

William & Mary Environmental Law and Policy Review

Volume 40 (2015-2016)
Issue 2 Symposium Issue: *What's in Your
Water? A Discussion of Threats to Virginia's
Water Quality*

Article 6

February 2016

Coal Ash and Groundwater: Past, Present and Future Implications of Regulation

John Daniels

Follow this and additional works at: <https://scholarship.law.wm.edu/wmelpr>



Part of the [Environmental Law Commons](#), [Water Law Commons](#), and the [Water Resource Management Commons](#)

Repository Citation

John Daniels, *Coal Ash and Groundwater: Past, Present and Future Implications of Regulation*, 40 Wm. & Mary Env'tl. L. & Pol'y Rev. 535 (2016), <https://scholarship.law.wm.edu/wmelpr/vol40/iss2/6>

Copyright c 2016 by the authors. This article is brought to you by the William & Mary Law School Scholarship Repository.
<https://scholarship.law.wm.edu/wmelpr>

COAL ASH AND GROUNDWATER: PAST, PRESENT AND FUTURE IMPLICATIONS OF REGULATION

JOHN DANIELS*

INTRODUCTION

Coal is forecasted to be the number one fuel source, accounting for 34% of the nation's electricity supply by 2040, ahead of natural gas, nuclear, petroleum, and all renewable sources.¹ As such, and notwithstanding non-governmental organization opposition, strident regulation, and unfavorable market conditions, coal and coal combustion residuals ("CCRs") will be around for the foreseeable future. Even if coal combustion were to cease, there would still be several billion tons of ash distributed throughout the United States. In North Carolina, for example, there is an estimated 102 million tons of ash stored in various landfills and surface impoundments.²

Coal is a naturally occurring rock consisting of carbon from the compressed remains of prehistoric vegetation from swamps and forests.³ Upon combustion, most of the carbon is released leaving the inorganic fraction behind in the form of CCRs.⁴ CCRs include several byproduct types, depending on the type of air pollution control technology employed, but for this manuscript we will relegate our focus on two, namely bottom ash and fly ash, as these have historically been discharged in the greatest volumes and closest proximity to surface and groundwater supplies.⁵ In a modern combustion boiler, larger bottom ash particles settle near the bottom whereas smaller fly ash particles are carried with the flue gas

* Professor and Chair, Department of Civil and Environmental Engineering, The University of North Carolina at Charlotte. D.Eng. Civil Engineering, University of Massachusetts (Lowell).

¹ U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2015 WITH PROJECTIONS TO 2040 24–25 (2015), available at [http://www.eia.gov/forecasts/aeo/pdf/0383\(2015\).pdf](http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf) [<http://perma.cc/XS9E-FETG>].

² Clarke Morrison, *What do you do with 100 million tons of coal ash?*, CITIZEN-TIMES (July 10, 2014, 7:08 AM), <http://www.citizen-times.com/story/local/2014/07/09/tons-coal-ash/12435649/> [<http://perma.cc/H4PN-G7DG>].

³ *Coal Explained*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energyexplained/print.cfm?page=coal_home [<http://perma.cc/94FY-2TVT>] (last visited Nov. 12, 2015).

⁴ RICHARD W. GOODWIN, COMBUSTION ASH RESIDUE MANAGEMENT 11 (2nd ed. 2013).

⁵ See *id.* at 1–4.

and collected prior to leaving a chimney.⁶ In either case, coal ash is chemically similar to soil, consisting principally of oxides of silicon, calcium, iron, and aluminum, along with trace levels of other constituents such as arsenic, chromium, selenium, and boron.⁷

Until approximately the middle of the 20th century, fly ash from coal-fired power plants was simply released to the atmosphere through tall chimneys, while bottom ash was collected in piles or mixed with water, and piped (sluiced) to settling ponds also known as surface impoundments.⁸ By the 1970s, particulate control technology was relatively common, achieved through electrostatic precipitators or baghouse filters.⁹ These treatment systems collected the fly ash and sent it to the settling pond along with the bottom ash.¹⁰ Surface impoundments function as a type of water treatment, allowing the ash to settle out of the water which is then returned to the nearest river or lake through a permitted discharge under the U.S. Environmental Protection Agency's ("EPA") National Pollutant Discharge and Elimination System ("NPDES") program, as managed by authorized states.¹¹ This paper reviews the past, present, and future implications of coal ash management and regulation, with a focus on groundwater impacts.

I. HISTORICAL REGULATORY CONTEXT

As with other forms of waste and byproduct management, there has been an evolution of design standards. For example, EPA did not promulgate rules for landfills containing municipal solid waste (i.e., household garbage) until the Solid Waste Disposal Act of 1965.¹² Much of what constitutes the standard of care today in terms of barrier covers (to prevent precipitation from infiltrating into the waste) and liners (to prevent leachate escaping from the base into groundwater) is derived from research

⁶ *Id.* at 1.

⁷ ISSA S. OWEIS & RAJ P. KHERA, *GEOTECHNOLOGY OF WASTE MANAGEMENT* 382–83 (2nd ed. 1998); WILLARD LINDSAY, *CHEMICAL EQUILIBRIA IN SOILS* 383 (1979).

⁸ See generally Dennis Carlton-Jones, *Electrostatic Precipitation of Fly Ash Reaches Fiftieth Anniversary*, 24 *J. AIR POLLUTION CONTROL ASS'N* 1035, 1036 (1974) (describing that before technological advances, coal ash would pollute the air by entering the atmosphere at much higher rates).

⁹ GOODWIN, *supra* note 4, at 1–4.

¹⁰ Steven T. Moon & Amanda B. Turner, *Coal Ash Law and Regulation in the United States: An Overview*, 18 *SOUTHEASTERN ENVTL. L.J.* 173, 174 (2010).

¹¹ See MICHAEL D. LAGREGA ET AL., *HAZARDOUS WASTE MANAGEMENT* 426 (2d ed. 2001).

