ENVIRONMENTAL PROTECTION AGENCY
Attention: Docket ID EPA-HQ-RCRA-2009-6040

Hazardous and solid waste management system; identification and listing of special wastes; disposal of coal combustion residuals from electric utilities.

Comments by Frank Ackerman, Ph.D., and Elizabeth A. Stanton, Ph.D.[1]

## 1. Introduction

EPA is revisiting its regulation of the disposal of coal combustion residues (CCRs), in the wake of the catastrophic release of coal ash in Kingston, Tennessee, in December 2008, and other concerns. Numerous risks, costs, and benefits associated with CCR use and disposal are described, estimated, and monetized in EPA's Regulatory Impact Analysis (RIA),[2] which provides a cost-benefit analysis that plays an important role in the evaluation of the proposed regulations. EPA is comparing the options of strict federal regulation under Subtitle C of the Resource Conservation and Recovery Act (RCRA) versus less stringent regulation, relying on states and citizen lawsuits for enforcement, under RCRA Subtitle D. The RIA also evaluates a third proposal, referred to as "D prime," which is a weaker variant on Subtitle D regulation.

In these comments we examine the RIA calculations, describe our attempt to replicate the RIA results, and offer a corrected, alternative version where needed. The corrected version is summarized in the body of these comments, and described in full in the appendix. In brief, there are errors of varying magnitudes in many of the RIA's numbers. Relative to the RIA estimates, our corrected calculations raise the benefits of avoiding accidental releases of CCRs and lower the annual lifecycle benefits of beneficial reuse (or recycling) of CCRs. In several scenarios for which the RIA reports negative net benefits of regulation, our corrected version shows positive net benefits. In all reasonable scenarios, Subtitle C regulation either has the greatest net benefits, or would have the greatest net benefits if a relatively small dollar value is assigned to the many benefit categories that are not quantified in the RIA.

### *What's missing from the RIA calculations?*

Cost-benefit analysis is designed to weigh the relevant costs of a proposal against the corresponding benefits. This process cannot yield a meaningful result unless the calculations of costs and benefits are equally complete.  In the private sector, a balance sheet that weighs all of a company's income against *some* of its expenditures does not provide a useful picture of the company's true financial condition. Likewise, in the public sector, a comparison of complete costs and incomplete benefits does not provide an accurate picture of net benefits to society.

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[2] U.S. Environmental Protection Agency (2010), "Regulatory Impact Analysis for EPA's Proposed RCRA Regulation Of Coal Combustion Residues (CCR) Generated by the Electric Utility Industry." Washington, DC: Office of Resource Conservation & Recovery, April 30, 2010. Cited later in this document as "RIA."

Yet a comparison of complete costs and incomplete benefits is exactly what EPA has produced in this case. The costs of compliance with regulation of CCRs are the monetary costs of building and operating disposal sites, installing engineering controls, and similar categories. Such costs are backed up by detailed engineering analyses, and often by recent experience in building similar facilities, or buying and installing similar equipment. These costs are well understood, and are well defined in monetary terms. In our detailed review of the RIA, we found only a few small errors in the calculation of costs of regulatory compliance.

Contrast this with the calculation of the benefits of regulating CCRs. These benefits consist, in large part, of reductions in health risks and ecological damage, due to the reduced risks of spills and pollution from CCRs. How should those benefits be measured and monetized? There are two related problems that prevent a simple answer: measurement of outcomes is difficult, while monetization can be even more challenging. In the case of health risks, how many cancers and other illnesses are avoided by CCR regulation? And what is the monetary value of each avoided cancer or other serious health outcome? The questions are analogous for ecological outcomes: How much ecosystem damage is avoided by regulation? And what is the dollar value of that reduced ecological damage? Categories that cannot be carefully measured are typically excluded, effectively valuing them at zero.

In short, the difficulties of both measurement and monetization ensure that the benefit estimates in the RIA are incomplete, and that only a fraction of these benefits are awkwardly or indirectly expressed in monetary terms. Thus there is a built-in bias in the completeness of coverage: regulatory costs are more thoroughly measured and more meaningfully expressed in monetary terms; regulatory benefits are much less completely measured, and much less adequately monetized.

So imagine finding (as we do for some scenarios in this case) that the estimated, monetized costs of regulation slightly exceed the estimated, monetized benefits. This would be comparable to a business discovering that an exact tally of monthly expenses slightly exceeds a guess at some fraction of the month's revenues. This does not prove that the bottom line for the month is a loss; on many reasonable assumptions about the missing data, the business actually ends the month in the black. Similarly, in this case we will demonstrate that omitted benefits of just $40-56 million per year would tip the EPA's cost benefit analysis in favor of the more stringent, Subtitle C, policy governing the disposal of CCRs.

***Many acknowledged benefits of CCR regulation are not monetized***

The RIA's monetary estimate of risks avoided by regulation omits all health risks from CCR disposal except one category of cancer risks, and addresses ecological damage only through weak surrogates, such as the cost of groundwater cleanup. These omissions are not hidden from view, the RIA makes clear (pp.7-8):

> The proposed regulation has categories of other benefits from avoiding future CCR impoundment structural failures which this RIA did not quantify and monetize, including potential avoided costs associated with a few possible benefit categories:

1. Litigation costs: Avoided litigation and related costs associated with such damage events.

2. Riparian damages: Reduction of toxic chemical contaminated effluent discharges from CCR impoundments to surface waters (i.e., rivers and lakes) through future phase-out of surface impoundments.

3. Non-cancer health risks: Reduction in human health risks from future reduction in human exposure to non-carcinogenic but otherwise toxic chemicals contained in CCR, such as selenium, cobalt, nitrate/nitrite, and molybdenum, which, as currently managed in CCR disposal units, can exceed the human health hazard quotient (HQ) or Maximum Contaminant Limit (MCL).

4. Dry CCR disposal risks: Human health effects from improperly managed dry disposal, which are based on ongoing research by EPA's Office of Research & Development (ORD), may pose greater risks than previously estimated by EPA in 2000 and 2007.

The RIA omits additional costs of pollution for the utilities that are responsible for CCR disposal, such as litigation and related costs due to major spills and releases, the need to buy up adjacent properties when groundwater becomes contaminated by releases from CCR disposal sites, and the supply of drinking water to residents to compensate for the contamination of wells. Litigation costs can be substantial, as illustrated by two recent settlements. In December of 2008, Constellation Energy Group paid $54 million to settle a class action suit brought by residents affected by groundwater contamination at the company's ash disposal site in Anne Arundel County, Maryland. [3] The agreement resulted in closure of the site, which is costing Constellation $14 million a year (according to the RIA), as coal ash must be shipped to a Virginia landfill nearly two hundred miles away. Landowners near the Colstrip plant in Montana settled another CCR contamination case for $25 million.[4]

Other pending lawsuits suggest that litigation costs are likely to increase in the future, absent standards that require safer management of CCR. A second group of landowners is reportedly still pursuing legal action in the Colstrip case,[5] while nearly 400 residents of Centreville, Virginia, are seeking over $1 billion in damages from Dominion Virginia Power, alleging that fly ash used to contour a nearby golf course has contaminated an aquifer that supplies the community with drinking water.[6] Victims of the TVA Kingston spill are also seeking damages,

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[3] Shultz, S. (2008), "Constellation Reaches $54 Million Settlement of Fly Ash Lawsuit," *Baltimore Business Journal*, Dec. 31. Available online at http://www.bizjournals.com/baltimore/stories/2008/12/29/daily26.html.
[4] Goldman, N. (2010), "Federal Regulation Needed for Coal Fly Ash," *The Missoulian*, April 27. Available online at http://missoulian.com/news/opinion/columnists/article_fe67cc86-5204-11df-80ee-001cc4c03286.html.
[5]Ibid.
[6] McCabe, R. (2009), "400 Residents Sue Dominion, Developer, over Fly Ash Site," *The Virginian-Pilot*, March 27. Available online at http://hamptonroads.com/2009/03/400-residents-sue-dominion-developer-over-flyash-site.

while neighbors of an Alabama landfill that had been receiving ash from the Kingston cleanup filed a citizen suit alleging violations of the Clean Air Act.[7]

Responsible parties have had to pay for alternative drinking water supplies for residents affected by coal ash sites, and these costs are likely to rise in the absence of protective standards that prevent groundwater contamination from spreading. For example, Dominion Virginia Power has committed $6 million to bring municipal water to residents concerned about ash leachate from the nearby golf course, and the city has requested additional funds.[8] Northern Indiana Public Service Companies and other parties have paid for municipal connections for 270 households in the Town of Pines, Indiana, after high levels of boron and molybdenum left private wells unfit for use. The EPA should have no trouble obtaining cost data here, as the Agency is directing Superfund cleanup at this site.[9]

EPA acknowledges in the preamble to the rule that fugitive dust blown from landfills can expose workers and nearby communities to high levels of particulate matter. The Agency's own risk screening shows that absent effective dust control measures, maximum exposures can exceed PM10 standards by nearly two orders of magnitude.[10] Even if only a small fraction of the fugitive dust is composed of fine particles (PM 2.5), monetizing the value of reducing these emissions could have a favorable impact on the cost-benefit analysis used to support the rule. For example, reducing total PM 2.5 emissions from landfills by just 500 metric tons nationwide (an average of several tons per site) through more effective controls could add a quarter of a billion dollars per year to the benefits of the proposed rule.[11]

Moreover, the RIA deals exclusively with projected future disposal of CCR – a 4.71 billion ton problem over the next 50 years – but ignores the costs of conversion to more appropriate disposal and the benefits of avoided leaching and impoundments failures for historical disposal – a 3.58 billion ton problem.[12]

There have been other attempts to value the categories of benefits omitted from the RIA. EPA's own *Handbook for Non-Cancer Health Effects Valuation* provides a detailed discussion of

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[7] Huotari, J. (2009), "$165M TVA Lawsuit Could Get Bigger," *Oak Ridger*, Jan 1. Available online at http://www.oakridger.com/community/x1277304648/-165M-TVA-lawsuit-could-get-bigger. Also, Spencer, T. (2010), "Opponents of Coal Ash Landfill in Perry County File Federal Lawsuit," *The Birmingham News*, June 26. Available online at http://blog.al.com/spotnews/2010/06/opponents_of_coal_ash_landfill.html.

[8] Saewetz, M. (2009), "Chesapeake to Extend Public Water to Fly Ash Site," *The Virginian-Pilot*, Aug. 26. Available online at http://hamptonroads.com/2009/08/chesapeake-extend-public-water-fly-ash-site.

[9] U.S. Environmental Protection Agency (2009), "Town of Pines Groundwater Plume." Region 5 Superfund. EPA ID# INN000508071. Available online at http://www.epa.gov/region5superfund/npl/sas_sites/INN000508071.htm.

[10] U.S. Environmental Protection Agency (2010), "Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills." Office of Solid Waste and Emergency Response, Draft, May 2010, p. 7. Document ID# EPA-HQ-RCRA-2009-0640-0142.

[11] Table 5C-5 of the RIA estimates a benefit of $486,312 for each ton of PM2.5 reduced, based on avoided health costs; 500 metric tons x $486,312 = $243,156,000.

[12] The EOP Group Inc. (2000), "Economic Analysis Of the Regulatory Determination On Wastes From Combustion Of Fossil Fuels." Sept. 19, 2000.

methodologies that have been used for regulatory analyses[13]. Calculations by U.S. Forest Service biologist Dennis Lemly imply that ecological damages from six CCR disposal sites (*not* including the massive Kingston, Tennessee, spill) could be as large as $1.8 billion.[14] These examples suggest that an appropriate measurement and monetization of the missing health and ecological impacts could produce a substantial increase in the RIA's estimate of net benefits from regulation, potentially more than enough to make Subtitle C regulation the most attractive option from a cost-benefit perspective.

Similarly, the RIA explores the potential stigma created by strict regulation of disposal, and its possible negative impact on CCR reuse. This effect, if it exists (reasons to doubt it are discussed below), would argue against strict regulation. Another potential stigma, the impact of spills and pollution risks on property values near CCR disposal sites, is not considered; this effect, if monetized, would argue for strict regulation.

Thus the RIA repeatedly omits categories of costs and benefits which would support the case for stronger regulation of CCR disposal. The value of these omitted costs and benefits is not zero, and it may be significant. In the median case (including the measure of induced increase to beneficial use advocated by the EPA), inclusion of omitted benefits valued at $2.1 to 2.8 billion dollars for the 50-year period, or $40 to $56 million per year would result in a favorable recommendation for the more stringent Subtitle C ruling overseeing the disposal of CCRs.[15]

In a broader perspective, much of the volume and toxicity of CCRs results from regulations under the Clean Air Act, which require a number of pollutants to be removed from the air. The cost of preventing surface water and groundwater pollution from CCR disposal could be considered part of the cost of reducing the well-documented hazards of air pollution. This would suggest a joint calculation of costs and benefits for air pollution control and for disposal of the resulting residues. In the absence of such an integrated analysis, the regulatory treatment of CCR disposal is forced to rely on the more limited measurement and monetization of water pollution risks to date.

Our recalculation corrects errors in the categories of costs and benefits calculated in the RIA, but it does not attempt to place dollar values on the categories that are not included or not monetized in the RIA.  Thus the risks of CCR disposal, and the corresponding benefits of strict regulation, are sure to be understated in the numerical estimates discussed further below.

***Regulation and reuse of CCRs***

With or without our corrections, the assumed effect of regulation on future reuse of CCRs is the dominant factor in the RIA calculations. In EPA's Scenario #1, where regulation raises the costs

[13] U.S. Environmental Protection Agency (2000), *Handbook For Non-Cancer Health Effects Valuation.* Non-Cancer Health Effects Valuation Subcommittee of the EPA Social Science Discussion Group. Sponsored by the EPA Science Policy Council. Available online at http://www.epa.gov/osa/spc/noncancer.htm.
[14] Lemly, D. (2010), "Environmental Damage Cases from Surface Impoundment of Coal Combustion Waste: the cost of poisoned fish and wildlife." Report to the Environmental Integrity Project.
[15] The range of values reflects calculations at different discount rates.

of disposal and therefore induces more reuse, the net benefits of regulation are positive under every set of assumptions, and are largest under Subtitle C.

The results are almost exactly opposite under EPA's Scenario #2, which models the "stigma" hypothesis favored by some stakeholders: Subtitle C, even though it applies only to disposal, not reuse, of CCRs, nonetheless is assumed to create a stigma of association with hazardous waste, which causes an abrupt and long-lasting drop in reuse of CCRs. In Scenario #2, net benefits of regulation are negative under almost all assumptions, and the cost-benefit balance looks worst, by far, for Subtitle C. This is true in the RIA and in our corrected version as well. Our corrections reduce the dollar value of the stigma, but do not generally reverse the finding of negative net benefits, particularly for Subtitle C, under the extreme and controversial assumptions of Scenario #2.

