COAL ASH IN CONTEXT

Separating Science from Sound Bites
As Regulatory and News Media Debates Continue

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As America nears the end of three years of vigorous debate over how to regulate coal ash disposal, certain descriptions of coal ash are becoming commonplace and misunderstood. Supported by a steady stream of news stories, reports, and press releases from environmental activist and other groups, the phrases "toxic coal ash" and "hazardous waste" appear frequently in the news media.

What do these phrases really mean, and how does coal ash compare to other materials in the environment around us? Not surprisingly, the science paints a picture very different from media stories.

So what is coal ash?

Coal ash is the unburned/unburnable residuals from the combustion of coal. Coal is naturally present in our environment and was made over millions of years from decayed plant matter. Minerals present in the soil were taken up into the plants as they grew. When organic matter in the coal is burned and consumed, inorganic minerals are left unburned and make up what we know as coal ash. These same minerals are present in the soils in the U.S. today, and throughout the world.

The Electric Power Research Institute (EPRI) has published a report that compares the levels of minerals in coal ash and in natural materials (EPRI, 2010a). Of the four types of coal ash compared in the report, fly ash generally has the highest concentrations of unburned minerals, thus we will focus on that here. Figure 1 compares the range of concentrations of

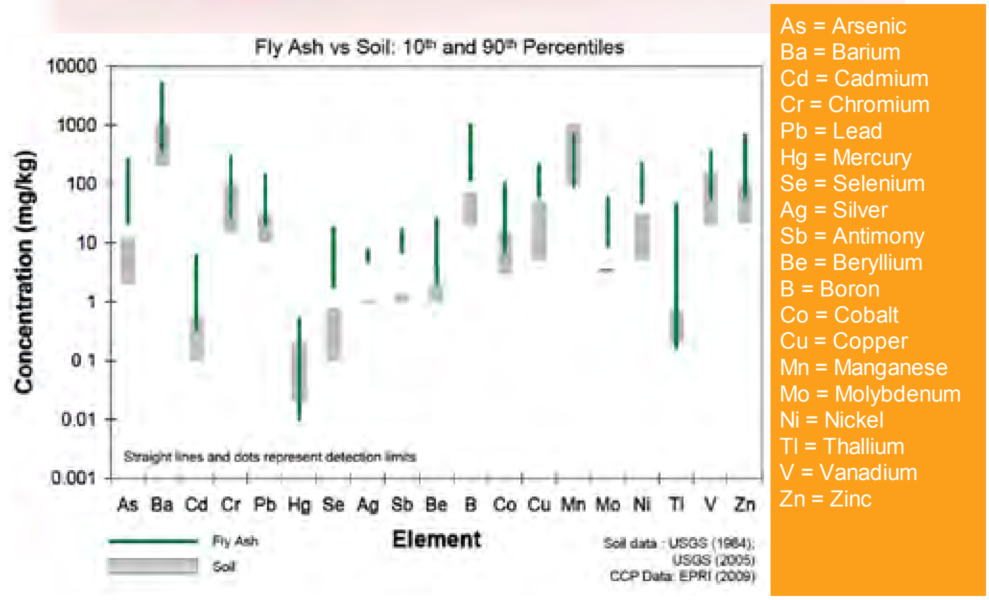


Figure 1: Coal Ash is Similar to Other Natural Materials.

Source: EPRI, 2010. Comparison of Coal Combustion Products to Other Common Materials – Chemical Characteristics. Report No. 1020556. Available for download at www.epri.com.

minerals in fly ash versus soils in the U.S. As shown, there are many cases of overlap between the concentration ranges, although fly ash generally has a higher concentration range than soil.

Of the minerals presented in Figure 1, arsenic has gained the most attention. Figure 2 shows the range of concentration of arsenic is soils in the U.S., in data compiled by the U.S. Geological Survey (USGS, 2010). Note that USGS has compiled national maps for many of the minerals present in coal ash, and they are continually adding to this database.

Is coal ash "hazardous waste?"

