REINHOLD ENVIRONMENTAL ®

2023 Reinhold/PCUG Round Table Presentation

Cohosted by Duke Energy and Vistra in The Westin Hotel, Cincinnati, OH on June 26-27, 2023

The CCR Leachate Debate: Achieving Clarity with Effluent Limitations Guidelines (ELGs)

2023 Proposed ELGs

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- Senior Environmental Consultant
- 28+ years CWA permitting & compliance experience
- 17 years working with ELGs -
  - Reviewing, commenting, and developing implementation strategies

Agenda

- Proposed Combustion Residual Leachate ELGs
- EPA's Treatment Basis
- How CRL may be different from FGD wastewater
- Collection and Treatment Options
- Oxidation & Polishing Technologies
- Next Steps & Recommendations
- Other Requirements

Sun Safety

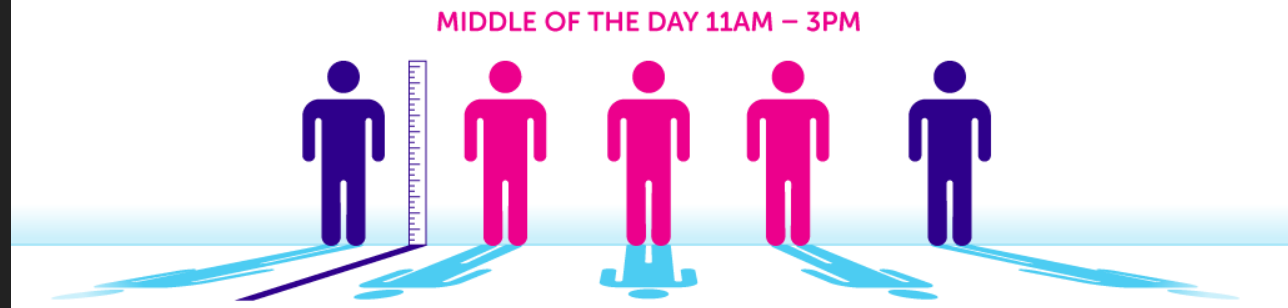
The sun's UV rays are strongest when your shadow is shorter than you

Here are some tips:

- **SHADE:** Stay out of the sun when feasible
- **CLOTHING:** Wear UV protection clothing and cover up
- **HAT:** Broad brim hats that also cover the neck and ears
- **SUNGLASSES:** Wear to reduce risk of cataracts
- **SUNSCREEN:** Broad spectrum for both UVA and UVB rays and has a SPF 15 or higher. Apply 30 minutes before going outside. Reapply every 2 hours, use even on cloudy days.

2x the SPF does **NOT** mean 2x the protection

SPF	UVB PROTECTION PERCENTAGE
15	93%
30	97%
50	98%
100	99%



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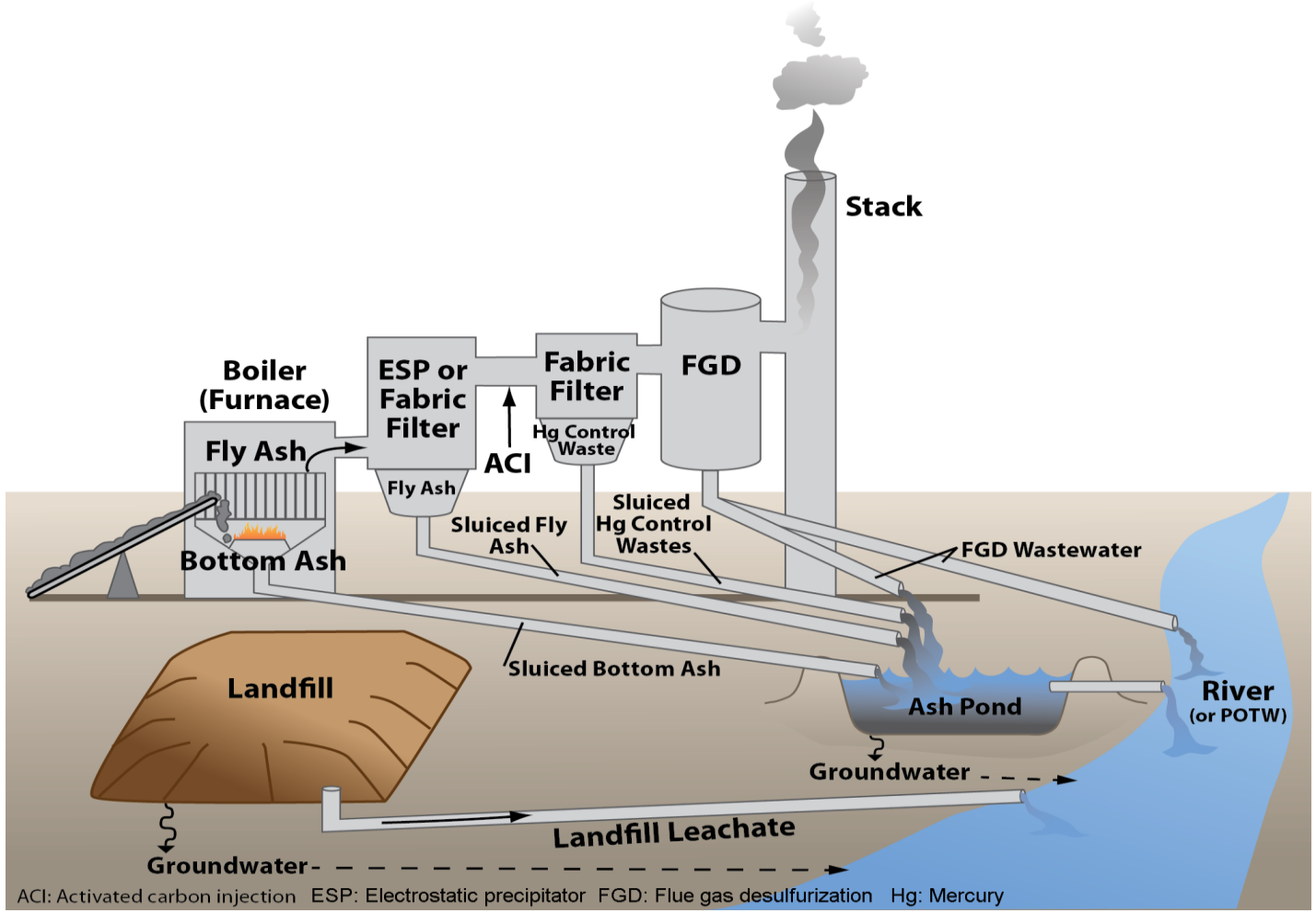
The 2023 Proposed Steam Electric ELGs



