REINHOLD ENVIRONMENTAL Ltd.

2014 Wastewater-Ash Round Table & Expo Presentation

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

Paste Technology Options for Ash Disposal

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Agenda

- Summary of the changes in fly ash operations
- Introduction of paste technology for dewatering of ash
- Project experiences
- Facility life cycle
- Solution options
- Path forward

Impetus for Change

- Changing EPA legislation
  - Movement towards dry disposal
- Risk of Failure
  - Tennessee Valley Authority
- Environmental impacts
  - Seepage
  - Dust
  - Run off
  - Water management
    - selenium
- Long term closure and reclamation
  - Strength
  - Capping

Paste Technology

- Proven method for dewatering fine waste products like tailings, mine wastes, coal combustion residues
  - Mining
  - Oil and gas
  - Power
- Site specific system design
  - Based on unique properties and circumstances of each site and waste material
  - No one size fits all – no silver bullet
  - Many options in the dewatering continuum to consider
  - Integrated solutions
    - Process and deposition

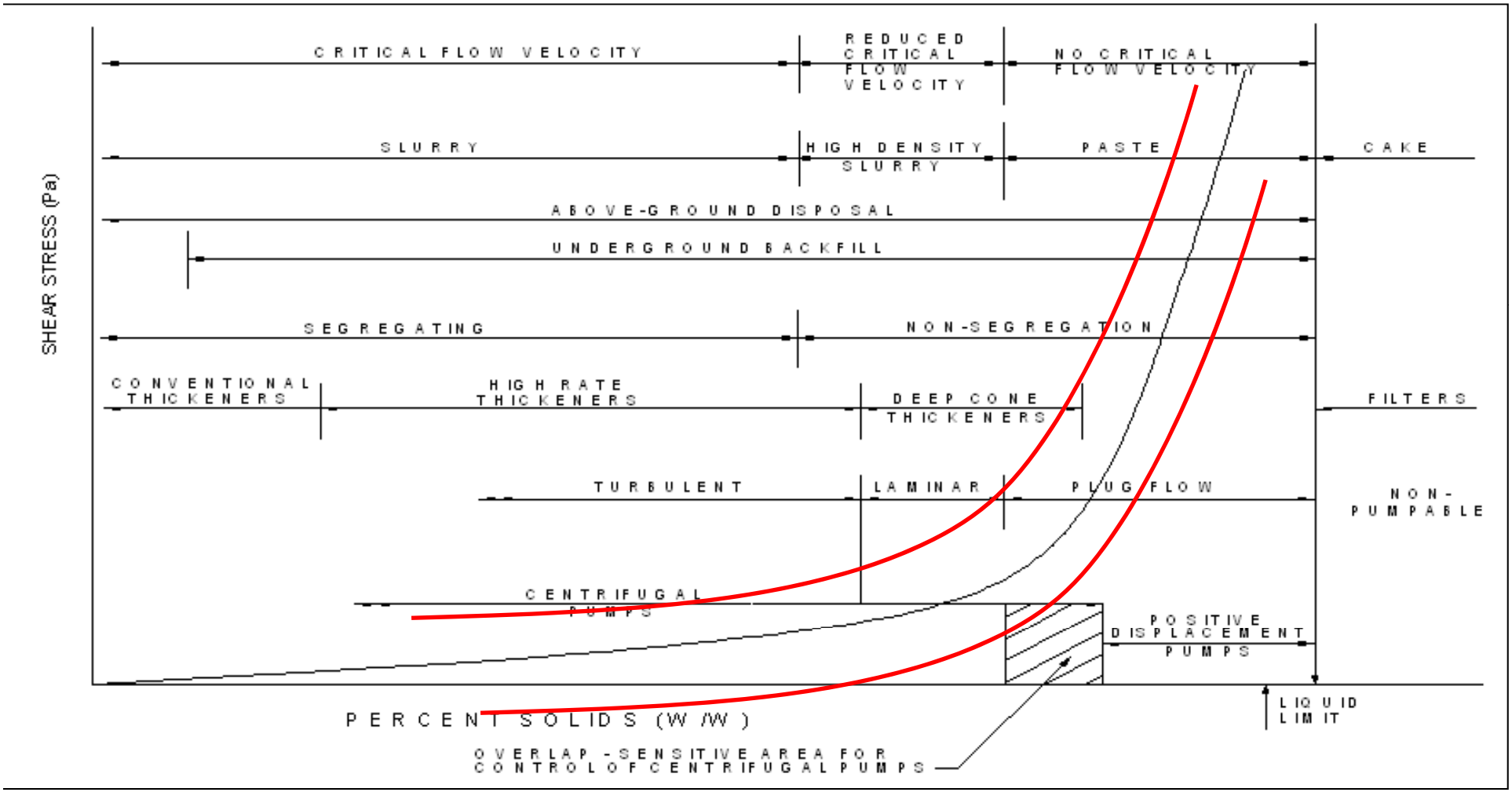
What is “Paste or Thickened Ash/Tailings”?

