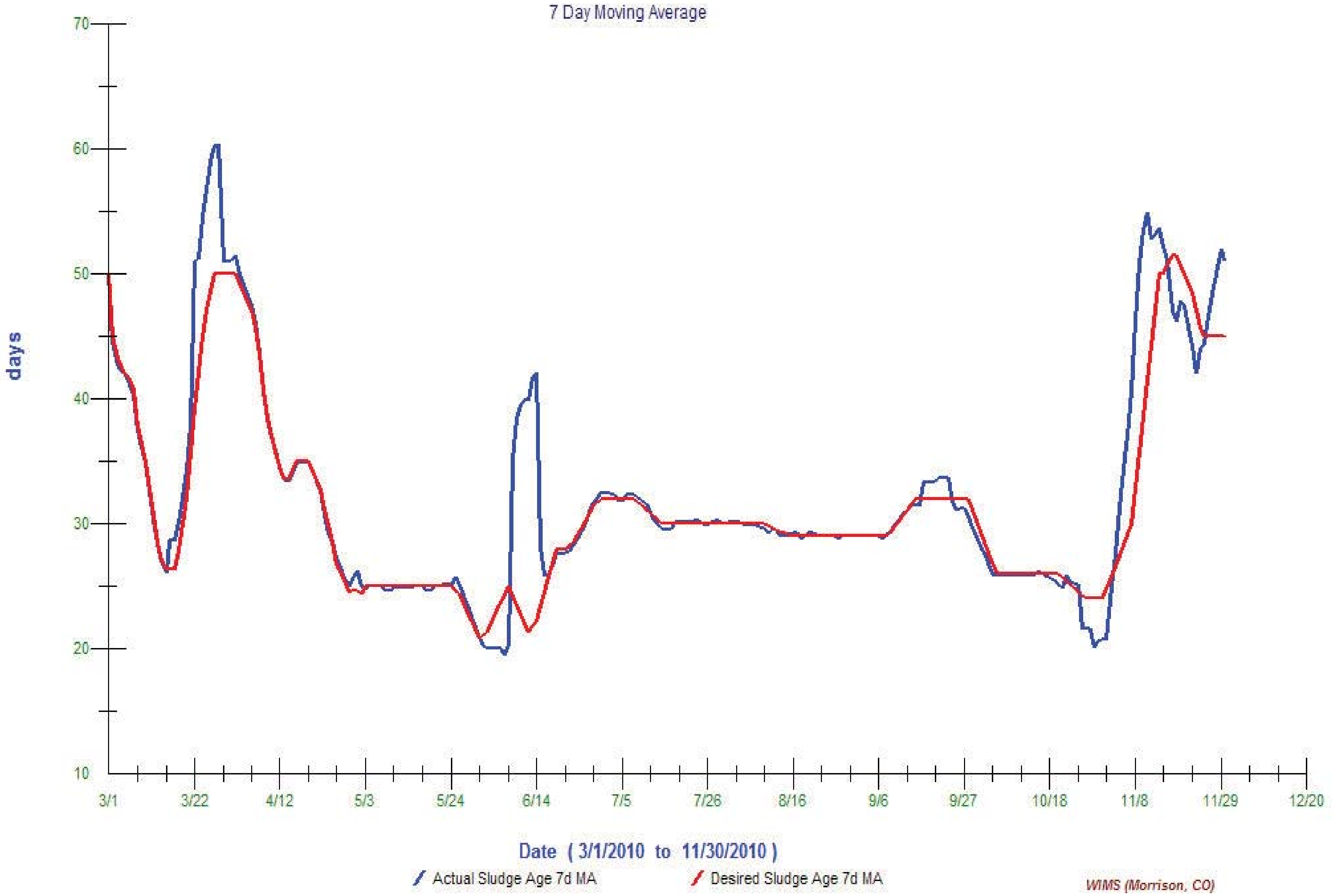
Pounds of Sludge Wasted



Desired vs Actual Sludge Age

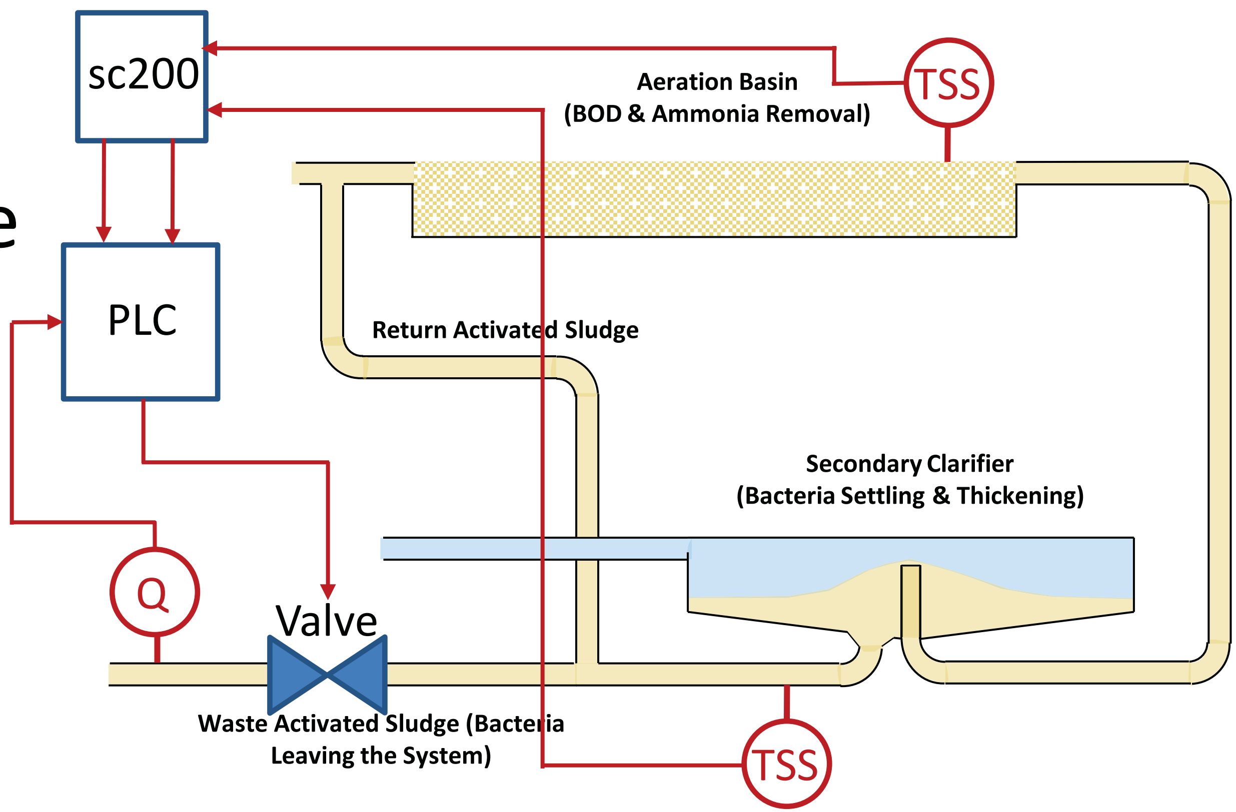


Desired vs Actual Sludge Age



Automatic Sludge Age Control

- No guessing if sample was representative
- Use today's data now
- Free up operators to other tasks



DAFT Polymer Control Issues

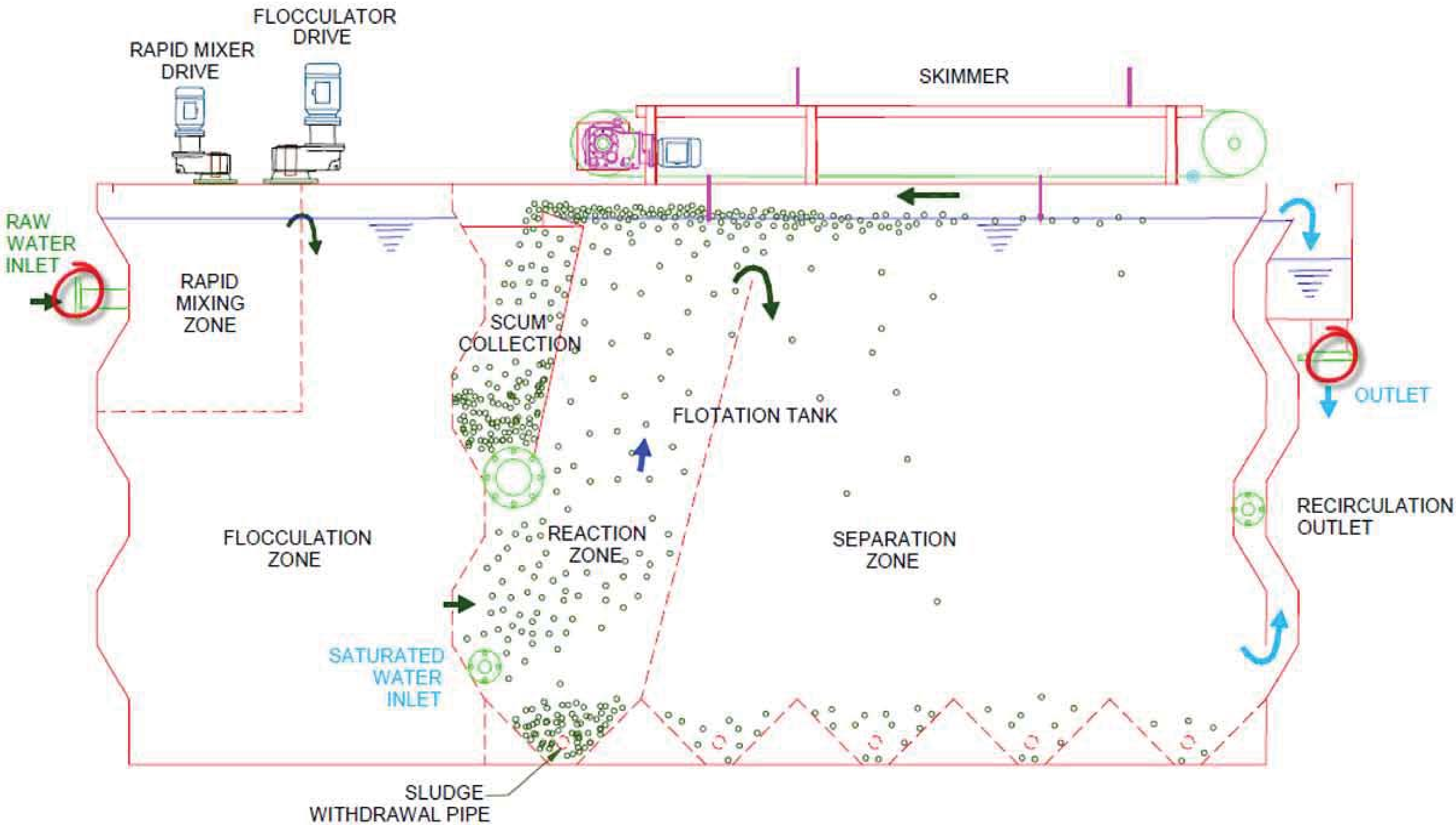
King County-

Renton Washington

-Single Loop Cascade control System

- Overfeed of Polymer
- Underfeed of Polymer
- Thickened sludge variability

DAF- Dissolved Air Flotation

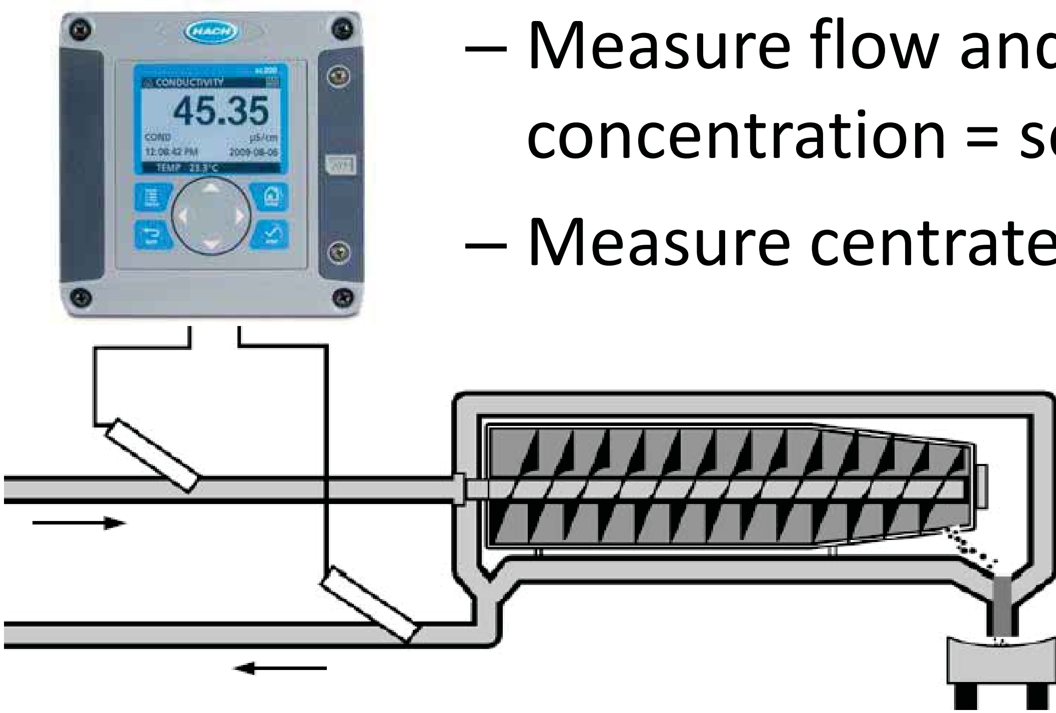


DAFT Polymer Control- Solution

- **Control Polymer dose in real time**
  - Measure flow and solids concentration = solids loading
  - Proactive vs. reactive control
  - 30% reduction in Polymer
  - Maintained 6 – 6.5% sludge Concentration
  - Low Maintenance due to self clean wiper
  - About $30,000/year savings

Removal Efficiency – Centrifuges & Belt Presses

- **Control Polymer dose in real time**
  - Measure flow and solids concentration = solids loading
  - Measure centrate TSS to trim



Belt Press Application

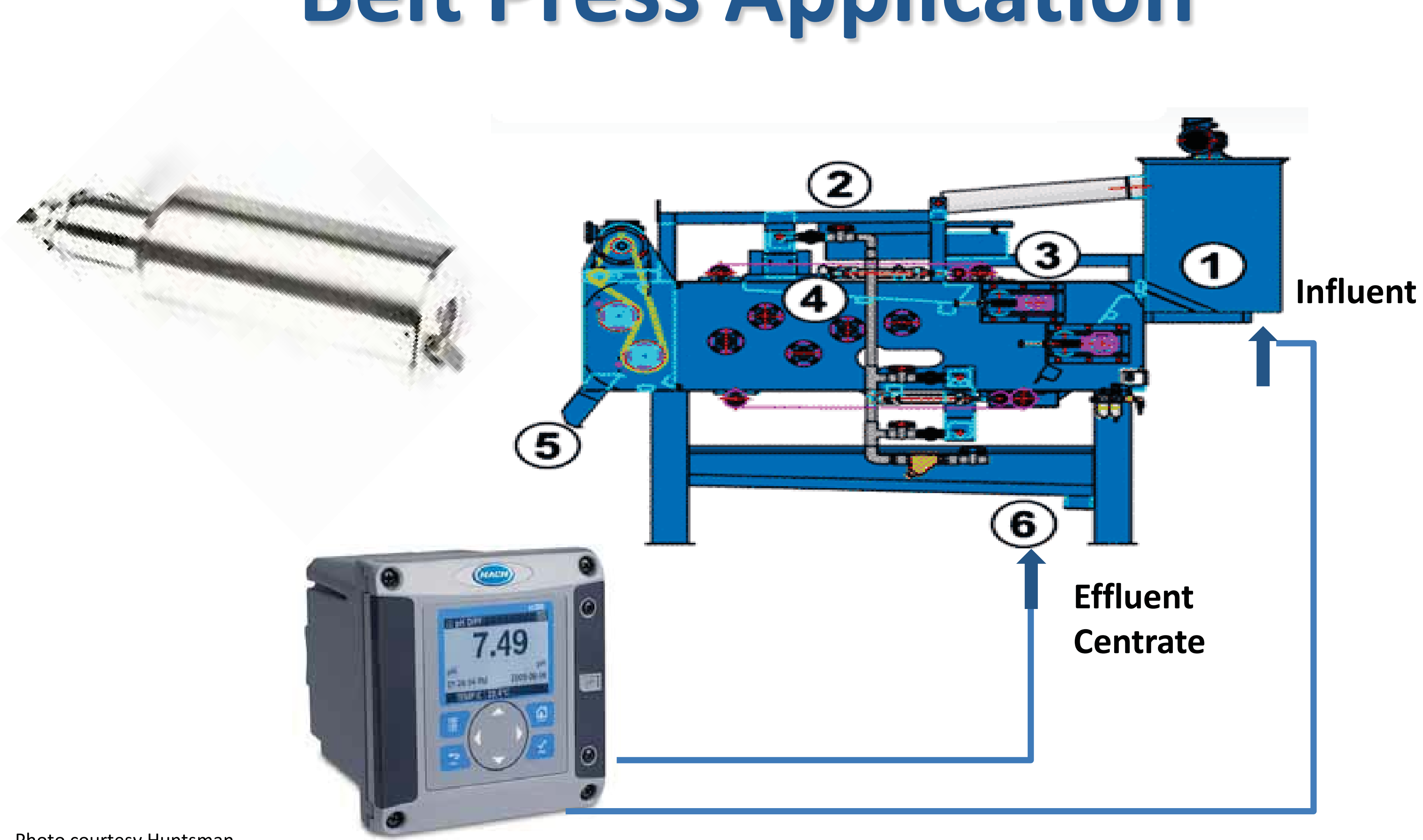
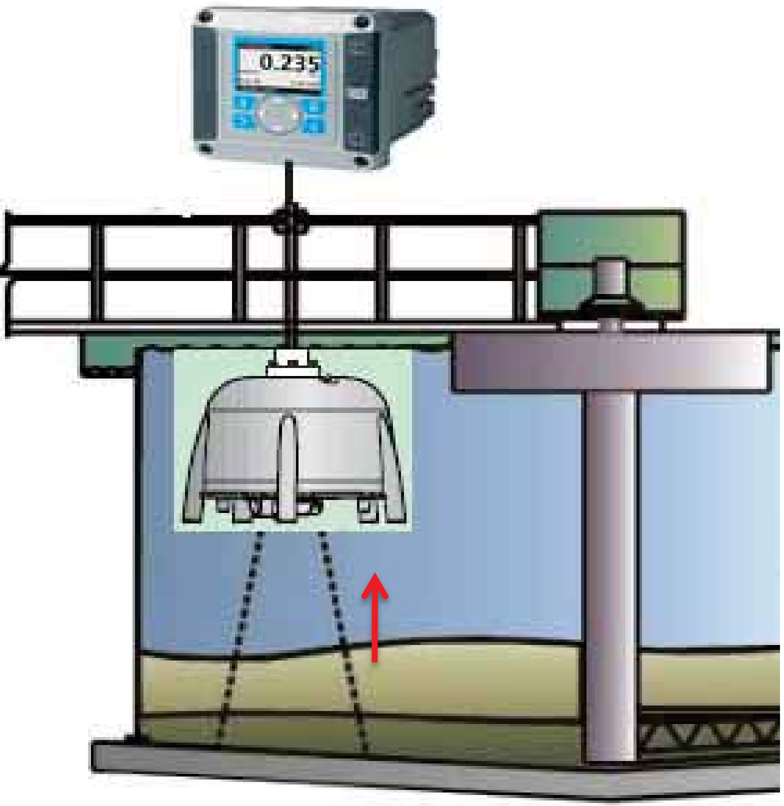
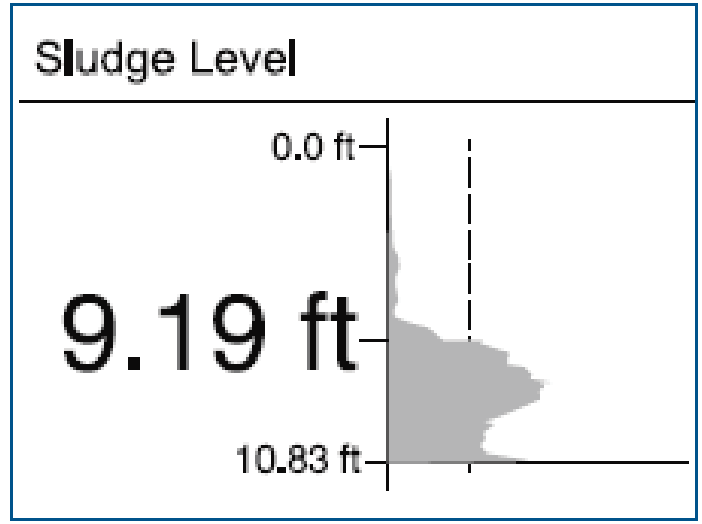


