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Kingston Power Plant Ash Spill

It was not long ago that one of our members gave a paper on common table salt where he brought out its role in history and the importance it has for us today. About the time that paper was given, an event happened in our neighboring state of Tennessee that gave me an idea for a paper about an even more common material: dirt. Not the dirt you might find in your backyard, but something very similar, similar elements but different composition.

In the early morning of December 22, 2008; a retention dam for an ash pond at TVA's Kingston Power Plant gave way and a large volume of coal ash sludge escaped into the Emory River and the surrounding area. I heard about it on a morning news show and over the next several days, read many newspaper reports of the catastrophe. Depending on whose account you believe, anywhere from 3.5 million to 1.1billion cubic yards of the material were released leading to deposits up to ten feet thick in some areas. More accurately, near the source ash deposits were up to six feet thick, then tailing off to a few inches at the extremities. Also, early reports had this ash as being some very toxic stuff and potentially very harmful to local air and water.

Lawyers for environmental organizations and others such as Erin Brockovich were there in a matter of days. Quoting from an article by Ms. Brockovich:

"As a result of a 1.1 billion gallon spill of contaminated fly ash, there has been discussion, press reportage and blogging about the environmental disaster in eastern Tennessee. Most of us have seen the pictures -- a 300+ acre area strewn with black and brown muck as far as the eye can see. Houses lifted off their foundations and thrown across the road, yards filled so high with ash that people can't leave their homes without stepping in it, roadways littered with the ash from trucks going to and from the site, and an eerie still where active life once existed. While this story continues to unfold -- as more samples are taken that delineate the true toxicity of this mess, as TVA makes plans to contain and abate the disaster --

there is a story that has not been told. It is a story that must be told. And that story is the lives of innocent bystanders that have been turned upside down by this avoidable disaster."

She then relates how she got involved, saying she was asked to come. Followed by:

"When I first arrived on the site, I was pretty quiet. It took a while to absorb what I was looking at. I knew there was a lake but an entire area was gone. I kept wondering "Where did the water go?" I couldn't decide if it looked more like a tornado had gone through, a mudslide, landslide, maybe a volcano erupted or a tidal wave. It is now a "moonscape." The landscape has completely changed. It is almost unidentifiable. Watching TV never gives you an idea of the extent of damage. It's only when you stand there that you can actually feel the magnitude.'

'It struck me that I had an unusual taste on my lips and in my mouth. I asked others if they noticed that, and they did. Some experienced scratchy throats, respiratory problems, itchy and burning eyes and tasted what one expert believed to be sulfuric acid. If we were experiencing this much discomfort after a few minutes, what on earth are the people who live here feeling?'

'We all wonder what will happen to the ecosystem: the fish and wildlife, the human life. How far reaching is this event? What does the future hold for the public health and safety? Overnight a whole community's lifestyle is gone."

The article concludes with:

"Science usually lags behind the law. But in this case, law lags behind science because coal fly ash handling is not regulated as it should be. And we have a pretty good grasp on the fact that Coal Fly Ash is *not healthy.*'

'A poison is a poison. It certainly can't be good for you. Does anyone believe that the arsenic in the fly ash along with other heavy metals won't leech into the groundwater? 5.4 million cubic yards of toxic compounds unleashed into the garden. We don't need a crystal ball to see the rough road ahead."

The spill was bad; I am not denying that, but it was not as potentially harmful to health as some of the early reports indicated or as harmful as Ms. Brockovich implies, nor was it as large as some reports indicated. It also was not as

catastrophic: twelve homes were impacted with three being uninhabitable and only one being washed from its foundation. For the owners of these homes it was catastrophic. Also, a train delivering coal to the plant was stalled by ash covering the track and an estimated 100 or so fish were killed. No one was hospitalized or seriously injured.

I have spent the last thirty two plus years helping power plants improve the collection of fly ash from coal fired boilers and did not realize that I was in contact with such bad stuff. Just what is flyash or for that matter coal ash in general? It usually comes from three sources: 1) the over or under burden of the coal seam, that is, dirt removed with the coal in the mining process, 2) mineral deposits imbedded in the coal, and 3) residual organic and inorganic matter, from the raw materials that produced the coal.