In the regulatory world, "hazardous waste" has a very specific meaning. This meaning has frequently been taken out of context in the public debate over coal ash. According to U.S. Environmental Protection Agency (EPA) regulations, a material is considered "hazardous" for the purposes of disposal if constituents are "leached" from the material at concentrations higher than regulatory-defined levels. The test used to make this determination, called the Toxicity Characteristic

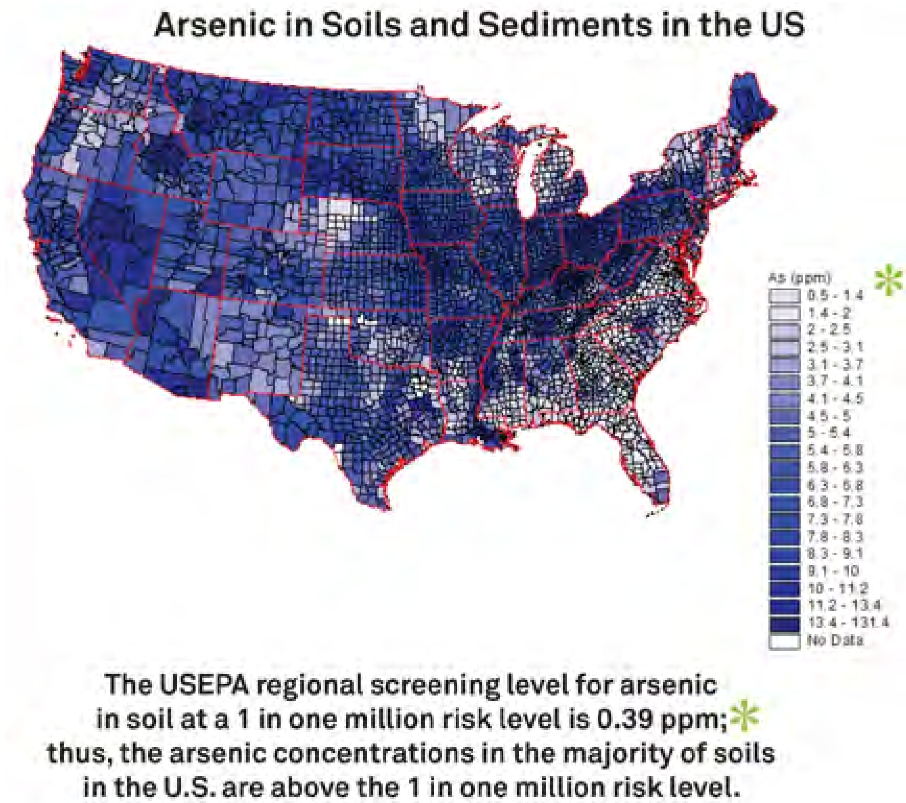


Figure 2: Arsenic is Present in our Natural Environment

Sources: USEPA, 2010. Regional Screening Level Table. May 2010. http://www.epa.gov/region09/superfund/prg/index.html
USGS, 2010. The National Geochemcial Survey. Database and Documentation. http://tin.er.usgs.gov/geochem/doc/home.htm

Leaching Procedure (TCLP), is meant to mimic the harsh and acidic conditions found in municipal solid waste (MSW) landfills. If a material is classified as hazardous using this procedure, it cannot be disposed of in a municipal solid waste landfill and it can be considered for regulation as a "hazardous" waste (40 CFR Part 261.24).

Rarely have samples of coal ash "failed" the TCLP test (EPRI, 2010a), indicating that coal ash does not qualify for regulation as a "hazardous waste" based on its toxicity. Indeed, the EPA reached this conclusion in two Reports to Congress (in 1988 and 1999) and two formal Regulatory Determinations (in 1993 and 2000).

So where did the prevalent link of "hazardous waste" to coal ash come from? Responding to the failure of a Tennessee coal ash disposal facility in December 2008, the EPA proposed options for regulating coal ash disposal in proposed rules issued in June 2010. One of those options called for regulation under Subtitle C of the Resource Conservation and Recovery Act (RCRA), which is the section that covers "hazardous waste." Two things about that proposal are worth noting. First, EPA did not claim that coal ash qualifies as a hazardous waste based on the toxicity characteristic. Rather, the agency cited "damage cases" like the Tennessee incident as justification for regulation under Subtitle C. Second, the landfill design EPA proposed under both its "hazardous" (Subtitle C) and "non-hazardous" (Subtitle D) regulatory options were essentially the same. EPA acknowledged that disposing of coal ash in landfills that meet "non-hazardous waste" design is protective of human health and the environment. Note that only regulation under Subtitle C would provide EPA with direct enforcement authority over coal ash disposal that excludes the states.

