

REINHOLD ENVIRONMENTAL Ltd.



## **2016 APC-Wastewater Round Table & Expo Presentation**

July 18 & 19, 2016 in Dearborn, MI / Hosted by DTE Energy

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# Volume Reduction Technologies for Coal Plant Wastewaters

Patricia M. Scroggin, P.E.

# Agenda



Drivers

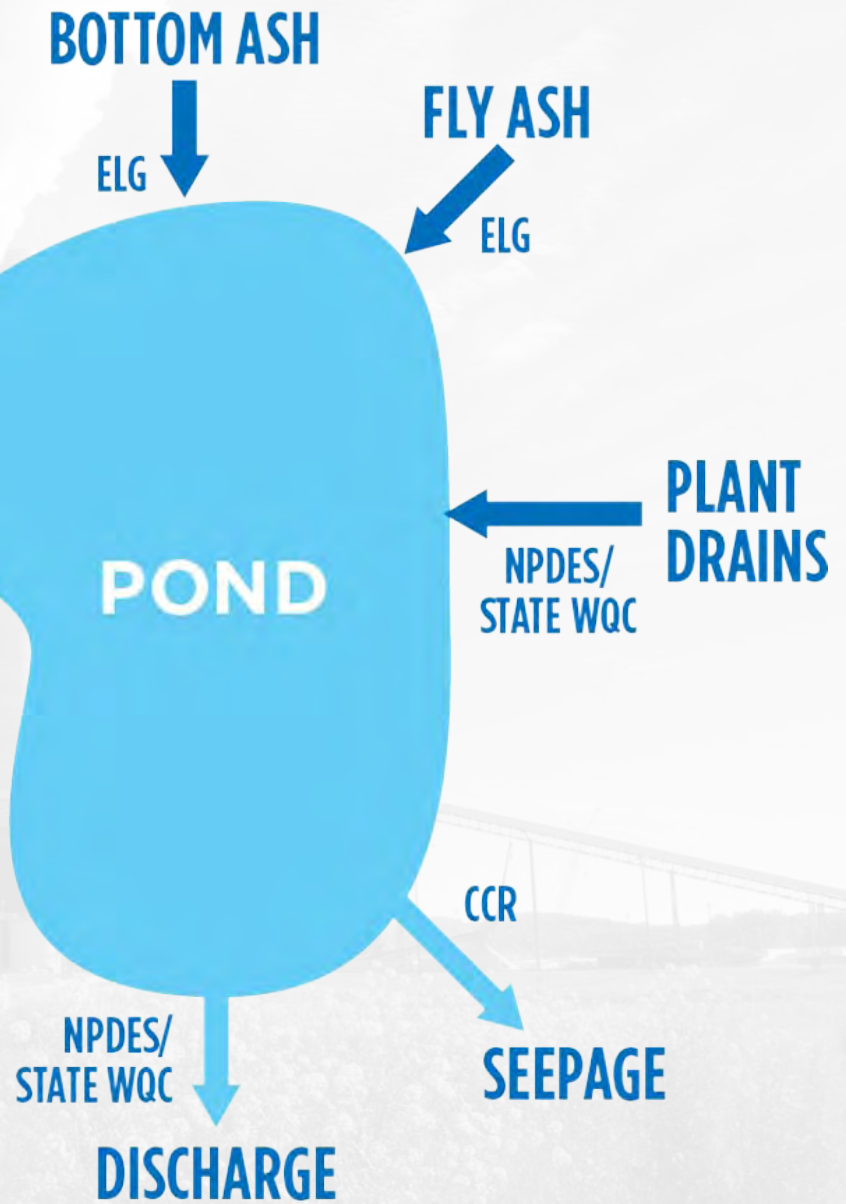


Bottom Ash  
Systems



FGD Wastewater  
Treatment  
Technologies

# COAL COMBUSTION RESIDUALS

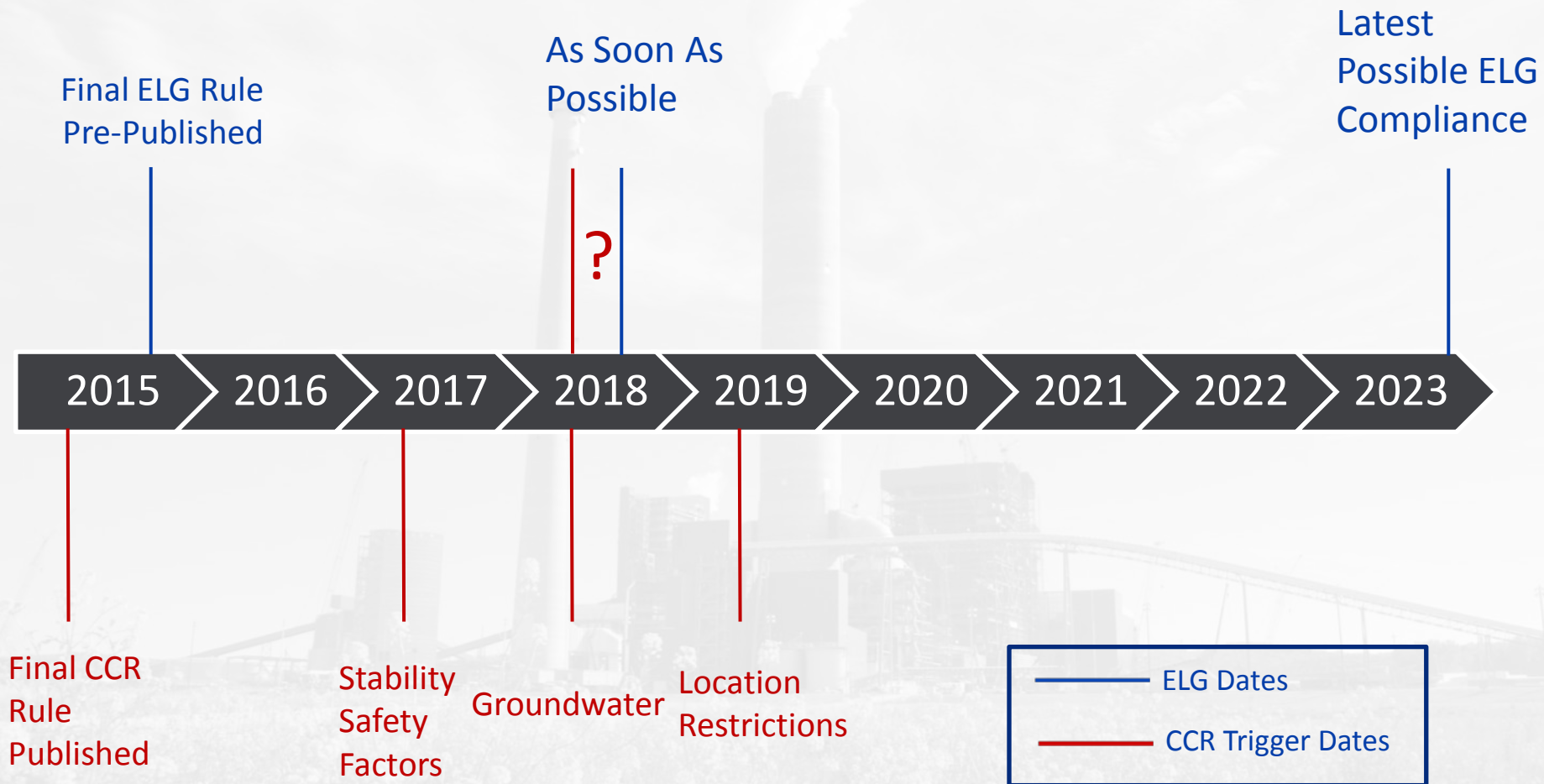


# CCR Rule – Triggers for Pond Closure

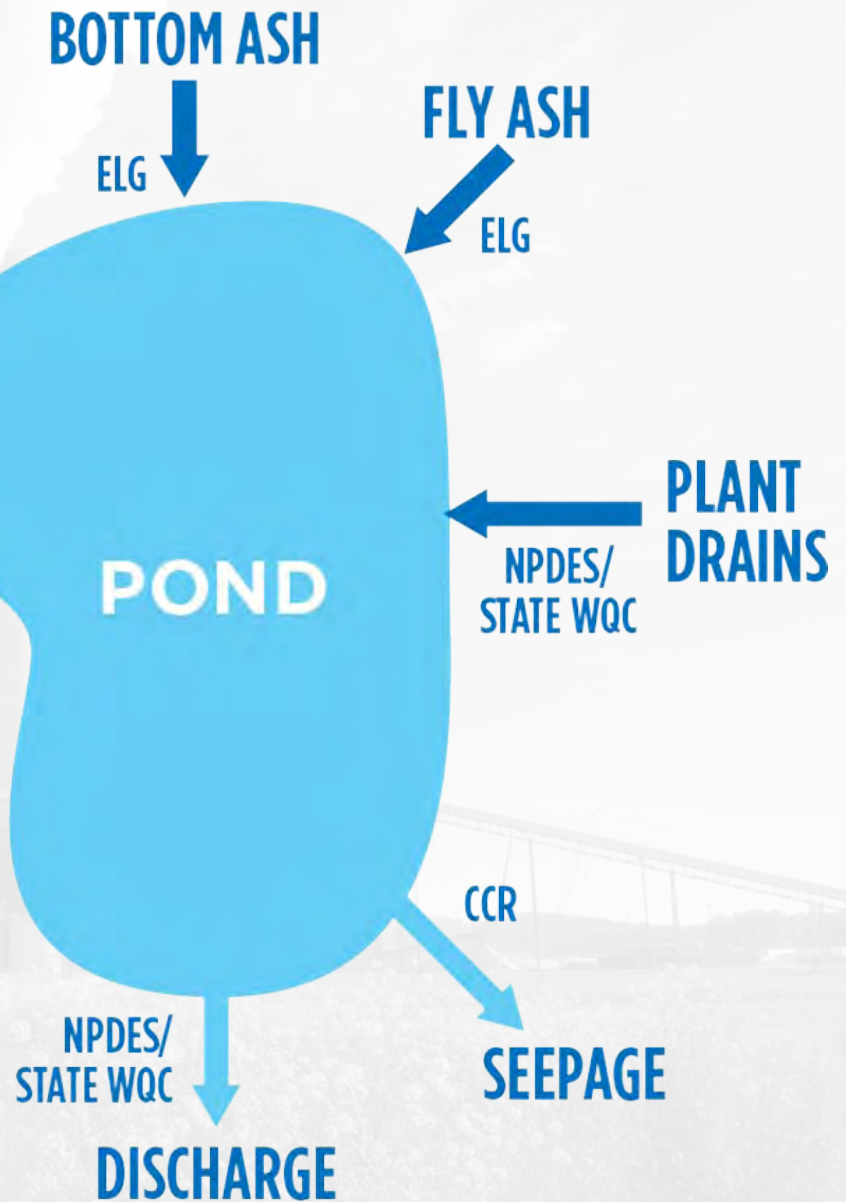
- ▶ Structural Integrity Criteria/Safety Factor Assessments
  - 18 months/October 2016
- ▶ Groundwater contamination from unlined ponds
  - 30 months/October 2017 with first annual report due January 2018
- ▶ Failure to meet location restrictions
  - 42 months/October 2018
- ▶ 6 months to cease sluicing and begin closure



# Collision with ELG Schedules



# EFFLUENT LIMITATIONS GUIDELINES (ELG)



# BAT Identified by EPA

<b>Waste Streams</b>	<b>Technology Basis for Existing Plants</b>
<b>FGD Wastewater</b>	Chemical Precipitation + Biological Treatment
<b>Fly Ash Transport Water</b>	Dry Handling
<b>Bottom Ash Transport Water</b>	Dry Handling/Closed Loop
<b>FGMC Wastewater</b>	Dry Handling
<b>Gasification Wastewater</b>	Evaporation
<b>Combustion Residual Leachate</b>	Impoundment (Equal to BPT)
