Implications of Clean Air Act Regulations on the Management of Coal Ash and FGD Gypsum

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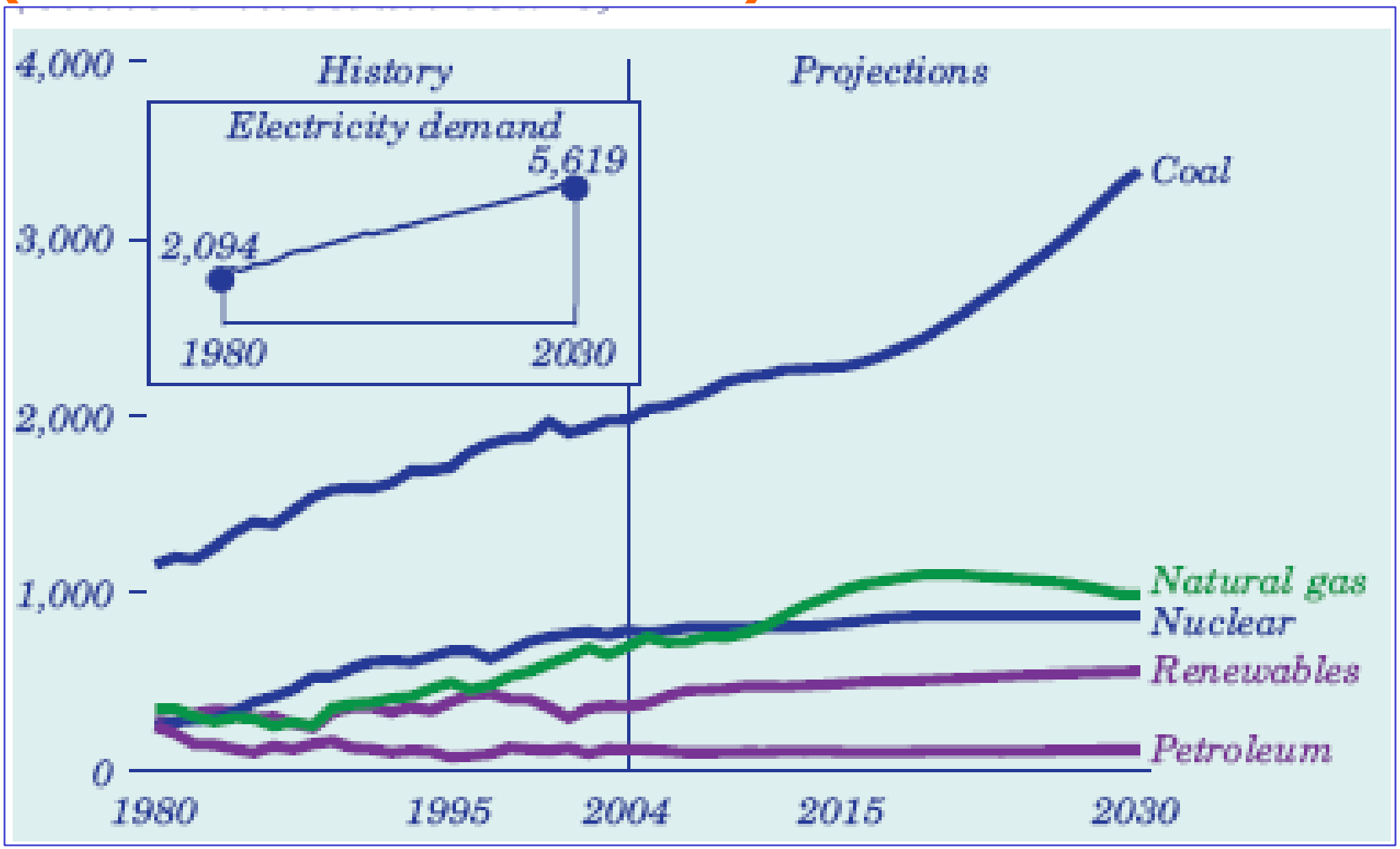
Background

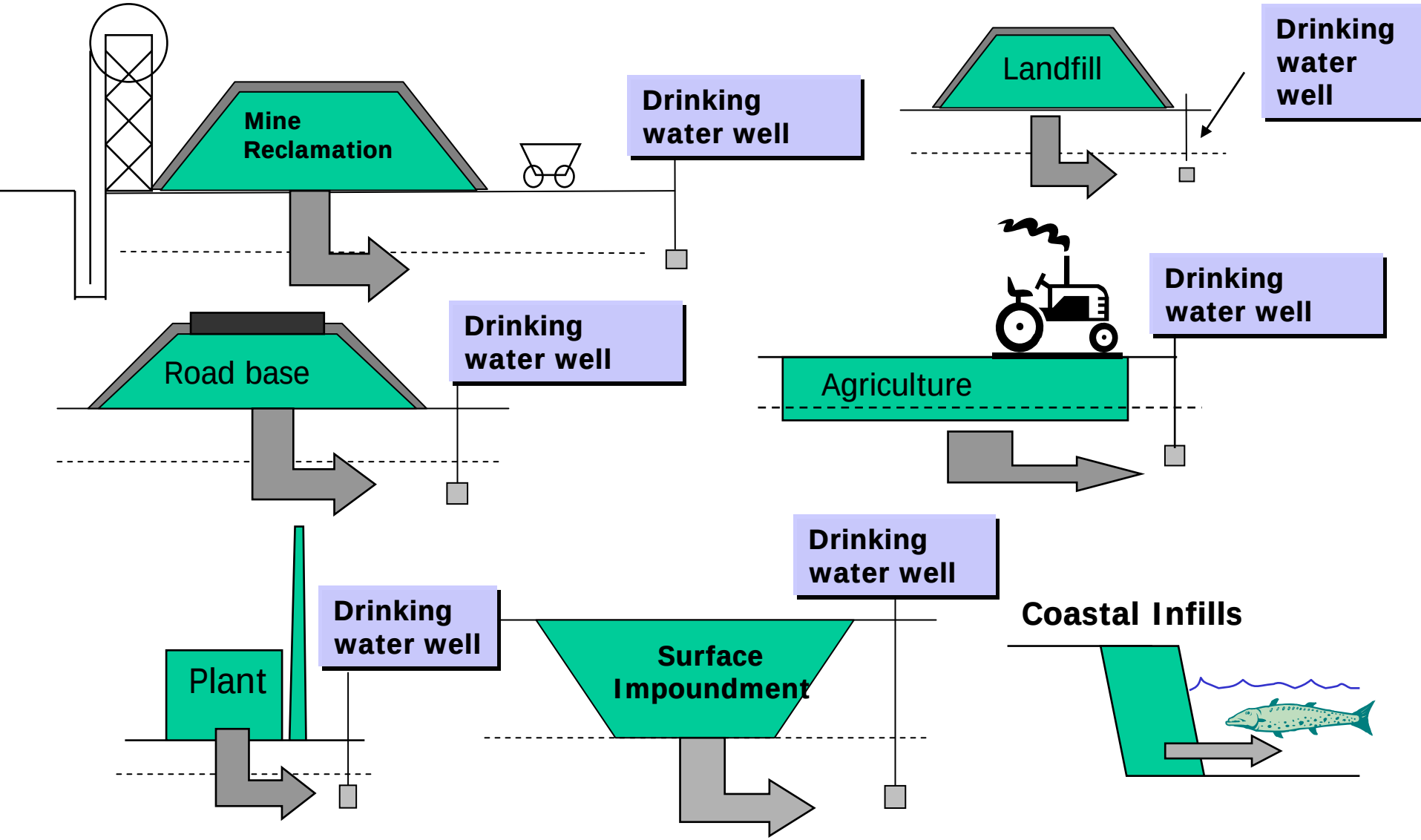
- In March 2005, EPA announced a multipollutant approach to reduce power plant air emissions through the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR) through a cap and trade approach.
- Air pollution control (APC) results in transferring metals from the flue gas to fly ash and other APC residues. The fate of these metals is tied to how these residues are managed.
  - Anticipate that wet scrubber usage and production of FGD gypsum will double or triple in response to CAIR.
  - Primary focus on mercury but also interest in arsenic, selenium, and other constituents of concern.
- Key release route for land-managed coal combustion residues (CCRs) is leaching to groundwater. Also concern for release to surface waters, re-emission of mercury (e.g., cement kilns), and potential for bioaccumulation.