Silica, or sand, and aluminum oxide (alumina), found in clays, make up 80 to 90% of the ash's composition. Iron, calcium, magnesium, potassium, titanium and sulfur are the other primary constituents. These last elements, along with the silica and alumina typically make up 99 plus percent of the ash. Some of trace elements found in the ash are: arsenic, beryllium, mercury, copper, nickel, zinc and selenium. Usually only a few parts per million or less of these elements are found in the ash. That is, less than one percent of the ash is composed of toxic chemicals. Typically, all of these are found in soils. In fact, most of the trace elements found in coal ash are found in the wood ash from your fireplace. It is the trace elements that are potentially toxic. Before looking at their involvement in the spill, I would like to tell you a little bit about the plant.

The Kinston Plant has nine coal-fired boilers and nine steam-driven generators with an installed generating capacity of 1,700 megawatts. These units were first

put into service in 1954 and 1955. They were built to supply power to the Oak Ridge National Laboratories. In the recent past, the annual average generating rate has been 1,150 megawatts. The plant burns approximately 14,000 tons of coal a day or 5.1 million tons per year. A rail car holds approximately 100 tons of coal and a unit train is made up of 150 cars. Thus, the plant consumes 140 car loads or almost a unit train per day. That's a lot of coal. As a boy, my family used a coal-fired floor furnace for heat during the winter; and at the rate we burned it, it would have taken more than 50 years for us to consume a car load.

Nationwide, the U.S. has approximately 1.1 million megawatts of generating capacity with 48% of it from coal, and here in Kentucky, 93% of our electricity is generated from coal. Nationwide, we burn 1.05 billion tons of coal per year.

The coal used at Kingston typically has an ash content of 6 – 12% with greater than 99.5% of that ash being captured as waste, which means they are generating approximately 1,120 tons of ash per day or 409 thousand tons of ash per year. Approximately 10 to 15% of the ash is captured in the boilers as bottom ash while 85 -90% consists of fly ash and is captured by electrostatic precipitators or fabric filters. The fly ash is mixed with water and conveyed, along with the bottom ash, to a dredge pond. At the Kingston plant there were and still are more than one dredge pond. Most of the ash settles there while the over flow water goes to a stilling pond were remaining ash settles. After de-watering, the ash is either sold for use as road bed or in the production of cement or it is land filled.

A retaining wall of one of the dredge pond gave way causing the spill. News reports stated that the ash released had been building up for decades. Using the reported volume of the pond a simple calculation would lead to approximately 5 to 7 years of normal operation being required to fill it. When it is dredged after

dewatering of the ash, there is always some residual. So a small portion of the release may have been there for decades, but not all of it.

A legitimate concern was that in the settling and dewatering process some of the heavy metals may have leached from the ash and settled in the residue. Many tests by EPA, TVA, the State of Tennessee and others have been done to determine the impact of the spill on the land, water and plant and animal life in the area.

Arsenic was a major concern. Arsenic is found throughout the U.S. in water, air soil and food. It basically takes two forms: organic and inorganic. The organic forms are rapidly excreted from animals and are considered non-toxic. The inorganic forms are the ones toxic to humans. These are less toxic to other animals. Algae, aquatic plants and fish can convert inorganic forms to organic forms, lessening the impact that the arsenic from ash found in the river might have on humans.

Tennessee soils have arsenic concentrations ranging from 0.1 to 120 milligrams per kilogram or 0.1 to 120 parts per million. Other areas of the country can have much higher levels where arsenic bearing minerals are found. Test samples of the Kingston spill had levels of 2.8 to 166 parts per million, slightly higher than surrounding soils.

Drinking water standards limit arsenic levels to 10 micrograms per liter or 10 parts per billion. One has to be exposed to arsenic levels above 100 parts per billion for long periods of time for it to impact health. As an example, lifetime exposure to arsenic at 100 parts per billion leads to an estimated 1 in 10,000 chance of developing lung cancer. Arsenic levels in Emory River samples following the spill were either undetectable or below drinking water standards in all but four out of 200 samples. Similar tests of wells above and below the site yielded similar results

as to levels of arsenic. Of the possible toxins, arsenic was the only one to show any elevated levels.