<b>Non-chemical Metal Cleaning Wastes</b>	(Reserved)

# BAT – Best Available Technology

## Economically Achievable

- ▶ As soon as possible

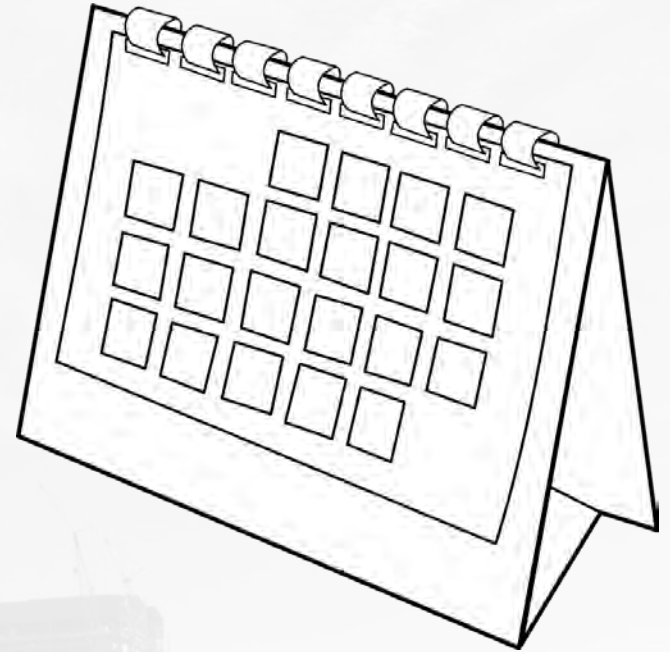
Pollutant	Maximum, any 1-day	30-day average
Arsenic, total	11 ug/L (ppb)	8 ug/L (ppb)
Mercury, total	788 ng/L (ppt)	356 ng/L (ppt)
Nitrate/nitrite, as N	17.0 mg/L (ppm)	4.4 mg/L (ppm)
Selenium, total	23 ug/L (ppb)	12 ug/L (ppb)

- ▶ In the meantime, BPT applies:

Pollutant	Maximum, any 1-day	30-day average
Oil and grease	20 mg/L (ppm)	15 mg/L (ppm)
Total suspended solids (TSS)	100 mg/L (ppm)	30 mg/L (ppm)

# Federal Compliance Schedule

- ▶ ELG earliest compliance:
  - “As soon as possible”
  - Starting November 1<sup>st</sup>, 2018
- ▶ Federal compliance backstop:
  - ***Not later than*** December 31<sup>st</sup>, 2023
- ▶ Through NPDES permit system:
  - Permit application must justify compliance schedule
  - Compliance schedule issued with permit
  - Legacy wastewater not included (generated before compliance date)



# Other Considerations

- ▶ Existing installed BAT technologies likely require upgrades
- ▶ Discharge of FGD wastewater through POTW or trucking offsite
  - Compliance still required
  - Ash transport water used as scrubber makeup
- ▶ Non-chemical metal cleaning wastewater
  - “Reserved” status
  - Revisions likely in future

# WATER BALANCES

THE FIRST  
STEP!