Historical and Projected Electricity Production by Fuel for 1980 – 2030 (Billion kilowatt hours)



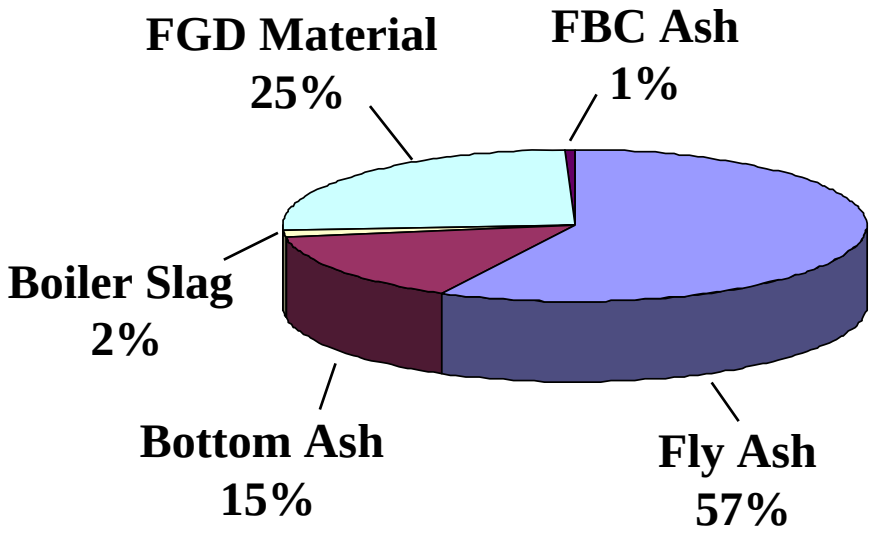
Source: DOE/EIA, 2006

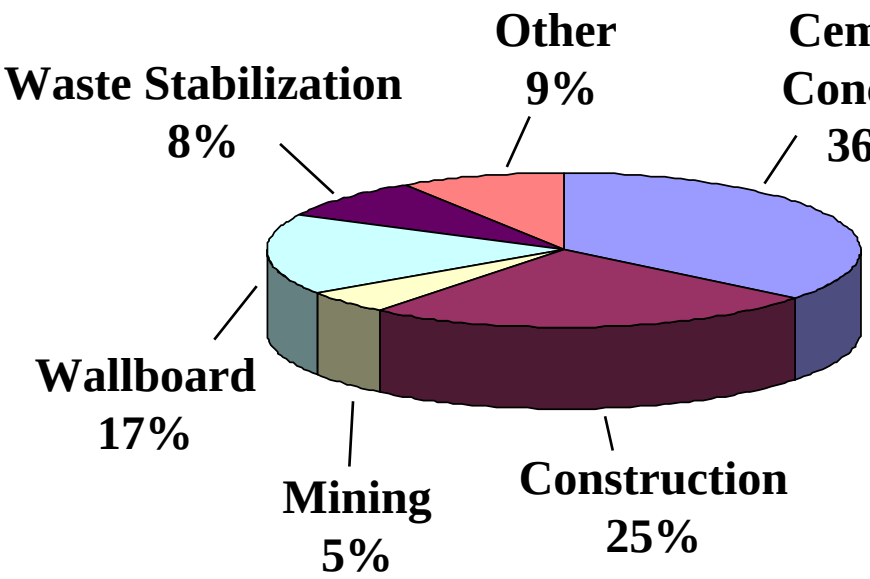
Wide Range of CCR Management Practices & Potential Release Scenarios