Photo courtesy Huntsman

Sludge Blanket Monitoring

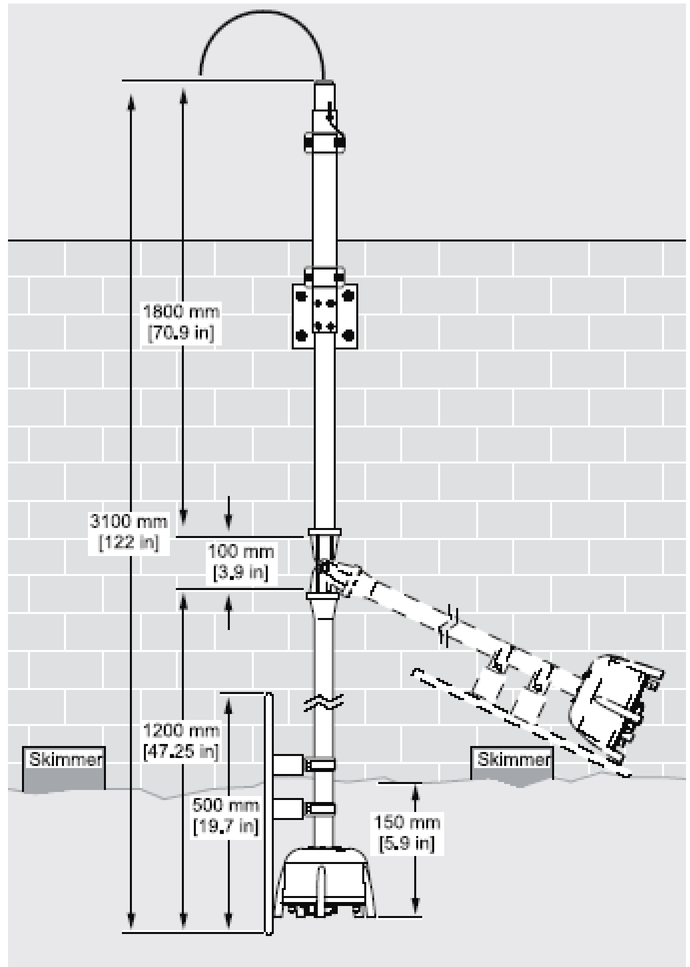


Measuring Principle



- Improved control of sludge pumping
- Early detection of Solids Washout
- Optimize sludge extraction from clarifiers/thickeners
- Reduced labor costs of manual measurement

Pivot Point Mounting



Suspended Solids Products

Other Applications

- Effluent TSS or Turbidity
- Influent TSS
- Clarifier Influent for Polymer Control
- Aerobic Digester TSS
  - Ensure volatile solids reduction

Suspended Solids

pH Applications

Wastewater Influent

Wastewater Effluent

EQ Basin

Typical pH Applications

*Wastewater treatment

*Drinking water

*Neutralization of effluent

- Steel
- Pulp and Paper
- Food
- Chemical
- Pharmaceutical

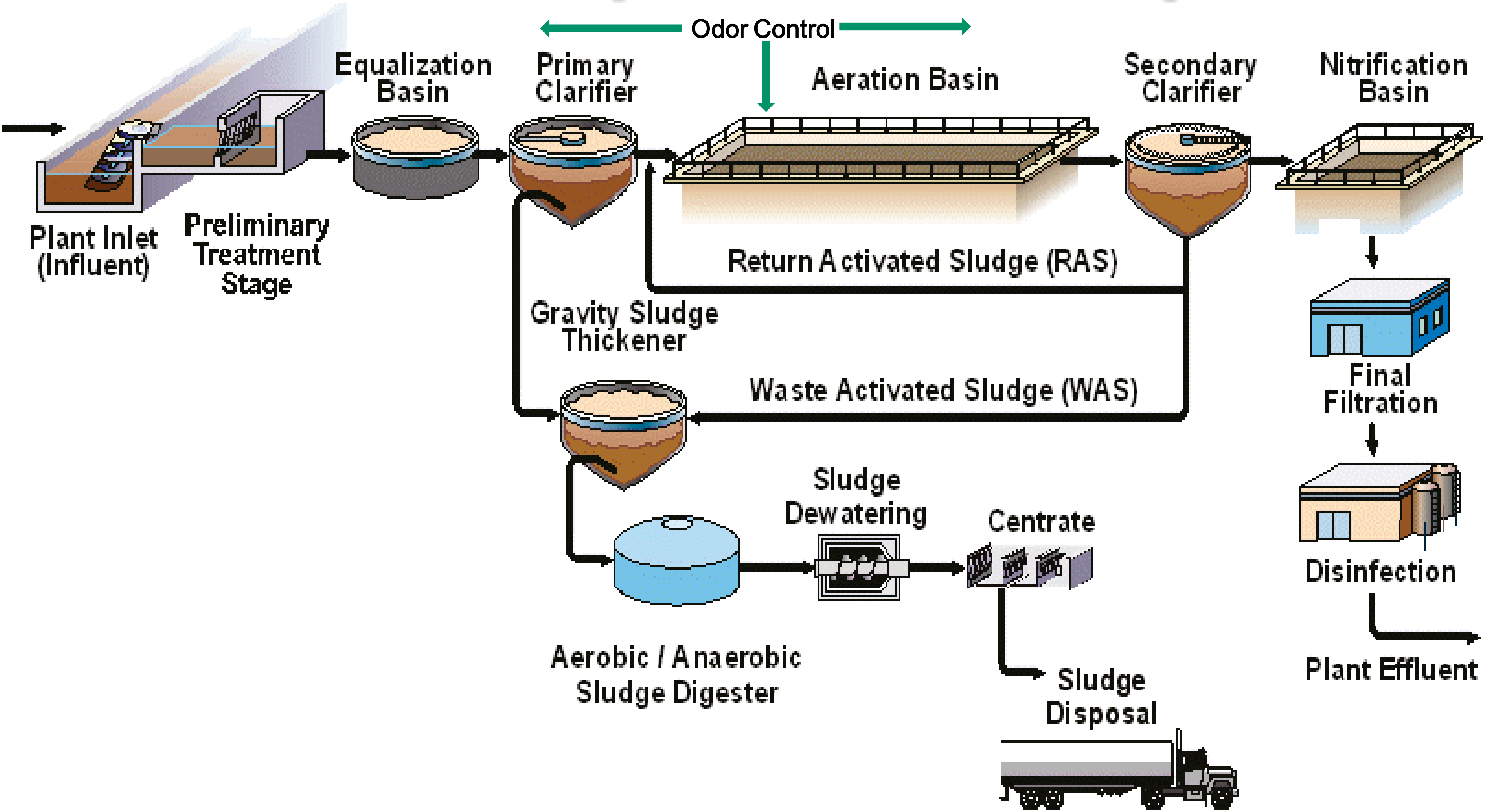
Chrome destruct

Cyanide destruct

High purity water

- Odor scrubbers
- Pharmaceutical
- Chemical & Petrochemical
- Reverse osmosis
- Cooling tower control
- Food processing
  - Carbon dioxide control
  - Cleaning
  - Canning

Where do you measure pH?



Why measure pH in wastewater?

- Inlet
  - protect biological treatment (bacteria)
- Aeration Basins/Denitrification
  - monitor biological activity
- Digester
  - control reactor pH levels (bacteria)
- Outlet:
  - protect environment (fish etc.)
- Neutralization
  - largely industrial requirement

pH Measurement Problems

- Lab vs. Online
- Fouling
- Reference Electrolyte
- Ground Loops
- Low Conductivity (industrial)
- Lifecycle
- How accurate do you need?

Process pH Accuracy

- Real life reproducibility is +/- 0.1 or 0.2 pH units if:
  - Proper Sensor Chosen
  - Proper Installation
  - Properly Maintained
- "The best results are often obtained by going to three electrodes and leaving them alone."
  - Choose the middle signal
  - Only recalibrate when:
    - Sensor is cleaned & gel layer disturbed
    - Difference between lab & process consistently large

Source: McMillan, G.K. and Cameron, R.A., *Advanced pH Measurement and Control,* 3rd Edition, ISA – The Instrumentation, Systems, and Automation Society, 2005.

Selecting the right Sensor

Industrial Environments

Process Applications

Lab Applications

High Purity Water

Complete Solutions

Dirty Samples

Technical Support

Quick Sampling

Choose the Right Sensor

Industrial Environments

- Replenish "dirty" probes with rebuildable references
- Rugged, non-glass probes keep process running safely

High Purity Water

- Electrode design optimized for fast response time
- High flowing reference junctions ensure quick reading and calibration

Process Applications

Lab Applications

Technical Support

Quick Sampling

- Rugged portable meters for rapid analysis throughout plant
- Measure multiple parameters right inside the meter – no probe needed

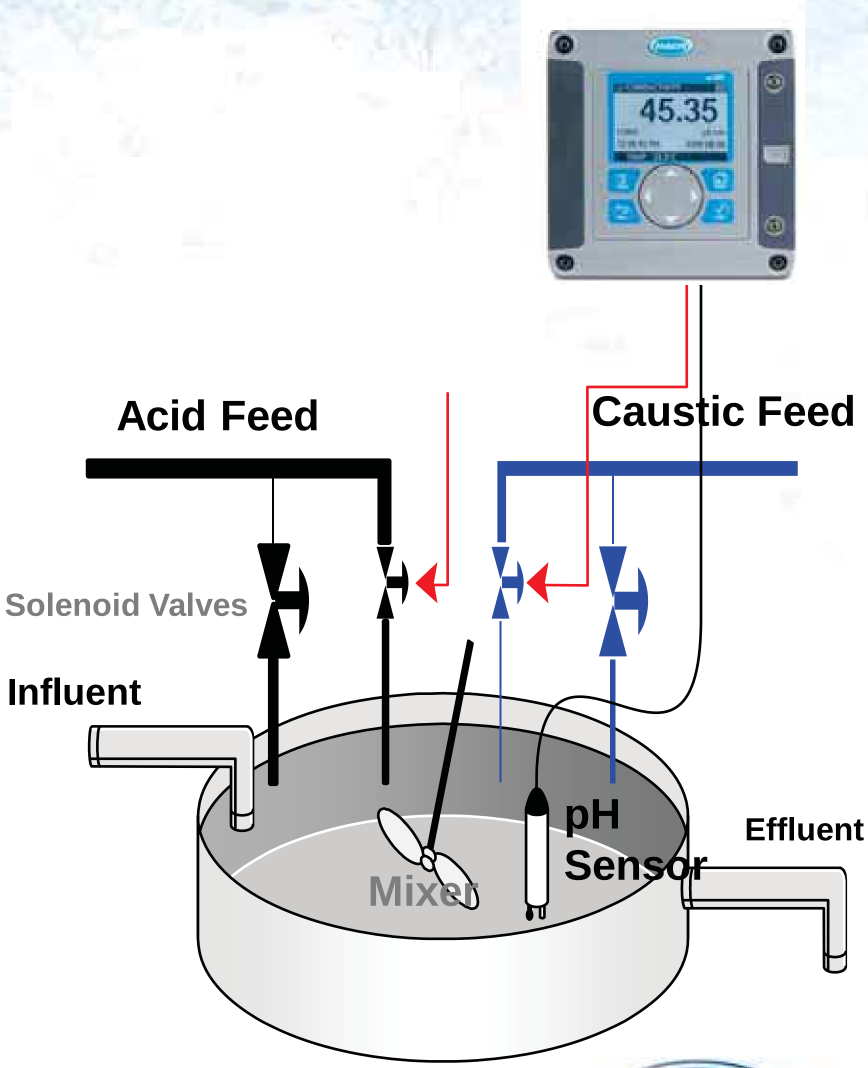
Dirty Samples

- Probe life extended with references protected from sulfides & proteins
- Clogging reduced with junctions designed for particulates and suspensions

Industrial Pre-treatment

- Industrial dischargers may send their waste directly to municipal wastewater plants.
- Acids
- Heavy metals
- Solvents

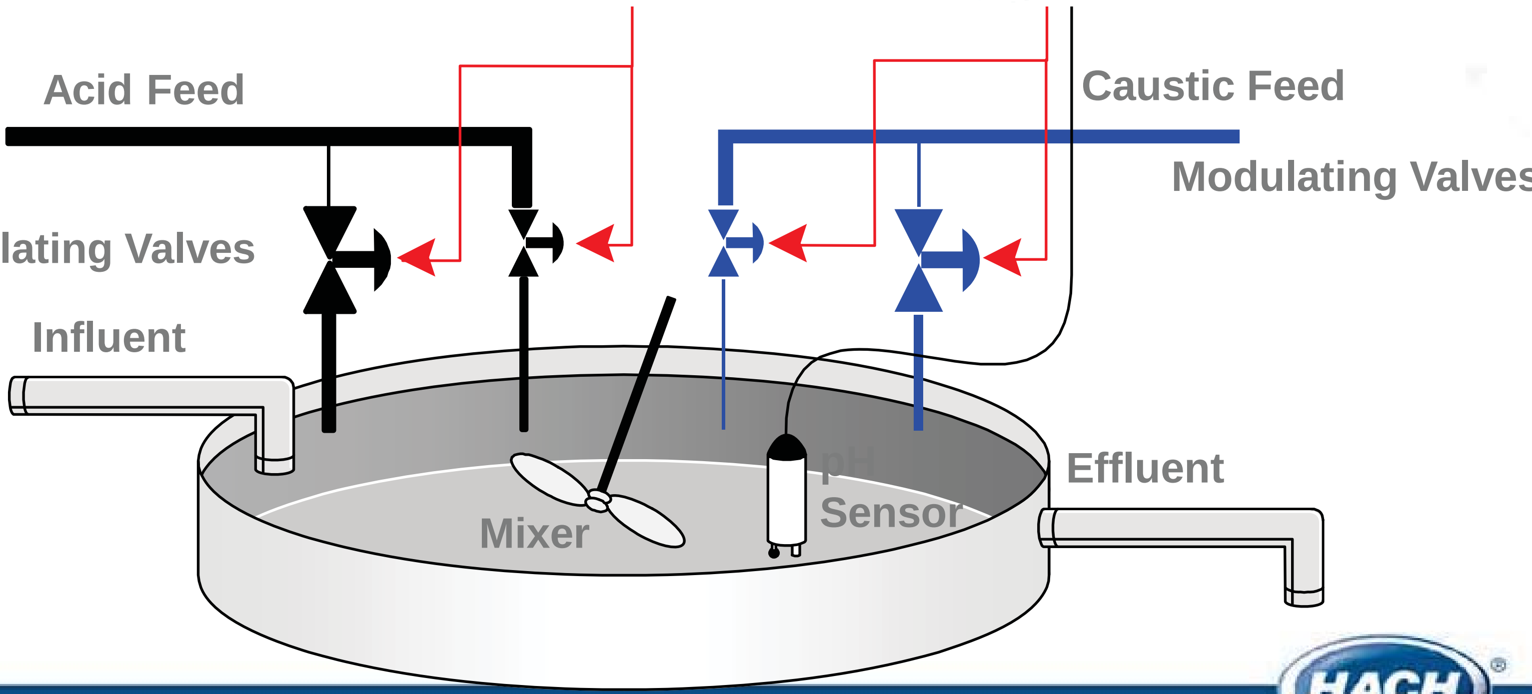
-These substances must be monitored to ensure the health of the bio-system and ensure effluent quality is not adversely affected.



pH Control

PID Control

Equalization Basin



Odor Control

Odors are released as they enter the primary clarifier and sludge drying areas. There are mechanical systems that use pH measurement to make chemical feed adjustment to control odor.

Courtesy of: Donovan Sheppard, City of Monroe, WA

Specific pH Applications

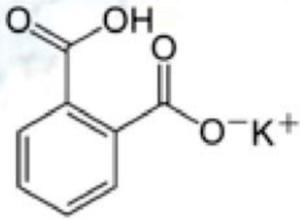
pH Applications

Wastewater Influent

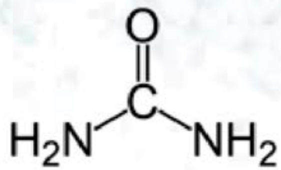
Wastewater Effluent

EQ Basin

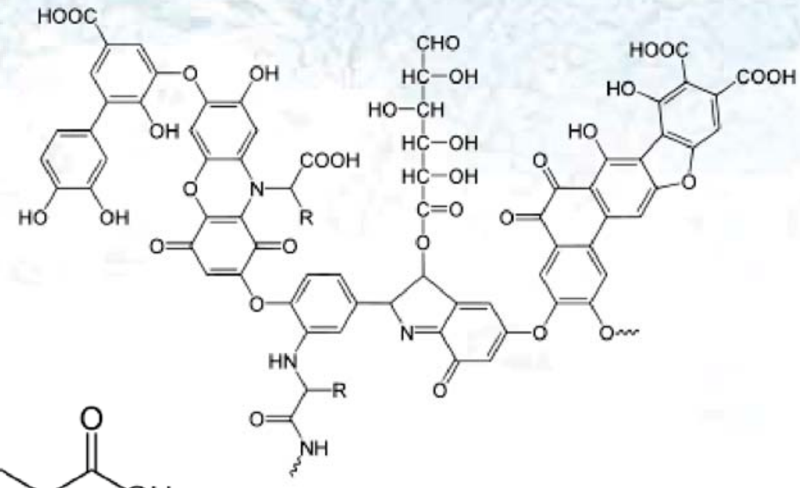
Managing Organics



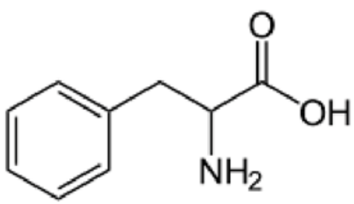
potassium hydrogen phthalate (KHP)



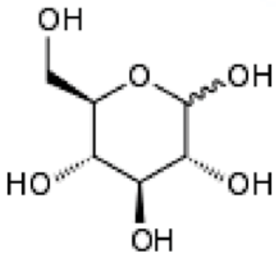
urea



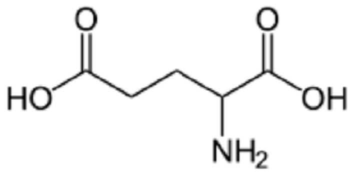
humic acid



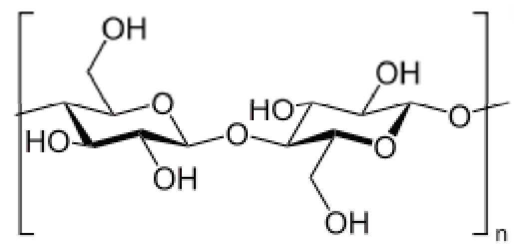
phenylalanine



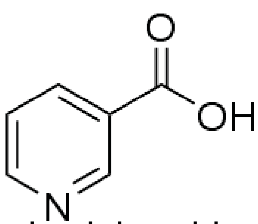
glucose



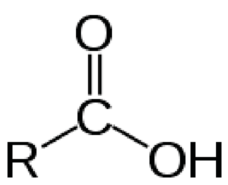
glutamic acid



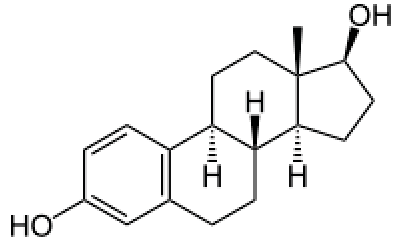
cellulose



nicotinic acid

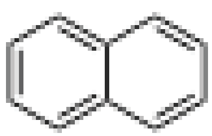


carboxylic acids



estradiol

dodecane (and other alkanes/paraffins)

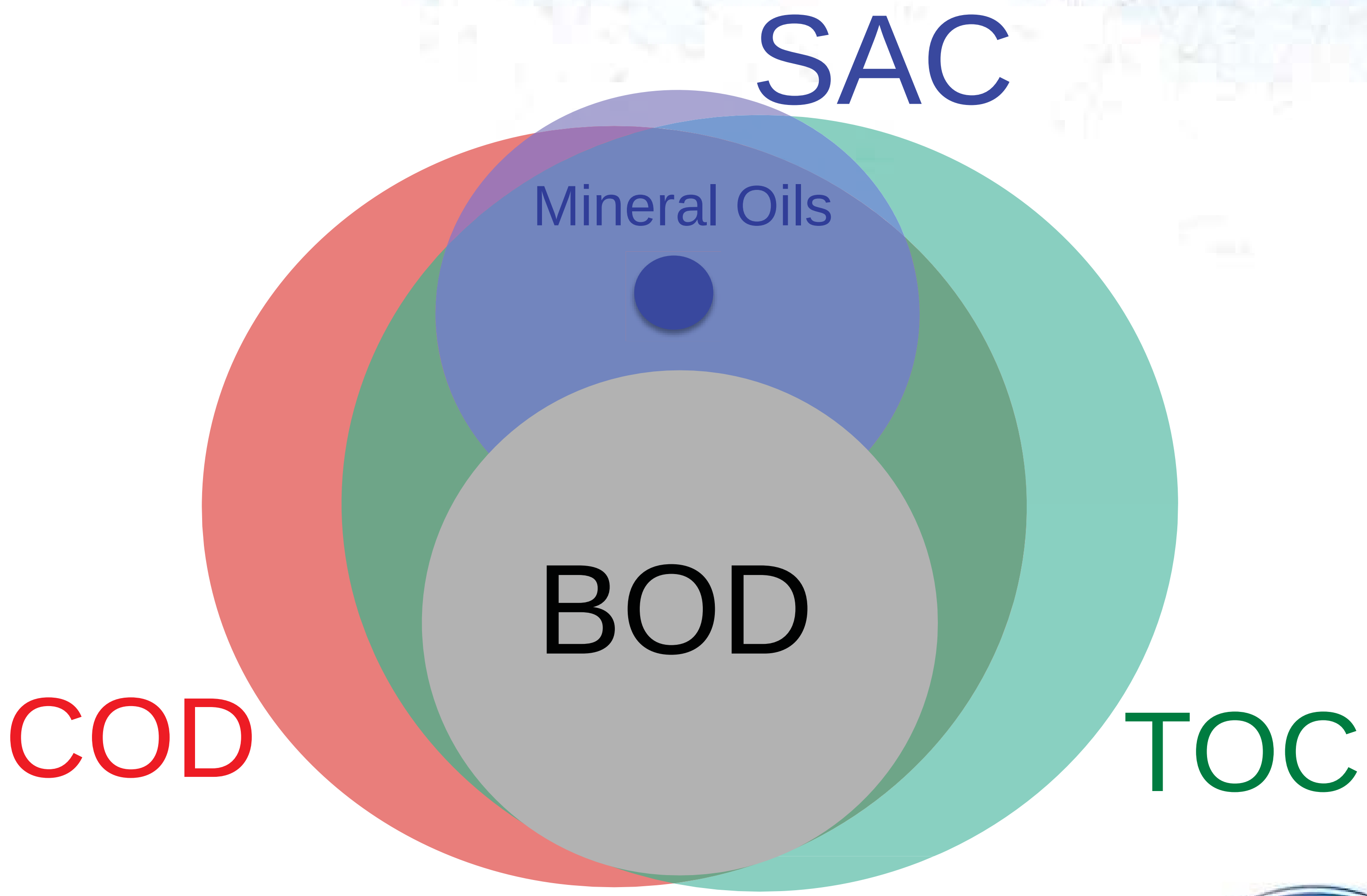


naphthalene

Biggest Issues with Organics

- BOD – is there anything that is good about it?
- Comparing BOD, TOC, UV, COD can this be done?
- Can it be used to tune the food to microorganism ratio (F/M)? What about DO?
- Waiting 2 hours or 5 days doesn’t allow me to see what is coming into my plant right now, how do I know if I have a large organic slug?