# Finding Balance

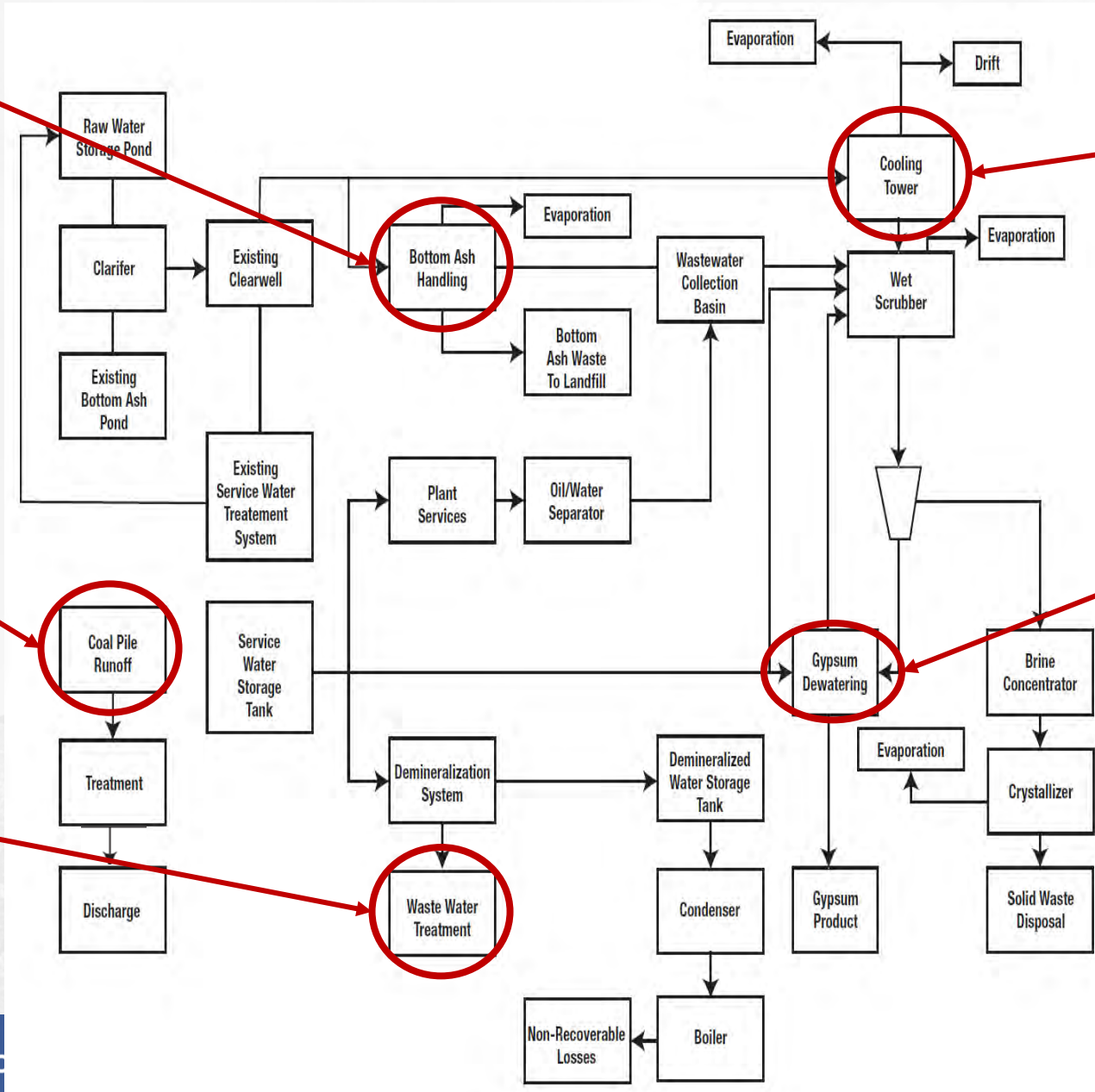
**Bottom Ash Handling**

**Cooling Tower**

**Coal Pile Runoff**

**Gypsum Dewatering**

**Waste Water Treatment**



# Master Plan

## Water Balance – Evaluate Current Operation

- ▶ What does the balance do that is good?
- ▶ Where is the balance deficient?
- ▶ How can water utilization be improved?

## Develop Water Management Plan

- ▶ Meet predicted limits
- ▶ Minimize changes in process
- ▶ Meets regulator's expectations and addresses concerns

# Balance the Budget

- ▶ **This change will challenge everyone**
- ▶ Past practices must evolve
- ▶ There's gold in them thar pipes!



# Change and Opportunities

## Challenges Ahead

- Operational Changes
  - New Equipment = Straight Forward
  - Culture Changes = Much Harder
- Reducing Water = New Approaches
  - Dry vacuum and shovels
  - Eliminate streams
  - Recycle streams



# New Paradigms

- ▶ This change will challenge everyone
- ▶ **Past practices must evolve**
- ▶ There's gold in them thar pipes!



# Creating New Habits

- ▶ Optimize and understand all practices
  - Air heater wash 12, 24... 48 hours.
  - Fire hose... everything
  - FGD problem... drain and fill
  - High  $\text{NO}_x$ ... turn up the ammonia slip
- ▶ Take nothing for granted
  - Dry scrubber... ash transport water
  - Bottom ash system to FGD... chemistry issues



# Money in the Bank

- ▶ This change will challenge everyone
- ▶ Past practices must evolve
- ▶ **There's gold in them thar pipes!**



