Mystic Completes Year One Operating the BioMag Process

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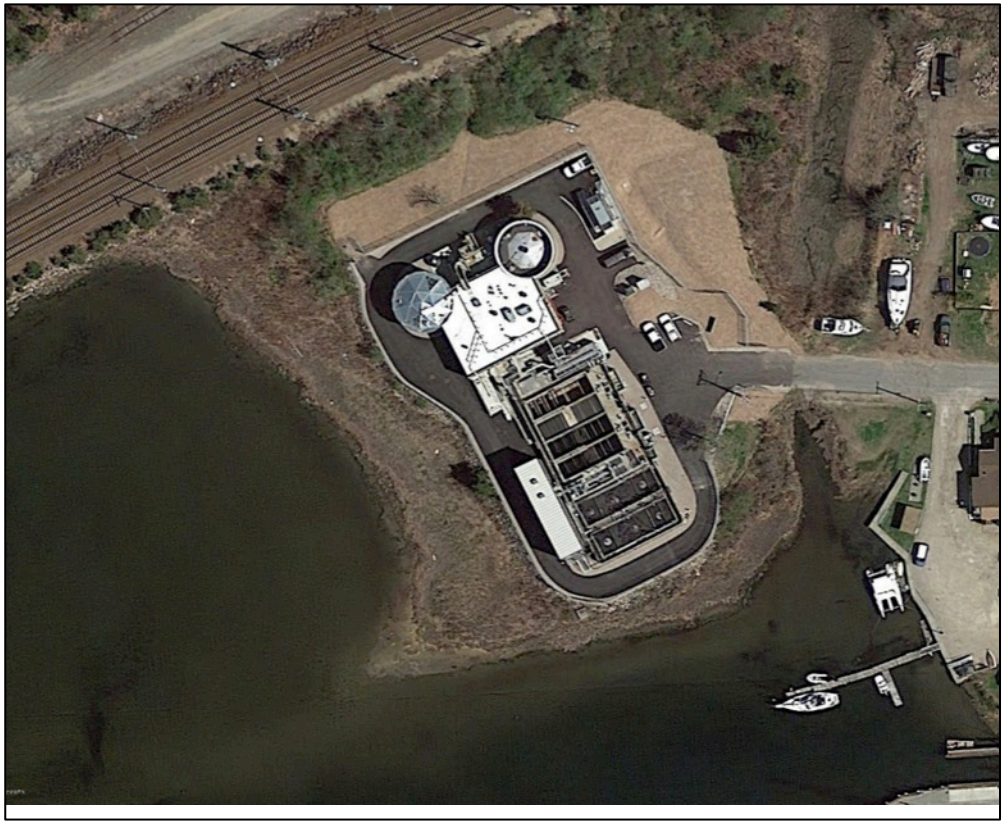
Mystic WPCF Background

