World of Coal Ash Conference 2009
Lexington Kentucky May 5 2009

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Current Issues In The Regulation of Coal Ash

The Obama Administration has indicated that it is committed to developing a proposal for comment for regulation of coal combustion waste ("CCW"). (March 8, 2009 NYT). My presentation will discuss current issues in regulation of coal combustion wastes, including co-disposal of coal combustion wastes at mining sites, and test methods used for characterization of the leaching potential of CCW.

A. Background and composition of coal combustion wastes[1]

The burning of coal produces large amounts of fly ash, bottom ash, boiler slag and flue gas desulfurization sludge that are collectively called coal combustion wastes or CCW. Today CCW is the second largest industrial waste stream in America, surpassed only by mining waste.

As efforts to control pollutants in emissions from coal combustion increase, so have both the volume and potential toxicity of CCW. The volume of CCW produced nationally increased by 30 - 40% to approximately 130 million tons annually in 2004 largely due to use of flue gas desulfurization devices in order to meet the requirements of the Clean Air Act Amendments of 1990.[2] Additional initiatives for controlling power plant emissions, including proposed controls on mercury are likely to increase total CCW generation further with estimates of as much as 170 million tons being generated annually by 2015.[3] The disposal of CCW has caused a variety of environmental problems particularly to soils and waters, due to an extreme pH and high concentrations of soluble salts, trace metals and other pollutants that leach from different CCWs.

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[1] The author is indebted to Lisa Evans, Earthjustice, for much of this background discussion. Lisa and Fitz co-presented extensive comments on the OSMRE proposal to regulate co-disposal of CCW at mines, and also presented to the National Academies of Science panel on co-disposal of CCW at mines.

[2] Degeare, Truett, U.S. Environmental Protection Agency, Office of Solid Waste. Overview of U.S. Environmental Protection Agency Coal Combustion Waste (CCW) Mine Fill Issues. Undated. http://www.mcrcc.osmre.gov/PDF/Forums/CCB3/5-1.pdf

[3] U.S. EPA, Clean Air Markets Division. Memorandum to the Docket entitled Economic and Energy Analysis for the Proposed Interstate Air Quality Rulemaking. January 28, 2004

Coal and CCW have been analyzed and characterized by a number of researchers, and the composition of coal and coal combustion wastes varies widely. According to Block and Dams (1976), the composition of fly ash is "significantly different from the original coal composition." In comparison to coal, fly ash is relatively enriched in elements such as chlorine, copper, zinc, arsenic, selenium, and mercury (Block and Dams, 1976). According to Carlson and Adriano (1993), fly ash is also enriched in boron, strontium, molybdenum, sulfur, and calcium. Trace elements in the ash are concentrated in the smaller ash particle sizes.

In a study by the Electric Power Research Institute (1983), chemical analysis of coal, bottom ash, and fly ash from a southwest U.S. power plant burning southwestern subbituminous coal revealed large quantitative differences in elemental concentrations of the three materials:

	Aluminum (ppm)	Arsenic (ppb)	Barium (ppm)	Chromium (ppm)	Iron (ppm)	Magnesium (ppm)	Lead (ppb)	Silicon (ppm)
Coal	29100	7100	71.8	6.1	5130	1130	11000	50200
Bottom Ash	142000	24100	2830	29	28100	4640	23000	260000
Fly Ash	144000	32750	3110	31	24800	5260	51500	258000

The great majority of the metals were retained in the solid waste and only a very small percent were present in the atmospheric stack emissions. For example, for trace metals, arsenic, cadmium, chromium, lead, antimomy and selenium, 97%, 97.2%, 99%, 97.5%, 97.7% and 91.5% of the total mobilization of each of these metals, respectively, was retained and concentrated in the coal ash. (Bignoli, 1989).

The mineral and trace element content of CCW can vary substantially depending on the locations of parent coals within different coal basins, different coal seams within the same basin, and different locations within single coal seams. Using the Lower Kittanning Coal seam in western Pennsylvania, Rimmer and Davis (1986) analyzed the physical, chemical and biological processes that affected the mineral composition of coals. The Lower Kittanning Coal seam demonstrates lateral variations in mineral compositions that were related to the depositional environments.[4] Research by Lindahl and Finkelman (1986) and Harvey and Ruch (1986) support the variability of the mineral content within and between coal seams and between regional basins. For example, the mean concentrations of lead, chromium, nickel, and arsenic are three to five times higher in Appalachian and Illinois Basin coals than in coals of the Rocky Mountains and Northern Plains.

[4] For example, high pyrite concentrations occurred in areas where the overlying shale indicated brackish, swamp-like, anoxic conditions. High quartz content in the northern part of the coal seam coincided with a source area where quartz was transported into the swamp by water and/or air from a topographic high area.

Numerous researchers have documented adverse environmental impacts caused by CCW to groundwater[5] and surface waters, plants, aquatic life, and other organisms. Carlson and Adriano (1980) maintain that the major environmental impacts of CCW include: leaching of potentially toxic substances into soils, groundwater and surface waters; hindering effects on plant communities; and the accumulation of toxic elements in the food chain. Adriano et al. (1980), Elseewi et al. (1980), Phung et al. (1979), and Menon et al. (1990) analyzed the chemical and physical composition of fly ash under various experimental conditions to determine the environmental impact of inorganic constituents at disposal sites, such as the release of trace elements in water and treated soils. Sandhu et al. (1993) specifically studied the leaching of nickel, cadmium, chromium, and arsenic from coal ash impoundments of different ages. The general conclusion indicated that leaching produces a measurable release of metals into the environment from both old and new ash deposits: "[A]sh deposits…weathered and leached for over 10 years, yet still may provide a source of metal contamination to infiltrating water. Thus, ash disposal basins may be potential sources of ground water contamination for many years after ash deposition has ceased" Sandhu et al. (1993).

Researchers such as Rowe et al. (2002) have documented the negative effect of coal combustion waste on the physiology, morphology and behavior of aquatic organisms and the health of aquatic ecosystems. According to Rowe et al (2002), the "release of CCR [coal combustion residues such as fly ash] into aquatic systems has generally been associated with deleterious environmental effects. A large number of metals and trace elements are present in CCR, some of which are rapidly accumulated to high concentrations in aquatic organisms. Moreover, a variety of biological responses have been observed in organisms following exposure to and accumulation of CCR-related contaminants. In some vertebrates and invertebrates, CCR exposure has led to numerous histopathological, behavioral and physiological (reproductive, energetic and edocrinological) effects." [6]

Lemly (1999) found that selenium leaching from coal ash landfills posed a great danger to fish populations and documented the elimination of a diverse fish population at Belews Lake, North Carolina from such contamination. Rowe et al. (2000) studied the effects on southern toads living in an environment polluted by coal ash concluding that major reductions occurred in local populations because less food algae could survive in the polluted water and the toxicity of coal ash trace elements in the sediments and surviving food algae killed larval toads. The study suggests that the widespread practice of

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[5] Groundwater is particularly important because half of the population of the United States relies on groundwater as its source of potable water either through public or domestic supplies (Solley et al., 1998).