# Cost Per GPM

You can save more than you realize

- FGD Physical/Chemical Biological

Installed cost ~\$85,000 per gpm

- FGD Evaporation/Crystallization

Installed cost ~\$125,000 per gpm

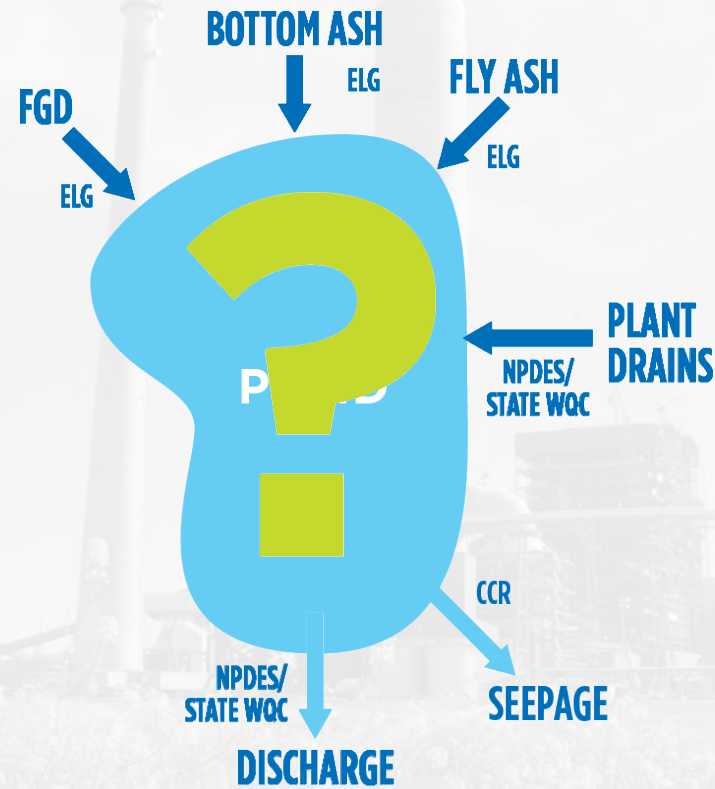


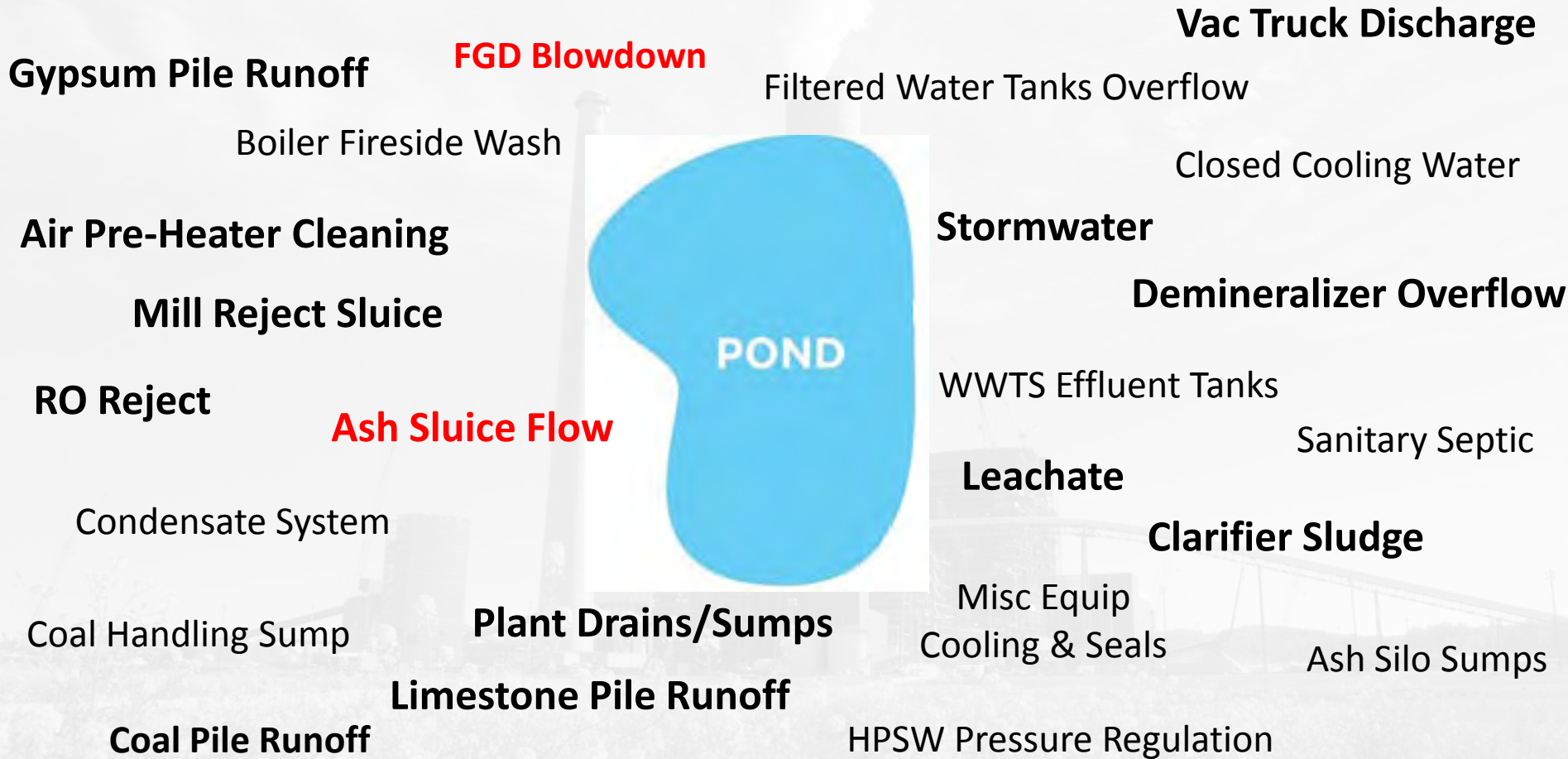
# Spray Dryer Absorbers & ELG's

- ▶ Recycle Ash Systems
- ▶ Case Study:
  - 500 MW
  - 2 x 50% SDA's
  - 200 gpm BD from recycle ash system
  - Tighten up your water balance!

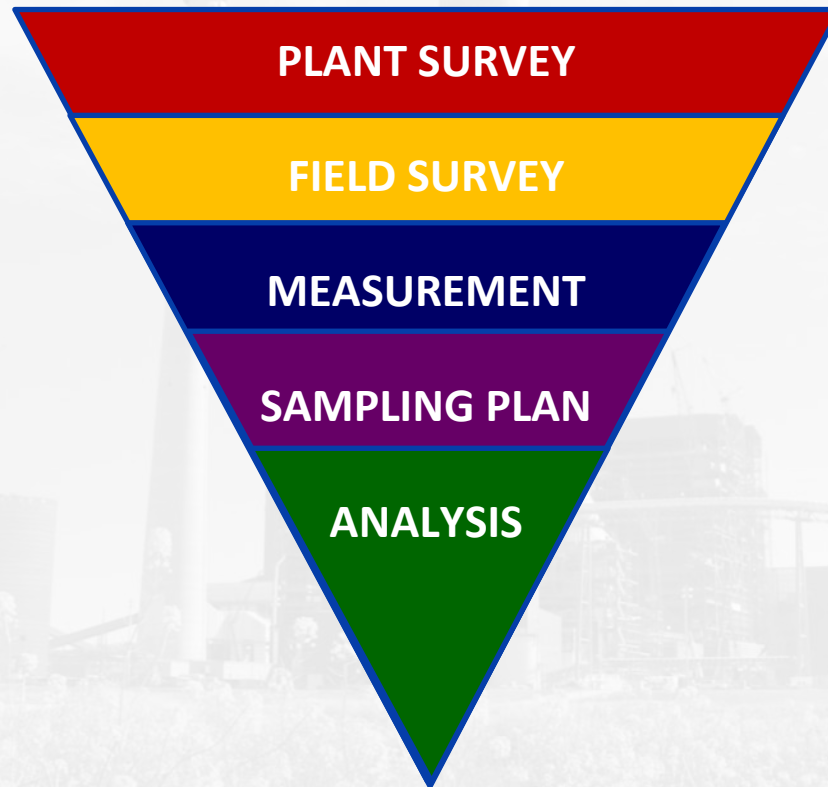


# Water Balance Status Quo





# Water Balance Optimization



# Water Balance Development

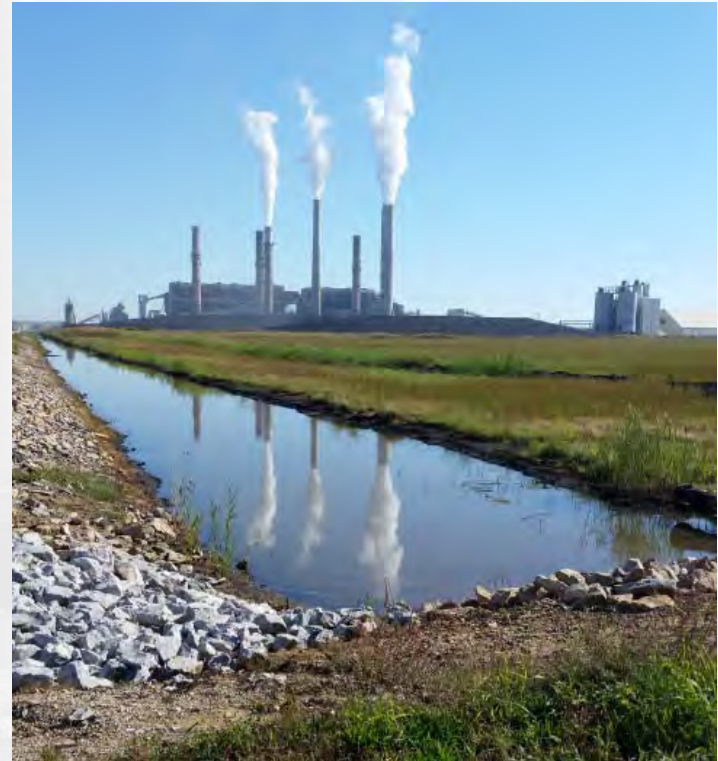
## Flowmeters

- Clamp-on
- Insertable
- Doppler (ditches & culverts)
- Rain gauges
- Pump-hour meters



