Prove It! Demonstrating Performance of a Combined Carbon and Ammonia Removal BAF

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Presentation Outline

- Introduction & Background
- Demonstration Study Drivers & Goals
- Methodology and Equipment
- Experimental Approach & Results
- Conclusions
- Questions

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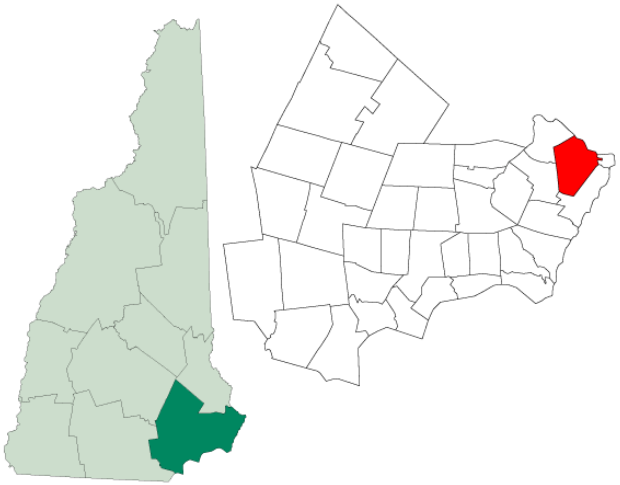
Introduction



- Project location - Portsmouth, NH
  - Population 21,200
  - Historic seaport / summer tourist destination
- Two WWTFs (Peirce Island and Pease)
  - Combined sewer system
- Peirce Island WWTF Design Flows
  - Average day flow 4.5 mgd
  - Peak flow 22 mgd

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Background

- Peirce Island WWTF originally built in 1964 – primary treatment with disinfection
- 1985 – NPDES permit issued with 301(h) waiver
- Upgraded in 1990 to advanced primary with filtration
- Upgraded in 2002 as chemically enhanced primary treatment
- 2005 draft permit issued with 301(h) waiver – denied
- 2007 new permit issued with secondary requirements

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WWTF Upgrade Process Selection

- Provide secondary treatment within existing WWTF fence line
- Desk top evaluation of 8 high rate treatment technologies
  - ✓ Based on capital cost, 20 year life cycle cost, and cost to value ratios using a weighted value matrix
- Top three technologies piloted in the field in 2012:
  - ➢ Activated Sludge with BioMag
  - ➢ MBBR with DAF
  - ➢ Biological Aerated Filter (BAF)
- BAF selected based on cost and non-monetary criteria matrix as the technology that best met the City's needs

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Demonstration Study Drivers & Goals

- Near the end of 2012 Initial Piloting, EPA informed City that nitrogen removal now required
- 2012 Initial Piloting provided limited data on BAF combined stage carbon oxidation and ammonia removal (CN) and performance at cold temperatures
- Limited installations of combined stage CN BAF in the US & proposed loading rates at high end of range of operating installations
- Need for additional data on BAF backwash solids coagulation, settling, thickening, and dewaterability
- Desire for City's WWTF operations staff to gain experience with BAF process

Demonstration Pilot Study Methodology

- Operate pilot scale first stage BAF to remove BOD and oxidize ammonia at or near proposed full-scale maximum month loading rate at cold temperatures
- Conduct jar tests on BAF backwash to establish effective ferric chloride and polymer doses for coagulation
- Conduct settling tests of combined raw wastewater and BAF backwash to assess settling performance
- Conduct thickening compression tests of combined primary sludge and BAF backwash to assess thickening performance
- Conduct bench scale testing of dewaterability of thickened combined primary sludge and BAF backwash

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Demonstration Pilot Study Equipment

- Pilot scale primary clarifier
- Sized to mimic hydraulic overflow rate of full scale primary clarifier
- Raw wastewater pumped to influent
- Primary effluent pumped to BAF Pilot

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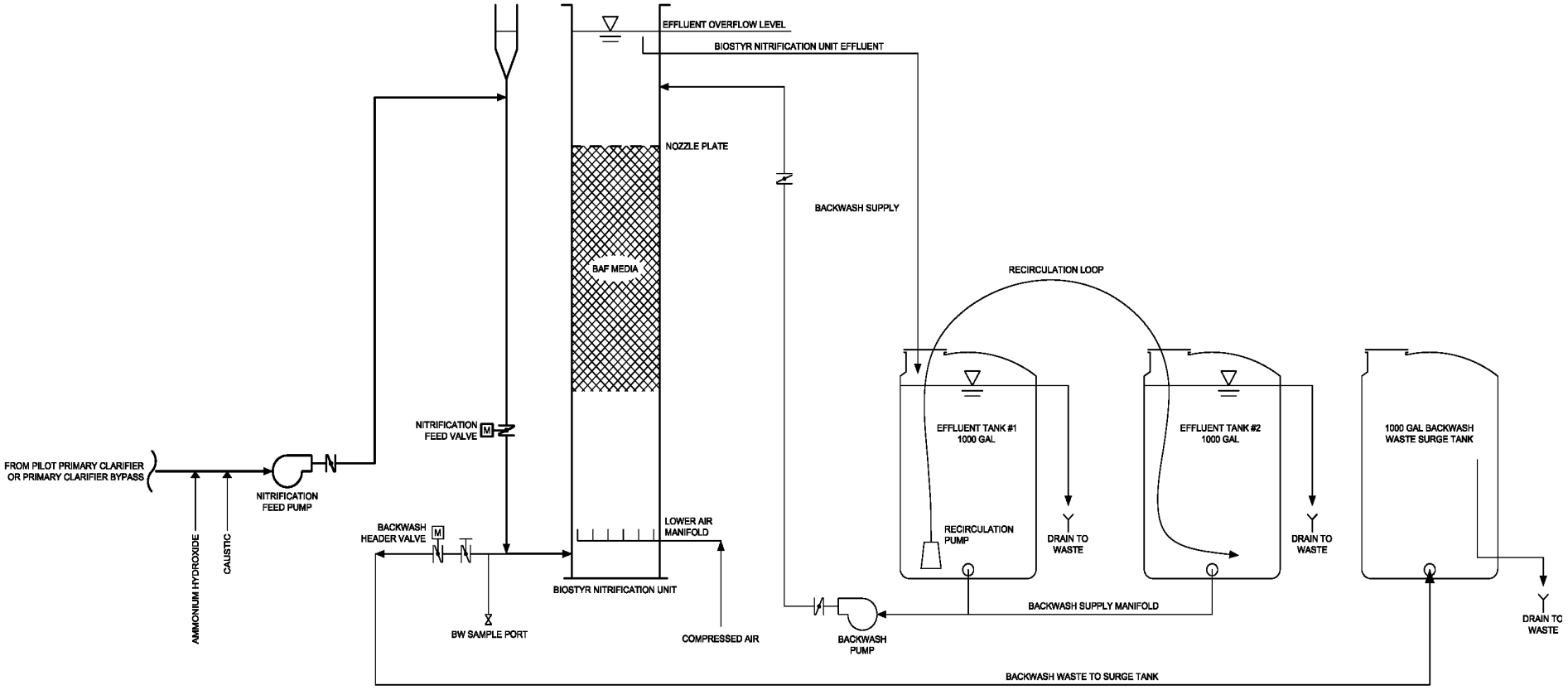
Demonstration Pilot Study Equipment