[6] Rowe et al. (2001) studied the adverse impact of trace metals from CCW on the standard metabolic rate of crayfish (*Procambarus acutus*). Other researchers such as Hopkins et al. (2000) studied the detrimental impact of trace elements on lake chubsuckers (*Erimyzon sucetta*). Fish exposed to lake sediments polluted with coal ash exhibited "substantial decreases in growth and severe fin erosion."

disposing of coal ash in open aquatic basins may result in sink habitats for some amphibian populations. Cherry (2000) and coworkers, after evaluating the level of toxicity at 32 CCW sites throughout the world, concluded that coal combustion wastes have adverse impacts on ecosystems. Namely, trace elements and other constituents such as sulfates, chlorides, sodium, boron, manganese, iron, selenium, arsenic, lead, chromium, nickel, copper and zinc leach from CCW ash particle surfaces at toxic levels into groundwater and surface water and threaten human and aquatic life.

Elseewi et al. (1980) maintain that solutions from fly ash are mostly alkaline, have a high salt content primarily due to the dissolution of Ca^{2+} and OH^{-} ions, and contain an elevated concentration of boron that may be toxic to plants. According to Adriano et al. (1980), "…coal ash usually is not suitable for agricultural uses due to the high cost of handling and transportation from the source, very low C [carbon] and N [nitrogen] contents, and usually high pH and toxic B [boron] contents. Thus, if lands are to be used for fly ash disposal purposes, application rates should be balanced between environmental impacts and economics of waste disposal. Massive applications are usually associated with adverse effects to soils and growing plants."

There has been very little research on the environmental impacts of organic constituents in CCW. Researchers have long known that coal fly ashes contain a number of polynuclear aromatic hydrocarbons (PAHs), (Griest and Guerin, 1979) (Hanson et al, 1983, citing Sucre et al, 1979) (Bennett et al, 1979) (Hanson et al, 1979, 1980 & 1981). Examples of these PAHs include naphthalene, acenaphthylene, anthracene, dibenzofuran, fluorene, and fluoranthene. A number of the PAHs in CCW are toxic, mutagenic and/or carcinogenic in laboratory studies. Their bioaccumulation appears to be limited due to metabolism. The metabolism itself, however, may produce oxidation damage in tissues and breakdown products that are more mutagenic than their precursors. Researchers have documented that fly ashes from both pulverized coal combustion and fluidized bed combustion contain PAHs that readily cause bacteria to mutate, (Hanson et al., 1983, citing Chrisp et al, 1978, Fisher et al, 1979, Kubitschek and Haugen, 1980, Clark and Hobbs, 1980, Hill et al, 1981, and Wei et al, 1982). Hansen et al, 1983 documented that treatment of FBC fly ash with N2O4 increased its mutagenic potency by as much as 3200 times on a laboratory strain of salmonella bacteria. They concluded that potent, direct acting mutagens such as dinitropyrenes and dinitrofluoranthenes in fly ash from fluidized bed combustion power plants might be products of reactions between PAHs in the ash with nitrogen oxides in combustion gases. However, Harrison et al, 1986, concluded that the concentrations of PAHs detected in fly ash probably would not pose an environmental hazard, although they acknowledged difficulties in their ability to detect and measure PAHs in the fly ash. Griest and Guerin, 1979, concluded similarly that PAHs adhere strongly to ash, making analysis of their quantities and types in CCW difficult**.**

The EPA Report to Congress on Wastes from the Combustion of Fossil Fuels, (March, 1999), cited data collected by the Electric Power Research Institute in 1997 showing that co-combustion of petroleum coke wastes, coal gasification wastes, mixed plastics, tire-derived fuels and other organic wastes with coal generates CCW with detectable levels of benzene, chlorobenzene, cyanide, dioxins, furans, PCBs, chlorophenol, and polycyclic aromatic hydrocarbons. Despite documentation of the existence of harmful organics in CCW, monitoring for organics in groundwater and surface water surrounding CCW sites is extremely rare. Thus little is known about actual impacts to the environment from organic compounds in CCW.

B. Regulatory background on CCW management

In 1988, the U.S. Environmental Protection Agency presented a report to Congress concerning coal combustion wastes, acknowledging the existence of potential for groundwater contamination among and within the categories of coal combustion waste. According to the **Wastes from the Combustion of Coal by Electric Utility Power Plants**, EPA/530-SW-88-002:

> The primary concern regarding the disposal of wastes from coal-fired power plants is the potential for waste leachate to cause ground-water contamination. Although most of the materials found in these wastes do not cause much concern (for example, over 95 percent of ash is composed of oxides of silicon, aluminum, iron and calcium), small quantities of other constituents that could potentially damage human health and the environment may also be present. These constituents include arsenic, barium, cadmium, chromium, lead, mercury and selenium. At certain concentrations these elements have toxic effects.

Id., at ES-4.

In May, 2000, the EPA published a final rule captioned "**Regulatory Determination on Waste from the Combustion of Fossil Fuels**," 65 Fed. Reg. 32213 (May 22, 2000).

The 2000 EPA determination that coal combustion wastes need *not* be regulated under RCRA Subpart C as hazardous, was predicated on the assumption that mitigative measures under RCRA Subpart D such as installation of liners, leachate collection systems, ground water monitoring systems and corrective action to clean up ground-water contamination would be employed to protect public health and the environment.

In the intervening eight years, EPA backed away from the proposed course of action of adopting national regulations governing coal combustion waste management, proposing instead to issue guidelines – an approach endorsed by the Interstate Mining Compact Commission.

Meanwhile, additional evidence accumulated concerning the potential for contamination of land and water resources from undermanagement of such wastes. The National Academies of Science acknowledged the threat posed by disposal of coal ash in mines, landfills and surface impoundments. Both the NAS and EPA have documented extensively the contamination of groundwater and surface water by leached constituents from coal ash.[7]

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[7] See, for example, the following reports:

EPA's 2007 "**Human and Ecological Risk Assessment from Coal Combustion Wastes**" documented the highest cancer risks from surface impoundments, but also found unacceptable health risks from clay-lined coal combustion waste landfills leaking arsenic into groundwater. The same study showed that both impoundments and landfills threaten to overwhelm aquatic ecosystems with toxic levels of other heavy metals.

EPA reports published in 2005 and 2006 have documented that the majority of states still lack regulations mandating basic safeguards at waste disposal sites, including liners and groundwater monitoring. *See* U.S. Dep't of Energy & U.S. Envtl. Prot. Agency, **Coal Combustion Waste Management at Landfills and Surface Impoundments**, 1994–2004 (Aug. 2006) *and* DPRA Inc., **Estimation of Costs for Regulating Fossil Fuel Combustion Ash Management at Large Electric Utilities Under Part 25**8 (prepared for the Office of Solid Waste, U.S. Envtl. Prot. Agency) (Nov. 30, 2005).

The National Research Council warned in 2006 that coal ash used to reclaim abandoned mines could release their toxic burden into groundwater or surface water, unless the federal government established safe standards for this practice. As noted above, the EPA's 2007 assessment estimated risks to both human health and aquatic life from surface impoundments and landfills to be well above levels that EPA generally considers "acceptable."

As improvements continue to be achieved in both pre- and post-combustion scrubbing and capture of particulates and metals, we will of necessity change the composition and increase the potential toxicity of the wastes and leachate.

