Startup & Commissioning of the Eau Claire Water Resource Recovery Facility

WWOA
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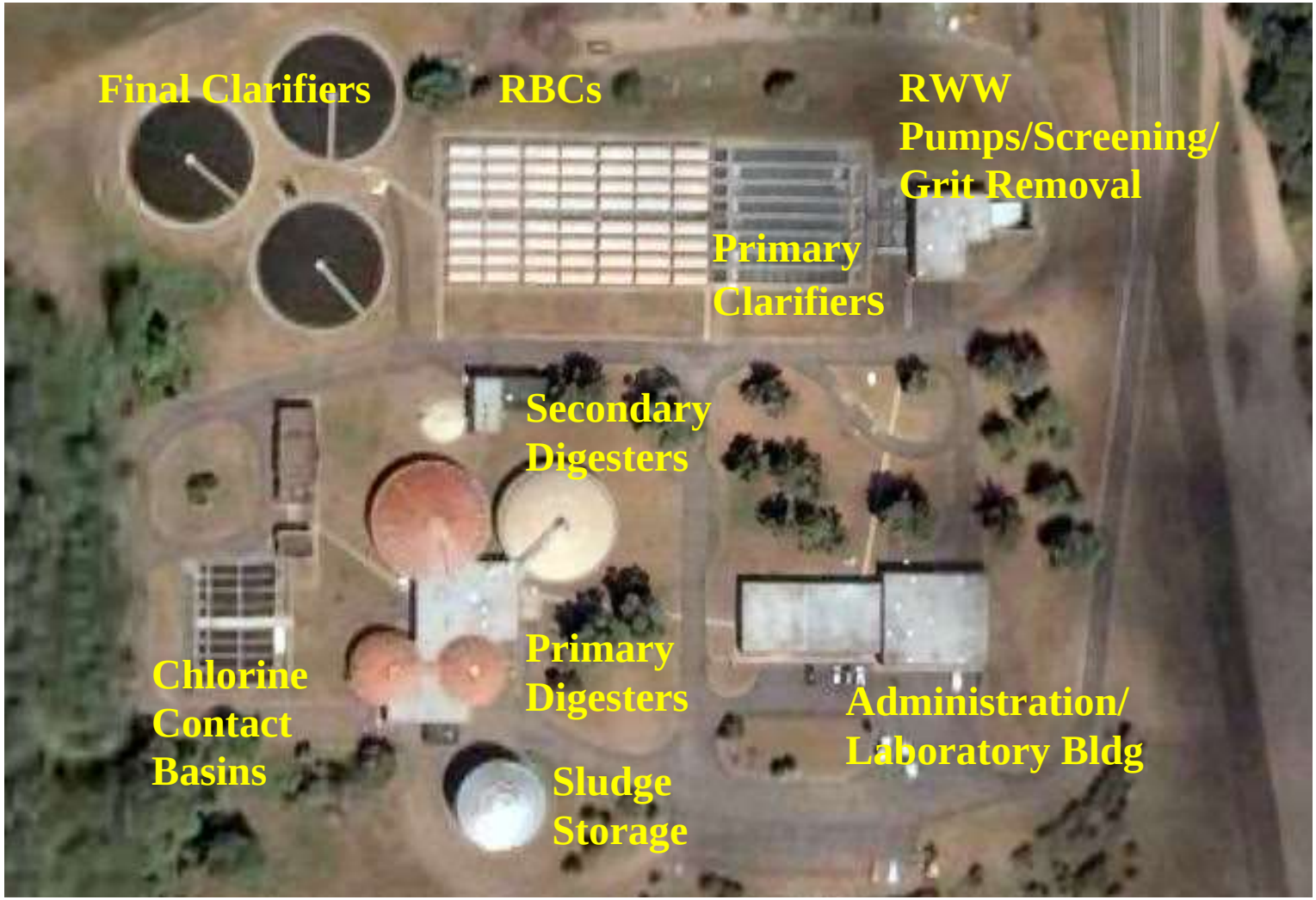
Presentation Outline

- Background
  - Utility/Existing Plant
  - New Equipment and Processes
- Upgrade History
  - Phased Upgrade
  - Key Considerations & Features
- Facility Startup & Transition
  - Challenges
  - Results

Eau Claire, WI Wastewater Utility

- Located ~ 85 miles East of Twin Cities, in Heart of Wisconsin
- Wastewater Utility
  - Serves Cities of Eau Claire and Altoona
    - Service Population ~75,000
  - WWTP
    - Average Daily Flow 5 mgd
    - 2030 Design ADF 6.8 mgd
    - Last Major Upgrade 1980

Eau Claire's Existing WWTP



Eau Claire's Existing WWTP

- Liquid Treatment
  - Preliminary Treatment
  - Primary Clarification
  - Rotating Biological Contactors (RBCs)
  - Secondary Clarification
  - Disinfection
  - Discharge to Chippewa River

Eau Claire's Existing WWTP

- Solids Treatment
  - Gravity Thickening Primary Sludge
  - Gravity Belt (GBT) Thickening RBC Sludge
  - Anaerobic Digestion
  - GBT Thickening Digested Sludge
  - Biosolids Storage
  - Land Application
  - Biogas Used in Engine Generators