# Case Study 1

- Exposed conservative runoff estimates
  - Reduced sizing basis of new basin



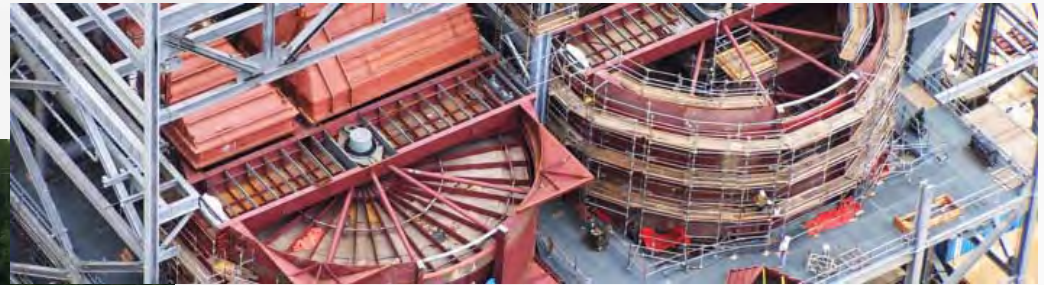
# Case Study 2

- Confirmed FGD blowdown rate higher than necessary
  - Future capital and O&M cost savings for ELG compliance technology



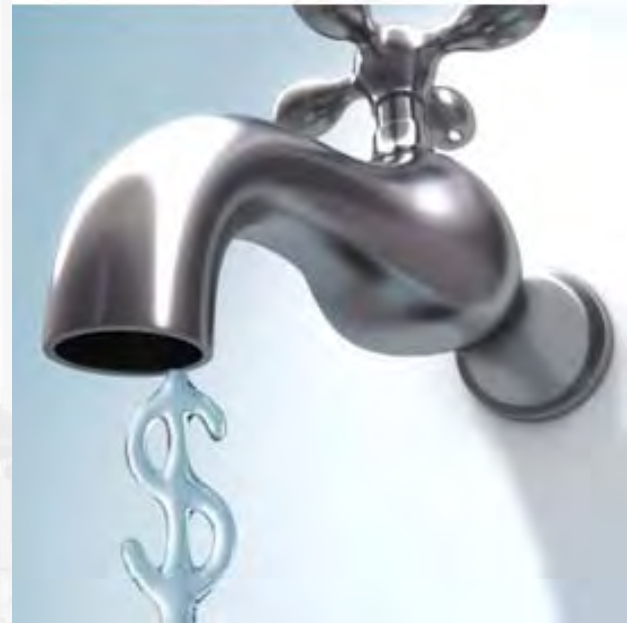
# Case Study 3

- Characterized impacts from intermittent flows
  - Air heater wash, vacuum truck disposal



# Case Study 4

- Uncovered service water optimization opportunities
  - Operations changes equate to cost savings



# BOTTOM ASH WASTEWATER REDUCTION



# Bottom Ash Water Options

## ▶ Under boiler conveyor

- Discharge
  - ▶ Low Volume Waste

## ▶ Remote Conveyor

- Transport Water
- Zero Discharge
  - ▶ Except as FGD Makeup



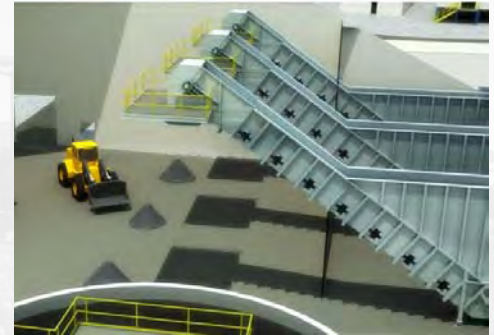
# Bottom Ash Water Chemistry – Historically

- ▶ Historical systems not 100% closed loop
- ▶ pH concerns
- ▶ Scaling and corrosion
- ▶ Source of problems



# Performance Guarantees – Bottom Ash

- ▶ Removal rate
- ▶ Total suspended solids – instantaneous vs. average
- ▶ Moisture content
- ▶ Zero discharge