- Is simply dewatered material (generally tailings or other mineral wastes i.e. ash) that is an engineered mixture of solids and water
- Possesses a yield stress
- Produces a measurable slump and has a maximum slump of ~10 inches
- Has a homogenous appearance i.e. no segregating of coarse to fine particles

What is “Paste or Thickened Ash/Tailings”?

- Is normally free standing when deposited
- Has low or no critical flow velocity
- Uses pumps or gravity to move through a pipeline
- Exhibits plug flow characteristics
- Exhibits little to no water bleed and is generally non-segregating at any stage of transport or placement

Dewatering Continuum Pre Deposition



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How do we move along the continuum?

- Processing Slurry → Thickened Ash → Paste → Filter Cake
  - Mechanically
    - Thickeners, clarifiers, filters, cyclones, centrifuges
  - Chemically
    - Flocculants, admixtures, retarders etc either pre-pipeline or in-line
  - Other options
    - Electro-kinetics

- Transporting Slurry → Thickened Ash → Paste → Filter Cake
  - Pumps and pipelines (centrifugal vs positive displacement)
  - Conveyors
  - Trucks

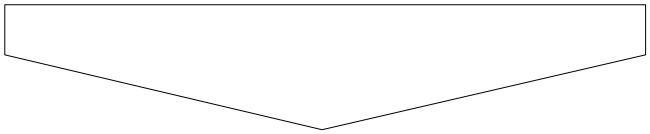
Full Scale Thickener Options

- Thickener Types:
  - High Rate Thickener (9.5 deg cone angle)
  - High Compression Thickener (14 deg cone angle)
  - Deep Tank Thickener (29 deg cone angle)
- Factors to consider:
  - Diameter
  - Wall height
  - Cone angle
  - Rake drive
- Commercial Applications:
  - High Rate Thickener (max operating diameter: 128 m)
  - High Compression Thickener (max operating diameter: 80 m) and
  - Deep Tank Thickener (max operating diameter: 45 m; max design size: 60 m)

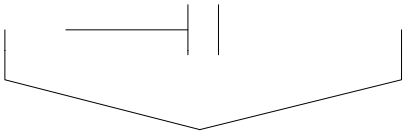
Thickener Technology Development

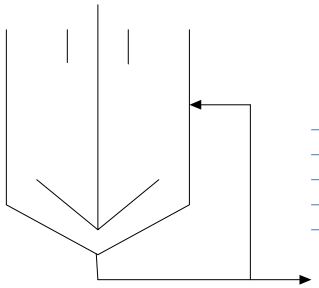
MAJOR Ddensification MILESTONES

CONVENTIONAL – "OLD" THICKENER



FEEDWELL / FLOCCULENT MIXING





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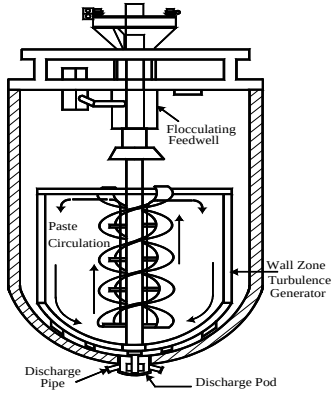
- PACHUCA
- FEEDWELL
- FLOCCULENT
- RECYCLE
- RAKE