The proper management of CCW is essential for protection of human health and the environment. Adequate and comprehensive safeguards will prevent trafficking in

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1. U.S. Environmental Protection Agency, "Damage Case Assessment under RCRA for Fossil Fuel Combustion Wastes," dated August 2006. This assessment recognizes 24 proven damage cases and 39 "potential" damage cases. Damage cases are CCW disposal sites that show evidence of groundwater and/or surface contamination.
2. F. Sanchez, Keeny, R., Kosson, D., Delapp, R., Thorneloe, S. Characterization of Mercury-Enriched Coal Combustion Residues from Electric Utilities Using Enhanced Sorbents for Mercury Control, EPA/600/R-06/008, January 2006. This report confirmed that CCW leaches arsenic and selenium at levels of potential concern. The report tested both laboratory leachate and field leachate of CCW and found significant exceedances of MCLs for arsenic and selenium in groundwater in a substantial percentage of the samples. In fact, the concentrations of some samples approached 100 times the MCL. The report concludes that use of activated carbon injection to capture mercury at coal-fired power plants substantially increases the arsenic and selenium content of CCW. The report found, in addition, that CCW commonly leached arsenic and selenium in excess of 10 times the MCL from both plants that employed sorbent technologies and those that did not. The report would be particularly useful if the power plant proposes hg controls.
3. Evans, Lisa, Clean Air Task Force. "Cases of Damage from Mismanagement of Fossil Fuel Combustion Waste, October 2005." 2005.
4. U.S. Environmental Protection Agency. "Regulatory Determination on Wastes from the Combustion of Fossil Fuels," 70 Fed. Reg, 32214, May 25, 2000. EPA acknowledged in its Regulatory Determination that "coal combustion wastes could pose risks to human health and the environment if not properly managed" and "national regulations under subtitle D of RCRA are warranted for coal combustion wastes when they are disposed in landfills or surface impoundments."

environmental contamination by removing the incentive for those more interested in currying market share and short-term economic gain rather than the long-term public interest, to undermanage the wastes. Adoption of a program of uniform, comprehensive and appropriate minimum standards for the characterization and management of coal combustion wastes for reuse and disposal is **the** best way to improve the beneficial utilization of CCW.

C. TVA Kingston Plant, H.R. 493, CERCLA And Emergency Action Planning

The December 2008 release of coal ash from the TVA Kingston Tennessee facility flooded more than 300 acres of land, damaged homes and property, polluted the Emory and Clinch rivers, and will cost somewhere over one billion dollars after consideration of long-term remediation costs and property damage litigation.

In response, Congressman Nick Jo Rahall of West Virginia, Chair of the House Resources Committee, introduced HR. 493 "The Coal Ash Reclamation, Environment, and Safety Act of 2009" as a vehicle for opening the dialogue with the utilities and with OSM and EPA on coal combustion waste management. While underscoring in a letter he released soon after introducing the bill his long-held belief that the U.S. Environmental Protection Agency should take the lead in developing a comprehensive regulatory framework for management of coal combustion wastes establishing a national floor of standards for the characterization, management, disposal and beneficial reuse of the various wastestreams associated with coal combustion, Congressman Rahall proposed HR 493 in order to assure that in the interim, no new embankment-type structures for storage or disposal of coal combustion wastes will undermanage coal combustion wastes in the manner that the TVA did at the Kingston Plant. By requiring that all new dam or embankment structures for coal ash, slag, and flue gas desulfurization materials be designed to meet the requirements currently applicable to coal processing waste structures, and by defining the term "impoundment" broadly enough to encompass all embankment-type structures that retain these wastes whether in a solid, semi-solid, or liquid form, the bill will help avoid future catastrophes such as the failure of the TVA structure.

That the TVA structure that failed was classified under Tennessee state regulations as a *landfill* rather than an a dam or impoundment, underscores the need to **carefully** define the terms "covered wastes" and "impoundments" as H.R. 493 does, and is one of numerous examples of the undermanagement of coal combustion wastes under the hodgepodge of state regulatory programs that have developed in the vacuum created by the absence of EPA's leadership.

The H.R. 493 would have provided a backstop that would assure that new embankment structures retaining coal combustion wastes meet engineering, design, construction, and location standards for any new impoundments or landfill units retaining coal combustion wastes that are built above grade, and would have required upgrading of existing structures to meet certain performance standards, and an inventory of the engineering and structural integrity of existing structures.

Soon after a hearing was held on HR 493, EPA Administrator Jackson communicated with the Congress the intention of the Administration to move forward on development of such a set of regulations. In deference to the Administration, Congressman Rahall does not plan to move forward with HR 493.

As Matt Hale described, the EPA has moved forward with the first step towards development of such a regulatory framework – issuing a letter on March 9, 2009 under CERCLA Section 104(e) requesting information from all electric utilities nationwide relating to "the surface impoundments or similar diked or bermed management unit(s) or management units designated as landfills which receive liquid-borne material from a surface impoundment used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals." CERCLA Section 104(e) authorizes EPA to request information from any person whenever the agency has reason to believe that there may be a release or a threat of release of a pollutant or contaminant. EPA has indicated also that it plans to conduct on-site assessments to determine the structural integrity and vulnerabilities of these structures, to order cleanup and repairs where needed, and to develop new regulations.

As to whether coal ash is within the ambit of a "hazardous substance, pollutant or contaminant" under CERCLA, see: *Eagle-Picher Industries v. U.S. EPA*, 759 F.2d 922 (D.C. Cir. 1985); *U.S. v. Conservation Chemical Co.,* 619 F. Supp 162 (D.C. Mo. 1985); contra *U.S. v. Iron Mountain Mines, Inc.,* 812 F. Supp. 1528 (E.D. Cal. 1992). Irrespective of whether EPA revisits the 2000 Regulatory Determination and classifies CCW or some component waste streams of CCW as hazardous, utilities contemplating allowing third parties to manage and dispose of their generated CCW would do well to remember that CERCLA imposes strict liability for any resulting releases, with few exceptions.

The Kingston release also prompted an amendment to House Joint Resolution 119, which was intended to recognize the existing authority of the Kentucky Division of Water to require owners of high-hazard impoundments to prepare emergency action plans (EAPs). A bait-and-switch coal industry amendment to what had been an agreed-upon text, reducing the planning requirement to a "file only" plan, resulted in the measure not passing the 2009 General Assembly session. The issue of Emergency Action Plans is one that is particularly dear to me, since I lost a friend and client when a coal waste structure, misclassified as a "refuse pile," collapsed and she was crushed to death by a wall of slurried coal processing wastes.

As noted above, one of the threshold issues to be addressed is the characterization of above-grade structures - the impoundment structure at the Kingston facility as a "landfill" rather than an impoundment so that even *if* Tennessee required EAPs of high-hazard structures, it would likely not have required one in that instance. Ultimately, the goal must be to move away from wet to dry management of coal combustion wastes.

D. Co-Disposal of CCW In Mine Workings

My understanding is that TVA is considering disposal of the released coal combustion wastes from the Kingston plant in one or more mines. I would caution the agency that co-disposal of coal combustion wastes at former or current mine sites represents perhaps **the** least appropriate place among options for disposal of such wastes.

A small but growing percentage of coal combustion wastes are backhauled and disposed, or "beneficially reused," in mine workings (including both underground mine voids and more commonly, in surface mine backfills or spoil/mine waste fills). Such use and disposal occurs not because such sites offer a hydrologically or geologically preferable location, but primarily because coal companies offer the backhauling and mine site disposal as a "service" or incentive in order to increase market share for their coal in an increasingly competitive marketplace.

