REINHOLD ENVIRONMENTAL Ltd.

2017 APC & Wastewater Round Table & Expo Presentation

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OG&E Utilizes Ballasted Clarification for Coal Pile Runoff Pond

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OGE Energy Corp.

VEOLIA Water Technologies

Introduction

- Oklahoma Gas & Electric (OG&E) utilized ballasted clarification to help drain down (dewater) over 50 million gallons of water and recover coal from an active coal pile runoff pond.
- The Muskogee plant has a NPDES discharge permit for the pond effluent, but typically evaporation maintains the pond water level.
- The normal settling characteristics of the pond do not typically provide the level of clarity the station desires when discharging.
- Several technologies had been trialed with undesirable results until ballasted clarification was piloted.
- Heavy rains late spring 2015 accelerated the need for dewatering, so an emergency mobile clarification trailer capable of 1 – 2 MGD was deployed. Veolia Water Technologies provided the mobile service utilizing Actiflo® Turbo. This presentation highlights the various technologies tested and dives into the details of the ballasted technology results from the pilot and emergency service.

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Topics

- OGE Energy Corp.
- Problem Statement
- Past Experiences
- Ballasted Technology
- Pilot Effort
- Mobile Deployment
- Economics
- Conclusions

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OGE Energy Corp.

- Largest regulated utility in Oklahoma
- Started in 1902
- Approximately 800,000 customers spanning 30,000 square miles in Oklahoma and western Arkansas.
- Company is committed to operating in a cost-effective manner which meets or exceeds requirements established in environmental laws and regulations.

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Muskogee Generating Station

- 3-550 MW Coal Fired Plants
- Permitted discharge includes CT blowdown, Low Volume Waste, Coal Pile Runoff

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Coal Pile Run Off Pond

- 20 acres surface
- 70 acre drainage area.
- 23 Million GL (normal level)
- Evaporation
- Natural Settling before NPDES Discharge

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Problem Statement

- Turbidity was higher than desired for discharge
  - Clear pond TSS was still 100 – 1000 mg/l and the majority of the mass was 1 – 10 micron.
  - Stokes law indicates 0.5 – 55 hours to settle 1’

    1 – 10 microns with density similar to silica sand
- May 2015 13” of rain fell compared to 3.5”/month previous Springs
- Dam repairs needed due to beavers