¹² Solid Waste Disposal Act of 1965, Pub. L. No. 89-272, 79 Stat. 997 (1965).

in the 1980s¹³ and ultimately manifested as technical guidance from the U.S. EPA in 1993.¹⁴

CCR was considered for regulation as part of the Resource Conservation and Recovery Act (“RCRA”) of 1976 but was exempted as a special waste by amendment.¹⁵ Introduced by Representative Thomas Bevill (D-Ala.), the so-called Bevill Amendment persists to the present day such that ash is not regulated as a hazardous waste. Previous regulatory determinations by the EPA in 1993 and 2000 have reiterated this support.¹⁶ One basis for this designation is that when subjected to leaching tests such as the Toxicity Characteristic and Leaching Procedure, ash does not generally leach contaminants at concentrations that exceed toxic thresholds.¹⁷ For example, chromium is regulated at 5,000 µg/l, yet it has been shown to leach at levels that range from 5.5 µg/l to 1,184 µg/l,¹⁸ as compared to an EPA maximum contaminant limit for drinking water of 100 µg/l.¹⁹ EPA’s 2015 rule for CCR promulgated national criteria regulating ash as a solid waste, not a hazardous waste, while deferring a recommendation on the Bevill exemption until further study has been completed.²⁰ One reason cited by EPA for this need for additional study is that air pollution control regulations have increased the amount of contaminants in the ash.²¹

So coal ash was initially managed in surface impoundments during a time in which more objectionable materials (e.g., household garbage, hazardous materials, and nuclear waste) were relegated to any available low-lying depression, with little protection from precipitation nor prevention of

¹³ LAGREGA ET AL., *supra* note 11, at 1–4.

¹⁴ SOLID WASTE DISPOSAL FACILITY CRITERIA, U.S. ENVTL. PROT. AGENCY, PA EPA 530-R-93-017 (1993).

¹⁵ 42 U.S.C. § 6921(b)(3)(A) (2006).

¹⁶ Notice of Regulatory Determination on Wastes From the Combustion of Fossil Fuels, 65 Fed. Reg. 32214, 32218 (May 22, 2000); LINDA LUTHER, CONG. RESEARCH SERV., BACKGROUND ON AND IMPLEMENTATION OF THE BEVILL AND BENTSEN EXCLUSIONS IN THE RESOURCE CONSERVATION AND RECOVERY ACT: EPA AUTHORITIES TO REGULATE “SPECIAL WASTES” 2 (2013).

¹⁷ See GOODWIN, *supra* note 4, at 115.

¹⁸ John L. Daniels & Gautham P. Das, *Practical Leachability and Sorption Considerations for Ash Management*, GEO-CONGRESS 2014 TECHNICAL PAPERS: GEO-CHARACTERIZATION AND MODELING FOR SUSTAINABILITY, 2014, at 362.

¹⁹ 40 C.F.R. § 141.62 (2012).

²⁰ See Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. 21,302 (Apr. 17, 2015) (to be codified at 40 C.F.R. pts. 257 & 261).

²¹ *Id.*

leachate.²² This context, coupled with familiarity of coal ash as a construction material that has much in common with soil, resulted in an industry-wide management strategy based on physical processing rather than chemical containment or treatment.²³ The concern for groundwater impacts, while obvious now, was simply not in the collective conscious of the coal-fired utility industry during much of its growth. As such, impoundments were created from topographical depressions and lowland features in proximity to the plant.²⁴ These impoundments were often unlined and in intimate contact with the prevailing groundwater.²⁵

II. ACCIDENTS: THE IMPETUS FOR REGULATORY CHANGE

As the general knowledge of waste management has evolved, so has industry practice. As early as the 1980s ash handling has shifted from wet handling (low-lying surface impoundments) to dry handling (storage in dry monofills in upland areas).²⁶ This trend has been dramatically accelerated by laws and regulations prompted by several coal ash spills, namely (1) Pennsylvania Power and Light, Martins Creek Station, 100 million gallons of fly ash into the Delaware River in 2005;²⁷ (2) Tennessee Valley Authority, Kingston Fossil Plant, 5.4 million cubic yards of ash into the Emory and Clinch Rivers in 2008;²⁸ and (3) Duke Energy, Dan River Station, 39,000 tons of ash into the Dan River in 2014.²⁹

The TVA spill was the impetus for the EPA's June 21, 2010 Proposed Rule³⁰ and April 17, 2015 final CCR rule.³¹ The rules affect 735

²² See GOODWIN, *supra* note 4, at 97; LAGREGA ET AL., *supra* note 11, at 812.

²³ See Moon & Turner, *supra* note 10, at 175–76.

²⁴ See Blake Korb, *Holding Our Breath: Waiting for the Federal Government to Recognize Coal Ash as a Hazardous Waste*, 45 J. MARSHALL L. REV. 1177, 1179 (2012).

²⁵ *Id.* at 1180, 1186.

²⁶ See GOODWIN, *supra* note 4, at 10–11.

²⁷ Scott Kraus, *Talen to settle Martins Creek fly ash spill claims for \$1.3 million*, MORNING CALL (July 28, 2015), <http://www.mcall.com/news/breaking/mc-talen-fly-ash-settlement-20150728-story.html> [<http://perma.cc/FM8J-MQP9>].

²⁸ Shaila Dewan, *Tennessee Ash Flood Larger Than Initial Estimate*, N.Y. TIMES (Dec. 26, 2008), http://www.nytimes.com/2008/12/27/us/27sludge.html?_r=0 [<http://perma.cc/7C67-J6KV>].

²⁹ Bruce Henderson, *Duke Energy to pay Virginia \$2.5 million for Dan River spill*, CHARLOTTE OBSERVER (Apr. 3, 2015), <http://www.charlotteobserver.com/news/local/article17313746.html> [<http://perma.cc/7RJP-NUTD>].

³⁰ Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities, 75 Fed. Reg. 35,123 (June 21, 2010) (to be codified at 40 C.F.R. pts. 257, 261, 264, 265, 268, 271, & 302).

³¹ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,309.

surface impoundments located at 478 coal-fired electric utility plants nationwide.³² The rule is self-implementing, meaning that the EPA does not have the authority to require or permit the activities.³³ Instead, affected facilities must be in compliance with EPA's rules or be subject to citizen suits that could allege "open dumping" according pursuant to the Hazardous and Solid Waste Amendments of 1984 ("HSWA"), 42 U.S.C. 6945.

The CCR rule contains numerous provisions that address disposal and beneficial reuse of ash. It provides minimum criteria for existing and new landfills and surface impoundments, defining location restrictions, design and operating criteria, groundwater monitoring and corrective action, closure and postclosure requirements, and overall record keeping and public notification.³⁴ In terms of impacts to groundwater by existing unlined surface impoundments, the rule essentially requires retrofitting or closure.³⁵ In short, decades of past management practices are coming to an end.

In terms of groundwater, a monitoring system must be installed by October 17, 2017, to determine the effect of surface impoundments on groundwater quality.³⁶ A sampling and analysis program must be implemented to discern which contaminants originate from the ash and which are naturally occurring.³⁷ Given that the CCR rule was first made public in a prepublication form on December 19, 2014, utilities have nearly three years to comply.³⁸ EPA observed that shorter time frames would not have been feasible.³⁹ Indeed, such time is required given the complexity and heterogeneity of surface impoundments and the general sites in which they are located. Every site has to be considered individually and requires scientific and engineering expertise to determine the location of monitoring wells, as well as subsequent installation, operation, and analysis of data.⁴⁰ The installation and sampling of one well can take weeks and the process is typically iterative.⁴¹ For example, one reviews the location of a surface impoundment on a given site, its proximity to topographical

³² *Id.*

³³ *Id.* at 21,311.