# COMPLIANCE TECHNOLOGIES FGD WASTEWATER

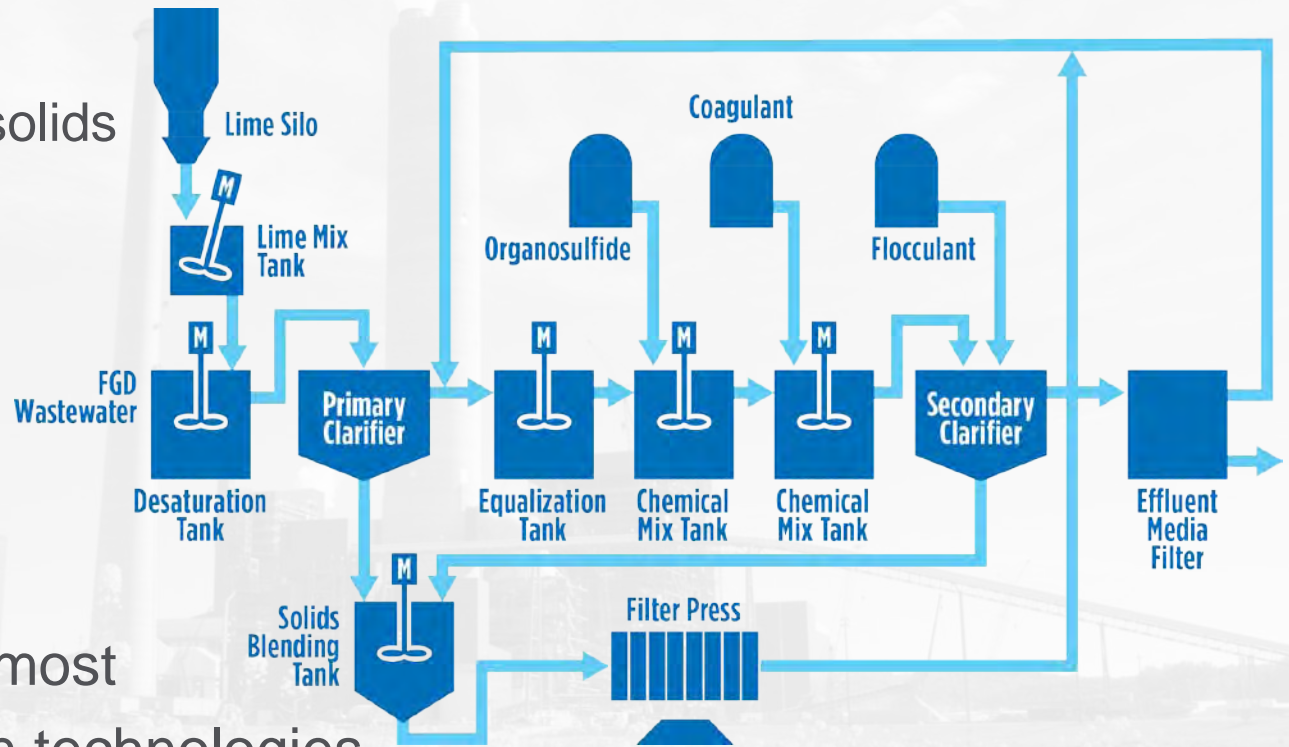


# Wastewater Reduction Technologies



# Phys-Chem Treatment with Organosulfide

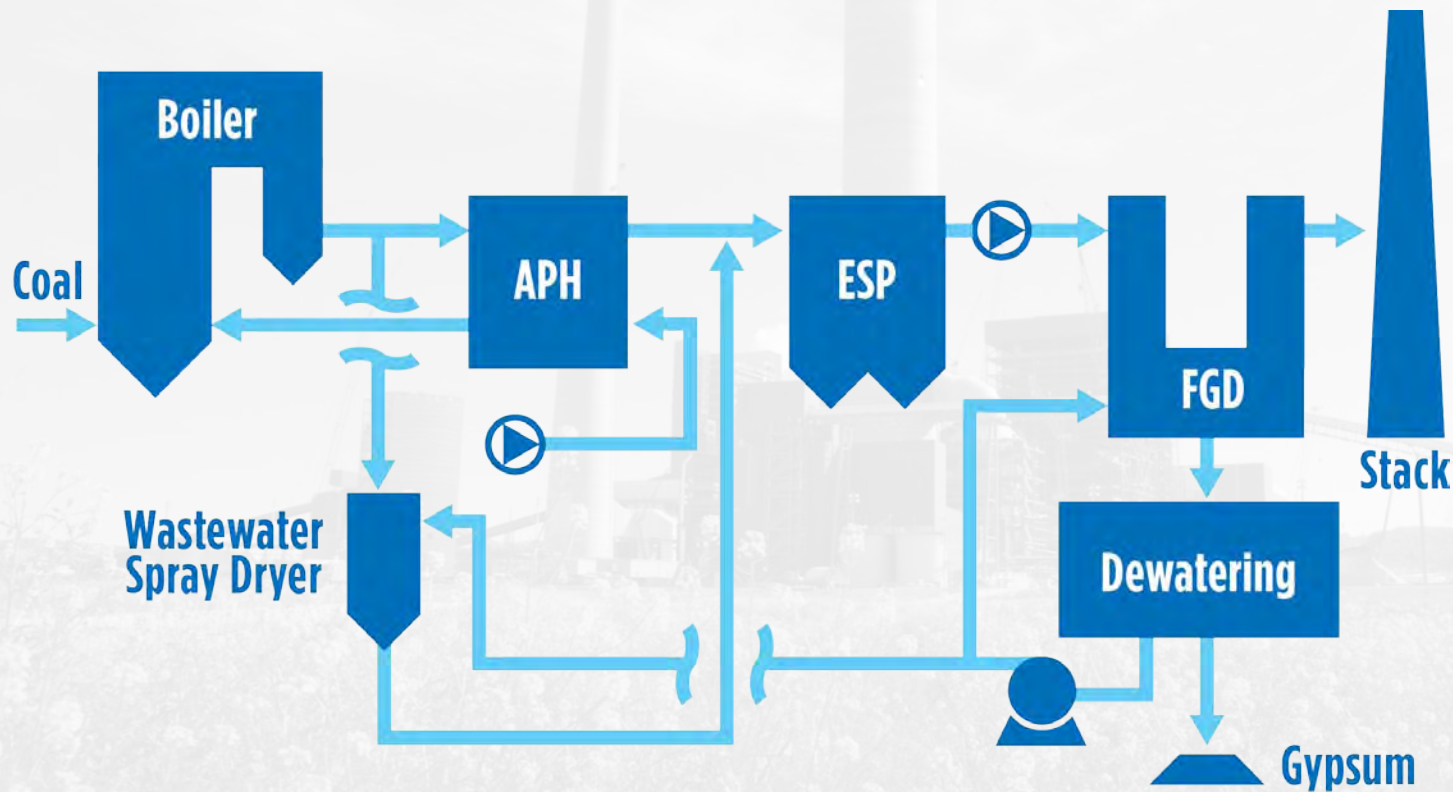
- ▶ Established process
  - Many steps
- ▶ Removes metals/solids
- ▶ **Not:**
  - Selenium
  - Nitrate
- ▶ Multiple vendors
  - Equipment
  - Chemicals
- ▶ Pretreatment to most volume reduction technologies





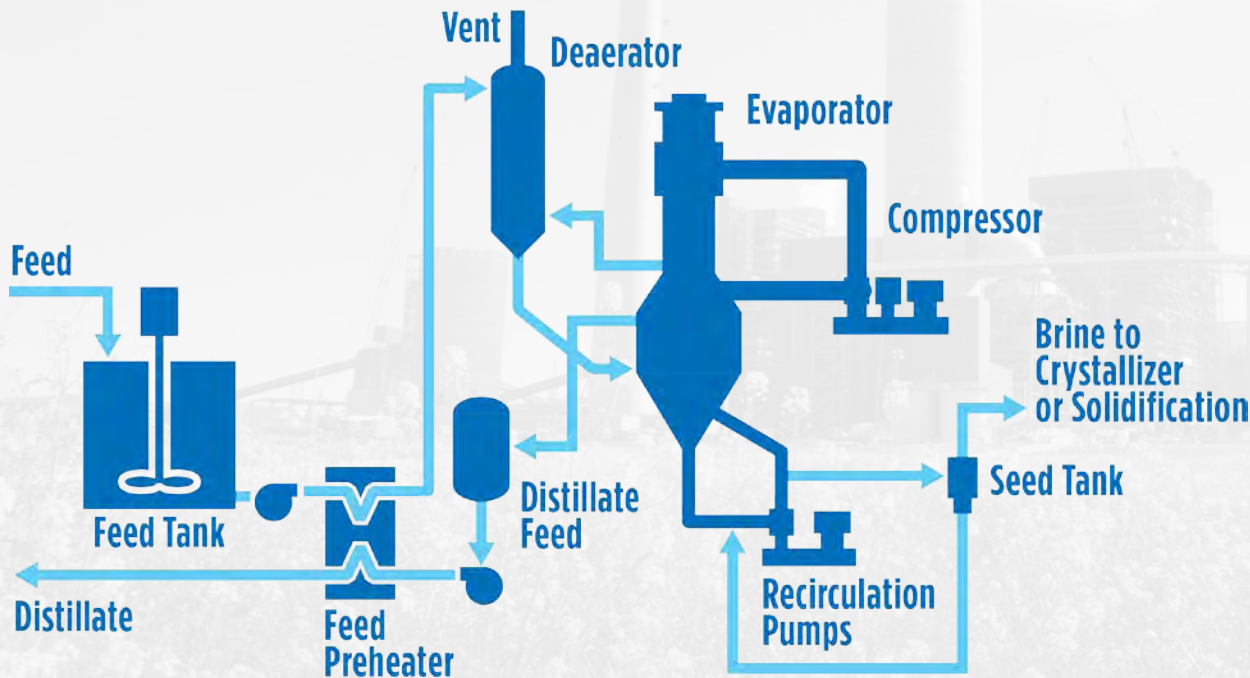
# Evaporation into Flue Gas

- ▶ Number of Pilots in the works
- ▶ Full Scale coming online end of 2016



# Thermal Evaporator/Crystallizer

- ▶ Established technology
  - In use at Merrimack, Duke, others
- ▶ Produces low TDS reusable waste stream
- ▶ Limited number of vendors
- ▶ High parasitic power
- ▶ Expensive
- ▶ Operator-intensive