In 2003, Congress directed the EPA to commission an independent study on the health, safety and ecological risks associated with the placement of CCWs in active and abandoned coal mines. The National Research Council accepted a request to undertake that study, and established the Committee on Mine Placement of Coal Combustion Wastes in 2004. On March 1, 2006, the National Academies of Science (NAS) released a report entitled Managing Coal Combustion Residues in Mines which outlined the essential elements of a uniform, comprehensive and appropriate program for characterization and management of coal combustion residues. Acknowledging concerns over the poor state of monitoring of coal combustion residues at minefills, the NAS called for national regulations that would set minimum safeguards at CCR placement sites.

The NAS, the most prestigious scientific instrument of government in America, established by Abraham Lincoln to give the government independent advice for tackling scientific questions, examined minefilling and concluded that this practice can cause unacceptable harm if it is not carried out under enforceable safeguards. These safeguards must, according the NAS:

(1) characterize the waste and the disposal sites credibly,
(2) monitor the sites competently, and
(3) clean up pollution found by that monitoring.

The NAS recommended that EPA and OSM collaborate on developing enforceable federal regulations for minefilling and that these regulations should employ a level of protection consistent with EPA's planned regulation of CCW landfills and surface impoundments. Lastly, the NAS report stated that the public should be actively involved in developing these regulations and enforcing them in permits at mine sites.

As defined by the National Academies of Science, the study reviewed the placement in abandoned and active, surface and underground coal mines in all major coal basins, and defined several specific questions and areas of focus, including:

1. The adequacy of data collection from surface water and ground water monitoring points established at CCW sites in mines.

2. The impacts of aquatic life in streams draining CCW placement areas and the wetlands, lakes, and rivers receiving these drainage.

3. The responses of mine operators and regulators to adverse or unintended impacts such as the contamination of ground water and pollution of surface waters.

4. Whether CCWs and the mines they are being put in are adequately characterized for such placement to ensure that monitoring programs are effective and groundwater and surface waters are not degraded.

5. Whether there are clear performance standards set and regularly assessed for projects that use CCW for "beneficial purposes" in mines.

6. The status of isolation requirements and whether they are needed.

7. The adequacy of monitoring programs including:

    a. The status of long-term monitoring and the need for this monitoring after CCW is placed in abandoned mines and active mines when placement is completed and bonds released;

    b. Whether monitoring is occurring from enough locations;

    c. Whether monitoring occurs for relevant constituents in CCW as determined by characterization of the CCW; and

    d. Whether there are clear, enforceable corrective actions standards regularly required in the monitoring.

8. The ability of mines receiving large amounts of CCW to achieve economically productive post mine land uses.

9. The need for upgraded bonding or other mechanisms to assure that adequate resources area available for adequate periods to perform monitoring and address impacts after CCW placement or disposal operations are completed in coal mines.

10. The provisions for public involvement in these questions at the permitting and policy-making levels and any results of that involvement.

11. Evaluation of the risks associated with contamination of water supplies and the environment from the disposal or placement of coal combustion wastes in coal mines in the context of the requirements for protection of those resources by RCRA and SMCRA.

The NAS concluded that placement of CCW in coal mines may be a viable option *only if* "(1) CCR placement is properly planned and is carried out in a manner that avoids significant adverse environmental and health impacts and (2) the regulatory process for issuing permits includes clear provision for public involvement." (p 1.)

Regarding potential impacts from CCW placement in mines, the Committee "concludes that the presence of high contaminant levels in many CCR leachates may create human health and ecological concerns at or near some mine sites over the long term."

To reduce the potential impacts associated with the placement of CCWs in mines, the Committee recommended "an integrated process of CCR characterization, site characterization, management and engineering design of placement activities, and design and implementation of monitoring . . . to reduce the risk of contamination moving from the mines to the ambient environment." Report, p. 12. The NAS's specific recommendations included these:

1. Consider safer alternatives: Other secondary uses of CCW that pose minimal risks to human health and the environment should be strongly encouraged before CCW is used at any coal mine. (p.4)

2. "Beneficial use programs," operative in many states, should not limit the effective regulation or oversight of CCW placement.

3. Characterization of the CCW material and the mine placement site is essential to engineering design, permitting decisions, reclamation management and the development of monitoring programs.

4. CCW must be characterized prior to significant mine placement and with each new source of CCWs. CCW characterization should continue periodically throughout the mine placement process to assess any changes in CCW composition and behavior.

5. A comprehensive site characterization specific to CCW placement should be conducted at all mine sites prior to substantial placement of CCW.

6. Site-specific management plans, including site-specific performance standards that are tailored to address potential environmental problems associated with CCW disposal, should be required.

7. CCW placement in mines should be designed to minimize reactions with water and the flow of water through CCW.

8. The number and location of monitoring wells, the frequency and duration of sampling, and the water quality parameters selected for analysis should be carefully determined for each site, in order to accurately assess the present and potential movement of CCW-associated contaminants.

9. Placement of CCW in abandoned and remining sites should be subject to the same CCW characterization, site characterization and management planning standards recommended for active coal mines.

10. Research should be conducted to provide more information on the potential ecological and human health effects of placing CCWs in coal mines.

11. Enforceable federal standards should be established for the disposal of CCW in minefills.

The federal Office of Surface Mining published an Advance Notice of Proposed Rulemaking (ANPR) on placement of coal combustion by products in active and abandoned coal mines. 72 Fed. Reg. 12026 (March 14, 2007). The agency planned to go to proposed rule in 2007 and to finalize a rule in 2008. Approximately 1,900 comments were received, many of which stressed the need for collaboration with EPA, the preparation of an Environmental Impact Statement, formation of a federal advisory committee, and protection of groundwater sources. The OSM proposed rule was at the OMB from October until the end of the Bush Administration, and was sent back by the new Administration for further review. OSM has indicated that it will try to put the package into the approval pipeline within the month, and anticipates publication of a proposed rule this summer.

The OSMRE approach outlined in the ANPR was criticized by the environmental community for failing to address the NAS recommendations. The agency, after summarizing the recommendations of the National Academies of Science for development of an enforceable set of federal standards addressing characterization of coal combustion residues (CCRs), comprehensive site characterization, site-specific management plants, minimization of hydration of CCRs, design of monitoring systems to enable detection of any potential movement of CCR-associated contaminants, site-specific performance standards tailored to address potential environmental problems associated with CCR disposal, and a requirement that placement in abandoned mine workings be subject to the same enforceable standards as those for active mines, proposes an approach that **fails** to meet the recommended requirements in all respects, and which instead simply "[identified] the permit application requirements and performance standards in our existing regulations in 30 CFR Chapter VII that apply to the use and disposal of CCBs in mines." Rather than developing a specific set of regulations that require characterization of the waste and of the site, a plan for management and performance standards as well as monitoring to demonstrate achievement of the goals, OSMRE proposes to rely on the existing permitting and performance standards that were neither designed nor intended for management of wastes generated by combustion of the coal.[8]

Sufficient evidence of instances of contamination from the undermanagement of coal combustion wastes at coal mine sites exists to warrant the development of national minimum standards concerning the characterization, storage, disposal and reuse of these wastes.[9]

The available evidence suggests that disposal of coal combustion wastes in mine pits or other workings may be of particular concern, due to a number of factors:

1. The increase in surface area available for leaching of elements resulting from fracturing of overburden and confining layers;

2. Higher total dissolved solids levels in mine spoils that compete for sorption sites on solids with toxic elements released from the buried ash;

3. Direct communication between surface and underground mine workings and aquifers through stress-relief fracture systems and subsidence-induced fracture flow;

4. The dependence of residents of coal-bearing regions on private, groundwater supplies and the significant potential for contamination of those supplies; and

5. The presence of site conditions conducive to creation of acid or toxic-forming material that can solubilize constituents of concern from the waste.