How do we Measure Organics?

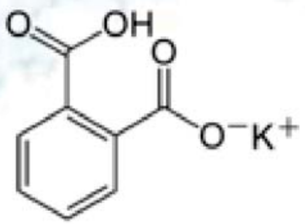


What we are seeing...

Type	Definition	Accuracy*
BOD	Bio-available organics and other compounds that can be oxidized through consumption of dissolved oxygen	15%
CBOD	Bio-available organics with an inhibiting agent added to prevent nitrogen oxidation through consumption of dissolved oxygen	15%
COD (Cr)	Chemical oxygen demand, measuring the reduction of chromium: $Cr_2O_7^{2-}$ (orange-colored) → Cr^{3+} (green-colored)	<3%
COD (Mn)	Chemical oxygen demand, measuring the reduction of manganese: Manganese Mn(III) purple-colored → Mn(II)	<3%
TOC	Total organic carbon, measuring the amount of CO_2 generated after oxidation of carbon	<3%
SAC	Spectral absorbance coefficient, measuring the absorbance of 254nm by certain organic molecules with double & triple bonds	Trending Tool

* As determined by recovery of a known standard

Organics Discussion



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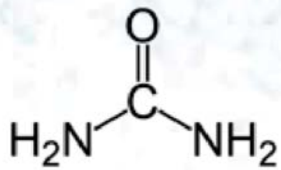
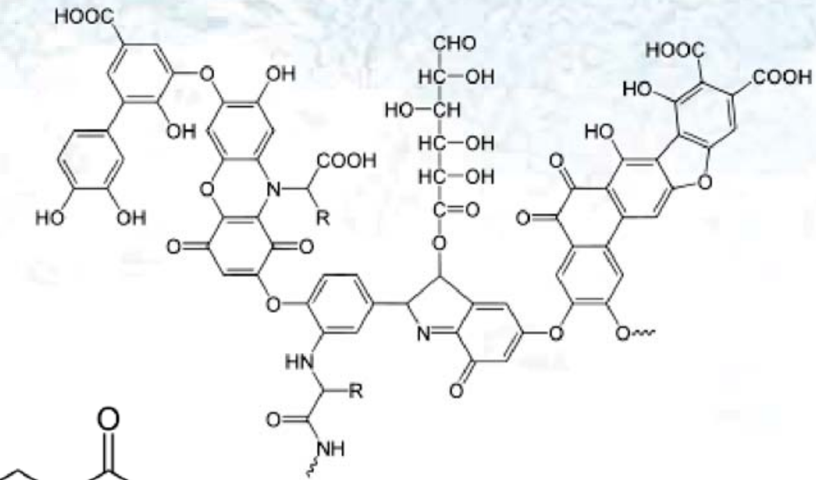
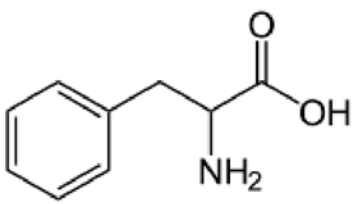


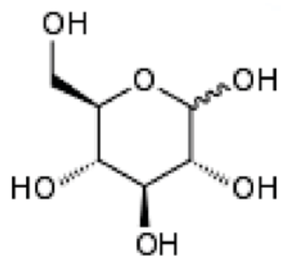
urea



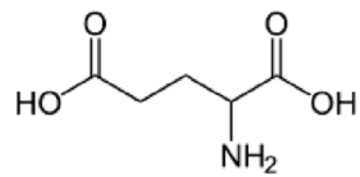
humic acid



phenylalanine



glucose



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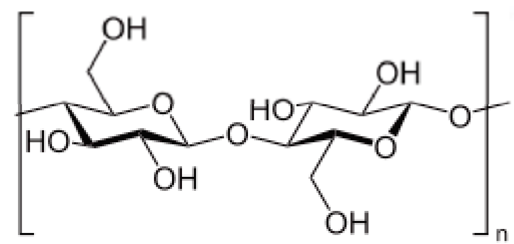

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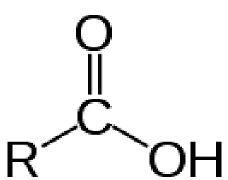
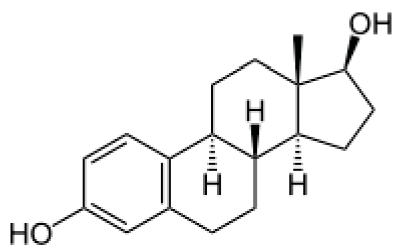
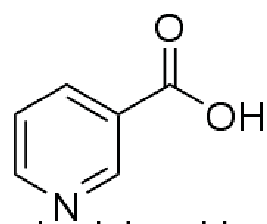


carboxylic acids



estradiol



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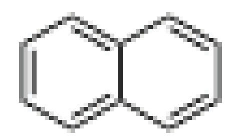


naphthalene

Key Applications and Issues with Each Measurement

BOD & CBOD

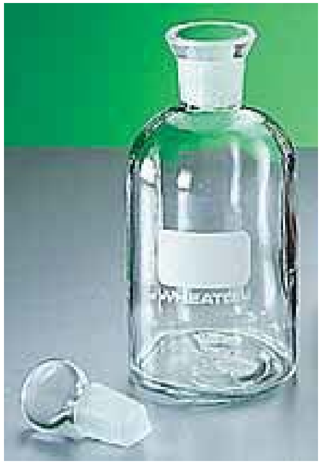
Average number of hours/week a typical WW facility spends on BOD?	15 hours
Average number of bottles set per week for BOD?	21 bottles
Average number of times per week BOD is run?	2 sets
Percent of BOD tests that FAIL to meet Standard Methods Guidelines?	5-10%

Issues and Root Causes

Failure Mode	Key Root Cause(s)
Blank depletion	Organic contamination in dilution water or bottles Drift in DO sensor
Effluent fails to achieve 2 ppm depletion	Insufficient nutrient or seed Toxicity
Fail G/GA reference	Inaccurate G/GA Toxicity Insufficient seed

www.boddoctor.com

Products for BOD



Chemical Oxygen Demand

- COD is a measure of the oxygen demand of a sample that is susceptible to oxidation by a strong chemical oxidant

- Not all organics are susceptible to oxidation by the COD method

Common Uses of COD

- Please share how you use COD…

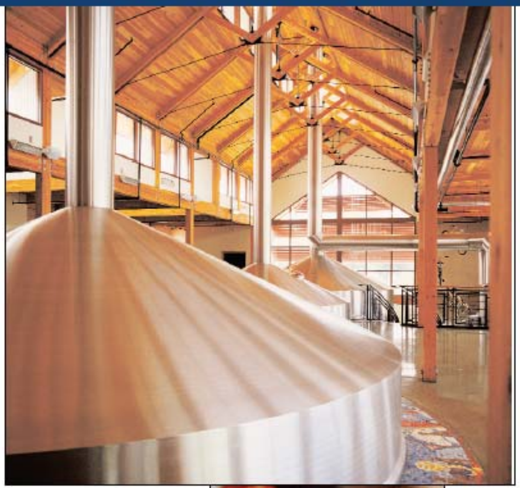
- Food estimate?
- Tracking industrial dischargers?
- Anyone charging industrial discharges based on COD instead of BOD?

COD for Rapid Organic Estimates

Hach COD— Treating Brewery Process Water On Site

Process Water Conservation, Treatment & Recycling Minimizes Water Consumption

by Mandy Miller



New Belgium Brewing Company today reuses much of its process water for evaporative cooling, cleaning, and landscape purposes. On-site digestion by aerobic and anaerobic bacteria to reduce the organic components in process effluent, coupled with a continuous testing program to accurately monitor the most important sources of high organic loadings within the brewery, have been important keys to the breweryís successful process water treatment and re-use program.

For every barrel of beer a typical brewery produces, an average of eight to 10 barrels of water are consumed. New Belgium Brewing Company in Fort Collins, Colorado, produces one barrel of beer using about four barrels of water, thanks in part to a strong company-wide commitment to resource recovery that includes on-site process water treatment and an ambitious water re-use program.

New Belgium Brewing Company is the fifth largest craft brewery in the country; it produced more than 320,000 barrels of beer in 2004, including the breweries flagship brew, Fat Tire Amber Ale. The company strives to be on the cutting edge of technology to best meet its high objectives for environmental

has a rated capacity of 80,000 gallons/day. Average daily flows for 2004 was 58,274 gallons, and the plantís total outlet flow for the year was about 20 million gallons.

The automated process water treatment plant, supplied by German systems provider Von Nordensköld, includes a three-stage anaerobic digester, an aerobic lagoon,

The COD Problem…Waste…

- EZ COD recycling
  - Fill bucket with used COD Vials
  - Heritage Environmental will pick up and recycle
- Mercury Free COD
  - TNTplus packaging
  - Not EPA approved
  - Only for low-chloride waters

Products for COD

Rapid Organics Assessment

Total Organic Carbon

Fluorescence

UV254

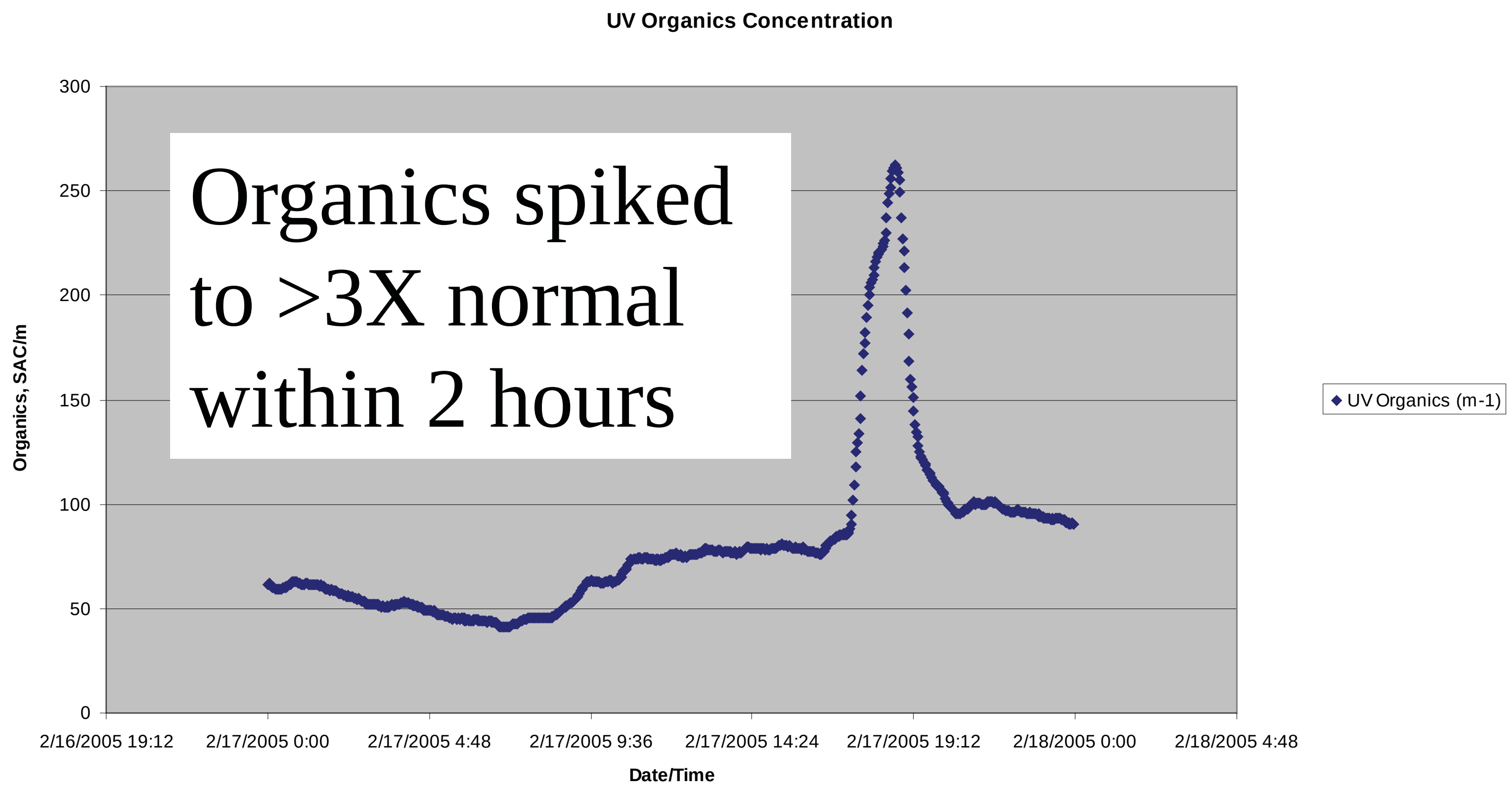
Time…the Achilles Heel of Organics Measurements

- BOD5 – 5 Day Procedure
- COD – 2-3 Hour Procedure

- Organics can be monitored using other technologies for more rapid assessment

What if this was your facility?

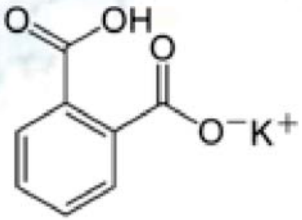
- Organic spike from 75 sac/m to >250 sac/m
- What do you do?



Total Organic Carbon

- Anyone tried TOC on Wastewater???
- Most facilities that try on-line TOC pull them off line
- Why??? They are complex analyzers with tiny tubes that require frequent calibration, maintenance, and rebuild

TOC Organics Discussion



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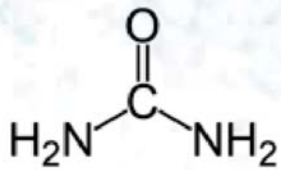

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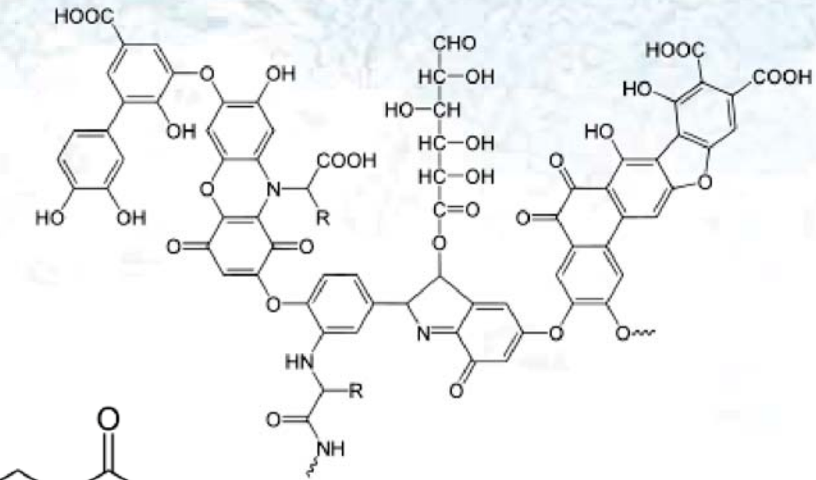
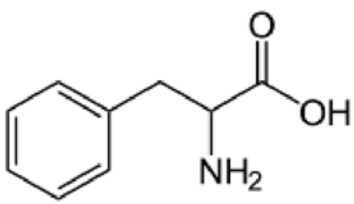


humic acid



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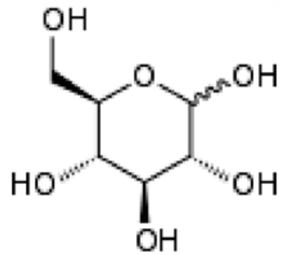
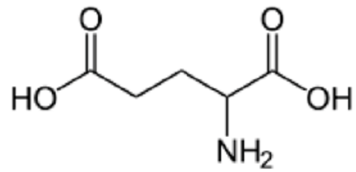


glucose



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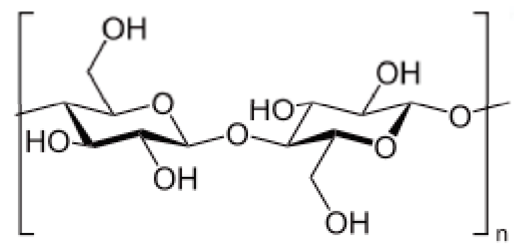

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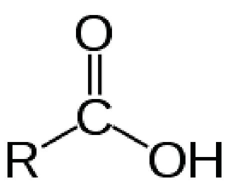
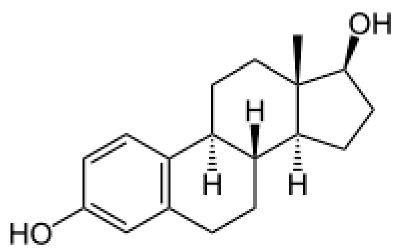


carboxylic acids



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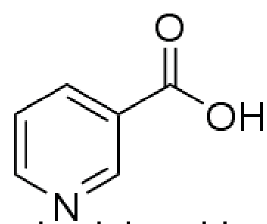

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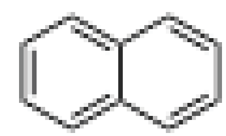


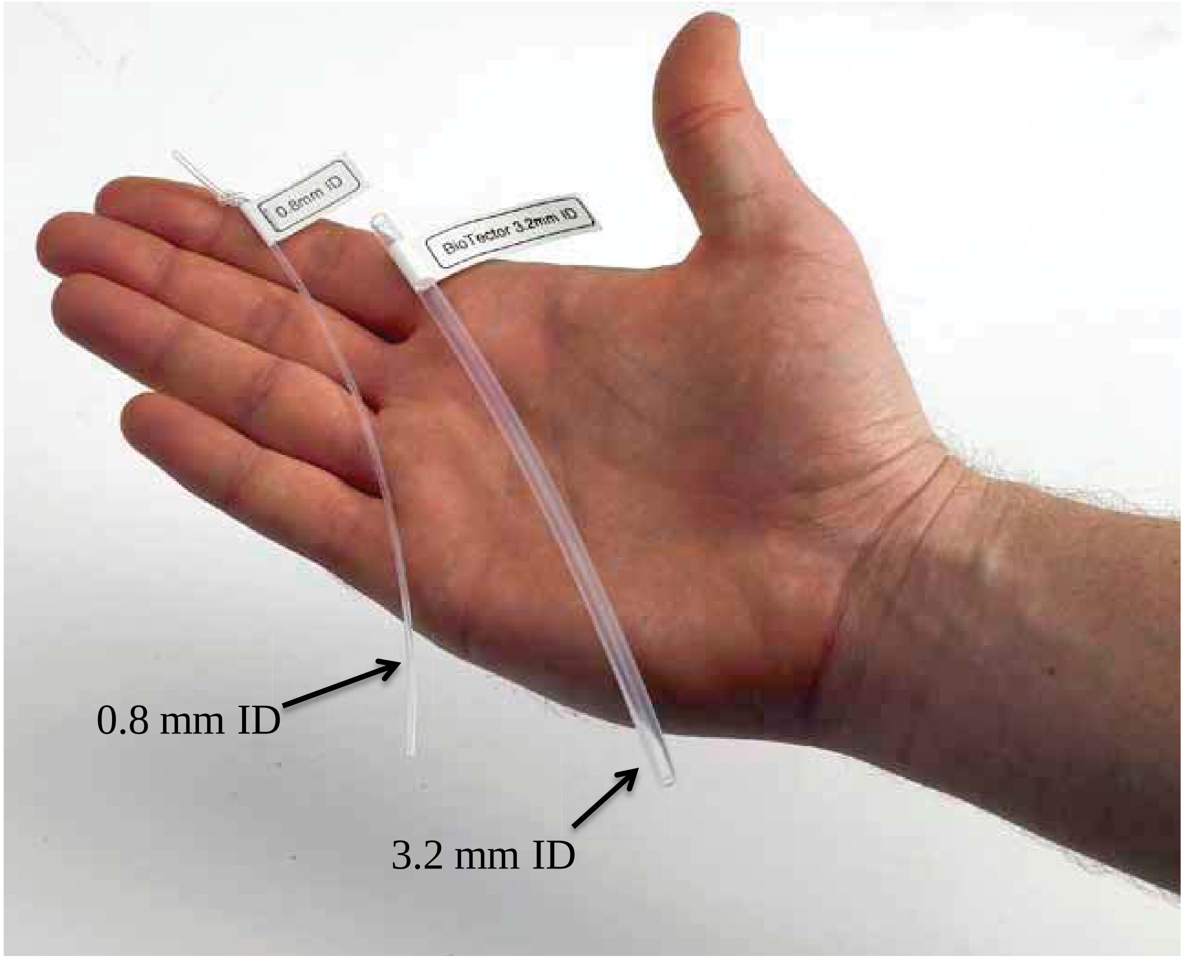
naphthalene

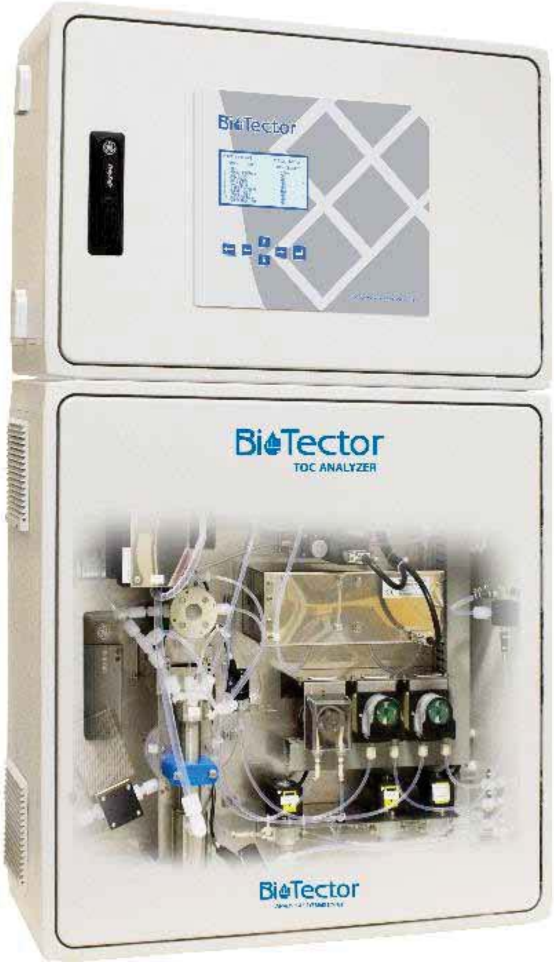
Online Total Organic Carbon

- Digestion with Ozone and Hydroxyl Radicals
  - Converts all organic carbon to CO_2
  - Direct measurement of CO_2

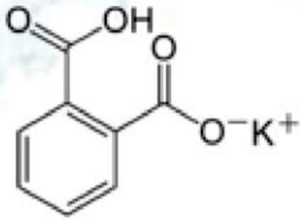
- Range: 0.3 – 100,000 mg/L C
- Accuracy: +/- 3%
- Avg. < 8 min. cycle time
- Automatic cleaning
- Scheduled (routine) maintenance every 6 months, period!