³⁴ *Id.* at 21,302, 21,304–06.

³⁵ *Id.* at 21,302.

³⁶ *Id.* at 21,485.

³⁷ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,396–98.

³⁸ *Id.* at 21,409.

³⁹ *Id.*

⁴⁰ *See id.*

⁴¹ *See id.*

features such as rivers, lakes, and ridgelines, as well as potential receptors such as drinking water supplies and residential areas. This informs the initial placement of wells and sampling. Upon examination of this first round of sampling, it becomes clearer what additional data is required to increase understanding of the site and where additional monitoring wells should be placed. Such is the nature of geoenvironmental and hydrogeological engineering; we cannot easily “see” into the earth. So data are collected at discrete locations and interpolated for points in between.

III. COMBINED EFFECTS OF STATE LAW AND FEDERAL REGULATION

Just as the TVA spill was the motivation for the EPA’s federal rules, The Duke Energy spill in 2014 was the reason that North Carolina passed the Coal Ash Management Act (“CAMA”).⁴² No other state in the union has passed similar legislation. This law was enacted in August of 2014, prior to issuance of final or prepublished versions of the EPA CCR rule and applies to all thirty-two impoundments located at fourteen plants across the state.⁴³ As with the CCR rule, CAMA provides a comprehensive set of requirements governing ash disposal and beneficial use, with specific and aggressive time frames by which various activities are to be completed.⁴⁴ In theory, a well sited, designed, and maintained surface impoundment could continue operation under EPA’s CCR rule. Not so under CAMA, they all must close. In terms of groundwater impacts, key reporting requirements include groundwater action plans (“GAP”), comprehensive site assessments (“CSA”), and corrective action plans (“CAP”).⁴⁵ In plain language, these three reports essentially require groundwater plans for (1) how to measure impact, (2) measuring impact, and (3) fixing measured impacts. CAMA dictated the timing of these activities to occur much faster than similar requirements by the EPA, requiring GAPs by December 31, 2014, CSAs within 180 days of GAP approval, and CAPs within 90 days of CSA submission.⁴⁶ Essentially, the above noted iterative

⁴² *Coal Ash Management Act of 2014*, SIERRA CLUB NORTH CAROLINA CHAPTER, <http://nc2.sierraclub.org/article/coal-ash-management-act-2014> [<http://perma.cc/X5QV-9MFH>] (last visited Nov. 12, 2015).

⁴³ Div. of Water Res., *Duke Energy Drinking Water Receptor Surveys for Coal-Fired Power Stations*, N.C. DEPT OF ENVTL. QUALITY, <http://portal.ncdenr.org/web/wq/drinking-water-receptor-surveys> [<http://perma.cc/RGV8-48K7>] (last visited Nov. 12, 2015).

⁴⁴ S. 729, Gen. Assemb., Reg. Sess. § 130A-309.208, §130A-309.209, § 130A-309.210, § 130A-309.216, § 130A-309.224 (N.C. 2013).

⁴⁵ *Id.* § 130A-309.209.

⁴⁶ *Id.*

process for assessing groundwater impacts is required to occur within the span of one calendar year, i.e., 2015. This has resulted in the installation of nearly 1,000 new wells across North Carolina within six months, an unprecedented number.⁴⁷

We can use these new wells and associated data from North Carolina's thirty-two impoundments to provide insight into what might be expected over the next decade from the 703 other impoundments across 46 states, as the utilities begin to comply with EPA regulations. Specifically, how and to what extent do unlined ponds impact groundwater and surface water supplies and what methods might be appropriate for corrective action? Have these unlined ponds created major environmental impacts, no impact at all, or something in between?

One objective of the CSA is to determine the horizontal and vertical extent of soil and groundwater contamination, as defined by an exceedance of groundwater standards or other applicable comparison.⁴⁸ For example, the standard for boron in groundwater is 700 µg/L⁴⁹ while the residential and industrial screening levels for soil is 1,600 mg/kg and 23,000 mg/kg, respectively.⁵⁰ Not all constituents have a level for both groundwater and soil. For example, the North Carolina groundwater standard for chromium is 10 µg/L while there is no EPA residential or industrial screening level.⁵¹ A key component to the CSA is the comparison of existing concentrations from monitoring wells and collected soil samples to these levels, as well as a comparison to naturally occurring background concentrations.⁵² For North Carolina, these concentrations would have to meet standards within the compliance boundary.⁵³ For impoundments permitted before 1983, this compliance boundary is defined

⁴⁷ See *Duke Energy Groundwater Assessment Plans for Coal-fired Power Stations*, N.C. DEP'T OF ENVTL. QUALITY, http://portal.ncdenr.org/web/wq/coal_ash_gw_assessment_plans [<http://perma.cc/DUT4-ZFPX>] (last visited Nov. 12, 2015); *Groundwater Studies*, DUKE ENERGY, <http://www.duke-energy.com/ash-management/groundwaterstudies.asp> [<http://perma.cc/YZ5Y-7CWZ>] (last visited Nov. 12, 2015).

⁴⁸ Div. of Water Res., *Duke Energy Groundwater Assessment Plans for Coal-Fired Power Stations*, N.C. DEP'T OF ENVTL. QUALITY, http://portal.ncdenr.org/web/wq/coal_ash_gw_assessment_plans [<http://perma.cc/4BNA-D99W>].

⁴⁹ 15A N.C. ADMIN. CODE 02L.0202(h) (2013).

⁵⁰ Div. of Water Res., *Table 12-6 Soils (0-2) Analytical Results Industrial Soils and Residential HH VTV*, N.C. DEP'T OF ENVTL. QUALITY, <http://its.enr.state.nc.us/Weblink8/0/doc/295979/Page1.aspx> [<http://perma.cc/3EFN-Y47N>].

⁵¹ *Id.*

⁵² 15A N.C. ADMIN. CODE 02L.0102 (1993).