The lack of federal standards has resulted in uneven standard-setting among the states; a regulatory "one-downsmanship" in which states are unwilling to establish stronger

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[8] OSM recognized the limitations of its responsibility and authority in a white paper developed on **Placement of CCBs at Coal Mines – Risk Assessment** (January 17, 2006), in which it also acknowledged that the determination of risk to public health and the environment during a permit review would require a complete physical and chemical analysis of the CCB materials to predict leaching potentially toxic pollutants; a detailed plan for placement of the materials; and a monitoring plan sufficient to ensure that post-reclamation groundwater quality is not contaminated. That same abstract acknowledged the limitations of using TCLP and the variable hydrogeologic conditions of coal mines from the alkaline and arid west to the acid and humid east. Unfortunately, the preferred OSMRE approach contains none of the components acknowledged to be needed for SMCRA permit review to adequately address CCW placement.

[9] Zimmerman, A Preliminary Evaluation of the Potential for Surface Water Quality Impacts From Fly Ash Disposal at the Navajo Mine, New Mexico (2005); Hansen, Water Quality Impacts of Coal Combustion Waste Disposal In Two West Virginia Coal Mines (2005); and Norris, Water Quality Impacts From Remediating Acid Mine Drainage With Alkaline Addition (2005).

standards that might disadvantage their coal industry relative to those standards of other states. This destructive interstate competition in environmental degradation has long been acknowledged as a problem among the coal states, particularly in those areas of the east, midwest and west where the coalfields span a number of states.

OSMRE is not the appropriate agency, and SMCRA is not the appropriate regulatory vehicle, for leading in the development of regulations governing minefilling of coal combustion wastes. There are many problems with OSM's approach:

1. Guidance rather than regulation. Some 23 states have a version of "no more stringent" provisions in their laws that would restrict or preclude those states' agencies from asserting regulatory authority over use or disposal of the wastes by incorporating federal guidance. Those states are typically limited to adoption and imposition of counterpart state rules based only on those standards that have been adopted by regulation at the federal level. Also, some states cannot under state law impose substantive requirements based on "policies."

2. Surface Mining Control and Reclamation Act of 1977 not intended to be the primary vehicle to regulate coal combustion wastes, and a number of potential conflicts with the core provisions of SMCRA are created in any proposal for disposal of CCW at a minesite:

* Since all spoil material generated by a mining operation must be returned to the mine site in order to restore the mined area to the "approximate original contour" and to minimize off-site placement of "excess" mine spoil, no CCW could lawfully be placed in a location where it would displace spoil and cause more material to be disposed of in a hollow fill. Since disturbance of the strata overlying coal seams results in a typical "swell" of 15-25%, addition of CCW to the active works likely displaces spoil and violates this mandate.

* The requirement for contemporaneous reclamation of mined areas is implicated by any delay in reclamation associated with disposal of coal combustion wastes in active mining and reclamation areas. The essence of SMCRA is that mining is to be a temporary use of land, not a permanent dedication of land for waste disposal, and the requirement of contemporaneous reclamation is intended to effectuate the mandate that backfilling, grading, and revegetation follow coal removal promptly.

* Blending of coal combustion wastes in backfill without proper barriers to prevent migration to groundwater and to prevent saturation of the waste from infiltration of rainfall or groundwater, would violate provisions of the SMCRA which require protection of the hydrologic balance and prevention of off-site damage, and which specifically demand isolation of acid- or toxic-forming materials from surface or groundwater.

* Right of entry and other approvals and waivers under the mining laws are intended to authorize specific coal extraction-related activities, and do not extend to include the

backhauling and dumping or blending of wastes generated from combustion of the removed coal.

* Public notice and public comment period.

* The duration of monitoring and bonding for coal mines is far too short relative to the timeframe needed to demonstrate that the disposed wastes have been properly isolated to prevent off-site contamination.

* SMCRA does not require that the chemical, physical, and radiological characteristics of the wastes be assessed, nor that the fate and transport mechanics of those wastes be evaluated. Neither are the groundwater monitoring requirements of SMCRA designed to identify the presence of and migration of constituents of concern from CCW disposal; nor does SMCRA require testing for the full panoply of contaminants present in CCW.

* To satisfy the surface coal mining regulatory program obligations under federal and state law of protecting the hydrologic balance on and off the mine site, a broad array of metals and any other constituents identified through chemical characterization of the composition of the coal combustion waste, would need to be imposed as monitoring parameters for on-going groundwater and surface water monitoring. Each of the 17 potentially toxic elements are commonly present in CCW: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, and zinc, as well as other metals present, radionuclides, and in the case of fluidized bed combustion (FBC) wastes, volatile and semi-volatile elements would need to be assessed.

* The placement and spacing of groundwater monitoring wells would need to be significantly upgraded to be sufficient to detect leachate generation and movement off-site at the bench elevation and through fracture systems, for strip mine bench disposal, and along and below the seam for pit disposal. Monitoring parameters and well location would need to be altered to detect contamination at the waste boundary, necessitating continuous monitoring wells along the area where the waste is disposed. Long-term site maintenance and groundwater monitoring after mining bond release would need to be addressed.

* Finally, financial responsibility requirements would need to be addressed, since the performance bond under SMCRA guarantees only reclamation under Title V and is neither calculated to cover nor extensive enough in the scope of liability to cover on of off-site damage and reclamation needs associated with CCW disposal. Separate bonding, insurance, and long-term financial responsibility would need to be established.

By contrast, regulation under Subtitle C or D of RCRA would provide a comprehensive framework for CCW management.

The Resource Conservation and Recovery Act (RCRA) of 1976, which amended the Solid Waste Disposal Act, was the first substantial effort by Congress to establish a regulatory structure for the management of solid and hazardous waste. Subtitle C of RCRA establishes "cradle-to-grave" requirements for hazardous waste from the point of generation to disposal. Subtitle D of RCRA contains less restrictive requirements for non-hazardous solid waste. According to the national policy statement set forth in Section 1002(b) of RCRA, the purpose of RCRA is to ensure that the generation of waste is minimized and that solid waste is treated, stored or disposed of to minimize the present and future threat to human health and the environment. (42 USC §6902(b)).

It may surprise some of you to hear me state that regulation of coal combustion waste under Subtitle C may not be the best solution. After the May 2000 regulatory determination, the reversal of agency position concerning the listing of CCW would provoke a new round of litigation as to whether the leached constituents from the wastes exceeded the criteria of toxicity. Additionally, there is the practical consideration of whether sufficient capacity exists for landfilling CCW as a hazardous waste. The regulatory sleight-of-hand by which benzene-contaminated soils from underground storage tank remediation activities became “non-hazardous” while failing TCLP, in order to avoid overwhelming the nation’s Subtitle C landfill capacity, suggests that Subtitle D or a “hybrid” of C and D tailored to these waste streams and their characteristics might be more appropriate.

What is needed is an effective, comprehensive set of regulations for characterizing the waste constituents, assessing the possible pathways of exposure under the proposed management or disposal scenario, appropriate standards for separating legitimate reuse from waste disposal masquerading as such, and comprehensive regulatory criteria for storage and disposal of CCW, including siting, design, construction, maintenance, monitoring, closure care and financial assurance requirements. The case of the “well-traveled ash” from one industrial boiler in Kentucky suggests that the scope must extend beyond coal-fired utility boilers and must include all industrial furnaces and boilers utilizing coal as a fuel.