In EPA's Scenario #3 – described as an artificial benchmark for analysis, not a realistic possibility for the future – the new rule induces no change to beneficial use of CCRs; in this scenario costs outweigh benefits, in the RIA, under almost all assumptions. (Again, many important benefits are not monetized in Scenario #3.) The RIA makes a strong case for Scenario #1's assumption of an increase in beneficial use due to higher disposal costs. If, as economic evidence strongly suggests, higher disposal costs under the new rule would give electric utilities an added incentive to sell CCRs, give them away, or start subsidiary businesses using CCRs as raw materials, Scenario #3 is extremely unlikely.

We review the economic and legal literature on stigma, finding that the Scenario #2 hypothesis does not match the standard academic description of environmental stigma, and that it falls into a category for which courts have rarely awarded stigma damages. We also find that EPA's modeling of stigma losses in Scenario #2 is completely lacking in empirical foundation, based on arbitrary, round-number guesses about potential market impacts. Not only the magnitude, but also the duration, of the Scenario #2 stigma appears arbitrary: It is assumed to remain in effect throughout the 50-year time span of the RIA analysis. In contrast, empirical research on real instances of environmental stigma finds that the effects are often of very short duration, vanishing in as little as two years.

Thus the conclusion from Scenario #2, which appears to argue against regulation in general and Subtitle C in particular, depends on the arbitrary modeling of both the magnitude and the duration of the assumed stigma.

Based on our analysis, we recommend that EPA revise its RIA to address the numerous errors we have identified. And we recommend adoption of Subtitle C regulation, which has positive net benefits, and looks better than the alternatives, under any reasonable set of assumptions.

Our comments begin with a summary description of the RIA and our attempts to replicate its calculations, followed by an extended discussion of the stigma issue. An appendix provides additional detail on our recalculations, along with full citations of the sources we used.

## 2. Replication of EPA Results

EPA's RIA for proposed RCRA regulation of CCRs generated by the electric utility industry calculates net benefits (benefits less costs) for three different rule options, three scenarios of the frequency of future impoundment failures, three scenarios of the induced impact of the new rule on the beneficial reuse of CCR, and two discount rates. Table 1 reports net benefits for the median impoundment failure scenario, in which 10 percent of the most vulnerable impoundments fail in the next 20 years; the results of this scenario almost always have the same sign as the average net benefits across all three impoundment failure scenarios.[16]

**Table 1: Net benefits in median impoundment failure scenario, 2012-2061 (millions of 2009 dollars)**

| **7% Discount Rate:** | | | | | |
|---|---|---|---|---|---|
| **Subtitle C "Special Waste"** | | **Subtitle D (version 2)** | | **Subtitle "D prime"** | |
| **EPA (2010)** | **SEI Calculation** | **EPA (2010)** | **SEI Calculation** | **EPA (2010)** | **SEI Calculation** |
| ***Scenario #1 – Induced Increase in Future Annual CCR Beneficial Use*** | | | | | |
| $73,483 | $2,433 | $29,874 | $3,421 | $12,341 | $3,365 |
| ***Scenario #2 – Induced Decrease in Future Annual CCR Beneficial Use*** | | | | | |
| ($244,555) | ($62,738) | ($3,922) | ($183) | ($1,177) | $1,923 |
| ***Scenario #3 – No Impact on Future Annual CCR Beneficial Use*** | | | | | |
| ($11,006) | ($6,577) | ($3,922) | ($183) | ($1,177) | $1,923 |
| | | | | | |
| **3% Discount Rate:** | | | | | |
| **Subtitle C "Special Waste"** | | **Subtitle D (version 2)** | | **Subtitle "D prime"** | |
| **EPA (2010)** | **SEI Calculation** | **EPA (2010)** | **SEI Calculation** | **EPA (2010)** | **SEI Calculation** |
| ***Scenario #1 – Induced Increase in Future Annual CCR Beneficial Use*** | | | | | |
| $127,437 | $5,079 | $51,752 | $6,369 | $21,379 | $6,269 |
| ***Scenario #2 – Induced Decrease in Future Annual CCR Beneficial Use*** | | | | | |
| ($456,983) | ($123,076) | ($7,848) | ($350) | ($2,461) | $3,581 |
| ***Scenario #3 – No Impact on Future Annual CCR Beneficial Use*** | | | | | |
| ($21,564) | ($10,810) | ($7,848) | ($350) | ($2,461) | $3,581 |

The RIA estimates values for three categories of costs and four categories of benefits:

- Regulatory costs

[16] Net benefits in the median impoundment failure scenario have the same sign as the average of the three impoundment failure scenarios across all rule options, beneficial use scenarios, and the 3 and 7 percent discount rates with the following exceptions: In the SEI corrections under Scenario D (version 2), at the 7 percent discount rate, with an assumed induced decrease in future annual CCR beneficial use (Scenario #2) and no impact on future beneficial use (Scenario #3), median net benefits are negative but average net benefits are positive, although both terms are relatively close to zero.

- Engineering costs of CCR disposal
- Ancillary costs of CCR disposal
- Cost of conversion to dry CCR disposal

- Regulatory benefits
  - Avoided costs of human cancers
  - Avoided costs of groundwater remediation
  - Avoided costs of impoundment failure cleanup
  - Costs of disposal and impacts of replacement virgin resource use from induced effects on beneficial use of CCRs

We replicated these calculations (but not the assumptions regarding parameters and other values behind the calculations except where explicitly stated) and found numerous errors, large and small. Our replication includes the following corrections to EPA calculations:

**Table 2: SEI Corrections to RIA**

| | **Corrections:** |
|---|---|
| **1. Regulatory Costs (1A+1B+1C):** | |
| 1A. Engineering Controls | Changed the profile of realized cancers from 48% to 20% in Subtitle D V.2, and from 30% to 16% in Subtitle D Prime |
| | Subtitle D Prime based on scaling factor, not set equal to Subtitle D V.2 |
| 1B. Ancillary Regulatory Requirements | Transcription error in Ancillary cost #15 corrected (incorrect value = $7 million; correct value = $28.1 million) |
| | Changed scaling factors from 48% to 20% in Subtitle D V.2, and from 30% to 16% in Subtitle D Prime |
| 1C. Conversion to Dry CCR Disposal | None |
| | |
| **2. Regulatory Benefits (2A+2B+2C+2D)** | |
| 2A. Monetized Value of Human Cancer Risks Avoided | Changed scaling factors from 48% to 20% in Subtitle D V.2, and from 30% to 16% in Subtitle D Prime |
| *Cancer risks:* | None |
| 2B. Groundwater Remediation Costs Avoided | Changed remediation costs to match source |
| | Changed total number of sites from 115.2 to 173 |
| 2C. CCR Impoundment Failure Costs Avoided | |
| Cost per failure | Method 1 significant cost weighs Kingston spill value by average size of signficant spills. |
| Cost per failure | Corrections to Kingston valuation affects Method 1 and Scenario 2&3 |
| Method 1 | Corrected historical period and release data |
| Scenario 2&3 | None |
| 2D. Induced Impact on Future CCR Beneficial Use | Lifecycle benefit reduced from $474 per ton to $24 per ton |
| | Avoided disposal cost corrected from $85 per ton under Subtitle C to $75 per ton |
| | Correct constant tons of induced decrease each year to 51% of beneficial use per year |
| | Correct Scenario #2 minefilling share (incorrect = 5.6 percent; correct = 2.3 percent) |
| | Correct Scenario #2 value per ton adjustment factor (incorrect = 85 precent; correct = 82 percent) |

The following sections summarize the findings of our replication and discuss EPA's errors and our corrections. (For a more complete description of our replication, see the appendix below.)

***Regulatory costs***

EPA estimated baseline disposal costs using its "landfill and impoundment engineering controls cost estimation model"; the result was a baseline (before rule implementation) disposal cost of $59 per ton of CCR. The cost of regulatory requirements related to engineering controls under Subtitle C is $491 million per year. Here, and throughout the RIA, Subtitles D (version 2) and "D prime" are calculated as shares of the Subtitle C costs. The rationale for this scaling procedure is that Subtitle C would impose uniform regulations nationwide, while D and D prime would leave more up to state regulators. The scaling factor is meant to represent the fraction of CCRs covered by strict state regulations. EPA, however, relied on an inaccurate survey of state regulations when developing the scaling factors.[17] As a result, the scaling factors reported by EPA (see Table 3) are incorrect; the correct factors are 20 percent for Subtitle D (version 2) and 16 percent for Subtitle "D prime."

**Table 3: Scaling factors used by EPA**

| Economic Impact Category | Subtitle C "Special Waste" | Subtitle D (version 2) | Subtitle "D prime" |
|---|---|---|---|
| **Regulatory Compliance Costs:** | | | |
| 1. Engineering control costs | 100% | 48% | 48% |
| 2. Ancillary costs | 100% | 48% | 48% |
| 3. Dry conversion costs | 100% | 40% | 0% |
| **Regulatory Benefits:** | | | |
| 1. Groundwater contamination prevention benefits: | | | |
| Groundwater remediation costs avoided | 100% | 48% | 30% |
| Monetized value of human cancer risks avoided | 100% | 48% | 30% |
| 2. Impoundment structural failure cleanup costs avoided | 100% | 45% | 23% |
| 3. Induced impact on CCR beneficial use: | | | |
| Scenario #1: Induced increase | 100% | 40% | 16% |
| Scenario #2: Induced decrease | 100% | 0% | 0% |
| Scenario #3: No change | Not relevant | Not relevant | Not relevant |

Ancillary costs for CCR disposal are $107 million per year under Subtitle C. After correcting an apparent transcription error in the EPA analysis, these costs rise to $127 million per year. Conversion to dry CCR disposal is projected to cost $876 million per year. The present value of regulatory costs at 3- and 7-percent discount rates, before and after our corrections, is presented in Table 4.

[17] See Section IIIB of Earthjustice, Environmental Integrity Project, Sierra Club et al. (2010) comments submitted Nov. 19, 2010.

**Table 4: Discounted regulatory costs from 2012 to 2061**

| *(millions 2009$)* | **EPA (2010)** | | **SEI Corrections** | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | **$20,342** | **$37,926** | **$20,615** | **$38,434** |
| 1A. Engineering Controls | $6,776 | $12,633 | $6,776 | $12,633 |
| 1B. Ancillary Regulatory Requirements | $1,477 | $2,753 | $1,749 | $3,262 |
| 1C. Conversion to Dry CCR Disposal | $12,089 | $22,539 | $12,089 | $22,539 |
| **Subtitle D (version 2)** | **$8,092** | **$15,087** | **$6,180** | **$11,522** |
| 1A. Engineering Controls | $3,257 | $6,072 | $1,341 | $2,501 |
| 1B. Ancillary Regulatory Requirements | $5 | $9 | $3 | $5 |
| 1C. Conversion to Dry CCR Disposal | $4,830 | $9,005 | $4,836 | $9,016 |
| **Subtitle "D prime"** | **$3,262** | **$6,081** | **$1,075** | **$2,005** |
| 1A. Engineering Controls | $3,257 | $6,072 | $1,073 | $2,001 |
| 1B. Ancillary Regulatory Requirements | $5 | $9 | $2 | $4 |
| 1C. Conversion to Dry CCR Disposal | $0 | $0 | $0 | $0 |

### *Regulatory benefits: avoided risk of cancer*

EPA estimates the risk and monetary value of lung and bladder cancer from leached arsenic in groundwater. Missing from the RIA are other forms of cancer, non-cancer health risks, other pollutants in CCR, and other exposure pathways. Cancer slope factors from two previous studies are applied to estimates of the population that lives near CCR facilities and drinks well-water. EPA estimates 1,560 bladder cancers and 949 lung cancers from 2015 to 2090 and provides a schedule of their increasing incidence over time.

The monetary value of each cancer depends on the likelihood that it is fatal or non-fatal based on: each type of cancer's 5-year survival rate; EPA's value of a statistical life; medical costs associated with each type of fatal cancer; and a cost of non-fatal cancers estimated as 58.3 percent that of fatal cancers.

EPA assumes that some of the expected cancers would be avoided through monitoring and remediation. The present value of avoided cancers for each year is multiplied by a year and rule-option-specific parameter based on the share of surface impoundments requirement groundwater monitoring at both new and existing units. A 12-percent initial rate of prevention increases gradually to 100 percent in 2090.

EPA makes numerous errors in assessing the value of avoided human cancer risk, which are discussed in detail elsewhere.[18] Here we only correct for an error made in the scaling factors (and therefore in the profile of realized cancers) used to determine Subtitle D (version 2) and "D prime" benefits. EPA further assumes that under Subtitle C all cancers from CCR leaching would be avoided. Corrections to EPA's scaling factors (discussed above) change the profile of realized cancers in Subtitle D (version 2) and Subtitle "D prime."

**Table 5: Avoided cancer risk costs, 2012 to 2090**

| *(millions 2009$)* | **EPA (2010)** | | **SEI Replication** | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | $504 | $1,825 | $504 | $1,824 |
| **Subtitle D (version 2)** | $207 | $750 | $60 | $218 |
| **Subtitle "D prime"** | $104 | $375 | $30 | $109 |

***Regulatory benefits: Avoided groundwater remediation costs***

EPA combines the risk of leached materials reaching groundwater with the expected cost of remediation to set a value for the groundwater remediation costs that would be avoided under the new rule. Data from a previous study are used to estimate the share of sites likely to require either of two categories of remediation: early detection at plants subject to more stringent monitoring requirements, and late detection at plants with less stringent monitoring. The number of late detection sites is assumed to be one-third that of early detection sites. EPA makes numerous errors in assessing the potential damages from CCR contamination leaching into groundwater, which are discussed in detail elsewhere.[19] Here, and in the appendix to this testimony, we discuss the errors for which we have been able to offer corrections.

EPA makes a large error in the per unit cost of groundwater remediation at the "late detection" sites: $10 per 1000 gallons is used in place of $61 (see appendix for details and sources). EPA also mistakenly assumes that surface water bodies will prevent the need for remediation in two-thirds of cases; we correct this error and, therefore, calculate remediation costs for 173 rather than 115 sites. The present value of avoided groundwater remediation costs at 3- and 7-percent discount rates, before and after our correction, is presented in Table 6.

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[18] See Sections IIIB of Earthjustice, Environmental Integrity Project, Sierra Club et al. (2010) comments submitted Nov. 19, 2010, and Hutson, M.A., and C.H. Norris (2010), "Geo-Hydro Inc. Critique of EPRI CCW Risk Evaluation." Memorandum prepared by Geo-Hydro Inc. for Earthjustice and the Environmental Integrity Project.
[19] See Sections IIIB of Earthjustice, Environmental Integrity Project, Sierra Club et al. (2010) comments submitted Nov. 19, 2010, and Hutson and Norris (2010).