The 2023 Proposed Steam Electric ELGs

Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category—40 CFR Part 423 (ELGs)

Proposed updates to ELGs related to:

1. **Flue Gas Desulfurization (FGD) Wastewater**
2. **Bottom Ash Transport Water**
3. **Legacy Wastewaters**
4. **Leachate**

Docket No.: EPA-HQ-OW-2009-0819

Published in Federal Register: March 29, 2023. Comments were due 5/30/23.

The following is a technical overview of the proposed rule and is not intended to be comprehensive or provide legal interpretation, advice, or site-specific regulatory guidance.

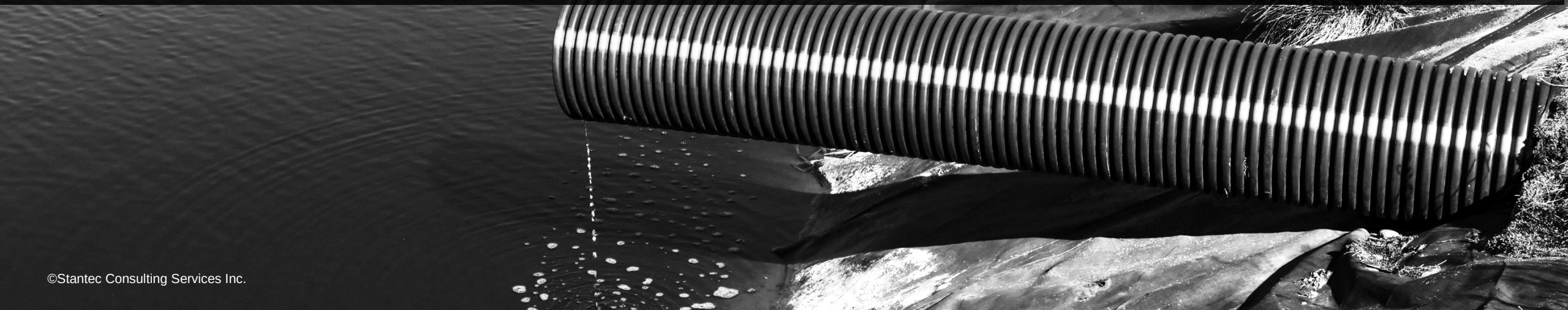
Combustion Residual Leachate (CRL)

Leachate from landfills or surface impoundments containing combustion residuals.

Composed of liquid, including any suspended or dissolved constituents in the liquid, that has percolated through waste or other materials emplaced in a landfill, or that passes through the surface impoundment's containment structure *(e.g., bottom, dikes, berms).*

Includes seepage and/or leakage from a combustion residual landfill or impoundment unit.

Includes CRL from landfills and surface impoundments located on non-adjoining property when under the operational control of the permitted facility.



What Drives WWT Design – REGULATIONS!

Effluent Limitation Guidelines (Proposed 2023 ELGs)

- Arsenic
- Mercury
- TSS & O&G (Currently applicable, same as LVW)

NPDES Permits (National Pollutant Discharge Elimination System)

- Site-specific water quality standards – e.g., additional limitations for copper, selenium to protect water quality

Proposed CRL ELGs

Category	CRL Leachate
Limits	Meet TSS limits (100 daily max/30 monthly average ppm) Arsenic - 8 ug/L (monthly avg) Mercury - 356 ng/L (monthly avg)
Timing	As soon as possible Final Rule Publication + 60 days - 12/31/29
Notes	• *Basis is chemical precipitation.* • *Definition seems to differentiate between leachate & stormwater.* • ***Leachate discharged via groundwater could broaden applicability. Proposed annual monitoring.*** • *Pre-treatment Std appears to be an error - applicable 60 days from date of final rule publication*