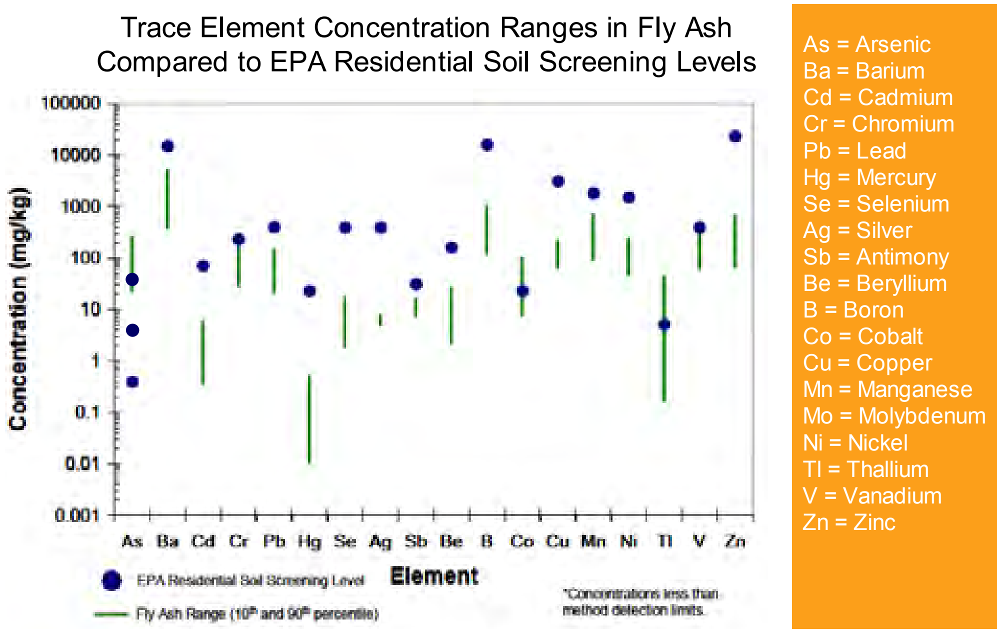


Figure 3: Coal Ash Levels Similar or Less than Risk-Based Screening Levels
Source: EPRI, 2010. Comparison of Coal Combustion Products to Other Common Materials – Chemical Characteristics. Report No. 1020556. Available for download at www.epri.com.

Is coal ash "toxic?"

As noted earlier, the sensational word "toxic" has appeared frequently in the media. And like hazardous waste, it too has a specific scientific meaning. A substance is considered to be toxic only if it has a way to move from a material in the environment and into a person or organism in sufficient quantities to cause damage.

For example, one of the elements of concern in coal ash is mercury. But compact fluorescent light bulbs in our homes contain mercury – in much higher concentrations than in coal ash[1]. The presence of mercury in coal ash does not make it "toxic" any more than light bulbs are "toxic." To determine if a material poses a "toxic" threat, environmental scientists and regulators perform "risk assessments."

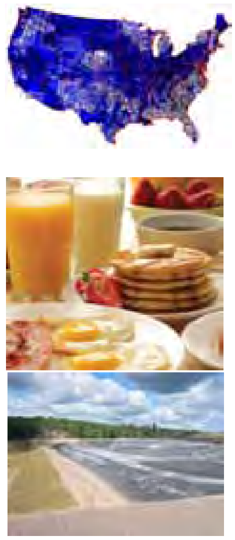
Risk assessment is a process that combines estimates of exposure with estimates of toxicity to identify if a health risk is posed by a specific exposure. Risk assessment can also be used to develop screening levels for constituents in soil in a residential setting (USEPA, 2011). These are levels in soil that a child and adult could be exposed to daily without adverse effect. These levels take into consideration both potentially carcinogenic effects and noncarcinogenic effects (i.e., effects other than cancer). These are called screening levels because they are derived for a very generic and universal exposure setting and can be applied anywhere. If concentrations are below these levels, then it is accepted that there is no expectation of adverse effects. However, if concentrations are higher than these levels, the specific situation needs to be evaluated in more detail. It does not mean that there is a risk of adverse effects. Higher levels can also be without adverse effect, depending on the specific situation.

Figure 3 shows the range of mineral concentrations in fly ash compared to the EPA's residential soil screening levels. Other than for arsenic, all of the minerals have concentration ranges in fly ash below the residential soil screening level, or overlapping the screening level (only cobalt and thallium).