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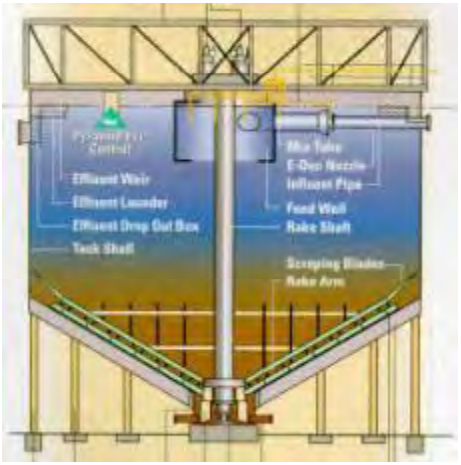

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Full Scale Filtration Options

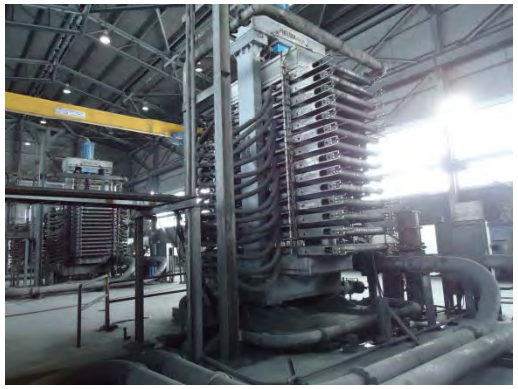
- Filter Types:
  - Belt Filter
  - Vacuum Disc Filter
  - Rotary Drum Filters
  - Pressure Filter
- Factors to consider:
  - Cake loading
  - Thickness
  - Moisture content
  - Blinding
  - Release
- Commercial Applications:
  - Belt Filter – 1 belt up to max width of 6.5 m
  - Vacuum Disc Filter (typical is 3-6 filters with 12 discs each)
  - Rotary Drum Filters
  - Pressure Filter (max operating is 48 filters – 60 chambers)

Filtration

- Vacuum Disc Filters

- Belt Filters

- Pressure Filters



- Rotary Drum Filters

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Paste Advantages

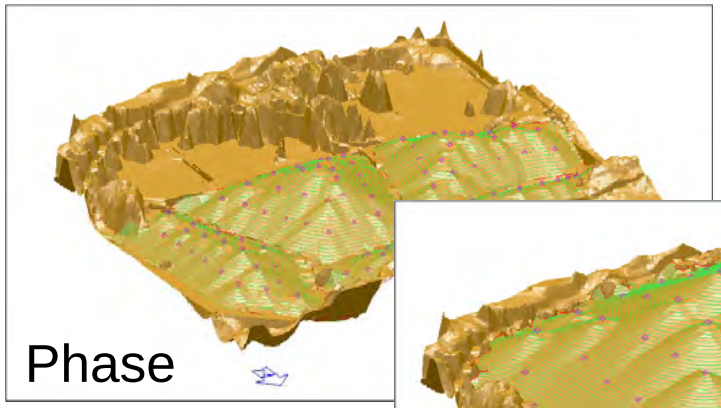
- Increased water reuse/recycling
- Smaller surface footprints (stackable)
- Reduces likelihood of seepage/leachate from waste facilities (10^{-6} or better)
- Extended life of facilities
- Smaller containment dikes (not dams)
- Reduces risk of failure of dikes
- Reduces dusting on surface
- Faster reclamation (progressive)
- Co-disposal opportunities