⁵³ *Id.*

as 500 feet from the waste boundary, or the property boundary, whichever is less.⁵⁴ For impoundments permitted after 1983, this boundary is reduced to 250 feet from the waste boundary or within 50 feet of the property boundary, whichever is less.⁵⁵ To the extent to which there are exceedances, corrective action is then required.⁵⁶

Facilities in North Carolina are subject to the EPA rule as well as CAMA.⁵⁷ To gauge groundwater impacts, EPA first recommends detection monitoring of a smaller set of constituents typically associated with fly ash, including boron, calcium, chloride, fluoride, pH, sulfate and total dissolved solids ("TDS").⁵⁸ If one or more of these are found to occur at statistically significant levels in excess of background, then assessment of a broader suite of contaminants is required, namely antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, selenium, thallium, and radium 226 and 228 (combined).⁵⁹ In contrast to North Carolina and many other states that provide distance for dilution and attenuation of contaminants between the impoundment and a compliance boundary,⁶⁰ EPA requires groundwater standards to be met at the waste boundary.⁶¹ This boundary is defined as a vertical plane that extends into the shallowest aquifer immediately downgradient of the impoundment.⁶² For EPA, groundwater standards are defined by the maximum contaminant limits ("MCL")⁶³ or, if there is no MCL, then the naturally occurring background concentration is the standard.⁶⁴ If the background concentration exceeds the MCL, then the standard is the background concentration.⁶⁵ Overlaying EPA rules upon

⁵⁴ *Id.* at 02L.0107(a).

⁵⁵ *Id.* at 02L.0107(b).

⁵⁶ 15A N.C. ADMIN. CODE 02L.0106(a) (1998).

⁵⁷ *Coal Ash: Waste or Resource, A Preliminary Report on the Beneficial Use of Coal Ash* (June 2015), N.C. COAL ASH MGMT. COMM'N, available at [http://www.camc.nc.gov/documents/FINAL%20-%20CAMC%20Preliminary%20Beneficial%20Use%20Report%20\(June%202015\).pdf](http://www.camc.nc.gov/documents/FINAL%20-%20CAMC%20Preliminary%20Beneficial%20Use%20Report%20(June%202015).pdf) [<http://perma.cc/32MB-3SGX>].

⁵⁸ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,305, 21,342.

⁵⁹ *Id.* at 21,397.

⁶⁰ 15A N.C. ADMIN. CODE 02L.0102 (1993).

⁶¹ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities 80 Fed. Reg. at 21,454, 21,471.

⁶² *Id.* at 21,471.

⁶³ Protection of the Environment, 40 C.F.R. §§ 141.62, 141.63 (2007).

⁶⁴ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,405.

⁶⁵ *Id.* at 21,487.

North Carolina law gives rise to standards at the waste boundary and compliance boundary. For example, EPA requires chromium concentrations at the waste boundary to be less than 100 $\mu\text{g/L}$ (i.e., the MCL),⁶⁶ while North Carolina requires chromium to be less than 10 $\mu\text{g/L}$ at the compliance boundary.⁶⁷ Both levels would be subject to a comparison with naturally occurring concentrations. In North Carolina, chromium commonly occurs naturally in groundwater and surface water at levels between 10 and 100 $\mu\text{g/L}$.⁶⁸

IV. RECENT EMPIRICAL EVIDENCE IN NORTH CAROLINA

The recently completed CSAs, as publically available from the North Carolina Department of the Environment and Natural Resources (“NCDENR”), provide new insight for assessing the impact of unlined ash impoundments on groundwater and surface water. The North Carolina impoundments are located in geographically diverse (e.g., mountainous, piedmont, and coastal) regions,⁶⁹ and in that respect represent a microcosm of many sites nationwide. Because state law required these facilities to be studied more quickly and with greater scrutiny as compared to the EPA rule, we can use the results to frame general expectations of other sites as the EPA rule is implemented.

In particular, the CSAs provide empirical evidence that contaminants from coal ash will indeed leach from unlined ponds and migrate into the prevailing groundwater.⁷⁰ This evidence augments and corroborates the limited data that utilities, EPRI, and EPA have collected heretofore, albeit with greater detail.

Data from the CSAs reveal exceedances of groundwater standards by various contaminants (e.g., total dissolved solids, sulfate, boron, etc.)

⁶⁶ 40 C.F.R. § 141.62 (2007).

⁶⁷ 15A N.C. ADMIN. CODE 02L.0202 (2015).

⁶⁸ See *Concentration of Chromium Detected in NC Private Well Water ($\mu\text{g/L}$), Average 1998–2010*, UNC SUPERFUND RESEARCH PROGRAM-RESEARCH TRANSLATION CORE, http://sph.unc.edu/files/2013/07/chromium_allyears.pdf [<http://perma.cc/ALQ7-JMX8>] (last visited Nov. 12, 2015).

⁶⁹ See *Coal Ash Facilities*, N.C. DEP’T OF ENVTL. QUALITY, <http://portal.ncdenr.org/web/guest/facilities> [<http://perma.cc/5QPV-XEG5>] (last visited Nov. 12, 2015).

⁷⁰ See, e.g., SCOTT SPINNER & MALCOLM SCHAEFFER, DUKE ENERGY CAROLINAS, LLC, COMPREHENSIVE SITE ASSESSMENT REPORT: RIVERBEND STEAM STATION ASH BASIN (2015), available at https://www.duke-energy.com/pdfs/Executive-Summary_Riverbend-CSA-Report_NCENR-Submittal_08-18-2015.pdf [<https://perma.cc/57NZ-G8CP>].

at the waste boundary, compliance boundary, or beyond.⁷¹ Still, a common conclusion in the reports is that there are no “imminent hazard[s].”⁷² In particular, conditions do not present a substantial likelihood that death, serious illness, severe personal injury, or a substantial endangerment to health, property, or the environment would occur.⁷³ These seemingly conflicting observations can be reconciled through consideration of (1) typical groundwater flow at impoundment sites; (2) the location and depth of private drinking water wells; and (3) the similarity between ash contaminants and those that occur naturally.

With localized exceptions, the groundwater flow direction at most sites is such that it moves from higher elevations, through the surface impoundment, and on to the nearest discharge location, for example, the river or lake. This is important because there are typically no private or public drinking water wells located in between an impoundment and the receiving surface waters. The constituents found in groundwater are relatively low. By the time they reach and mix with lakes or rivers they are typically less than water quality standards, if measurable at all.⁷⁴ Of course, ash impoundments have a well-documented history of impacting surface water, as noted in the EPA CCR rule.⁷⁵ The distinction is that these impacts have been a function of permitted discharges, not necessarily groundwater (e.g., Belews Lake and Hyco Lake).⁷⁶ This is consistent with EPA findings that suggest the presence of surface water bodies can reduce risks posed by contaminated groundwater from unlined surface impoundments by an order of magnitude.

A critical observation with the CSAs, which are consistent with findings from the NCDENR,⁷⁷ show that virtually all of the constituents which leach from ash are also naturally occurring.⁷⁸ This is an anticipated

⁷¹ *Id.* at ES-2 to ES-3.

⁷² *Id.* at ES-2.