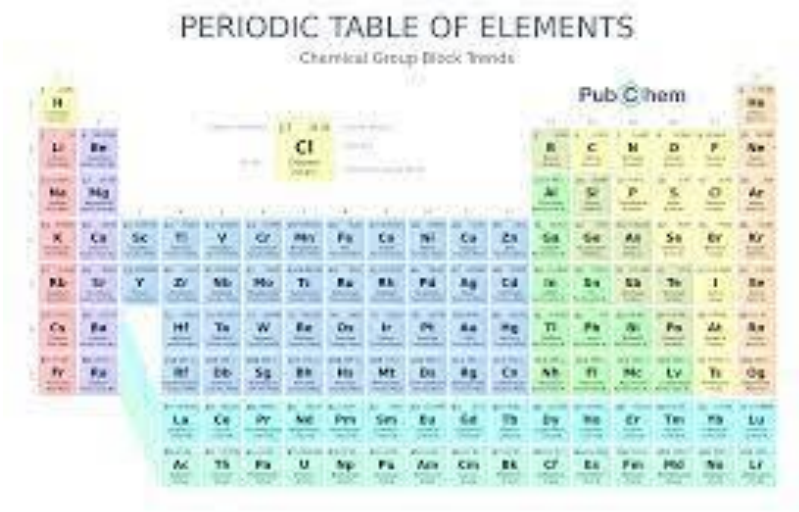
Note:

CCR leachate arsenic concentrations may be greater than found in FGD wastewater.

What Drives WWT Design – REGULATIONS! (cont.)

EPA also seeking comments on regulating the following in CRL…

- Antimony
- Barium
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Copper
- Lead
- Magnesium
- Manganese
- Molybdenum
- Nickel
- Thallium
- Titanium
- Vanadium
- Zinc



How Does CRL Compare to FGD Wastewater?

- When plant ceases operation, shut down the FGD systems
- CRL treatment may continue for years after plant shutdown
  - General 30-year landfill post-closure requirements
  - Treatment needs may vary over time
- Treatment for multiple CRL locations may be required
- Varying landfilled materials and potential variability of soils/etc. with different chemical properties vs FGD

How does CRL Compare to FGD Wastewater? (cont.)

May be decades old/open or closed/centralized or remote/different flow regimes
May have various materials in storage with different properties

- Fly ash
- Bottom ash
- FGD solids

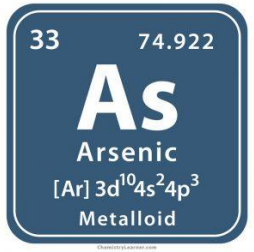
How does CRL Compare to FGD Wastewater? (cont.)

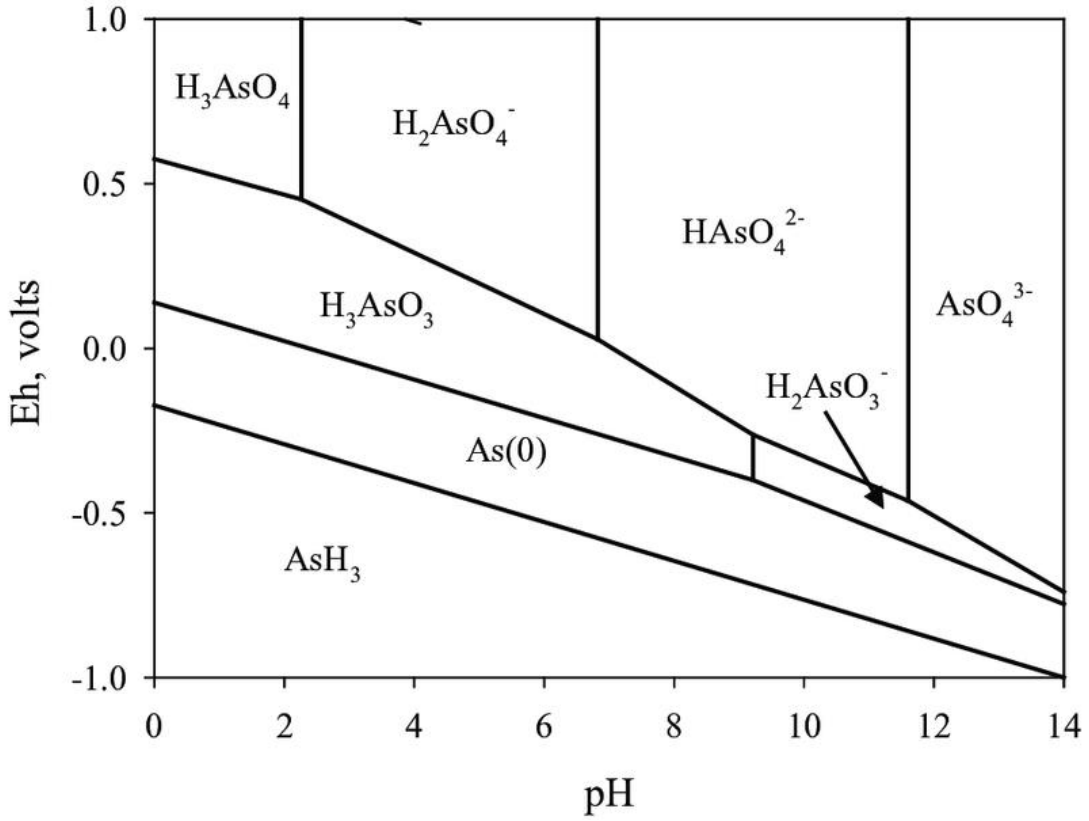
- Mill rejects (pyritic materials), outage wash solids, economizer ash, other waste streams
- May be recovering landfilled CCRs – exposure to air may change leachate chemistry/oxidation state/solubility
- Do not assume landfills are homogenous
- Leachate can change over time

ELGs Are Technology – Based Limits

Technology basis but do not require a prescribed technology.

End of pipe limits: cannot use dilution or receiving body's assimilative capacity to comply.