Of the minerals present in fly ash, arsenic is the only one classified as a carcinogen for the ingestion route of exposure. As a carcinogen, three residential soil

[1] Compact fluorescent light bulbs (CFLs) currently contain approximately 5 milligrams of mercury (NEWMOA, 2008; see the EPA-funded report at http://www.newmoa.org/prevention/mercury/imerc/factsheets/mercuryinproducts.pdf). The maximum amount of mercury detected in the various types of coal ash is 1.5 milligram of mercury, in a kilogram of ash (EPRI, 2010a), though the normal range of mercury in coal ash is much lower than this.

screening levels are depicted on the graph in Figure 3, corresponding to EPA's target risk range for regulatory purposes of a one in one million risk level (the lowest blue dot on the graph), a one in one hundred thousand risk level (the middle blue dot on the graph), and a one in ten thousand risk level (the upper blue dot on the graph). Thus, the risks associated with daily direct ingestion exposure to fly ash over a residential lifetime overlap and are slightly above EPA's target risk range. This type of exposure scenario could only occur if someone lived on top of a fly ash landfill or if all of the soil in their yard was replaced specifically with fly ash. Also note that even the range of background concentrations of arsenic in soils (shown in Figure 1) are above EPA's residential soil screening levels for the one in one million and one in one hundred thousand risk levels.



ARSENIC COMPARISONS

Material	Arsenic
Average in the Earth's crust	3.4 mg/kg
Background levels in soils in the US	
Range	<0.001 - 97 mg/kg
Average	7.2 mg/kg
Range in Fly ash	22 - 261 mg/kg
Range in Bottom Ash	2.6 - 21 mg/kg
Total Daily Exposure from Food	0.05 - 0.058 mg/day
Range of incidental arsenic ingestion if child exposed to fly ash rather than soil on a daily basis	0.0044 - 0.052 mg/day
Range of incidental arsenic ingestion if child exposed to bottom ash rather than soil on a daily basis	0.00052 - 0.0042 mg/day

Figure 4: Arsenic in Perspective
EPRI, 2010. Comparison of Coal Combustion Products to Other Common Materials – Chemical Characteristics. Report No. 1020556. Available for download at www.epri.com; ATSDR Toxicological Profile for Arsenic. Available for download at www.atsdr.cdc.gov/toxprofiles/index.asp; See text for calculation.

Because arsenic is naturally present in soils, it is also present in the foods that we eat. Figure 4 shows the range of concentrations of arsenic in soils, and in fly ash and bottom ash (EPRI, 2010a). The U.S. Agency for Toxic Substances and Disease Registry (ATSDR) has estimated the amount of arsenic ingested from a standard diet in the U.S. population (ATSDR, 2007); this is also presented in Figure 4. Using the same assumptions about exposure used by EPA to calculate the residential soils screening levels, and assuming that a child does live on top of a fly ash or a bottom ash landfill, the amount of arsenic that would be ingested from the coal ash has been calculated[2], and presented in Figure 4. As shown, these ranges are within or below the range of arsenic exposure from our diet.

In other words, a person would have to eat a lot of coal ash in order for it to become "toxic."

What about the "2 in 100" risk number that gets reported?

As part of its rule-making proposal, EPA published a draft risk assessment for the disposal of coal ash (EPA, 2010). This risk assessment evaluated the risk of using groundwater as drinking water down gradient from a coal ash disposal unit. EPA made many conservative assumptions when conducting the risk assessment, such that the risk results are much more likely to over-estimate than under-estimate risk to human health and the environment. (This element of the EPA

[2] Calculated assuming a child incidentally ingests 200 milligrams of soil or coal ash per day [e.g., for fly ash at the low end of the concentration range: (200 mg coal ash per day) × (22 milligrams arsenic per kilogram of coal ash) ÷ (1,000,000 mg coal ash per kilogram of coal ash) = 0.0044 milligrams of arsenic per day].

risk assessment has not been widely noted in the media.) Despite this, it is instructive to look at the results in more detail.

The highest risk that EPA calculated was for coal ash surface impoundments that contain both coal ash and coal refuse (which is coal that is not suitable to be burned). The predicted drinking water risk is two in one hundred, which is clearly much higher than the EPA's target risk range identified above. This number has been used in media reports and in public comments on the rule-making process to support the need for a "hazardous waste" designation for coal ash. But what does this risk result really mean?