CCR Production and Utilization

Production
122 million tons





40% Utilization
49 million tons

Source: ACAA 2004 CCR Survey; DOE, 2005

RESEARCH & DEVELOPMENT

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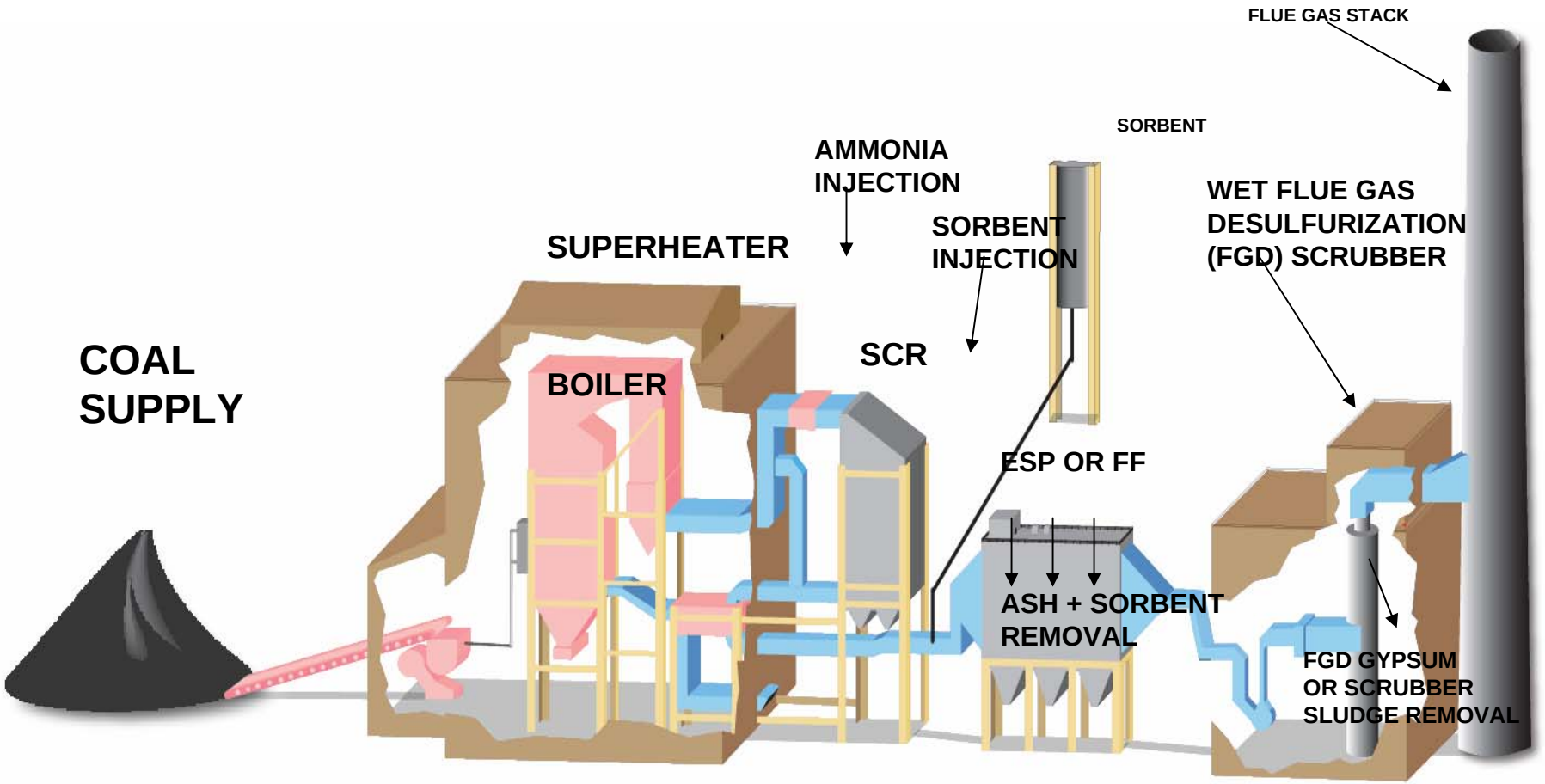
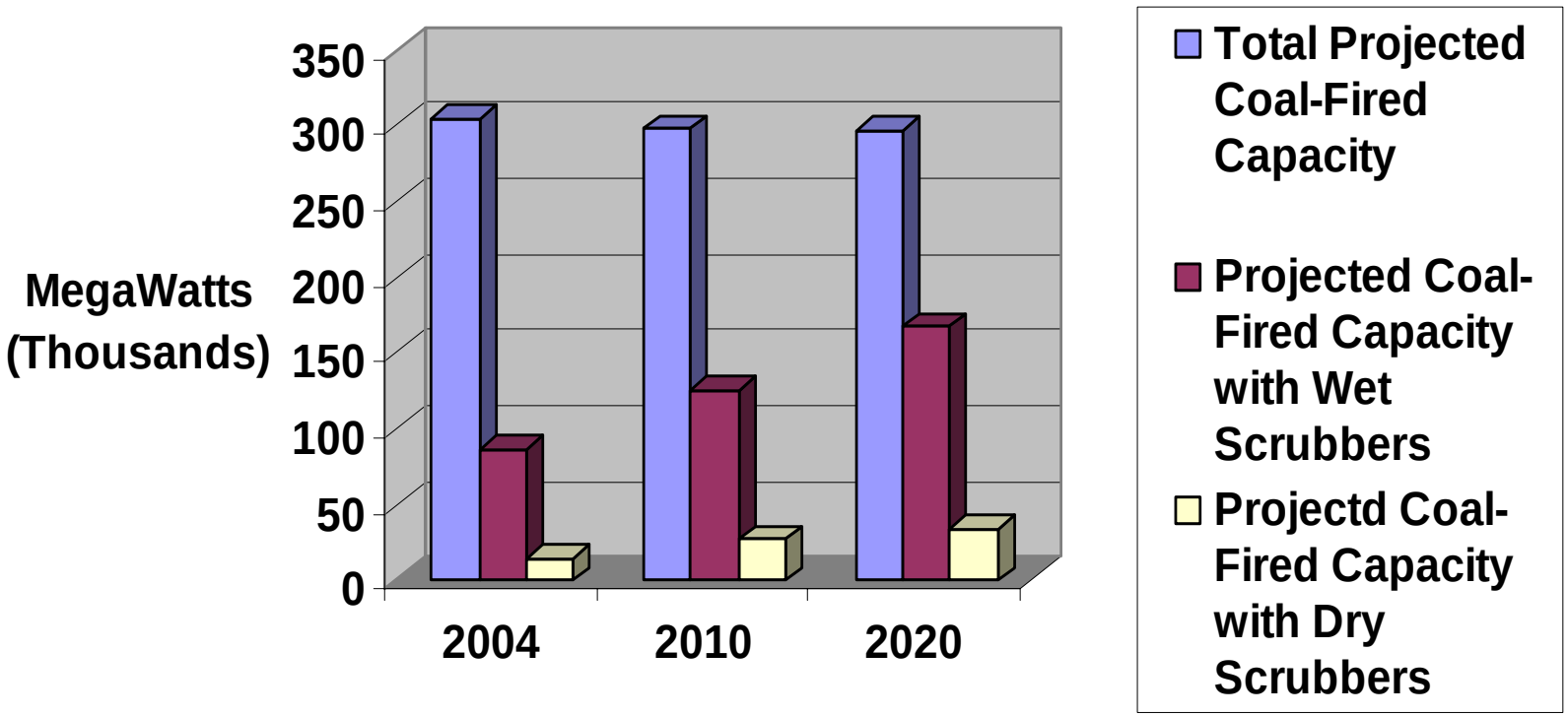
EPA Research Objectives

- Evaluate impact of air pollution control on coal combustion residues (CCRs)
- Identify potential cross-media transfers of mercury and other metals from CCR management which includes FGD gypsum and fly ash
- Compare life-cycle environmental tradeoffs from use of CCR and non-CCR materials