Pourbaix vs Field Conditions

Theory: 25º C in pure water

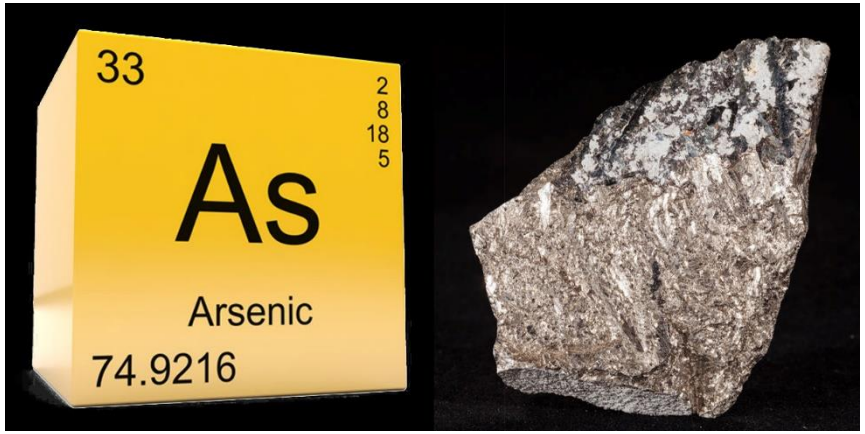
Reality: Witches' Brew

- High TDS
- Other metals
- Acidic conditions
- Other anions/cations

Leachate Sampling

✓ Capture dry weather/dry season flows

✓ Avoid stormwater dilution to extent practicable



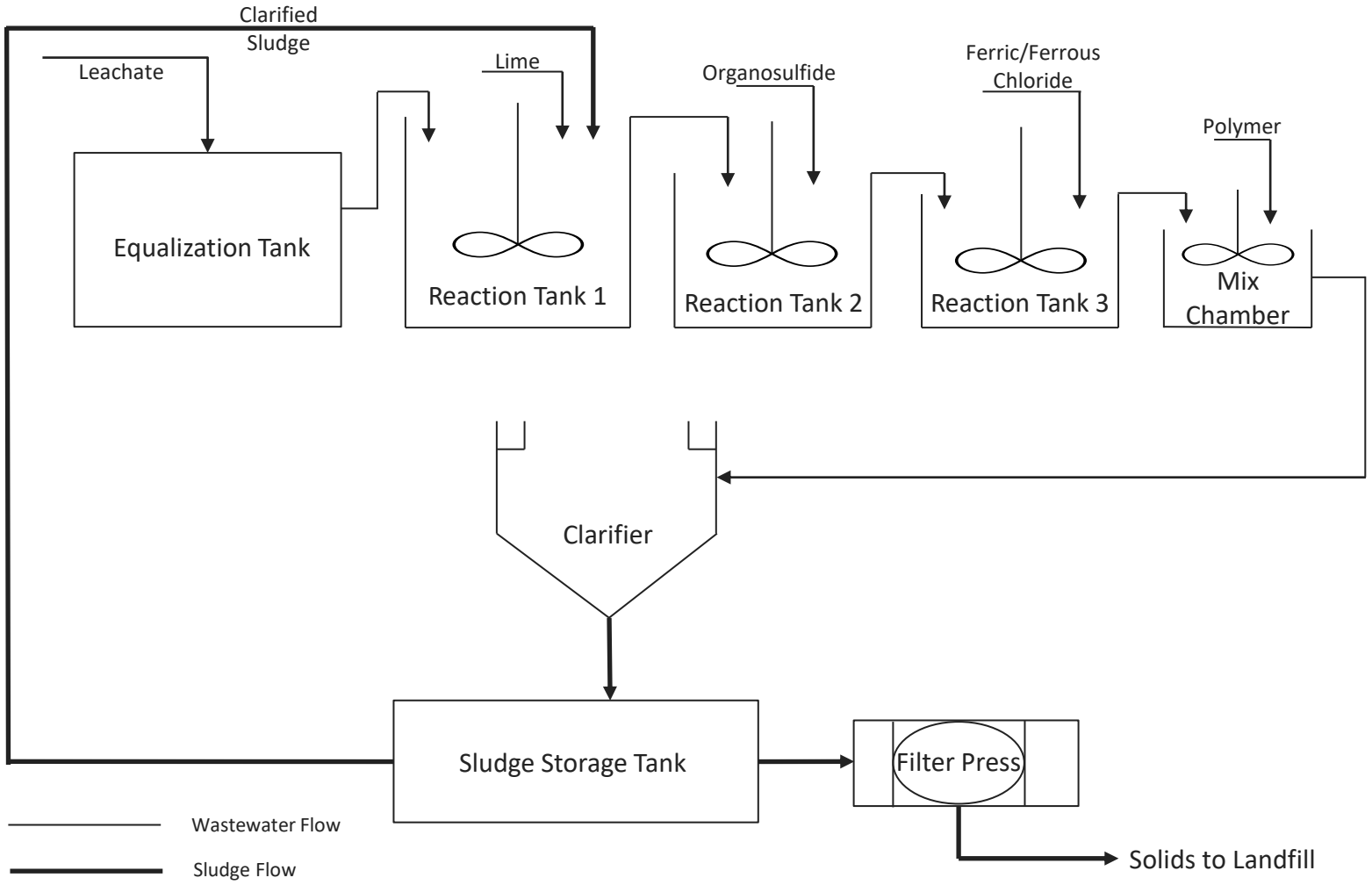
First Steps – Act Now (Arsenic & others)