Construction Overview

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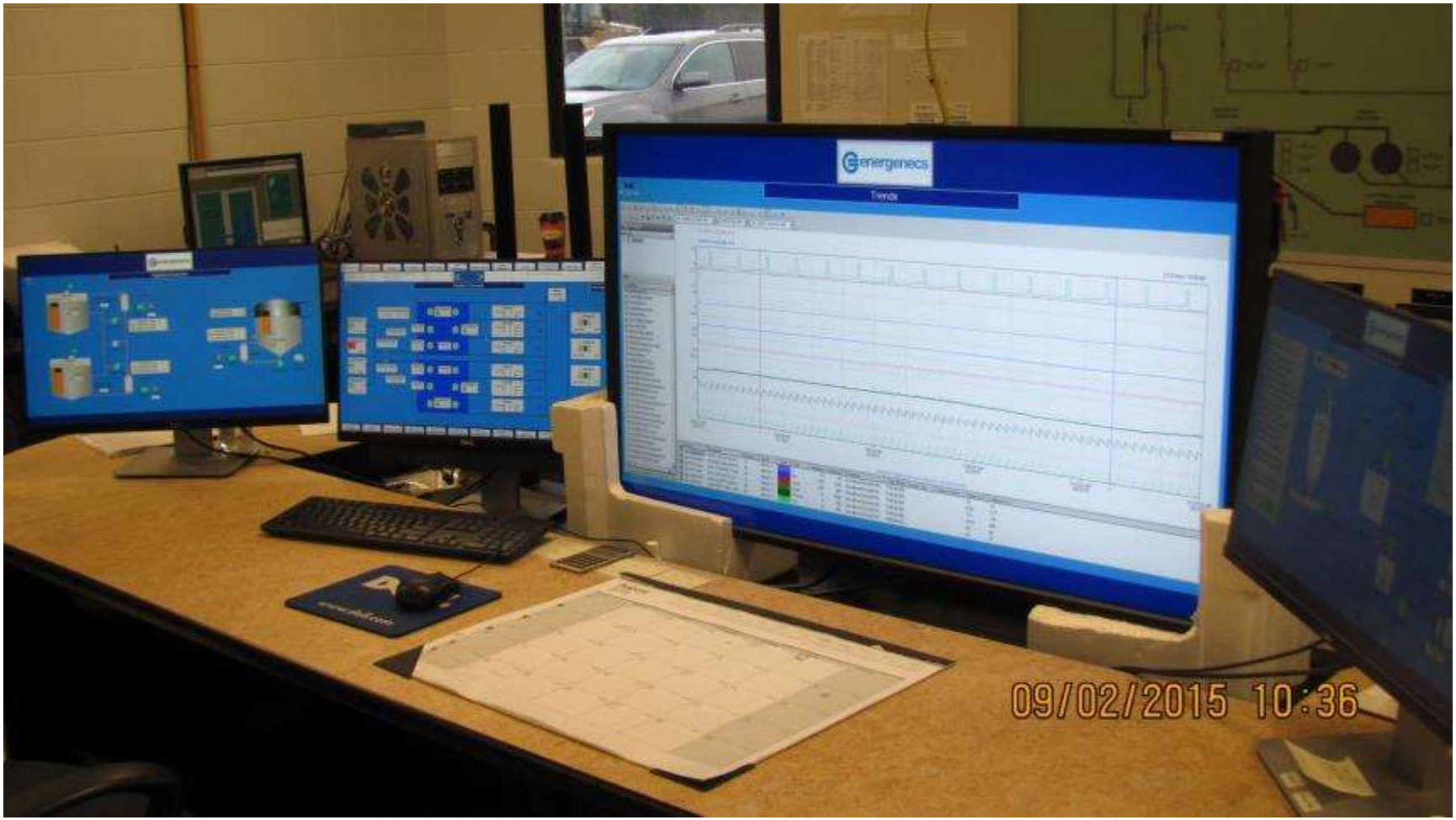
RBC Demo/Removal

- Recycling Was an Important Element
  - 20 Units Reused
  - All Plastic Media Recycled

Electrical Distribution

SCADA/Controls



BNR Activated Sludge System

BNR Selector Zones

BNR Aeration Basins

Aeration Blowers

Solids Thickening

- WAS Thickening
  - Two (2) Gravity Belt Thickeners (GBTs)

- Digested Sludge Thickening
  - One GBT
  - Odor Hood

Primary Sludge Screens

Standby Generators

Digested Gas Conditioning

Includes Provisions to Remove:

- Moisture
- Hydrogen Sulfide (H_2S)
- Siloxanes

Methane Generators

Methane Boilers

Digester Cover Replacements

- Primary Digesters (2)
  - New Fixed Steel Covers

- Secondary Digester (1)
  - New Floating Steel Cover

This Story Began a Decade Ago…

- New Draft Permit Included Effluent NH_3-N Limits

Effluent pH (s.u.)	NH_3-N Limit (mg/L)	Effluent pH (s.u.)	NH_3-N Limit (mg/L)
$6.0 < pH \leq 6.1$	108	$7.6 < pH \leq 7.7$	29
$6.1 < pH \leq 6.2$	106	$7.7 < pH \leq 7.8$	24
$6.2 < pH \leq 6.3$	104	$7.8 < pH \leq 7.9$	20
$6.3 < pH \leq 6.4$	101	$7.9 < pH \leq 8.0$	17
$6.4 < pH \leq 6.5$	98	$8.0 < pH \leq 8.1$	14
$6.5 < pH \leq 6.6$	94	$8.1 < pH \leq 8.2$	11
$6.6 < pH \leq 6.7$	89	$8.2 < pH \leq 8.3$	9.4
$6.7 < pH \leq 6.8$	84	$8.3 < pH \leq 8.4$	7.8
$6.8 < pH \leq 6.9$	78	$8.4 < pH \leq 8.5$	6.4
$6.9 < pH \leq 7.0$	72	$8.5 < pH \leq 8.6$	5.3
$7.0 < pH \leq 7.1$	66	$8.6 < pH \leq 8.7$	4.4
$7.1 < pH \leq 7.2$	59	$8.7 < pH \leq 8.8$	3.7
$7.2 < pH \leq 7.3$	52	$8.8 < pH \leq 8.9$	3.1
$7.3 < pH \leq 7.4$	46	$8.9 < pH \leq 9.0$	2.6
$7.4 < pH \leq 7.5$	40		

2006-2007 Facility Planning

- Recommendation: Phased Upgrade
  - Phase 1: Address Critical Needs
    - Additional Biosolids Storage Tank
    - Major Pump Station Upgrade
    - Effluent pH Adjustment System
    - ~$4.5 M Cost, Constructed 2007-2008
    - Allow City to Adjust User Rates for Phase 2 Upgrade
  - Phase 2: Address 20 Year Planning Period Needs
    - “expected to be required within next 5-10 years due to age of and potential failure of RBC units”

Major Elements of Phase 2

- Nitrifying Activated Sludge
  - With Biological Phosphorus Removal
  - Rehab Secondary Clarifiers
- Sludge Thickening Improvements
  - New GBTs & Sludge Pumps
- Anaerobic Digestion Improvements
  - Covers, Mixing, Heating
  - New Biogas Engine Generators & Boilers
- Design Complete & Construction Began 2013

Key Energy Conservation Design Features

- Aeration
  - High Speed Turbine Blowers
  - Membrane Fine Bubble Diffusers
- Mixing
  - Selector Zones – Low Energy Vertical Shaft Mixers
  - Primary Digesters – Linear Motion Mixers
- Digestion
  - New Fixed, Well Insulated Covers
  - New Heat Exchangers & Recirculation Pumps
  - New Biogas Engine-Generators & Boilers

Key BNR Challenges

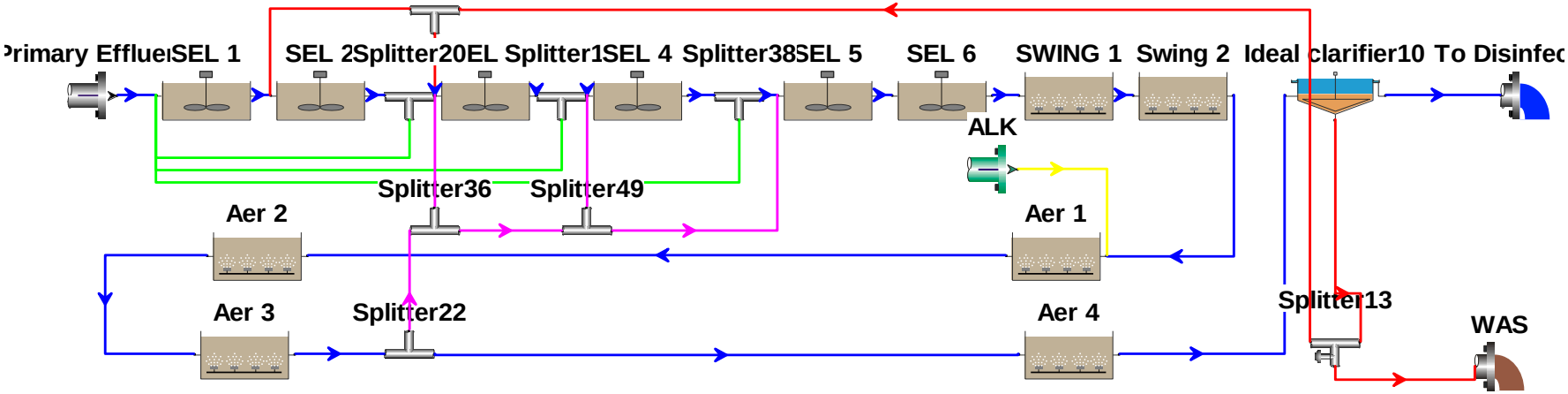
Primary Effluent

- BOD: TP Ratio ~ 50:1
  - Ideal for Enhanced Biological Phosphorus Removal (Bio-P)
- TKN ~ 70 mg/L
  - Full Nitrification Will Consume Close to 500 mg/L Alkalinity as $CaCO_3$
  - PE Alkalinity ~ 240 mg/L as $CaCO_3$
  - Supplemental Alkalinity Needed!