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Demonstration Pilot Study Equipment

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Demonstration Pilot Study Equipment

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Experimental Approach and Results

Frozen Feed Pump

Snapped Backwash Pipe

BAF Pilot

- Idle Stage 1 pilot unit re-started January 2, 2014
- Extremely cold temperatures presented operating challenges
- Unusually cold wastewater temperatures coupled with above ground piping and exposed metal pilot column inhibited nitrifier growth until mid-April
- Temperature correction applied to design loading rates to compensate for rising wastewater temperatures April-June
- BAF effluent analyzed for COD, BOD_5,TSS, TKN, NH_3, NO_2, NO_3, PO_4, alkalinity, temperature

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Experimental Approach and Results

BAF Pilot

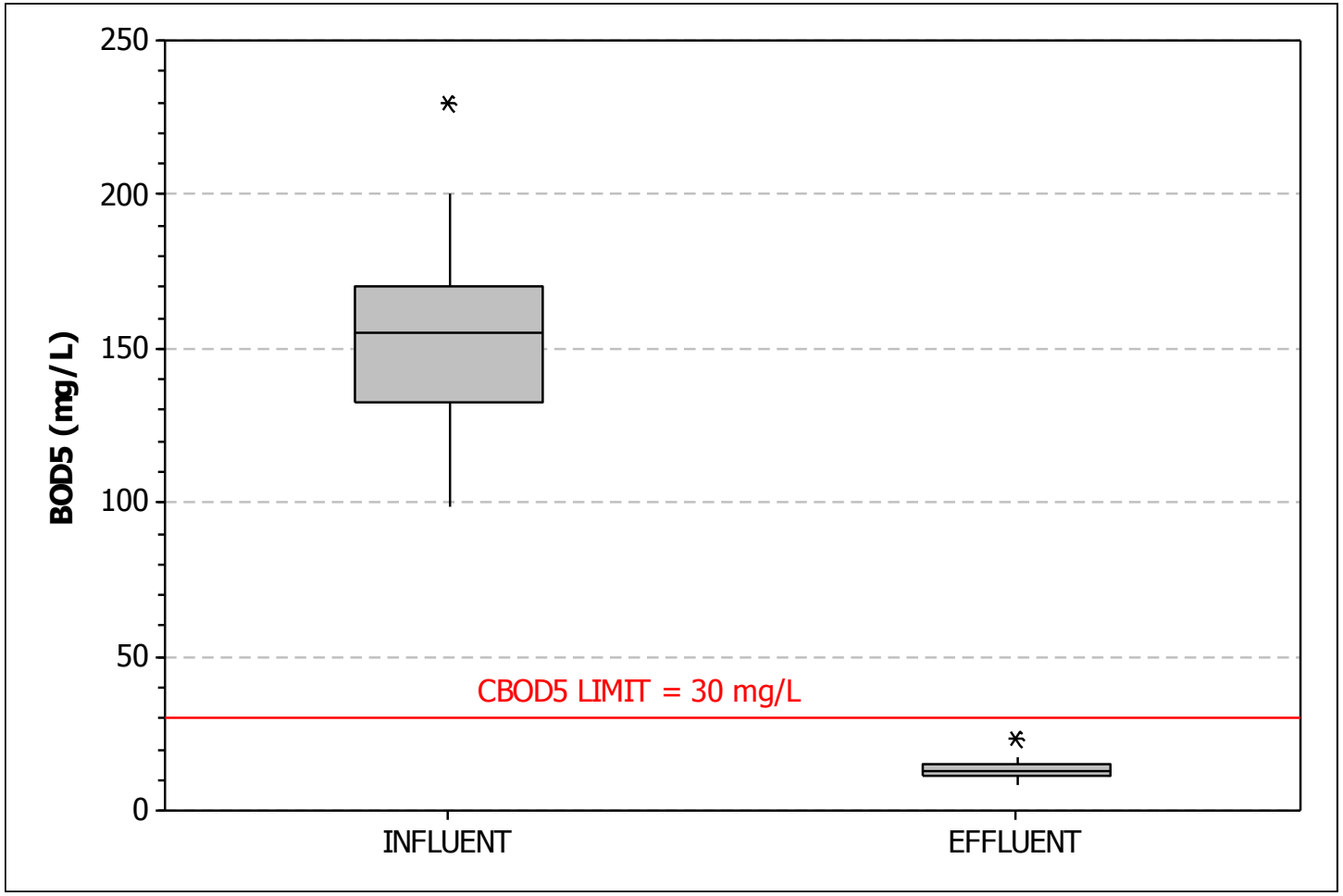
– Operated January – June 2014

– Target Loading Rates:

Parameter	Loading Rate Objective
Hydraulic Loading Rate	1.04 gpm/sf
BOD_5 Loading Rate	147 lb BOD_5 per 1,000 ft^3/d at 10°C 165 lb BOD_5 per 1,000 ft^3/d Corrected
NH_3-N Loading Rate	13.7 lb NH_3-N per 1,000 ft^3/d at 10°C 15.3 lb NH_3-N per 1,000 ft^3/d Corrected

