REINHOLD ENVIRONMENTAL Ltd.

2014 Wastewater-Ash Round Table & Expo Presentation

September 22, 2014, in Birmingham, AL / Hosted by Southern Company

UNITED CONVEYOR CORPORATION

Options, Considerations and Implications of Bottom Ash Transport Conversions

Prepared for: Reinhold Wastewater-Ash / PCUG Conference

Presented By: Kevin L. McDonough

22 September 2014

Discussion Overview

- Regulatory Update & Implications
- Activity Summary & Technology Selection Criteria
- Bottom Ash Wet-to-Dry Conversion Technology
- Water Balance & Wastewater Considerations

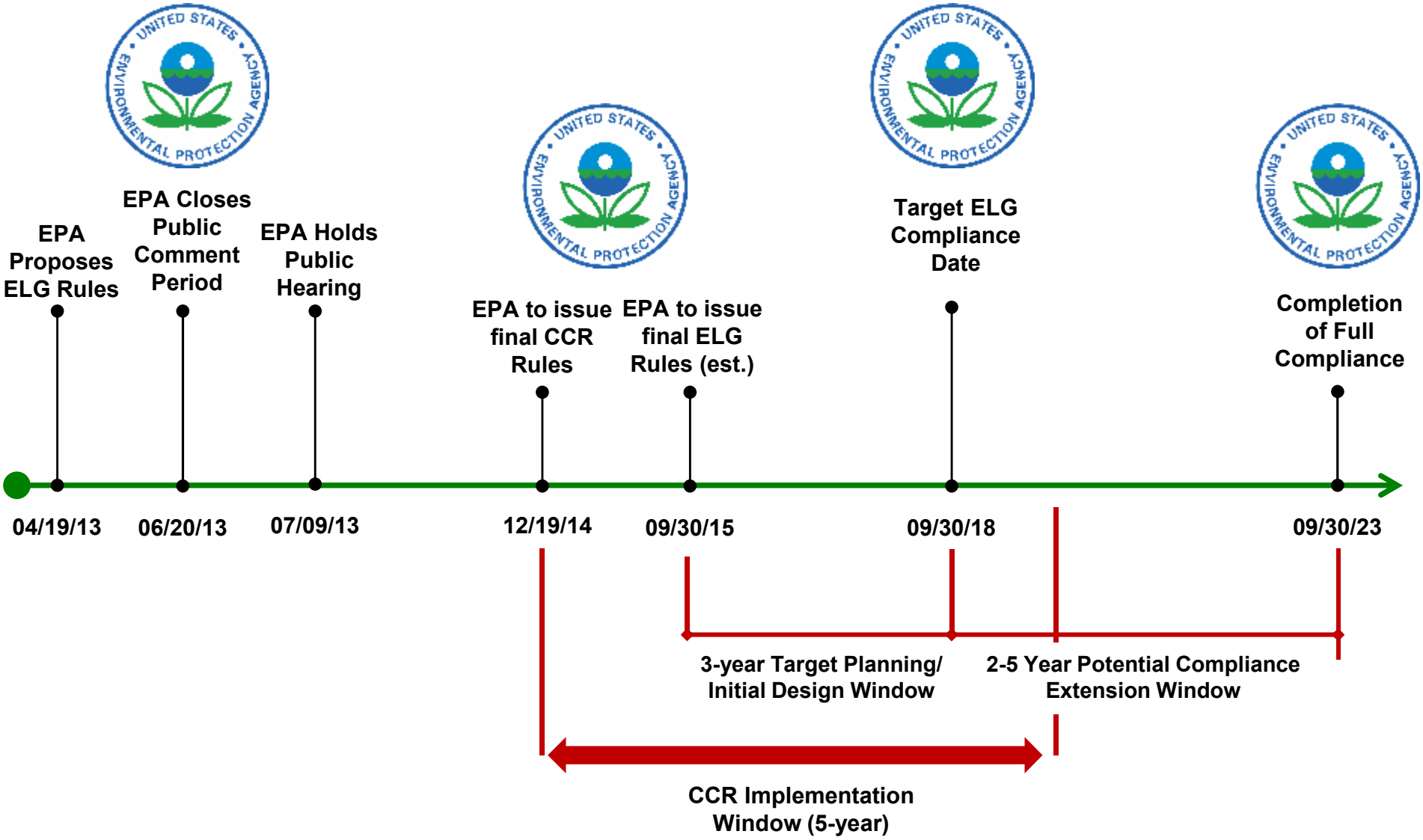
Safety Moment

“Haste Makes Waste”