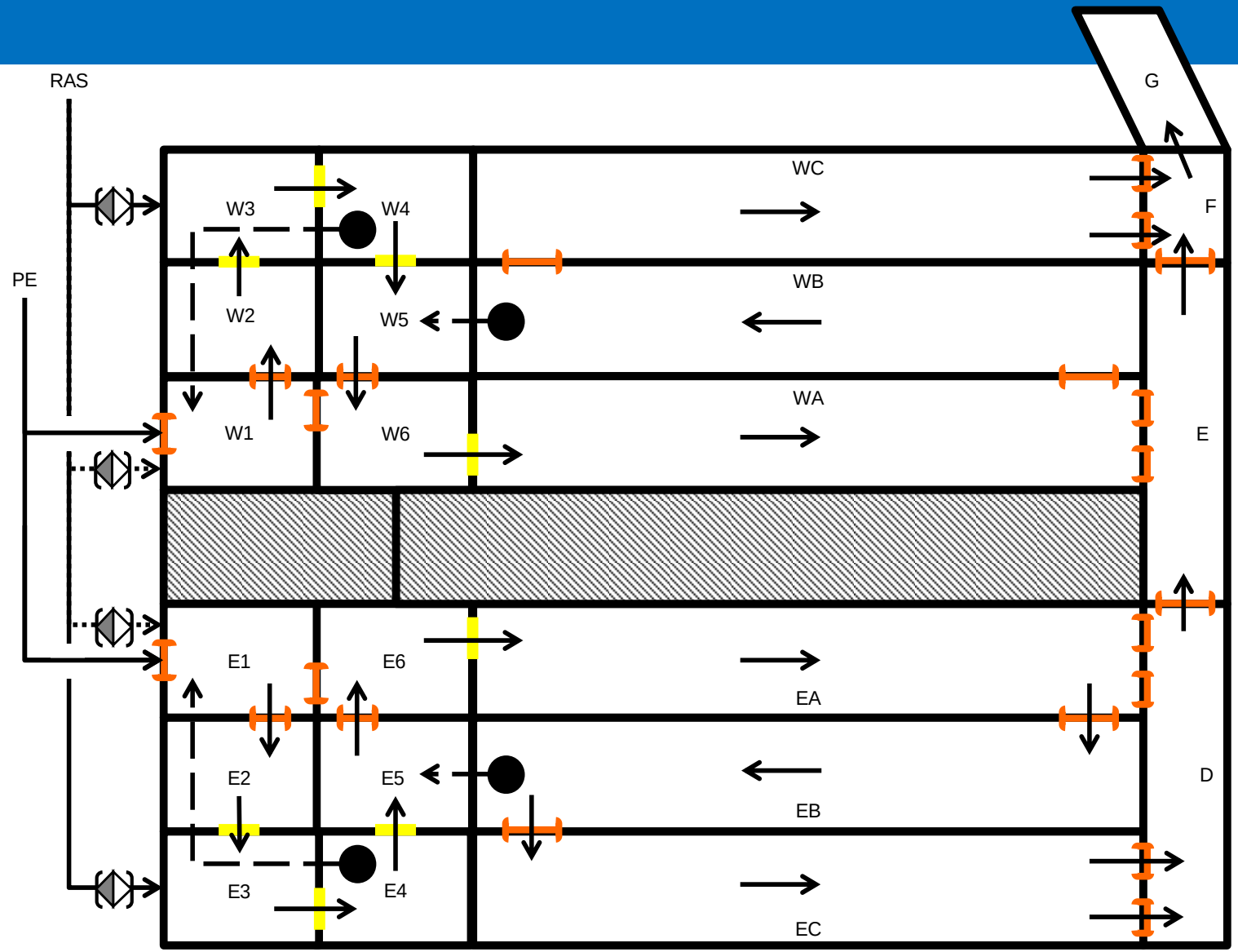
Biowin Modeling Optimizes BNR Design

MUCT Bio-P Configuration

- Denitrification of Mixed Liquor Recycle Included
  - Maximize Denitrification & Alkalinity Production
- Effluent Ammonia-Based Aeration Control
  - Minimize Nitrification, Aeration Energy Requirement & Alkalinity Consumption



Activated Sludge MUCT Configuration



“State of the Art”
Secondary Clarifier Upgrades

Ok, Let's Talk Some Results to Date…

- Energy Efficient Vertical Shaft Mixers

Primary Digesters 1 & 2

- Careful, Planned Restarts
  - Preheat with hot water
  - Transfer from active digester
  - Gradual increase in feed
  - Careful monitoring of VA/Alkalinity
- Achieving 50% VSR @ VA/Alk = 0.28