**Table 6: Avoided groundwater remediation costs, 2012 to 2090**

| *(millions 2009$)* | **EPA (2010)** | | **SEI Corrections** | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | $696 | $2,176 | $2,190 | $8,110 |
| **Subtitle D (version 2)** | $251 | $786 | $791 | $2,930 |
| **Subtitle "D prime"** | $126 | $393 | $396 | $1,465 |

***Regulatory benefits: Avoided impoundment failure costs***

EPA bases its significant (greater than 1 million but less than 1 billion gallons) and catastrophic (greater than 1 billion gallons) costs of impoundment failure on three data points: the PPL Martins Creek Power Station ash basin failure in 2005 ($37 million); the TVA Widows Creek Power Station wet stacking area failure in 2009 ($9.2 million); and the TVA Kingston Power Station dredge pond failure in 2008 (projected $3 billion). EPA averages the costs of the two smaller spills for its significant failure valuation ($23.1 million), and takes the Kingston cost as its catastrophic failure valuation.

The costs of the Martins Creek and Widows Creek failures appear to be much less thoroughly documented, and may not include as comprehensive an accounting of failure-related costs as the more carefully studied Kingston event. Thus it seems reasonable to apply the average cost per gallon from the Kingston spill to smaller failures. EPA's estimate of the cost of the Kingston spill includes three elements: the TVA cleanup, ecological damages, and socio-economic damages, for a total cost of $3 billion, or $2.73 per gallon. A review of the assumptions behind the Kingston value led to an alternate valuation of $4.07 billion, implying a cost per gallon of $3.70. In our replication, we apply $69 million per spill (or $3.70/gallon applied to the average number of gallons in a significant spill, 25.3 million) to significant failures and $4.07 billion per spill to catastrophic failures.

EPA uses historical data on impoundment failures to estimate future impoundment failures' frequency and severity in its low-end scenario.[20] Data used in EPA's calculation contain several errors. Most importantly, EPA uses 15 years as its period of historic record, but the actual record includes only 10 years of data. In addition, several of the historical releases have erroneous dates or amounts in EPA's dataset. Using the same source data cited by EPA, we corrected dates on 10 out of 42 releases, amounts on five releases, and added six omitted releases. EPA's expected number of release events for the 50-year period covered by the projections are compared to the corrected replication in Table 7.

EPA also presents results based on two alternate assumptions regarding the frequency of future releases – its medium and high-end scenarios[21] – both using information about the share of impoundments that are most vulnerable to failure: 10 and 20 percent of 96 at-risk facilities are projected to fail over the course of 20 years. In these scenarios, the cost of all spills is estimated at the catastrophic-spill cleanup rate. The present value of avoided impoundment failure cleanup

[20] EPA's "Method 1."
[21] EPA's "Scenarios 2 and 3."

costs at 3- and 7-percent discount rates, before and after our corrections, for the low-end, medium and high-end scenarios is presented in Table 8.

**Table 7: Average expected number of release events**

| Type of Release | Exhibit 5B-4 | SEI Corrections |
|---|---|---|
| **Catastrophic** | 3 | 5 |
| **Significant** | 17 | 45 |

**Table 8: Avoided costs of impoundment failure**

| *(millions 2009$)* | EPA (2010) | | SEI Corrections | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Low-end scenario** | | | | |
| Subtitle C "Special Waste" | $1,761 | $3,123 | $4,163 | $7,382 |
| Subtitle D (version 2) | $793 | $1,405 | $1,873 | $3,322 |
| Subtitle "D prime" | $405 | $718 | $957 | $1,698 |
| **Medium scenario** | | | | |
| Subtitle C special waste | $8,366 | $13,046 | $11,344 | $17,689 |
| Subtitle D (version 2) | $3,795 | $5,918 | $5,145 | $8,024 |
| Subtitle "D prime" | $1,897 | $2,959 | $2,573 | $4,012 |
| **High-end scenario** | | | | |
| Subtitle C special waste | $16,732 | $26,092 | $22,687 | $35,379 |
| Subtitle D (version 2) | $7,590 | $11,836 | $10,291 | $16,048 |
| Subtitle "D prime" | $3,795 | $5,918 | $5,146 | $8,024 |

### *Regulatory benefits: Induced impact on future beneficial use*

The final value estimated in the RIA relates to the beneficial use of CCR materials in concrete and wallboard. If this beneficial use were to increase as a result of the EPA rule, two potential costs would be avoided: CCR disposal costs, and the negative health impacts of producing virgin materials for use in concrete and wallboard. If instead the rule drives down CCR use, the result would be higher disposal costs and more virgin materials produced. EPA values the gain or loss of 1 ton of CCR going towards a beneficial use as the sum of its “unitized lifecycle benefit” and the average disposal cost by rule option. The RIA does not, however, include in its calculations the impact of an increase or decrease in beneficial use (and therefore a decrease or increase in disposal) on avoided cancer risks, groundwater remediation, and impoundment failure cleanup (nor do we model these related impacts).

The lifecycle benefits of a ton of CCR beneficial use, which include resource consumption savings and avoided air pollution and other wastes, are grossly overestimated in the RIA. Problems in this area include: double-counting of emission reductions that are already occurring in response to other regulations; inappropriate valuation of all particulate matter based on health risks caused by the most dangerous, smallest varieties; and miscellaneous data errors.[22] We correct the following values: we reduce avoided energy consumption from $4,880 million per year to $255 million; sulfur oxides from $1,491 million to $0; large-size particulate matter from $4,719 million to $0; and particulate matter of unspecified size from $12,741 million to $258 million. In total, these corrections reduce the lifecycle benefits of CCR beneficial use from $474 per ton to $24 per ton.

In addition, EPA incorrectly reports the value of average avoided disposal costs as $85 per ton – $59 per ton in baseline costs and $26 per ton in new costs under Subtitle C. The value of new costs appears to be a transcription error. The correct value is $16, for a total average avoided disposal cost of $75 per ton.

The RIA calculates baseline beneficial use of CCRs as the expected tons of coal burned in future years (based on a continuation of a multi-year growth trend), multiplied by the ratio of 2008 tons of CCR generated to 2008 tons of coal burned (0.13), multiplied by an assumed share of beneficial use (out of all CCRs generated) for each future year. Future shares of beneficial use follow recent years' growth trend; the share of beneficial uses grows from 51 percent in 2012 to 88 percent in 2061. While extrapolation of the past trend in total reuse is not a sound methodology, it does produce an upward trend in beneficial use, which is the expected result of Subtitle C regulation. EPA assigns each ton of beneficial use the value discussed above: the unitized lifecycle benefit per ton ($474) plus the incorrect avoided disposal costs per ton ($85).

In Scenario #1, the EPA ruling induces an increase in beneficial use as electric generators seek out new customers for CCRs in order to avoid higher disposal costs. EPA assumes that the induced effect will grow linearly to 28 percent of baseline disposal in 2019, and remain at 28 percent of baseline disposal in each year after that. The estimated 28-percent impact is the ratio of the same $26 in additional disposal costs discussed above to a baseline raw material cost of $94.10. The correct ratio, therefore, would be 17 percent. In a final step, the induced impact in each future year is reduced by 2.3 percent to omit CCRs used in minefilling.

**Table 9: Scenario #1 induced increase in beneficial CCR use, 2012-2061**

| *(millions 2009$)* | **EPA (2010)** | | **SEI Corrections** | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | $84,490 | $148,999 | $9,010 | $15,890 |
| **Subtitle D (version 2)** | $33,796 | $59,600 | $3,604 | $6,356 |
| **Subtitle "D prime"** | $13,518 | $23,840 | $1,442 | $2,542 |

In Scenario #2, the EPA ruling induces a decrease in beneficial use due to the stigma of the hazardous or special waste classification. According to the text of the RIA, EPA assumes an induced decrease of 51 percent in every year for the next 50 years (a 50-percent reduction in

[22] See attached memorandum by Eric Schaeffer, Annual Lifecycle Benefits of CCR Recycling: Re-evaluation of Estimates in EPA Regulatory Impact Analysis, prepared for Environmental Integrity Project and Earthjustice, (Nov. 19, 2010) [hereinafter Schaeffer Memorandum).

consolidated uses and an 80-percent reduction in unconsolidated uses). The RIA does not, however, follow this method in its calculations. Instead, EPA subtracts a constant 35.3 million tons from beneficial use – 51 percent of year 2012 beneficial use – in each future year. The total reduction to beneficial use over 50 years is 1.8 billion tons using the method employed by EPA, or 2.9 billion tons following the method explained in the RIA text.

EPA then decreases all years' induced change in beneficial use to omit minefilling, but incorrectly reduces each year's value by 5.6 percent, and not the 2.3 percent described in the text and shown in calculations for Scenario #1.

EPA calculates the value of this reduction in beneficial use using an adjusted value per ton – 82 percent of the value used in Scenario #1 – to account for reductions coming in specific sectors of use with differing prices. Backcasting from the EPA's reported results, however, shows that an adjustment factor of 85 percent has been used.

**Table 10: Scenario #2 induced decrease in beneficial CCR use**

| *(millions 2009$)* | **EPA (2010)** | | **SEI Corrections** | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | ($233,547) | ($419,146) | ($56,160) | ($112,266) |
| **Subtitle D (version 2)** | $0 | $0 | $0 | $0 |
| **Subtitle "D prime"** | $0 | $0 | $0 | $0 |

In Scenario #3, all three rule options are assumed to induce no change in beneficial use.

***Measuring the benefits gap***

EPA has left numerous types of benefits out of this RIA: The result is an incomplete cost-benefit analysis with a strong bias towards less stringent rules or no action at all. Sensitivity analysis reveals the size of a "benefits gap" – or the difference between costs and benefits – in these results. The size of the benefits gap answers the following question: How large would the omitted Subtitle C benefits need to be to indicate that Subtitle C has more benefits than costs, and has larger net benefits than either Subtitles D (version 2) or "D prime"?

We express this benefits gap in two ways: first, as a percentage increase to the non-beneficial reuse benefits (the value of avoided human cancer risks, groundwater remediation costs, impoundment failures); and second, in a dollar value that could be additions to existing benefit categories or the value of omitted benefit categories.

Benefits gap for the median impoundment failure scenario:

- Scenario #1, 7 percent discount rate: 15 percent more non-beneficial use benefits (rounded to nearest 5 percent), or $2.1 billion (rounded to nearest 100 million dollars) over 50 years
- Scenario #1, 3 percent discount rate: 10 percent more non-beneficial use benefits, or $2.8 billion over 50 years

Benefits gap for all impoundment failure scenarios:

- Scenario #1, 7 percent discount rate: 120 percent more non-beneficial use benefits, or $8.2 billion over 50 years
- Scenario #1, 3 percent discount rate: 70 percent more non-beneficial use benefits, or $12.1 billion over 50 years

In comparison to the likely value of omitted benefits (discussed above), this benefits gap – just $40 to 56 million per year in the median case – is not large and calls the basic results of the RIA into question.

### 3. Would Subtitle C stigmatize beneficial use of CCRs?

As Table 10 shows, Scenario #2 assumes that Subtitle C causes a stigma resulting in a huge loss of beneficial reuse, with a present value (over the 50-year period of analysis) in the hundreds of billions of dollars. Even in our corrected version of the RIA calculations, the assumed loss of beneficial reuse due to stigma dominates the calculations of costs and benefits in Scenario #2. Thus evaluation of the claimed stigma is essential to a decision about CCR regulation.

Beneficial use of CCRs has long been exempt from RCRA regulation, and would remain exempt under Subtitles C, D (version 2), or "D prime," as the RIA makes clear (RIA, p. 157). Some stakeholders, however, assert that regulation of CCR *disposal* as "special waste" under Subtitle C would stigmatize CCR *reuse* as hazardous, leading to widespread rejection of reuse in the marketplace. EPA has labeled CCR disposal as "special waste" under Subtitle C in order to avoid the use of the word "hazardous," but advocates of the stigma hypothesis have maintained that this change in wording would have no effect on the markets for CCR reuse.[23] Whatever the wording, the stigma affecting reuse is said to derive from a regulation that does not apply to reuse. That is, the stigma is based on a misperception, which is assumed to be widespread and long-lasting.

In view of the importance of the hypothesized stigma, we address several aspects of it below. To preview our findings on this question: The proposed stigma in Scenario #2 does not fit academic definitions of environmental stigma, and falls into a category of stigma claims for which courts have almost never awarded damages. Empirical research shows that environmental stigmas are not consistent from one location to another, and are often very short-lived. Economic theory suggests that companies that can ignore any stigma of CCR reuse will out-compete those that are in the grip of the stigma.

Turning back to the RIA, we find that its calculations of the magnitude and duration of the alleged stigma in Scenario #2 are arbitrary and lacking in empirical basis – and that EPA itself offers substantial evidence against the existence of such a stigma. Finally, we argue that acceptance of the Scenario #2 stigma calculation would set a terrible precedent for other regulatory proceedings, suggesting that detailed examination of real costs and benefits is secondary to the invention of imagined, irrational reactions to regulation.

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[23] Based on oral testimony by many industry representatives at EPA's August 31, 2010, public hearing in Arlington, VA.

***Stigma in law and economics: not applicable to CCR reuse***

"Stigma," according to a dictionary definition, means "a mark of disgrace or infamy; a stain or reproach, as on one's reputation."[24] Originally it applied to people, typically in the context of discrimination or unjust treatment. Thus, in a 2007 analysis, Cass Sunstein argued that the stigma resulting from lack of handicapped-accessible facilities in a workplace caused "expressive and symbolic harm" to a disabled worker, and could have entitled her to compensation.[25]

Note that this analysis rests on the impact of a correctly perceived, harmful fact, i.e. the lack of accessible facilities. The disabled worker was harmed by the lack of these facilities, as Sunstein explained. The existence of actual harm was crucial to the case. Contrast this to variants of the same story, where stigma would be based on misperception of the facts, as in the case of CCR reuse: No compensation would be owed, under Sunstein's argument, to a disabled worker who believed *incorrectly* that her office lacked handicapped-accessible facilities, or who assumed that an adjacent office which lacked accessible facilities would somehow contaminate her own, better situation.

Stigma has gained an additional meaning, often related to environmental contamination and applied to technologies, products, and places, that is more directly relevant to the CCR analysis. In the words of an important analysis of stigma and health policy:[26]

> …stigma refers to something that is to be shunned or avoided not just because it is dangerous but because it overturns or destroys a positive condition, signaling that what was or should be something good and acceptable is now marked as blemished or tainted.