Experimental Approach and Results

BAF Pilot – Influent & Effluent BOD_5



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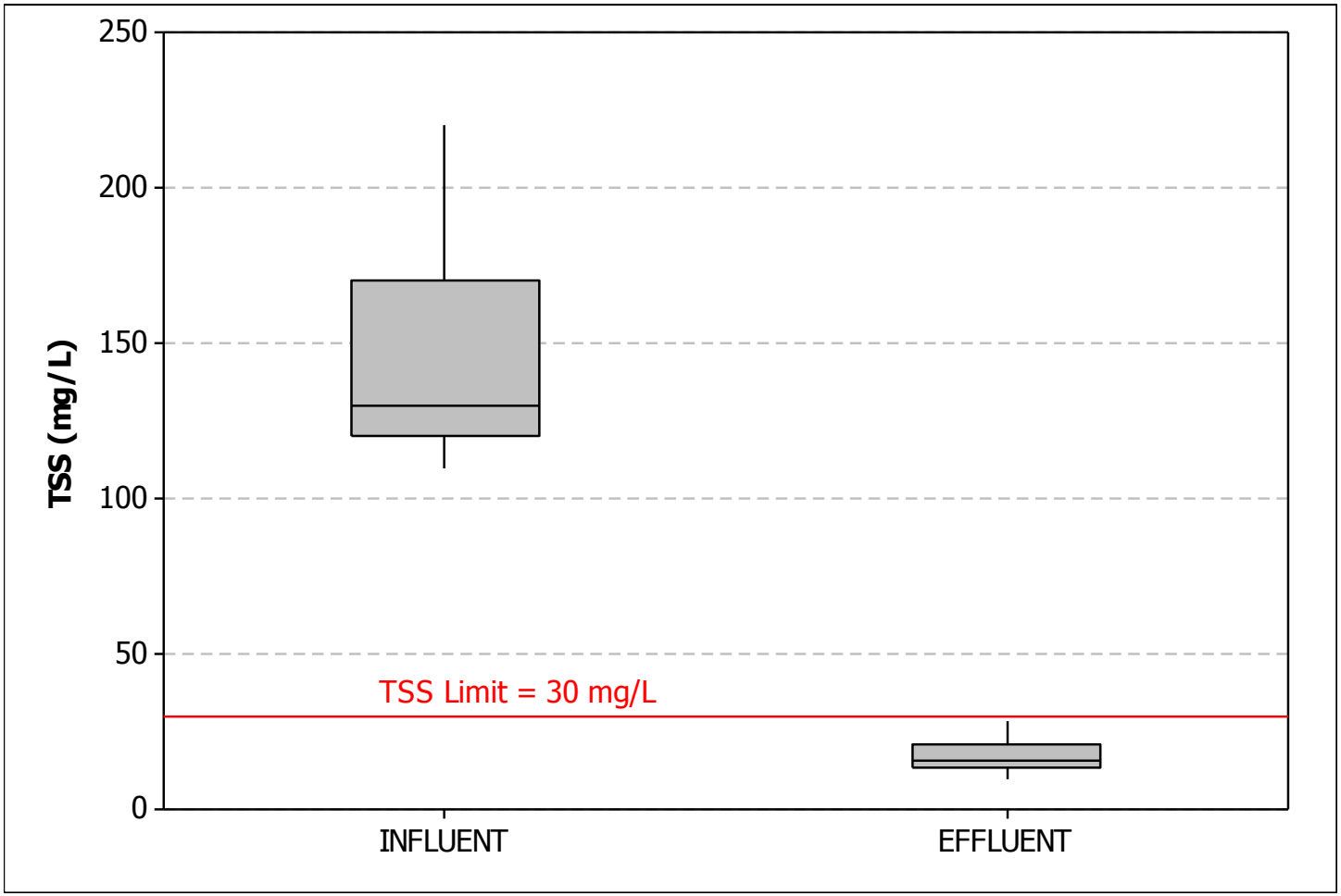
Experimental Approach and Results

BAF Pilot-Influent & Effluent TSS



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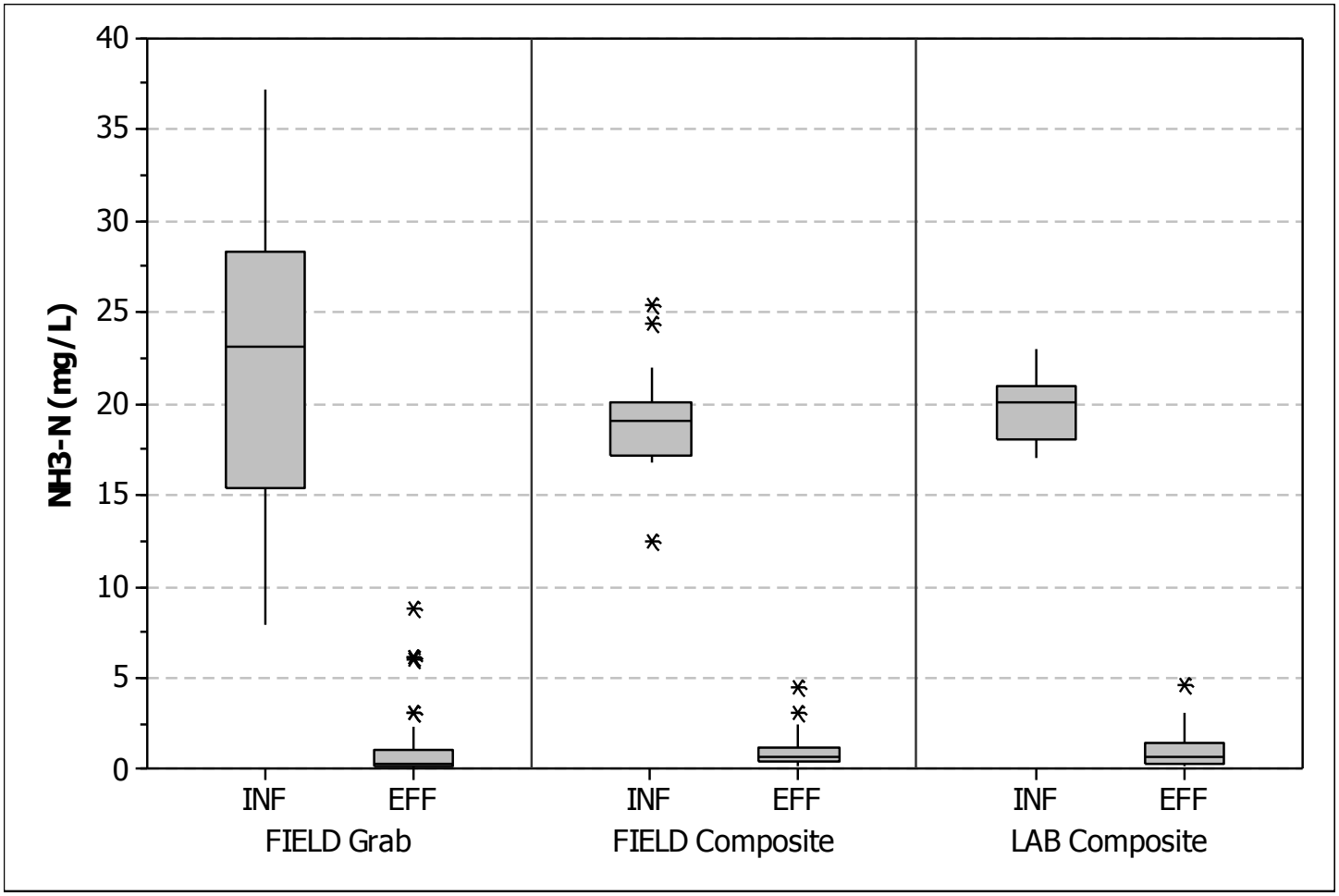
Experimental Approach and Results