Going From RBCs to BNR Activated Sludge

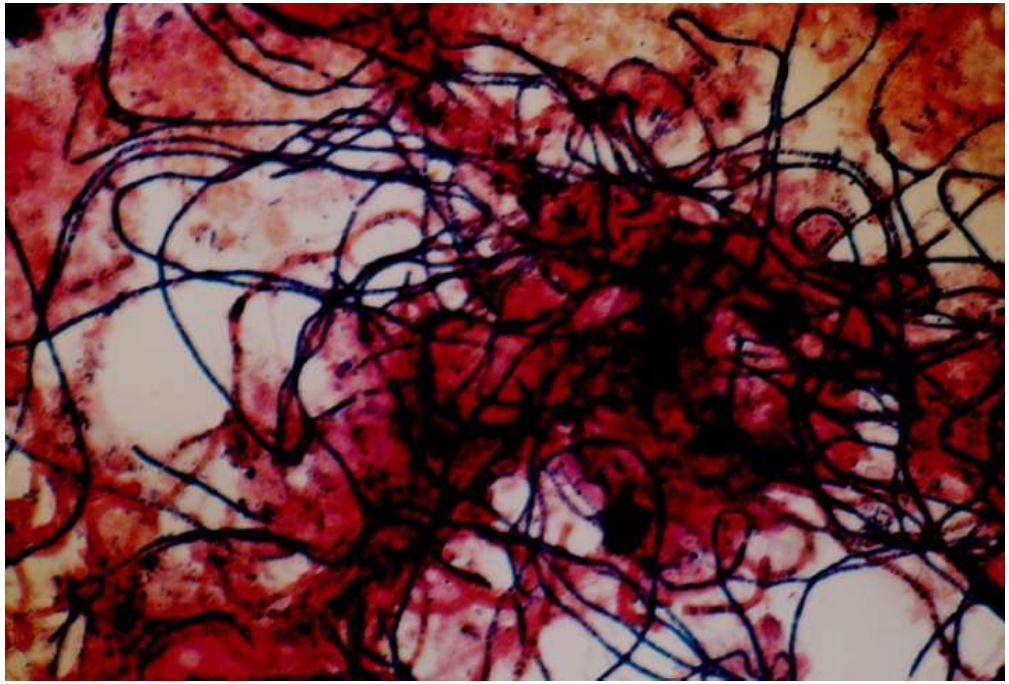
- RBCs
  - Simple, “Run Themselves”
  - O&M Primarily Breakdown Maintenance
- BNR Activated Sludge
  - Proactive Process Monitoring & Control
    - SRT/Sludge Age
    - System Monitoring
    - Nitrification/Alkalinity Challenge

Transitional Startup

- October 2014 – Train 1 Startup
  - Seed Sludge: Chippewa Falls WWTP WAS
  - 50/50 PE Flow Split Between RBCs & NAS
  - Began Wasting Early November w/MLSS > 1,000 mg/L
    - Daily Target SRT/Sludge Age Wasting Basis
- January 2015 – Train 2 Startup
  - Seed From Train 1
  - Continued 50/50 PE Flow Split Between RBCs & NAS

BNR Activated Sludge Process Control

- Sludge Wasting
  - Initially – Target SRT on Low Side – Industry Slug Load Led to Severe Digester Foaming
  - Overcompensated to Extremely High SRT
    - Provide More Stable Biology With Higher MLSS
    - Mid-January 2015 – Microthrix Outbreak