There are five defining features of stigma, as applied to places and things:[27]

- Its source is a hazard that is perceived to be highly risky.
- It violates standards of fairness or what is natural.
- Its impacts seem to be inequitably distributed (e.g. differentially affecting certain demographic groups, or certain locations).
- The possible outcomes are scientifically uncertain or unbounded.
- The hazard appears to have been improperly managed.

Some stakeholders in the CCR ruling claim that ash reuse, which should be good and acceptable, would be stigmatized by its classification as hazardous or special waste. Is there a reasonable basis for this claim? Of the five defining features identified by Gregory et al., only the first and, to a lesser extent, the fourth, apply: The source of the alleged stigma is the anticipated negative

[24] Dictionary.com, accessed September 2010. http://dictionary.reference.com/browse/stigma.
[25] Sunstein, C.R. (2007), "Cost-Benefit Analysis without Analyzing Costs or Benefits: Reasonable Accommodation, Balancing, and Stigmatic Harms." *The University of Chicago Law Review* 74, Special Issue: *Commemorating Twenty-Five Years of Judge Richard A. Posner*, pp. 1895-1909. Available online at http://www.jstor.org/stable/20141892.
[26] Gregory, R., P. Slavic and J. Flynn (1996), "Risk perceptions, stigma, and health policy." *Health & Place* 2:4, pp. 213-220. Available online at http://dx.doi.org/10.1016/1353-8292(96)00019-6.
[27] Gregory et al., ibid.

perception of the hazardous nature of CCRs, as signaled by Subtitle C regulation of disposal; and there is scientific uncertainty about the impacts of some (not all) areas of CCR reuse.[28] For the other features to apply – that the Subtitle C ruling would be unfair, inequitably distributed, or result in poor management of the hazard – it would be necessary to assume in advance that strict regulation of CCR disposal is illegitimate, that is, that CCR is not in fact hazardous.

Regarding the second feature, there is no sense of fairness or naturalness that is violated by Subtitle C regulation: CCRs are not a naturally occurring substance, and regulation of them does not conflict with any established rights. On the third point, the impacts of the alleged stigma would fall on the industries that generate and use CCRs, and their customers; it is hard to see why this would be inequitable. On the contrary, having the impacts fall on anyone else would be unfair. Finally, there is no suggestion that the stigma of reuse reflects improper management of the real hazards of CCR disposal; Subtitle C provides the maximum protection against the only real hazards that are under discussion.

Legal analysis of stigma claims distinguishes two categories: stigma due to incomplete repair or cleanup of a past hazard, versus general marketplace stigma, due to contamination of neighboring properties or other nuisance-type impacts.[29] The courts have almost always denied recovery of damages for general marketplace stigma, when plaintiffs could not prove that defendants had physically affected their property.[30] The alleged stigma attached to CCR reuse is analogous to general marketplace stigma, not incomplete cleanup: There is no hazard which affected reuse in the past and was incompletely cleaned up; rather, there is a claimed effect on reuse from publicizing the hazards of a "neighboring" process, namely CCR disposal. That is, the CCR reuse stigma falls into the category that the courts have almost always rejected as a basis for compensation.

Economic analysis of environmental stigma has often examined the effects of Superfund and other hazardous waste sites on surrounding property values. Individual analysis is required, because even Superfund sites do not have consistent, predictable effects on nearby property: Some sites have no effect, and a few appear to have had a positive effect on property values.[31] Some observers have concluded that property markets have become more sophisticated, thanks to improved cleanup standards and new forms of environmental insurance – implying that stigma has a diminished effect on property values in general.[32]

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[28] Unencapsulated uses of CCRs generally pose greater risks, since the material can potentially leach out into air or water. Among encapsulated uses, questions have been raised about the safety of CCR reuse in wallboard, due to risks of exposure to high mercury content during manufacturing, demolition, and final disposal. This is an area of limited knowledge and uncertainty, not a proven health hazard.

[29] Muldowney, T.J., and K.W. Harrison (1995), "Stigma Damages: Property Damage and the Fear of Risk," *Defense Counsel Journal* 62, pp. 525-538.

[30] See Muldowney and Harrison (ibid.) and Fisk, E.S. (2005), "Stigma Damages in Construction Defect Litigation: Feared by Defendants, Championed by Plaintiffs, Awarded by (Almost) No Courts – What Gives?" *Drake Law Review* 53, pp. 1029-1062.

[31] Kiel, K.A., and M. Williams (2006), "The impact of Superfund sites on local property values: Are all sites the same?" *Journal of Urban Economics* 61:1, pp. 170-192. Available online at http://dx.doi.org/10.1016/j.jue.2006.07.003.

[32] Neustein, R.A., and R. Bell (1998), "Diminishing Diminution: A Trend in Environmental Stigma." *Environmental Claims Journal*, 1547-657X, 11:1, pp. 47-59. Available online at http://dx.doi.org/ 10.1080/10406029809383899.

While numerous studies have found that environmental contamination lowers property values, the duration of the effect is not consistent, and can be quite short. The discovery of elevated arsenic levels in wells in two towns in Maine depressed property values for only two years after the contamination was first publicized.[33] A lead smelter that had polluted the Dallas area since 1934 was closed in 1984 and cleaned up in 1985-86, providing an opportunity to study the duration of stigma. Two studies found that the stigma effect on property values near the smelter site was sharply reduced during the cleanup years (1985-86), and disappeared after 1986.[34] Note that both of these cases, in which environmental stigma was found to be quite short-lived, involved health hazards – arsenic in drinking water wells, and lead pollution in the air – at least as serious as the possible threat from building materials containing reused CCRs.

Economic theory also suggests limits to the stigma attached to CCR reuse, since that stigma rests entirely on an incorrect belief about the world. The stigma that allegedly decimates the market for beneficial reuse is based on a mistaken view of reused ash as hazardous waste, even though reuse has been and continues to be explicitly exempt from RCRA regulation. The buyers of construction materials and other beneficial reuse products are apparently expected to be in the grip of an irrational fear of a regulation that has not been proposed, let alone adopted.

That is, construction companies and their customers, many of which are themselves sizeable companies, are expected to let an unfounded stigma block them from using a profitable, low-cost, high-performance product. Since the market for construction materials and projects is a competitive one, companies that view the issue rationally will be able to profit from using coal ash, allowing them to gain market share at the expense of those blinded by stigma.

For instance, coal-burning power plants might find it profitable to open up subsidiaries producing wallboard or other CCR-based products, as an alternative to paying the cost of CCR disposal. Such enterprises will have lower costs of production, since they can obtain a major raw material at no cost. This should allow them to undersell competing firms that avoid use of coal ash due to an irrational stigma. This is no accident or idiosyncrasy of the CCR business; rather, it is exactly how competition is supposed to work. The market economy is frequently praised for allowing rational profit-maximizers to outcompete those hampered by irrational prejudices. There is every reason to expect that this will be the case in the market for CCR reuse.

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[33] Boyle, K.J., N.V. Kuminoff, C. Zhang, M. Devanney, and K.P. Bell (2010), "Does a property-specific environmental health risk create a 'neighborhood' housing price stigma? Arsenic in private well water." *Water Resources Research* 46: W03507. Available online at http://dx.doi.org/10.1029/2009WR008074.

[34] See Dale, L., J.C. Murdoch, M.A. Thayer, and P.A. Waddell (1999), "Property Values Rebound from Environmental Stigmas? Evidence from Dallas." *Land Economics* 75:2, pp. 311-326. Available online at http://www.jstor.org/stable/3147013, and:
McCluskey, J.J., G.C. Rausser (2003), "Stigmatized asset value: Is it temporary or long-term?" *The Review of Economics and Statistics* 85:2, pp. 276-285. Available online at http://dx.doi.org/10.1162/003465303765299800.

***Estimating stigma losses: Pick a number***

Where do the huge Scenario #2 estimates of economic losses due to stigma come from? The answer, as revealed on pages 175-177 of the RIA, is more or less from thin air. In sharp contrast to the detail involved in many other portions of the analysis, the RIA simply assigns a 50-percent loss to private-sector encapsulated beneficial uses, and 80 percent to unencapsulated beneficial uses. The justification for these numbers is merely that the former is thought to be big, but not the whole market, while the latter is even bigger, but still not quite everything. Public-sector beneficial uses are not projected to decline, since the government can still require rational decision-making in that area. This level of arbitrary imprecision would be simply unacceptable in a debate about health hazards, cancer risks, or anything else where quantitative information exists.

Nor is anything said to support the unusually long duration of the stigma. It is modeled as a large drop in beneficial reuse in 2012, the first year of the analysis – which persists, unchanged, throughout the 50-year period of economic analysis. (As noted above, the RIA text assumes that the same *percentage* reduction in beneficial use persists for 50 years, while the RIA calculations assume that the same *tonnage* reduction persists for 50 years; both are large, although the text's approach would be even larger than the calculations.) The industry is assumed to be not only mistaken about the exemption of beneficial reuse from Subtitle C, but also extraordinarily persistent in its mistake.

Not a single survey result, historical statistic, or empirical analysis supports these losses or their duration. In fact, the RIA contains quite a bit of information arguing against stigma-based losses. Many state programs explicitly recognize CCR reuse as beneficial, and exempt it from treatment as a hazardous waste. Florida's beneficial use program allows the use of municipal incineration ash, even though incineration facility operators have to determine on a case-by-case basis whether their ash meets the standards for exemption from hazardous waste regulation – a much greater burden than is proposed for coal ash (RIA, Appendix K12, pp. 315-316).

EPA recounts several success stories in recycling of materials that either are hazardous wastes, or would be if disposed in quantity: (RIA, pp. 157-158)

1. Electric arc furnace dust is classified as a hazardous waste, yet roughly half of it is recycled for a range of industrial uses.
2. Electroplating wastewater sludge, another listed hazardous waste, has a 35-percent recycling rate.
3. Chat (lead-contaminated Superfund cleanup waste) is used in road construction.
4. Used oil, regulated under RCRA subtitle C, is frequently a hazardous waste if disposed of – and (unlike CCRs) is still subject to subtitle C when recycled. Yet it is widely recycled by users ranging from individuals to large commercial oil customers.
5. Spent etchants (etching solutions) are used as ingredients in the production of micronutrients for livestock.
6. Spent solvents from metal washing are used in the production of roofing shingles.

Indeed, the list of familiar consumer products which, like CCRs, would be classified as hazardous if disposed of, includes gasoline, motor oil, many common drain cleaners and household cleaners, cathode ray tube monitors, many fluorescent lamps, nicotine gum, and dental amalgam. None of these appear to suffer from stigma due to their potentially hazardous disposal status (RIA, p. 158).

EPA is quite explicit about its belief that Scenario #2 is wrong:

> EPA does not believe that market "stigma" of CCR regulation under RCRA Subtitle C --- as alleged in numerous stakeholder letters to the EPA in 2009 --- will result in a reduction in future annual CCR beneficial use… (RIA, p. 8)

The stakeholders who favor the stigma hypothesis would need to produce much more empirical information in order to make it relevant for rulemaking. In contrast, Scenario #1's hypothesis, that higher disposal costs under Subtitle C would cause an *increase* in beneficial use of CCR, seems well-grounded in theory and is supported with careful detail.

Some of the confusion about stigma may result from reactions to the massive Kingston spill, an event that brought public attention to the potential hazards of coal ash. In the trade publication *Ash at Work*, David Goss, former executive director of the American Coal Ash Association (ACAA), writes about the recent decline in beneficial use of CCRs (outside of mining), and erroneously mentions the stigma created by news coverage of Kingston as a possible explanation. However, Goss' latest data are for 2008; since the Kingston spill occurred on December 22 of that year, it had almost no effect on the year's sales of CCRs.

The real reason for the dip in CCR sales in 2008 – as Goss partly acknowledges – is the recession. Construction, a primary market for CCRs, is more cyclical than the economy as a whole. When the economy slumps, as it did throughout 2008, construction falls even faster. More years of data and careful analysis will be needed to distinguish the effects of Kingston-related stigma, if any, from the effects of the major economic downturn that began in early 2008.

***Stigma losses as precedent: The end of cost-benefit analysis?***

Finally, consider the precedent that would be created by basing regulation of CCRs on the stigma calculations of Scenario #2. The monetary losses attributed to stigma are more than ten times as large as the costs of controls and other direct expenditures required by Subtitle C regulation (this is true at either the 3-percent or 7-percent discount rate; see RIA Exhibits 6C and 6D, pp. 194-195). If the stigma calculation were allowed to stand, precision about the actual costs and benefits of regulation would be irrelevant; the bottom line of the comparison of costs and benefits would be driven entirely by stigma.

The message this would send to analysts on the next rulemaking procedure is a powerful and misguided one: Forget about careful calculation of costs and benefits; just make up some really big numbers for the monetary value of fears associated with the case. Since there is no rational basis needed for these numbers, they can be as big as you think you can get away with.

A detailed argument for measurement and valuation of fear, well-founded or not, and inclusion of the value of fear in cost-benefit analysis, has been made by Matthew Adler.[35] He addresses numerous potential pitfalls, including the risk of bias due to strategic overstatement of fear by interested parties. (Strategic overstatement will often be a danger, as it is in the CCR case, when the only evidence or measurement of the fear of regulation is self-reporting by stakeholders who are opposed to the regulation in question.) Adler calls for development of a standard value per fear-day, comparable to quality-adjusted life year (QALY) estimates for various illnesses and medical conditions; he argues that it should be based on willingness to pay to avoid fear-days, as expressed by people who are currently calm but remember recent episodes of fear. Adler's unconventional proposal has been cited by many other authors (e.g., Posner and Sunstein[36]), but has not gained acceptance for regulatory analysis.

If it were applied to the CCR rulemaking, Adler's approach would suggest valuation of both the fear-days of ash producers and users caused by the risk of expanded hazardous waste regulation in the future, and the fear-days of communities near ash disposal sites caused by the risk of Kingston-style massive spills. Subtitle C regulation of ash disposal increases industry fears of future regulation, but decreases community fears of catastrophic spills (because strict regulation reduces their likelihood). It is entirely possible that Subtitle C regulation would lead to a net reduction in society's total fear related to ash disposal, which Adler would count as a benefit.

Monetization of fear, whether done as carefully as proposed by Adler, or as casually as in Scenario #2, has a fundamental, troubling implication: Suppression of information would often improve the bottom line. For instance, who cares whether substance X causes cancer? Suppose that it does, but regulation of X as a carcinogen would create a stigma that would be bad for its sales. Then stigma-based losses might dominate the cost-benefit analysis of rulemaking for X – showing that it is always better to hide the truth and avoid stigmatizing anything through regulation.