- **Characterize Leachate**
  - Arsenic, mercury, other metals (in case EPA adds to the list) - total & dissolved
  - Speciate dissolved arsenic
    - Arsenite, As(III)
    - Arsenate, As(V)
  - Other treatability constituents (alkalinity, pH, scaling & fouling factors)

First Steps – Act Now (Hg)

- **Characterize Leachate**
  - Low level mercury
  - Use sufficiently sensitive methods
    - Some methods not sensitive enough for in-stream water quality criteria
    - 200 **ng/L** detection vs 51 **ng/L WQS**
    - Use 1631E or 245.1

Treatment Basis



Design Basis to Meet CRL ELGs

Equalization

- Potential chemical variability buffered
- Storm surge flow managed

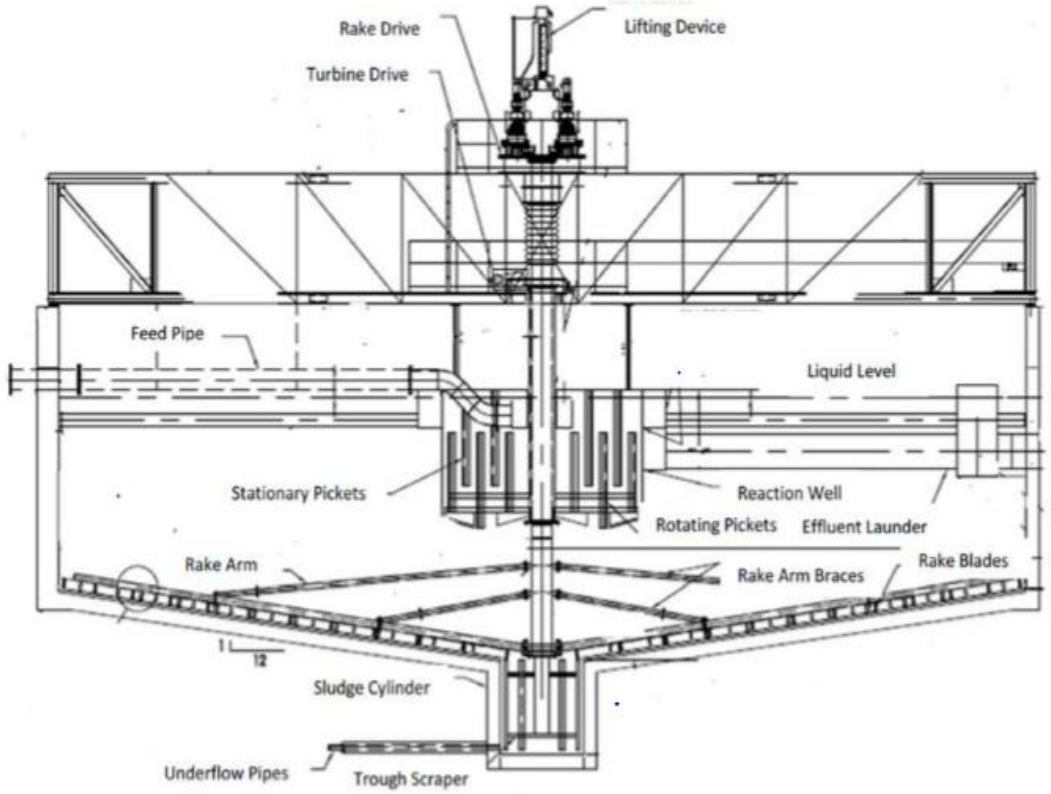
Chemical Addition

- Lime (**Necessary for leachate?**)
- Organosulfide
- Ferric chloride (**Sulfate?**)

Clarification

- Polymer addition
- Flocculate & coagulate to get bigger, settleable particles

Diameter of particle	Type of particle	Settling time through 1 m of water
10 mm	Gravel	1 seconds
1 mm	Sand	10 seconds
0.1 mm	Fine sand	2 minutes
10 micron	Protozoa, Algae, Clay	2 hours
1 micron	Bacteria, Algae	8 days
0.1 micron	Viruses, Colloids	2 years
10 nm	Viruses, Colloids	20 years
1 nm	Viruses, Colloids	200 years



Stokes' Law

Filtration as Part of Chemical Precipitation?

- Not explicitly cited by EPA
- Additional particulate removal
- Sizing flexibility