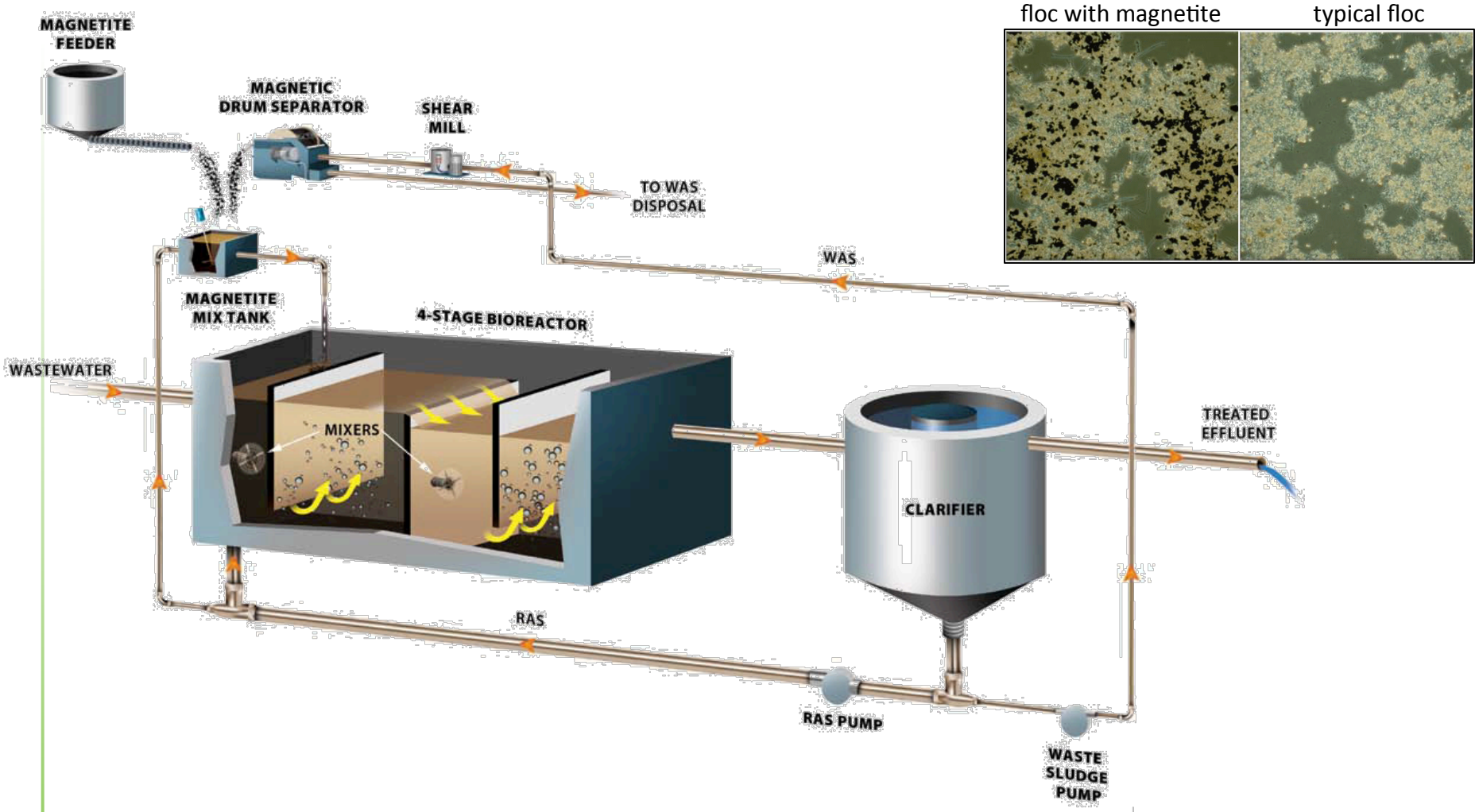
- Located in the coastal Town of Stonington, Connecticut
- Permitted capacity of 3.0 ML/d (0.80 mgd)
- Secondary treatment upgrade for nutrient removal (TN)
- Constrained site
- Minimal site modifications
- Existing Process:
  - Influent grinding
  - Primary clarifiers
  - Aeration basins (cyclic aeration)
  - Secondary clarifiers
  - Disinfection (NaOCl)
  - Solids diversion



Mystic WPCF Project Development

- 2007 Facilities Plan
  - Identified plant upgrade was required
  - Age and condition
  - Projected flow and load increase
  - Increased nitrogen removal
- 2009 Biological Process Evaluation
  - Evaluation of various treatment technologies
  - BioMag was identified to meet the project requirements
- 2010 Successful Full-Scale Demonstration
  - Effluent total nitrogen < 5 mg/L
- 2014 Permanent System Constructed