EPA's objective for the risk assessment was to "evaluate, at a national level, risk to individuals who live near WMUs [waste management units] used for CCW [coal ash] disposal." However, this was not achieved due to the structure of the risk assessment. EPA evaluated 508 coal-fueled electrical utility facilities in its risk assessment, and ran 10,000 calculations for each disposal scenario that it evaluated. For each and every one of those scenarios, EPA assumed that someone lived downgradient of the coal ash disposal unit and used shallow groundwater for drinking water. EPA did not acknowledge conditions where exposure would not occur, such as where no one lives downgradient of a coal ash disposal unit, or where municipal water or deep wells may be used for drinking water. EPRI did a detailed evaluation of aerial photos of the 508 facilities that EPA included in their risk assessment (EPRI, 2010c). EPRI found that only 15 percent of the facilities evaluated by EPA had buildings present downgradient from an ash disposal unit that could be residential dwellings. Fewer than 3,000 potential dwellings were identified. Based on U.S. Census data results showing an average of 2.59 people per household in the U.S. (USCB, 2010), this could be a population of less than 7,770 individuals compared to the U.S. population of over 307 million. If we assume that all of these potential 7,770 individuals live downgradient from an unlined surface impoundment, the scenario with the highest predicted risk of 2 in 100, and assume that they all use shallow groundwater as drinking water, then it can be calculated that 155 individuals could potentially develop cancer. Thus, the "risk to individuals who live near WMUs used for CCW disposal" "at a national level" is 155 in a population of 307 million, not a risk of 2 in 100.

To provide further context to EPA's predicted risks and these results, the measured background cancer incidence in the U.S. is 1 in 2 for men and 1 in 3 for women.

How does coal ash disposal compare to disposal of other wastes?

EPRI has published a report that provides a risk-based comparison between leachate generated from MSW landfills and coal ash management units (EPRI, 2010b). From the results presented in that report it can be concluded that the relative health risks associated with leachates from MSW landfills and coal ash management units are similar. One striking difference is that there is only one carcinogen that is a risk driver for the coal ash leachate, while MSW leachate risk drivers comprise over 30 potential carcinogens, including volatile organic compounds, semivolatile organic compounds, PCBs, dioxins and furans and pesticides. Thus, the engineering controls used to successfully manage "non-hazardous" MSW landfills and their contents and the generated leachate under Subtitle D of RCRA can be applied to coal ash management units and be protective of the environment.

While toxicity risks for coal ash and MSW are similar, the EPRI report points out that managing an MSW disposal facility is much more complicated than managing coal ash disposal. Coal ash is typically disposed in "monofills" containing a single, homogenous type of inorganic material. MSW landfills have a wide variety of contents including residential food scraps, yard trimmings, wood, metals, plastics, glass, and other materials. These materials are attractive to "disease vectors," such as vermin and other animals that must be managed at an MSW landfill to prevent the spread of diseases. Furthermore, because of the organic nature of much of the MSW landfill contents, methane gas is produced by the natural breakdown of these contents. Methane is flammable and explosive, as well as a potent greenhouse gas. Controlling for disease vectors and flammable gases are not issues associate with coal ash disposal facilities.

What are appropriate management approaches for coal ash disposal?

EPA's proposed Subtitle D "non-hazardous" regulations for coal ash disposal would be fully protective of human health and the environment. Also, legislation currently under consideration in Congress would create a coal ash disposal regulatory structure modeled after successful MSW disposal programs. HR 2273 – the "Coal Residuals Reuse and Management Act" – would prevent the EPA from regulating coal ash disposal as a "hazardous waste" while simultaneously directing states to enact enforceable permit programs modeled after successful municipal solid waste programs. HR 2273 would mandate a state-administered permit program to create enforceable requirements for groundwater monitoring, lining of landfills, corrective action when environmental damage occurs and structural criteria. The bill also would provide the federal EPA with the authority to directly regulate coal ash disposal if a state is unable or unwilling to implement the permit program.

More than 240 million tons of MSW are generated in the United States each year, compared to approximately 135 million tons of coal ash. States operate effective regulatory programs for the disposal of MSW at more than 1,900 locations and are more than capable of doing the same for coal ash – a material with similar toxicity risks and fewer management problems.

When science is considered over sound bites, coal ash is neither "hazardous" nor "toxic." America's environment would benefit if less time was spent on non science-based arguments and inflammatory language in the media and more time enacting meaningful, appropriate, and protective disposal regulations. ❖

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