REINHOLD ENVIRONMENTAL Ltd.

2015 Wastewater-Ash Round Table Presentation

September 22, 2015, in Charlotte, NC / Hosted by Duke Energy

Trusted for experience. Preferred for performance.

Planning Ahead for Bottom Ash Conversions to ZLD

Tyler Little

Allen-Sherman-Hoff

ISO 9001:2008 Certified

Allen-Sherman-Hoff®

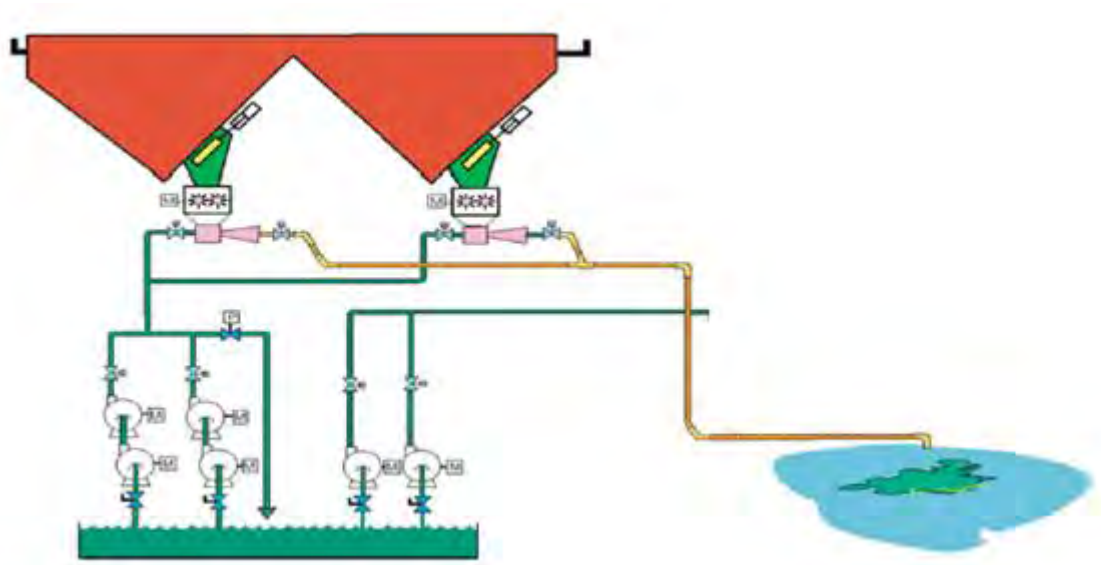
a Division of Diamond Power International, Inc.

Outline

- Review of current regulatory landscape for bottom ash (BA)
- Effect of zero discharge on water balance
- Effect of zero discharge on water quality
- Developing a robust system design

Current Landscape

Over 65% of coal generating units operate exclusively wet BA transport systems (from EPA 2009 survey)



Final CCR Ruling

- Existing surface impoundments (ash ponds)
  - Location restrictions
  - Groundwater protection standards
  - Structural requirements
  - Fugitive dust control
  - In-flow controls
  - Record keeping
- Existing impoundments may continue to operate through useful life provided they are not “leaking” contaminants into groundwater