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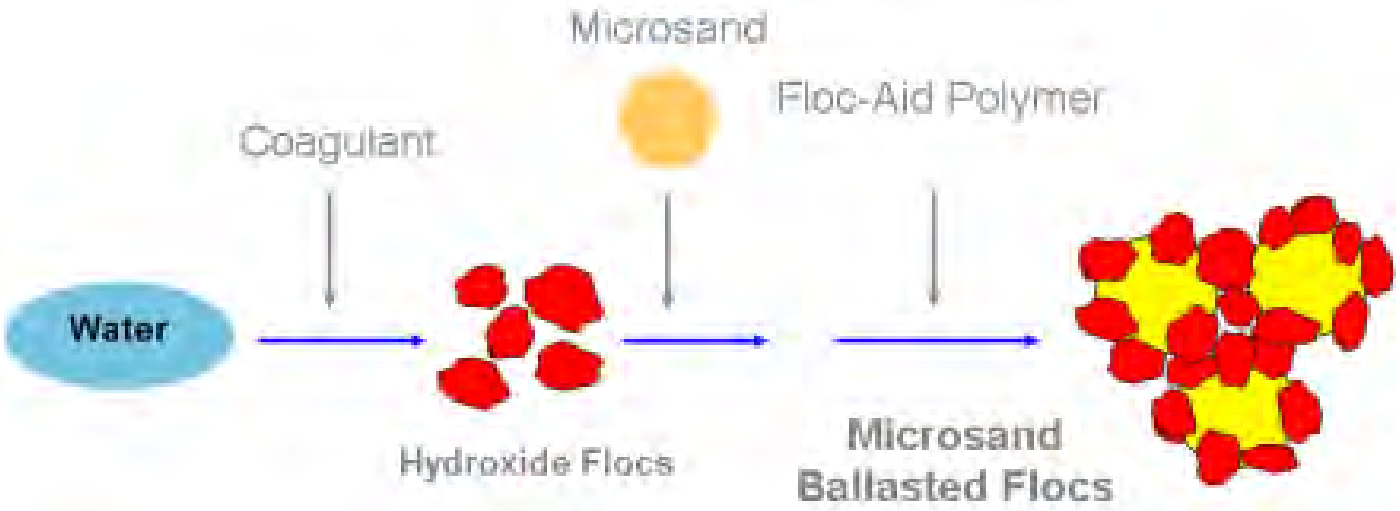
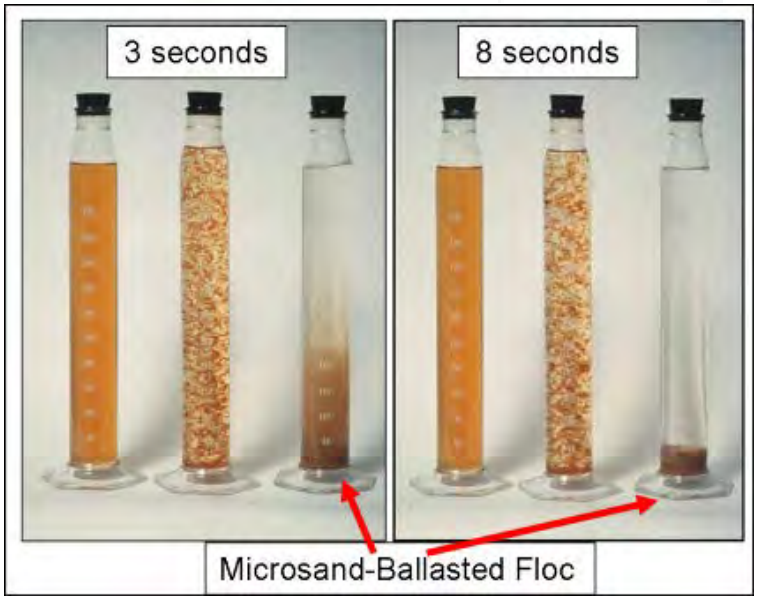
Past Experiences

- Natural settling
  - Challenges with stokes law and light particles
- Different pond decanting locations
- Conventional clarification
  - Low rise rates and sun convection problems
- Dissolved Air Floatation
- Compressible Sponge-like Media Filters
  - TSS loading
- Manual batch treatment tank & decanting

Ballasted Technology





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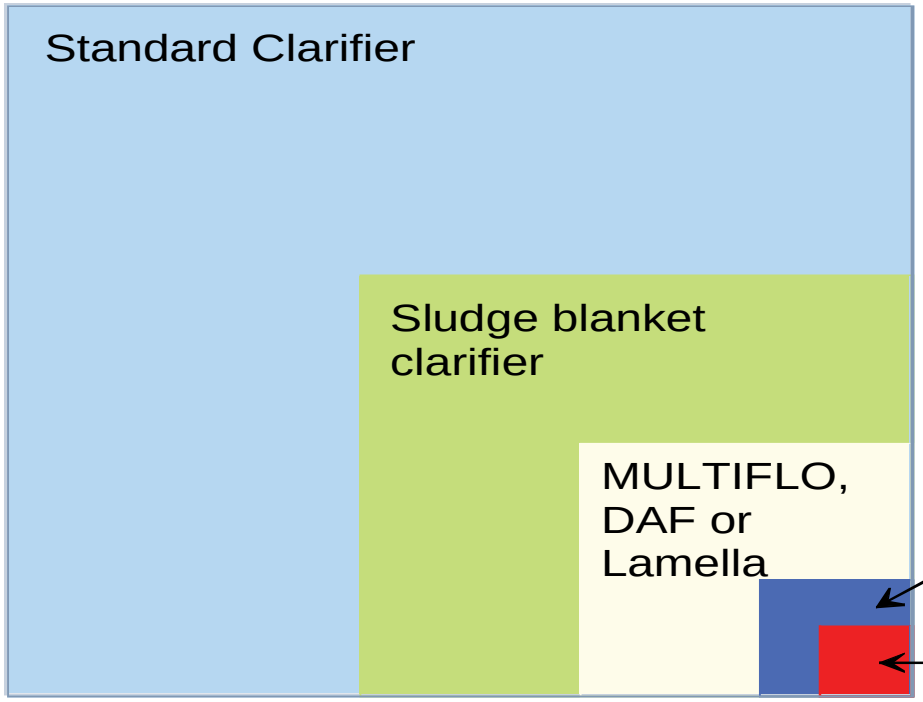
Conventional Vs. High Rate