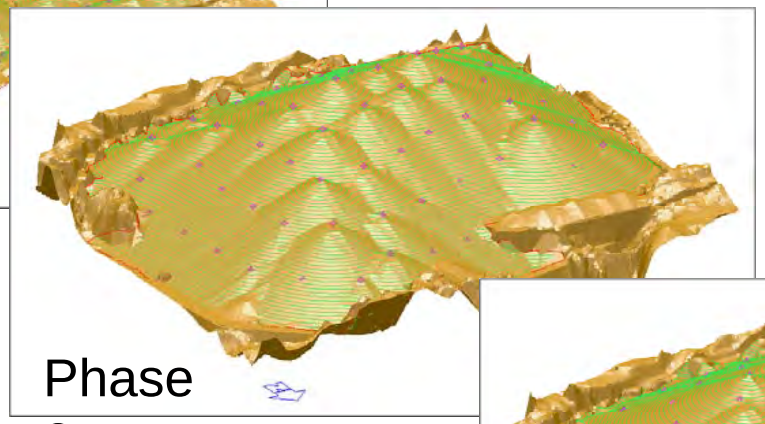
Project Experience

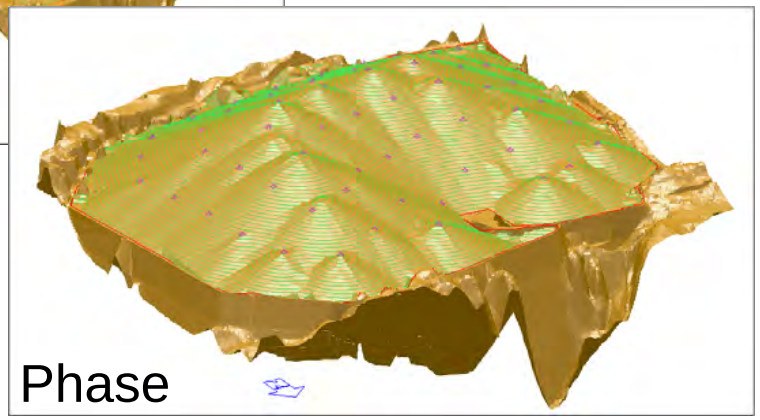
Water Recycling and Stacking – Bulyanhulu

Seepage Reduction – PPL Montana (fly ash)

Life of Mine extension – PPL Montana (fly ash)







Smaller Dikes / Containment - Essakane

Filter Cake – Raglan, Cerro Lindo, Minto

Progressive Closure – Neves Corvo

Progressive paste placement

Life of Mine Extension – Musselwhite

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Life Cycle Considerations

- Problems with fly ash disposal are multi-pronged when looking at a facility life cycle
- Four main areas to consider
  - Legacy ponds awaiting closure
    - No capital
  - Operations getting close to decommissioning and closure
    - Small window for capital expenditure
  - Existing operations looking at “switching” over to dry disposal
    - Long term operating costs
  - Reclamation and closure of dry disposal areas
    - Long term environmental impacts

Options

- To address the life cycle implications of a facility several options exist:
  - Processing Systems
    - Mobile paste systems
    - Dredge and dewater / pump systems
    - Fixed plant paste systems
    - WWT systems coupled with paste systems
  - Deposition systems
    - Consolidating ash into ponds (moving ash from multiple ponds into one)
    - Dewatering ash and depositing into lined landfills
    - Spigotting (perimeter discharge)
    - Single point discharge
    - Central cone discharge
    - Cell construction

Path Forward

- Design (Concept through to Detailed)
  - Testing of material (bench scale, pilot scale)
    - Index testing i.e. material fingerprinting
    - Recipe development (single stream; multi stream combinations)
    - Rheology
    - Settling / Filtration characteristics
    - Flocculent screening
    - Reagent screening i.e. additives, binder, flow modifiers
    - Pipe flow loop
  - Existing plant evaluation for retrofit
  - Trade off study on plant location and deposition scenarios including cost estimates
- Options analysis for integrated solutions
- Construction, Commissioning and Operations