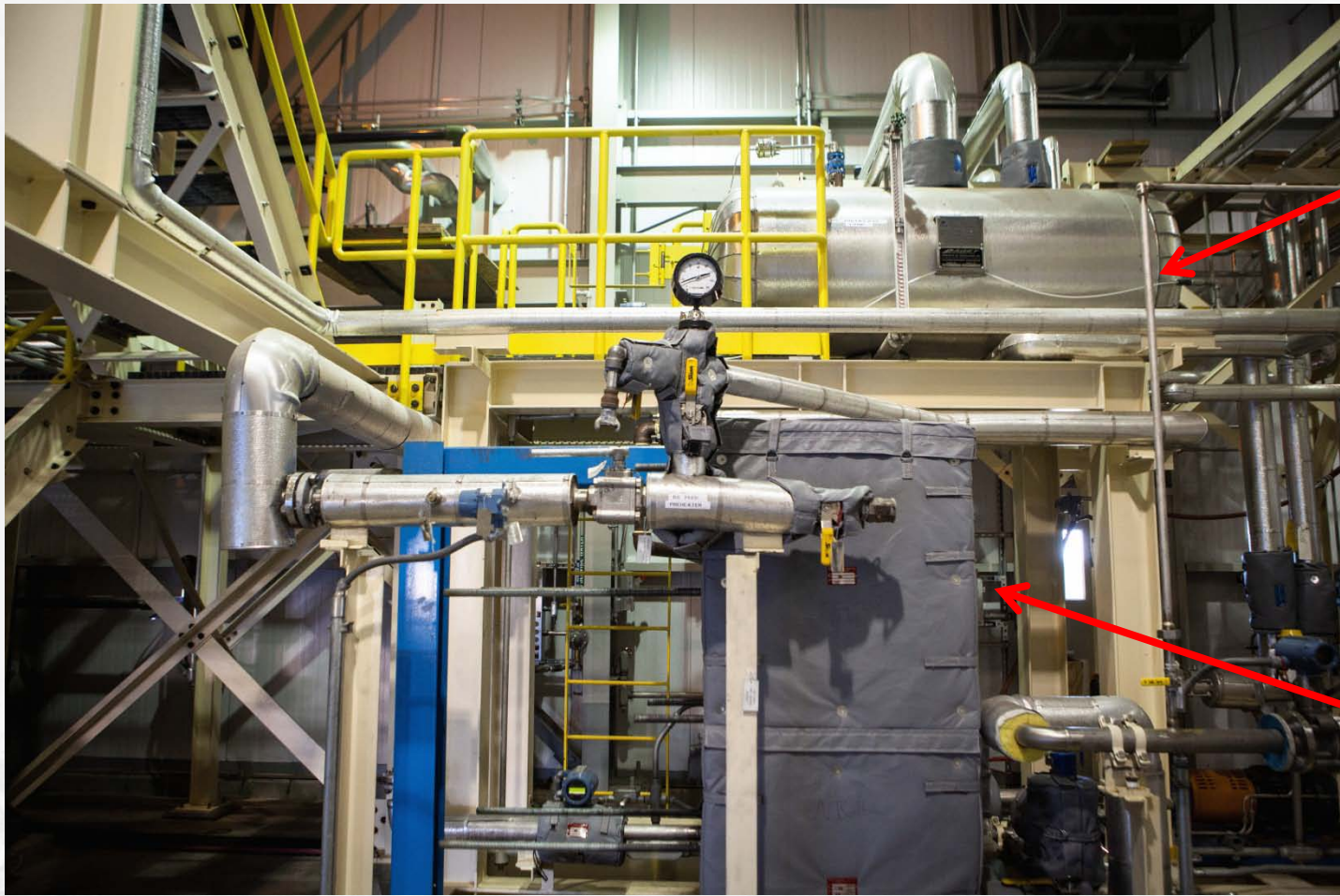


Crystallizer  
Flash Tank

Crystallizer  
FCHX Skid



Falling Film Evaporator  
(Brine Concentrator)



Distillate  
Tank

Feed Stream  
Pre-Heater

# PSNH ZLD

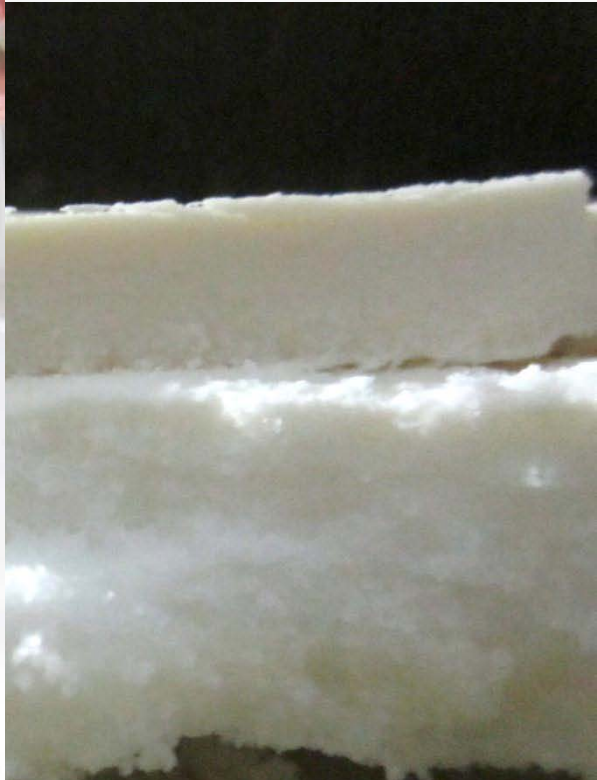


Vapor  
Compressor



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Full ZLD Salt Cake



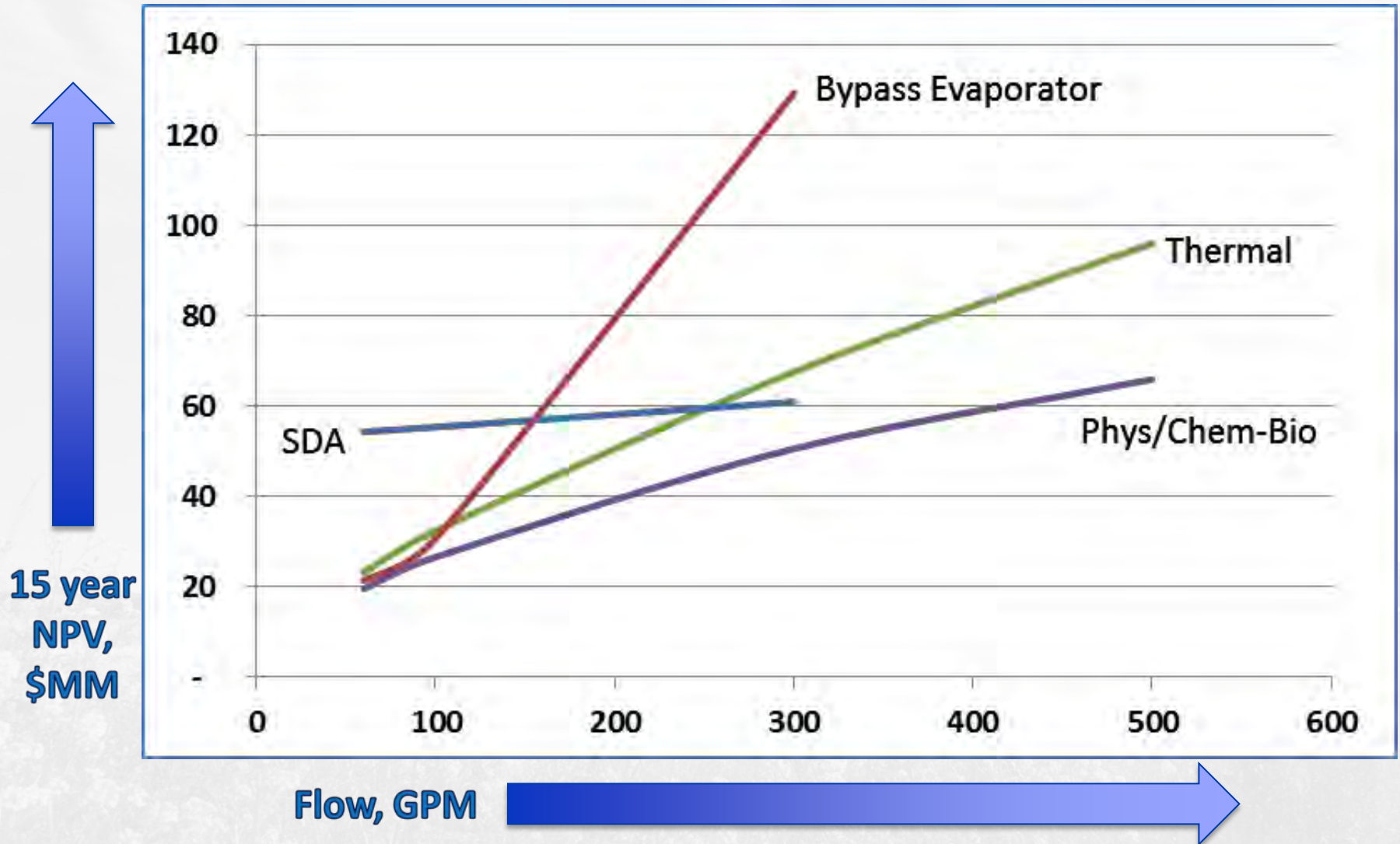
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# Case Study: Flow vs. Technology Selection