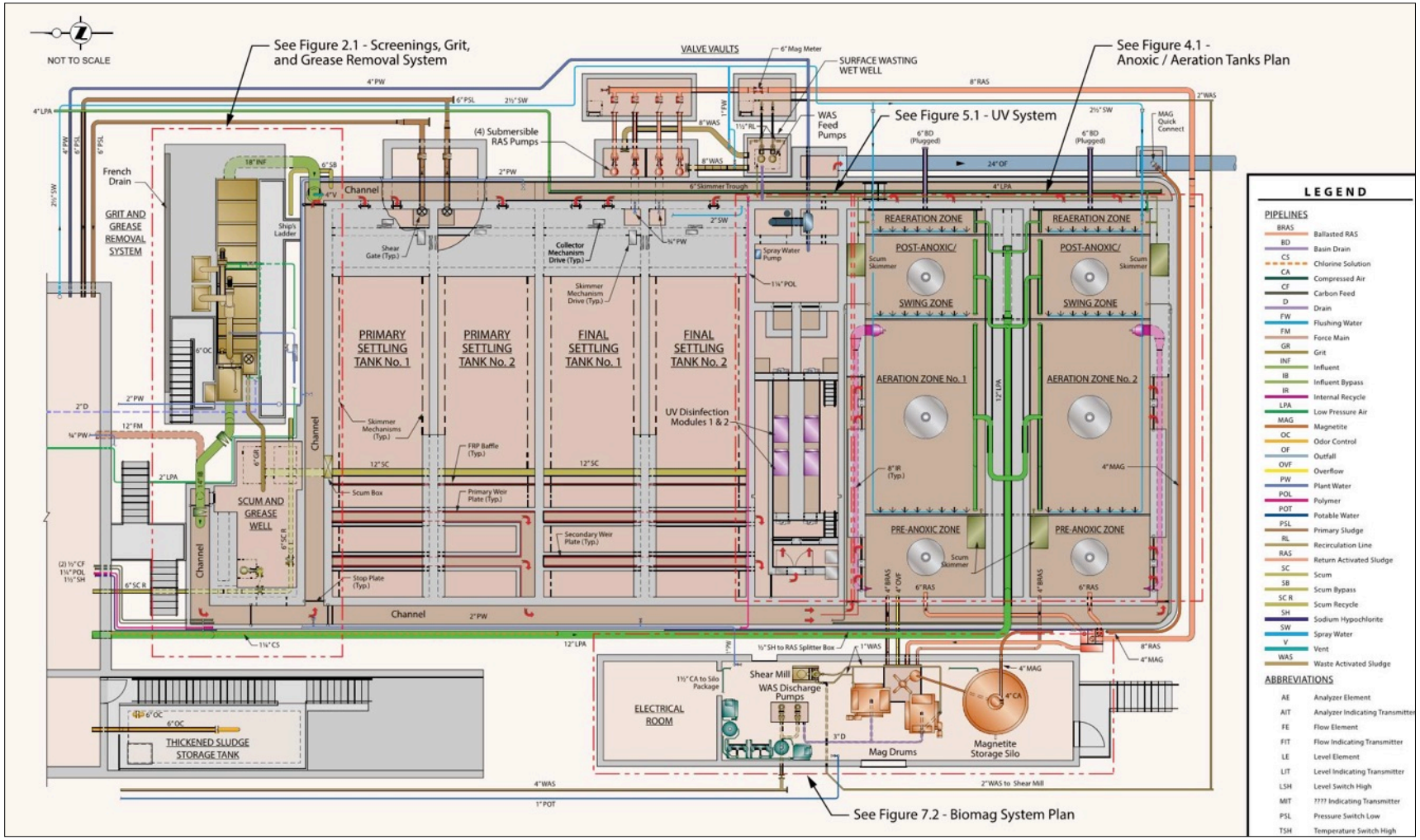
BioMag - Evoqua Water Technologies



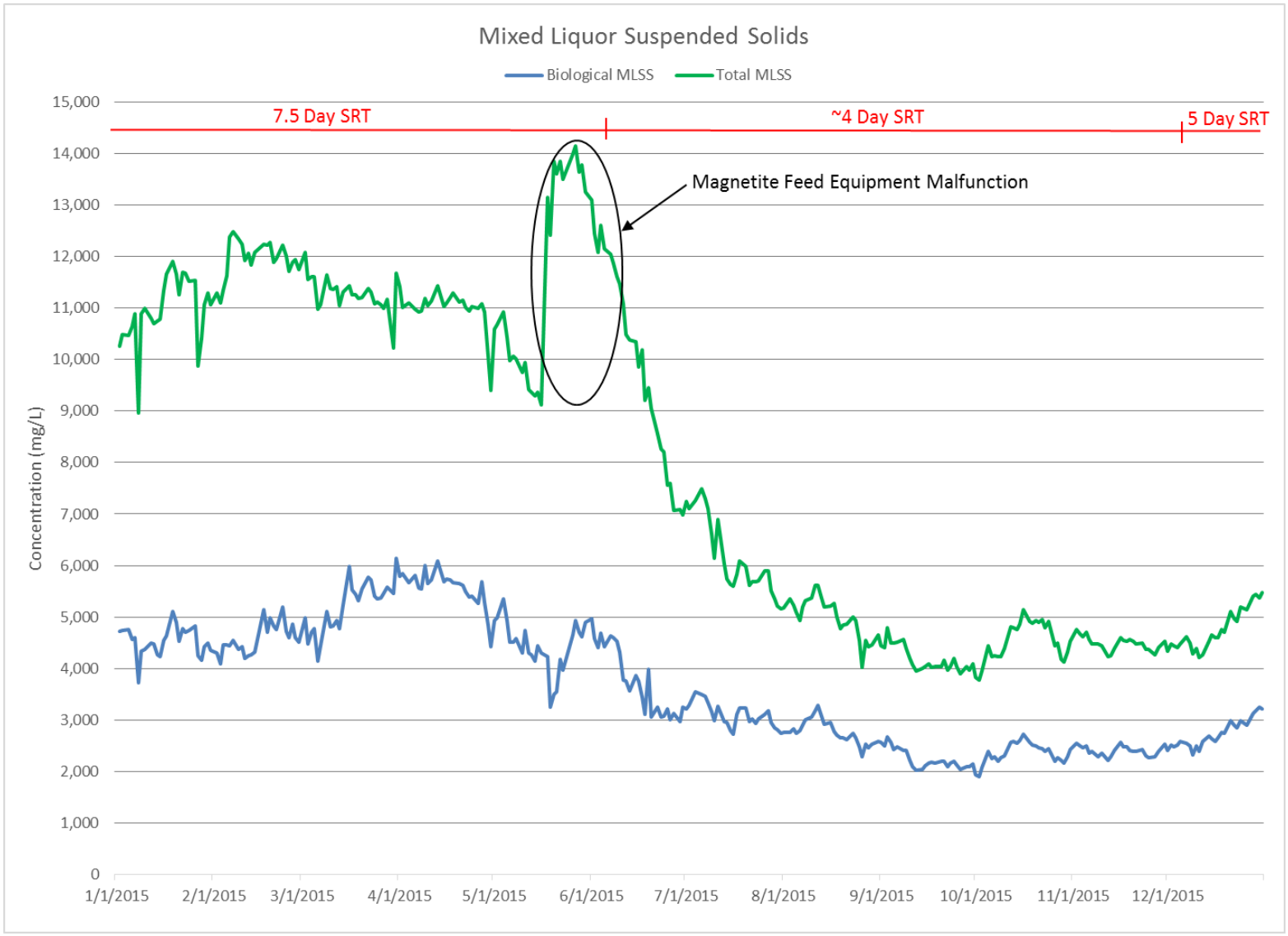
Biological Design Criteria

Process	Conventional activated sludge in 4-stage Bardenpho configuration; can be operated as MLE
Process Loads (30-day max.)	
- BOD_5	530 kg/day (1160 lbs/day)
- TSS	340 kg/day (740 lbs/day)
- TKN	90 kg/day (200 lbs/day)
Design Parameters	
- Design temp. (30-day min)	11 deg. C
- Aerobic SRT	9.9 days
- **MLSS concentration**	**8,800 mg/L (biological mass only)**
- **Total Nitrogen**	**6.4 mg/L (2014), 5.2 mg/L (2030)**
Aeration basins	
- Number	2
- Dimensions	6 m x 6.4 m x 4.04 m deep (52 ft x 21 ft x 13.25 deep)
- 1^{st}-stage anoxic volume	0.180 ML (0.0475 million gallons)
- 1^{st}-stage aerobic volume	0.416 ML (0.110 million gallons)
- 2^{nd}-stage anoxic volume	0.180 ML (0.0475 million gallons)
- Reaeration volume	0.049 ML (0.013 million gallons)
- Total volume	0.825 ML (0.218 million gallons)
Final Settling Tanks	
- Number	2
- Dimensions	16 m x 4.0 m x 2.50 (52 ft x 13 ft x 8.2 ft deep)
- Total clarifier surface area	124.6 m^2 (1,352 ft^2)