Cost-benefit analysis of hiding unpleasant truths from the public will often look favorable. A study of the economic losses due to the September 11, 2001, attacks found that the subsequent losses in airline ticket sales and New York-area tourism revenues were much larger than the loss of property destroyed in the attack.[37] If it had been possible to suppress all information about what actually happened, then the stigma associated with air travel and with visiting New York City after September 11 could have been avoided, saving tens of billions of dollars. (Both New York City and the nation's airports were extraordinarily well policed after September 11, so it is not clear that this stigma was any more rational than the claimed coal ash one.) Despite the huge potential for monetary savings and fear reduction, suppression of important information to avoid stigma does not seem like a desirable public policy.

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[35] Adler, M.D. (2004), "Fear Assessment: Cost-Benefit Analysis and the Pricing of Fear and Anxiety." *Chicago-Kent Law Review* 79:3, pp. 977-1053. Available online at http://www.cklawreview.com/wp-content/uploads/vol79no3/Adler.pdf.

[36] Posner, E.A., and Sunstein, C.R. (2005), "Dollars and Death." *University of Chicago Law Review* 537. Available online at SSRN: http://ssrn.com/abstract=600662.

[37] Rose, A.Z., and S. B. Blombergy (2010), "Total Economic Consequences of Terrorist Attacks: Insights from 9/11." *Peace Economics, Peace Science and Public Policy* 16:1, Article 2. Available online at http://dx.doi.org/10.2202/1554-8597.1189.

The choice made in this case will affect future cases as well: either keep decision-making contained within the realm of well-defined, well-documented costs and well-defined (although incomplete) benefits, in Scenario #1, or allow the process to spill out into the shadowy realm of unsupported monetization of unfounded fears, in Scenario #2.

## Appendix: CCR Coal Ash Replication

The EPA Regulatory Impact Analysis[38] presents a combination of partial regulatory impact analyses for six rule options (see Table 11):

**Table 11: Comparison of rule options**

| | Federal Enforcement | Requires Liners: New Landfills | Requires Liners: Existing Landfills | Requires Liners: Closed Landfills | Requires Liners: New Surface Impoundments | Requires Liners: Existing Surface Impoundments | Requires Liners: Closed Surface Impoundments | Requires Conversion of All Surface Impoundments within 5 years; Bans New Surface Impoundments |
|---|---|---|---|---|---|---|---|---|
| Subtitle C "Hazardous Waste" 2009 | Yes | Yes | No | No | N/A | N/A | N/A | Yes |
| Subtitle C "Special Waste" 2010 | Yes | Yes | No | No | N/A | N/A | N/A | Yes |
| Subtitle D (version 1) 2009 | No | Yes | No | No | Yes | No | No | No |
| Subtitle D (version 2) 2010 | No | Yes | No | No | Yes | Yes | No | No |
| Subtitle "D prime" 2010 | No | Yes | No | No | Yes | No | No | No |
| Hybrid Subtitles C & D 2009 | Unclear | Yes | No | No | N/A | N/A | N/A | Yes |

**Table 12: Scaling factors for 2010 rule options**

| **Economic Impact Category** | **Subtitle C "Special Waste"** | **Subtitle D (version 2)** | **Subtitle "D prime"** |
|---|---|---|---|
| **Regulatory Compliance Costs:** | | | |
| 1. Engineering control costs | 100% | 48% | 48% |
| 2. Ancillary costs | 100% | 48% | 48% |
| 3. Dry conversion costs | 100% | 40% | 0% |
| **Regulatory Benefits:** | | | |
| 1. Groundwater contamination prevention benefits: | | | |
| Groundwater remediation costs avoided | 100% | 48% | 30% |
| Monetized value of human cancer risks avoided | 100% | 48% | 30% |
| 2. Impoundment structural failure cleanup costs avoided | 100% | 45% | 23% |
| 3. Induced impact on CCR beneficial use: | | | |
| Scenario #1: Induced increase | 100% | 40% | 16% |
| Scenario #2: Induced decrease | 100% | 0% | 0% |
| Scenario #3: No change | Not relevant | Not relevant | Not relevant |

[38] U.S. Environmental Protection Agency (2010), "Regulatory Impact Analysis for EPA's Proposed RCRA Regulation Of Coal Combustion Residues (CCR) Generated by the Electric Utility Industry." Washington, DC: Office of Resource Conservation & Recovery, April 30, 2010. All exhibit, table, appendix, section, and page numbers in this comment refer to this document, unless otherwise specified.

An initial RIA had been prepared based on three rule options proposed by EPA in 2009.[39] After EPA offered a new set of rule options – excluding, for example, consideration of a "hazardous" label for CCRs – the RIA was updated to reflect those options, primarily by applying scaling factors to bridge between cost and benefits estimates for the old and new rule options. Specifically, the cost and benefits estimates for the Subtitle C "Hazardous Waste" rule option presented in the 2009 draft multiplied by the scaling factors presented in Exhibit 6F (reproduced in Table 12 above) are the cost and benefits estimates for the 2010 rule options (with a few exceptions of updated analyses and some variation from the stated scaling factors as described below).

Two of the benefits considered in the RIA are estimated for multiple scenarios: impoundment failures for three scenarios of the distribution of future failures, and induced impact on future beneficial use for three scenarios of possible impacts. With two discount rates (3 and 7 percent) and three rule options, net benefits are presented for 54 different cases; of these, 20 show positive net benefits to the ruling and 34 net negative.

The following sections discuss replication of each of three costs and four benefits in these 54 cases, along with errors identified in the RIA and alternate, equally defensible modeling assumptions. In brief:

- Correction of scaling factors decreases engineering costs by 59 percent under Subtitle D (version 2) and 67 percent under Subtitle "D prime."
- Correction of modeling, scaling factor, and transcription errors raises ancillary costs by 18 percent under Subtitle C and decreases costs by 45 percent under Subtitle D (version 2) and 55 percent under Subtitle "D prime."
- **With these corrections, total regulatory costs are 1 percent higher under Subtitle C, 24 percent lower under Subtitle D (version 2), and 67 percent lower under Subtitle "D prime."**
- Correction of scaling factors decreases the value of avoided human cancer risks by 71 percent under both Subtitle D options.
- Correction of per unit groundwater remediation costs and the number of sites needing remediation raises the avoided groundwater remediation costs by 370 percent under all three rule options.
- Corrections to the historical period, release data, and valuation of significant and catastrophic failures for impoundment release cleanup raises the low end of these avoided costs by 136 percent under all three rule options, and raises the medium and high end by 36 percent.
- **With these corrections, total regulatory benefits excluding those related to beneficial use are approximately 133 to 151 percent higher (depending on rule option and discount rate) using the low end of impoundment failure cleanup costs and 40 to 50 percent higher using the high end of cleanup costs.**

[39] That version of the RIA, completed Oct. 8, 2009, and submitted to the Office of Management and Budget for review, is referenced at length in the revised, April 2010 version. Where the October 2009 version is referenced in this text, it is called the "2009 draft," and it is as cited in the April 2010 document.

- Corrections to the per-ton lifecycle benefit and disposal costs and various transcription errors reduce Scenario #1 beneficial use benefits by 89 percent under all three rule options, and raise benefits to a 76-percent smaller negative number in Scenario #2 Subtitle C. (Scenario #2 Subtitle D benefits are assumed to be zero, as are all Scenario #3 benefits.)
- **After all corrections, a few scenarios change from net negative to net positive, and one from net positive to net negative.**
    - Beneficial Use Scenario #1, 7- and 3-percent discount rates, Subtitle C, Impoundment Failure Scenario 1 changes from net positive to net negative.
    - Beneficial Use Scenarios #2, 7- and 3-percent discount rates, Subtitle D (version 2), Impoundment Failure Scenario 3 changes from net negative to net positive.
    - Beneficial Use Scenarios #2, 7- and 3-percent discount rates, Subtitle “D prime,” Impoundment Failure Scenarios 1 and 2 change from net negative to net positive.
    - Beneficial Use Scenarios #3, 7- and 3-percent discount rate, Subtitle C and Subtitle D (version 2), Impoundment Failure Scenario 3 changes from net negative to net positive.
    - Beneficial Use Scenarios #3, 7- and 3-percent discount rate, Subtitle “D prime,” Impoundment Failure Scenarios 1 and 2 change from net negative to net positive.

**1. Regulatory Costs**

EPA estimated 2009 baseline disposal costs using its “landfill and impoundment engineering controls cost estimation model” (p. 51); the result was a baseline (before rule implementation) disposal cost of $59 per ton of CCR (Exhibit 3L). Regulatory costs for engineering controls, ancillary costs for CCR disposal, and conversion to dry CCR disposal were estimated using this same model, and each of the 2009 rule options was assigned the increment between these regulatory costs and baseline disposal costs. The 2010 rule options are modeled as the product of the Subtitle C “Hazardous Waste” costs estimated in the 2009 draft and each option’s respective scaling factor.

For the cost of regulatory requirements related to engineering controls, the 2009 draft made very different assumptions than the 2010 version. In the 2009 draft, EPA explains: “This RIA assumes that that same set of RCRA 3004(x) custom-tailored engineering controls is required under each of the regulatory options, so the costs for engineering controls for all regulatory options are mostly, but not entirely, based on the same cost estimation formulae described above … for estimation of baseline engineering control costs” (p. 69). All three 2009 rule options – Subtitle C “Hazardous Waste,” Subtitle D (version 1), and Subtitle “D prime” – had the same engineering costs, $491 million per year. In contrast, in the 2010 Subtitle D (version 2) and Subtitle “D prime” rule options, engineering costs are 48 percent those of 2010 Subtitle C “Special Waste.” The 2010 version notes that, “For both RCRA subtitle C and subtitle D, the engineering control costs would be identical under both options. However, state governments are not required to develop comparable programs under RCRA Subtitle D rules, and states cannot enforce Federal subtitle D rules.” This change in assumptions lowers costs in the 2010 Subtitle D rule options. (The development of the 2010 scaling factors is discussed in Section 6B.) Here and elsewhere, small rounding or transcription errors lead to slightly different results in our replication than those reported in the RIA.

The scaling factors reported by EPA (see Table 3) are incorrect; the correct factors are 20 percent for Subtitle D (version 2) and 16 percent for Subtitle "D prime." EPA bases its 48 percent scaling factor for Subtitle D on "the percentage of waste disposed of in states with some level of groundwater monitoring programs is a reasonable estimate of benefits for the subtitle D approach."[40] A closer examination of state law reveals that the percentage of CCR covered by such programs is only 20 percent of the CCR generated nationally, less than half of EPA's estimate.[41] The RIA similarly overestimates the costs that will be prevented under subtitle D prime taking the midpoint "somewhere between the Subtitle D option and the baseline," which the RIA estimates to be 30%.[42] Using the corrected subtitle D option percentage (20 percent), the midpoint between the baseline (defined as 12 percent) and 20 percent would be 16 percent.

Ancillary costs for CCR disposal differ significantly by rule option in both RIA drafts. A cost of $107 million per year is estimated for Subtitle C based on EPA assumptions regarding higher-than-baseline offsite disposal, inspection, investigation, corrective action, permitting, reporting, and potential cleanup costs (where wastes classified as hazardous required different treatment) (Exhibit 4K).[43] There is a transcription error in the Subtitle C ancillary cost category, "15. RCRA TSDF hazardous waste disposal permit." This cost is estimated as $28.1 million per year (see pp. 77-78 and Exhibit 4B), but reported in Exhibit 4K and all downstream calculations at $7 million per year; total ancillary costs for Subtitle C, therefore, would be $127 million per year.

Costs of conversion to dry CCR disposal for Subtitle C are updated in the 2010 version to reflect a decreasing trend in CCR impoundment over the years 1996 to 2005 (p. 97); the updated estimate is $876 million per year.

The present value of regulatory costs at the 7-percent discount rate over the 50-year period of analysis from 2012 to 2061 was replicated by dividing EPA's reported average annual regulatory costs by the "capital recovery factor" of 0.07246 reported in a note to Summary Exhibit 5. This factor can be replicated by taking the ratio of the annual value for engineering costs in Subtitle C ($491 million) to the present value of these costs ($6,776, with 50 years of costs and discounting beginning in the initial year). Using the same method, the scaling factors for the 3 percent discount rates is 0.03887 (see Table 4).

[40] RIA, p. 124.
[41] See Sections IIIB of Earthjustice, Environmental Integrity Project, Sierra Club et al. (2010) comments submitted Nov. 19, 2010.
[42] RIA, p. 114.
[43] Despite a statement to the contrary in the RIA p. 198, EPA has confirmed that the compliance rate calculations in Subtitle D (version 2) and Subtitle "D Prime" are in fact scaled to Subtitle D (version 1). (Personal communication via e-mail from Richard Benware, October 2010.)

**Table 13: Discounted regulatory costs from 2012 to 2061**

| *(millions 2009$)* | EPA (2010) | | SEI Corrections | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | **$20,342** | **$37,926** | **$20,615** | **$38,434** |
| 1A. Engineering Controls | $6,776 | $12,633 | $6,776 | $12,633 |
| 1B. Ancillary Regulatory Requirements | $1,477 | $2,753 | $1,749 | $3,262 |
| 1C. Conversion to Dry CCR Disposal | $12,089 | $22,539 | $12,089 | $22,539 |
| **Subtitle D (version 2)** | **$8,092** | **$15,087** | **$6,180** | **$11,522** |
| 1A. Engineering Controls | $3,257 | $6,072 | $1,341 | $2,501 |
| 1B. Ancillary Regulatory Requirements | $5 | $9 | $3 | $5 |
| 1C. Conversion to Dry CCR Disposal | $4,830 | $9,005 | $4,836 | $9,016 |
| **Subtitle "D prime"** | **$3,262** | **$6,081** | **$1,075** | **$2,005** |
| 1A. Engineering Controls | $3,257 | $6,072 | $1,073 | $2,001 |
| 1B. Ancillary Regulatory Requirements | $5 | $9 | $2 | $4 |
| 1C. Conversion to Dry CCR Disposal | $0 | $0 | $0 | $0 |

## 2A. Monetized Value of Human Cancer Risks Avoided

The 2010 version of the RIA estimates the risk and monetary value of lung and bladder cancer from leached arsenic in groundwater. Missing from the RIA are other forms of cancer, non-cancer health risks, other pollutants in CCR, and other exposure pathways.[44] Cancer slope factors from two previous studies are applied to estimates of the population that lives near CCR facilities and drinks well-water. EPA estimates 1,560 bladder cancers and 949 lung cancers from 2015 to 2090 and provides an increasing schedule of their incidence in Appendix K7, Table H.1.[45]

The monetary value of each cancer depends on the likelihood that it is fatal or non-fatal based on: each type of cancer's 5-year survival rate (p. 121); EPA's value of a statistical life; medical costs associated with each type of fatal cancer; and a cost of non-fatal cancers estimated as 58.3 percent that of fatal cancers (see Exhibit 5A-8). Discounted present values for baseline costs in each year are presented in Appendix K7, Table H.1.