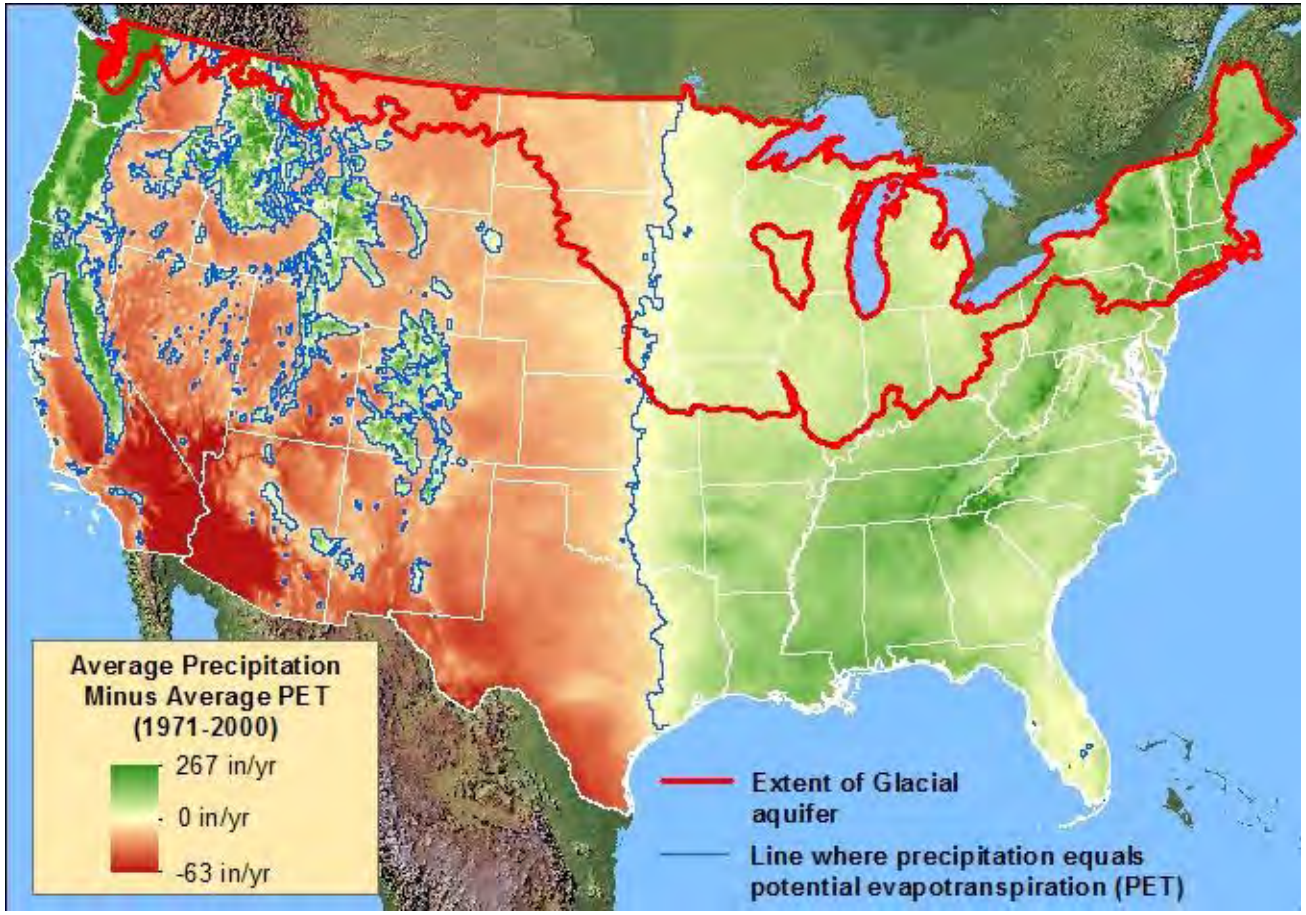
Proposed ELG for BA Transport Water

	Option 3a, 3b or 3		Option 4a
TSS	30 mg/L avg. of daily values for 30 consecutive days	100 mg/L max. for any 1 day	Zero Discharge (ZLD) for >400 MW
Oil and Grease	15 mg/L avg. of daily values for 30 consecutive days	20 mg/L max. for any 1 day	
pH	6 – 9		

What does ZLD really mean?

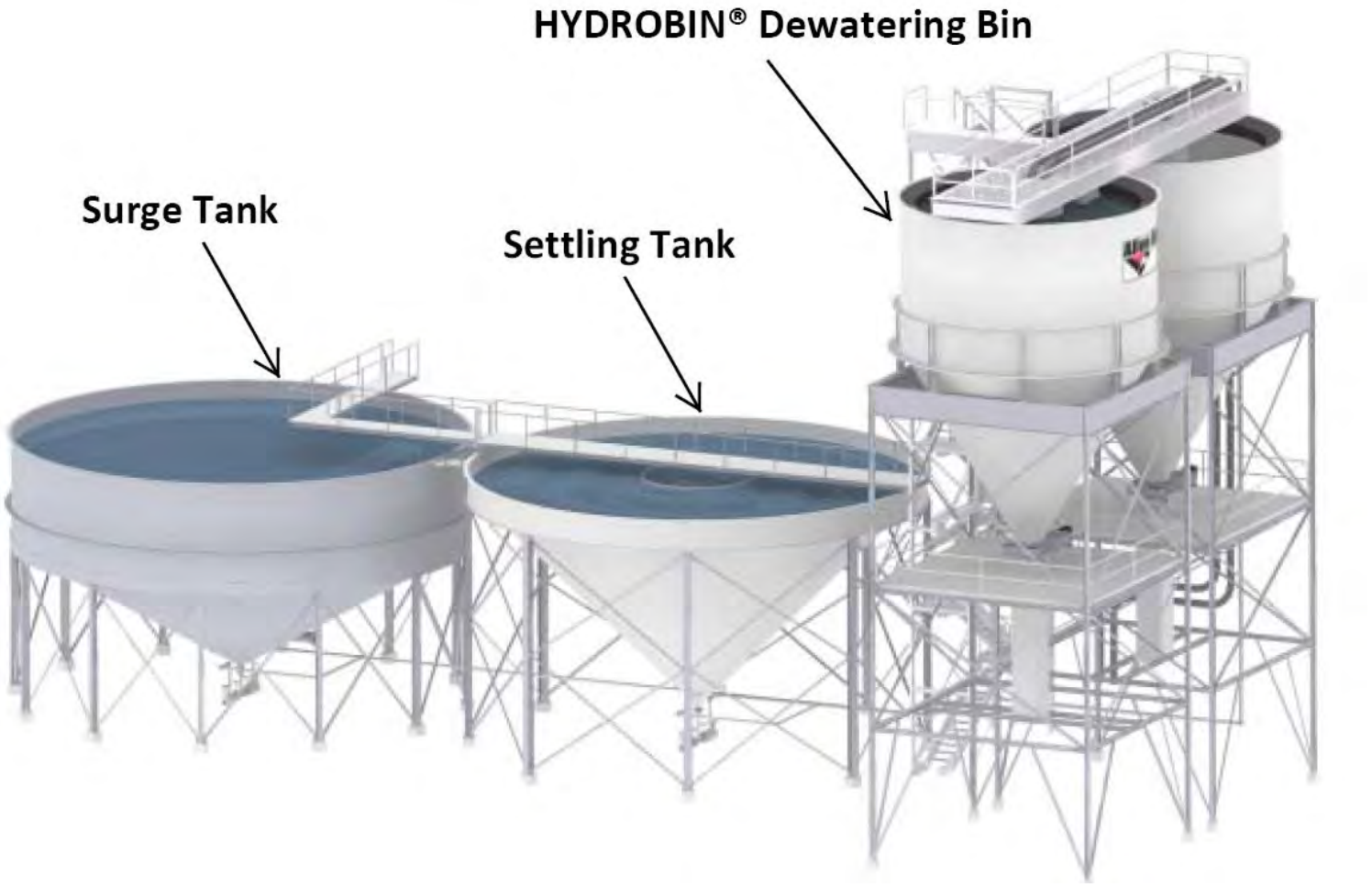
- Zero discharge from a contained system
  1. Recirculation with ponds
     - No pond overflow
     - Rely on evaporation & rain water controls
  2. Recirculation with tanks or concrete basins
     - Dewatering bins (HYDROBIN®)
     - Remote drag conveyors (RSC²™)
     - Dewatering basins
- Blowdown is not an option