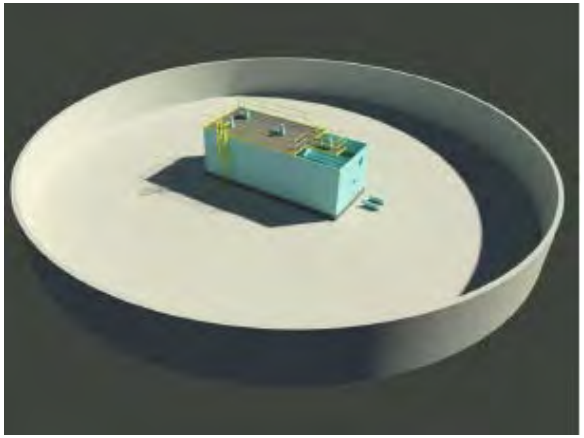
0.2 - 0.6 gpm/ft2

1.6 gpm/ft2

4 - 6 gpm/ft2

ACTIFLO®
16 gpm/ft2

ACTIFLO®
32 gpm/ft2



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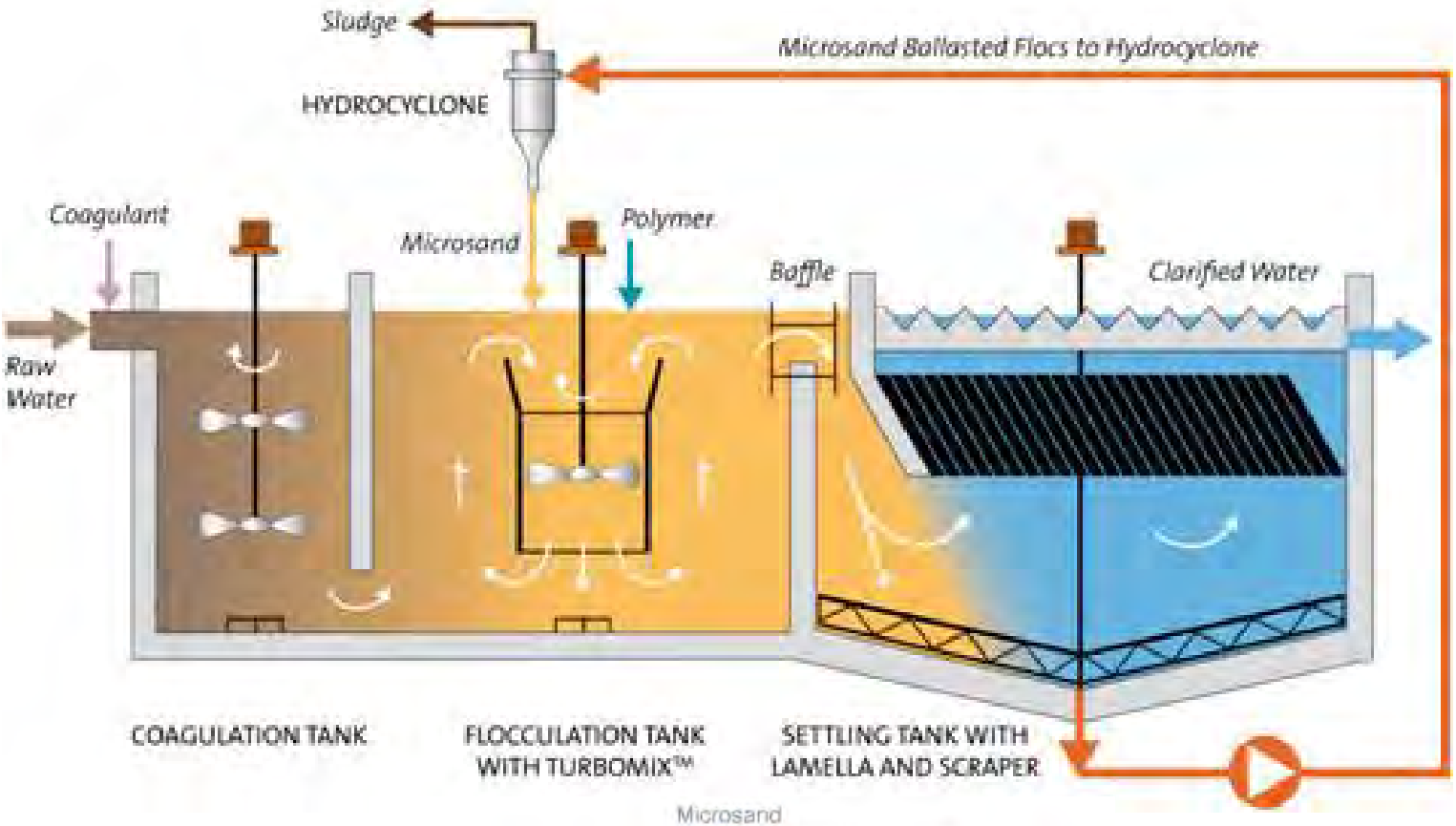
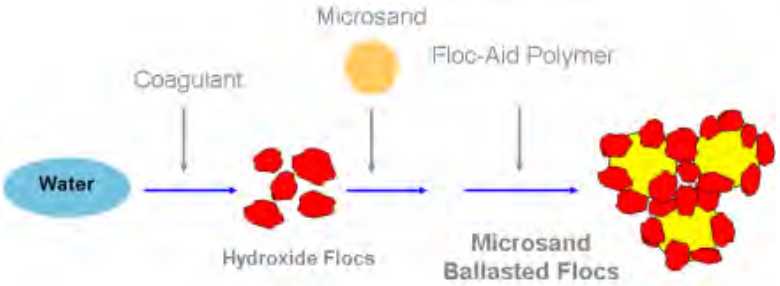
Actiflo® Turbo