⁷³ *See id.*

⁷⁴ J.L. Daniels, *Lose it by Using it: A Plan for Coal Fly Ash from the 32 Ponds Throughout North Carolina*, 24 THE PROF'L ENG'R 6, 6-12 (2014).

⁷⁵ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,319.

⁷⁶ *See id.* at 21,363.

⁷⁷ *Id.* at 21,322.

⁷⁸ *See Groundwater Reconnaissance Well Water Sampling Study Results Posted*, N.C. DEPT OF ENVTL. QUALITY, http://portal.ncdenr.org/web/guest/coalashnews/-/blogs/groundwater-reconnaissance-well-water-sampling-study-results-posted?_33_redirect=%2Fweb%2Fguest%2Fcoalashnews [<http://perma.cc/R2XM-BPH9>] (last visited Nov. 12, 2015); *DENR Releases Groundwater Reconnaissance Well Water Sampling Summary*, N.C.

result as ash derives from coal, which derives from the subsurface along with soil and rock.⁷⁹ For some constituents, the difference lies in the relative concentration, a distinction that becomes more difficult to discern with attenuation and dilution in groundwater and surface water. Consistent with EPA's recommended list of constituents for detection monitoring, CSA data confirm that boron is the best indicator of groundwater impacts from unlined ash impoundments.⁸⁰ That said, boron is also naturally occurring and is the tenth most abundant element in seawater.⁸¹ Seawater, in turn, can influence monitoring well data collected adjacent to the few impoundments located in coastal regions.

The reason for all these reports, i.e., the GAP, CSA, and CAP, is to inform both the ultimate closure plans as well as to inform priority. For example, according to CAMA, sites have to be classified as high, intermediate, or low risk.⁸² The criteria for this classification includes:

- (1) Any hazards to public health, safety, or welfare resulting from the impoundment.
- (2) The structural condition and hazard potential of the impoundment.
- (3) The proximity of surface waters to the impoundment and whether any surface waters are contaminated or threatened by contamination as a result of the impoundment.
- (4) Information concerning the horizontal and vertical extent of soil and groundwater contamination for all contaminants confirmed to be present in groundwater in exceedance of groundwater quality

DEP'T OF ENVTL. QUALITY, <http://portal.ncdenr.org/web/guest/jmtest/-/blogs/denr-releases-groundwater-reconnaissance-well-water-sampling-summary> [<http://perma.cc/Z3BP-Y5P9>] (last visited Nov. 12, 2015).

⁷⁹ See, e.g., SCOTT SPINNER & MALCOLM SCHAEFFER, DUKE ENERGY CAROLINAS, LLC, COMPREHENSIVE SITE ASSESSMENT REPORT: CLIFFSIDE STEAM STATION ASH BASIN ES-2 to ES-16 (2015), available at https://www.duke-energy.com/pdfs/Executive-Summary_Cliffside-CSA-Report_NCDENR-Submittal_08-18-2015.pdf [<https://perma.cc/N5V5-WCUX>].

⁸⁰ *Id.* at ES-3.

⁸¹ Leif R. Uppström, *The boron/chlorinity ratio of deep-sea water from the Pacific Ocean*, 21 DEEP-SEA RES. 161, 161-62 (1974); ROGER W. LEE, DEP'T OF THE INTERIOR, OPEN-FILE REPORT 84-237, GROUND-WATER QUALITY DATA FROM THE SOUTHEASTERN COASTAL PLAIN, MISSISSIPPI, ALABAMA, GEORGIA, SOUTH CAROLINA, AND NORTH CAROLINA (1984).

⁸² N.C. GEN. STAT. § 130A-309.213(b) (2014).

- standards and all significant factors affecting contaminant transport.
- (5) The location and nature of all receptors and significant exposure pathways.
 - (6) The geological and hydrogeological features influencing the movement and chemical and physical character of the contaminants.
 - (7) The amount and characteristics of coal combustion residuals in the impoundment.
 - (8) Whether the impoundment is located within an area subject to a 100-year flood.
 - (9) Any other factor the Department deems relevant to establishment of risk.⁸³

The law then defines the method and time by which a given impoundment must be closed.⁸⁴ High and intermediate risk impoundments must be beneficially used or excavated and relocated to a lined landfill.⁸⁵ Low risk sites do not necessarily have to be excavated and moved to a lined landfill.⁸⁶ Closure of impoundments classified as high, intermediate, and low-risk is required to occur by December 31st of 2019, 2024, and 2029 respectively.⁸⁷ Note that this classification was intended to cover ten of the fourteen sites across North Carolina.⁸⁸ Impoundments at four locations, identified by formal name in the legislation as Asheville Steam Electric Generating Plant, Dan River Steam Station, Riverbend Steam Station, and Sutton Plant, were labeled as “high-priority.”⁸⁹ This designation has the same effect as a site being labeled “high-risk,” without the benefit of being subjected to an engineering or scientific review.⁹⁰

Overall risk determination necessarily involves the judgment of engineers and scientists employed at utilities, consulting firms, or agencies. These groups do not necessarily reflect general public perceptions of risk.⁹¹ To that end, final classifications are not assigned until a review

⁸³ *Id.* § 130A-309.213(a).

⁸⁴ *Id.* § 130A-309.214.

⁸⁵ *Id.* § 130A-309.214(a).

⁸⁶ *Id.* § 130A-309.214(a)(3).

⁸⁷ *Id.* § 130A-309.214(a).

⁸⁸ *See* Coal Ash Management Act, 2014 N.C. SESS. LAWS 122, pt. II § 3.(b)–(c) (2014).

⁸⁹ *Id.* § 3.(b) (2014).

⁹⁰ *Id.* § 3.(b)–(c).

⁹¹ *See generally* Eileen Gay Jones, *Risky Assessments: Uncertainties in Science and the*

by NCDENR and the CAMA-created Coal Ash Management Commission (“CAMC”), as well as input from the public.⁹²

A concern with the above classification criteria is the commingling of disparate technical issues. For example, if a given impoundment is found to be structurally deficient, then this can be addressed without legislating design features to protect groundwater. Instead, this concern could be addressed by dewatering the impoundment and breaching the dam. The extent to which the ash must be lined to protect groundwater should be based on an evaluation of the site groundwater, soils, ash, and overall modeling. These activities are designed and executed by engineers and geologists who are in a better position to define appropriate means, methods, and time lines. It may be appropriate for legislators and regulators to define the start of closure activities but not the completion. The latter depends on site-specific details that are encountered as data are collected and professionally evaluated. This logic is understood by EPA in reference to its approach to evaluating corrective action:

EPA understands that there are a variety of activities that may be necessary in order to select the appropriate remedy (e.g., discussions with affected citizens, state and local governments; conducting on-site studies or pilot projects); and, once selected, to implement the remedy (e.g., securing on-site utilities if needed, obtaining any necessary permits, etc.). That is why EPA does not find it appropriate to set specific timeframes for selecting the remedy or to begin implementing the selected remedy.⁹³

This logic is also understood by CAMA, given that it created the CAMC.⁹⁴ The CAMC exists to perform several tasks, one of which is to “review and make recommendations on statutes and rules related to the management of coal ash.”⁹⁵

Human Dimensions of Environmental Decisionmaking, 22 WM. & MARY ENVTL. L. & POL’Y REV. 1 (1997).