The placement of CCW in active or abandoned coal mines is, under most conditions, the “disposal of solid waste” as those terms are defined in RCRA. According to Section 6903(27) of RCRA, solid waste is defined as:

> any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting form industrial, commercial, mining and agricultural operations, and from community activities[.]

42 USC §6903(27). According to Section 6903(3), disposal means:

> the discharge, deposit, injection, dumping, spilling, leaking or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any water, including ground waters.

42 USC §6903(3)

Application of RCRA requirements would address these areas:

1. Groundwater Monitoring:

Pursuant to RCRA, 40 C.F.R. Part 258, the owner/operator is to monitor groundwater on-site to detect adverse impacts of waste placement on on-site groundwater such that the owner/operator will have opportunity to intervene to avoid adverse impacts on off-site users and uses of groundwater, including users and uses of surface waters affected by groundwater. For example, pursuant to section 258.51(a), (c) and (d), (well design and deployment) the purpose of monitoring wells is to allow the acquisition of groundwater samples from which adverse impacts on groundwater could be detected. Wells too few in number or which are located or screened in the wrong horizontal or vertical planes may fail to produce samples that adequately characterize impacts on groundwater. Location is critical to the ability to detect effects of waste placement before the effects can spread widely, thereby adversely affecting current or future uses of the water resource.

In addition, pursuant to sections 261.24 and 258.54(a) and Appendix I, samples are to be analyzed for specific constituents which will detect and define adverse impacts on groundwater and for which valid statistical comparisons can be made among well samples to detect adverse impacts. Of particular concern in defining and detecting adverse impacts are the eight metals that define the RCRA toxicity characteristic (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Lastly, pursuant to sections 258.50(b) and 258.61(a), (b), and (e), groundwater monitoring samples are to be acquired and analyzed over the time period for which the effects on groundwater from waste placement could be reasonably expected to be measured or observed; i.e., considering aquifer recharge times and rate of migration of groundwater through and away from the waste.

In contrast, SMCRA does not require specific numbers of wells, design specifications, or requirements for well placement. Furthermore SMCRA monitoring design and deployment do not focus on waste impacts, but instead the purpose is to examine the impacts from the mine as a whole. Monitoring design is not intended to separate impacts from waste disposal from impacts of mining. Furthermore, SMCRA regulations lack levels of concern for monitoring parameters and require only a limited list of parameters, intended to capture mining, not waste, impacts (TDS or specific conductance, pH, total iron, total manganese and water levels). SMCRA does not require monitoring for Appendix I or for specific ash parameters, although on a permit-by-permit basis, additional monitoring may be required. Also, SMCRA regulations provide for cessation of groundwater monitoring at bond release, typically within a number of years following completion of revegetation. This can be as soon as 3 years after revegetation. This would be far too soon to assess impacts from disposal of large quantity of coal ash.

2. Performance Standards:

Under RCRA, the Maximum Contaminant Levels (MCLs) specified under the Safe Drinking Water Act serve as the groundwater performance standard. The facility is to be operated so that it does not cause groundwater quality to exceed the MCLs. The point at which compliance is demonstrated is to be no more than 150 meters from the waste placement boundary and located on the facility property. (40 C.F.R. 258.40(d) and 258.2)

In contrast, SMCRA regulations do not identify the elements of a performance standard: parameters to be assessed, allowable concentration levels, and point of compliance. The statute and regulations fail to define key terms such as "contamination," "material damage," and "minimize disturbance."

<u>3. Deed Recordation And Notice To Subsequent Purchasers</u>

Section 258.60(i) requires the owner/operator is to ensure that official land records note the locations and dates for all waste placement on all portions of the property, particularly where the property may be subdivided for future use. SMCRA does not contain a requirement for recordation. SMCRA regulations require restoration of all disturbed areas to conditions capable of supporting those uses which the land supported prior to mining or to higher or better uses. There are no apparent restrictions on post-mining uses of land which would protect future users.

<u>4. Corrective Action</u>

In the case of exceedance of performance standards, the owner/operator must undertake corrective action to protect human health and the environment. The first step in response to an exceedence may be to assess the scope of the problem through additional monitoring. The owner/operator may demonstrate that the exceedance results from a source other than the waste placement or that the exceedance results from error in sampling, analysis, statistical evaluation, or natural variation in ground-water quality. If the exceedance is determined to result from the ash placement, however, corrective measures should be implemented. The steps in the corrective action process include: assessment of corrective measures, selection of a remedy, selection of a schedule for the remedy, and implementation of corrective action, including interim measures that may necessary for the immediate protection of human health and the environment. (See 40 C.F.R. Sections 258.54(c)(3), 258.56, 258.57, and 258.58.)

Under SMCRA, triggers for corrective action and determination of remedial measures must be specified through permit-specific conditions and the hydrologic reclamation plan, rather than set forth in the regulations.

<u>5. Post-closure/Post-reclamation Care</u>

RCRA sections 258.61(a), (b) and (c) require monitoring and maintenance of the ash placement area should continue throughout the time period for which the effects on groundwater from waste placement could be reasonably expected to be measured or observed. This time period may extend beyond the completion of reclamation and the time of bond release for the overall mine site. Post-closure activities are to include inspection and maintenance as needed of the vegetation over the waste placement area and of any other engineered controls, such as a final cover, that may have been placed. In addition, section 258.619a)(3) requires that maintenance and operation of the groundwater monitoring system should continue throughout the post-reclamation period.

These activities are to include evaluation of results against the performance standards, and implementation, if needed, of corrective action.

In contrast under SMCRA, regulations provide for cessation of maintenance and monitoring at bond release, typically within a number of years following completion of revegetation. The period of time is usually far too short to guarantee meaningful maintenance of the cap or cover.

<u>6. Financial Assurance</u>

RCRA regulations require the owner/operator of the waste disposal unit to establish financial assurance to provide for maintenance and monitoring of the waste disposal area, specifically, and for any potential corrective action associated with waste placement. (See 40 C.F.R. 258.72, 258.73 and 258.74.) SMCRA does not require such financial assurance and SMCRA bond release typically is within a number of years following completion of revegetation.

Finally, the proposal to craft rules allowing the disposal and placement of coal combustion residues in active and abandoned coal mines is one that is fraught with environmental justice concerns. Despite the wealth realized from those who extract coal from this nation's coal-bearing regions, the wealth is not generally realized by the residents who live downhill, downstream and downwind of the mining activities; rather many of the coal-producing communities have significant low-income populations and suffer disproportionately the effects of coal extraction, transportation and beneficiation.

Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations demands that each Federal agency must make achieving environmental justice part of its mission <u>by identifying and addressing</u>, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minorities and low-income populations. 59 FR 7629, February 16, 1994. Executive Order 12898 requires OSMRE and EPA to take into account the environmental justice consequences of their actions. Id. EPA states that its goals are "to ensure that no segment of the population, regardless of race, color, national origin, income, or net worth bears disproportionately high and adverse human health an environmental impacts as a result of EPA's policies, programs and activities." 72 Fed. Reg. 14214.