Impact of Air Pollution Control on CCR Characteristics and Utilization



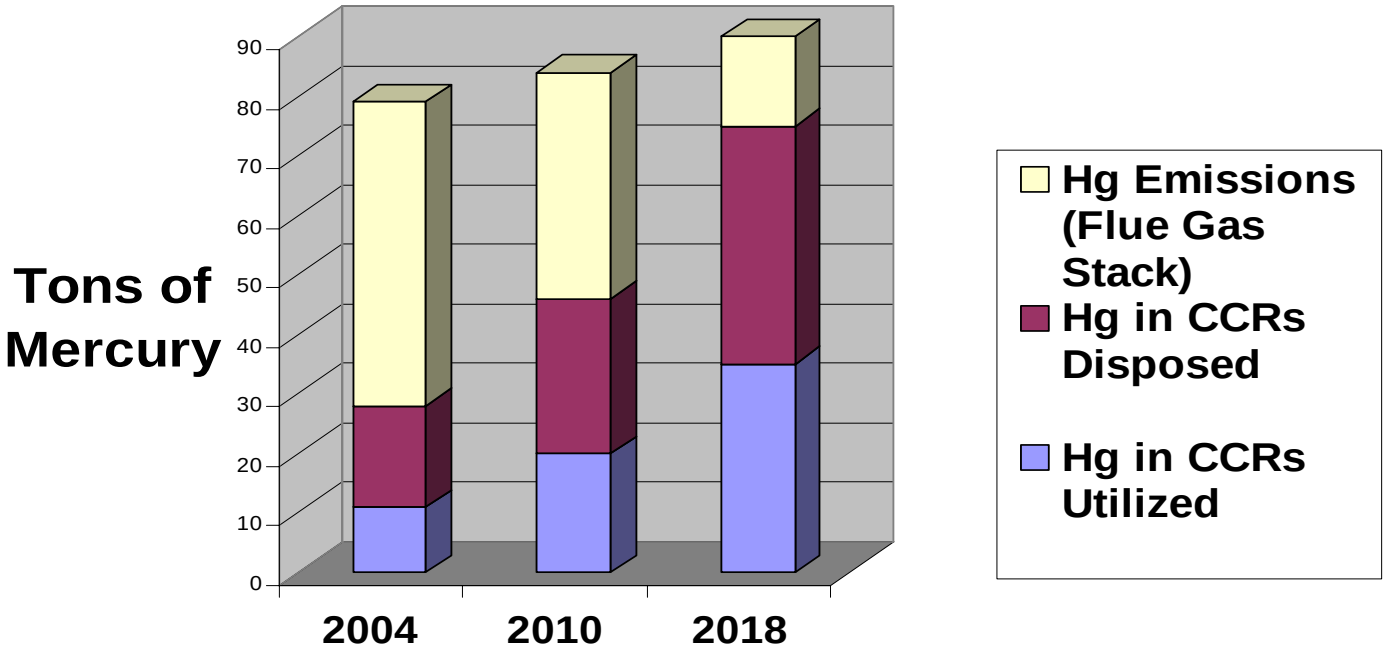
Projection of Scrubber Use at Existing Units



Increasing quantities of Wet Scrubber Residues

- In 2004, 31 million tons of wet scrubber residues were produced.
  - 12 million tons (or 40%) used to make gypsum.
  - 90% of the 12 million tons used to make wall board.
  - Expect increased interest in other uses of FGD gypsum such as use as soil amendment (collaboration with China).

Projection of Hg Mass Balance in Response to CAIR and CAMR Implementation



Source: Thorneloe, 2006

Leach Testing Protocol

- ORD adopted OSW's recommended approach to evaluating the leaching potential of CCRs that result from CAIR & CAMR implementation
- OSW recommended the use of a leach testing framework developed by Kosson et.al, from Vanderbilt University.
  - The detailed protocol is published at: Kosson, D.S., van der Sloot, H.A., Sanchez, F. and Garrabrants, A.C., 2002. ***An Integrated Framework for Evaluating Leaching in Waste management and Utilization of Secondary Materials***. *Environmental Engineering Science* 19(3):159-204.
  - An additional publication on using the data in probabalistic modeling is: Sanchez, F., Kosson, D.S., 2005. ***Probabilistic approach for estimating the release of contaminants under field management scenarios*.** Waste Management, 25(5), 643-472.

Leach Testing Protocol

- Considers range of values for key parameters that affect leaching and vary with disposal and reuse:
  - pH: The solubility of constituents of concern vary with pH.
  - Liquid to Solid ratio (L/S):
    - Reflects rainfall infiltration
    - Lower L/S ratio can result in different pH and contaminant concentration
  - Waste form –
    - Fine particles (equilibrium test)
    - Stabilized and solid materials (mass transfer effects)
- *A Single set of test results can be used to evaluate leaching potential for a range of management scenarios.*

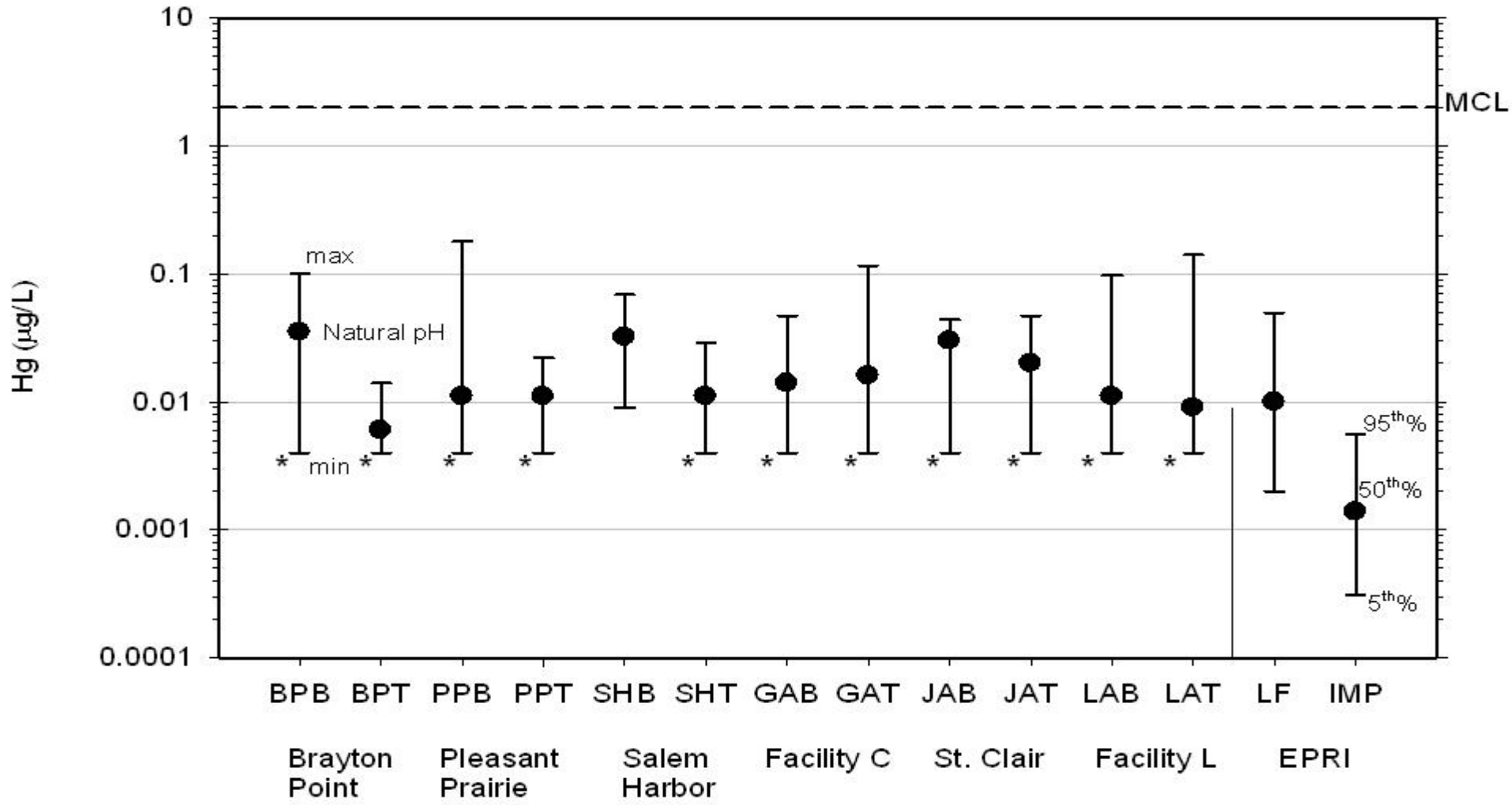
Results for Leach Testing Analysis for Coal Fly Ash From Facilities Using Sorbents for Enhanced Hg Capture