EPA assumes that some of the expected cancers would be avoided through monitoring and remediation. The present value of avoided cancers for each year is multiplied by a year and rule-option-specific parameter (these values are shown in Appendix K, Table H.2). The assumptions used to create these shares are as follows: Under baseline conditions, 12 percent of cancers would be prevented in 2015 and all cancers would be prevented in 2090 (see Exhibit 5A-9). The

[44] For a more detailed discussion, see U.S. Environmental Protection Agency (2010), "Human and Ecological Risk Assessment of Coal Combustion Wastes." Washington, DC: Office of Solid Waste and Emergency Response and Office of Resource Conservation and Recovery. RIN 2050-AE81. Available online at http://www.regulations.gov/search/Regs/home.html#documentDetail?R=0900006480ae585b.
[45] Note that EPA assumes that no existing surface impoundments units have composite liners. (Personal communication via e-mail from Richard Benware, October 2010.)

RIA explains, "Since all but 4 of the 2,509 cancers projected above result from surface impoundments, only surface impoundment monitoring data were used in the calculations." Twelve percent is the share of surface impoundments requirement groundwater monitoring at both new and existing units. This initial rate of prevention increases gradually to 100 percent in 2090: "Since the rate of discovery is unpredictable, further assumed detection would be at a constant rate, reaching 100% detection by the final year of the analysis. These discoveries were assumed not to start for six years because the first percentile of time duration until peak risks for unlined surface impoundments occurred." (p. 125) EPA further assumes that under Subtitle C all cancers from CCR leaching would be avoided. Corrections to EPA's scaling factors (discussed above) changes the profile of realized cancers in Subtitle D (version 2) and Subtitle "D prime."

**Table 14: Avoided cancers from CCR leaching, 2012 to 2090**

| *(millions 2009$)* | EPA (2010) | | SEI Replication | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | $504 | $1,825 | $504 | $1,824 |
| **Subtitle D (version 2)** | $207 | $750 | $60 | $218 |
| **Subtitle "D prime"** | $104 | $375 | $30 | $109 |

Note that these discounted present values cover 78 years of costs instead of the stated 50 years for the assessment as a whole.

## 2B. Groundwater Remediation Costs Avoided

The RIA combines the risk of leached materials reaching groundwater with the expected cost of remediation to set a value on the avoided costs of groundwater remediation from the new rule. On p. 127, the percentile of cleanup levels in the "EPA-ORCR 2009 CCR Risk Study"[46] is reported, and from this, the percent of utility plants requiring future groundwater remediation is estimated: "Model results equal to or above these percentiles [Exhibit 5A-12] would require a state or federal cleanup. In other words, the percentage of sites above the cleanup level displayed in Exhibit 5A-13 can be derived by subtracting the percents in Exhibit 5A-12 above from 100%. However, while states may require remediation of all groundwater, whether or not it is potable, they may also choose not to on a site by site basis. As discussed in the EPA-ORCR 2009 CCR risk report, it is estimated that two-thirds of sites are located closer to a surface waterbody than to the nearest groundwater well. Therefore, sites located on surface waterbodies may not be cleaned in some states. This 2/3 decrease is accounted for in the second set of values in Exhibit 5A-13."

EPA mistakenly assumes that surface water bodies will prevent the need for remediation in two-thirds of cases;[47] we correct this error and, therefore, calculate remediation costs for 173 rather than 115 sites.

[46] U.S. Environmental Protection Agency (2010), "Human and Ecological Risk Assessment Of Coal Combustion Wastes." Office of Solid Waste and Emergency Response and Office of Resource Conservation and Recovery, April 2010 draft. Regulation Identifier Number 2050-AE81.
[47] See Hutson and Norris (2010).

In Exhibit 5A-13, two categories of sites are established:

> Category 1: "Assuming All Groundwater is Remediated": The share of sites, by category, requiring state or federal cleanup is calculated as 100 percent minus the "percentile of cleanup levels" by category.
>
> Category 2: "Assuming All Potable Groundwater is Remediated": Surface water is estimated to prevent two-thirds of leach incidents from reaching wells. The share of sites, by category, requiring state or federal clean-up in Category 2 is one-third that of Category 1.

These two categories of shares are then multiplied by the estimated number of electric utility plants by CCR disposal unit type in Exhibit 5A-14 to calculate the "number of facilities that would lead to state or federal clean ups" (p. 128) in Exhibit 5A-15.

The subsequent text and tables in the RIA describe two types of remediation that sum to avoided remediation costs: early costs and late costs.

> Early Costs/Early Detection/More Stringent Requirements: "First, EPA assumed contamination that might occur at sites in states with more stringent monitoring requirements, would be discovered promptly. This suggests that there is likely to be less remediation required than at the typical site. Thus, EPA assigned these sites the 25th percentile remediation costs displayed in Exhibit 5A-16 below as the midpoint of the bottom half of costs. These future remediation events were spread evenly across all 75 years of the analysis." (p. 128)
>
> Late Costs/Late Detection/Less Stringent Requirements: "For the remaining sites expected to require remediation, but lacking groundwater monitoring requirements, EPA assumed discovery of contamination would take longer. That is, CCR contamination would have migrated for some number of years, resulting in a larger groundwater plume to remediate, or more extensive remediation. EPA assigned these sites the 75th percentile remediation costs as the midpoint of the top half of costs. Since the first percentile time to peak results for unlined surface impoundments is six years, it is assumed that no discoveries and cleanups will be made in the first six years for these sites (three years once the two years for state adoption and one year for groundwater monitoring are considered). The costs are thus spread evenly over the remaining 72 years." (p. 129)

The RIA reports neither the total number of sites requiring remediation nor the share of sites assigned early and late costs. Backcasting from Appendix K10, Table K.1 results in the following (see Table 15):

**Table 15: Backcasting remediation sites**

| | Per-site cost | Annual cost | Implied sites/year | Years studied | Total leach sites | Share of sites |
|---|---|---|---|---|---|---|
| **Discount rate 3%** | | | | | | |
| **Early costs** | $8,054,142 | $3,160,637 | 0.392 | 75 | 29.4 | 25.5% |
| **Late costs** | $49,455,605 | $58,923,688 | 1.191 | 72 | 85.8 | 74.5% |
| **Total** | | $62,084,325 | | | 115.2 | |
| **Discount rate 7%** | | | | | | |
| **Early costs** | $7,315,422 | $2,870,746 | 0.392 | 75 | 29.4 | 25.5% |
| **Late costs** | $38,902,453 | $46,350,176 | 1.191 | 72 | 85.8 | 74.5% |
| **Total** | | $49,220,922 | | | 115.2 | |

These calculations indicate that the expected number of sites requiring remediation is 115, of which 25 percent are detected early (29) and 75 percent late (86). EPA assumes that sites with groundwater monitoring face early costs and sites without groundwater monitoring face late costs.[48] Using the corrected number of sites, we instead assume that there are 44 sites are detected early and 129 are detected late.

An additional error was made in EPA's calculation of per-site groundwater contamination remediation costs as reported in Exhibit 5A-16. Annual O&M costs are calculated as the product of the average volume of groundwater treated and a per unit treatment cost. The 25$^{th}$ percentile treatment cost, $10 per 1000 gallon, was applied to both the 25$^{th}$ and 75$^{th}$ percentile estimates; the correct 75$^{th}$ percentile unit cost is $61 per 1000 gallons.[49]

**Table 16: Per-Site Groundwater Contamination Remediation Costs**

| Cost element category | 25th percentile "early costs" | 75th percentile "later costs" |
|---|---|---|
| Exhibit 5A-16: | | |
| Capital Costs | $6,075,900 | $21,195,000 |
| Annual O&M | $98,910 | $1,413,000 |
| SEI Calculations: | | |
| Capital Costs | $6,075,900 | $21,195,000 |
| Annual O&M | $98,910 | $8,621,951 |

[48] Personal communication via e-mail from Richard Benware, October 2010.

[49] EPA pointed out this error in response to our questions regarding the derivation of the values. (Personal communication via e-mail from Mark Eads, October 2010.) Data source: "Cost data from Exhibits 3 and 4 in EPA 'Cost Analyses for Selected Groundwater Cleanup Projects: Pump and Treat Systems and Permeable Reactive Barriers,' Office of Solid Waste Emergency Response, EPA-542-R-00-013. February 2001 at: http://www.epa.gov/tio/download/remed/542r00013.pdf." Note that EPA uses the costs associated with "Other combinations of contaminants (solvents, BTEX, metals, PCBs or PAHs)" and not the general groundwater remediation costs, and that EPA employs an inflation adjustment factor that is specific to water supply planning (for the latter see, see St. Johns River Management District (2010), "Cost Estimating and Economic Criteria for 2010 District Water Supply Plan," Special Publication SJ2010-SP4, available online at http://www.sjrwmd.com/technicalreports/pdfs/SP/SJ2010-SP4.pdf).

**Table 17: Avoided groundwater remediation costs, 2012 to 2090**

| *(millions 2009$)* | EPA (2010) | | SEI Corrections | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | $696 | $2,176 | $2,190 | $8,110 |
| **Subtitle D (version 2)** | $251 | $786 | $791 | $2,930 |
| **Subtitle "D prime"** | $126 | $393 | $396 | $1,465 |

Note that these discounted present values cover 78 years of costs instead of the stated 50 years for the assessment as a whole, and that the scaling factors employed do not following the parameters set out in Exhibit 6F.[50]

## 2C. CCR Impoundment Failure Costs Avoided

### *Cost per failure*

The RIA bases its significant (greater than 1 million but less than 1 billion gallons) and catastrophic (greater than 1 billion gallons) costs of impoundment failure on three data points: PPL Martins Creek Power Station ash basin failure in 2005 ($37 million); TVA Widows Creek Power Station wet stacking area failure in 2009 ($9.2 million); and TVA Kingston Power Station dredge pond failure in 2008 (projected $3 billion). EPA averages costs of the two smaller spills for its significant failure valuation ($23.1 million), and takes the Kingston cost as its catastrophic failure valuation. The Martins Creek and Widows Creek failure costs are based, however, on fragmentary documentation, while the Kingston cost is explored in detail. A review of the assumptions behind the Kingston value (described below) led to an alternate valuation of $4.07 billion, implying a cost per gallon of $3.70. In our replication, we apply $69 million per spill (or $3.70/gallon applied to the average number of gallons in a significant spill, 25.3 million) to significant failures and $4.07 billion per spill cost to catastrophic failures.

EPA's estimate of the cost of a catastrophic spill may also warrant correction (see Appendix Q, p. 435 for a discussion of the costs of the Kingston impoundment failure). This cost includes three elements: the TVA cleanup, ecological damages, and socio-economic damages. TVA has projected that the Kingston cleanup will cost $933 million to $1.2 billion;[51] the RIA uses the midpoint $1.07 billion. This figure does not include legal fees or restitution related to lawsuits

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[50] EPA confirms the latter and explains that, "Scaling factors are due to compliance rates.  However, compliance rates merely change the number with groundwater monitoring, or the number with wet handling. It is the difference in number of sites remediated and the cost of that remediation that lead to benefits, and thus these numbers should not correlate 1-to-1 like they do for engineering costs." (Personal communication via e-mail from Richard Benware, October 2010.)

[51] Tennessee Valley Authority (2010), Form 10-Q, Quarterly report pursuant to Section 13, 15(d), or 37 of the Securities Exchange Act of 1934, for the period ended December 31, 2009. Filed with the U.S. Securities and Exchange Commission on February 3, 2010. Available online at http://investor.shareholder.com/tva/secfiling.cfm?filingID=1376986-10-5.

(57 have been filed and are moving forward[52]); fines (Tennessee EPA has set a fine of $11.5 million for the Kingston spill[53]); or costs to local, state and federal agencies.

A January 2010 review of TVA's Kingston spill-related contracts showed a completed contract for emergency response ($510 million), and 68 open contracts for cleanup and other spill-related costs totaling $428.5 million. These contracts did not include payments to cover the costs of the Tennessee EPA and federal EPA;[54] TVA's purchase of 150 properties for an undisclosed amount; or $40 million paid to local governments "to help restore the image and economy of the community."[55]

TVA's contracts include $75 million for hauling the ash to Perry County, Alabama, and $17 million for ash disposal. TVA's fourth-quarter 2009 SEC filing (see footnote 23) notes that a Perry County landfill contracted to receive the spilled coal ash had filed for bankruptcy; it had already received about 20 percent of the Kingston ash. The bankruptcy put a halt to plans by a community group and county government to sue the landfill in federal court over the disposal of the Kingston coal ash.[56] In May 2010, TVA announced a new plan to store the remaining spilled ash on site in unlined containment areas.[57] TVA studied several alternatives for storage, on and off site, ranging in cost from $270 million to $740 million, and chose the lowest-cost method.[58] A news article quoted the TVA's cleanup project manager as saying, "It was the cheapest of several options TVA considered … it should keep overall costs within the projected $1.2 billion total."[59] Given these considerations, the $1.07 million cost estimate used by EPA seems unwarrantedly conservative.

Because of the high cost of doing a site-specific study of these costs, the RIA uses the benefits transfer method to apply costs under the EPA's oil spill response program[60] (we refer to this

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[52] Barker, S. (2010), "TVA faces 57 suits over ash spill." *Knoxville News Sentinel*, January 13, 2010. Available online at http://www.knoxnews.com/news/2010/jan/13/tva-faces-57-suits-over-ash-spill/.
[53] Sohn, P. (2010), "State fines TVA $11.5 million for ash spill." *Chattanooga Times Free Press*, June 15, 2010. Available online at http://www.timesfreepress.com/news/2010/jun/15/state-fines-tva-115-million-ash-spill/.
[54] Barker, S. (2010), "Ten firms to make $10M each from first phase of ash spill cleanup." *Knoxville News Sentinel*, January 7, 2010. Available online at http://m.knoxnews.com/news/2010/jan/07/cleanup-nets-millions/.
[55] Sohn, P. (2009), "1 year later: Digging out of the ashes." *Chattanooga Times Free Press*, December 22, 2009. Available online at http://www.timesfreepress.com/news/2009/dec/22/1-year-later-digging-out-of-the-ashes/.
[56] See Faulkner, L. (2010), "Perry County landfill bankruptcy raises questions." *Selma Times Journal*, September 21, 2010. Available online at http://www.selmatimesjournal.com/2010/01/27/perry-county-landfill-bankruptcy-raises-questions/, and:
Sturgis, S. (2010), "Disaster in East Tennessee." *Facing South*, Institute of Southern Studies, May 25, 2010. Available online at http://www.southernstudies.org/2010/05/disaster-in-east-tennessee.html.
[57] Tennessee Valley Authority (2010), "TVA will store all ash on site in next phase of Kingston cleanup" (press release). Available online at http://tva.com/news/releases/aprjun10/ash_storage.html.
[58] Tennessee Valley Authority (2010), "Kingston Ash Recovery Project Non-Time-Critical Removal Action Embayment/Dredge Cell Engineering Evaluation/Cost Analysis (EE/CA)." Prepared by Jacobs for TVA. Released for public comment January 15, 2010. Available online at http://media.timesfreepress.com/docs/2010/01/Swan_Pond_ash_report_0120.pdf.
[59] Poovey, B. (2010), "TVA to take next step in cleanup." Associated Press article published in the *Tuscaloosa News*, May 20, 2010. Available online at http://www.tuscaloosanews.com/article/20100520/NEWS/100519358/.
[60] See Etkin, D.S. (2004). "Analysis of Benefits of EPA oil program." Cortlandt Manor, NY: Environmental Research Consulting. Presented at the Freshwater Spills Symposium, April 6-8, 2004. Available online at http://www.environmental-research.com/erc_reports/ERC_report_9.pdf.

study here by its author, Ektin) to estimate the ecological damage costs of a catastrophic spill. The RIA applies the Etkin ratio of ecological damages to cleanup costs in historical oil spills to the Kingston cleanup costs (1.59 * $1.07 billion = $1.7 billion). In actuality, Etkin reports data for four different scenarios: EPA jurisdictional water vs. other inland waters; and 1982-2002 data vs. 1982-2012 data. EPA's choice (other inland waters, 1982-2002) results in the lowest ecological to cleanup costs ratio of the four; the others range from 1.61 to 1.65. The RIA attributes the choice of "EPA jurisdictional waters" to characteristics found in a table not shown in the Etkin document available online; it does not explain the choice of 1982-2002.