ELG & CCR Ruling

Regulatory Timeline

Presentation Prepared For:



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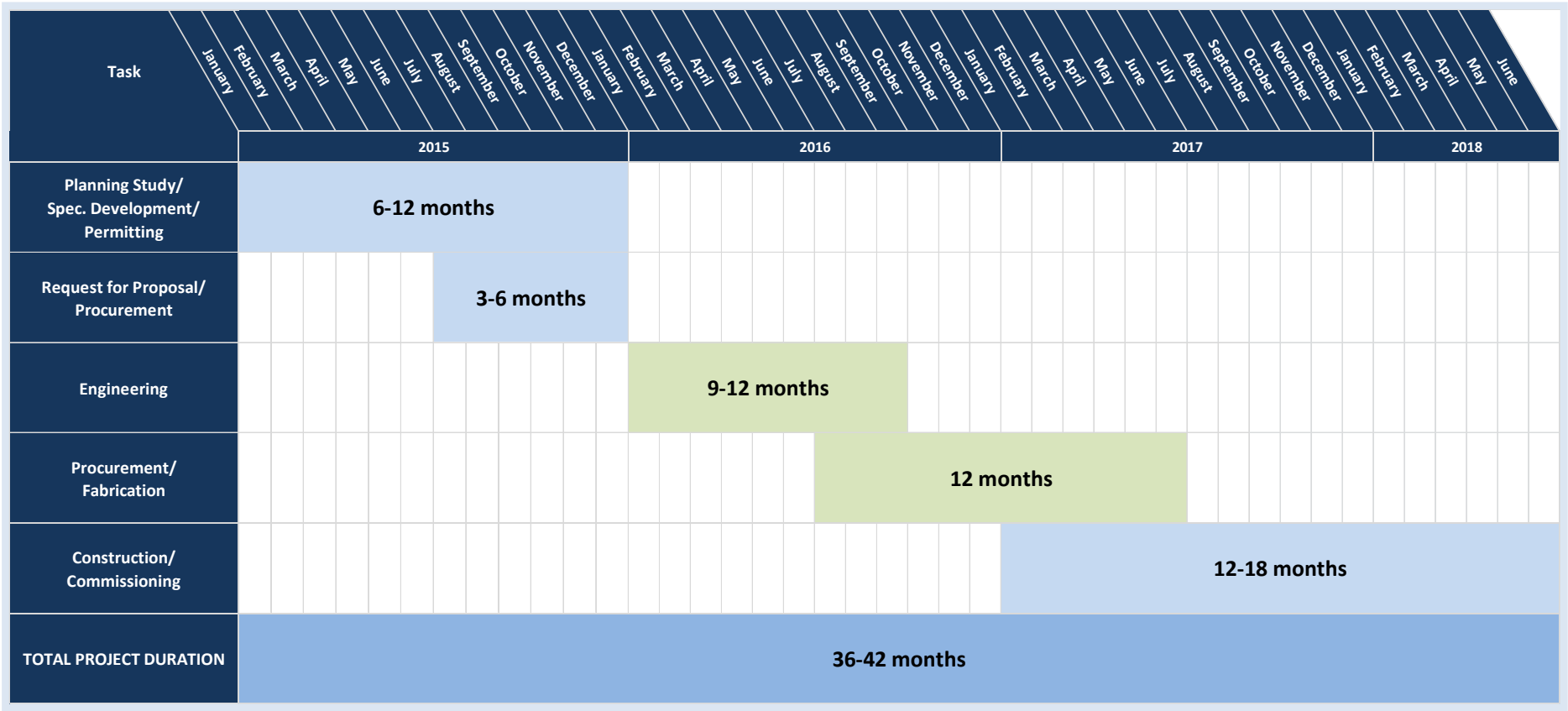
ELG & CCR Ruling

Typical Wet-to-Dry Ash Conversion Project Durations

Presentation Prepared For:



- Rules will likely drive dozens of WTD ash conversion, pond closure, dry landfill and wastewater treatment projects
- Potential to test the capacity of Utilities, AE Firms, Technology Providers & Installation Contractors

ELG Ruling

Steam Electric Main Regulatory Options

Presentation Prepared For:

Wastestreams	Technology Basis for the Main Regulatory Options			
	3a	3b	3	4a
FGD		Chemical Precipitation + Biological Treatment for units		ation + ment
Fly Ash				g
Bottom Ash				losed- 00W; qual to 00MW
Comb				nt T)
FGMC Wastewater	Dry Handling	Dry Handling	Dry Handling	Dry Handling
Gasification Wastewater	Evaporation	Evaporation	Evaporation	Evaporation
Nonchemical Metal Cleaning Wastes	Chemical Precipitation	Chemical Precipitation	Chemical Precipitation	Chemical Precipitation

EPA will choose (1) of the (4) Options and issue as final in September 2015

ELG Ruling

Requirements of the Ruling – Direct Discharges from Existing Facilities

Bottom Ash BPT Requirements

Pollutant or Pollutant Property	BPT Standard Options 3a, 3b, 3 and 4a (<400 MW)	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and Grease	20.0	15.0

Implications of ELG Ruling

Fly Ash Wet-to-Dry Conversions (All 4 Options)

- Remaining wet fly ash systems will be converted to dry systems
- Existing wet back-up systems will be decommissioned and will likely require additional redundancy for primary dry systems

Bottom Ash Wet-to-Dry Conversions

- Under 3 of 4 regulatory options, utilities will have to determine if existing impoundments can meet BPT requirements (TSS, oil and grease)
- Utilities will also have to weigh BA WTD conversion costs against CCR Subtitle D requirements: “Must remove solids and retrofit with a composite liner or cease receiving CCR’s within 5 years of effective date and close the Unit”
- For Option 4a, all generating units >400 MW will have to implement BA WTD conversions; generating units <400 MW will have to evaluate BA WTD conversion costs against BPT requirements

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- Bottom Ash Wet-to-Dry Conversion Technology
- Water Balance & Wastewater Considerations

Technical Design Considerations

Wet-To-Dry Ash Conversion Project Design Criteria	
Budget	Plant Water Balance Considerations
Outage Requirements	Ash Conveying Capacities
Physical Parameters	Conveying Distance Considerations
Site Environmental Considerations	Operations & Maintenance Issues
Ash Characteristics	Multiple Unit Synergies
Ash Marketability/Beneficiation	Unburned Carbon Concerns

- Evaluate Criteria Against Multiple Alternatives
- Determine Optimal Solution for each Plant
- “One Size Does Not Fit All”

Discussion Overview

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- **Bottom Ash Wet-to-Dry Conversion Technology**
- Water Balance & Wastewater Considerations

Bottom Ash Wet-To-Dry Conversions

Technical Alternatives

Presentation Prepared For:

Re-Circulating Hydraulic System (2 Options)

- No Changes Under Boiler, Uses Existing Hopper
- Minimizes Outage Requirements

Submerged Flight Conveyor – SFC™

- Long-Term Economical Choice (Low O&M Costs)
- Simple Solution if Space is Available

Dry Hopper Pneumatic Conveying – PAX™

- No Water, Returns Heat Back to Boiler
- Easiest 100% Dry Option to Move Ash Out of Boiler Building

Vibratory Conveying – VAX™

- No Water, Returns the Most Heat Back to Boiler
- Continuous Removal of Bottom Ash
- Unburned Carbon % Guarantee