Metal -	Hg	As	Se
Total in Material (mg/kg)	0.1 -1	20 - 500	3 - 200
Leach results (ug/L)	Most 0.1 or lower	<1 - 1000	5 – 10,000
MCL (ug/L)	2	10	50
TC (ug/L)	200	5,000	1,000
Variability relative to pH	Low	Moderate to High	Moderate

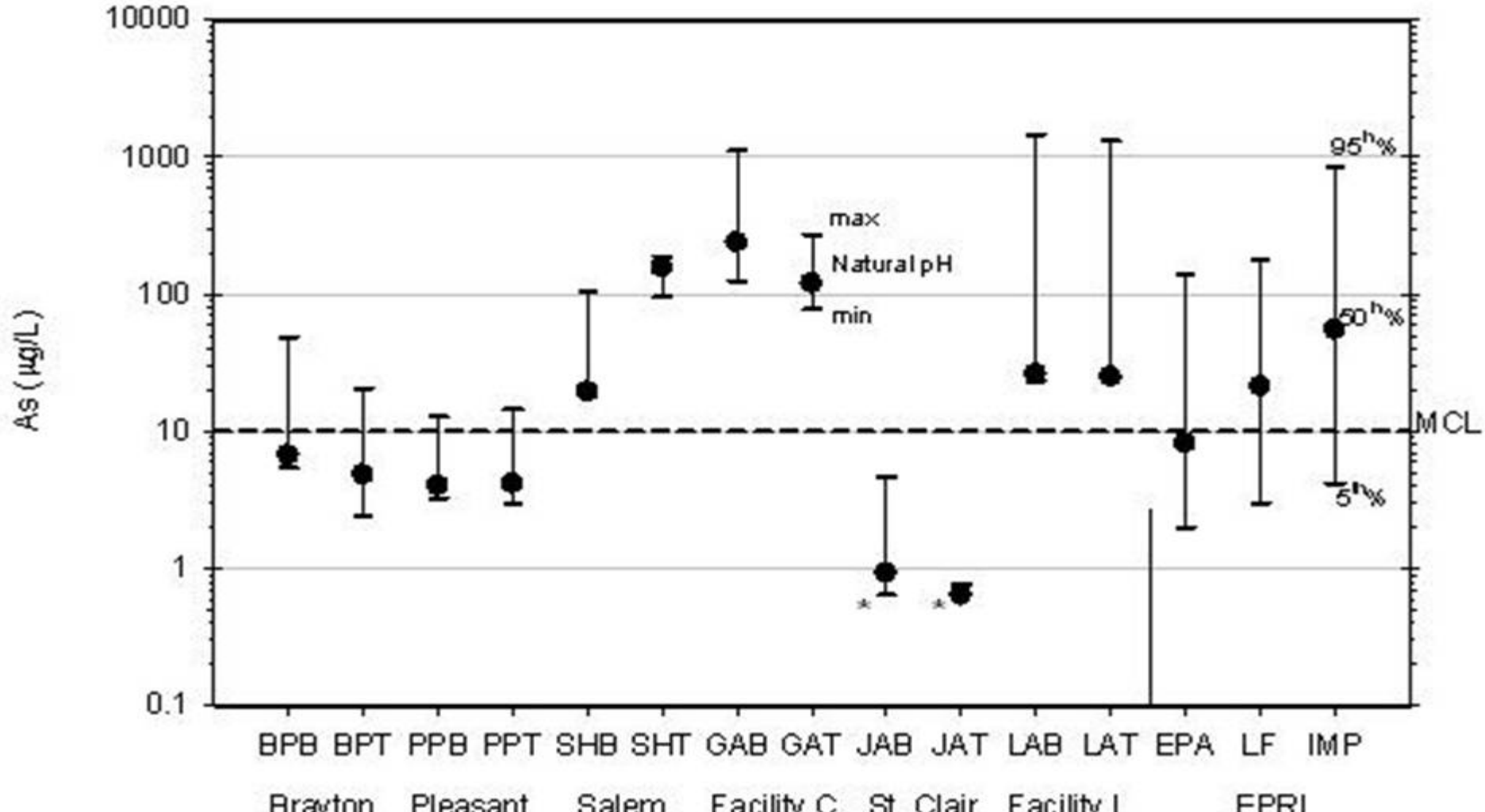
MCL - Maximum concentration limit (for drinking water)

TC – Toxicity Characteristic – above the TC, material is considered a hazardous waste

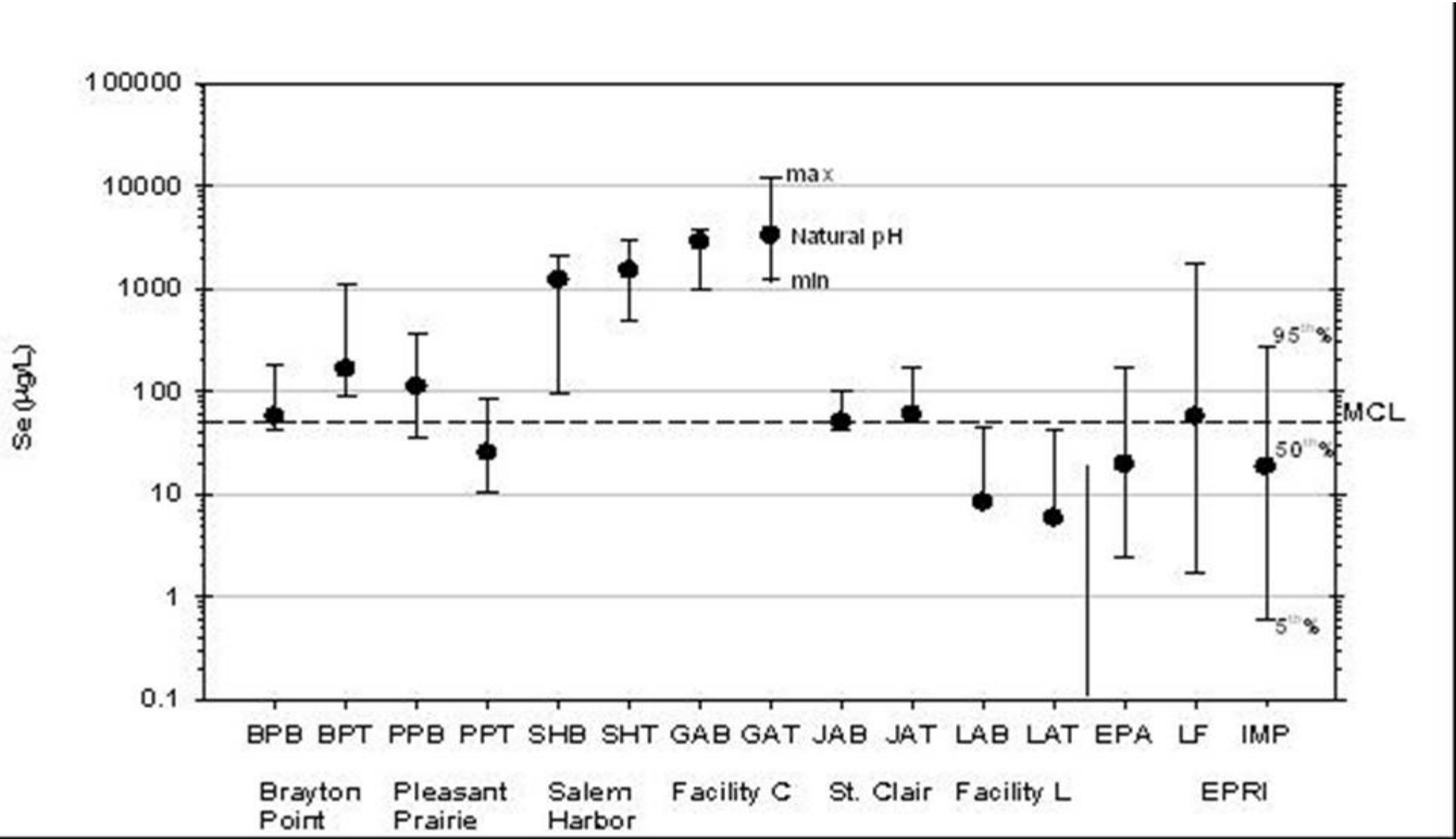
Ranges of Hg Leachate Concentrations (From Report 1 on Use of Sorbents)