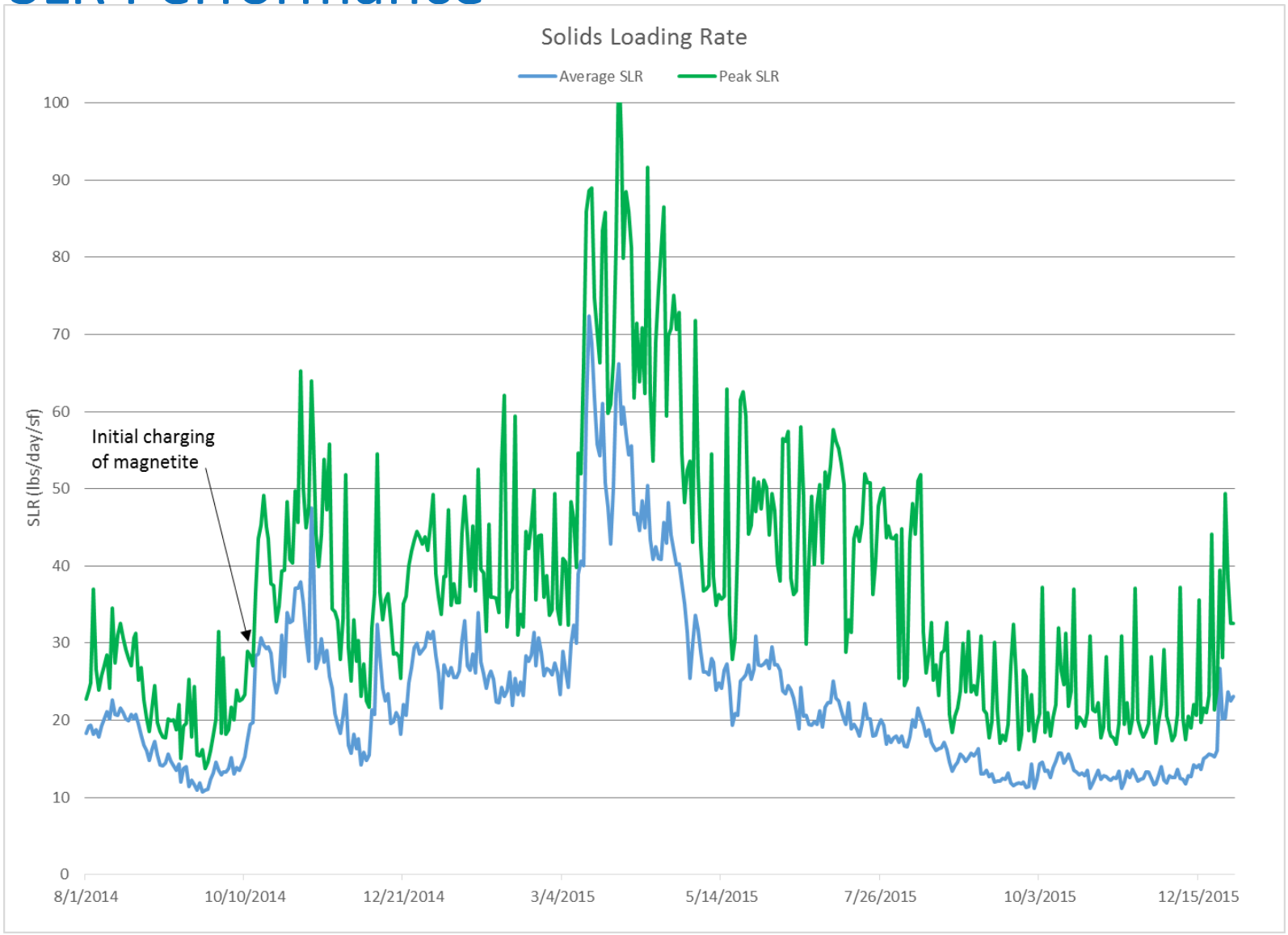
Process Tanks and BioMag Arrangement



MLSS Performance

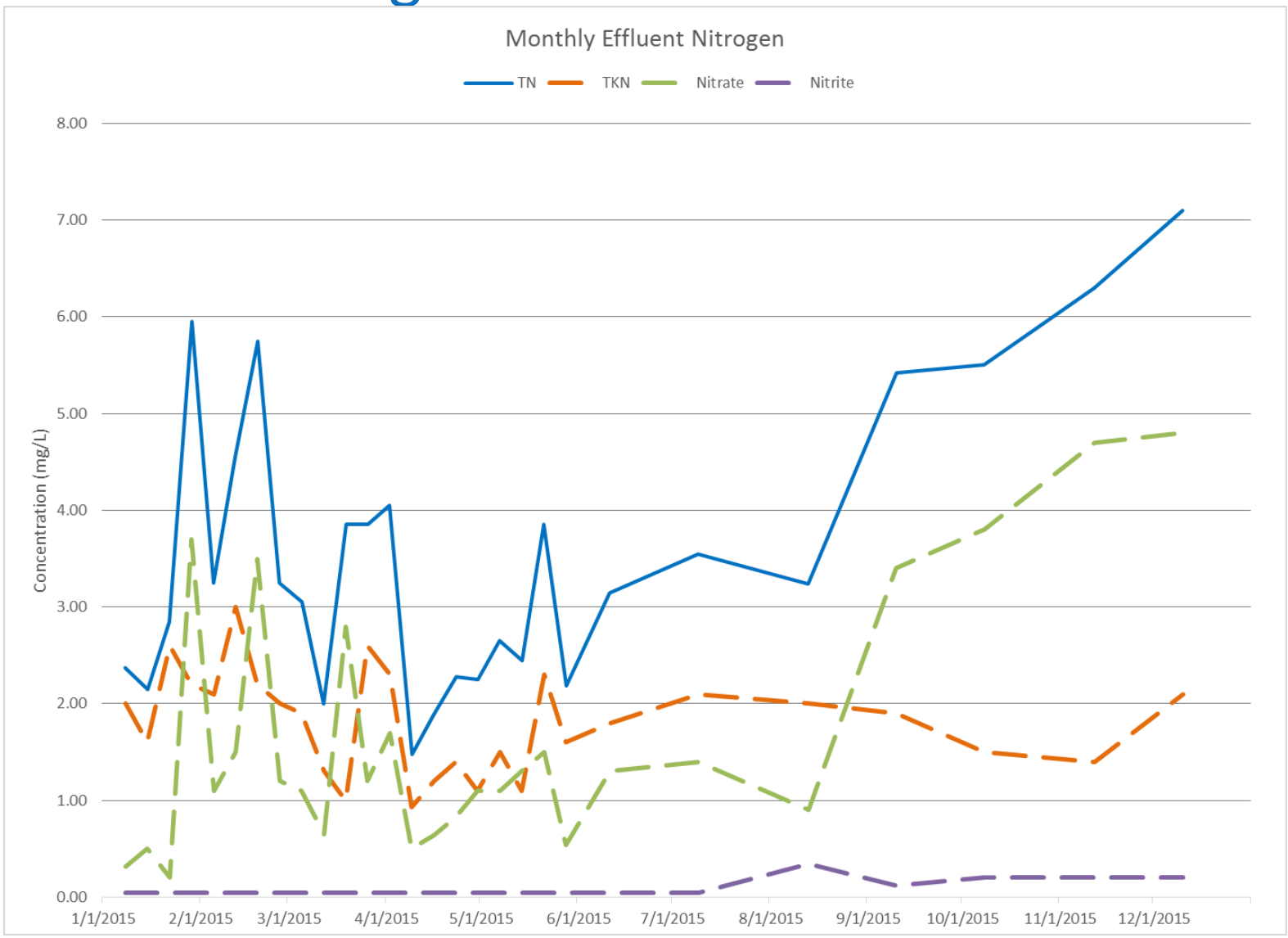


SLR Performance



SVI Performance

Effluent Nitrogen Performance



Aeration Tank Foam

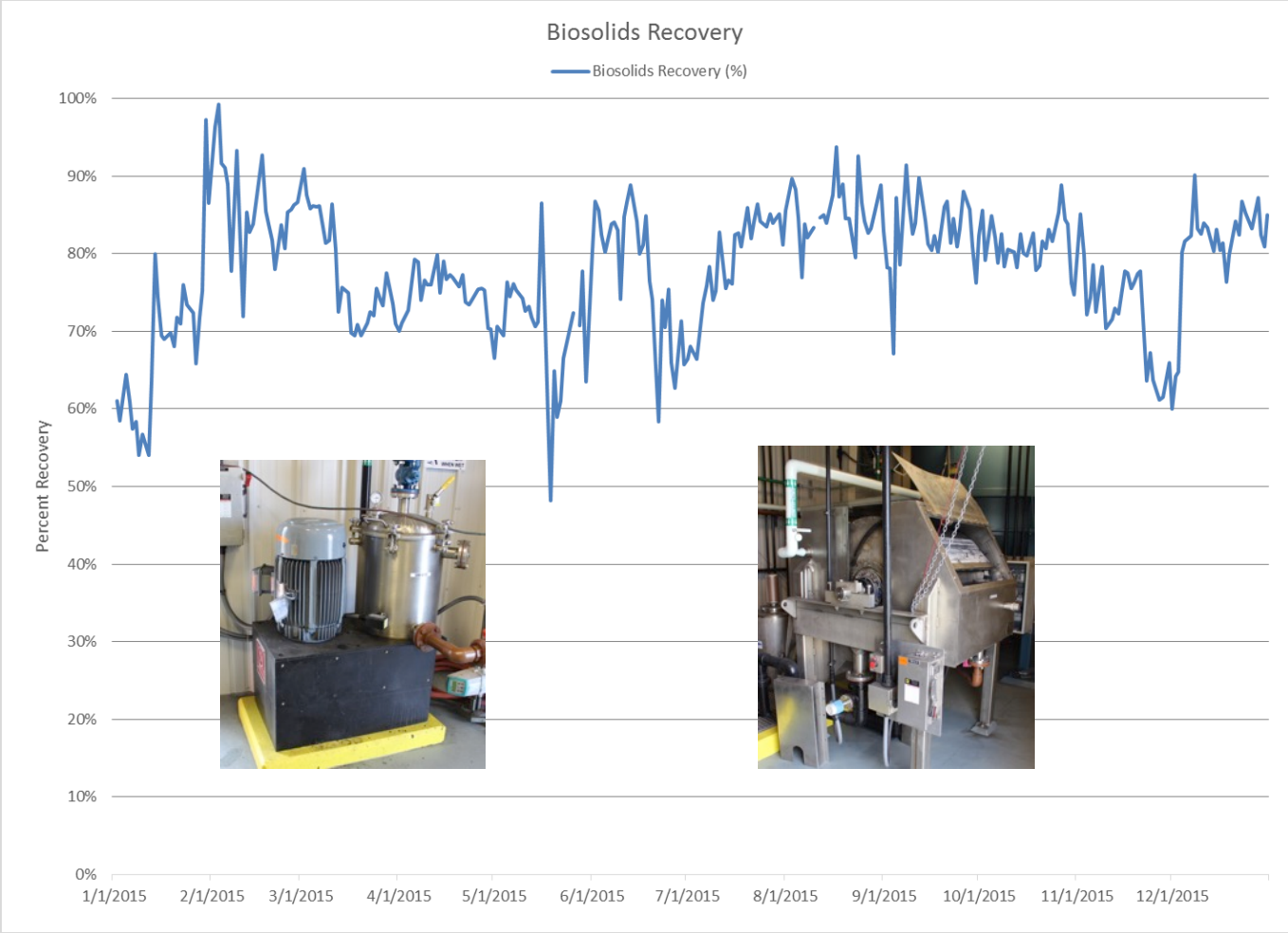
- Foam Mitigation Measures - Design
  - Surface cut outs in baffle walls