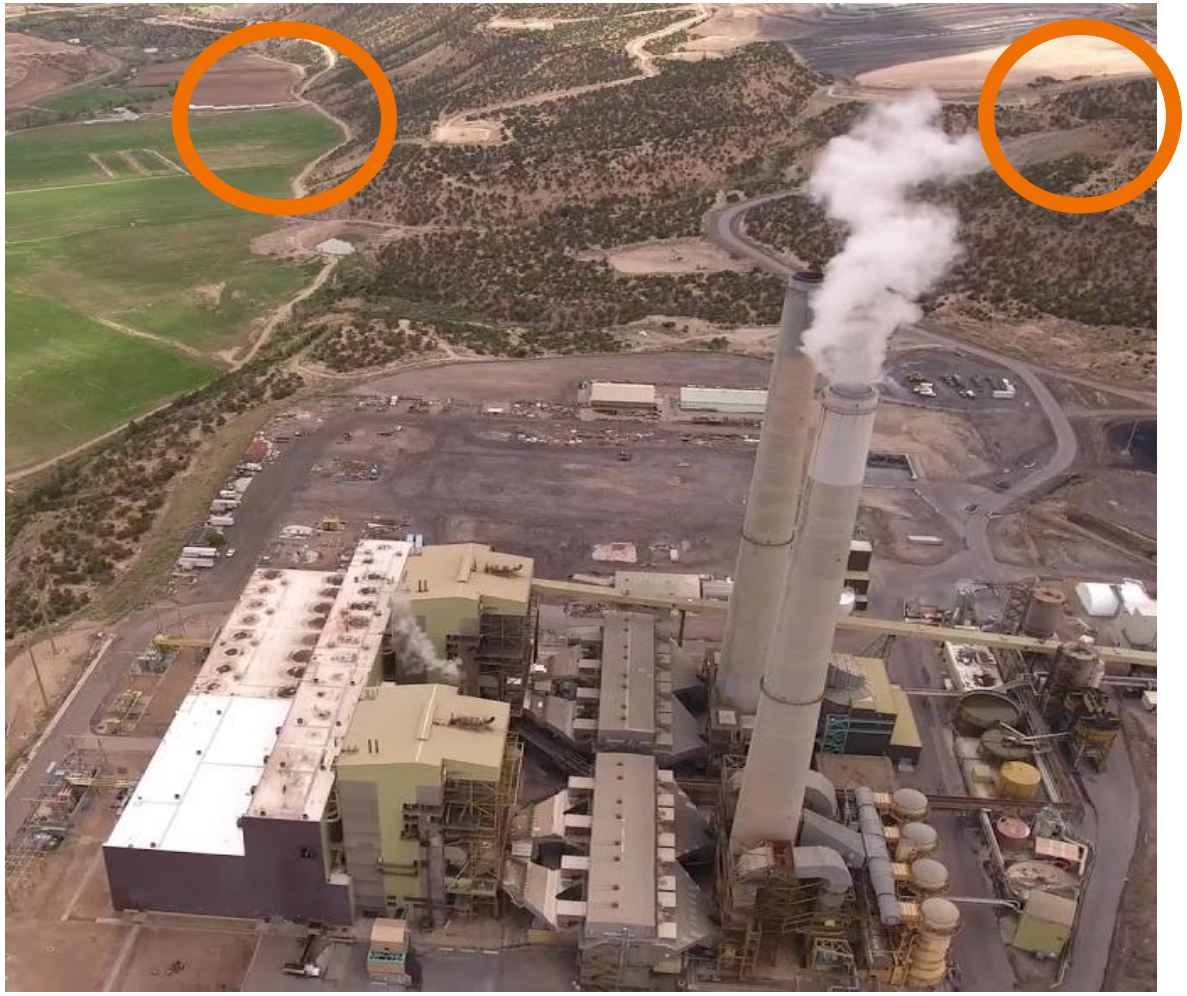
Solids Dewatering for Disposal

- Filter press
- Screw press
- Other means of solids dewatering?

Design Considerations

Leachate Treatment Collection System Questions

- How leachate collected and conveyed to treatment?
- Multiple CCR disposal units - combine CCR leachate or keep separate?
- Combine with existing WWT treatment?
- Consider direct discharge or pipe to other location
  - Direct discharge requires pH 6.0 – 9.0
  - Meet limits prior to mixing
- Decisions on pre-treatment and polishing
- Disposal of wastes generated by treatment
- Costs/complexity of treatment depend on influents/flow/treatment targets



Locations combined?