BAF Pilot-Influent & Effluent NH_3-N



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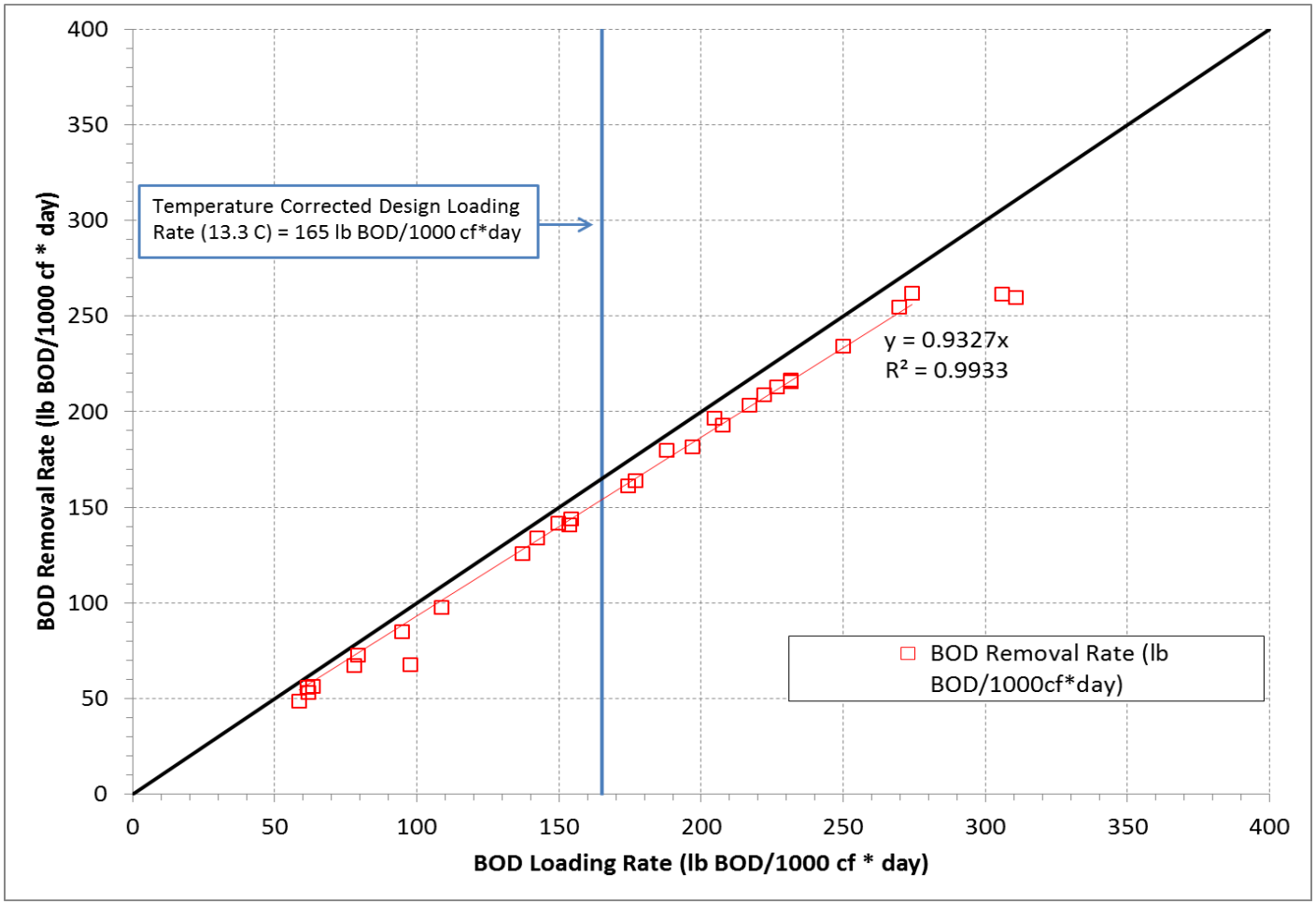
Experimental Approach and Results

BAF Pilot- BOD_5 Loading Rate Versus Removal



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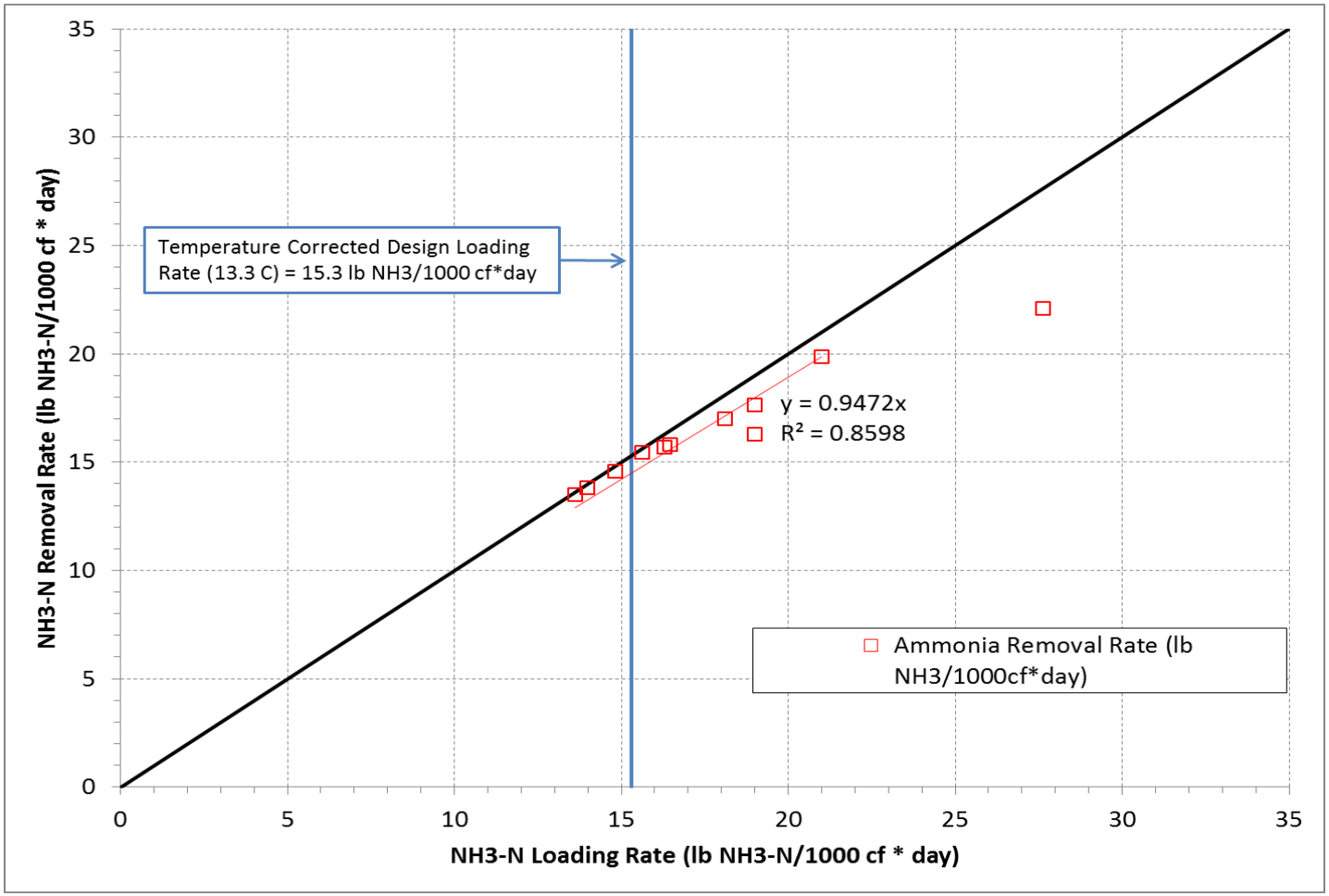
Experimental Approach and Results