Precipitation vs. Evaporation

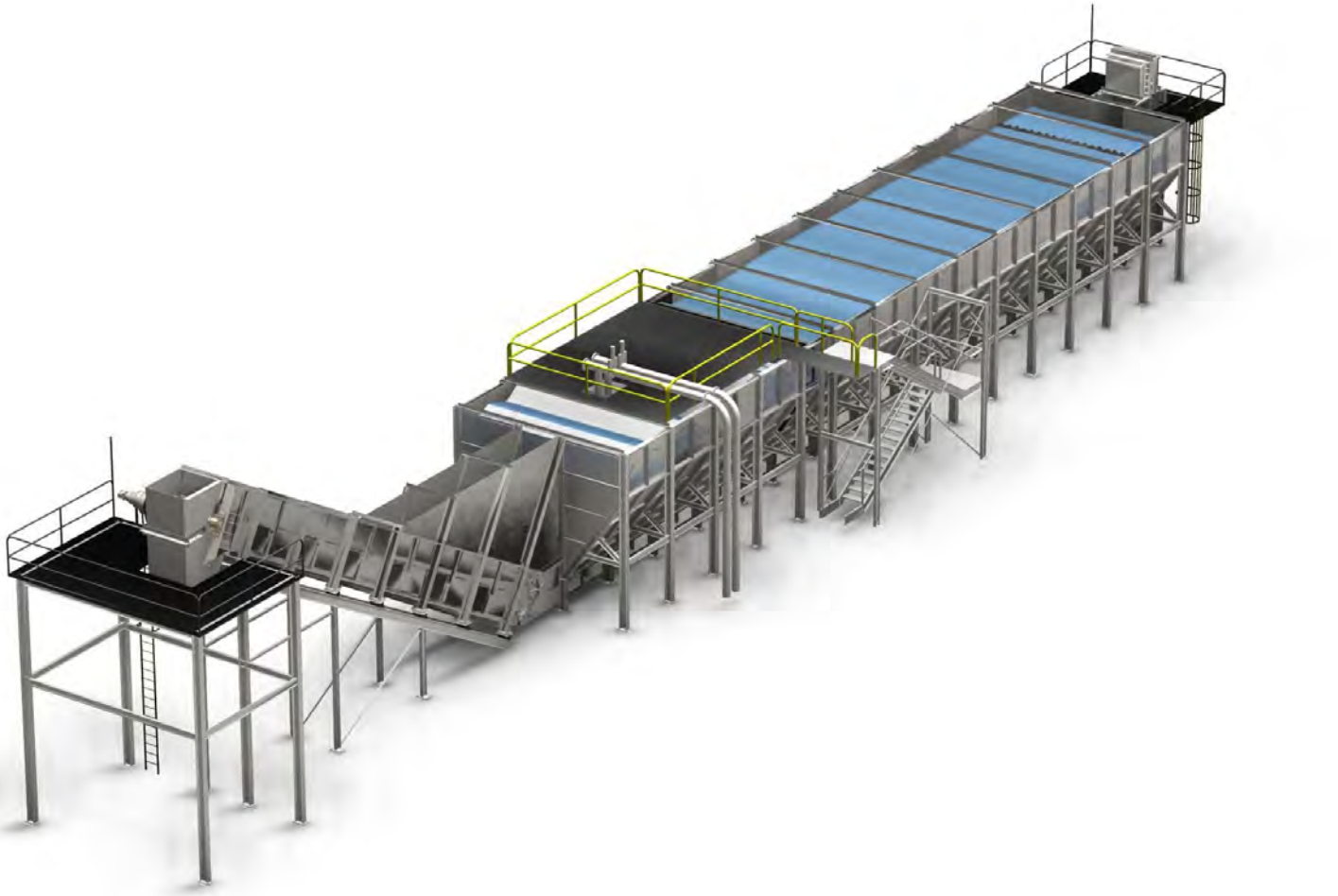


http://mi.water.usgs.gov/projects/WaterSmart/background.html

HYDROBIN® System



Remote Submerged Chain Conveyor (RSC²™)