Ranges of As Leachate Concentrations (From Report 1 on Use of Sorbents)



Ranges of Se Leachate Concentrations (From Report 1 on Use of Sorbents)



Findings from Report (EPA/600/R-06/008, Jan 2006)

- Mercury is strongly retained by the resulting CCR and unlikely to be leached at levels of environmental concern.
- Arsenic and selenium
  - May be leached at levels of potential concern both with and without enhanced mercury control technology
  - Showed higher potential for release by leaching:
    - Highest As leach values at 20% of TC
    - Highest Se leach value is 10 x TC
- ***Leachate concentrations and the potential release of mercury, arsenic, and selenium do not correlate with total content***.

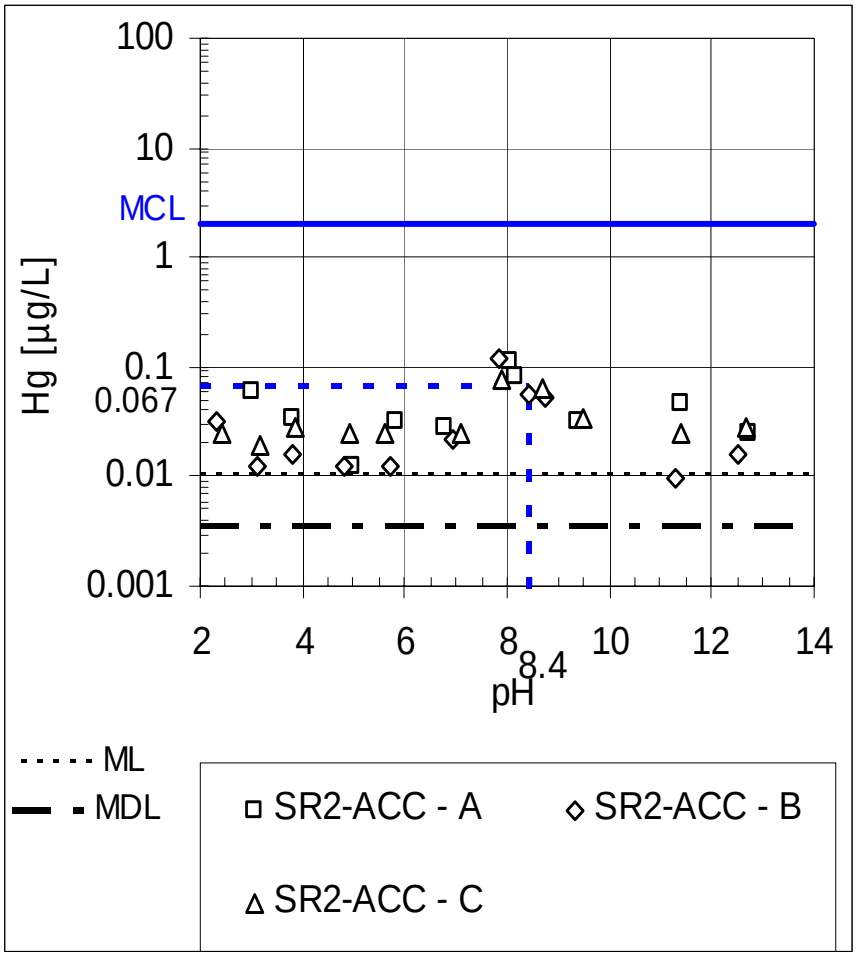
List of Wet Scrubber Facilities Providing Residues for Leach Testing

Facility Code	Coal Rank	Oxidation Type	NOx Control	Particulate Control
A	Bit	Natural	SNCR	Fabric Filter
A	Bit	Natural	SNCR-BP	Fabric Filter
B	Bit	Natural	SCR	ESP-CS
B	Bit	Natural	SCR-BP	ESP-CS
K	Sub-Bit	Natural	SCR	ESP-CS
M	Bit	Inhibited	SCR	ESP-CS
M	Bit	Inhibited	SCR-BP	ESP-CS
N	Bit	Forced	None	ESP-CS
O	Bit	Forced	SCR	ESP-CS
P	Bit	Forced	SCR & SNCR	ESP-CS