Online Total Organic Carbon





UV254 Organics Discussion



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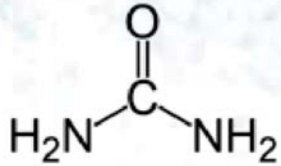

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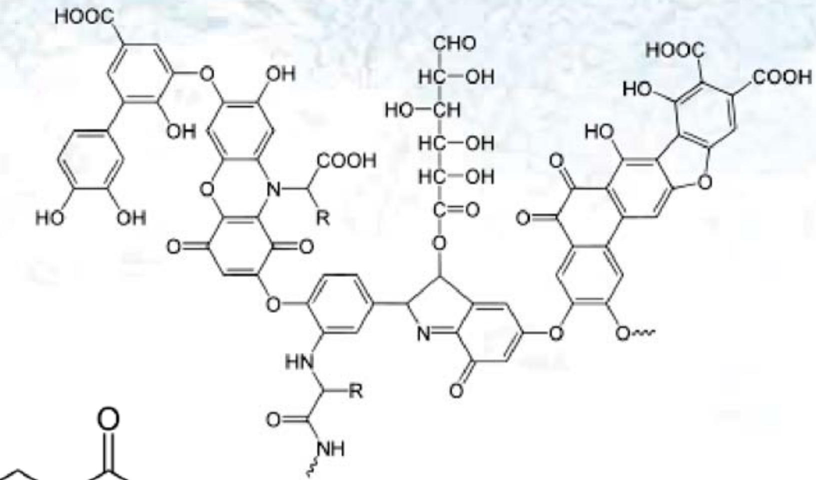

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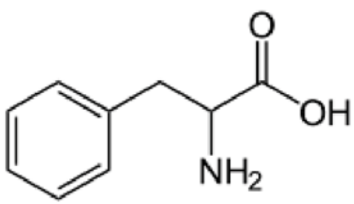

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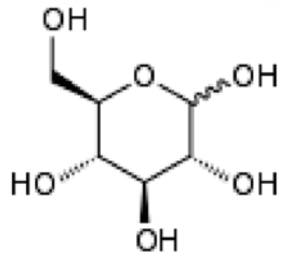
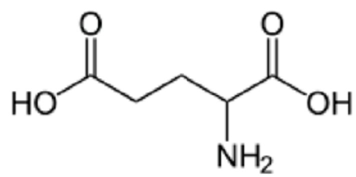


glucose



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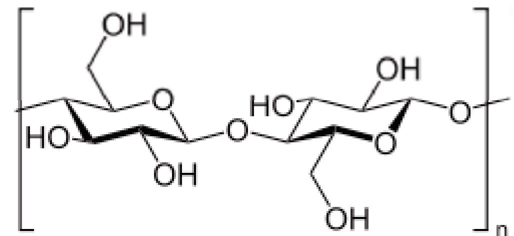

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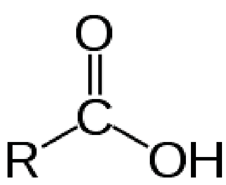

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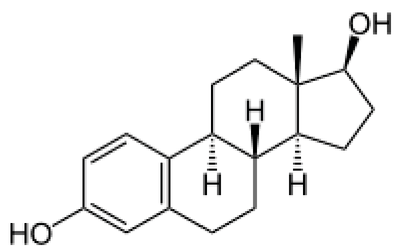

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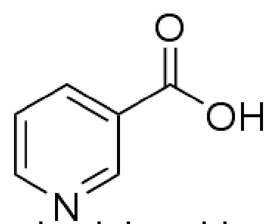

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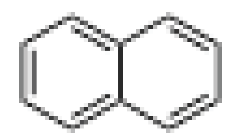


naphthalene

Spectral Absorbance Coefficient

- Absorbance of 254nm light (UV254)
  - Double and triple bonded organics
  - Single bonded organics do not absorb 254nm
- No chemicals or reagents necessary
- Lab method with Spectrophotometer

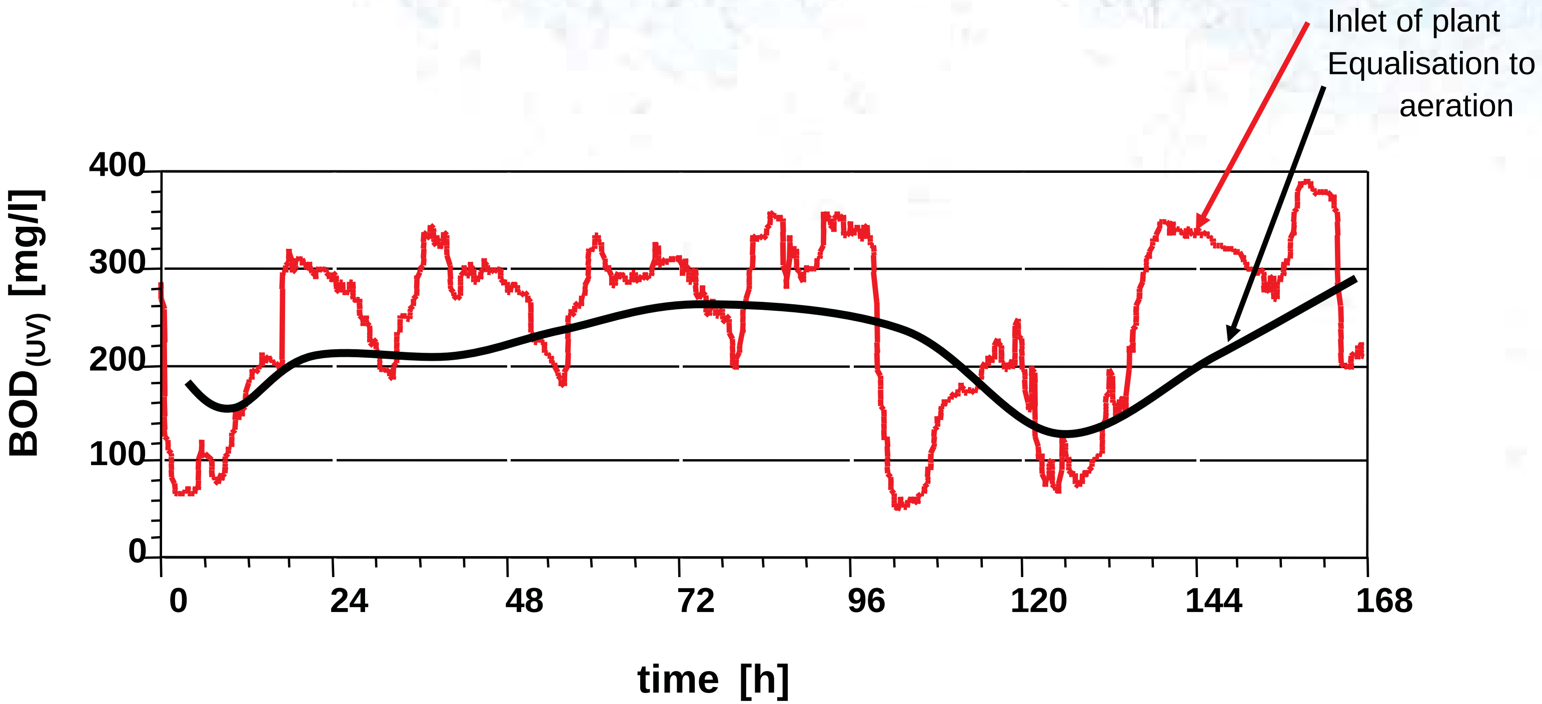
Spectral Absorbance Coefficient

- Online Organics Probe
  - Displays as BOD, COD, TOC, SAC, %T
  - Reagent-free measurement
  - Wiper automatically cleans optics

Influent Monitoring

- Allows operator to react
  - Divert & blend (dilute)
  - Step feed
  - Increase air
  - Increase MLSS

Organics Probe: Load Equalization



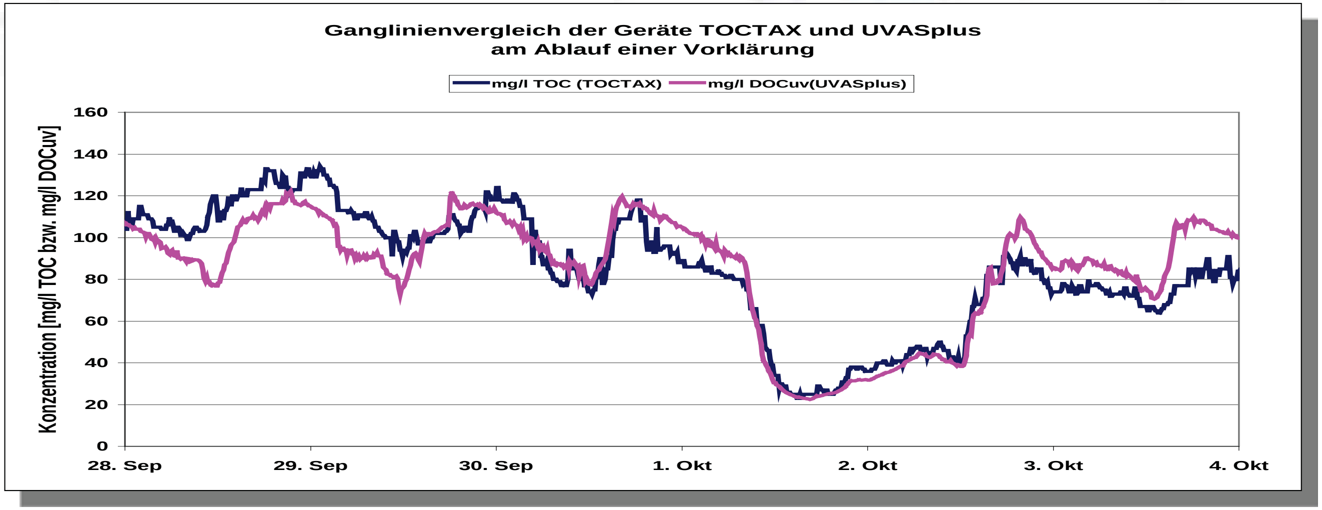
- <u>Target:</u> - steady loading to the aeration basin

  ->optimal denitrification and biological phosphorus removal

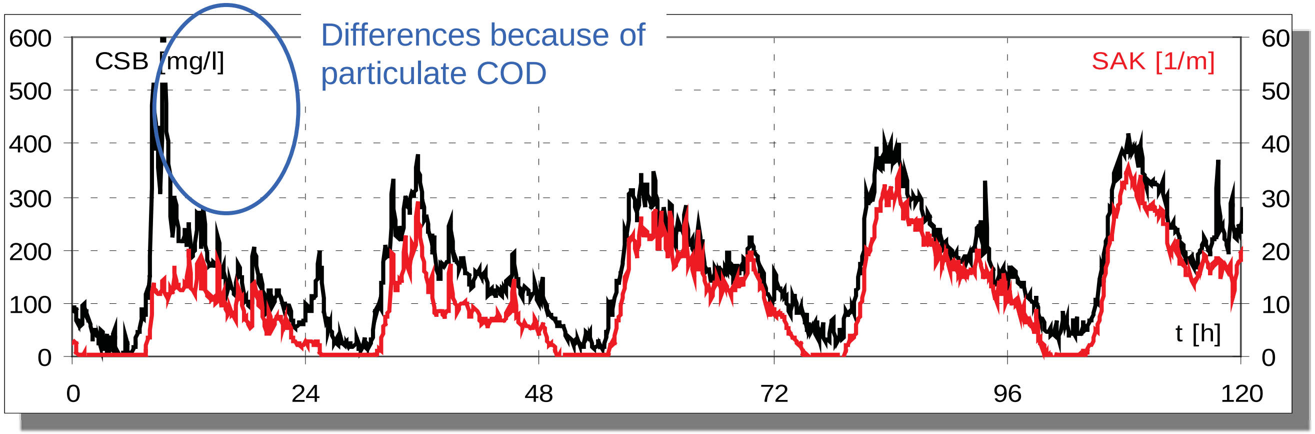
- <u>Solution:</u> - bypass the primary clarifier during low loading

  - supplement external carbon sources

Comparison between SAC/TOC and SAC/COD



SAC / TOC
Primary Effluent



SAC / COD
Raw Influent

Dissolved Organics


Men
FLUSH TWICE
THE CITY NEEDS THE MONEY!

Wastewater Instrumentation for Monitoring and Control

Shenandoah Valley

SHENANDOAH VALLEY PURE H2O FORUM

Wastewater Treatment Plant Network

Transforming Data into Information to Ensure Wastewater Quality

Making Data Meaningful

Some Words of Wisdom

"The goal is to transform data into information and information into insight"

- Carly Fiorina, Former CEO, Hewlett-Packard

Some Words of Wisdom

Data is dumb.

More data is not better…

unless you can do something with it to make it meaningful.

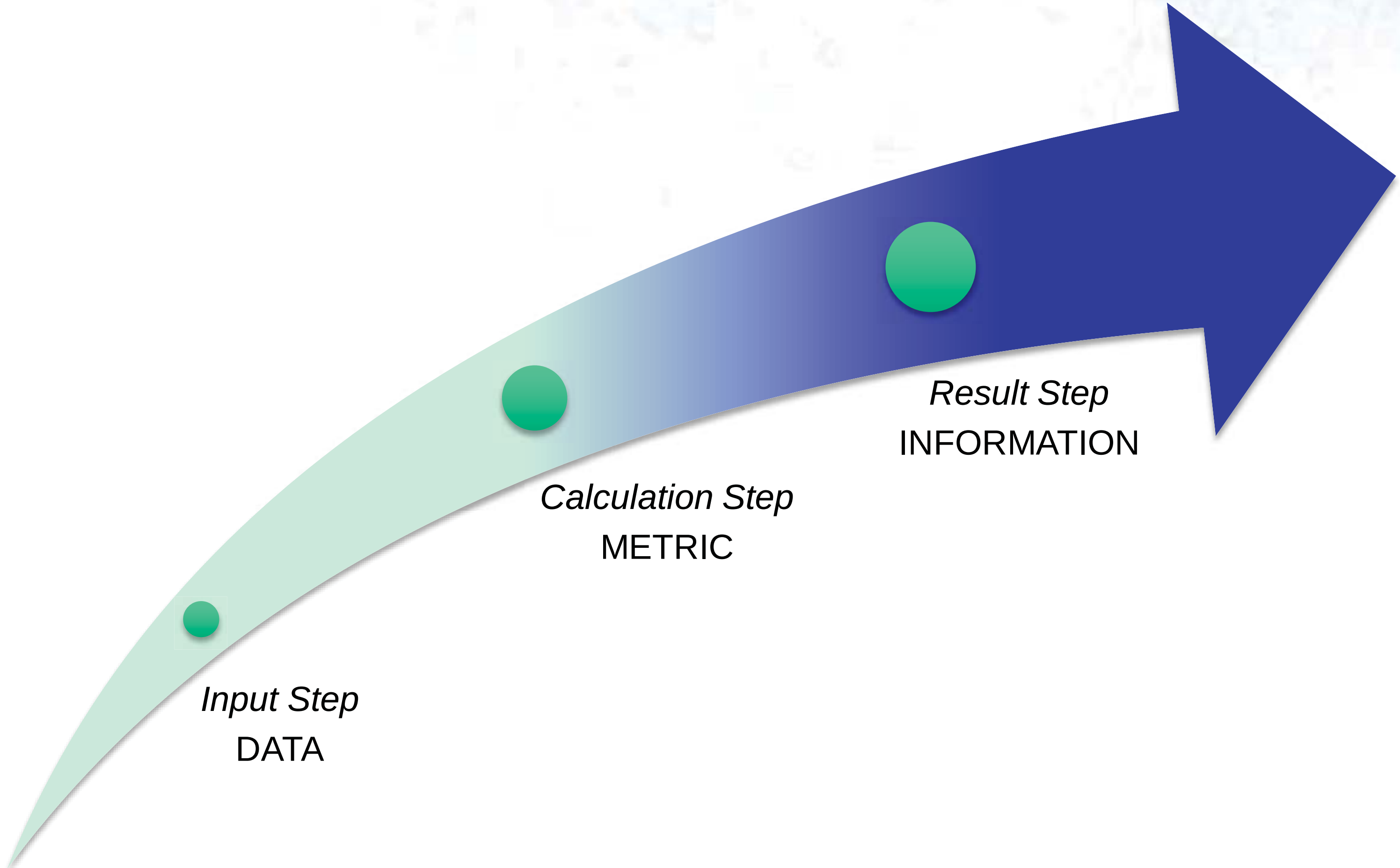
DATA… what is it?

- Individual facts, terms, numbers
- It is meaningless without CONTEXT
- Requires CONTEXT for conversion

CONTEXT... what is it?

- Drawing data from various sources provides context
- Often referred to as “data about data” (metadata)
- Context provides meaning to data
- Appropriate metrics for converting data into information
    - Calculations
    - Charts
    - Statistical Analysis
    - Summary Reports

How do we transform data into information?



Another way to think about it

DATA

Symbols	Individual facts

Processed to be Useful (INFORMATION)

Answers the questions

Who, what, where, when

Application of Data and Information (KNOWLEDGE)

Answers the questions

WHY

Acronyms …what do they mean?