BAF Pilot- NH_3-N Loading Rate Versus Removal



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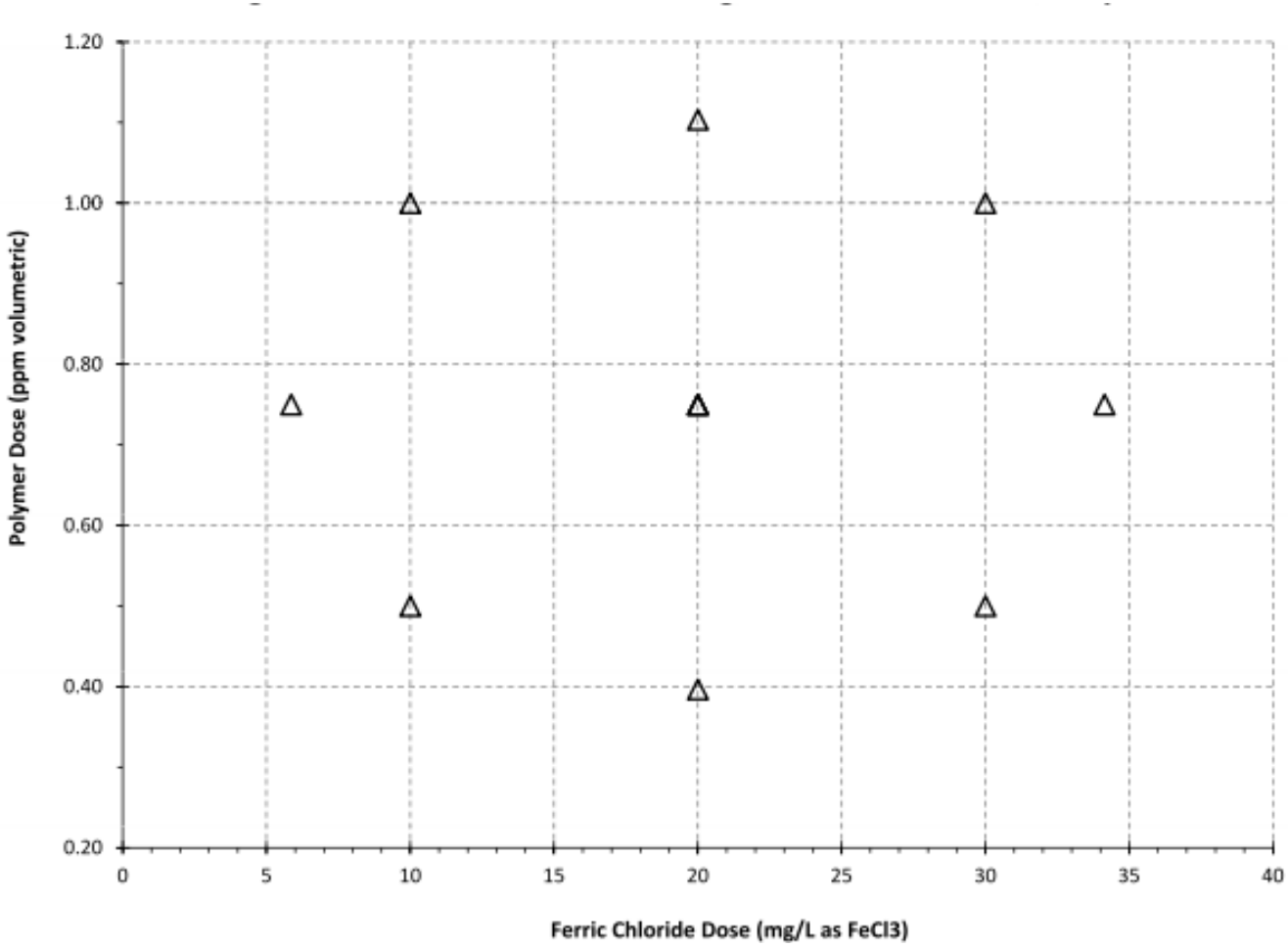
Experimental Approach and Results