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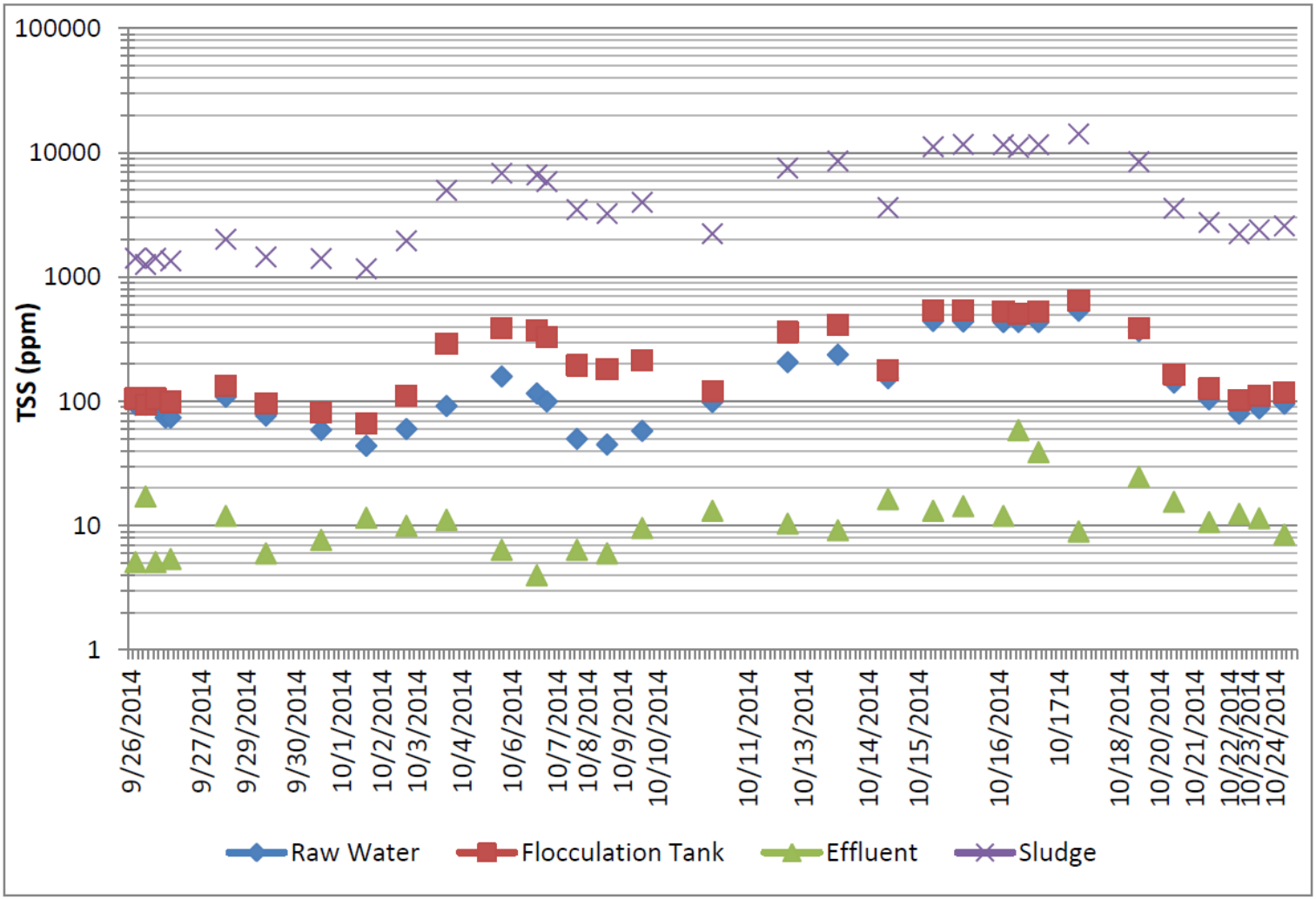
Pilot Effort