  - Foam spray nozzles
  - Skimmer trough in effluent channel for surface wasting

Aeration Tank Foam

- Foam Mitigation Measures – Field Implementation
  - Defoamer agent
  - Surface wasting wells in bioreactors
  - Process optimization

Magnetic Drum Biological Capture Efficiency

- 95% magnetite recovery
- 70% biological solids capture
- Unintended WAS to bioreactor
- Thinner WAS to sludge thickening

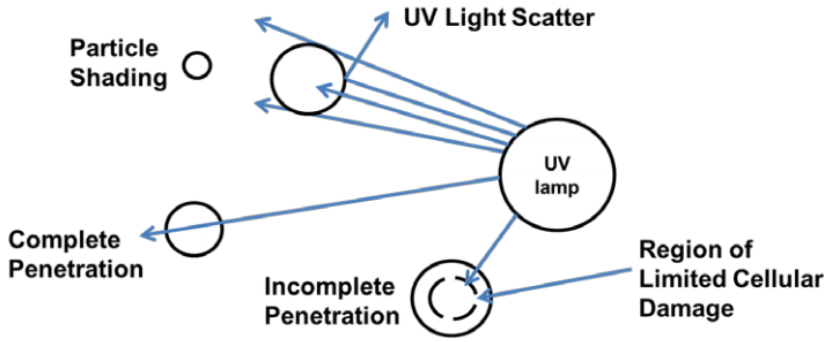


Solids Deposition

- RAS and WAS wet wells required mixing
- Recycle systems included in design
- Settling experienced after startup
- Creates unbalanced solids inventory
- Impacts sludge thickening
- Further mixing implemented in field