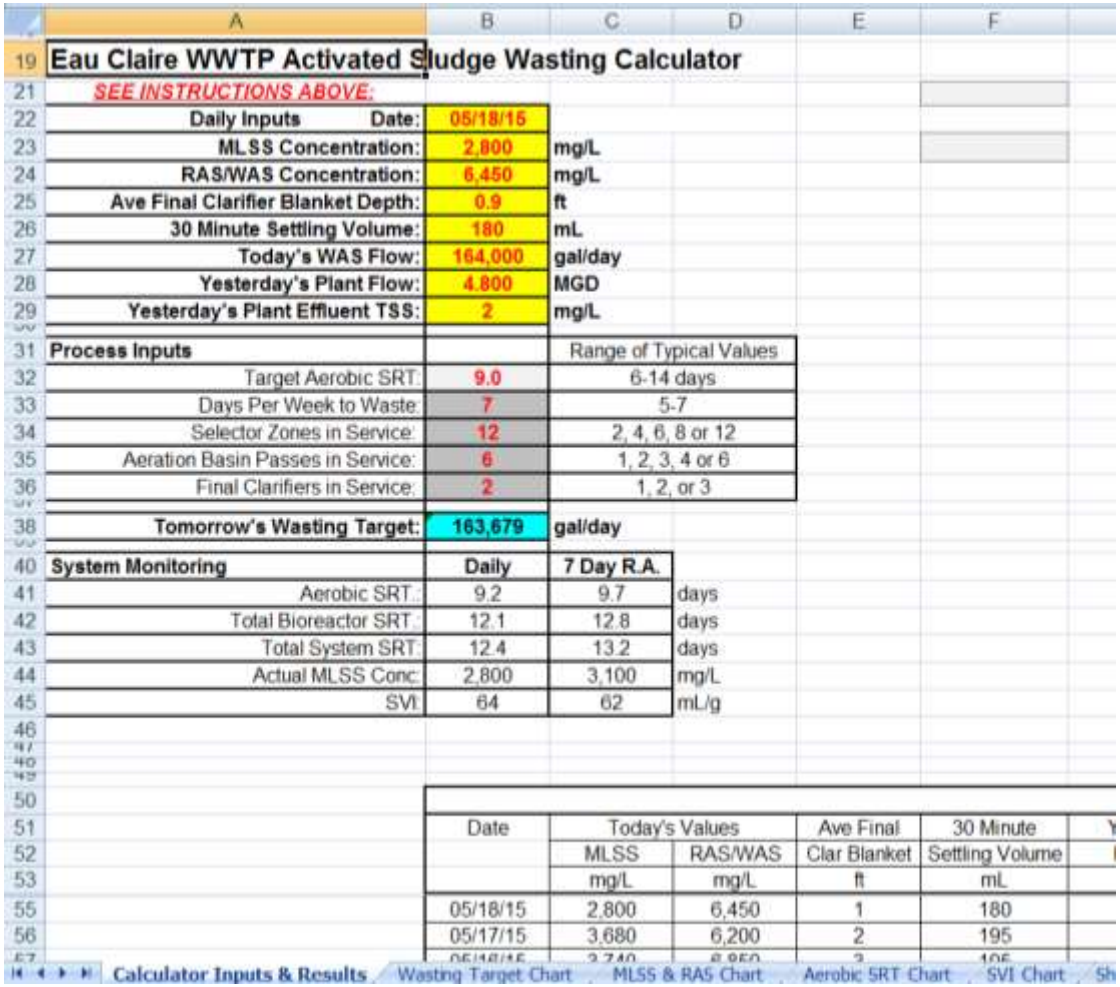


Microthrix => Foam!

…and not just in the Activated Sludge System

Process Control Paradigm Shift

- Running Average Aerobic SRT Based Wasting
  - Seasonally Change From 6-14 Days
  - Daily Settleometer/SVI Analysis
  - Regular Microscopic Examination



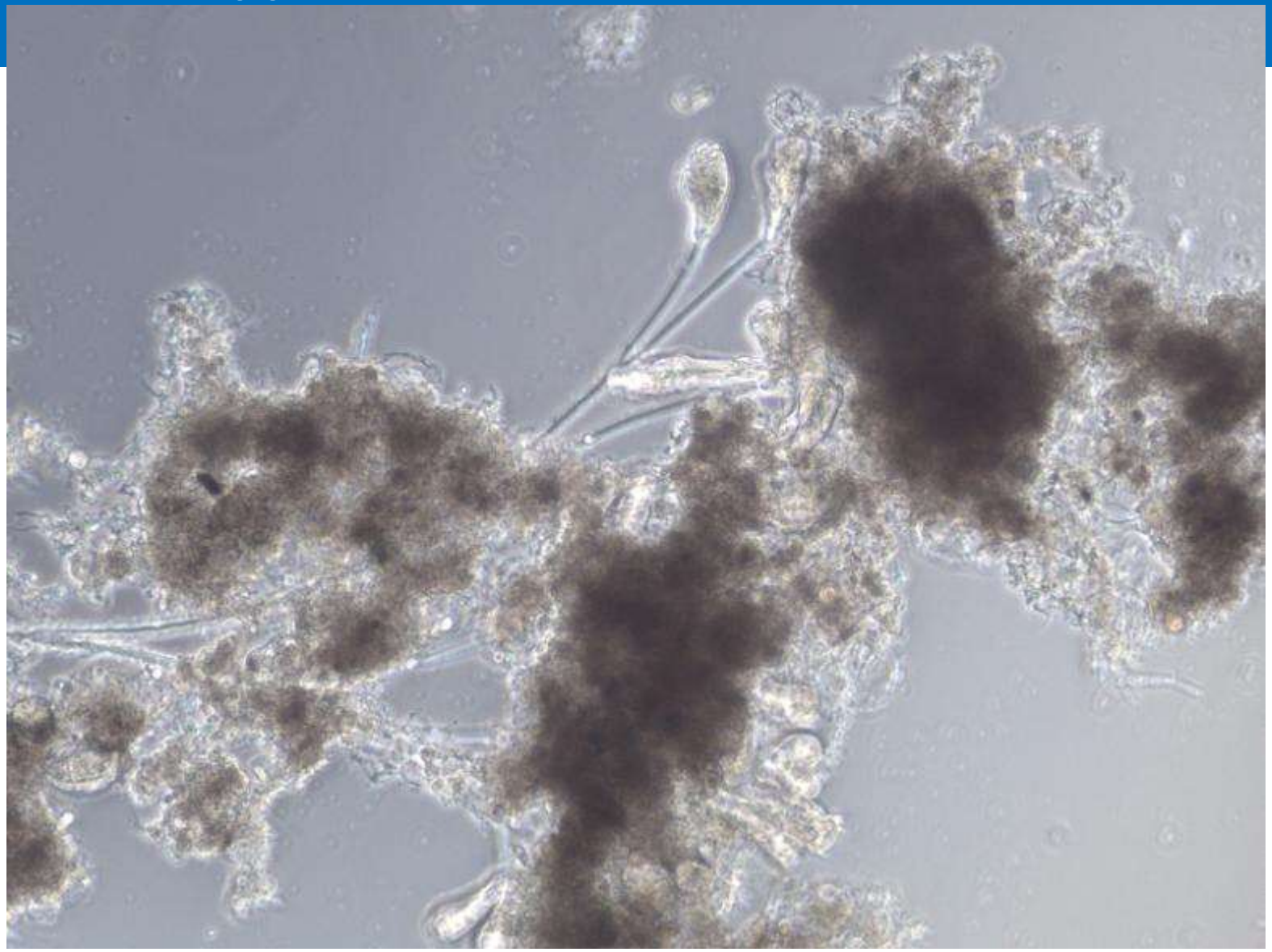
Eau Claire WWTP Activated Sludge Wasting Calculator			
SEE INSTRUCTIONS ABOVE:			
Daily Inputs Date:	05/18/15		
MLSS Concentration:	2,800	mg/L	
RAS/WAS Concentration:	6,450	mg/L	
Ave Final Clarifier Blanket Depth:	0.9	ft	
30 Minute Settling Volume:	180	mL	
Today's WAS Flow:	164,000	gal/day	
Yesterday's Plant Flow:	4.800	MGD	
Yesterday's Plant Effluent TSS:	2	mg/L	
Process Inputs		Range of Typical Values	
Target Aerobic SRT:	9.0	6-14 days	
Days Per Week to Waste:	7	5-7	
Selector Zones in Service:	12	2, 4, 6, 8 or 12	
Aeration Basin Passes in Service:	6	1, 2, 3, 4 or 6	
Final Clarifiers in Service:	2	1, 2, or 3	
Tomorrow's Wasting Target:	163,679	gal/day	