⁹² N.C. GEN. STAT. § 130A-309.202, 213 (2014).

⁹³ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,407.

⁹⁴ N.C. GEN. STAT. § 130A-309.202(a) (2014).

⁹⁵ *North Carolina Coal Ash Mgmt. Comm’n*, N.C. COAL ASH MGMT. COMM’N, <http://www.camc.nc.gov/> [<http://perma.cc/WMP8-5QUC>] (last visited Nov. 12, 2015).

V. GROUNDWATER PROTECTION: CLEAN AT WHAT COST?

Both EPA and CAMA are motivated by the premise that groundwater must be protected as a source of drinking water.⁹⁶ EPA notes that “[s]olid waste activities should not be allowed to contaminate underground drinking water sources to exceed established drinking water standards. Future users of the aquifer will not be protected unless such an approach is taken.”⁹⁷ It is for this reason that EPA’s CCR rule does not provide a mixing zone or compliance boundary within which elevated concentrations may dilute and attenuate before moving down gradient. Similarly, much of CAMA is based on the state’s groundwater protection statutes where policy is defined:

It is the policy of the Commission that the best usage of the groundwaters of the state is as a source of drinking water. These groundwaters generally are a potable source of drinking water without the necessity of significant treatment. It is the intent of these Rules to protect the overall high quality of North Carolina’s groundwaters to the level established by the standards and to enhance and restore the quality of degraded groundwaters where feasible and necessary to protect human health and the environment, or to ensure their suitability as a future source of drinking water.⁹⁸

EPA’s proven damage cases⁹⁹ and the CSA’s confirm that unlined ash impoundments result in exceedances of groundwater standards, especially at the immediate down gradient waste boundary. As such, these sites will require corrective action. EPA’s requirements for corrective

⁹⁶ See Coal Ash Management Act, 2014 N.C. SESS. LAWS 122.; see generally EPA, A GROUND-WATER PROTECTION STRATEGY FOR THE ENVIRONMENTAL PROTECTION AGENCY (1984), available at http://yosemite.epa.gov/water/owrccatalog.nsf/7322259e90d060c885256f0a0055db68/08e6baf8dfaec4c285256b0600723ad3?openDocument#_ga=1.71112409.855164771.1444778796 [<http://perma.cc/RZ65-8YTH>].

⁹⁷ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,452. 40 C.F.R. §§ 257, 261 (2014).

⁹⁸ 15A N.C. Admin. Code .103 (2013).

⁹⁹ See 40 C.F.R. §§ 257, 261, 264 (2015); Disposal of Coal Combustion Residuals from Electric Utilities, 75 Fed. Reg. 35,138 (June 21, 2010); Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,302–03 (Apr. 17, 2015).

action are more stringent than most states, including North Carolina. For example, North Carolina statutes note that: “Where groundwater quality has been degraded, the goal of any required corrective action shall be restoration to the level of the standards, or as closely thereto as is economically and technologically feasible.”¹⁰⁰ For its part, EPA requires that groundwater standards be met (not just approximately) and explicitly removes cost as a consideration in selecting the remediation process.¹⁰¹ EPA asserts that it did not receive authorization from Congress to consider the costs associated with creating minimum national standards under the RCRA sections 1008(a) and 4004(a).¹⁰²

This could be subject to challenge, as the consideration of cost is not explicitly authorized nor excluded in those individual sections of RCRA. Section 1008(a) includes the statement: “Such suggested guidelines shall—(1) provide a technical and economic description of the level of performance that can be attained by various available solid waste management practices (including operating practices) which provide for the protection of public health and the environment;”¹⁰³ likewise section 4004(a) includes the statement:

Not later than one year after October 21, 1976, after consultation with the States, and after notice and public hearings, the Administrator shall promulgate regulations containing criteria for determining which facilities shall be classified as sanitary landfills and which shall be classified as open dumps within the meaning of this chapter.¹⁰⁴

In general, EPA is legally required to consider the benefits and costs of any proposed regulation.¹⁰⁵ EPA indeed provides an estimate for the overall CCR rule.¹⁰⁶ It merely excludes it as a consideration for this

¹⁰⁰ 15A N.C. ADMIN CODE 106 (2013).

¹⁰¹ EPA, HANDBOOK OF GROUNDWATER PROTECTION AND CLEANUP POLICIES FOR RCRA CORRECTIVE ACTION (2004), available at <http://www2.epa.gov/sites/production/files/2015-08/documents/gwhb041404.pdf> [<http://perma.cc/7SDF-KQ66>].

¹⁰² Resource Conservation and Recovery (RCRA) Act, § 1008, 42 U.S.C. § 6907(a) (1976) [hereinafter RCRA].

¹⁰³ *Id.* § 6907(a)(1).

¹⁰⁴ *Id.* § 6944(a).

¹⁰⁵ *Statutory and Administrative Requirements for Economic Analysis of Regulations*, U.S. EPA, <http://www3.epa.gov/ttnecas1/econdata/Rmanual2/2.2.html> [<http://perma.cc/9KAG-LAME>] (last updated Sept. 1, 2015).

¹⁰⁶ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,309.

particular aspect of remedy selection. The extent and basis of benefit/cost consideration was recently argued for a rule entitled “National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units.”¹⁰⁷ EPA was sued for this rule and lost its case against the State of Michigan in the U.S. Supreme Court on June 29, 2015.¹⁰⁸ In writing for the majority, Justice Antonin Scalia wrote, “The Agency must consider cost—including, most importantly, cost of compliance—before deciding whether regulation is appropriate and necessary.”¹⁰⁹

Historical practice with general (e.g., hazardous) waste site remediation subject to RCRA allows for site-specific determinations regarding the contaminants of concern, the performance standard (e.g., MCL), and whether corrective action is warranted given the risk assessment and relevant exposure scenarios.¹¹⁰ CAMA also raises this question as to whether corrective action is required, stating:

The Coal Ash Management Commission, established pursuant to G.S. 130A-309.202, as enacted by Section 3(a) of this act, shall study whether and under what circumstances no further action or natural attenuation is appropriate for a coal combustion residuals surface impoundment that is classified as low-risk pursuant to G.S. 130A-309.211, as enacted by Section 3(a) of this act. In conducting this study, the Commission shall specifically consider whether there is any contact or interaction between coal combustion residuals and groundwater and surface water, whether the area has reverted to a natural state as evidenced by the presence of wildlife and vegetation, and whether no further action or natural attenuation would be protective of public health, safety, and welfare; the environment; and natural resources.¹¹¹

The foregoing logic derives from basic concepts of exposure. In general, risk to human health and the environment requires an unbroken

¹⁰⁷ See 77 Fed. Reg. 9304, 9305–06 (Feb. 16, 2012).