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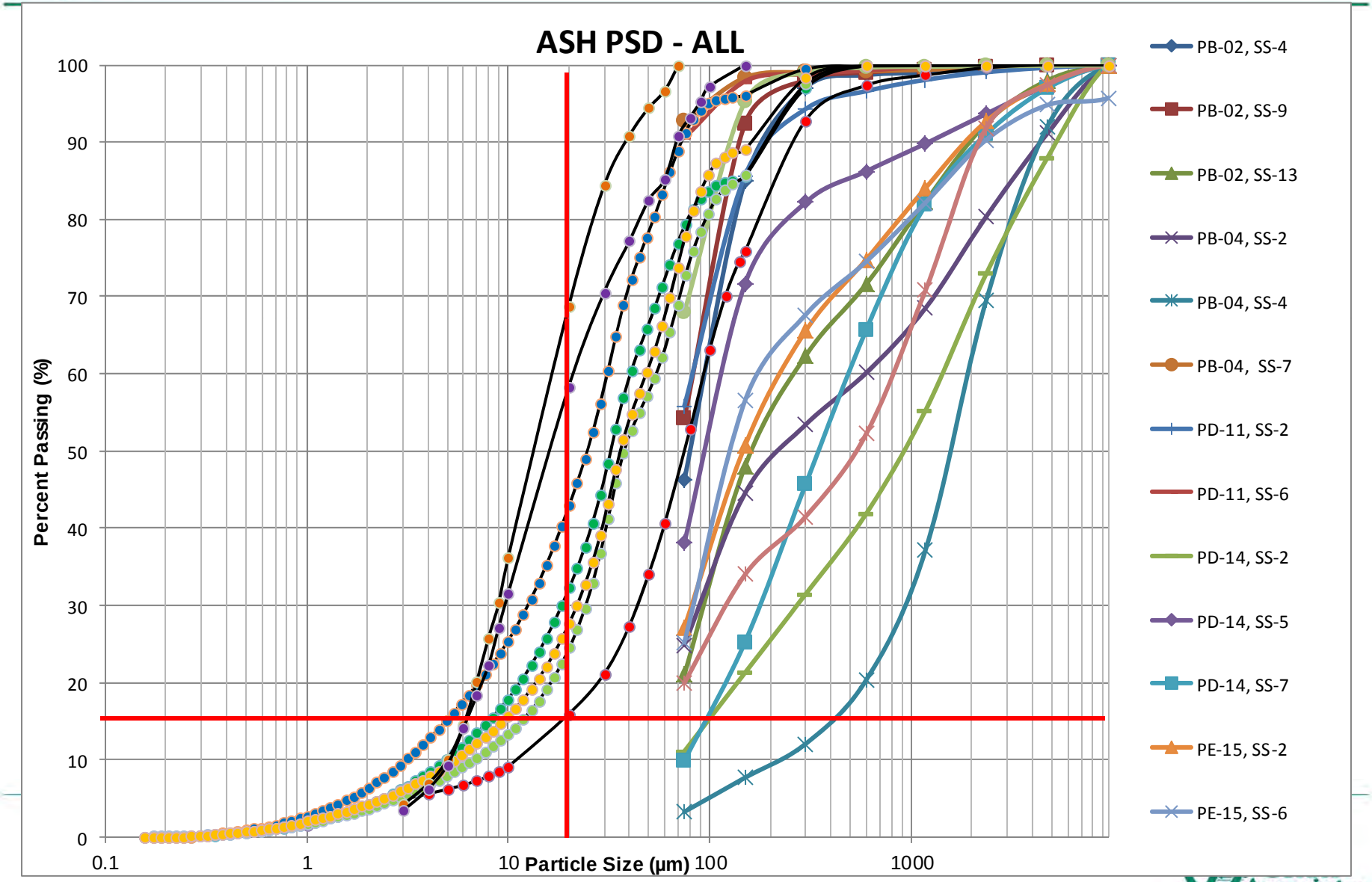
Ash PSD's



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THANK YOU