A little aside: In the play Arsenic and Old Lace, two sisters kill by giving their victims a cocktail containing arsenic. It also contained strychnine at twice the level of the arsenic. Strychnine is more lethal and kills more rapidly. It was the strychnine not the arsenic that got them and the play and the later movie should have been titled Strychnine and Old Lace, but that doesn't have the same ring.

TVA has brought 70 of the properties affected by the spill and the land has been cleared of ash. Watts Barr Lake and the Tennessee River downstream of the plant are open for swimming, boating and fishing. The dredging of the Emory River is to be completed by May 15 of this year. It will then be opened for the above activities.

The Kingston plant is one of approximately 600 coal burning plants in the United States. These plants generate slightly more than 48% of the electricity generated nationwide. Percentages for other sources are: natural gas, 23%; nuclear, 20%; hydro, 4.5%; oil and petroleum coke; 1.2%; wind, 0.8%; solar 0.2% and others, including garbage, wood waste, tires and manure, etc., 3.3%. If it burns, someone will find a use for it.

Going back to coal, when it is burned 90 to 95% goes up the stack as gases with the largest component other than nitrogen being carbon dioxide, CO_2. Approximately 60 to70% of coal is carbon and for every pound of coal burned, 3.67 pound of CO_2 is released. This means that for the 1.05 billion tons of coal we burn per year, we put approximately 2.5 billion tons of CO_2 into the atmosphere or 37% of the total annual CO_2 produced by the U.S. We generate approximately 84

million tons of ash. It is not the ash that worries me it is the CO_2. It is the elephant in the room that we don't want to see.

We, the United States, represent approximately 4% of the world population yet we consume 25 to 28% of the energy used. China with more than four times our population passed us in energy consumption at the end of 2006 and India's consumption is increasing as its economy grows. Europeans are far below us on a per-capita basis. I don't want to get into the global warming issue, but we do need to consider the impact our use of coal and other fossil fuels may be having on the environment since it is projected that the use of coal will continue to increase for the next 30 years.

Anything we do will cost, but there are several options to consider: increased efficiency, carbon sequestration, alternative fuels and alternative sources. Currently approximately 30 to 35% of the energy in coal is converted to electrical energy. That is, you give me a dollar and I will give you 33 cents back. Not a very good deal. With gasification of the coal and combined cycle generation the efficiency can be increased into the 50% range. This would reduce our current consumption by one-third. Nuclear is also an option with the generating cost per megawatt-hour less than that of coal, but the capital cost for new plants is much higher than other options. Natural gas is cheap now due to new techniques for extracting it from the ground. The potential for harm to our ground water aquifers by fracturing, one of these techniques, has led some to question the long term viability of natural gas as a serious alternative. I also remember the early 90's when gas was cheap and utilities built a lot of combined cycle units. It did not take long for gas prices to more than double and many of those units now sit idle. Also, it will be many years before wind or solar supply a significant portion of our