- Inlet Conditions of 40 – 550 mg/l TSS
- Jar Testing
  - Inorganic (Al based) + Organic Coagulant
  - Anionic Flocculant, Medium to High MW and Charge
  - Micro-sand 100 – 150 microns
  - Iron coagulation also worked, but required supplement alkalinity
- Actiflo® Pilot Trailer – Nominal 100 GPM
- Operated Sept. 26th to Oct 24th, 6 days a week, 10 hour shifts
- Tested 85 – 190 GPM (20 – 45 gpm/ft2)
  - 42 gpm/ft2 provided < 15 ppm TSS

Pilot Effort - TSS



Raw Water
50 – 500 ppm

Effluent
< 15 ppm

Sludge
0.15 – 1.5%
Or ~ 30X

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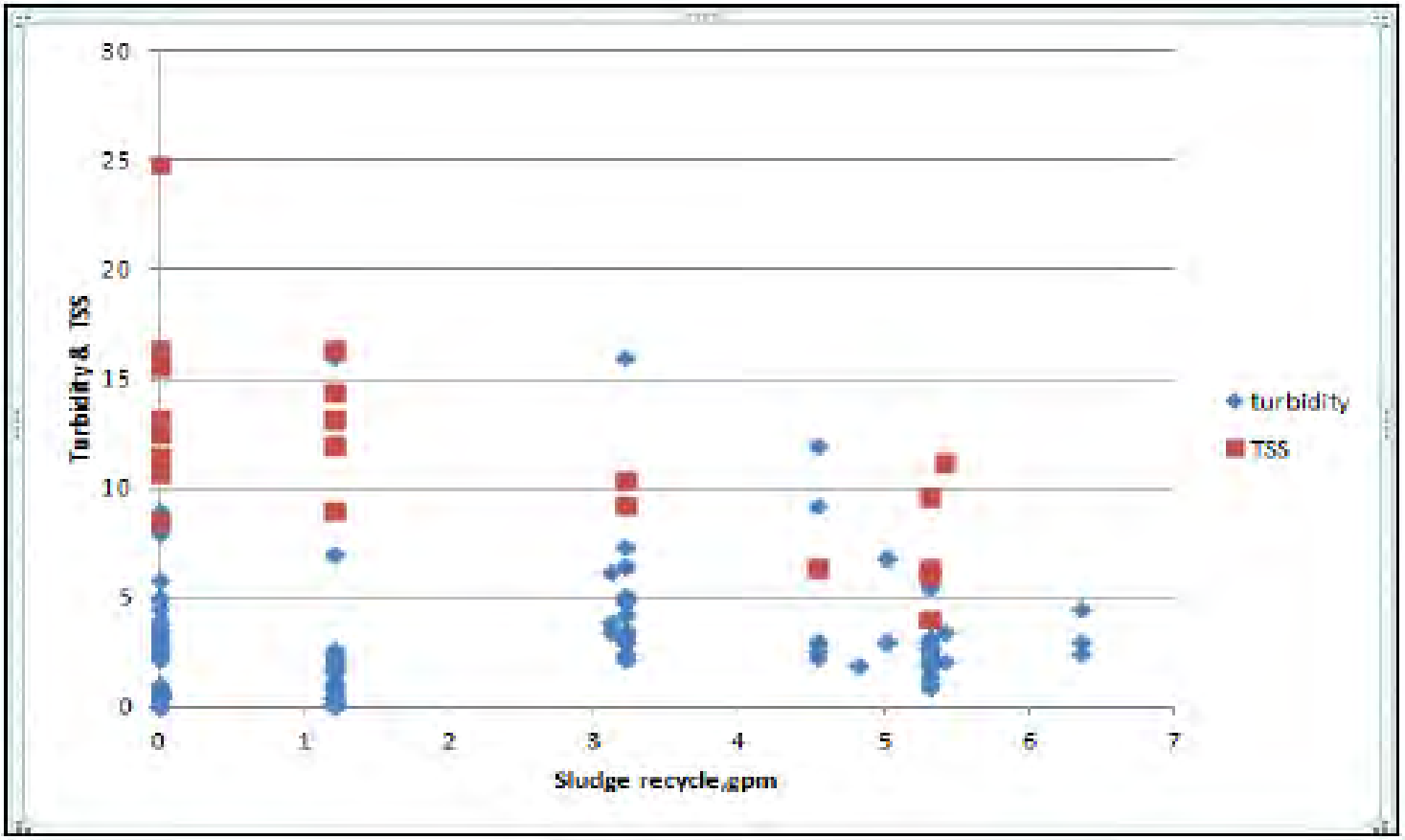
Pilot Effort – Sludge Recycle