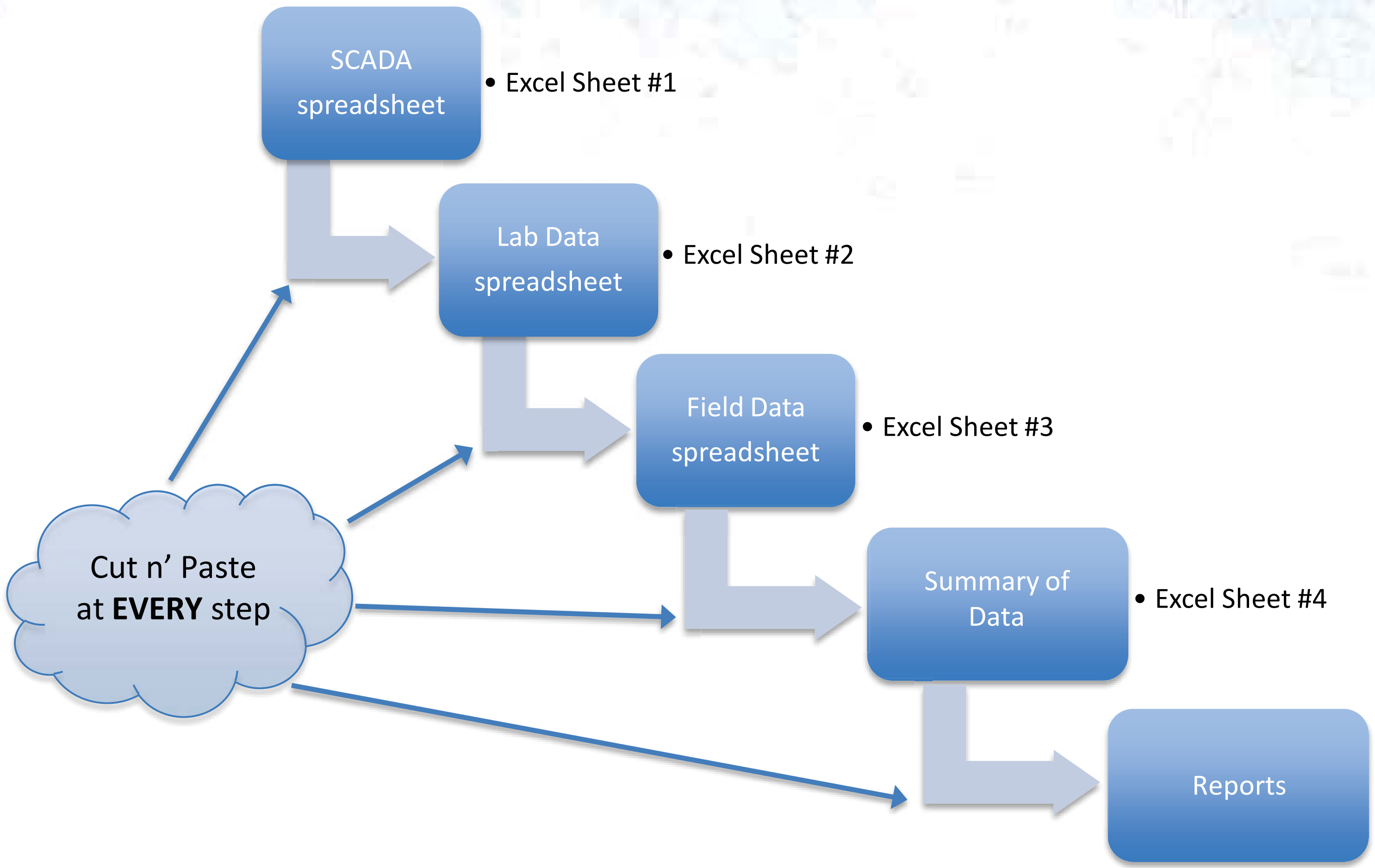
- SCADA
  - **S**upervisory **C**ontrol **a**nd **D**ata **A**cquisition (Single Data Source)
  - Not SCADA**R**
    - Reports were never part of the plan
    - DMR, MOR, regulatory reports never considered
      - Data set is incomplete
  - Not SCA**I**R either
    - Acquires data… not information
    - Data for process control
- LIMS
  - **L**aboratory **I**nformation **M**anagement **S**ystem (Single Data Source)
    - Collects data from instruments, technicians
    - Tracks samples, assigns unique identifiers, creates worksheets
    - Applies metrics and workflows
    - Reports lab information

Acronyms …what do they mean?

- Central Database Solutions (Data Repository)
  - A central repository of DATA
  - Provides CONTEXT to DATA
    - Combine data with data from many sources
      - » SCADA
      - » LIMS
      - » Contract Labs
      - » Bench Sheets
      - » Manual data entry
  - DATA is processed and transformed into INFORMATION
    - For compliance reporting
    - Optimize plant operations
    - Troubleshooting
  - KNOWLEDGE is the application of data and information
    - Allows for understanding of why
      - » Risk management
      - » Corrective actions

Excel… for information management?

Excel for Reporting



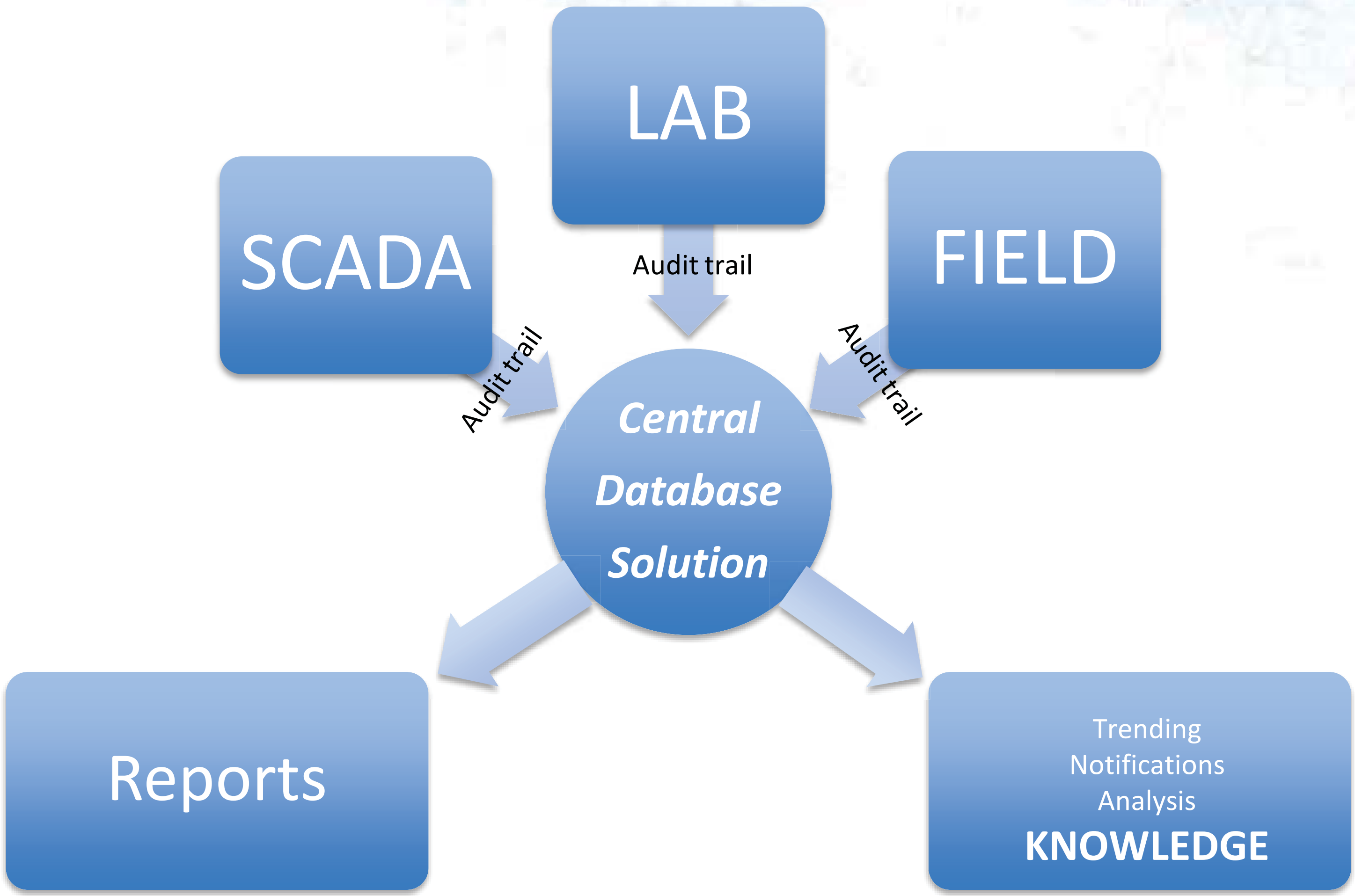
Do you know this person?

"I've been here for 30 years.
I've forgotten what my exact role is, but I do finally know how to fill out all the forms."

Information Management Benefits

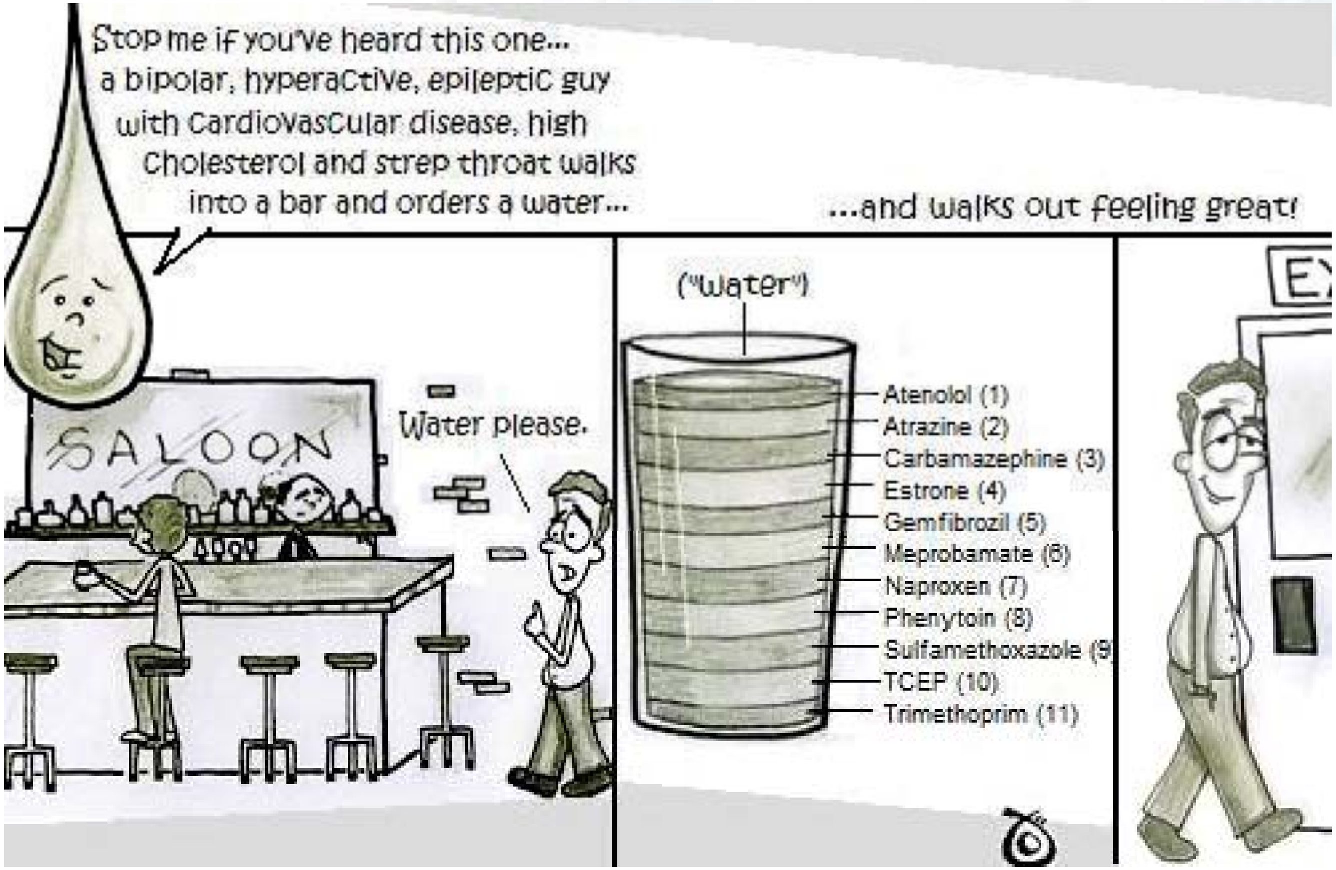
- Collect all data from different sources
- Use validated metrics to convert DATA into INFORMATION
- Eliminates the use of cut/paste strategies that:
  - Waste time
  - Waste human resources better spent on more important tasks
  - Increase error rate, re-entry of data, dyslexia
  - Not supported by a commercial vendor
    - "Joe wrote a great macro 10 years ago, but he retired"
- Honestly, how much time does it REALLY take?
  - One customer shared that it took 14, 12-hour days to create his reports
    - No time left for data review
    - No time to identify and correct any deviations

KNOWLEDGE Management



Big plants, Regulatory Agencies
Small plants, Regulatory Agencies

Ever-changing environmental concerns



More data, less time
Limited human resources

- More stringent reporting requirements
  - e-Reporting a reality
- More contaminants
  - New instrumentation required
  - More sources of data
- Less time to:
  - Navigate your data terrain
  - Manually put data into context … and into Excel
  - Convert data into information… and manually generate reports
  - Combine data and information to gain knowledge to
    - Optimize plant processes
    - Enable *"Predictive Troubleshooting"*
    - Take action before it creates a problem ***AND***
    - Manage risk, avoid violations, consent decrees

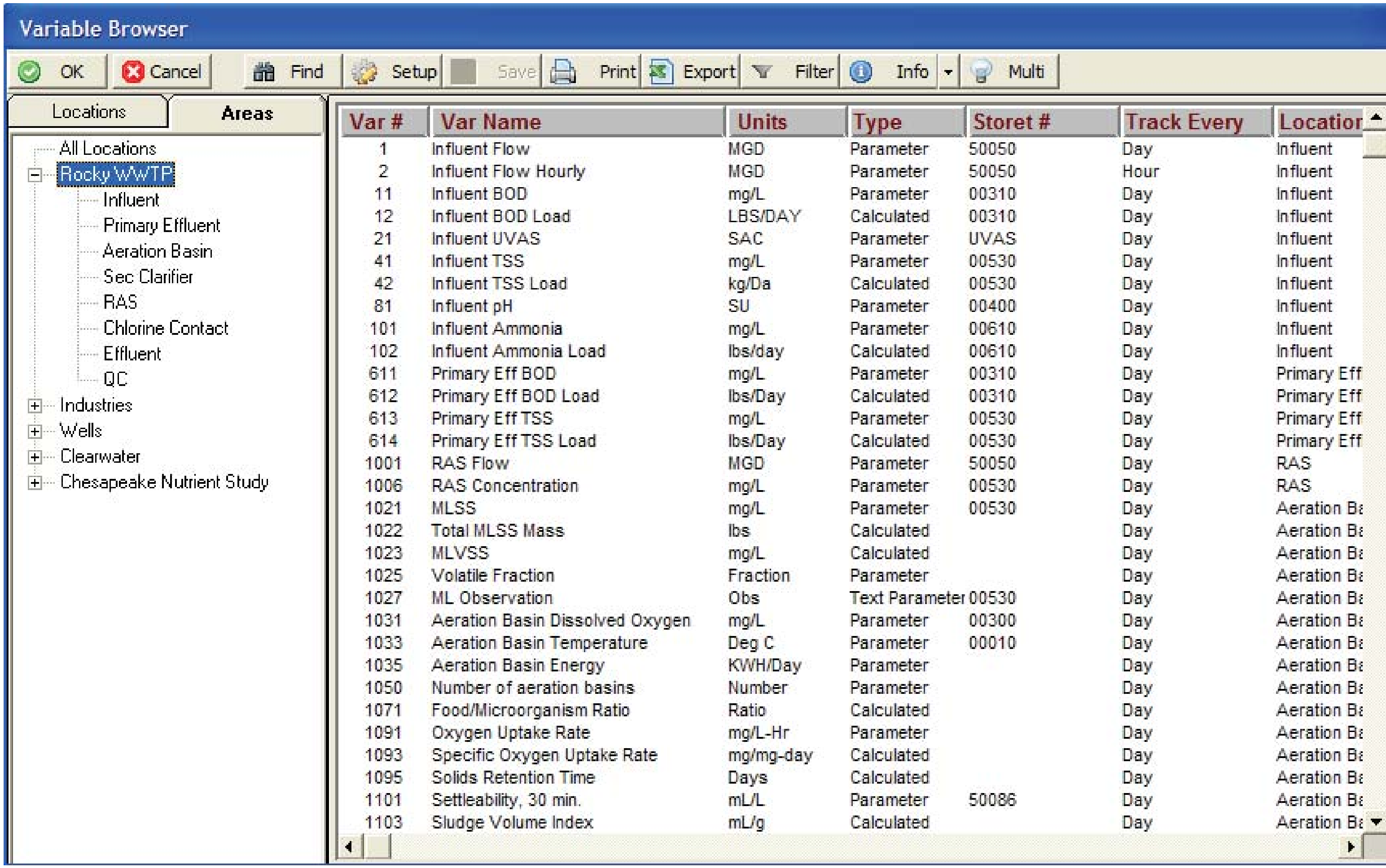
Available Options

- DO NOTHING
  - Wait for things to happen, hope for the best
- DO THE SAME THING
  - Try to react to the ever-changing environment we live in
- EMPLOY A INFORMATION MANAGEMENT STRATEGY
  - Maintain all of your data into a single database
  - Put into into context
  - Transform it into information
  - Create knowledge by bringing your data and information together
  - Use that knowledge to make the best decisions in the shortest time
  - Manage your risk, before it manages you.