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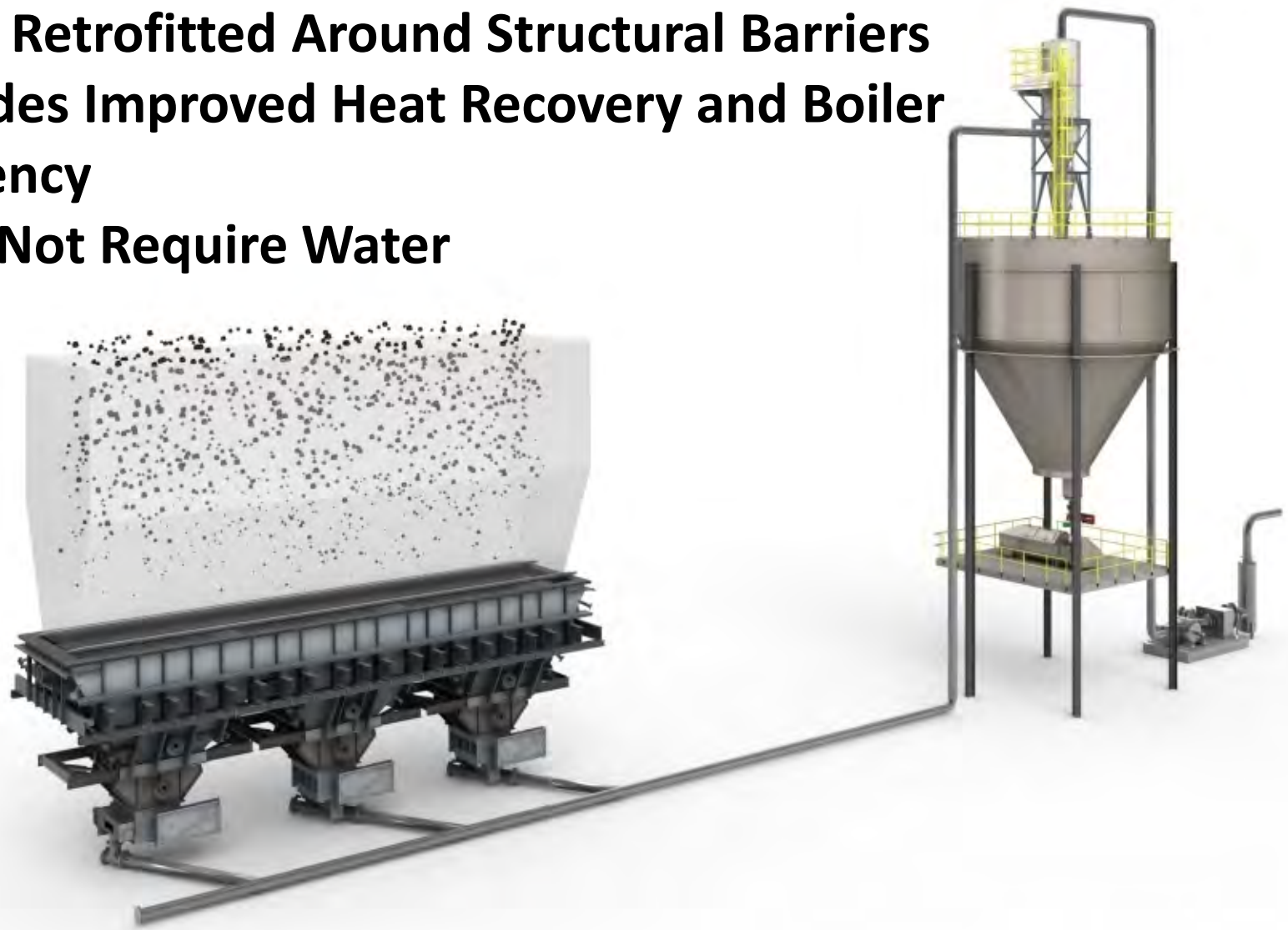
Bottom Ash WTD Conversion Alternatives

Pneumatic Ash Extractor (PAX)

Presentation Prepared For:

- **Easily Retrofitted Around Structural Barriers**
- **Provides Improved Heat Recovery and Boiler Efficiency**
- **Does Not Require Water**