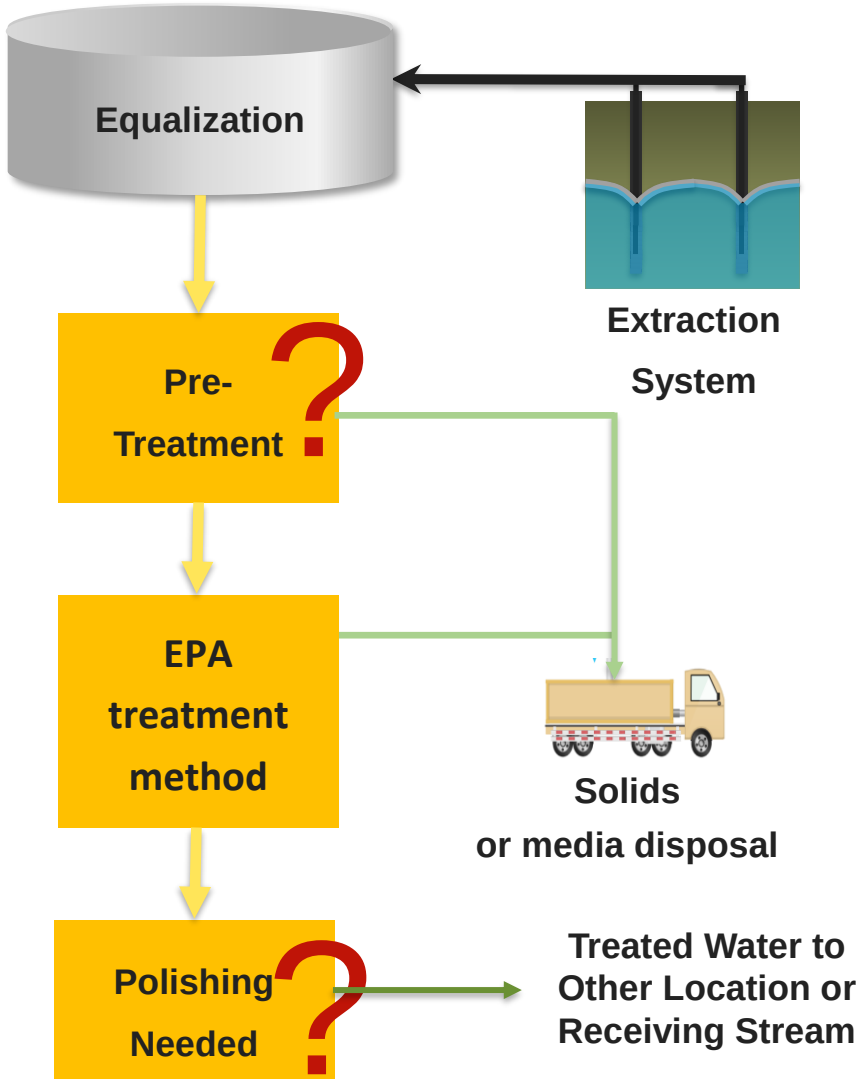
Multiple CRL locations possible on site

Combine with Existing FGD Treatment?

- Dilution flows for FGD-regulated parameters (e.g., Se & nitrate-nitrite)?
- Proposed 2023 ELGs for FGD are no discharge by 12/31/2029 – more stringent than leachate
- Post-retirement: Sizing & turndown issues?

Combine with Bottom Ash Transport Water System?

- Bottom ash blowdown volumes currently restricted
- Add to chemistry issues that could increase need to blow down
- Proposed ELGs for BATW are no discharge by **12/31/2029**
- Post-retirement: Sizing & turndown issues?



More Questions…

Is EPA's design robust enough?
Are other steps needed?

Comparison – Limited FGD & Leachate Data

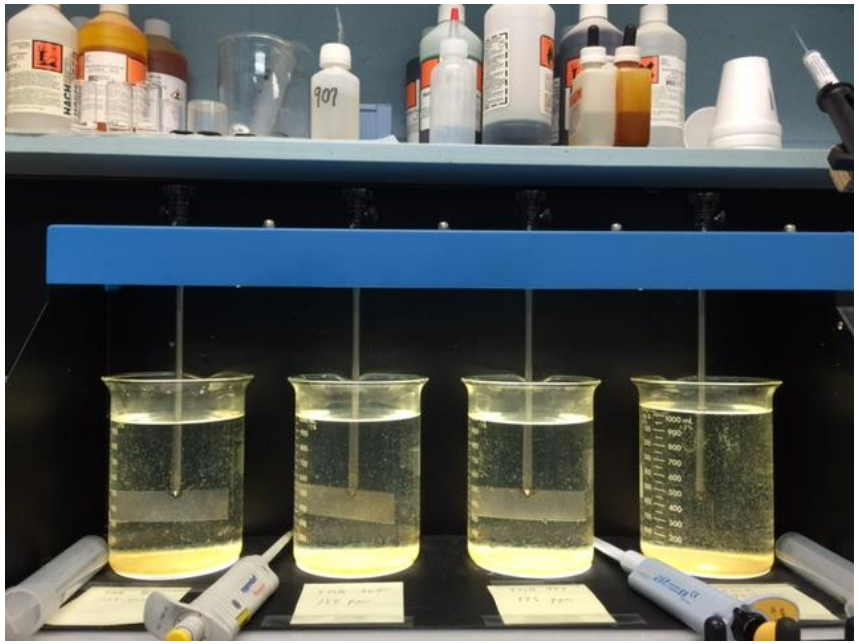
Parameter	FGD Influent	Leachate Influent
As, Total (ug/L)	342 – 1040	ND – 4490
As, Dissolved (%)	1.37%	0 – 100%
As(III), % of As(III) + As(V)	N/A	1.4 – 90%

- Limited Hg data shows <200 ng/L for leachate.
- Not sufficiently sensitive for water quality assessment

- Influents may differ widely in As concentration
- Forms different in some cases (As particulate vs dissolved)
- Speciation (arsenite As(III) vs arsenate As(V)) makes a difference in treatment – oxidize to As(V)

Next Steps - Jar Test Leachate

- **Test EPA's chemical precipitation steps**
  - Same need for sufficiently sensitive methods
  - Understand that jar tests and actual treatment efficacy can vary
  - Temperature matters



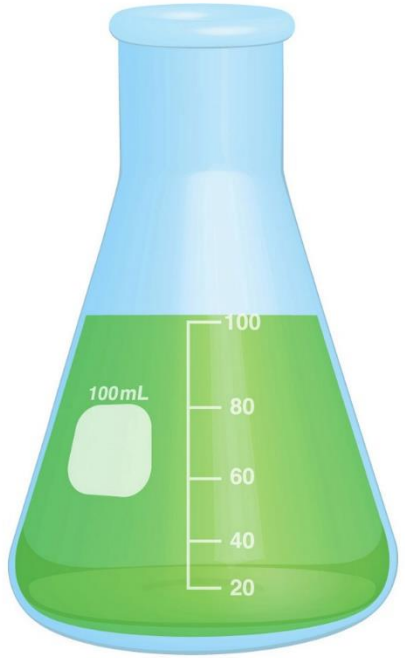
Next Steps - Jar Testing (cont.)

- **Bench (Jar) Testing with Leachate Samples**
  - EPA recommends hydroxide precipitation
  - Evaluate organosulfide dosing
  - Evaluate iron dosing – ferric chloride (ferric sulfate)
  - Evaluate polymer

- **Determine if Additional Treatment Needed**
  - Oxidation to arsenate? Impact to mercury compliance?
  - Polishing needed?