One common goal

Monitor & Improve Operations

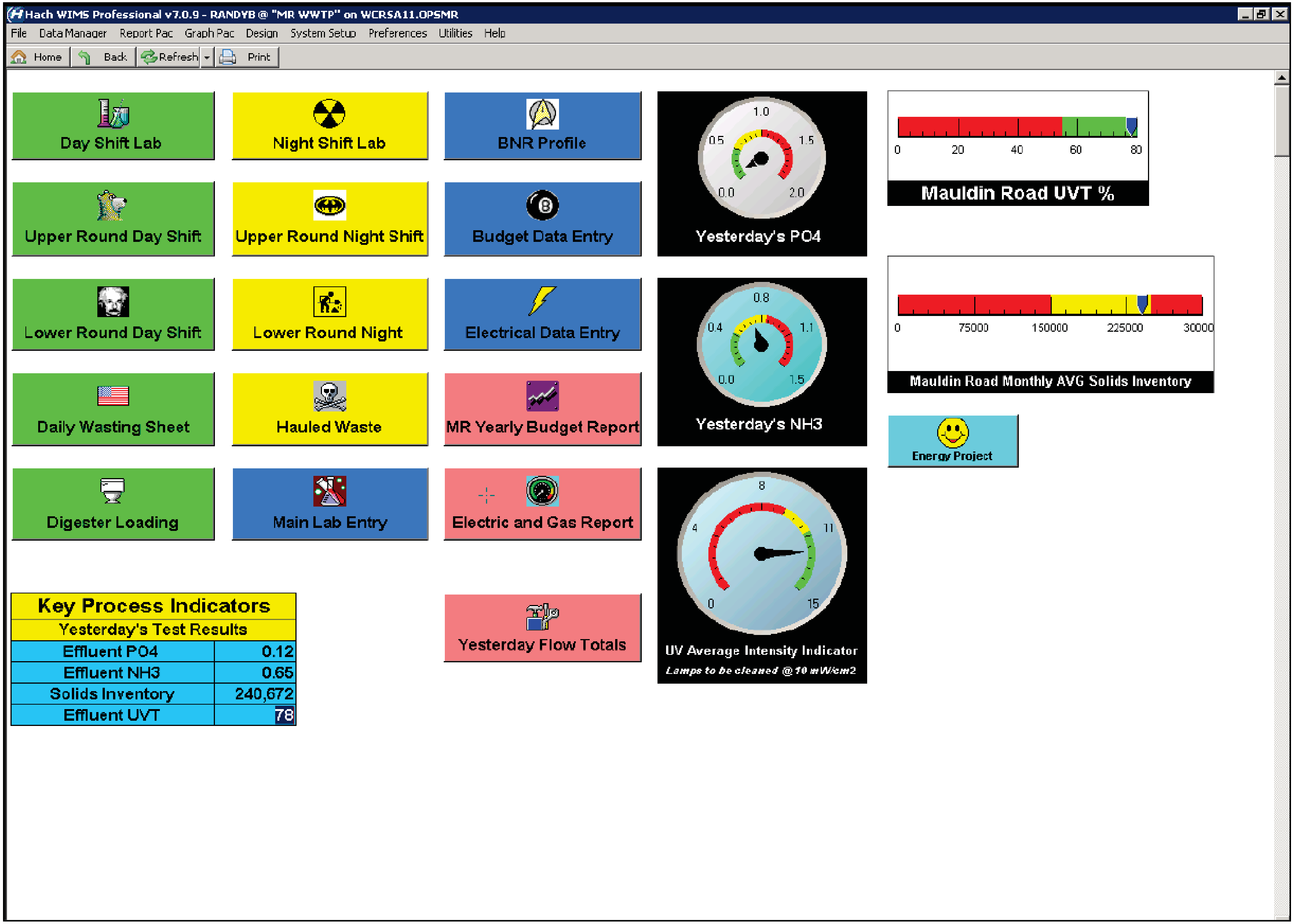
Central location for all of your data



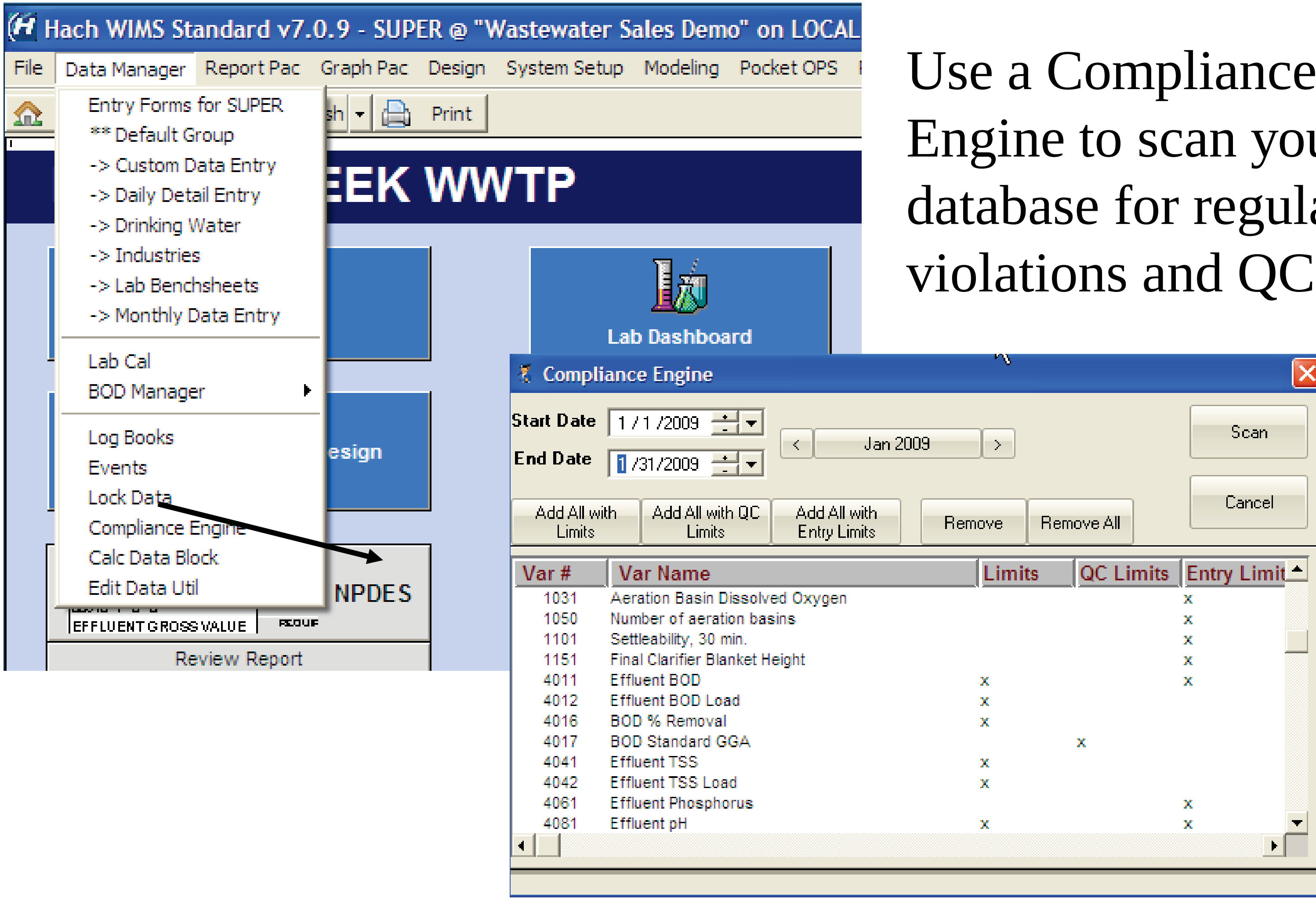
Var #	Var Name	Units	Type	Storet #	Track Every	Location
1	Influent Flow	MGD	Parameter	50050	Day	Influent
2	Influent Flow Hourly	MGD	Parameter	50050	Hour	Influent
11	Influent BOD	mg/L	Parameter	00310	Day	Influent
12	Influent BOD Load	LBS/DAY	Calculated	00310	Day	Influent
21	Influent UVAS	SAC	Parameter	UVAS	Day	Influent
41	Influent TSS	mg/L	Parameter	00530	Day	Influent
42	Influent TSS Load	kg/Da	Calculated	00530	Day	Influent
81	Influent pH	SU	Parameter	00400	Day	Influent
101	Influent Ammonia	mg/L	Parameter	00610	Day	Influent
102	Influent Ammonia Load	lbs/day	Calculated	00610	Day	Influent
611	Primary Eff BOD	mg/L	Parameter	00310	Day	Primary Eff
612	Primary Eff BOD Load	lbs/Day	Calculated	00310	Day	Primary Eff
613	Primary Eff TSS	mg/L	Parameter	00530	Day	Primary Eff
614	Primary Eff TSS Load	lbs/Day	Calculated	00530	Day	Primary Eff
1001	RAS Flow	MGD	Parameter	50050	Day	RAS
1006	RAS Concentration	mg/L	Parameter	00530	Day	RAS
1021	MLSS	mg/L	Parameter	00530	Day	Aeration Ba
1022	Total MLSS Mass	lbs	Calculated		Day	Aeration Ba
1023	MLVSS	mg/L	Calculated		Day	Aeration Ba
1025	Volatile Fraction	Fraction	Parameter		Day	Aeration Ba
1027	ML Observation	Obs	Text Parameter	00530	Day	Aeration Ba
1031	Aeration Basin Dissolved Oxygen	mg/L	Parameter	00300	Day	Aeration Ba
1033	Aeration Basin Temperature	Deg C	Parameter	00010	Day	Aeration Ba
1035	Aeration Basin Energy	KWH/Day	Parameter		Day	Aeration Ba
1050	Number of aeration basins	Number	Parameter		Day	Aeration Ba
1071	Food/Microorganism Ratio	Ratio	Calculated		Day	Aeration Ba
1091	Oxygen Uptake Rate	mg/L-Hr	Parameter		Day	Aeration Ba
1093	Specific Oxygen Uptake Rate	mg/mg-day	Calculated		Day	Aeration Ba
1095	Solids Retention Time	Days	Calculated		Day	Aeration Ba
1101	Settleability, 30 min.	mL/L	Parameter	50086	Day	Aeration Ba
1103	Sludge Volume Index	mL/g	Calculated		Day	Aeration Ba

User Defined Dashboards

User Defined Dashboards

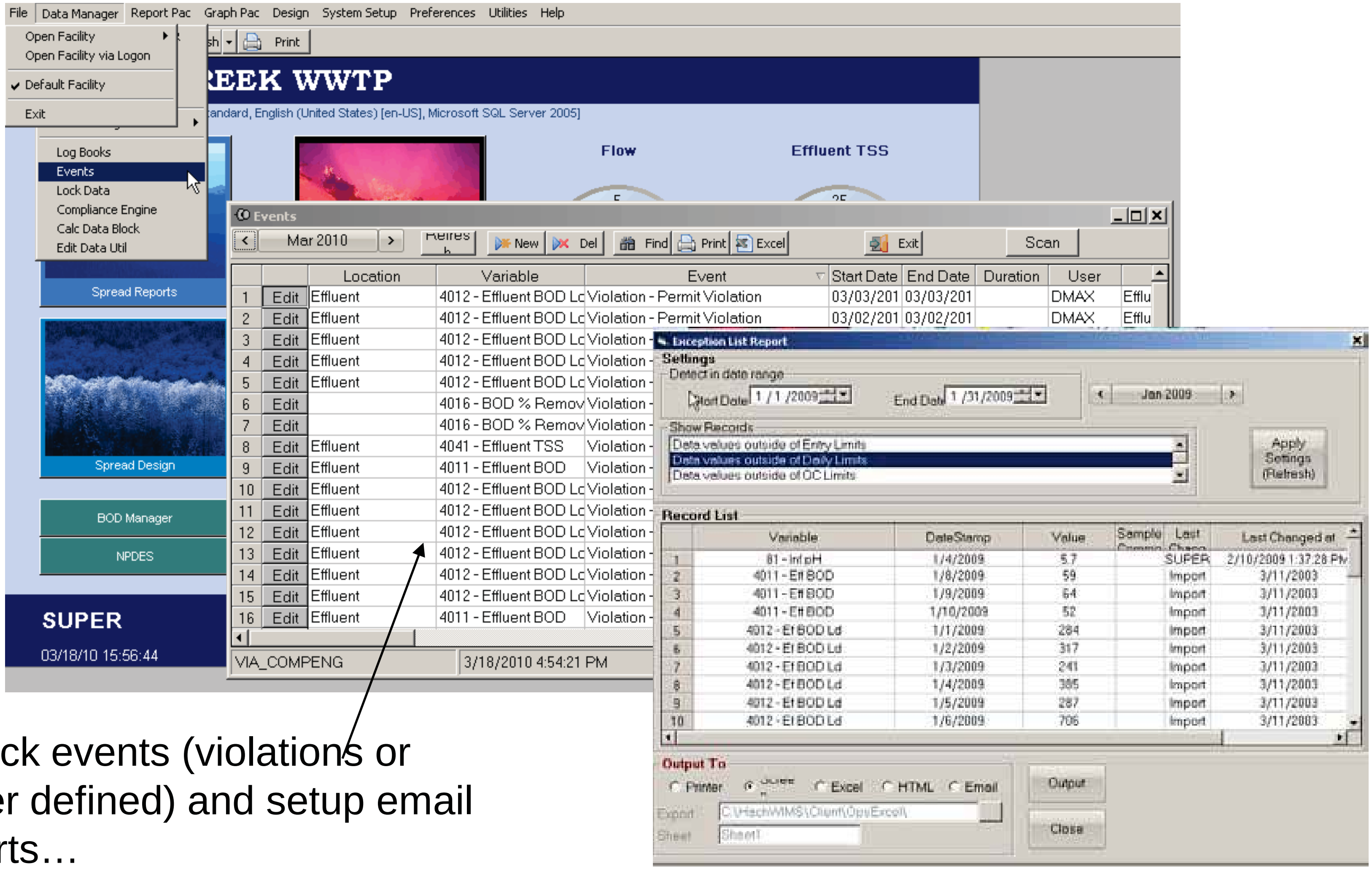


Manage by exception…



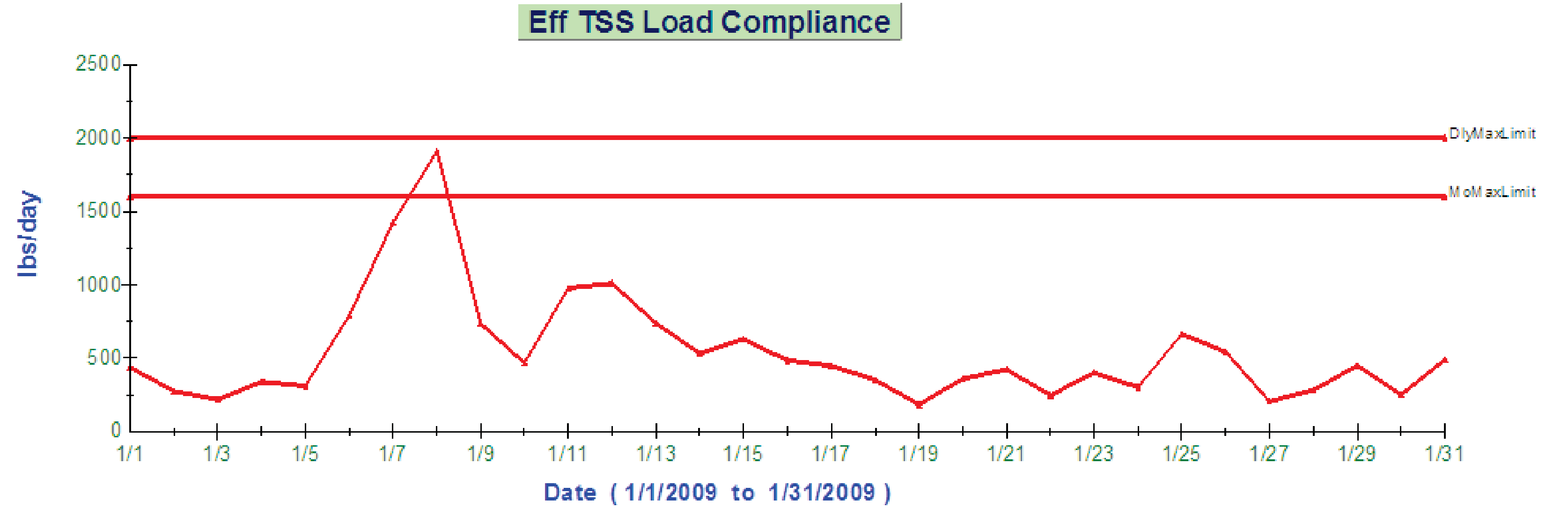
Use a Compliance Engine to scan your database for regulatory violations and QC Flags.

Manage by exception…



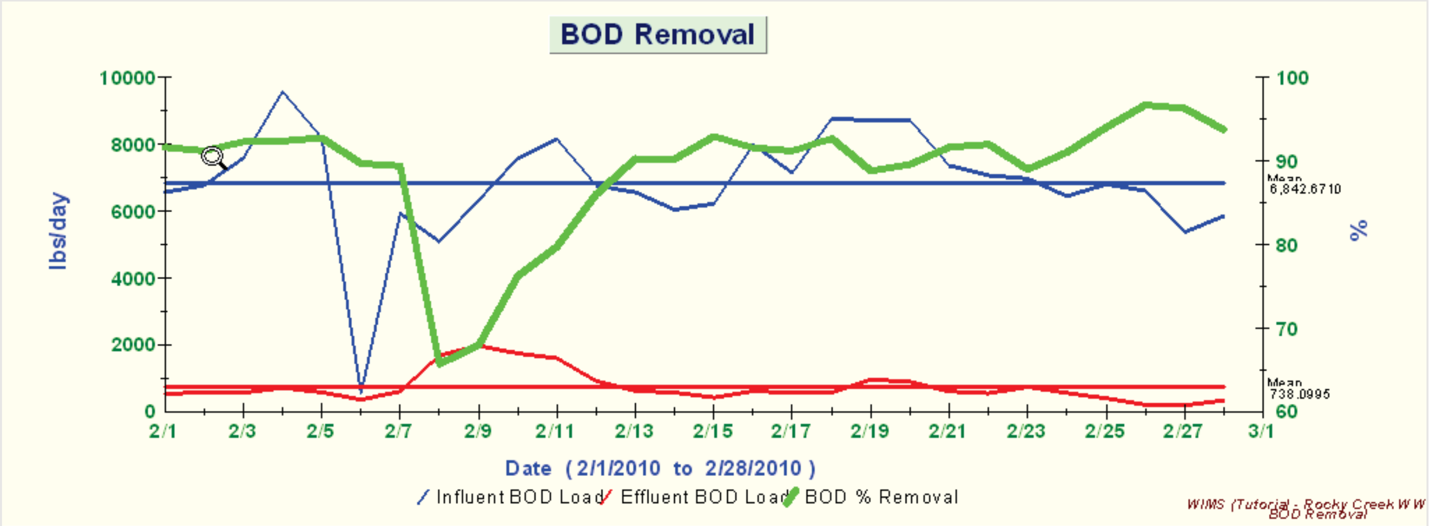
Track events (violations or user defined) and setup email alerts…

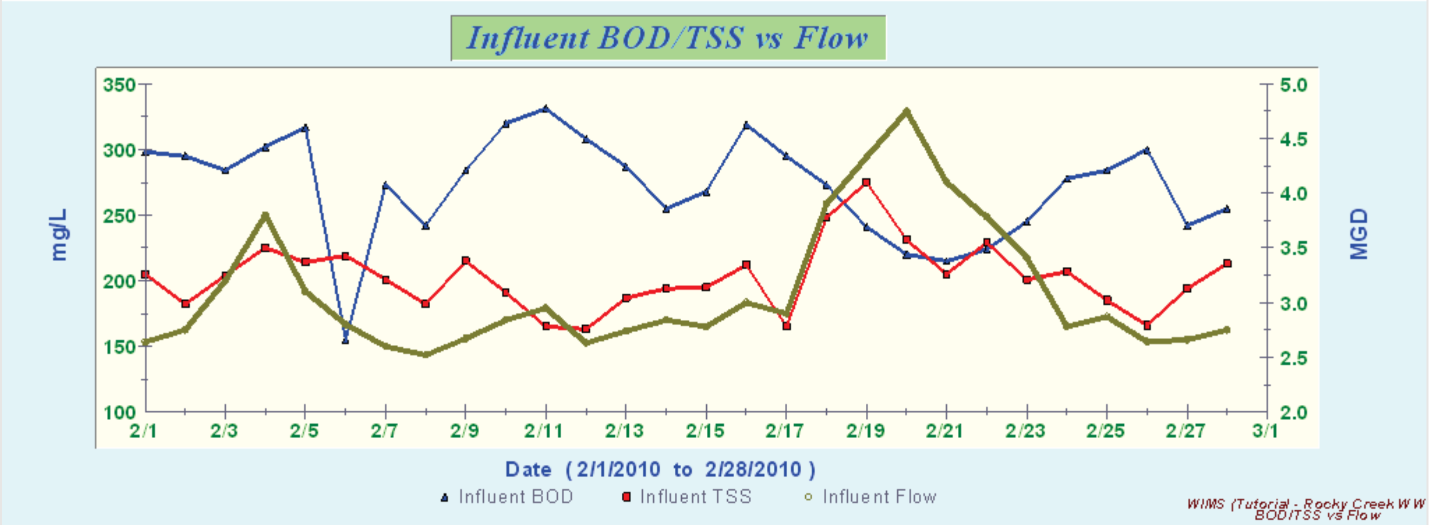
Compliance charts



Automatically chart data for key plant parameters.

Compliance charts





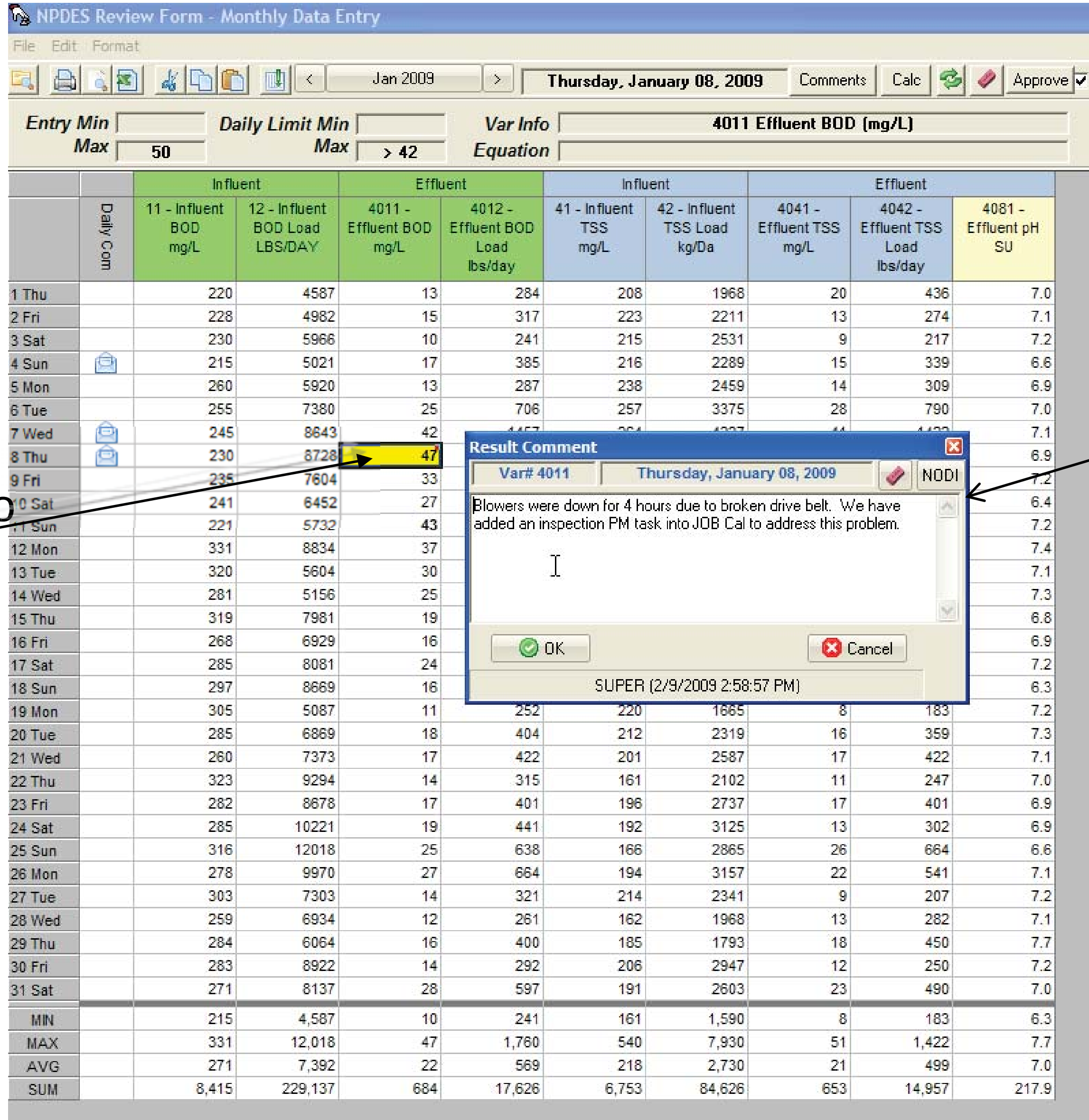
Troubleshoot Issues

Let Software do the Detective Work

- Gather information and find answers to:
  - System upsets
  - Cost overruns
  - Compliance issues
  - Customer complaints
- Use predictive modeling tools to prevent future issues from occurring
  - Develop "what if" scenarios
- Perform simple or complex search queries
  - Find the exact information you need