¹⁰⁸ *Michigan v. EPA*, 135 S. Ct. 2699, 2699 (2015).

¹⁰⁹ *Id.* at 2711.

¹¹⁰ See, e.g., *Cement Kiln Recycling Coal. v. EPA*, 493 F.3d 207, 212–13 (D.C. Cir. 2007).

¹¹¹ Coal Ash Management Act, 2014 N.C. SESS. LAWS 122.

path between the source (e.g., ash impoundment) and a receptor (e.g., a person, aquatic species, etc.).¹¹² The process for evaluating risk is well documented, as for example following EPA's logic for the beneficial use of coal ash.¹¹³ Any break in the path means there is no risk while a continuous path must be further evaluated to estimate the concentrations of a given contaminant relative to the exposure scenarios, such as groundwater consumption, particle inhalation, and so forth. No such flexibility is afforded to impoundment impacts to groundwater in the CCR rule, as EPA notes it is "too susceptible to potential abuse," in absence of a permitting program or state oversight.¹¹⁴

VI. FUTURE DIRECTIONS FOR COAL ASH IMPOUNDMENT REMEDIATION

It is clear that corrective action will be required for the sites in North Carolina where CSAs have been completed.¹¹⁵ Similar results can be anticipated at other sites nationwide in which unlined impoundments have been in operation. The only question is what form the corrective action will take. The engineering consultant market and general technical literature is replete with plausible mechanisms for remediation of contaminated soils.¹¹⁶ Entire textbooks are devoted to the subject.¹¹⁷ General strategies include excavation to a lined landfill, on-site remediation with various chemicals and stabilizers, on site containment (e.g., with vertically installed slurry wall barriers, horizontally placed barriers, geomembrane, or capillary-type barrier caps) and monitored natural attenuation ("MNA").¹¹⁸ As the name implies, MNA relies on natural processes to reduce contaminant concentrations in groundwater.¹¹⁹ In the

¹¹² See generally Neal C. Stout & Peter A. Valberg, *Bayes' Law, Sequential Uncertainties, and Evidence of Causation in Toxic Tort Cases*, 38 U. MICH. J.L. REFORM 781, 827–36 (2004).

¹¹³ U.S. EPA ET AL., COAL COMBUSTION RESIDUAL BENEFICIAL USE EVALUATION: FLY ASH CONCRETE AND FGD GYPSUM WALLBOARD (2014), available at http://www2.epa.gov/sites/production/files/2014-12/documents/ccr_bu_eval.pdf [<http://perma.cc/UGK4-2VDK>].

¹¹⁴ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,405.

¹¹⁵ See *supra* Part IV.

¹¹⁶ See e.g., AM. COAL ASH ASS'N, FLY ASH FACTS FOR HIGHWAY ENGINEERS i, 45 (2003).

¹¹⁷ See e.g., HARI D. SHARMA & KRISHNA R. REDDY, GEOENVIRONMENTAL ENGINEERING: SITE REMEDIATION WASTE CONTAINMENT, AND EMERGING WASTE MANAGEMENT TECHNOLOGIES (2004).

¹¹⁸ See *id.* at 331, 333, 398, 574, 687, 938.

¹¹⁹ U.S. EPA ET AL., *supra* note 113, at 574.

case of coal ash contaminants, these processes include physical absorption, precipitation, and dilution.¹²⁰

Based on the CSA data, it appears that MNA represents a viable approach, at least in part, for any corrective action.¹²¹ That said, one can make several distinctions with regard to the reason for a given corrective action. In the case of North Carolina, we can envision a hierarchical flow chart for closing ash impoundments and implementing appropriate corrective action. Such a chart requires, in order: (1) following the law, (2) performing corrective action motivated by engineering or maintenance issues, or (3) addressing groundwater remediation through on-site containment and MNA.

First, as required by CAMA, the impoundments at four different sites must be excavated and moved to a lined landfill or structural fill equivalent, or be beneficially used.¹²² The time frame (five years) relative to the volume of ash in these facilities (approximately 17.5 million tons) dictates that the vast majority of this ash, if the original law holds, will be ensconced in a lined landfill or structural fill,¹²³ e.g., such as is being constructed at the Asheville Airport.¹²⁴ This time frame is insufficient to encourage other forms of beneficial use, such as concrete or grout products.¹²⁵ It is conceivable that a new law would be passed, as has already occurred with the Mountain Energy Act, which effectively provided three more years for the impoundments at the Asheville plant.¹²⁶

¹²⁰ GREGORY P. MILLER, MONITORED NATURAL ATTENUATION: A REMEDIATION STRATEGY FOR GROUNDWATER IMPACTED BY COAL COMBUSTION PRODUCT LEACHATE 12 (2011).

¹²¹ See 2014-122 N.C. SESS. LAWS 29-30 (2014); see e.g., DUKE ENERGY, ASHEVILLE STEAM ELECTRIC GENERATING PLANT: COAL ASH EXCAVATION PLAN 4 (2014), available at http://portal.ncdenr.org/c/document_library/get_file?uuid=ebf30aef-9daa-47fc-ad38-ea380491c180&groupId=14 [<http://perma.cc/V7UD-APCD>].

¹²² Coal Ash Management Act, 2014 N.C. SESS. LAWS 122, 29-30 (2014).

¹²³ See 2014 N.C. SESS. LAWS 122, 29-30 (2014). See DUKE ENERGY, ASHEVILLE STEAM ELECTRIC GENERATING PLANT: COAL ASH EXCAVATION PLAN 4 (2014), available at http://portal.ncdenr.org/c/document_library/get_file?uuid=ebf30aef-9daa-47fc-ad38-ea380491c180&groupId=14 [<http://perma.cc/V7UD-APCD>]; DUKE ENERGY, DAN RIVER STEAM STATION: COAL ASH EXCAVATION PLAN 4-5 (2014), available at <http://www.duke-energy.com/pdfs/dan-river-excavation-plan.pdf> [<http://perma.cc/KF9E-LHTU>]; DUKE ENERGY, RIVERBEND STEAM STATION: COAL ASH EXCAVATION PLAN 4-5 (2014), available at <http://www.duke-energy.com/pdfs/am-riverbend-excavation-plan.pdf> [<http://perma.cc/7JCJ-FHXS>]; DUKE ENERGY, L.V. SUTTON ELECTRIC PLANT: COAL ASH EXCAVATION PLAN 4-5 (2014), available at <http://www.duke-energy.com/pdfs/sutton-excavation-plan.pdf> [<http://perma.cc/RK8S-9KKL>]. There is approximately a total of 17,543,000 tons of CCR at these four sites.