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Pilot Effort – Rx Time & Micro-sand

Reaction Time

- To determine impact of coagulant reaction time the injection points were moved from the first coagulation tank to the inlet of the floc tank, prior to sand injection.
- Within minutes of the change, NTU spiked from 1.7 to 16 NTU, so feed points were moved back. Five minutes later, effluent was back to 2 NTU.

Micro-sand Dosage

- Pilot averaged 6 g/l, 3 – 10 g/l is typical.
- At one point concentration dropped to 3 g/l and effluent TSS spiked from 15 to 35 ppm. Inlet was 370 ppm at this time. Corrected concentration, corrected effluent quality.

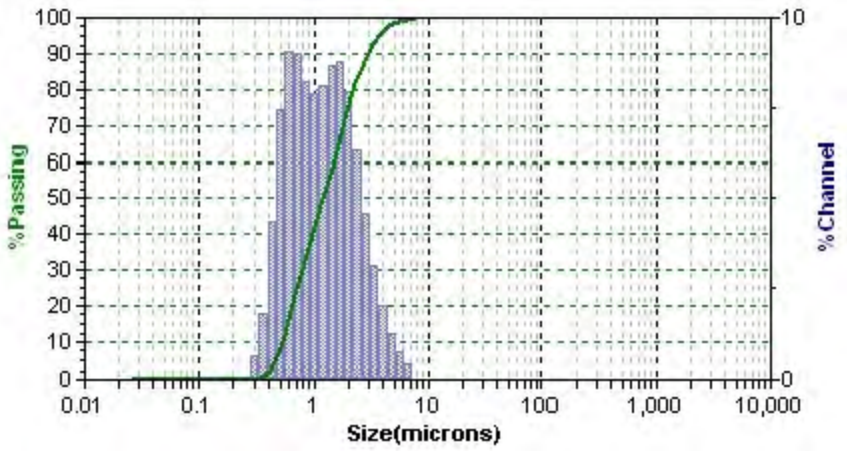
Pilot Effort – Metals & PSA

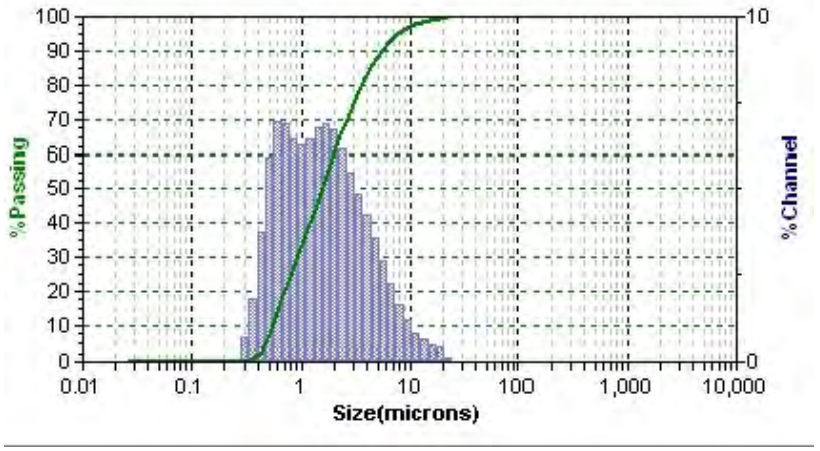
Metals

- 3rd Party analysis on influent & effluent – below lab limit, except influent zinc at 0.12 mg/l.
- Effluent zinc lab limit of 0.01 mg/l
- Aluminum < 0.3 mg/l typical of utilizing aluminum base coagulants

Particle Size Analysis

- Majority of influent mass was 1 – 10 micron





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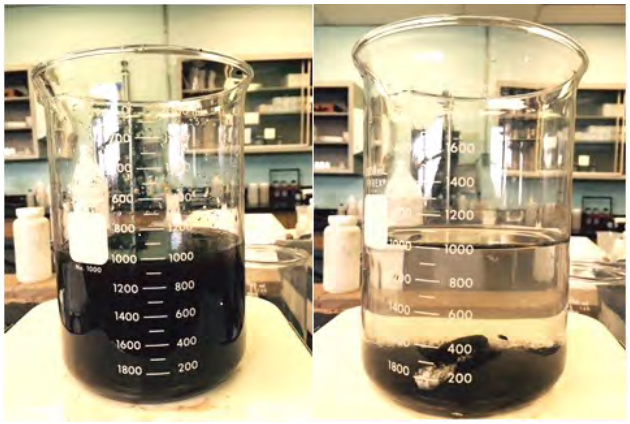