Coagulation Jar Tests



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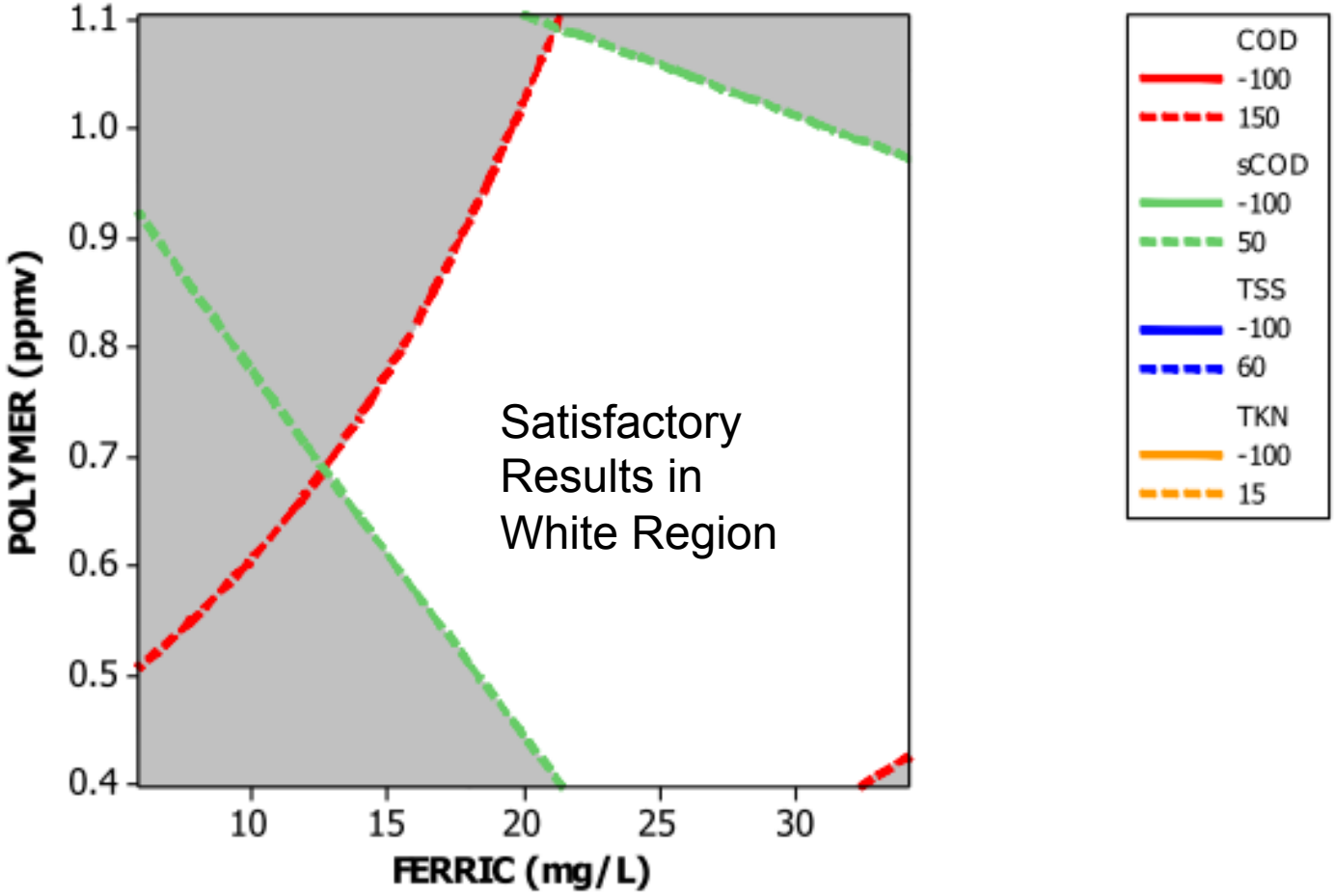
Experimental Approach and Results

Coagulation Jar Tests – Overlaid Contour Plot



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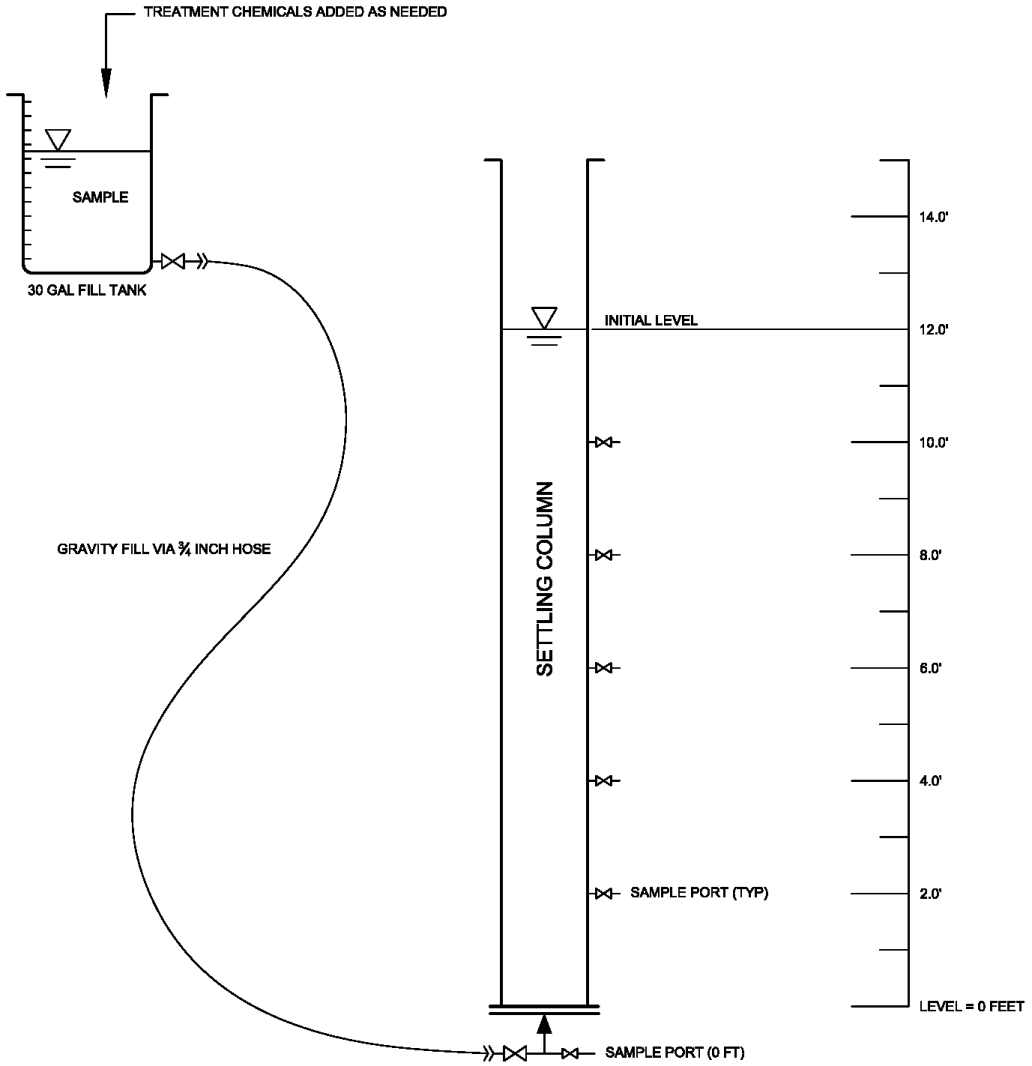
Experimental Approach and Results