Clarification and Disinfection

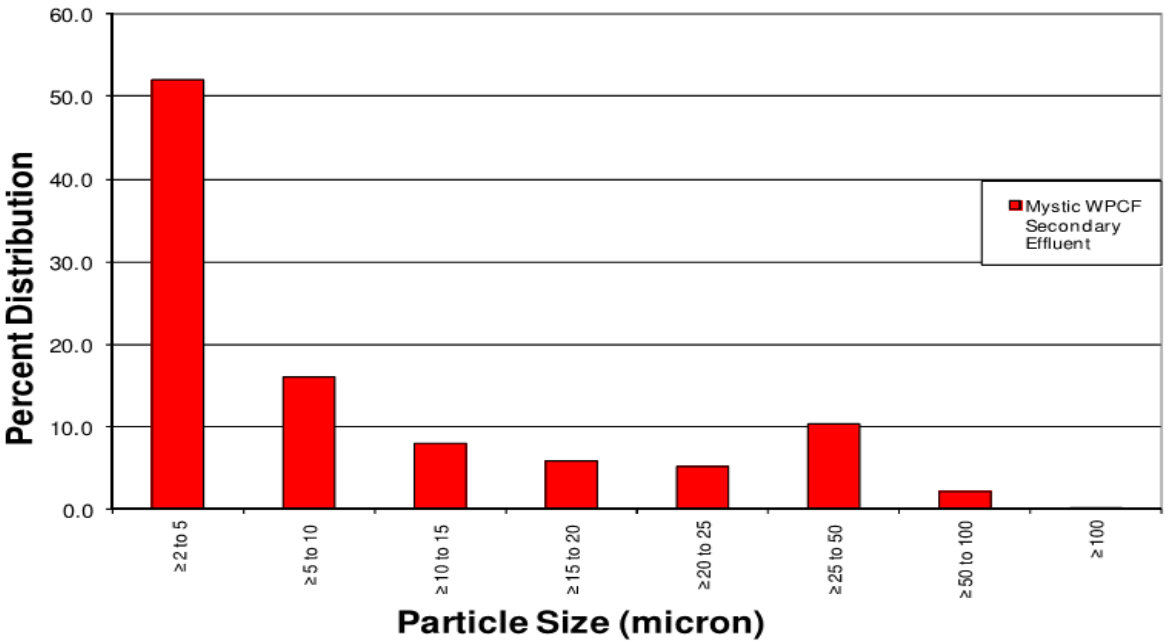
- Final settling tank performance issues
  - Polymer dosage
  - Foam carryover
  - Solids carryover to disinfection
    - Below TSS permit concentration of 30 mg/L
    - Above typical TSS concentration of 10 mg/L
  - Poor UV disinfection performance
    - Enterococci limit of 35 MPN/100mL
    - Potential shading/shielding
    - Partical size distribution



Loge et al., 1996

March 2015 Secondary Effluent Analysis

TSS Particle Size Distribution



Collimated Beam Testing

Dose (mJ/cm^2)	Log Inactivation	Enterococci (count/100ml)
0	0.000	904
10.14	0.850	128
20.27	1.394	37
30.41	1.696	18
40.54	1.628	21
50.68	1.698	18

Secondary Effluent Filtration Pilot

- Disk filter pilot to determine ability to meet disinfection permit requirement
- Filter secondary effluent to reduce TSS to less than 10 mg/L
- Preliminary results indicate that UV disinfection was effective on the filtered sample

Collimated Beam Testing

Filter Influent		
Dose (mJ/cm2)	Log inactivation	Enterococci (count/100mL)
0	0	7088
10	1.419	270
20	1.492	228
30	1.572	190
40	1.653	204
50	1.623	169

Filter Effluent		
Dose (mJ/cm2)	Log inactivation	Enterococci (count/100mL)
0	0	5930
10	2.511	18
20	3.773	0
30	3.773	0
40	3.773	0
50	3.773	0

Design and Operation Considerations

- Foam Mitigation Measures
  - Foam Spray
  - Defoamer Agent
  - Surface wasting directly from bioreactors
- Account for biological solids capture efficiency
- Track solids inventory
- Prevent solids deposition through process
- Continual process optimization
- Consider particle size distribution for UV disinfection of enterococci

Treatment Performance Summary

- UV disinfection has been problematic
- Particle size distribution and potential shielding may be contributors
- BioMag process successfully reduces total nitrogen
- Ballasted mixed liquor enhances settling and decreases SVI
- *Facility operates at a high MLSS concentration without any increase in tankage providing a high level of treatment in a small footprint*

Acknowledgements