Mobile Deployment

- Arrived onsite on a Friday
- Discharging water by Monday
- Treatment flows of 600 – 800 GPM limited by sump pump
- Influent TSS 100 – 1,000 mg/l
  - Particle size 1 - 10 microns
- Effluent TSS << 50 mg/l



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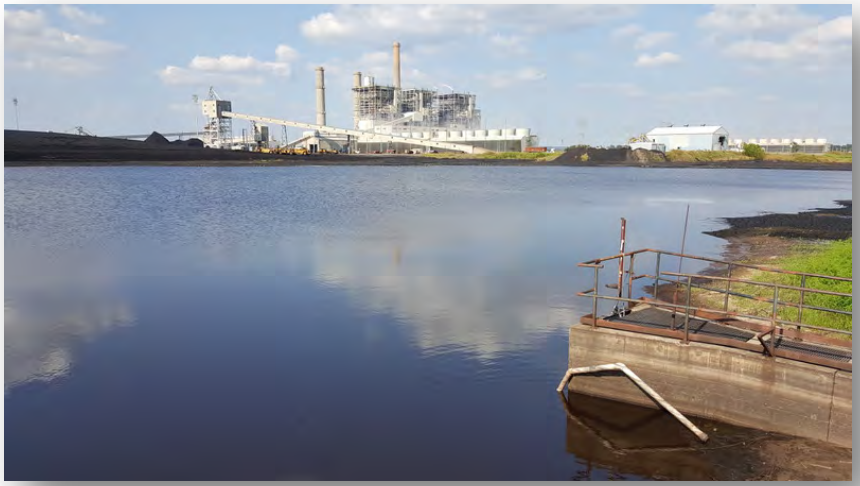
Economics

- Mobile campaign treated and discharged 50 Million Gallons
- Mobile system was onsite 3 months
  - Some interruptions in treatment to free up pockets of pond water
- Services cost was competitive with typical urban sewer rates
- Once pond was dewater, $5,000,000 in unburnt coal was made available



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Conclusions

- Muskogee's coal pile run off pond water was difficult to treat conventionally
- Piloting provided optimization and insurances in ballasted clarification
- Piloting and upfront due diligence made mobilization and startup fast and efficient
- Mobile treatment proved economically attractive versus permanent capital installation

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