Potential Streams in BA ZLD System

- BA transport water (1,500 – 3,500 GPM/line)
- Ash hopper service water (300 – 500 GPM/unit)
- Transport water for other materials
  - Mill rejects
  - Economizer ash
  - Air heater ash

Recirculated Streams

- Intermittent flows
  - Bottom ash Hydro-ejector (High Pressure)
  - Hopper & seal trough flushing (HP)
  - HYDROBIN® screen backwash (HP)
  - Ash hopper fill (Low Pressure)
- Continuous flows
  - Hopper wall refractory cooling (LP)
  - Hopper & seal trough make-up (LP)
  - RSC^{2}™ chain wash (LP)
- Miscellaneous system sumps
  - Dewatered ash pile runoff

System Water Balance

- Water losses
  - Ash hopper evaporation (5 – 15 GPM/unit)
  - Retained moisture in dewatered ash (2 – 20 GPM/unit)
  - Hopper leakage?
  - Natural evaporation (<1 GPM yearly average)
- Water additions
  - Seal water for pumps (20 – 100 GPM total for all pumps in system)
  - Rain if not in building (<1 GPM yearly average)

Water Surge Volume

- ZLD creates an issue for maintenance
- Need available volume in system to accommodate draining equipment for maintenance
  - HYDROBIN® tanks or RSC²™ volumes
  - Ash hopper volumes
  - Piping volumes
- Overflow from settling tank goes to surge tank/basin
  - Can be several hundred thousands of gallons
  - Consider dual 100% capacity surge tanks/basins

HYDROBIN® System with Surge Tank

RSC²™ Building Enclosures

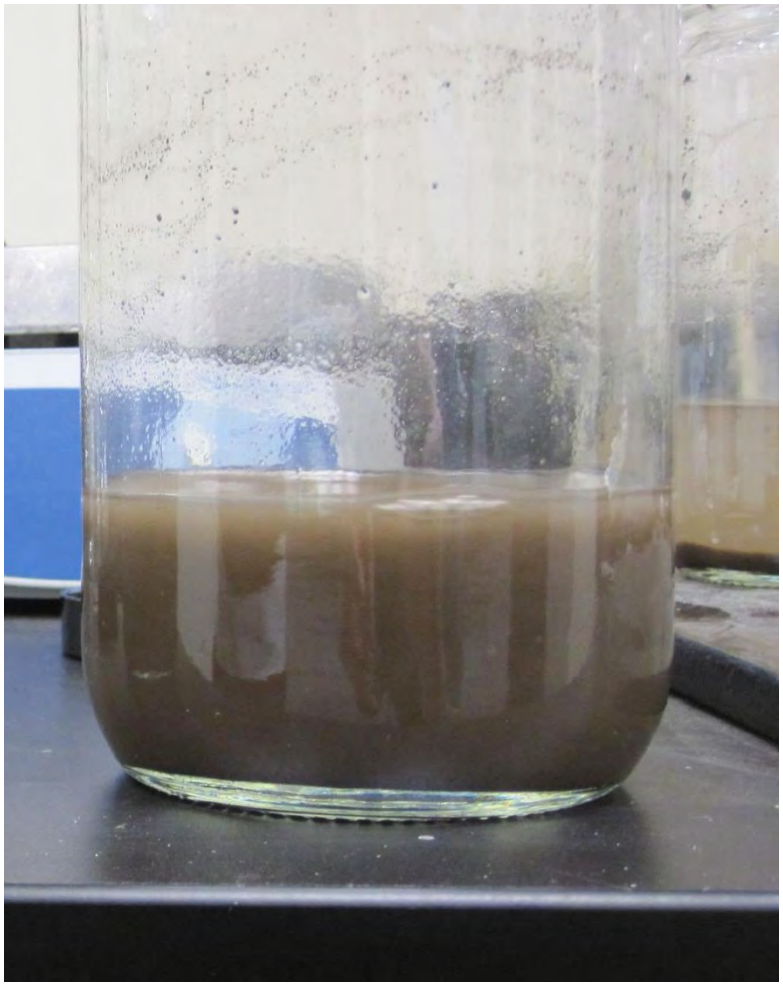
- Need covering for rain protection over dewatered ash piles
- Equipment is designed for outdoor service
- Considerations for conveyor enclosure
  - Freeze protection
  - Does it increase likelihood of good maintenance practices at your site?
  - Overhead lifting access
  - Cost
    - Number of conveyors, overflow water quality, and storage bunker capacity dictate size of building