Automatically Compare & Verify All Info

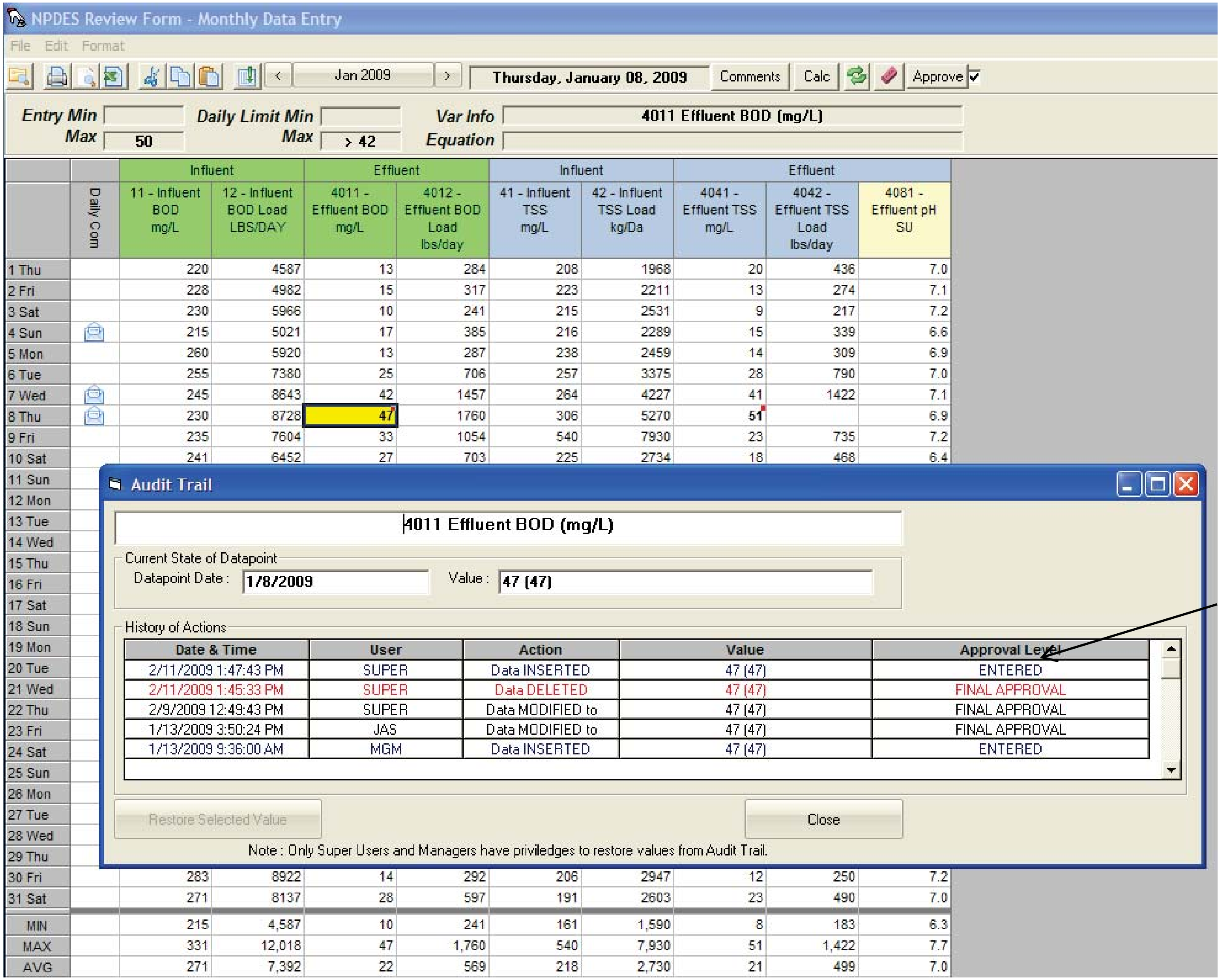
Flag problems so you know exactly where they occurred



	Daily Com	Influent		Effluent		Influent		Effluent		
		11 - Influent BOD mg/L	12 - Influent BOD Load LBS/DAY	4011 - Effluent BOD mg/L	4012 - Effluent BOD Load lbs/day	41 - Influent TSS mg/L	42 - Influent TSS Load kg/Da	4041 - Effluent TSS mg/L	4042 - Effluent TSS Load lbs/day	4081 - Effluent pH SU
1 Thu		220	4587	13	284	208	1968	20	436	7.0
2 Fri		228	4982	15	317	223	2211	13	274	7.1
3 Sat		230	5966	10	241	215	2531	9	217	7.2
4 Sun		215	5021	17	385	216	2289	15	339	6.6
5 Mon		260	5920	13	287	238	2459	14	309	6.9
6 Tue		255	7380	25	706	257	3375	28	790	7.0
7 Wed		245	8643	42						7.1
8 Thu		230	8728	47						6.9
9 Fri		235	7604	33						7.2
10 Sat		241	6452	27						6.4
11 Sun		221	5732	43						7.2
12 Mon		331	8834	37						7.4
13 Tue		320	5604	30						7.1
14 Wed		281	5156	25						7.3
15 Thu		319	7981	19						6.8
16 Fri		268	6929	16						6.9
17 Sat		285	8081	24						7.2
18 Sun		297	8669	16						6.3
19 Mon		305	5087	11	252	220	1665	8	183	7.2
20 Tue		285	6869	18	404	212	2319	16	359	7.3
21 Wed		260	7373	17	422	201	2587	17	422	7.1
22 Thu		323	9294	14	315	161	2102	11	247	7.0
23 Fri		282	8678	17	401	196	2737	17	401	6.9
24 Sat		285	10221	19	441	192	3125	13	302	6.9
25 Sun		316	12018	25	638	166	2865	26	664	6.6
26 Mon		278	9970	27	664	194	3157	22	541	7.1
27 Tue		303	7303	14	321	214	2341	9	207	7.2
28 Wed		259	6934	12	261	162	1968	13	282	7.1
29 Thu		284	6064	16	400	185	1793	18	450	7.7
30 Fri		283	8922	14	292	206	2947	12	250	7.2
31 Sat		271	8137	28	597	191	2603	23	490	7.0
MIN		215	4,587	10	241	161	1,590	8	183	6.3
MAX		331	12,018	47	1,760	540	7,930	51	1,422	7.7
AVG		271	7,392	22	569	218	2,730	21	499	7.0
SUM		8,415	229,137	684	17,626	6,753	84,626	653	14,957	217.9

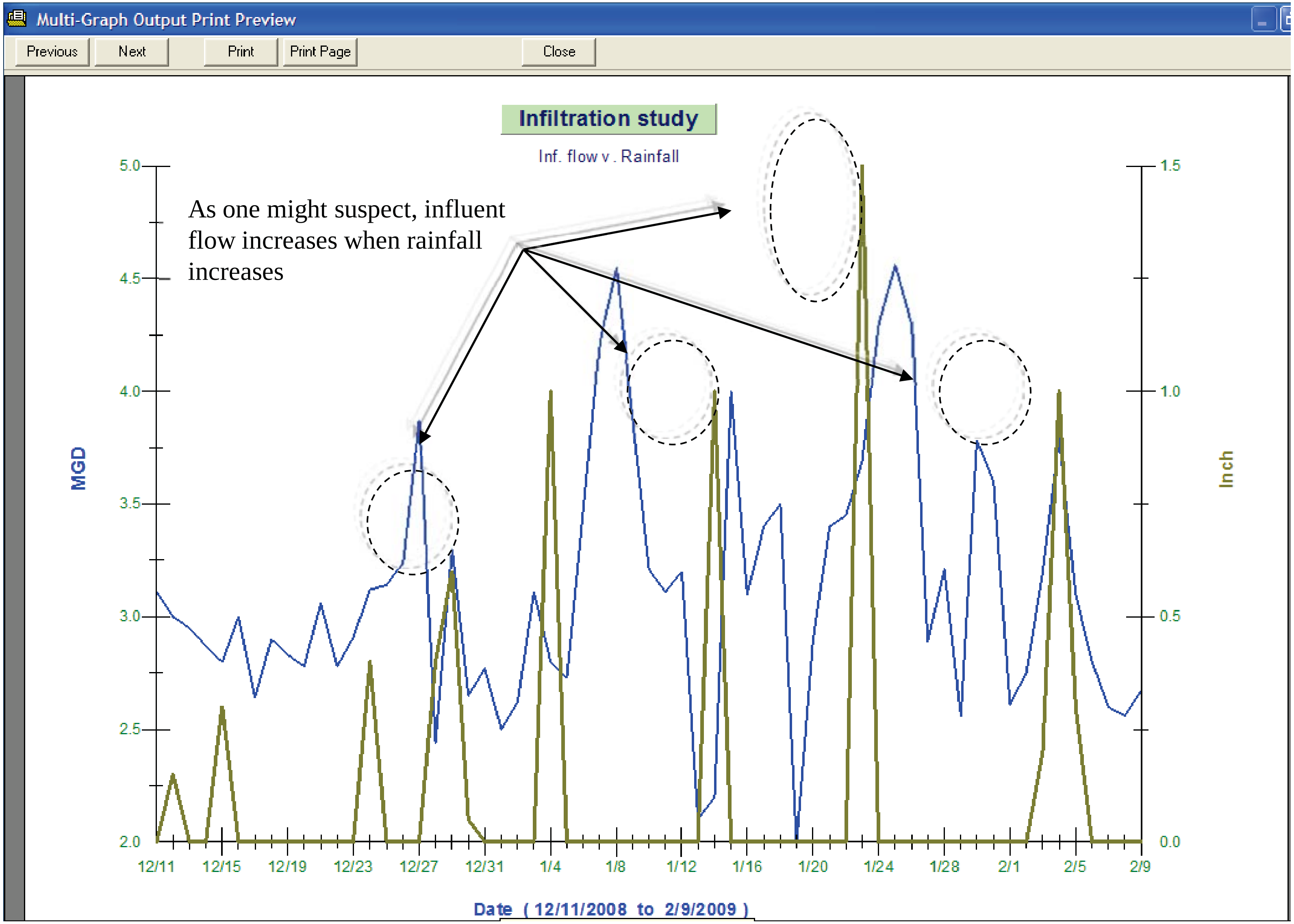
Immediately identify change in the system

Maintain Accurate Records with Audit Trails

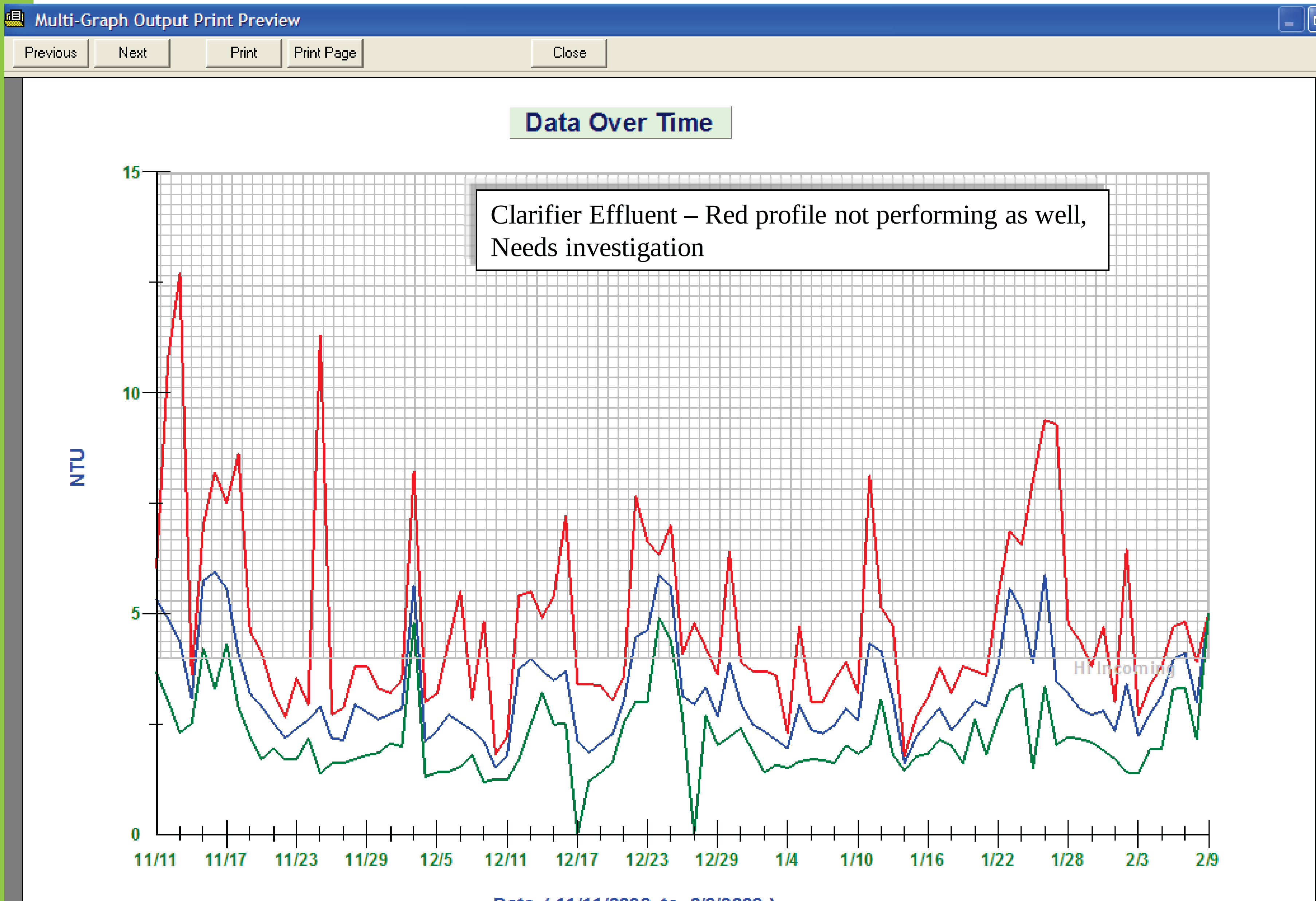


Audit trails show who touched the data

Waste water example-Inf flow v. rainfall



Waste water example—turbidity profile

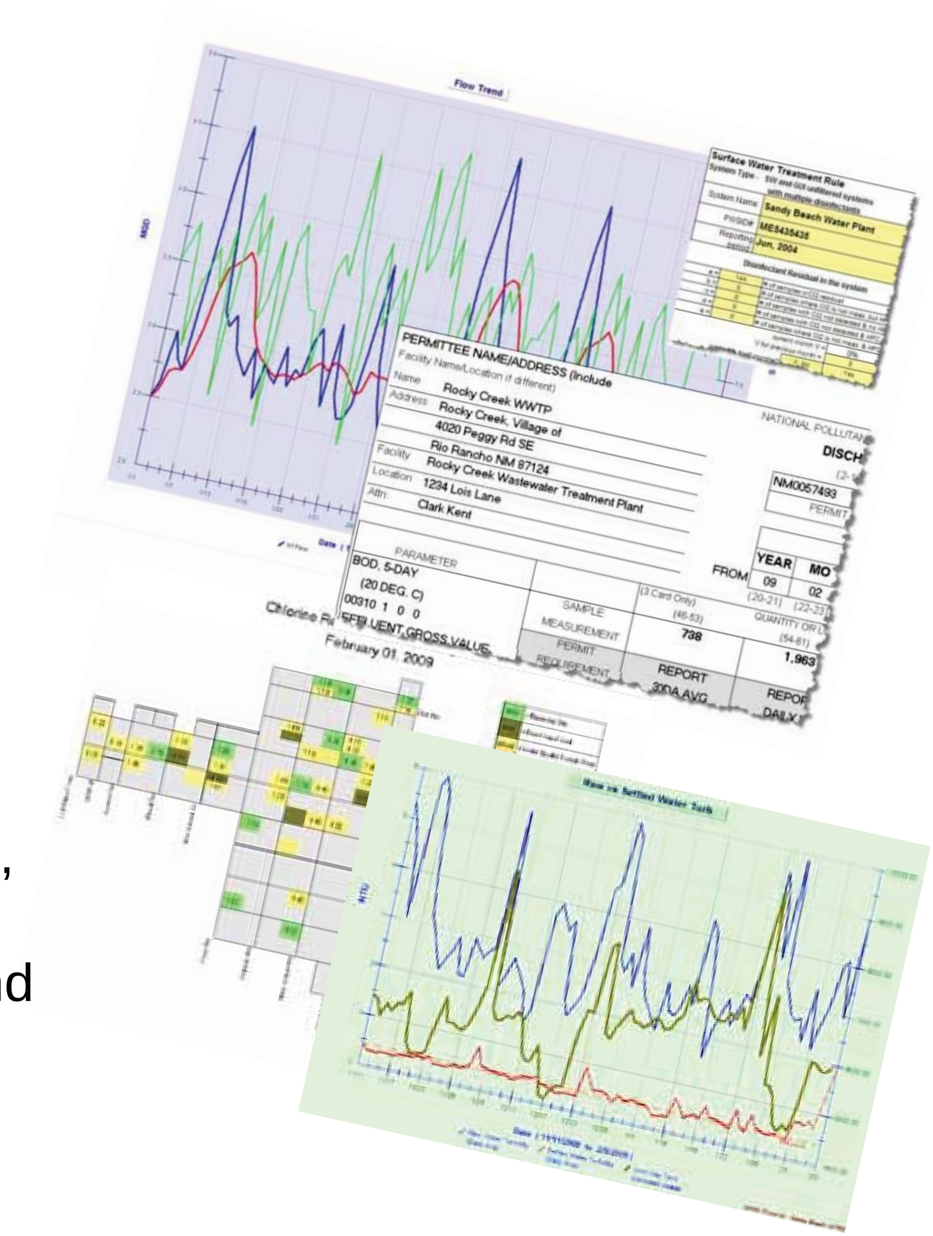


Prepare Regulatory & Internal Reports

You already have the raw data, use it to your advantage

Turn Raw Data into Actionable Information

- Create business and regulatory reports instantly
- Schedule automatic report output to the screen, print or email
- Quickly configure standard reports using templates and wizards
- EPA and state report templates (SWTR, DBR, NPDES, DMR, eDMR, MOR, SDWA, CCR, industrial pretreatment compliance, and more)



Powerful Information at your Fingertips

Waste Water

PERMITTEE NAME/ADDRESS (Include Facility Name/Location if different)
Name Rocky Creek WWTP
Address Rocky Creek, Village of
4020 Peggy Rd SE
Rio Rancho NM 87124
Facility Rocky Creek Wastewater Treatment Plant
Location 1234 Lois Lane
Attn: Clark Kent

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

(2-16) NM0057493 PERMIT NUMBER
(17-19) 001 A DISCHARGE NUMBER

	MONITORING PERIOD						
	YEAR	MO	DAY		YEAR	MO	DAY
FROM	02	06	01	TO	02	06	30
	(20-21)	(22-23)	(24-25)		(26-27)	(28-29)	(30-31)

COMBINED TREATED PROCESS
(SUBR M5)
F- FINAL
MAJOR
MUNICIPAL, NO PRE-TREATMENT
*** NO DISCHARGE ***
NOTE: Read instructions before completing this form
Form Approved.
OMB No.
Approval expires

PARAMETER (32-37)		(3 Card Only) QUANTITY OR LOADING (46-53) AVERAGE	(54-61) MAXIMUM	UNITS	(4 Card Only) QUALITY OR CONCENTRATION (38-45) MINIMUM	(46-53) AVERAGE	(54-61) MAXIMUM	UNITS	NO. EX (62-63)	FREQUENCY OF ANALYSIS (64-68)	SAMPLE TYPE (69-70)
BOD, 5-DAY (20 DEG. C)	SAMPLE MEASUREMENT	******	******	****	**205**	******	**331**	(19)	0	DAILY	CONT
00310 1 0 0 RAW SEW/INFLUENT	PERMIT REQUIREMENT	******	******	****	REPORT DAILY MN	******	REPORT DAILY MX	MG/L		DAILY	CONT
BOD, 5-DAY (20 DEG. C)	SAMPLE MEASUREMENT	**637**	**2,209**	(26)	******	**24**	**64**	(19)	3	DAILY	CONT
00310 1 0 0 EFFLUENT GROSS VALUE	PERMIT REQUIREMENT	REPORT 30DA AVG	REPORT DAILY MX	LBS/DAY	******	44.00 30DA AVG	45.00 DAILY MX	MG/L		DAIL	
PH	SAMPLE MEASUREMENT	******	******	****	**6.3**	******	**7.7**	(12)	0	DAIL	
00400 1 0 0 EFFLUENT GROSS VALUE	PREMIT REQUIREMENT	******	******	****	6.0 DAILY MN	******	8.0 DAILY MX	SU		DAIL	
SOLIDS, TOTAL SUSPENDED	SAMPLE MEASUREMENT	******	******	****	******	**206**	**264**	(19)	0	DAIL	
00530 1 0 0 RAW SEW/INFLUENT	PERMIT REQUIREMENT	******	******	****	******	REPORT 30DA AVG	REPORT DAILY MX	MG/L		DAIL	
SOLIDS, TOTAL SUSPENDED	SAMPLE MEASUREMENT	**612**	**1,910**	(26)	******	**23**	**59**	(19)	3	DAIL	
00530 1 0 0 EFFLUENT GROSS VALUE	PERMIT REQUIREMENT	REPORT 30DA AVG	REPORT DAILY MX	LBS/DAY	******	30 30DA AVG	45 DAILY MX	MG/L		DAIL	
FLOW, IN CONDUIT OR THRU TREATMENT PLANT	SAMPLE UREMENT	**2.96**	**4.49**	(03)	******	******	******	****	0	DAIL	
50050 1 EFFLUENT GROSS VALUE	PERMIT REQUIREMENT	REPORT 30DA AVG	REPORT DAILY MX	MGD	******	******	******	****		DAIL	
BOD, 5-DAY PERCENT REMOVAL	SAMPLE MEASUREMENT	******	******	****	**74.57**	******	******	(23)	4	DAIL	
81010 K 0 0 PERCENT REMOVAL	PERMIT REQUIREMENT	******	******	****	85.00 DAILY MN	******	******	PER CENT		DAIL	

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
SCOTT MOEHLING
CHIEF DATA MANAGER
TYPED OR PRINTED

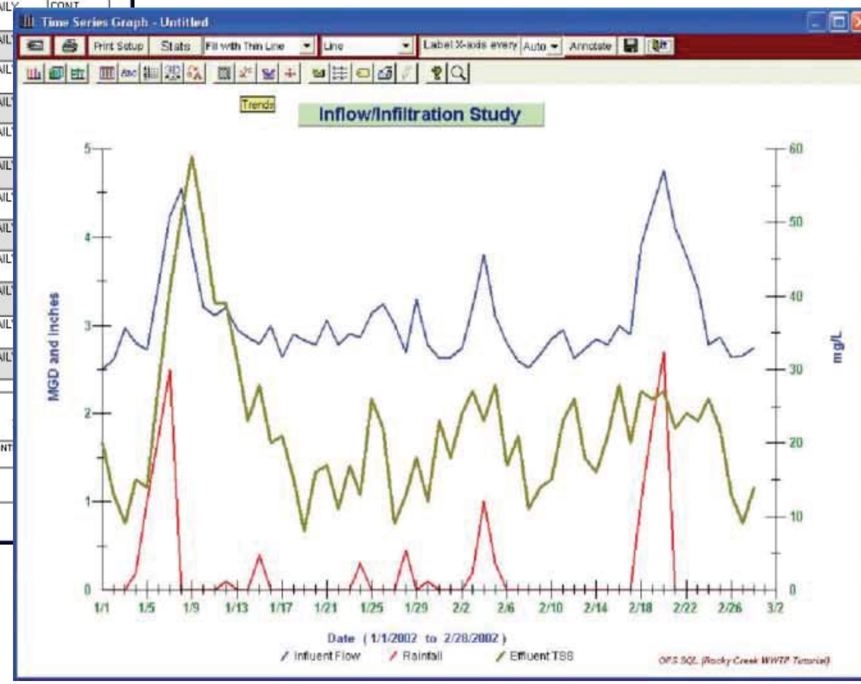
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE			
505	892-6700	02	
AREA CODE	NUMBER	YEAR	MONT