E. Test Methods For Characterization of CCW Leaching Potential

The last issue I will discuss is one of the critical issues in management of CCW – the misuse of TCLP testing to characterize the potential for leaching of metals and other constituents of concern. There is good reason for generators of the CCW to insist that prior to releasing coal combustion wastes for use as fill material, appropriate characterization is conducted of the short- and long-term leaching potential of the wastes in the context in which they will be managed, whether for "beneficial reuse," as a raw material for incorporation into a product, or management in the nature of disposal. As earlier noted, these wastes contain a number of constituents of potential environmental and public health concern.

Unfortunately, the testing that is typically utilized to determine the environmental risks associated with management of CCW focus almost solely on the groundwater pathway, and is based on TCLP testing and/or analysis of "total metals."

Analysis of total metals does not provide any indication of the leaching potential or leaching characteristics of coal combustion wastes, and the U.S. EPA has recommended that management decisions not be based on total content of constituents in coal combustion residues since total content does not consistently relate to quantity released.[10]

The TCLP (Toxicity Characteristic Leaching Procedure) is the EPA test method used to evaluate the leachability of metals, organic compounds and pesticides from wastes into groundwater under one set of disposal conditions – co-disposal of CCW in a municipal solid waste landfill. The TCLP is a batch test developed by EPA in response to deficiencies in an earlier test, the Extraction Procedure (EP) toxicity test. Many of the assumptions used in developing the EP were retained, however, and the TCLP is widely considered to have serious limitations.

In principle, the TCLP simulates the leaching of constituents from the waste into groundwater under conditions found in a municipal solid waste landfill. However, the TCLP has been applied to wastes in disposal and management settings other than municipal waste co-disposal.[11]

The EPA's Science Advisory Board has criticized the TCLP protocol on the basis of several technical considerations, including the test's consideration of leaching kinetics, liquid-to-solid ratio, pH, potential for colloid formation, particle size reduction, aging, volatile losses, and co-mingling of the tested material with other wastes (i.e., co-disposal).[12] Specific limitations of the TCLP are:[13]

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[10] EPA, <u>Characterization of Mercury-Enriched Coal Combustion Residues from Electric Utilities Using Enhanced Sorbents for Mercury Control,</u> EPA/600/R-06/008 (January 2006). The report explained that "leachate concentrations and the potential release of mercury, arsenic and selenium do not correlate with total content."

[11] Science Advisory Board, 1999. "Waste Leachability: The Need for Review of Current Agency Procedures". February 26, 1999. EPA-SAB-EEC-COM-99-002.

[12] SAB, 1999.

[13] U.S. EPA, 1996. "Hazardous Waste Characteristics Scoping Study". Office of Solid Waste and Emergency Response. Washington D.C.

* TCLP underestimates leachate from some high alkaline wastes or environments.
* TCLP underestimates the leachate concentrations from oily wastes and paint wastes.
* TCLP does not account for the conditions of waste disposed of in a monofill.
* TCLP may underestimate the chelation-facilitated mobility of some waste constituents.
* TCLP does not account for oxidation/reduction reactions occurring in landfills.
* TCLP may not predict the long-term mobility of organic constituents in some treated wastes.
* TCLP may not be appropriate for contaminated soil.
* TCLP does not predict releases to non-groundwater pathways.

The literature suggests that TCLP testing is generally insufficient to predict short-and long-term leaching characteristics of coal combustion fly and bottom ash. Because of the limitations of TCLP testing, management decisions are being made that may expose generators, transporters, and reusers or disposers of the CCW to residual liabilities.

The use of short-term batch leaching tests, such as TCLP, EP-Toxicity, SPLP, and ASTM-D2987 (Shake Extraction) are not necessarily reflective of field conditions and long-term leaching potential. According to Ann Kim of the National Energy Technology Laboratory, *"[t]he utilization of coal combustion by-products (CCB) as bulk fill and mine backfill has raised questions about the potential contamination of surface and groundwater. . . . Leaching is related to the solubility of a specific compound and can be influenced by pH, temperature, complexation, and oxidation/reduction potential. . . . Regulatory tests and standard methods are not necessarily appropriate for leaching tests intended to stimulate natural processes*."

Kim, <u>CCB Leaching Summary: Survey of Methods and Results</u>."

As noted above, the TCLP test method is a batch test developed by EPA in response to deficiencies in an earlier test, the Extraction Procedure (EP). The test

> *was designed as a screening test to consider conditions that may be present in a municipal solid waste (MSW) landfill. It is acetic acid buffered to pH 5 (initial); 20: 1 liquid/solid ratio; particle size reduction to 9.5 mm; equilibrium. The reason it was designed this way was because, under RCRA, EPA is required to regulate as hazardous all wastes that may pose a hazard to human health and the environment if they are mismanaged. . . . co-disposal of industrial solid waste with MSW is considered to be a plausible "worst-case" management of unregulated waste.*

Helms, <u>US EPA Leach Testing of Coal Combustion Residues.</u>

As Gregory Helms with the EPA Office of Solid Waste explained, the EPA Science Advisory Board commented on the TCLP test method in 1991 and again in 1999, expressing concern "*about overbroad use of the TCLP test*." <u>Id.</u> *The SAB found that TCLP is a screening test that evaluates leaching potential under a single set of* *environmental conditions*. The SAB has expressed concern over the use of the TCLP when it has been applied to determine the leaching potential of wastes in disposal settings other than municipal waste co-disposal has been criticized.[14]

The U.S. EPA utilized a new multi-tiered testing framework in a research program designed to evaluate the potential for mercury release from various types of coal combustion wastes.[15] The alternative framework evaluates the potential leaching of waste constituents over a range of values for parameters that affect the leaching potential. In explaining the EPA decision to utilize a leach testing approach developed by Kosson et al. at Vanderbilt in evaluating leaching from coal combustion residues resulting from mercury emissions controls, Helms explained that TCLP wasn't used for evaluating coal combustion residues from enhanced mercury controls because "TCLP is not technically appropriate" where the disposal is not co-disposal with MSW.

Others have noted the limitations of the use of TCLP as an analytical method for predicting leaching potential of coal combustion wastes. Hassett notes that

> *The TCLP is often used in a generic manner for the prediction of leaching trends of wastes, although the intent of this test was for the prediction of leaching under co-disposal conditions in sanitary landfills. The application of acidic conditions to predict field leaching that can occur under a wide range of conditions may lead to false prediction of leaching trends. Additionally, conditions imposed on leaching systems by inappropriate leaching solutions may alter the distribution of redox species that would be found in the field and, in some cases with reactive wastes, 18 hours, as specified in the TCLP and other short-term leaching tests, may be an insufficient equilibration time. In order for a batch leaching test to be used, in determining potential for environmental impact . . . when being used with CCBs, the test must take into account the unique properties of the material, especially the hydration reactions of alkaline CCBs.*

Hassett and Pflughoeft-Hassett, Evaluating Coal Combustion By-Products (CCBs) For Environmental Performance.

Because the tests are not designed for use with CCBs, they do not account for several typical reactions in CCBs under hydration. It has long been known that laboratory leaching procedures cannot precisely simulate field conditions nor predict field leachate concentrations. However, with careful application of scientifically valid laboratory procedures, it is possible to improve laboratory-field correlations and modeling efforts focused on predicting leachate concentrations. *Id.*

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[14] Science Advisory Board, 1999. "Waste Leachability: The Need for Review of Current Agency Procedures". February 26, 1999. EPA-SAB-EEC-COM-99-002.
[15] Kosson, D.S., et al., 2002. "An Integrated Framework for Evaluating Leaching in Waste Management and Utilization of Secondary Materials." *Environmental Engineering Science*, v. 19, No. 3. pp. 159-204.