The RIA also mentions but does not use an alternative approach to estimating Kingston's ecological damage costs: Sediment contamination of the Lower Watts Bar Reservoir cost $38 billion to clean up. A natural resource assessment of this incident estimated a "total ecological and human service cost" of $30 million, or an Etkin ratio to cleanup costs of 0.08 that would result in estimated ecological damages of $86 million.

In estimating the socio-economic damage costs of a catastrophic spill, EPA again draws on Etkin, and applies a ratio of 0.24 to the Kingston cleanup costs, for a value of $256 million. The actual costs estimated by Etkin would result in ratios ranging from 0.56 to 0.63, depending on scenario, but the RIA applies an additional "cost modifier" ratio derived from a second Etkin paper[61] to this ratio.

Etkin's cost modifiers are ratios of two rankings – dubbed the EPA Basic Oil Spill Cost Estimation Model (BOSCEM) Socioeconomic & Cultural Value Rankings – that range from "Extreme" at 2.0 for subsistence and commercial fishing and for aquaculture areas, to "None" at 0.1 for heavily industrial and designated dumpsites. The cost modifier used in the RIA is 0.3/0.7. The socio-economic cost estimates reported in Etkin 2004a are based on a cost modifier (0.7) for spill areas of "moderate" value: "Predominated by areas with medium socioeconomic value that may potentially experience short-term [defined as lasting days to weeks average the spill and being reasonably reversible] impact if oiling occurs. … Residential areas; urban/suburban parks; roadsides." The RIA, however, classifies the area surrounding the Kingston plant as "minimal value," with a cost modifier of 0.3: "Predominated by areas with a small amount of socioeconomic value that may potentially experience short-term impact if oiled. … Light industrial areas; commercial zones; urban areas."

The "minimal value" assessment for the Kingston area – rural farmland and riverfront homes; the impacted section of the Emory River was used recreationally for swimming, boating and fishing – is difficult to comprehend. A better assessment might be "High" value with a 1.0 cost modifier: "Predominated by areas with medium socioeconomic value that may potentially experience some long-term [defined as lasting months to years after the spill or being relatively irreversible] impact if oiled. … Recreational areas, sport fishing, farm/ranchland." Certainly, the impacts of Kingston have lasted well beyond the weeks into the years.

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[61] Etkin, D.S. (2004). "Modeling Oil Spill Response and Damage Costs" Cortlandt Manor, NY: Environmental Research Consulting. Presented at the Freshwater Spills Symposium, April 6-8, 2004. Available online at http://www.environmental-research.com/erc_reports/ERC_report_10.pdf.

Recalculating the socio-economic costs with the high modifier: 1.0/0.7 * 0.56 *$1.07 billion = $854 million; using the high modifier and the high end of the TVA cleanup cost estimates: 1.0/0.7 * 0.56 * $1.2 billion = $959 million (see Table 18).

**Table 18: Kingston release valuation**

| (billions 2009$) | RIA | RIA plus Etkin adjustments | RIA plus TVA high end | Both adjustments |
|---|---|---|---|---|
| **TVA Clean Up** | $1.07 | $1.07 | $1.20 | $1.20 |
| **Local/State/Federal** | | | | |
| **Ecological Damages** | $1.70 | $1.70 | $1.91 | $1.91 |
| **Socio-economic Damages** | $0.26 | $0.85 | $0.29 | $0.96 |
| **TOTAL** | $3.03 | $3.63 | $3.40 | $4.07 |

### *Method 1*

In Method 1,[62] the RIA uses historical release data and an assumed Poisson distribution to estimate the frequency and distribution of severity of future impoundment failures. Data used in EPA's calculation contains several errors. Most importantly, EPA uses 15 years as its period of historic record, but the actual record includes only 10 years of data. In addition, several of the historical releases have erroneous dates or amounts in EPA's dataset. Using the same source data cited by EPA,[63] we corrected dates on 10 out of 42 releases, amounts on five releases, and added six omitted releases. EPA's release frequency by type of event is compared to the corrected replication in Table 19.

**Table 19: Release frequency by type of release**

| | Expected Number of Release Events | | | |
|---|---|---|---|---|
| **Type of Release** | **99th percentile** | **95th percentile** | **90th percentile** | **Average** |
| **Exhibit 5B-4:** | | | | |
| **Catastrophic** | 8 | 7 | 6 | 3 |
| **Significant** | 27 | 24 | 22 | 17 |
| **Replication:** | | | | |
| **Catastrophic** | 11 | 9 | 8 | 5 |
| **Significant** | 61 | 56 | 54 | 45 |

The sum of the Method 1 average frequency of each type of event multiplied by estimated monetary values for each type of event, with each year adjusted for 1.33 percent annual decrease in wet disposal, is the low end of EPA range of avoided costs of impoundment failures (see

[62] EPA's Method 2 is not used in downstream results. For this reason, we do not discuss its replication here.
[63] On March 9, 2009, EPA sent a survey to utility companies with surface impoundments, seeking information about the facilities, safety measures, and "a brief history of known spills or unpermitted releases from the unit within the last ten years," whether or not they were reported to regulators, but only involving releases to surface water or to the land, not to groundwater. The survey responses are posted here: http://www.epa.gov/osw/nonhaz/industrial/special/fossil/surveys/. We reviewed only the surveys involving facilities included on EPA's list of "release events."

Table 20 below). Note that this and other results are sensitive to the assumed number of years to adoption – three years in most cases throughout the RIA. A longer interval before adoption would tend to lower cumulative costs and benefits, and would likely results in somewhat different net benefits.

**Table 20: Avoided costs of impoundment failure, low end of range**

| *(millions 2009$)* | EPA (2010) | | SEI Corrections | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Low-end scenario** | | | | |
| Subtitle C "Special Waste" | $1,761 | $3,123 | $4,163 | $7,382 |
| Subtitle D (version 2) | $793 | $1,405 | $1,873 | $3,322 |
| Subtitle "D prime" | $405 | $718 | $957 | $1,698 |

### *Scenarios 2 and 3*

EPA presents results based on two alternate assumptions regarding the frequency of future releases, both using information about the share of impoundments that are most vulnerable to failure. In Scenario 2, 10 percent of 96 at-risk facilities are projected to fail over the course of twenty years; in Scenario 3, 20 percent fail (see Table 21). In Scenarios 2 and 3, EPA assigns all spills the catastrophic spill cleanup costs.

**Table 21: Avoided costs of impoundment failure, medium and high** (millions 2009$)

| *(millions 2009$)* | EPA (2010) | | SEI Corrections | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Medium scenario** | | | | |
| Subtitle C special waste | $8,366 | $13,046 | $11,344 | $17,689 |
| Subtitle D (version 2) | $3,795 | $5,918 | $5,145 | $8,024 |
| Subtitle "D prime" | $1,897 | $2,959 | $2,573 | $4,012 |
| **High-end scenario** | | | | |
| Subtitle C special waste | $16,732 | $26,092 | $22,687 | $35,379 |
| Subtitle D (version 2) | $7,590 | $11,836 | $10,291 | $16,048 |
| Subtitle "D prime" | $3,795 | $5,918 | $5,146 | $8,024 |

## 2D. Induced Impact on Future CCR Beneficial Use

The final value relates to the beneficial use of CCR materials in concrete and wallboard. If this beneficial use were to increase as a result of the EPA rule, two potential costs would be avoided: CCR disposal costs, and the negative health impacts of producing virgin materials for use in concrete and wallboard. If instead the rule drives down CCR use, the result would be higher disposal costs and more virgin materials produced. The RIA values the gain or loss of 1 ton of CCR going towards a beneficial use as the sum of its "unitized lifecycle benefit" and the average disposal cost by rule option. The RIA does not, however, include in its calculations the impact of an increase or decrease in beneficial use (and therefore a decrease or increase in disposal) on avoided cancer risks, groundwater remediation, and impoundment failure cleanup (nor do we model these related impacts).

The lifecycle benefits of a ton of CCR beneficial use, which include resource consumption savings and avoided air pollution and other wastes, are grossly overestimated in the RIA. Problems in this area include: double-counting of emission reductions that are already occurring in response to other regulations; inappropriate valuation of all particulate matter based on health risks caused by the most dangerous, smallest varieties; and miscellaneous data errors.We correct the following values: we reduce avoided energy consumption from $4,880 million per year to $255 million; sulfur oxides from $1,491 million to $0; large-size particulate matter from $4,719 million to $0; and particulate matter of unspecified size from $12,741 million to $258 million. In total, these correction reduce the lifecycle benefits of CCR beneficial use from $474 per ton to $24 per ton (see attached memo for a detailed account of these corrections[64]).

In addition, EPA reports the value of average avoided disposal costs as $85 per ton with the new rule under Subtitle C (pp. 174, 184) and $59 without the rule (Exhibit 3L; p. 174). The difference between these two values is explained as follows: “In comparison to these baseline ‘raw materials acquisition cost’ elements, CCR disposal costs are estimated to be $83/ton for the Subtitle C option (source: Exhibit 4K). While this represents a 44% increase ($26/ton) over the baseline disposal cost of $59/ton, this ignores the CCR price and the transportation cost elements.” (p. 172) Exhibit 4K, however, shows incremental costs above the baseline for disposal of $15.65 per ton for Subtitle C, which would be $75 per ton under Subtitle C ($59 + $16).[65]

The RIA calculates baseline beneficial use of CCRs as expected tons of coal burned in future years (based on a continuation of a multi-year growth trend) multiplied by the ratio of 2008 tons of CCR generated to 2008 tons (0.13) of CCR burned multiplied by an assumed share of beneficial use (out of all CCRs generated) for each future year. Future shares of beneficial use follow recent years’ growth trend; the share of beneficial uses grows from 51 percent in 2012 to 88 percent in 2061. EPA assigns each ton of beneficial use the value discussed above: the unitized lifecycle benefit per ton ($474) plus the avoided disposal costs per ton ($85).

In Scenario #1, the EPA ruling induces an increase in beneficial use as electric generators seek out new customers for CCRs in order to avoid higher disposal costs. EPA assumes that the induced effect will grow linearly to 28 percent of baseline disposal in 2019, and remain at 28 percent of baseline disposal in each year after that. The estimated 28-percent impact is the ratio of the same $26 in additional disposal costs discussed above to a baseline raw material cost of $94.10 (pp. 171-2). As previously noted, $26 in additional disposal costs appears to be an error in transcription. The correct value is $16, and the correct ratio is 17 percent. In a final step, the induced impact in each future year is reduced by 2.3 percent to omit all CCRs used in minefilling.

[64] See Schaeffer Memorandum, attached.
[65] EPA confirms this error and plans to correct it in the final ruling. (Personal communication via e-mail from Mark Eads, October 2010.)

**Table 22: Scenario #1 induced increase in beneficial CCR use**

| *(millions 2009$)* | EPA (2010) | | SEI Corrections | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | $84,490 | $148,999 | $9,010 | $15,890 |
| **Subtitle D (version 2)** | $33,796 | $59,600 | $3,604 | $6,356 |
| **Subtitle "D prime"** | $13,518 | $23,840 | $1,442 | $2,542 |

In Scenario #2, the EPA ruling induces a decrease in beneficial use due to stigma. EPA assumes an induced decrease of 51 percent in every year for the next 50 years – a 50-percent reduction in consolidated uses and an 80-percent reduction in unconsolidated uses (pp. 176-7). The RIA does not, however, follow this method in its calculations. Instead, EPA subtracts a constant 35.3 million tons from beneficial use – 51 percent of year 2012 beneficial use – in each future year. The total reduction to beneficial use over 50 years is 1.8 billion tons using the method followed by EPA (see Exhibit 5C-15), or 2.9 billion tons following the method explained in the RIA text (p. 177).

EPA then decreases all years' induced change in beneficial use to omit minefilling, but reduces each year's value by 5.6 percent, and not the 2.3 percent described in the text (p. 169) and shown in calculations for Scenario #1.

EPA calculates the value of this reduction in beneficial use using an adjusted value per ton: "The $559 per ton social benefit value estimated above is the proper estimate for increased beneficial use because this RIA assumes that all beneficial uses will increase in equal proportions. However, it would not be appropriate to apply this same dollar estimate to decreased beneficial use from stigma because different uses decrease by different amounts, and therefore the decrease in benefits would not necessarily equal the 51% decrease in tons. Based on the breakdown of beneficial uses displayed below in Exhibit 5C-20, these individual use category losses were summed to create a weighted average benefit reduction of 42%. However, on a tonnage basis 51% of beneficial use tons are reduced. Dividing the weighted value by the unweighted value for each ton lost, the benefits decreased by only 82% of the average $559/ton, or $458/ton." Backcasting from the results reported in Exhibit 5C-21, however, EPA has used a value per ton adjustment factor of 85 percent.

Finally, the EPA's reported summary value for Scenario #2, Subtitle C at a 3-percent discount rate ($435 billion) does not match that of Exhibit 5C-21 ($419 billion, see Table 23); the Exhibit 5C-21 values were successfully replicated, noting the corrections listed above.