System Monitoring	Daily	7 Day R.A.	
Aerobic SRT:	9.2	9.7	days
Total Bioreactor SRT:	12.1	12.8	days
Total System SRT:	12.4	13.2	days
Actual MLSS Conc:	2,800	3,100	mg/L
SVI:	64	62	mL/g

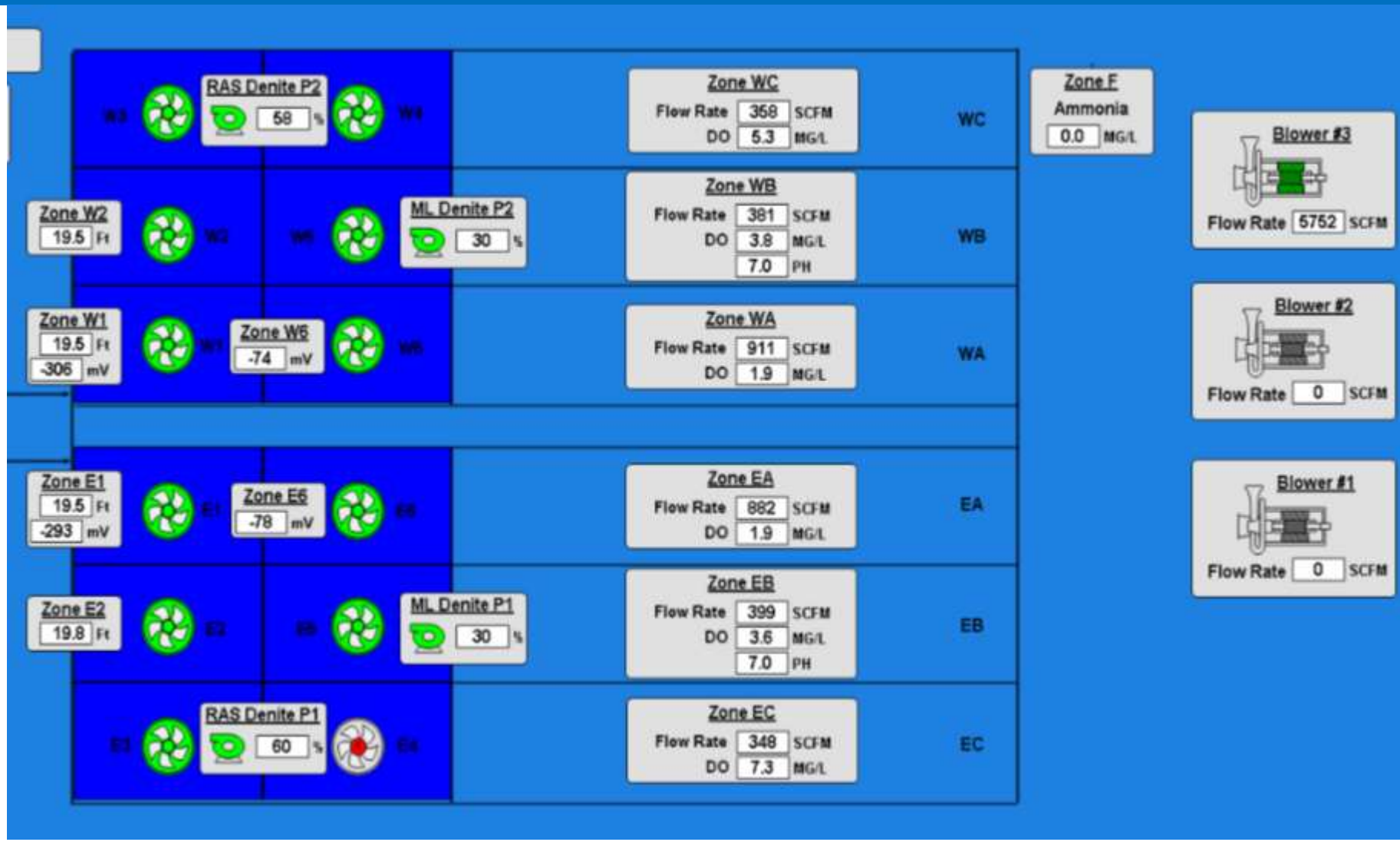
Date	Today's Values		Ave Final	30 Minute
	MLSS	RAS/WAS	Clar Blanket	Settling Volume
	mg/L	mg/L	ft	mL
05/18/15	2,800	6,450	1	180
05/17/15	3,680	6,200	2	195