RSC²™ Building Enclosure

Dewatered Ash Pile

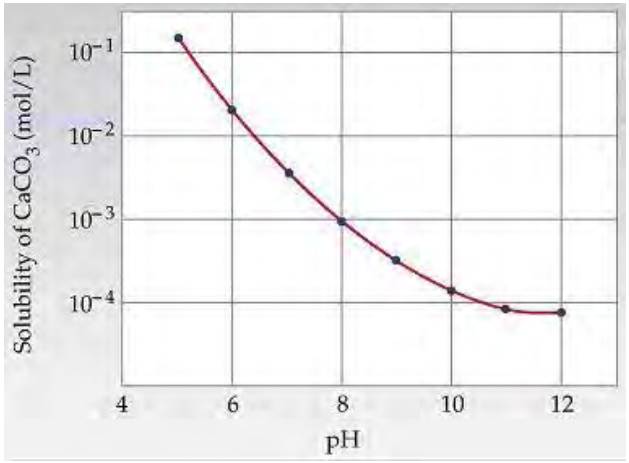
Water Quality in ZLD

- Scale formation
- Corrosion
- Total suspended solids (TSS)



Water Quality – Scale Formation

- Common with sub-bituminous coals
  - Usually calcium carbonate or aluminum hydroxide
- Factors affecting scale formation
  - Dissolved solids concentration
    - Concentration increases with water recirculation
  - pH
    - CaCO3 precipitates at high pH
    - Sub-bituminous slurry samples pH = 10 – 12
  - Temperature
    - CaCO3 solubility decreases with temperature (more dissolved solids precipitate as scale)
    - Recirculation systems will run a little higher water temperature (90 – 110 F)
  - Fouling due to deposition of suspended solids
    - High suspended solids increase scale potential by increasing number of nucleation sites



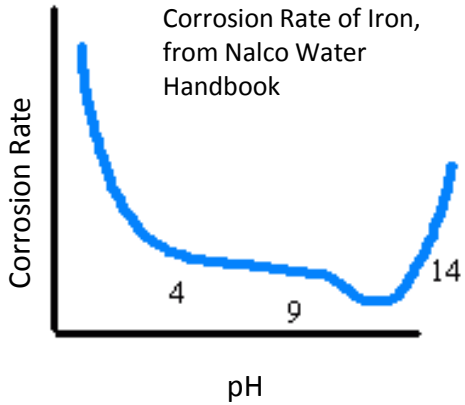
http://www.ldeo.columbia.edu/~sanpisa/OceanSed%20project/class%20project/caco3phsol.JPG

Water Quality – Scale Formation

- Controlling scale formation
  - pH adjustment
    - Keep pH below critical value for precipitation
    - May not be successful long term due to continual buildup of dissolved solids
  - Scale inhibitors
    - Polymers attach to crystals to inhibit growth