¹²⁴ Morrison, *supra* note 2.

¹²⁵ AM. COAL ASH ASS'N, *supra* note 116, at 57.

¹²⁶ 2015-110 N.C. SESS. LAWS 1-2 (2015).

Both the EPA rule and the CAMA legislation specify the need to obtain additional data to inform subsequent requirements.¹²⁷ It would be natural for such data to reveal the need to adjust various timelines imposed for complete closure. As noted above, CAMA requires closure to occur by 2019, 2024, and 2029, depending on its risk classification and priority. EPA requires similar time horizons, although their schedule is influenced mostly by impoundment size.¹²⁸ None of these proposed closure schedules account for actual site conditions, which in many cases have not been fully evaluated. For example, best management practices are not well established for the excavation of saturated or partially saturated ash. Ash properties change dramatically with location and time, and an arbitrarily accelerated excavation schedule can lead to unsafe conditions for contractor personnel while adversely impacting environmental conditions.¹²⁹

The second item that can influence corrective action is general engineering and maintenance issues. General issues include the need to repair impoundment infrastructure such as discharge pipes and slopes. In EPA's proposed rule, the first set of calculations that are required deal with structural stability of the impoundments.¹³⁰ Utilities must demonstrate that impoundments are stable and can withstand the forces imposed by an earthquake. Similarly, given that impoundments are located in low-lying areas, it is likely that some of them are subject to flooding in the event of major storms. In all of these cases, the net effect can be a need to drain and remove the impoundment from service. In that circumstance, given that the intent of EPA and CAMA is to eliminate impoundments as a means to store ash, it is clear that such closure may involve excavation and relocation to a lined landfill, or repositioning and capping in place with materials that prevent infiltration by precipitation.

The third category includes those impoundments that are not identified by law and do not have any particular engineering or maintenance concern. For these impoundments, the timing of closure and selection of corrective action remedy is driven exclusively by groundwater

¹²⁷ Improving Coal Combustion Residuals Regulation Act of 2015, H.R. 1734, 114th Cong. (2015).

¹²⁸ Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Fed. Reg. at 21,475–96; N.C. GEN. STAT. §§ 130A-309.211(a)–(b), 130A-309.212(b)–(c) (2014).

¹²⁹ See *Frequent Questions about the Coal Ash Disposal Rule*, EPA, <http://www2.epa.gov/coalash/frequent-questions-about-coal-ash-disposal-rule> [<http://perma.cc/3J8W-T782>] (last visited Nov. 12, 2015).

¹³⁰ See generally N.C. COAL ASH MGMT. COMM'N, *supra* note 57.

protection.¹³¹ Based on the CSA data emerging heretofore, a combination of repositioning, capping in place, and monitoring natural attenuation is expected to be a viable remedy or a component of a multiphase remedy.¹³²

This approach has been highlighted by CAMA and in general by EPA. EPA, for example, has long recognized the value in not creating more harm than good in the process of remediation¹³³ and there are books on the subject.¹³⁴ One needs to consider the net environmental benefits of any given activity. Consider, for example, a situation in which an impoundment has long since been drained and is covered by a mature stand of trees. One can quantify the extent to which the ecological damage of cutting down these forests, disturbing existing habitat, excavating, transporting, and placing ash at some other distant location results in greater environmental harm than simply allowing the ash to remain in place, and monitor any attenuating impacts to groundwater and surface water.

The foregoing approach can satisfy EPA's requirements for the selection of remedy, which include:

- (1) Be protective of human health and the environment;
- (2) Attain the groundwater protection standard;
- (3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents into the environment;
- (4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
- (5) Comply with standards for management of wastes.¹³⁵

While the current EPA rule provides no flexibility on the need for corrective action or the achievement of groundwater protection standards, it does provide time. Time is the one variable that is needed to holistically

¹³¹ See Coal Combustion Residuals Impoundment Assessment Reports, U.S. EPA, <http://www3.epa.gov/epawaste/nonhaz/industrial/special/fossil/surveys2/> [<http://perma.cc/298U-H93L>] (last visited Nov. 12, 2015).

¹³² See *Frequent Questions about the Coal Ash Disposal Rule*, *supra* note 129.

¹³³ INTERSTATE TECH. & REGULATORY COUNCIL GREEN AND SUSTAINABLE REMEDIATION TEAM, GREEN AND SUSTAINABLE REMEDIATION: A PRACTICAL FRAMEWORK (2011), available at <http://www.itrcweb.org/GuidanceDocuments/GSR-2.pdf> [<http://perma.cc/S44N-E9AX>].

¹³⁴ K.R. REDDY & J.A. ADAMS, SUSTAINABLE REMEDIATION OF CONTAMINATED SITES 160 (2015).

¹³⁵ 40 C.F.R. §§ 257, 261 (2014).

address the broader environmental impact and potential disturbance of a proposed remediation technique. It would also encourage more beneficial use, by providing the time needed for the market to absorb more ash.

CONCLUSION

As the foregoing discussion suggests, coal and coal ash has been part of modern society for decades and will continue for decades to come. As with other waste streams, the management of coal ash has evolved, especially in response to regulatory demands. These demands have been placed primarily because of two recent spills where ash was released into rivers, one in Tennessee and the other in North Carolina. The result has been a detailed set of regulations from the U.S. EPA (“CCR rule”) and a new law in North Carolina (“CAMA”). The aggressive schedule required in CAMA has yielded empirical data, some of which can be generalized to what may be expected as utilities comply with CCR regulations. The results indicate that unlined ash impoundments will leach contaminants and exceed groundwater protection standards at the waste boundary, thus requiring corrective action. There are many engineering solutions and monitored natural attenuation is expected to represent one of them. Any solution should maximize the net environmental benefit, achieving the greatest environmental protection locally while producing the least environmental harm locally, regionally and globally. Environmental policy is best served when it is informed by empirical evidence as well as interpretation by engineers and scientists. In the case of coal ash, much of the motivating policy has benefited from this approach. Both the EPA CCR rule and CAMA required the generation of data, reports, and analyses which are in turn, used to inform subsequent decisions. The absence of sufficient knowledge is a key reason why policymakers would be wise to regulate the start, not the finish, of any given ash impoundment closure activity.