Settling Tests



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Experimental Approach and Results

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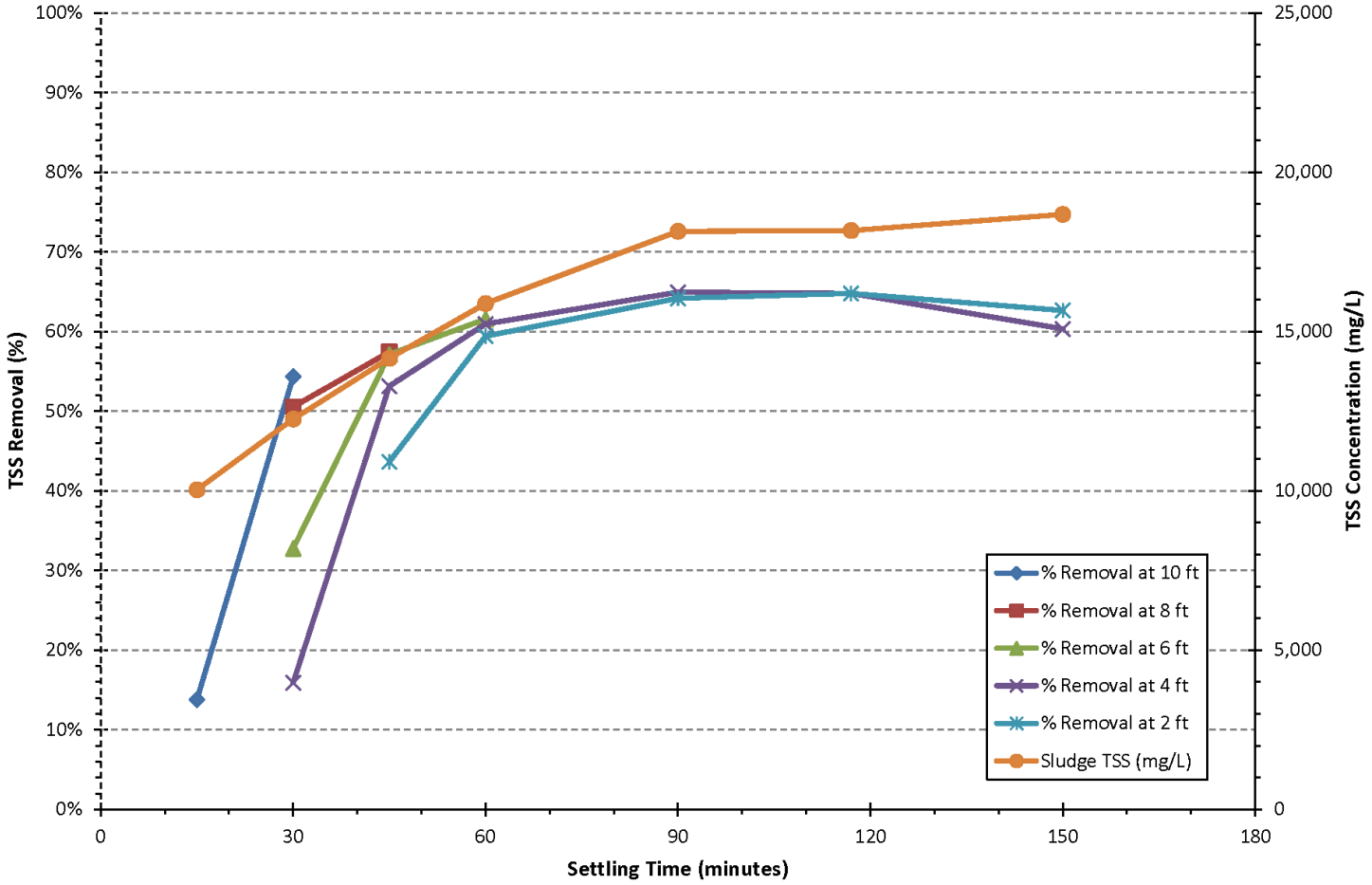

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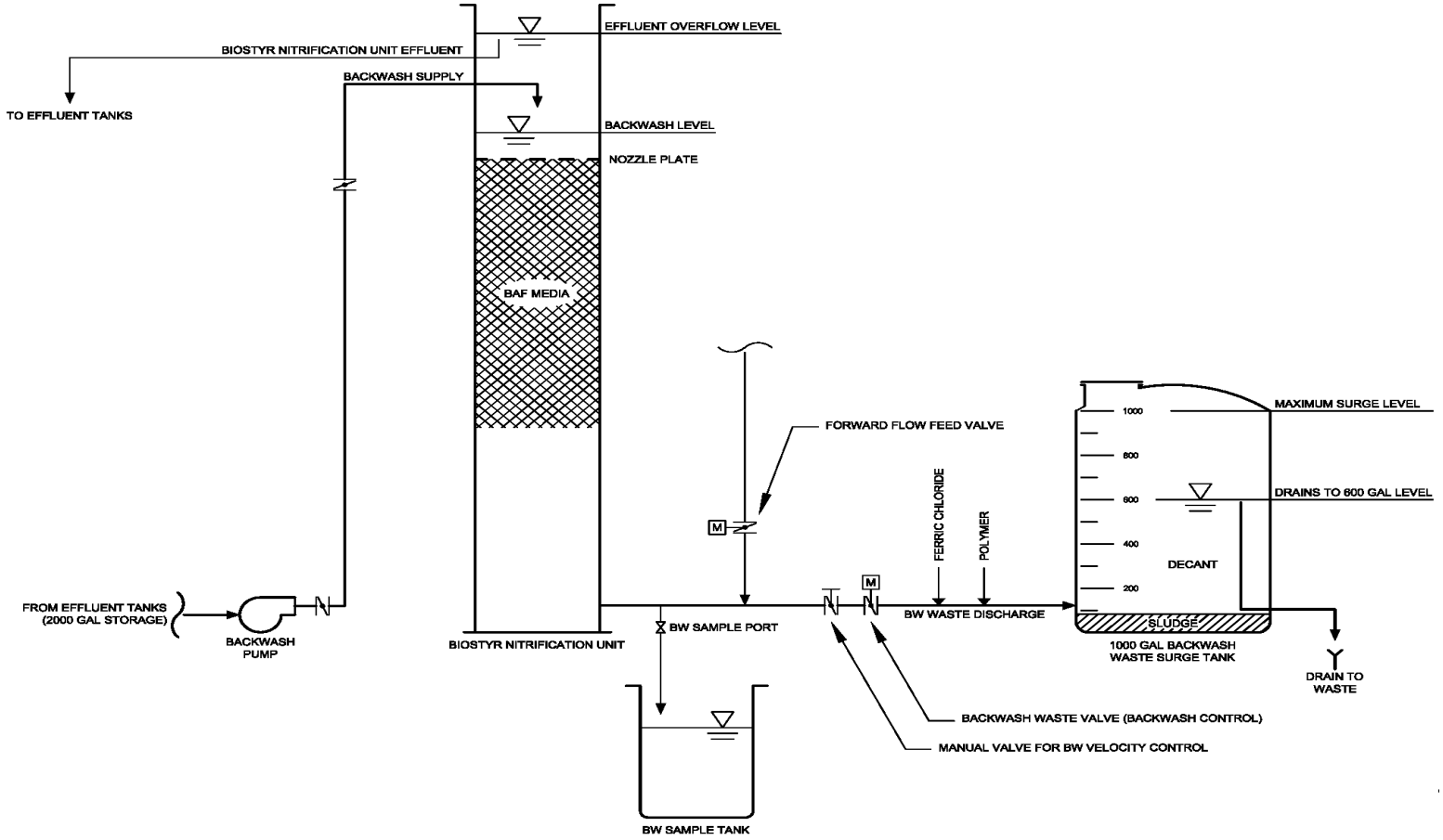
Experimental Approach and Results