Water Quality – Corrosion

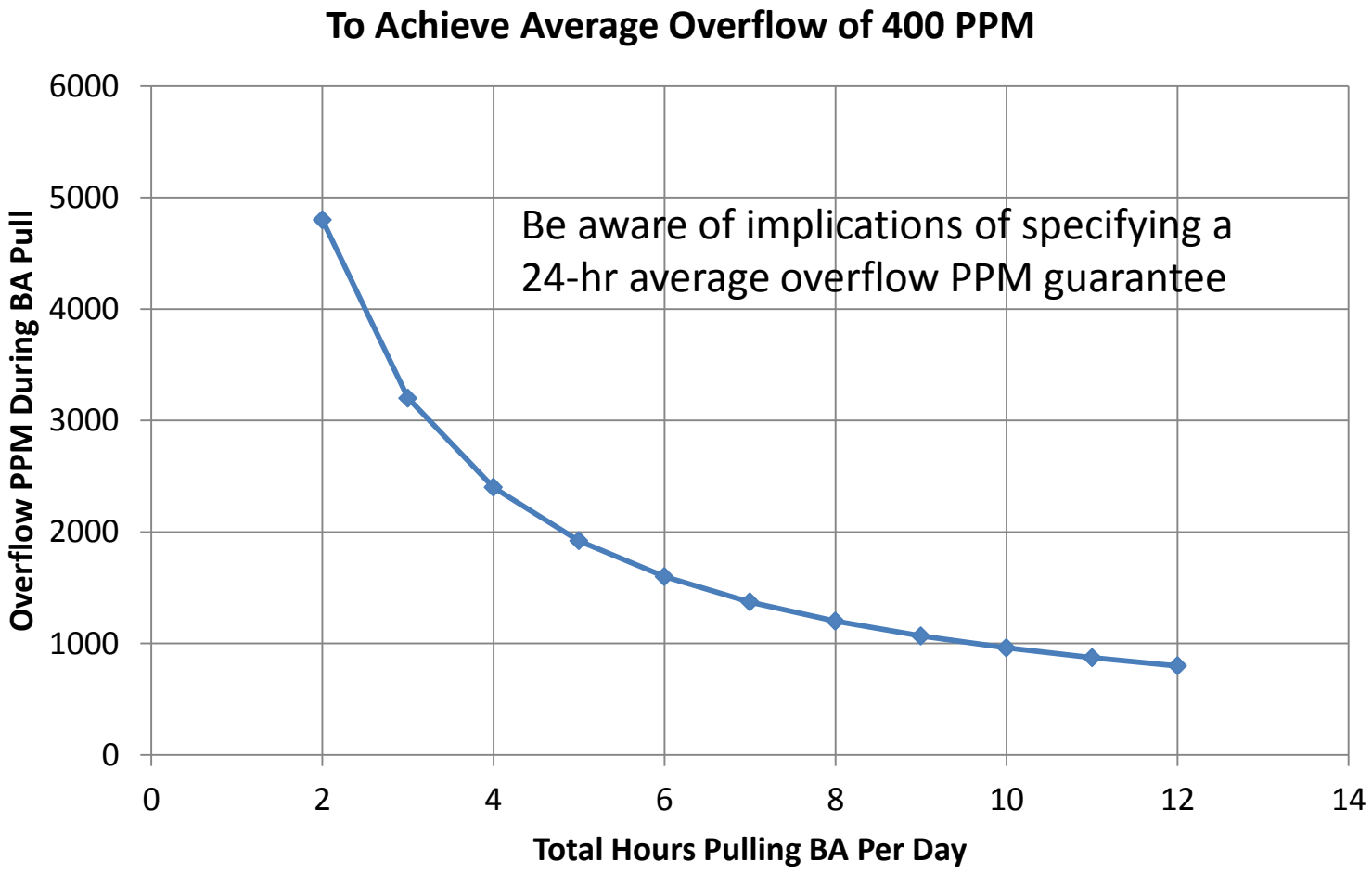
- High sulfur coals can produce low pH (4 – 6)
- Low sulfur coals tend to produce high pH (10 – 12)
- Largely depends on how much makeup water is added to system
- Wet/dry interfaces most susceptible
  - Overflow weirs and trough
  - Dewatering incline
- Acid or lime injection can be used



Water Quality – Suspended Solids

- Impact of high overflow TSS
  - Erosive wear
    - Pumps
    - Nozzles
  - Sludge accumulation
    - Seal water troughs
    - Effluent basins
  - Fouling
    - Pipes
    - Pump intakes