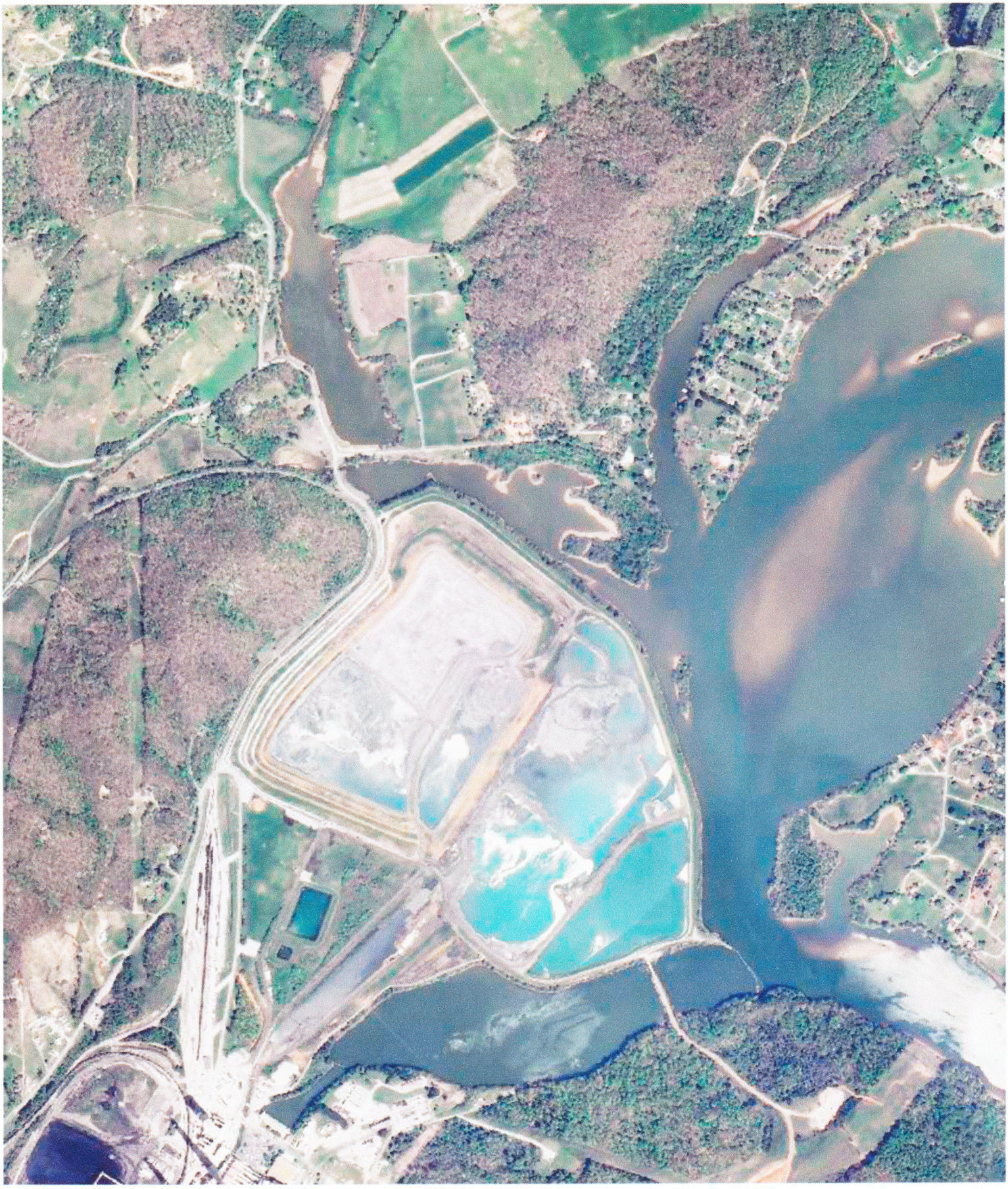
energy needs. And, carbon sequestration, if it is used, will be extremely expensive using current technology.

I have visited two plants that are switching one or two of their units to carbon neutral fuels, that is, they are to burn renewable plant or wood products. If you think about it for a few minutes you will see that they are not carbon neutral unless they plant much larger quantities of their fuel than they consume. This will be required to compensate for the fuel required to plant, cultivate and harvest the crop.

I have talked longer than I should have on a subject of more interest to me than many of you, but I would like to mention one hot topic of the day that has become a political football. I will try to keep away from politics. The topic is a cap-and-trade policy for reducing CO_2 emissions. I know you remember all of the talk during the late 70's and early 80's about "acid rain" due to sulfur and nitrogen oxides emitted from power plants. It was a cap-and-trade policy that led to the reduction in those pollutants. You hear very little about acid rain today. The smog in big cities due to nitrous oxides emitted from automobiles has been greatly reduced by the installation of catalytic converters on vehicles. A stick-and-carrot approach was used with the automotive industry to accomplish this. We are going to have to address CO_2 emissions as the global economy increases and we all need to become better informed as to available options if we are going to make good decisions.

Back when I was teaching, I used to tell students: "Our planet is a spaceship and we can help determine its destination or we can just go along for the ride."

Aerial Image of Kingston Ash Slide Pre-Event 2008



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Aerial Image of Kingston Ash Slide 12/23/2008

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