Combined Primary Sludge & BAF Backwash Compression Tests



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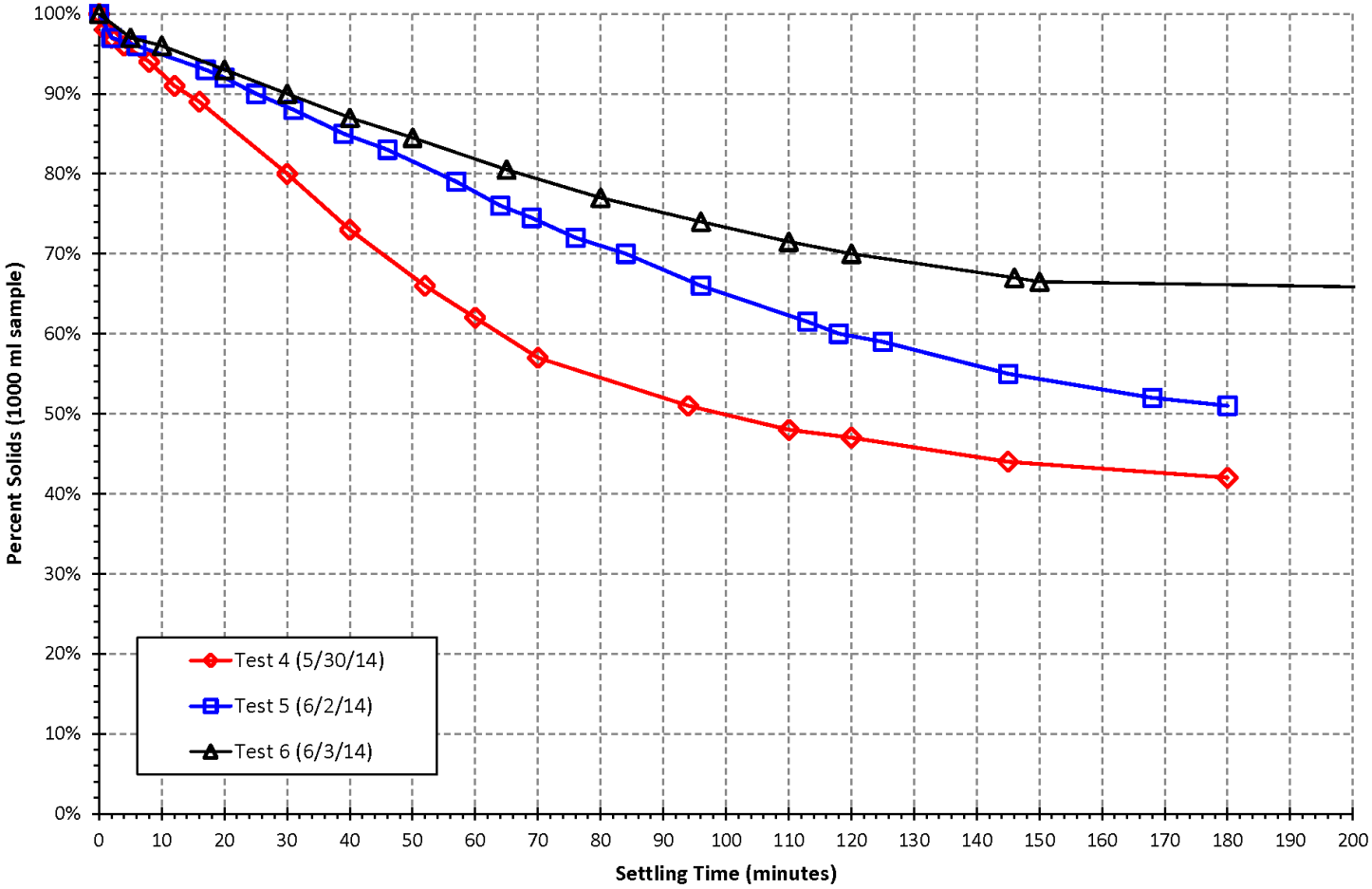
Experimental Approach and Results

– Combined Primary Sludge & BAF Backwash Compression Tests



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Experimental Approach and Results

Thickened Primary Sludge & BAF Backwash Dewatering Tests

– Thickened sludge from Compression Tests tested by screw press vendors

– Test results:

Parameter	FKC	Huber
Predicted polymer usage	22 lb/dry ton	25 – 35 lb/dry ton
Predicted dewatered cake solids	27.65%	>27%

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Conclusions

- ✓ BAF Demonstration piloting confirmed design loading rates for BOD_5 of 147 lb/1000 ft^3/d and up to 13.7 lb/1000 ft^3/d for NH_3-N
- ✓ Backwash coagulation: $FeCl_3$ dose of 20 mg/l and polymer dose > 0 provide effective coagulation
- ✓ Settling column tests confirmed satisfactory co-settling of raw wastewater and BAF backwash
- ✓ Combined sludge compression tests confirmed primary sludge and BAF backwash can be effectively co-thickened
- ✓ Bench-scale testing confirmed that co-settled, co-thickened primary sludge and BAF backwash can achieve 27% dewatered solids with reasonable polymer dosage

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Thank You

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For More Information, Project Documents Available at:
www.portsmouthwastewater.com/resources

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