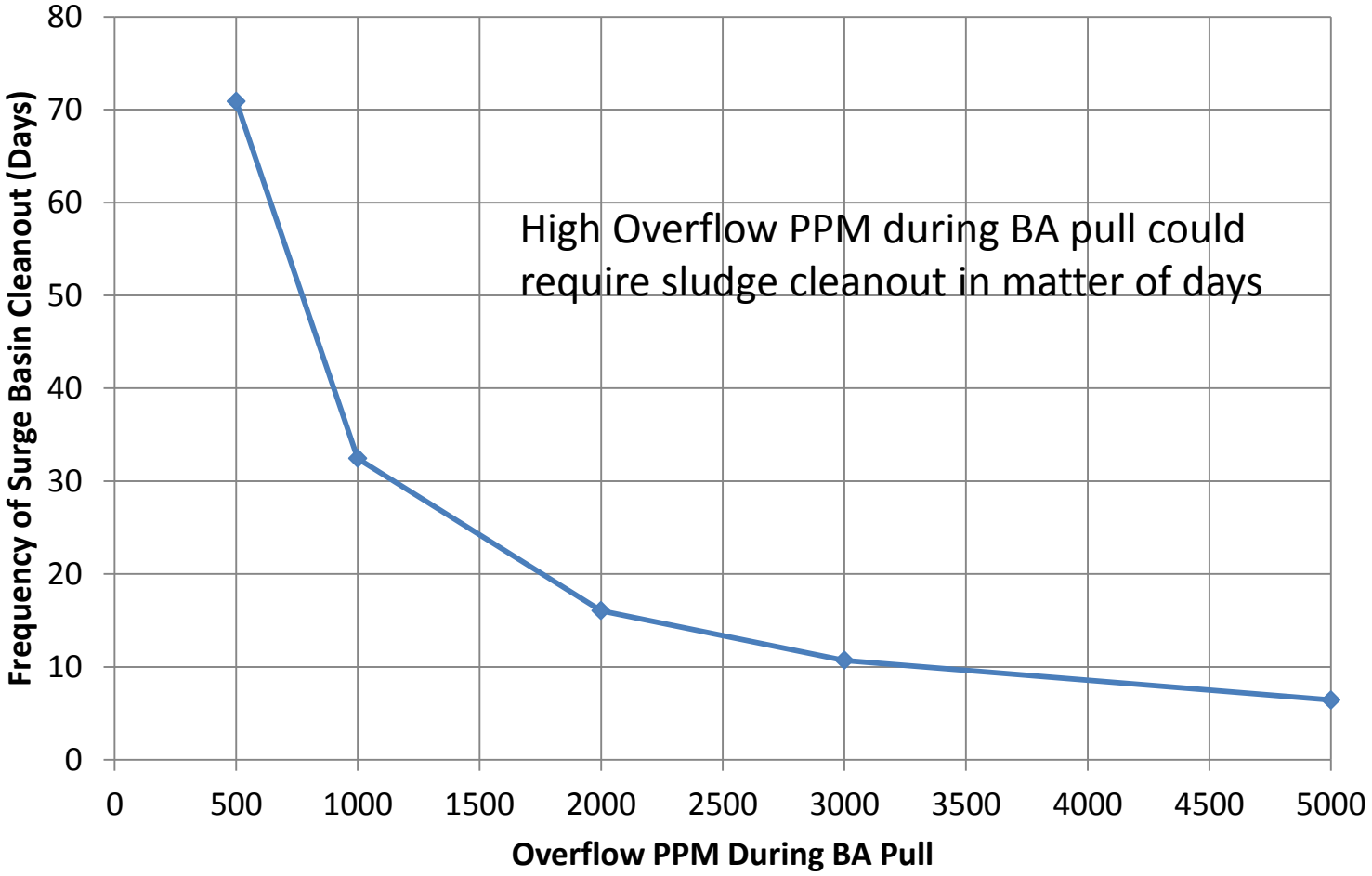
Overflow TSS – A Performance Guarantee



What Happens to Fines in Overflow Water?

- When not pulling BA, flow rate drops significantly and fines begin to settle in effluent basin
- >90% of fines will settle out in 3 hours under these conditions
- Sludge accumulation can be hundreds of cubic feet per day
- Agitation to keep solids in suspension will require large amounts of energy for the large volumes in these basins

Sludge Accumulation



Surge Volume Clean-out

- Elevated steel tank
  - Provides automated clean-out
    - Sludge pumps can be high maintenance
  - Need intermediate effluent sump for RSC^{2}™ due to elevation
    - Some material will still settle in sump
- In-ground concrete basin
  - Periodic cleanout with excavation equipment
  - Optional sloped floor drive-in design for clean-out
    - Footprint can be large

Elevated Steel Tank Clean-out

Equipment wear

- High TSS accelerates wear
  - Pumps
    - Are existing pumps rated for high TSS?
  - Nozzles
    - Degrading Hydro-Ejector performance

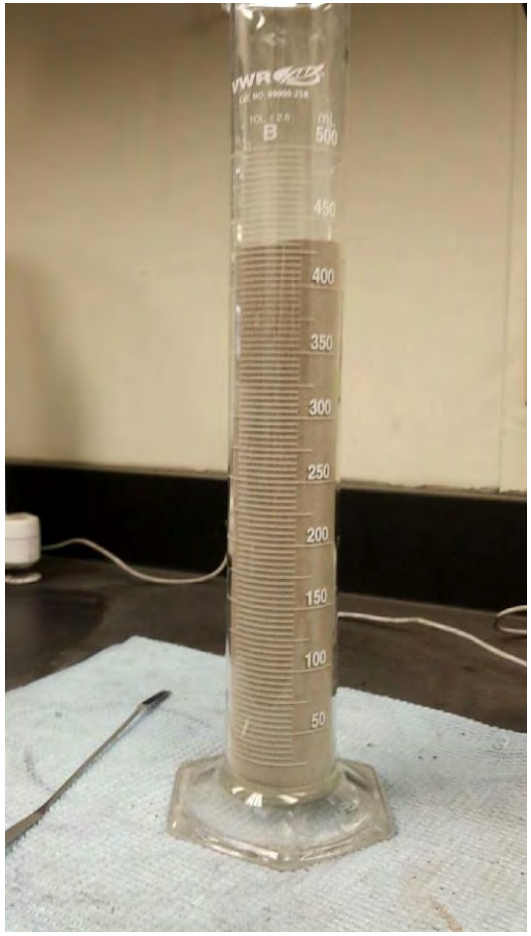
Developing a Robust System Design

- A well-designed system requires audit of existing system
  - Flow rates
  - Current operational practices
  - Water chemistry
  - Ash material properties