Bottom Ash WTD Conversion Alternatives

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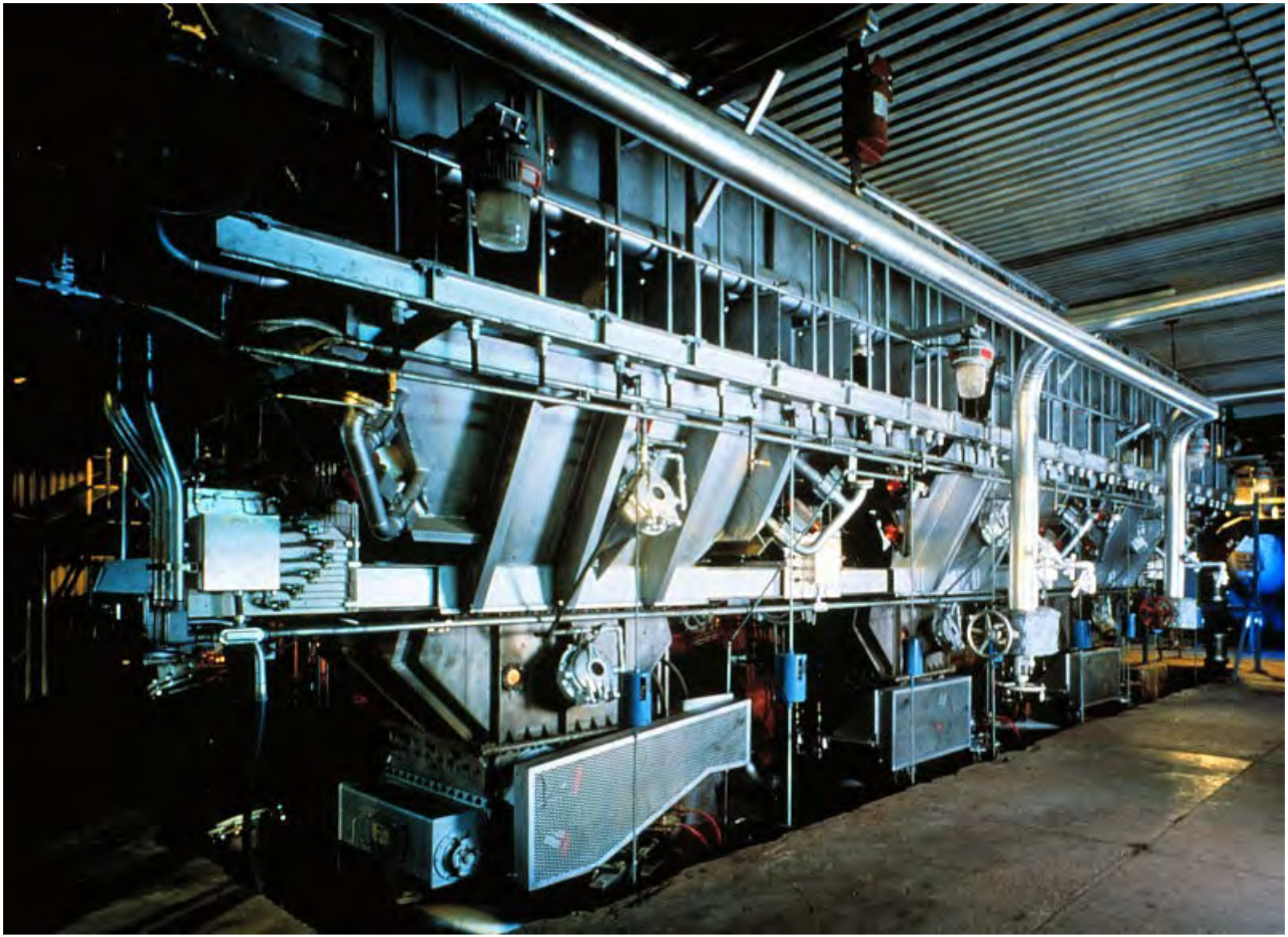

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Bottom Ash WTD Conversion Alternatives

Pneumatic Ash Extractor (PAX)

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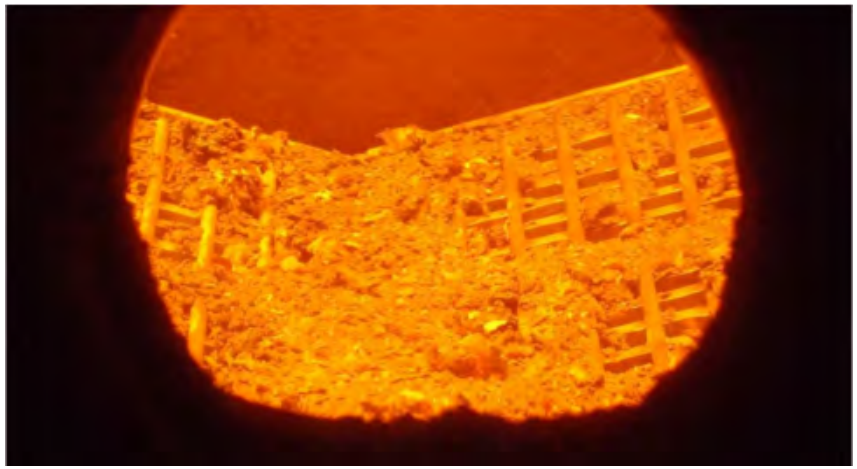

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Bottom Ash WTD Conversion Alternatives

Pneumatic Ash Extractor (PAX)

Presentation Prepared For:

1 = Worst, 5 = Best	Scale 1-5	Technology Alternatives: Re-Circ System (Hydraulic)		SFC (Mechanical)		PAX (Pneumatic)		VAX (Vibratory)	
W									
C									
T									
C									
P									
B									
M									
B									
Weighted Total Score			**81**		**90**		**112**		**106**

Decision Analysis Favors PAX™ System if criteria are weighted for:

- **100% Dry Solution**
- **Physical Space Limitations**
- **Boiler Heat Recovery / Unburned Carbon**

Bottom Ash WTD Conversion Alternatives

Vibratory Ash Extractor (VAX)

Presentation Prepared For:

- **Proven Vibrating Technology**
- **Highest Heat Recovery**
- **Reduced Operating Cost**

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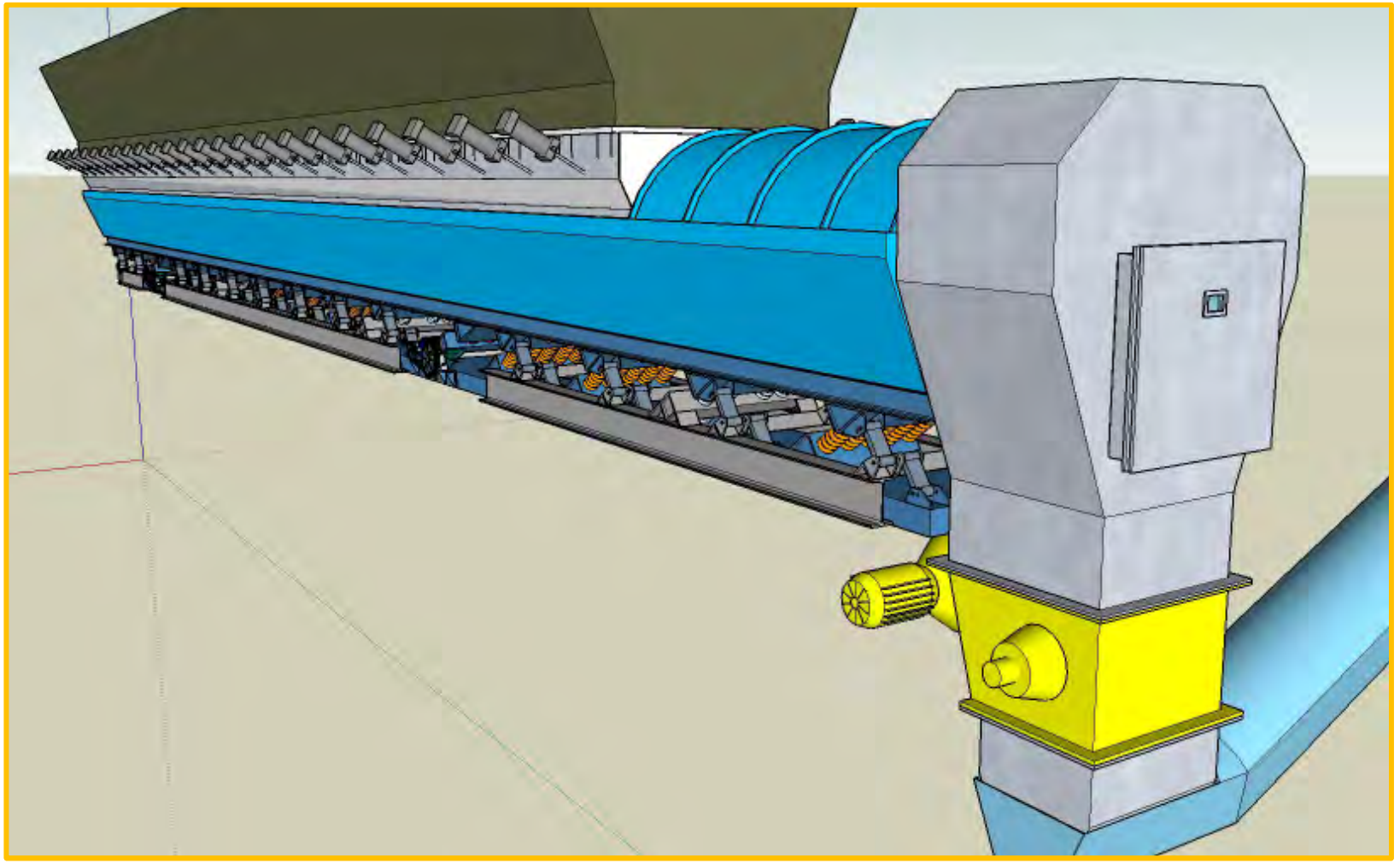
Bottom Ash WTD Conversion Alternatives

Vibratory Ash Extractor (VAX)

Presentation Prepared For:



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Bottom Ash WTD Conversion Alternatives