**Table 23: Scenario #2 induced decrease in beneficial CCR use**

| *(millions 2009$)* | EPA (2010) | | SEI Corrections | |
|---|---|---|---|---|
| Discount rate: | **7%** | **3%** | **7%** | **3%** |
| **Subtitle C "Special Waste"** | ($233,547) | ($419,146) | ($56,160) | ($112,266) |
| **Subtitle D (version 2)** | $0 | $0 | $0 | $0 |
| **Subtitle "D prime"** | $0 | $0 | $0 | $0 |

## Re-evaluation of Estimates in USEPA Regulatory Impact Analysis

**Eric Schaeffer**
**For the Environmental Integrity Project and Earthjustice**
**November 16, 2010**

The Regulatory Impact Analysis prepared for the USEPA's proposed regulation of coal combustion residues (CCR RIA) estimates that recycling ash and flue gas desulfurizatation (FGD) byproduct results in annual lifecycle benefits of almost $23 billion.[66] Closer analysis based on data from the USEPA, the US Geological Survey, and the Department of Energy suggests a more realistic estimate of $1.15 billion. The benefits itemized on Table 5C-5 of the RIA are incorrect because they:

- overstate emissions from cement kilns, and double count reductions that EPA has already claimed will occur under Clean Air Act rules adopted in August of 2010;
- mistakenly apply a formula designed to measure fine particle health costs to the reduction of much larger particles from gypsum manufacturers;
- assume unrealistic savings from reducing energy consumption at cement kilns and gypsum plants that contradict data available from the USEPA and other federal agencies.

### Particulate matter emissions

More than three quarters of the benefit attributed to CCR recycling (76%) is based on assumed reductions in particulate matter (PM) from gypsum plants and cement kilns that substitute CCR for raw feed or blend it into the final product.[67]

*PM Reductions at Gypsum Plants*

EPA projects that CCR recycling will yield annual lifecycle benefits of $4.7 billion a year, based on reductions of 9,704 metric tons of "particulate matter" from wallboard manufacturers, at a value of 486,312 per ton (row 7, Table 5C-5).[68] The "dollar per ton" value is based on a 2009 study by Fann, et. al., of health impacts associated with exposure to fine particles smaller than 2.5 microns in diameter, otherwise known as "PM 2.5."[69] The emission reductions assumed in the RIA appear to be based on a 2008 report by EPA's Office of Solid Waste, which estimated a 9.7 billion gram (or 9,700 metric ton) reduction at gypsum wallboard plants due to CCR recycling[70]

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[66] Office of Resource Conservation and Recovery, US Environmental Protection Agency, Regulatory Impact Analysis For EPA's Proposed RCRA Regulation Of Coal Combustion Residues (CCR) Generated by the Electric Utility Industry, Table 5C-5, pp. 155, 156, (April 30, 2010), [hereinafter RCRA RIA].
[67] *Id,*, at 156.
[68] *Id.*
[69] *Id.*, Fann study cited in Note to Table 5C-5, at 156.
[70] Economics, Methods and Risk Analysis Division, Office of Solid Waste, USEPA, Waste and Materials – Flow Benchmark Sector Report: Beneficial Use of Secondary Materials, - Coal Combustion Products, (February, 2008), Table ES-3, at ES-7 [hereinafter Flow Benchmark Sector Report].

But as Table ES-3 of that report makes clear, these estimated reductions concern particles greater than 10 microns in diameter – not the PM 2.5 particles that were the focus of the 2009 study that is the basis for the "dollar per ton" value in the CCR RIA.[71] EPA's risk assessment has generally focused on PM 2.5, given the well established link between the contribution that fine particles make to premature mortality, and the Fann study is concerned with these much smaller particles. Using values meant to estimate the damage from PM 2.5 exposure for particles that are much larger is an obvious error, and row 7 of Table 5-C-5 should be eliminated from the estimated benefits of CCR recycling.

*PM Reductions at Cement Kilns*

The RIA also estimates an additional $12.74 billion in lifecycle benefits due to an assumed reduction of 26,100 metric tons of "unspeciated PM" emissions from cement kilns (Table 5-C-5, row 8).[72] The claimed PM reductions are based on replacement of 15% of cement through blending with fly ash and other coal combustion residues. Emission estimates are once again based on the 2008 Office of Solid Waste study, and the RIA uses the same value ($486,312 per ton) for particulate matter.[73] As noted above, these dollar per ton estimates were developed for PM2.5; the RIA assumes without explaining that all of the "unspeciated PM" emissions are PM 2.5. Even if that is assumption is correct, the RIA is based on numbers that are about seven times higher than emission estimates from the Agency's own Office of Air Quality Planning and Standards.

In August of 2010, EPA published final National Hazardous Emission and New Source Performance Standards for Portland cement manufacturing. The RIA accompanying that rule estimates "baseline" emissions of fine particles <u>from the entire industry</u> totaled no more than 16,758 short tons (15,199 metric tons) in 2005, declining to 15,403 short tons (13,970 metric tons) by 2013 (Table 5-2, p. 5-4).[74] These industry-wide emissions are also expected to drop sharply after the new Clean Air Act rules take full effect, declining by 11,500 short tons (10,430 metric) by 2013.[75]

By that year, EPA expects that total PM 2.5 emissions will not exceed 3,900 short tons (3,540 metric), assuming a 3,900 ton reduction from EPA's projected 2013 baseline estimate of 15,403 short tons of fine particle emissions from all Portland cement manufacturing.[76] It will obviously

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[71] *The Influence of Location, Source and Emission Type in Estimates of the Human Health Benefits of Reducing a Ton of Air Pollution,* by Neal Fann, Charles Fulcher, and Bryan Hubbell, <u>Air Quality, Atmosphere & Health,</u> Vol. 2, No. 3, (Sept. 2009) , pp.169-176.

[72] <u>CCR RIA</u>, Table 5C-5, Row 8, at 156.

[73] *Id.*

[74] Air Benefits Group, Office of Air Quality Planning and Standards, USEPA, <u>Regulatory Impact Analysis: Amendments to the National Emission Standards for Hazardous Air Pollutants and New Source Performance Standards (NSPS) for the Portland Cement Manufacturing Industry: Final Report</u> (August 2010), Table 5-2 at 5-4 [hereinafter <u>Portland Cement RIA].</u>

[75] *Id*, and USEPA, "Fact Sheet: Final Amendments to National Air Toxics Emission Standards and New Source Performance Standards for Portland Cement Manufacturing," (August 9, 2010), p. 2, available at: http://www.epa.gov/ttncaaa1/t1/fact_sheets/portland_cement_fr_fs_080910.pdf

[76] *Id.* According to USEPA's fact sheet, 11,500 tons represent a 92% reduction, which suggests that industry-wide PM emissions could be as low as 1,000 tons by 2013.

be impossible for CCR recycling that displaces only 15% of total production to reduce fine particles by an amount nearly seven times larger than emissions from the entire industry sector.

Row 8 of Table 5C-5 should be revised to reflect the fact that PM 2.5 emissions from cement kilns are much lower than the CCR RIA assumed, and that most of these emissions will be eliminated within three years through the Clean Air Act Standards adopted in 2010. Accepting EPA's assumption that substitution of fly ash for 15% of cement production would reduce emissions proportionately, it is more reasonable to assume annual lifecycle benefits of $258 million, instead of the $12.74 billion proposed in the RIA for the RCRA CCR proposal:

0.15 recycling rate x 3,540 metric tons per year x 486,321 per ton = $258,012,831

EPA's analysis of benefits includes some PM emission reductions from off-site activities. These are not included in the revised analysis, for reasons explained below.

*Offsite Reductions in PM*

We do not believe that the recycling of CCR will result in significant offsite reductions in PM, e.g, by reducing the cement or gypsum industry's demand for power, or the need for the mining or transportation of virgin feedstock. According to the August, 2010 RIA for the cement kiln NESHAP rule, electricity demand accounts for less than 1% of the annual energy consumption at Portland cement plants.[77] Gypsum plants do not consume significant amounts of electricity from offsite sources, according to Department of Energy data.[78] Any emissions avoided by reducing the need for mining or transportation of virgin materials would have to be weighed against emissions created by the storage, excavation and transportation of fly ash and other combustion residues.

## Energy Benefits

*Cement Kilns*

The RIA prepared for the proposed rule assumes a total savings of $4.88 billion in energy costs, based on the 2008 Industrial Economics report. For cement kilns, EPA assumes that replacing about 15% of cement with fly ash reduces energy consumption for that industry by about 60 million mmbtu, and valued the savings at $1.8 billion. These estimates are based on the avoided cost of electricity, estimated to be about $30 per mmbtu.[79] But as noted earlier, purchased electricity accounts for less than 1% of energy consumption by cement kilns, while coal and petroleum coke account for three quarters of energy consumption at cement kilns, according to the Portland Cement RIA.[80] Consumption of these fuels costs much less than purchased

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[77] Portland Cement RIA, Table 3-12, at 3-24.
[78] The Energy Information Administration, US Dept. of Energy, Fuel Consumption 2006, Table 3.2, revised October 2009, [hereinafter Fuel Consumption 2006] at http://www.eia.doe.gov/emeu/mecs/mecs2006/pdf/Table3_2.pdf.

[79] Flow Materials Report, Exhibit ES-3, at ES-6, and Note g at ES-7.
[80] Portland Cement RIA, Table 3-12 at 3-24.

electricity, averaging $2.77 per mmbtu for coal in 2009, based on data from the Energy Information.[81]

The Portland Cement RIA estimates total energy costs of $1.7 billion for cement kilns.[82] Making the generous assumption that these costs are offset on a one to one basis when fly ash is substituted for cement, total savings would equal $255 million, based on a 15% substitution rate (0.15 x $1.7 billion = $255 million). To the extent this lower estimate does not offset all energy costs associated with cement production (e.g., mining of ore), the Agency needs to document these expenditures and compare them to costs related to the transportation and storage of fly ash.

*Gypsum Products*

Coal fired power plants generate millions of tons of flue gas desulfurization (FGD) waste that can be substituted for gypsum-based products like wallboard or soil conditioner. The RIA assumes that recycling 8.2 million tons of this FGD byproduct into wallboard cuts energy consumption by 98 million mmbtu a year, for a total annual savings of $2.9 billion.[83] That is unlikely, as the entire gypsum products industry consumes an estimated 86 million mmbtu per year, according to the Energy Information Administration.[84] In fact, the US Geological Survey reports that the *entire* value of total US shipments of gypsum products (including both wallboard and agricultural products) was just over $3 billion in 2007, declining to $1.85 billion in 2008 as the housing market slowed.[85]

About 80% of FGD-derived gypsum is processed into wallboard,[86] and requires calcining to remove impurities. The calcining process is energy intensive, but EPA has not demonstrated that substituting FGD byproduct for virgin material reduces these energy costs.

FGD gypsum may help to reduce costs associated with the mining or initial processing of virgin gypsum. But these energy savings are not reflected in price: FGD gypsum was actually slightly more expensive than mined gypsum in 2008, according to the USGS. Because mined gypsum is such a low value product (less than $9 per ton in 2008, with $125 million in total US sales) its replacement with synthetic gypsum will not yield significant savings in raw material costs.[87] No doubt some transportation expenses can be avoided for gypsum manufacturers close to a reliable source of high quality FGD gypsum, but EPA has not documented those. Until USEPA can better quantify how recycling FGD gypsum cuts energy costs, these savings should be excluded from the CCR RIA.

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[81] The Energy Information Administration, Electric Power Monthly, Table 4.5, October 2010, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html.
[82] Portland Cement RIA, at 2-4.
[83] Flow Materials Report, Exhibit ES-3, at ES-6.
[84] The Energy Information Administration, Fuel Consumption 2006, Table 3.2, revised October 2009, available online at http://www.eia.doe.gov/emeu/mecs/mecs2006/pdf/Table3_2.pdf.
[85] United States Geological Survey, Department of the Interior, 2008 USGS Minerals Yearbook: Gypsum [Advance Release], (July 2010), Table 1 at 33.6, available online at: http://minerals.usgs.gov/minerals/pubs/commodity/gypsum/myb1-2008-gypsu.pdf.

[86] *Id.*, at 33.1
[87] *Id.*, at 33.1, and Table 1, at 33.6. USGS Minerals Yearbook reports 9.7 million tons of synthetic FGD gypsum sold in 2008 at an estimated value of $84.6 million, or $8.72 per ton (p. 33.1). The same year, 14,400 tons of mined gypsum sold at an estimated value of $125 million, or $8.68 per ton. (Table 1 at 33.6).

The following table provides a summary of proposed changes to the life cycle benefits that appear in Table 5C-5 of the RCRA RIA:

**CCR: Revisions to Annual Life Cycle Benefits**
**($Million/Year)**

| *Category* | *CCR RIA* | *Revised* | *Explanation* |
|---|---|---|---|
| Energy Consumption | 4,880 | $255 | Revised estimate for cement kilns based on energy consumption, cost data from August 2010 cement kiln NESHAP; gypsum wallboard savings eliminated due to conflicting EIA and USGS data, lack of support in RIA. |
| Water Consumption | $81 | $81 | Not evaluated. |
| NOx Emissions | $312 | $312 | Based on 30,400 metric tons avoided, consistent with Portland Cement RIA. |
| PM – Particulate Matter | $4,719 | 0 | RIA assumes reduction of 9704 metric tons of large particles (greater than 10 microns) at $483,312 per ton. Revised to eliminate benefits, since RIA incorrectly applies dollar per ton estimates developed for fine particles (2.5 microns or less) to reduced emissions of much larger particles. |
| PM – Unspeciated | $12,741 | $258 | RIA assumes reduction 26,100 metric tons of fine particles from cement kilns. Revised to reflect Portland Cement RIA, which projects much lower industry-wide emissions by 2013 (3,540 metric tons). |
| GHG – Greenhouse Gas Emissions | $239 | $239 | Not evaluated. |
| ***Total*** | $22972<br>$474/ton | $1145<br>$24/ton | Does not include benefit of avoided disposal costs, which EPA estimates at $2.9 billion per year. |


Sources:

Office of Resource Conservation and Recovery, US Environmental Protection Agency, Regulatory Impact Analysis For EPA's Proposed RCRA Regulation Of Coal Combustion Residues (CCR) Generated by the Electric Utility Industry, (April 2010).

Economics, Methods and Risk Analysis Division, Office of Solid Waste, USEPA, Waste and Materials – Flow Benchmark Sector Report: Beneficial Use of Secondary Materials, - Coal Combustion Products, (February, 2008).

*The Influence of Location, Source and Emission Type in Estimates of the Human Health Benefits of Reducing a Ton of Air Pollution*, by Neal Fann, Charles Fulcher, and Bryan Hubbell, Air Quality, Atmosphere & Health, Vol. 2, No. 3, (Sept. 2009).

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