Hassett recommends the development of a selection of laboratory leaching procedures that more closely simulate field management scenarios, focusing specifically on technical and scientific variables such as the long-term hydration reactions that can impact leachate concentrations of several constituents of interest, the means by which water contacts the CCB in order to simulate the reduced permeability frequently exhibited in CCB utilization applications, the impact of pH and other CCB properties on the leachate and on resulting leaching; and the prediction of, and changes in, leaching over time. Id. Hassett recommends use of Synthetic Groundwater Leaching Procedure with a long-term leaching (LTL) procedure as a better predictor of leaching under field conditions. His work reflects that "[I]n many applications, the extended-time SGLP "*has demonstrated trends significantly different from TCLP and other commonly used leaching protocols."*

The explanation for the differing results and trends between the extended-time SGLP and TCLP "*can be explained by the fact that many commonly used leaching tests impose conditions different from those in a field environment on samples, and, thus, bias data in a manner leading to inappropriate interpretation for environmental impact. Elements most often affected include arsenic, boron, chromium, vanadium, and selenium."* Id.

The EPA Report on Characterization of Mercury-Enriched Coal Combustion Residues from Electric Utilities Using Enhanced Sorbents for Mercury Control, EPA/600/R-06/008 (January 2006) further underscores both the importance of utilizing proper test methods for characterization of these coal combustion wastes, and the trend towards increasing potential toxicity of such wastes as air pollution controls better capture metals entrained in and released during combustion of the coal. Among the observations of the agency were that "*arsenic and selenium may be leached at levels of potential concern from CCRs generated at some facilities both with and without enhanced mercury control technology [and that] further evaluation of leaching or arsenic and selenium from CCRs that considers site specific conditions is warranted."*

With respect to the sufficiency of TCLP, EPA noted that leaching tests "focused on a single extraction condition" would not have allowed for an evaluation of the variations in anticipated leaching behavior under the anticipated field disposal conditions.

The reliance on total metals analysis and TCLP data rather than on laboratory data that more accurately and adequately characterizes the leaching potential and "nonhazardous" nature of the wastes over the long-term, places generators in a position where they cannot demonstrate with any degree of confidence that the use of these CCBs meets the characterization and management requirements of the beneficial reuse regulations, or that the containment for a disposal facility has been properly designed to address the potential for leaching constituents of concern Coal combustion wastes may prove to leach constituents of concern at below levels of both regulatory and environmental concern, but the reliance on TCLP and total metals test methods is insufficient to support such a finding for these end uses.

Utilities and other facilities combusting coal that are contemplating allowing third-party use or management of generated CCW should contract with an independent entity that is familiar with the specific issues relating to testing of CCBs in order to identify and then conduct appropriate longer-term leaching procedures, such as Kosson protocol, the LTL extended-time variant of the SGLP as described by Hassert and sequential leaching tests such as that described by Ziemkiewicz that leach the CCB with a sample of the water that will come into contact with the CCB (through surface infiltration of rainfall or groundwater) until the alkalinity is exhausted and the pH of the leachate returns to that of the encountered water. Such dynamic testing under a range of conditions will better predict the long-term leaching potential of these coal combustion wastes when used as fill in conditions where they are not isolated from surface or groundwater infiltration.

With respect to co-disposal of coal combustion wastes at mines, the use of TCLP or SPLP testing is not appropriate as a test to characterize the long-term leaching potential of wastes co-disposed in coal mines, and will not enable prediction of the hydrologic consequences of introduction of such wastes into mine workings.

TCLP and SPLP tests measure the quantity of inorganic constituents that readily leach out of a coal ash sample under controlled laboratory conditions for short periods, and are *not* designed to simulate actual conditions in the coal mines where CCW is placed. The actual conditions in mines are more geochemically complex. Placements usually involve large volumes of coal ash in much more concentrated environments for leaching, a variety of overburden materials, and changing chemistries of groundwaters and leachates moving through the coal ash. Also missing from the SPLP is the ability to predict coal ash leaching behavior over time. Coal ash placements will produce leachate over decades, not hours. Different constituents in CCW and the surrounding overburden will become more or less soluble as these factors change. Not surprisingly, researchers at US EPA, US DOE, and at numerous universities have found standard leaching tests, such as the SPLP, to be unreliable, routinely failing to predict the leaching behavior of numerous contaminants in coal ash at CCW disposal sites.[16] As a result, concentrations of metals and other constituents in groundwater affected by CCW are often markedly different from concentrations generated in tests such as the SPLP.

A study of a bituminous fly ash disposal site revealed that several different leaching tests, both column and shake extraction, failed to predict the contaminants found in the monitoring wells.[17] The study found that leaching tests both over predict and under

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[16] From testimony of Greg Helms, USEPA Office of Solid Waste and Emergency Response, Washington D.C.; Ann Kim, US Department of Energy, National Energy Technology Laboratory, Pittsburgh PA; David Kosson, Ph.D., Chairman, Department of Civil and Environmental Engineering, Vanderbilt University, Nashville TN; and Rick Holbrook, US Office of Surface Mining, Western Region, given at the December 6, 2004 Meeting of the National Research Council's Committee on Mine Placement of Coal Combustion Wastes in Farmington, New Mexico.

[17] Dodd, D.J.R., A. Golomb, H.T.Chan and D. Chartier. **"**A Comparative Field and Laboratory Study of Fly Ash Leaching Characteristics,**"** Ontario Hydro Research Division, Toronto, Ontario, Canada, in *Hazardous Solid Waste Testing: First Conference, ASTM STP 760*, American Society for Testing and Materials, 1981, pp. 164-185.

predict concentrations of pollutants and that results should be field tested until the leaching characteristics of the particular ash are fully known. The study found that leach tests are unreliable field indicators "primarily because these tests are not designed, and should not be used, to predict exactly the concentrations of leachate components that will be found in the field."[18]

The placement of CCWs at coal mines will usually take one of two forms – placement as disposal, in which case the NAS recommendation for isolating the material from contact with water <u>and</u> the mandate of SMCRA that acid and toxic-forming material be isolated from contact with surface and groundwaters, would dictate one type of management; and the proposed use of alkaline ash materials for neutralization of AMD. In the latter circumstance, the fate and leaching potential of metals and organics in the ash must be evaluated over a <u>range</u> of pH conditions, as suggested by Ziemkiewicz,[19] since interactions of the CCWs and mine water over time, and geochemical reactions of dissolution/precipitation, adsorption/desorption, and oxidation/reduction will change with changes in pH as the alkalinity is exhausted and the pH of the leachate returns to that of the mine water.

In sum, generators of coal combustion wastes, and those proposing to reuse or to manage disposal of such wastes, should assure that the appropriate test methods and approaches to determining the short and long-term trends in leaching of constituents of concern from coal combustion wastes are employed. Regulatory agencies should cease misusing TCLP as the test for determining compliance with environmental performance standards in contexts other than the limited set of field conditions that the TCLP test was intended to replicate (i.e. co-disposal in municipal waste landfills).

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[18] Ibid.

[19] Ziemkiewicz, <u>The Mine Water Leaching Procedure;</u> Ziemkiewicz, <u>Prediction of Coal Ash Leaching Behavior in Acid Mine Water: Comparison of Laboratory and Field Studies.</u>