COMMENT AND EXPANATION OF ANY VIOLATIONS (Reference all attachments here)

EPA Form 3320-1 (Rev. 8095) Previous editions may be used. (REPLACES EPA FORM T-40 WHICH MAY NOT BE USED.) PAGE 1 OF 1

← Example Discharge Monitoring Report



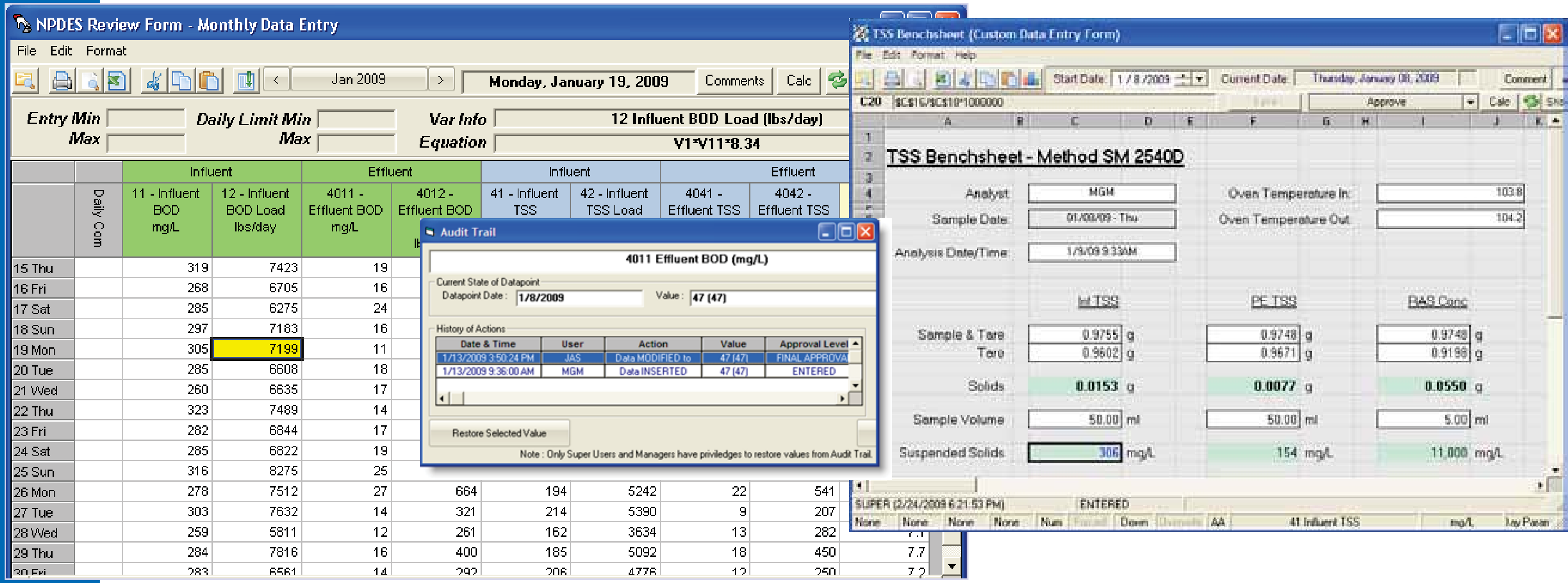
Example Inflow/ Infiltration Study →

Compile Data Easily

More data is not better unless you can do something with it

See Your Whole Operation: Combine Data From Field, Lab & Operations

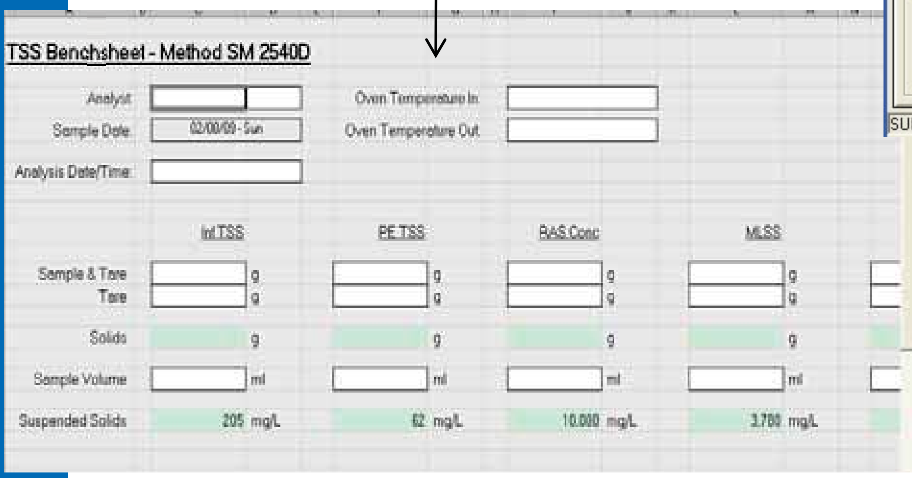
- Access to data, reports, entry forms, audit information
- Track dosages, flows, concentration, summarized data like daily average flow, 15 minute turbidity maxi, hourly DO min

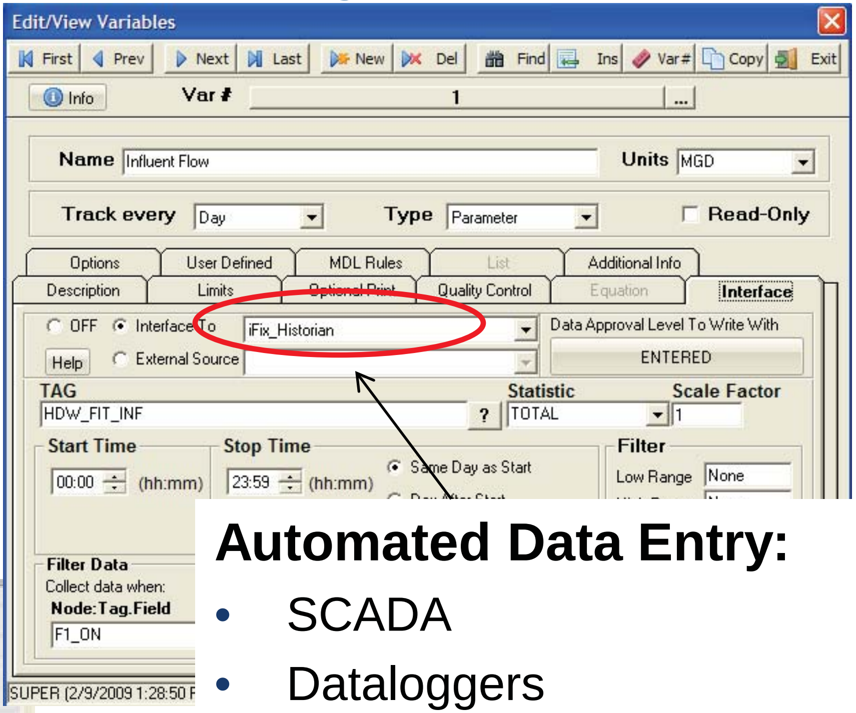


Transform Data Dumps Into Actionable Insight

Manual Data Entry:

- Built-in templates for data entry
- Screens that match spreadsheet, daily log and bench sheet formats





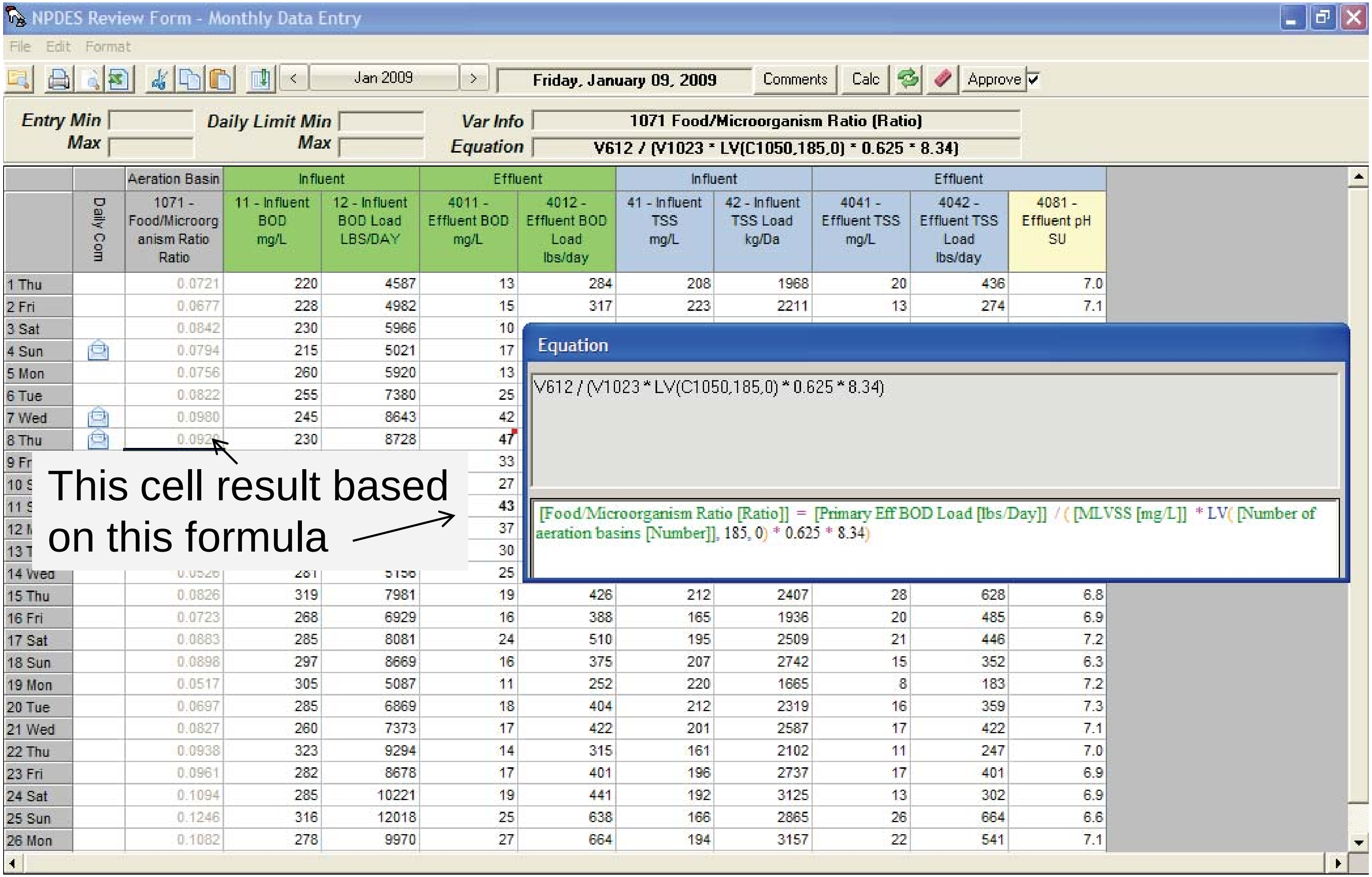
Automated Data Entry:

- SCADA
- Dataloggers
- LIMS
- Commercial Laboratory Reports
- Download data from portable field devices

Manage Complex Calculations

Stop worrying about making mistakes in complex calculations

Example of Complex F-to-M Ratio



NPDES Review Form - Monthly Data Entry

File Edit Format

Jan 2009 | Friday, January 09, 2009 | Comments | Calc | Approve

Entry Min | Daily Limit Min | Var Info: 1071 Food/Microorganism Ratio (Ratio)

Max | Max | Equation: V612 / (V1023 * LV(C1050,185,0) * 0.625 * 8.34)

		Aeration Basin	Influent		Effluent		Influent		Effluent		
	Daily Com	1071 - Food/Microorganism Ratio Ratio	11 - Influent BOD mg/L	12 - Influent BOD Load LBS/DAY	4011 - Effluent BOD mg/L	4012 - Effluent BOD Load lbs/day	41 - Influent TSS mg/L	42 - Influent TSS Load kg/Da	4041 - Effluent TSS mg/L	4042 - Effluent TSS Load lbs/day	4081 - Effluent pH SU
1 Thu		0.0721	220	4587	13	284	208	1968	20	436	7.0
2 Fri		0.0677	228	4982	15	317	223	2211	13	274	7.1
3 Sat		0.0842	230	5966	10						
4 Sun		0.0794	215	5021	17						
5 Mon		0.0756	260	5920	13						
6 Tue		0.0822	255	7380	25						
7 Wed		0.0980	245	8643	42						
8 Thu		0.0929	230	8728	47						
9 Fr					33						
10 S					27						
11 S					43						
12 M					37						
13 T					30						
14 Wed		0.0526	281	5156	25						
15 Thu		0.0826	319	7981	19	426	212	2407	28	628	6.8
16 Fri		0.0723	268	6929	16	388	165	1936	20	485	6.9
17 Sat		0.0883	285	8081	24	510	195	2509	21	446	7.2
18 Sun		0.0898	297	8669	16	375	207	2742	15	352	6.3
19 Mon		0.0517	305	5087	11	252	220	1665	8	183	7.2
20 Tue		0.0697	285	6869	18	404	212	2319	16	359	7.3
21 Wed		0.0827	260	7373	17	422	201	2587	17	422	7.1
22 Thu		0.0938	323	9294	14	315	161	2102	11	247	7.0
23 Fri		0.0961	282	8678	17	401	196	2737	17	401	6.9
24 Sat		0.1094	285	10221	19	441	192	3125	13	302	6.9
25 Sun		0.1246	316	12018	25	638	166	2865	26	664	6.6
26 Mon		0.1082	278	9970	27	664	194	3157	22	541	7.1

Equation

V612 / (V1023 * LV(C1050,185,0) * 0.625 * 8.34)

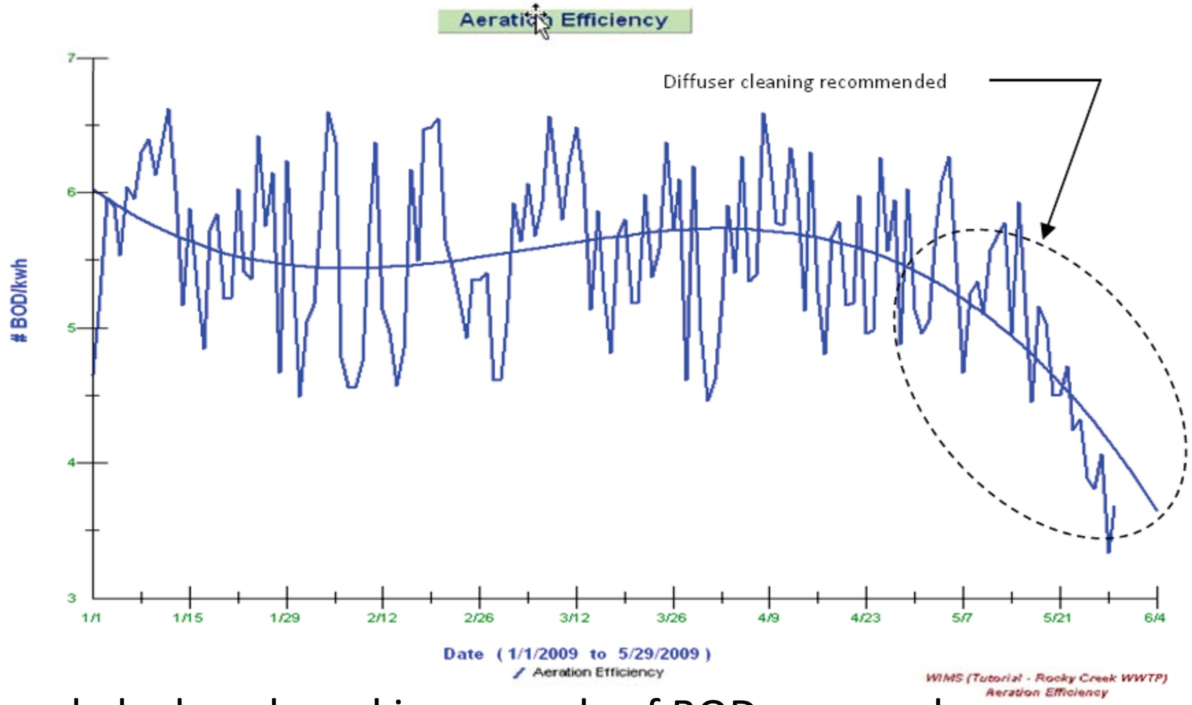
[Food/Microorganism Ratio [Ratio]] = [Primary Eff BOD Load [lbs/Day]] / ([MLVSS [mg/L]] * LV([Number of aeration basins [Number]], 185, 0) * 0.625 * 8.34)

This cell result based on this formula

Case Studies
Making Data Meaningful

Case 1: Improving Aeration Efficiency

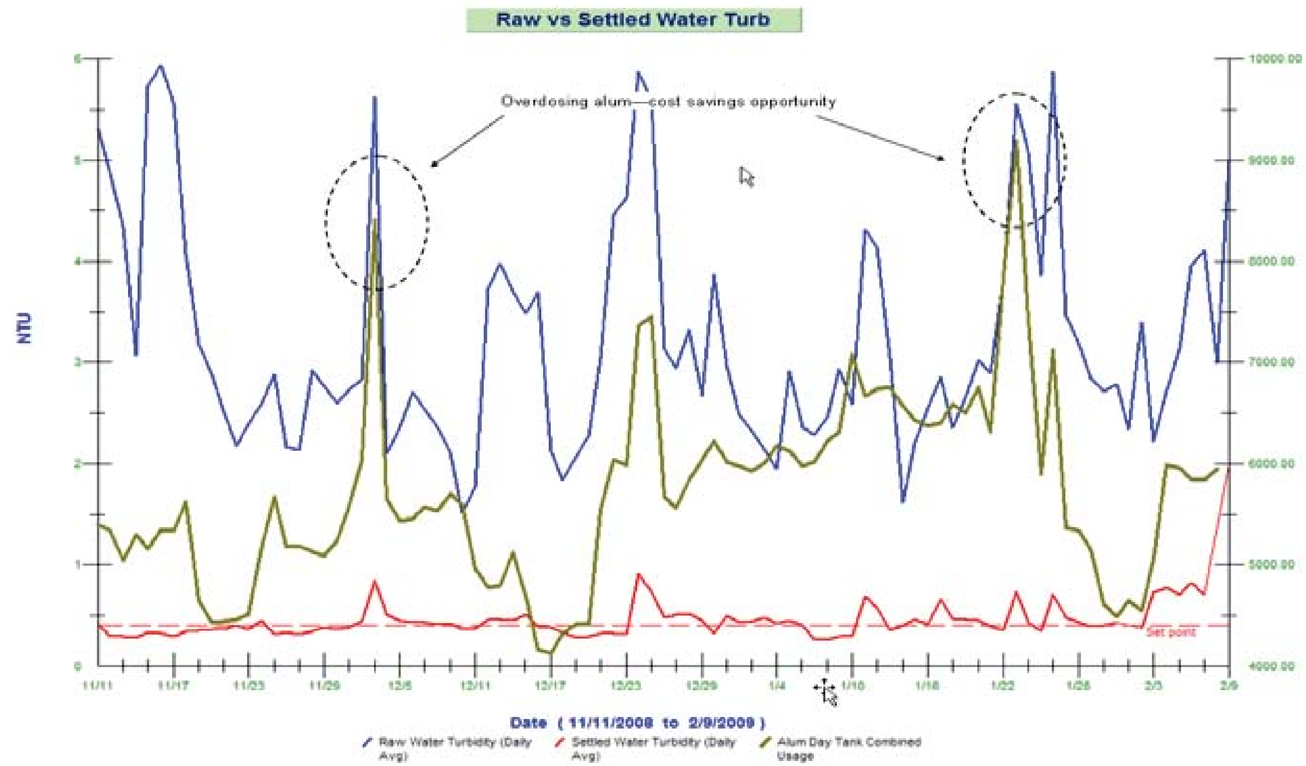
Oxygen transfer efficiency is a function of bubble size. The smaller the bubble, the higher the efficiency. Ceramic or membrane diffusers will foul in time, causing the bubble size to increase. To minimize energy used and reduce downtime, it is important to determine when diffusers need to be cleaned.



Determine cleaning cycle by benchmarking pounds of BOD removed per KW of electricity used.

Case 2: Lowering Chemical Costs

In the chart of raw and settled water turbidity against alum dosage , increased alum dosing (circled) did not improve clarified turbidity. This led to an opportunity to save up to 10 percent in alum dosage.



Case 3: Real-time estimation of BOD

The time-lag in obtaining BOD results, a 5-day lab test, make it challenging for plant operations to adjust treatment processes to adverse levels of BOD. A site-specific correlation between on-line UV absorbance against lab BOD measurements was obtained. With this BOD can be estimated in real-time, allowing for the optimization for treatment processes and avoidance of potential violations.