Calculator Inputs & Results | Wasting Target Chart | MLSS & RAS Chart | Aerobic SRT Chart | SVI Chart

Typical Micro Exam Results



Aeration & Denitrification Controls



Aeration & Denitrification Controls

- Denitrification
  - Lack of TKN Data => Hard to Quantify
  - Effluent NO3-N Data Suggests 20-30 mg/L N is being Denitrified From Forward Flow
    - 70-100 mg/L Added Alkalinity Produced
    - 50-90 mg/L O2 Demand Satisfied
- Aeration
  - Ammonia Control Not Yet Possible
  - D.O. Control Works Well, Ongoing Optimization
    - Initial Targets 2.0 mg/L all Three Passes
    - Later changed to Gradient Targets of 1.0/1.5/2.0
    - Recently Changed to Gradient Targets of 1.0/1.0/1.0 mg/L

Goodby RBCs

- With 50/50 PE Split Between RBCs & Bio-P
  - Effluent TP 0.7-1.1 mg/L Using Average 400 gpd $FeCl_3$
- April 6, 2015 – Second Final Clarifier Available Following Rehab
  - One Week Gradual Diversion of All PE Flow to Activated Sludge
- April 14, 2015 – Flow to RBCs Discontinued
  - Turned Off $FeCl_3$ Feed
  - Effluent TP 0.3-0.4 mg/L with no $FeCl_3$

The Bottom Line

- Effluent BOD5: < 10 mg/L
- Effluent NH3-N: < 0.3 mg/L, Typically Non-Detect

Date	Today's Values		Ave Final	30 Minute	Yesterday's	Yesterday's	Yesterday's	Today's
	MLSS	RAS/WAS	Clar Blanket	Settling Volume	Plant Flow	Effluent TSS	WAS Flow	SVI
	mg/L	mg/L	ft	mL	MGD	(mg/L)	gal/day	mL/g
09/05/15	2,340	6,000	1	160	5.76	3	117,000	68
09/04/15	2,460	5,650	1	170	5.31	3	115,000	69
09/03/15	2,160	5,400	1	160	5.11	3	105,000	74
09/02/15	2,320	6,600	1	170	4.72	4	94,000	73
09/01/15	2,340	5,900	1	160	5.01	4	88,000	68
08/31/15	3,840	8,350	1	270	4.68	3	87,000	70
08/30/15	4,060	10,900	1	270	5.24	4	89,000	67
08/29/15	3,920	10,850	1	275	5.35	2	91,000	70
08/28/15	4,220	9,300	1	280	5.24	3	90,000	66
08/27/15	3,760	9,100	1	265	5.47	3	88,000	70
08/26/15	3,920	7,600	1	270	5.24	3	88,000	69
08/25/15	3,860	8,150	0	260	4.74	1	87,000	67
08/24/15	3,460	8,250	1	260	5.86	3	86,000	75
08/23/15	4,100	9,850	1	275	5.06	2	86,000	67
08/22/15	4,000	9,750	1	270	5.50	2	85,000	68
08/21/15	3,900	9,150	1	280	5.40	3	86,000	72
08/20/15	4,120	9,750	1	270	5.64	3	85,000	66
08/19/15	4,080	9,750	0	280	5.06	2	85,000	69
08/18/15	3,840	8,450	1	255	5.77	2	83,000	66

Ongoing Challenges

- Maintaining Plant Performance as Construction Nears Completion (& Addressing Punchlist Items)
- Resolving Instrumentation & Equipment Issues
- Finding Balance Between Easy/Reliable Activated Sludge Process Control &Energy/Chemical Savings
  - Tapered DO Control, Effluent Ammonia Control
  - # Units In/Out of Service Seasonally
  - Aerated Effluent Target pH & Alkalinity Residual

Summing Up Thoughts

- Biowin Modeling Invaluable in Evaluating Alternative Strategies to Optimize Design & Performance
- Some Leading Edge Energy Conservation Strategies Are Still Evolving, While Others Have Proven Themselves
- Good, Sound Design & Control of Nitrifying Activated Sludge Leads to Great Results
- Plant Staff Must Be Involved Throughout Project, and Embrace New Facilities & Operations

The True Heroes in this Story…

The Eau Claire Wastewater Utility Staff, Including:

- Steve Hayden, Utility Engineer
- Craig Hendrickson, Plant Superintendent
- Kathy White, Lab Manager
- Jeff Pippenger, Utility Manager
- Tyler Fadness, Assistant Chemist
- Mike Thieste, Lab Tech
- Entire Plant O&M Staff

Thanks for Your Attention!

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