Vibratory Ash Extractor (VAX)

Presentation Prepared For:

1 = Worst, 5 = Best	Scale 1-5	Technology Alternatives: Re-Circ System (Hydraulic)		SFC (Mechanical)		PAX (Pneumatic)		VAX (Vibratory)	
									Total
Wat									25
Outa									3
Tota									6
Ope									2
Pow									25
Boile									6
Mult									2
Biomass / Unburned Carbon Concerns	4	1	4	1	4	4	16	5	20
Weighted Total Score			**48**		**81**		**85**		**99**

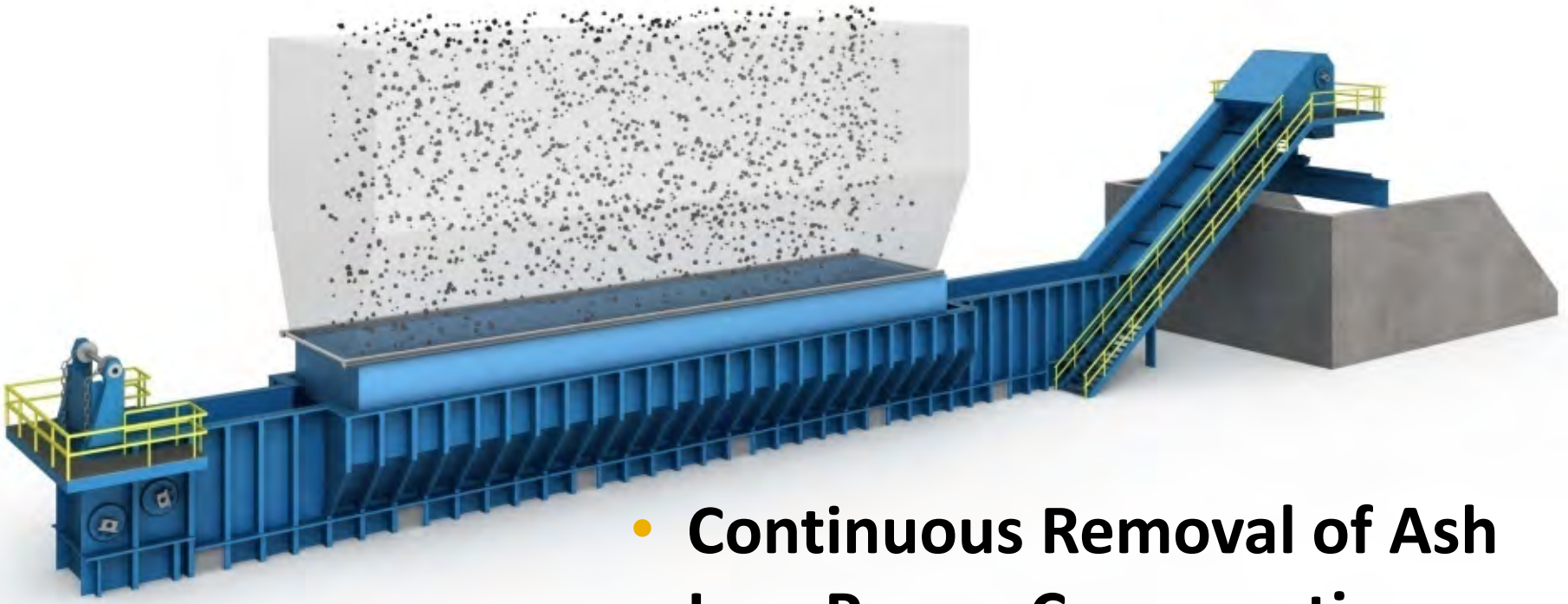
Decision Analysis Favors VAX™ System if criteria are weighted for:

- 100% Dry Solution
- Boiler Heat Recovery
- Unburned Carbon Considerations

Bottom Ash WTD Conversion Alternatives

Submerged Flight Conveyor (SFC)

Presentation Prepared For:



- **Continuous Removal of Ash**
- **Low Power Consumption**
- **Easily Incorporates Mill Rejects**
- **Industry Standard on New Units for past 30 years**

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Bottom Ash WTD Conversion Alternatives

Submerged Flight Conveyor (SFC)

Presentation Prepared For:

Decision Analysis Favors SFC™ System

Presentation Prepared For:

1 = Worst, 5 = Best	Scale 1-5	Technology Alternatives: Re-Circ System (Hydraulic)		SFC (Mechanical)		PAX (Pneumatic)		VAX (Vibratory)	
Criteria for Determining									
Wat									
Outa									
Tota									
Ope									
Pow									
Boile									
Mult									
Biomass / Unburned Carbon Concerns	1	1	1	1	1	4	4	5	5
Weighted Total Score			**56**		**81**		**68**		**75**

Decision Analysis Favors SFC™ System if criteria are weighted for:

- Total Installed Cost
- Reduced Maintenance Costs
- Reduced Operating Costs

Bottom Ash WTD Conversion Alternatives

Conventional Dewatering & Recirculation System

Presentation Prepared For:

- **Minimal Outage Time for Conversion**
- **Continue to Use Existing Bottom Ash Hoppers**
- **Easily Incorporates Mill Rejects**

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Bottom Ash WTD Conversion Alternatives

Settling and Surge Tanks

Presentation Prepared For:

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Bottom Ash WTD Conversion Alternatives

Settling and Surge Tanks

Presentation Prepared For:

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Bottom Ash WTD Conversion Alternatives

Conventional Dewatering & Recirculation System

Presentation Prepared For:

- **Large Equipment Scope**
- **Greater Foundation Design Requirements**
- **Inconsistent Bottom Ash Dewatering**
- **Higher Maintenance**

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Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

Presentation Prepared For:

- **CDR System with Remote SFC's**
- **Combines SFC Technology with Conventional Recirculation System**

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Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

Presentation Prepared For:

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Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

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Bottom Ash WTD Conversion Alternatives

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Presentation Prepared For:

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Bottom Ash WTD Conversion Alternatives

Continuous Dewatering & Recirculation System (CDR) with Remote SFC's

Presentation Prepared For:

1 = Worst, 5 = Best	Technology Alternatives								
	Scale 1-5	Re-Circ System (Hydraulic)		SFC (Mechanical)		PAX (Pneumatic)		VAX (Vibratory)	
									otal
Water									0
Outag									5
Total In									4
Operat									3
Power									0
Boiler									5
Multip									0
Biomas									5
Weighted Total Score			**88**		**80**		**85**		**77**

Decision Analysis Favors CDR™ System if criteria are weighted for:

- Reduced Outage Requirements
- Physical Space Limitations
- Multiple Unit Synergies

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- **Water Balance & Wastewater Considerations**

Water Balance/Wastewater Considerations

Pyrites System Considerations

Existing Systems:

- Most Mill Reject (Pyrites) removal systems use sluice conveying
- Most are connected to the Bottom Ash Sluice Conveying System and ponds, while some are independent sluice systems that discharge to separate ponds
- Some plants have Pyrites Dewatering Bins
- 100% Dry Solutions require separate systems

Water Balance/Wastewater Considerations

Pyrites System Considerations

Key Considerations:

- Not clearly defined in proposed ELG
- Many plants are now requesting separation of Bottom Ash and Mill Rejects to ensure Bottom Ash Marketability
- 100% Dry Systems can be difficult retrofits (physical space, cost)
- Can be readily connected to CDR or SFC systems
- Can have an independent pyrites dewatering system

Pyrites Dewatering Bins

Water Balance/Wastewater Considerations

Economizer Ash Considerations: Sluice vs. Dry Systems

Existing Systems:

- Over half of Economizer Ash removal systems use sluice conveying
- Of these wet systems, most are connected to the Bottom Ash Sluice Conveying System or SFC's
- Some systems collect Economizer Ash with Dry Flight Conveyors (DFC) and transfer to Vacuum System or Sluice Conveying System
- Balance are typically connected to Dry Fly Ash Vacuum System

Water Balance/Wastewater Considerations

Economizer Ash Considerations: Sluice vs. Dry Systems

Key Considerations:

- Not clearly defined in proposed ELG
  - Economizer Ash = Fly Ash (when collected with Fly Ash System)
  - Economizer Ash = Bottom Ash (when collected with Bottom Ash System)
- 100% Dry Solutions can likely be tied into existing Fly Ash Systems
- Dry collection eliminates potential concern for fines concentrations in closed-loop dewatering systems

Technical Design Considerations

Define Criteria As Early As Possible

Evaluate Criteria Against Multiple Alternatives

Determine Optimal Solution for each Plant

“One Size Does Not Fit All”

Determine Fleetwide Synergies

Begin Schedule Planning ASAP

Questions

Questions ?

Wet-to-Dry Conversions