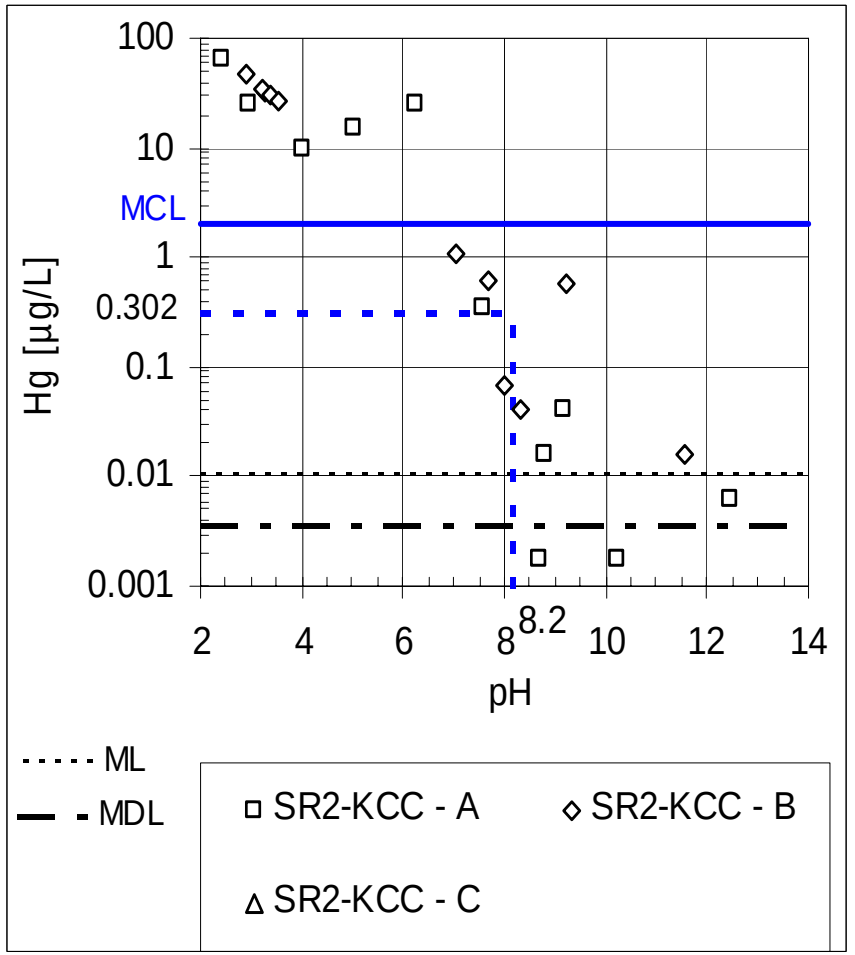
*BP – By-passed during winter months

Last update-11-27-06

Preliminary Results Comparing Hg Leaching from Scrubber Sludge from 2 Facilities

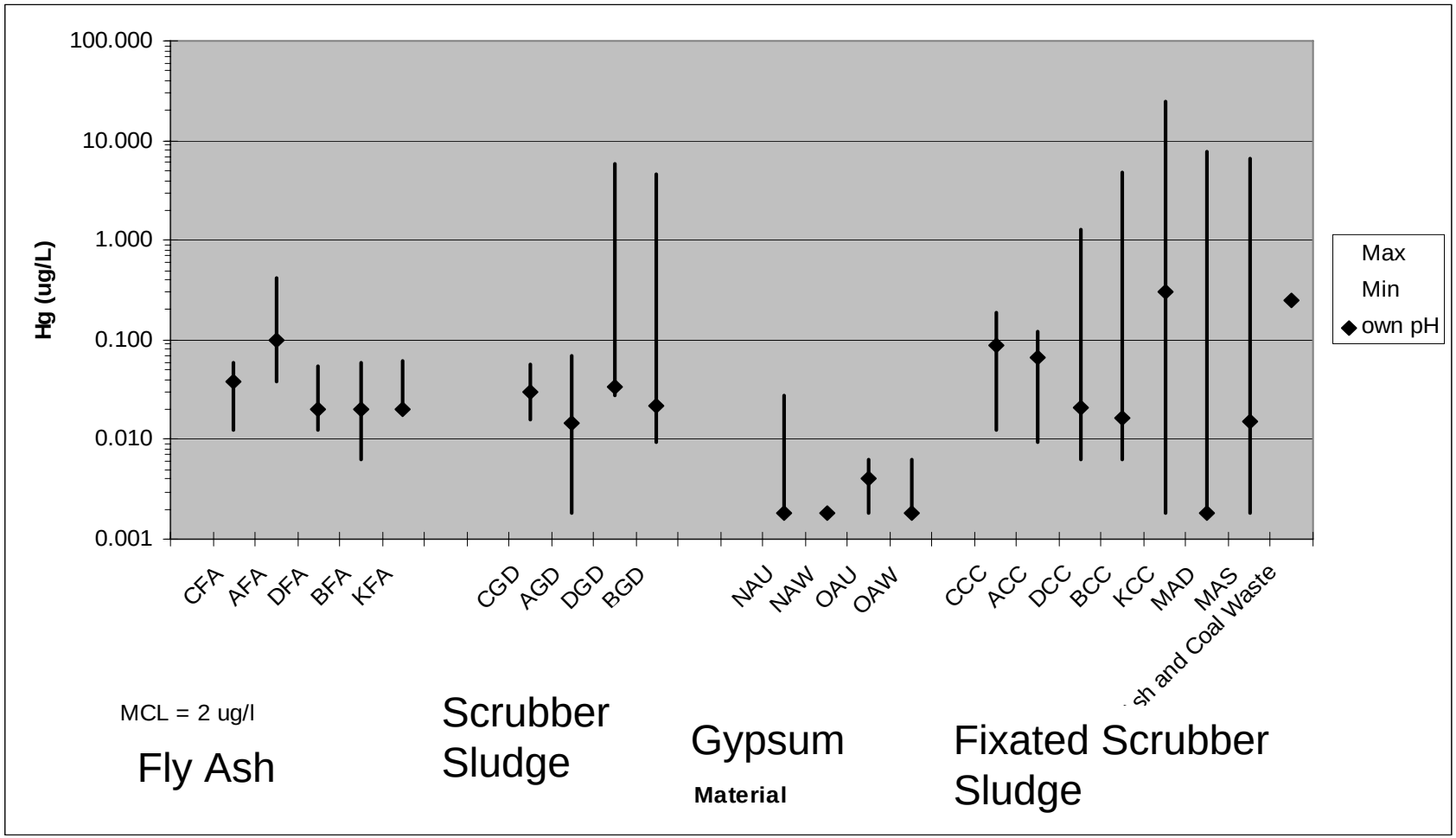


Facility A

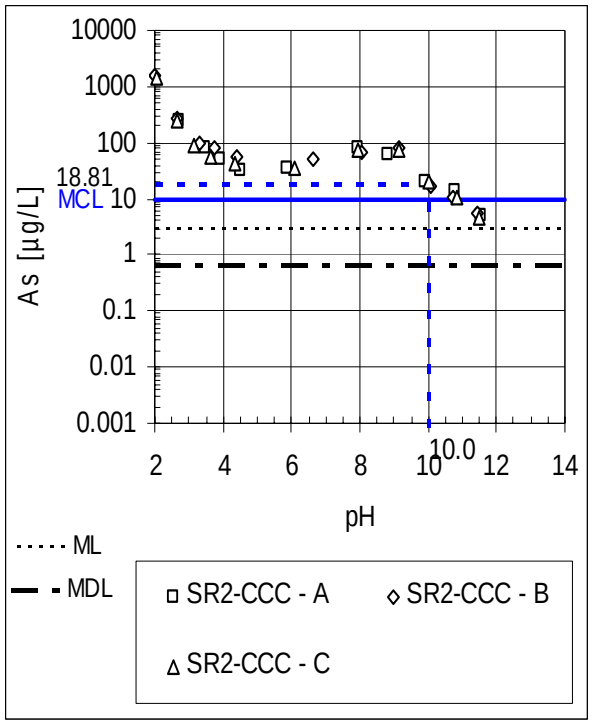


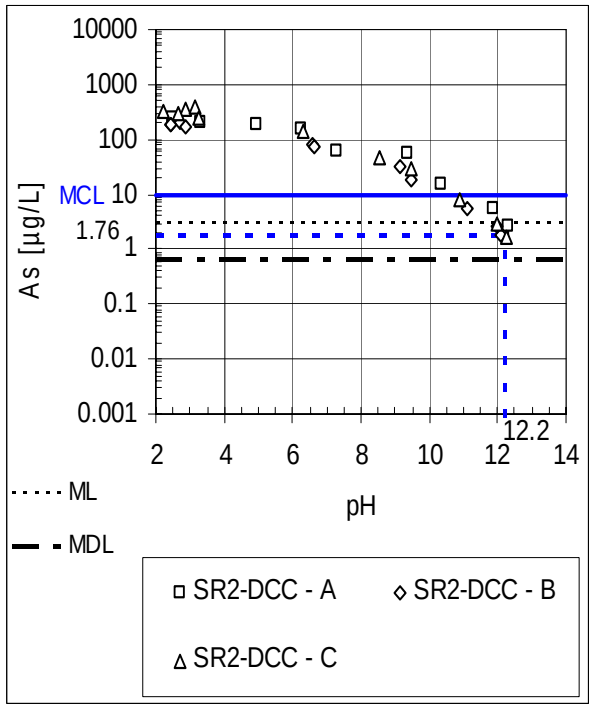
Facility K

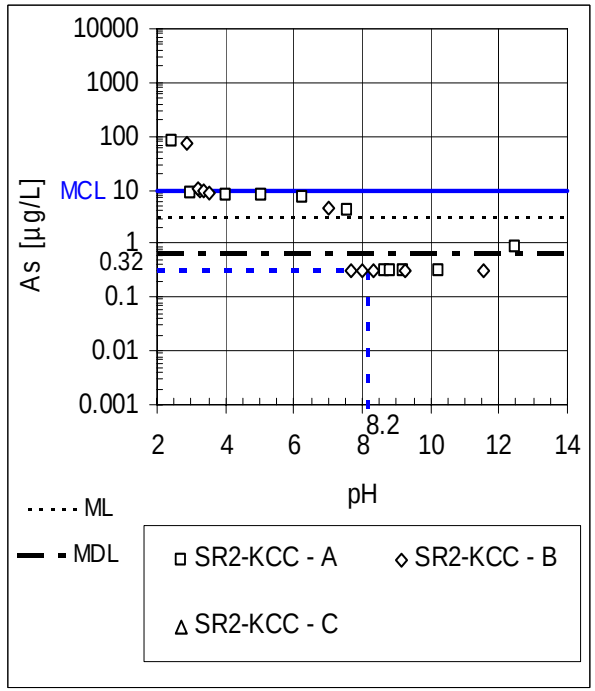
Preliminary Results for Range of Mercury Leaching Concentrations for 5.8<pH<12



Preliminary Results Comparing of Arsenic Leaching from Scrubber Sludge for 3 Facilities





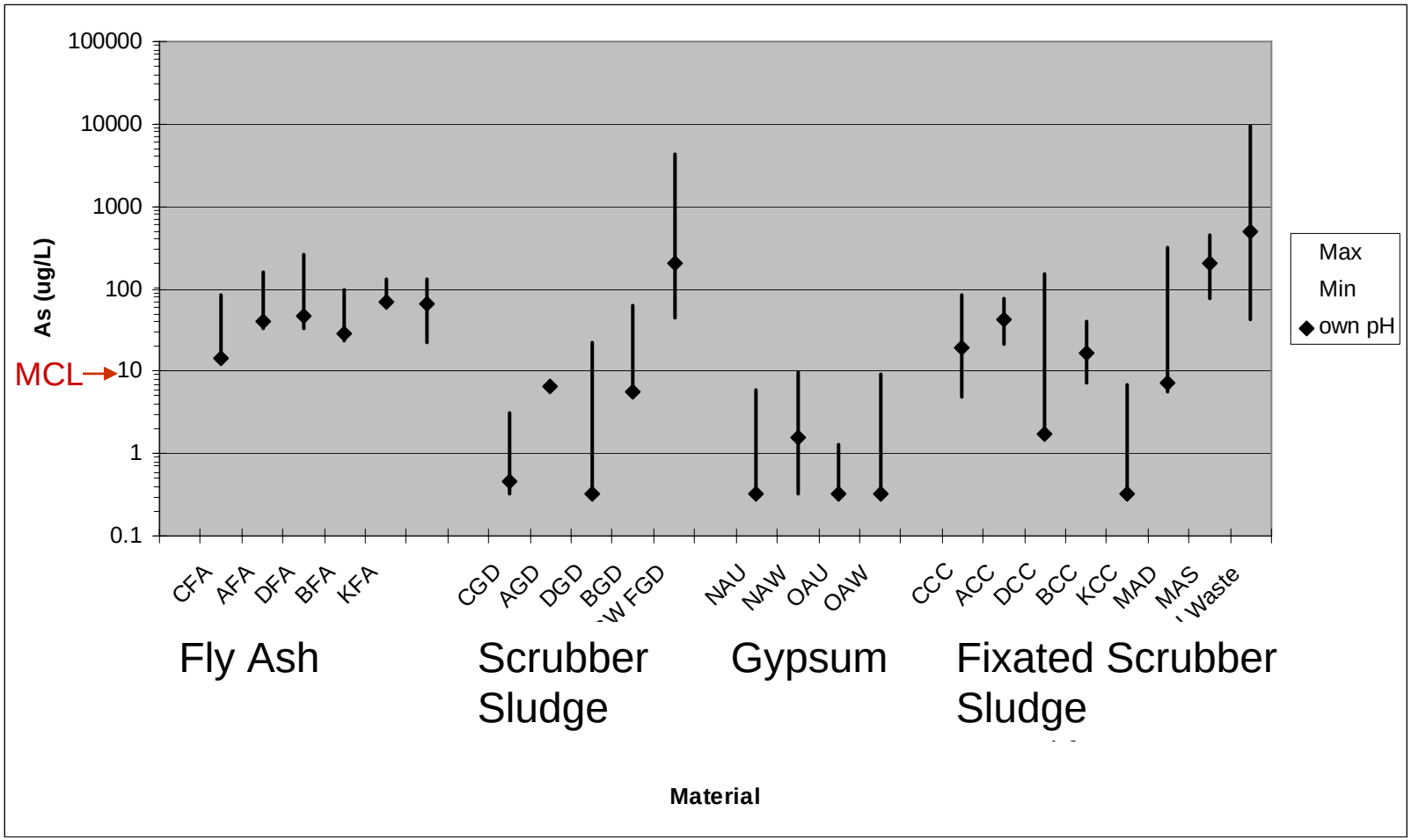


Facility A

Facility B

Facility K

Preliminary Results for Range of Arsenic Leaching Concentrations for 5.8<pH<12



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Series of 4 Reports Documenting Findings From Leach Testing

1. Enhanced sorbents for mercury capture (EPA, EPA/600/R-06/008, January 2006)
2. FGD gypsum and other scrubber residues (2007)
3. Residues from other air pollution control strategies (2008).
4. Probabilistic assessment of mass release rate for a range of management scenarios (disposal and beneficial use) (2008).

Conclusions

- Through collaborative program, research is underway to develop information to
  - Develop/utilize leach testing protocol
  - Characterize impact of air pollution control changes at coal fired power plants on CCRs;
  - Quantify potential life-cycle benefits from CCR utilization;
  - Provide more scientifically-based inputs needed for risk and environmental assessments; and
  - Help determine if intended reductions of CAMR cap and trade programs are achieved.


Questions?
Courtesy of J. Bachmann