Next Steps – Is Oxidation Needed?

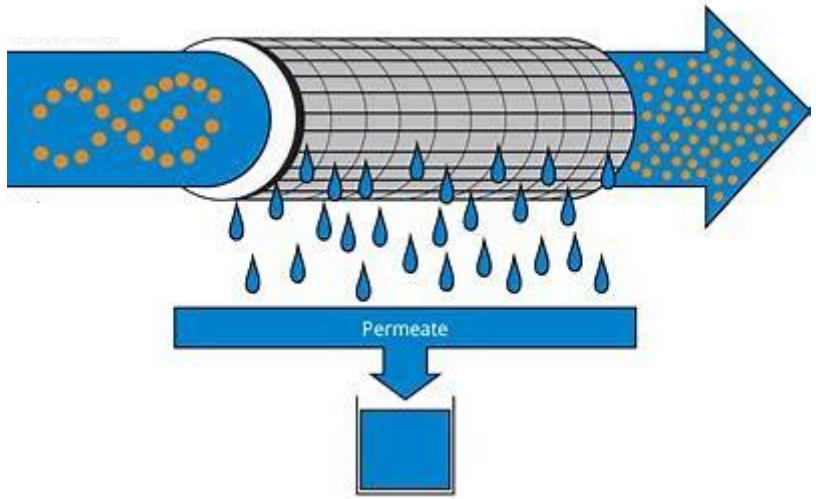
- **Oxidation of As(III) (arsenite) to As(V) (arsenate)**
- **Facilitates Chemical Precip w/iron**
  - Bleach
  - Permanganate
  - Hydrogen peroxide
  - Ozone



Next Steps: Is Polishing Needed?

Membrane Filtration

- **Filtration size determination**
- **Automatic Operation**
  - Maintenance & clean in place



Ion Exchange Practical?

Redundancy for Compliance & Reliability

Define redundancy requirements:

- N+1
- Spare parts not available in 24 hrs
- Repair time > than EQ tank capacity

Confusion by Station Operations:

- 100% duplication has pros & cons
- Duplication means different things to different people
- Membrane filtration – offline for CIP considered in redundancy

Flexibility for Landfill Post-Closure Operations

Flux (Mass Loading) can change over time once capped

- **ELGs**
  - May require operational flexibility – ability to turn down, start/stop, etc.

- **WQBELs – Mass vs concentration limitations**
  - Mass loading can diminish over time as flow through capped landfill is reduced, even if concentration does not decrease

Safety Considerations

- **Employee Safety & Chemicals**
  - Eyewash
  - Showers
  - Spill Containment
- **Remote Locations**
- **Coal Plant Closures**
- **Vandalism**

Summary of Next Steps

Characterization of CCR leachate	• Sample, sample, sample
Jar Testing	• Test, test, test
Determine if additional unit operations needed	• Oxidation step? Polishing Step?
Standalone? Combine?	• Existing treatment? Combined waste formula?

Additional Compliance Issues

Special Case…Chimney Drains

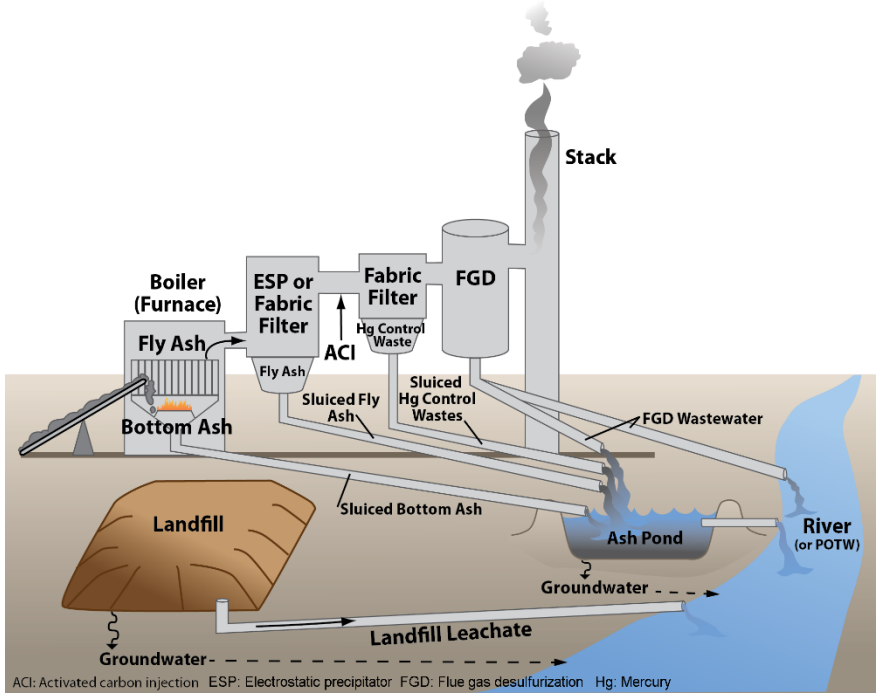
- 2023 ELG Rule - Federal Register page 18850 discussion on chimney drains
- EPA asks if should this be subcategorized as this flow would be more dilute
  - Storm flows do not percolate through CCRs
  - How to minimize costs to treat?

2023 Proposed ELGs require companies to develop ELG compliance websites*

*These can be combined with CCR websites

Key Consideration: The final Steam Electric ELGs may NOT be the same as proposed in 2023!!!

- Keep abreast of EPA's schedule
- Read the final rule
- Expect legal challenges



Thank You!

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