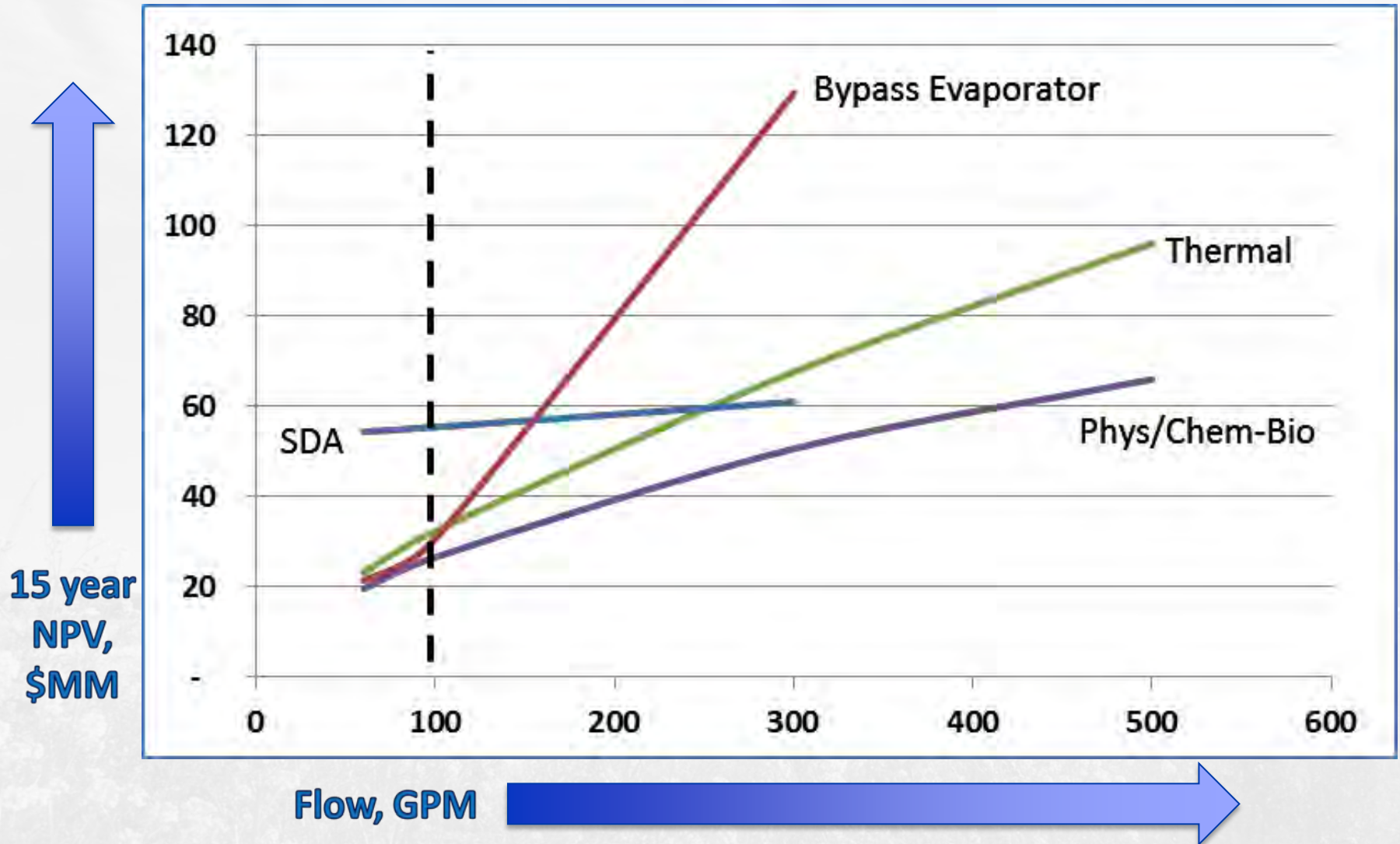
- ▶ 500 MW unit with wet FGD
- ▶ Blowdown 60-500 gpm
- ▶ 2018-2032 NPV of multiple technologies
  - Physical/chemical plus biological 2018
  - Thermal evaporation 2023
  - Spray dryer absorber 2023
  - Bypass evaporator (around APH) 2023
- ▶ Assumptions
  - Crystallizers necessary for higher flow rate thermal systems
  - All costs are capitalized in the first year of operation (2018 or 2023)
  - NPV includes 9 or 14 years of operation (2023 or 2018 startup, respectively)



# Flow vs. Technology Selection



# Flow vs. Technology Selection



# PROMISING TECHNOLOGIES



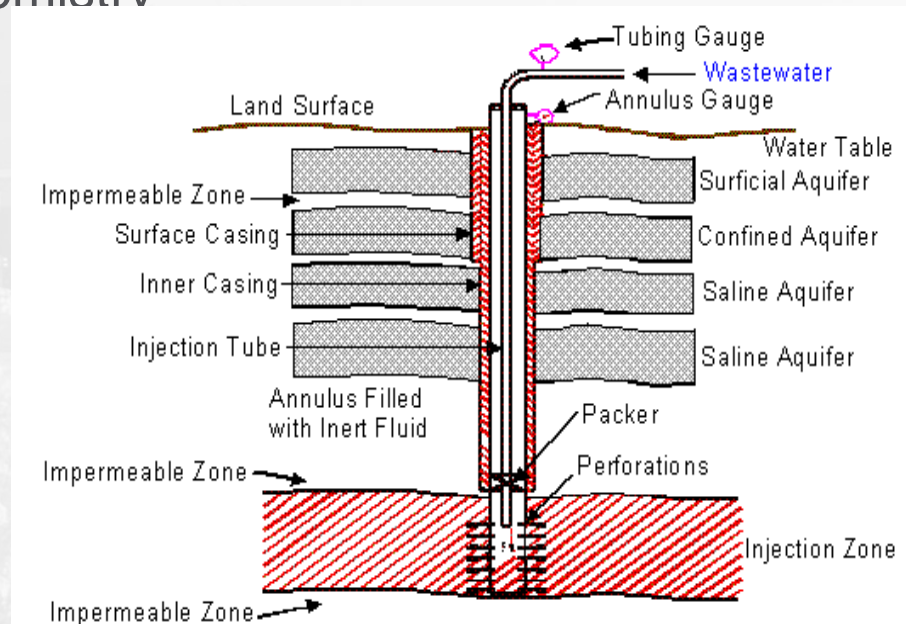
# MEMBRANE TREATMENT FOR VOLUME REDUCTION

- ▶ High Pressure RO
  - Pretreatment is intense
- ▶ VSEP
- ▶ Consistent high quality water
- ▶ Disadvantages
  - Higher capital costs
  - High energy cost
  - High membrane replacement costs
  - Concentrate waste disposal
  - Pretreatment typically required



# Deep Well Injection

- ▶ Permitting is site specific
  - ▶ Some states specifically prohibit due to seismic
- ▶ Bacteria develops due to organic carbon
- ▶ High temperature gradient with further precipitation
  - Reverse Solubility of FGD chemistry



# MEMBRANE TREATMENT

- ▶ Consistent high quality water
- ▶ Disadvantages
  - Higher capital costs
  - High energy cost
  - High membrane replacement costs
  - Concentrate waste disposal
  - Pretreatment typically required
  - Unproven technology for various streams such as FGD Blowdown

# THANK YOU!

## Burns & McDonnell

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