Ash Material Properties

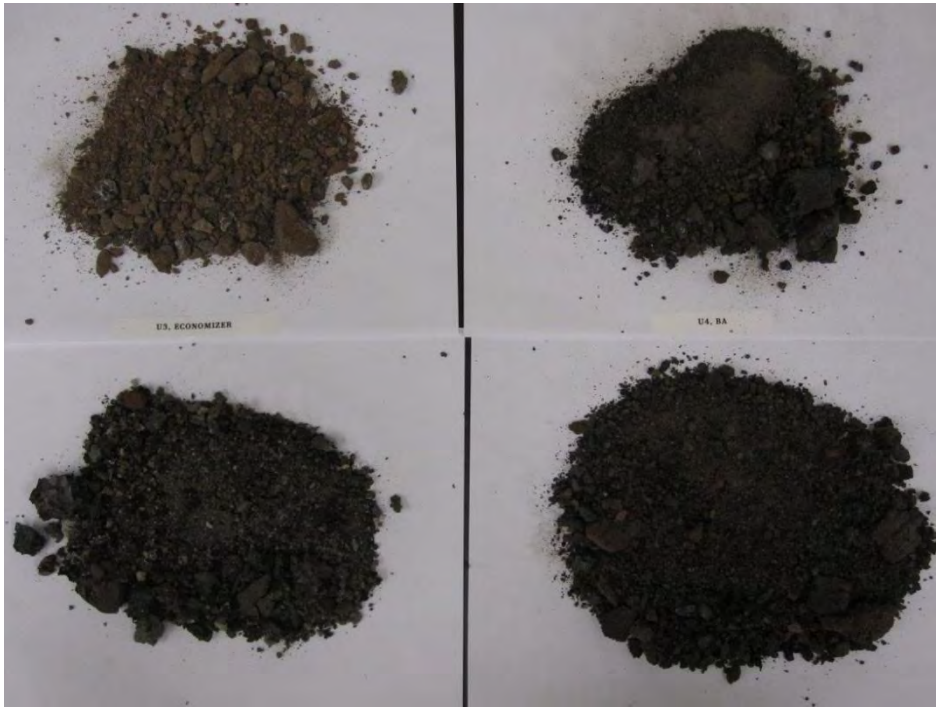
- Bulk density
  - Affects volumetric accumulation
  - Affects transport rates
- Compacted density
  - Affects structural calculations
- Particle density
  - Affects particle settling
- Cohesive strength
  - Affects chain loading and pull requirements for RSC²™
- Particle size distribution
  - Affects particle settling
  - Affects dewatering

By far the biggest impact on equipment size



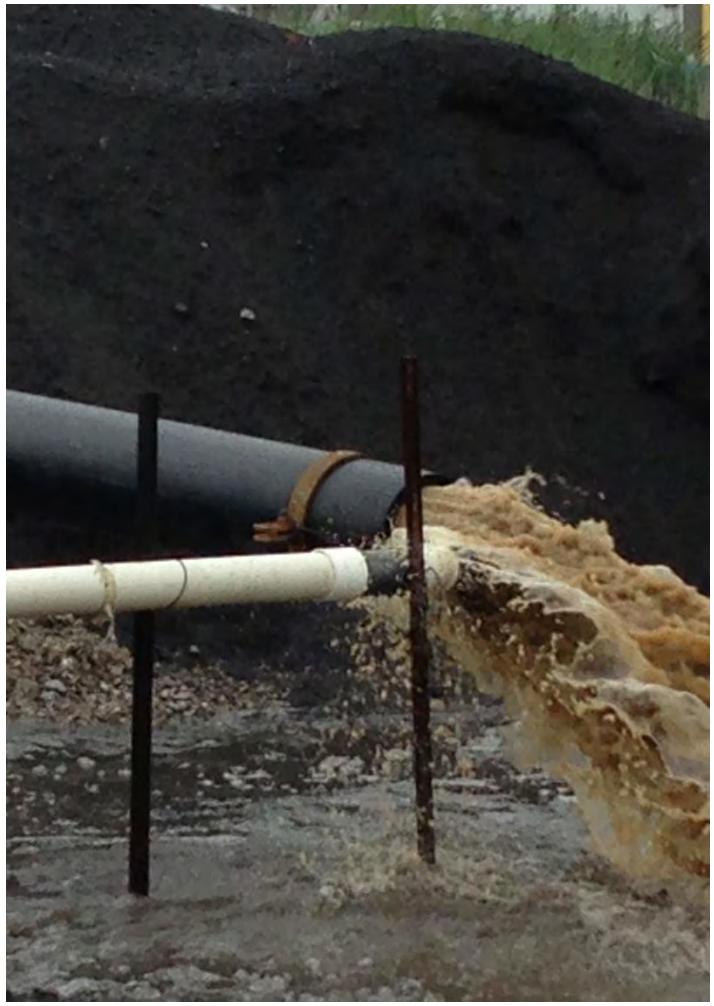
Sensitivity to Particle Size

- Fine vs. coarse material can cause:
  - 2 – 3x more chain pull force
  - 3 – 5x surface area for equivalent overflow TSS
  - 50% higher dewatered moisture content



Sampling

- To get samples with representative particle size distribution, the BA slurry must be sampled
  - Scooping solids from a pond will not provide this
- Slurry samples have more fines than pond samples
- Bottom ash is finer than most people think



Summary

- CCR rule will force closure of some impoundments
- New ELGs may force zero discharge systems for BA transport water
  - For most sites this would mean operation without ponds
- Water balance becomes important since rule would restrict system blowdown
  - A careful review of existing and new streams is necessary
  - Water addition is easy. Discharging water becomes difficult.

Summary Continued

- Water quality becomes a bigger concern in a contained system with more mechanical equipment
  - Prepare for water chemistry control
  - Consider impact of high overflow TSS and effect on O&M costs
- Develop a robust design by doing front-end homework
  - Audit existing system for operational practices, flow rates, ash properties, etc.

Thank You