Repairing the Damage

Cleaning Up Hazardous Coal Ash Can Create Jobs and Improve the Environment

Union of Concerned Scientists

Ohio River Valley Institute

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The Ohio River Valley Institute's mission is to support communities in the region working to advance a more prosperous, sustainable, and equitable Appalachia. The Institute produces data-driven research and proposes policies to improve the economic performance and standards of living for the greater Ohio River Valley, with a focus on shared prosperity, clean energy, and equitable democracy.

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Cleanup operations from the 2008 coal ash spill at the Kingston Fossil Plant in Tennessee, November 8, 2012.

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Although coal has powered the nation for generations and today offers well-paying jobs—often the best opportunities in more rural areas—coal negatively affects human health and the environment at every point in its life cycle: when it is mined, processed, transported, burned, and discarded (Freese, Clemmer, and Nogee 2008). Local communities—often low-income communities and/or communities of color—have for decades borne the brunt of these negative impacts, including air pollution, water pollution, and workplace injuries, illnesses, and fatalities.

One of the Nation's Largest Waste Streams

When coal is burned to produce electricity, not all of its components combust, leaving ash behind—massive amounts of it. Coal ash is one of the two largest industrial waste streams in the United States: From 1966 to 2017, US electric utility companies generated a total of 4.5 billion tons of coal ash and from 2015 to 2019 produced an average of 101 million tons of coal ash every year (ACAA 2021; Earthjustice 2019).

Coal ash is often mixed with water and stored in large impoundments, commonly called coal ash ponds. It can also be stored in dry form in landfills or reused in products like concrete. Many of the elements that make up coal ash—arsenic, boron, cadmium, chromium, lead, radium, and selenium, to name a few—are toxic, and exposure can cause a variety of severe health issues, including cancer, heart disease, reproductive failure, stroke, and even brain damage in children (Earthjustice 2020). Many coal ash constituents are also toxic to aquatic life, and disposal sites pose a risk of catastrophic spills that can contaminate soil, waterways, and groundwater. Despite being such a large waste stream with demonstrated serious impacts on human health and the environment (Gottlieb, Gilbert, and Evans 2010), only in 2015 did the Environmental Protection Agency (EPA) adopt monitoring standards and closure requirements for coal ash disposal sites under the Resource Conservation and Recovery Act (*Federal Register* 2015).

Coal Ash in the Ohio River Valley States

Coal-fired power plants are often located along major rivers because large amounts of water are needed for cooling, and many are concentrated along the Ohio River. Of the 738 coal ash disposal sites nationwide, 161 (more than one out of five) are found in the five states that make up the Ohio River Valley: Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia. One assessment of documented groundwater contamination from coal ash disposal sites put two coal-fired power plants in the Ohio River Valley on the list of the top 10 most contaminated nationwide: the New Castle Generating Station in Pennsylvania (#5) and the Ghent Generating Station in Kentucky (#10) (Russ, Bernhardt, and Evans 2019).

These 161 disposal sites are located at 57 operating or retired coal-fired power plants in these five states. At 33 of the plants (58 percent), the surrounding community is considered low-income, meaning that the residents within a three-mile radius have an average income level at or below twice the federal poverty level in their state. Six of the 57 plants (nearly 11 percent) are located within three miles of a community with a disproportionate number of people of color; half are in Indiana (Earthjustice 2020). Nationally, 52 percent of communities near operating or retired coal-fired power plants are low-income—meaning that the Ohio River Valley disposal sites are more likely to affect low-income communities relative to the national average.

Case Studies Explore the Costs and Benefits of Complete Cleanup

Generalizing the costs of coal ash cleanup nationally is difficult because the cleanup needs are site-specific, but case studies are useful in understanding costs and needs under specific conditions and in providing context for the problem nationally. New analysis by the Union of Concerned Scientists and the Ohio River Valley Institute evaluates the cleanup costs and job creation potential for two coal ash sites—the first two such case studies in the Ohio River Valley. One, the J. M. Stuart coal-fired power plant in Appalachian Ohio, closed in 2018, along with another nearby coal plant, dealing a blow to the local economy (MacGillis 2018). The other, the Sebree Generating Station, consists of three coal-fired power plants (one still in operation but slated for retirement) in western Kentucky. Our analysis evaluates site owners' plans for cleanup activities (both of which are in violation of federal regulations) and proposes a more complete "clean closure" plan for both. These case studies illustrate how investing in cleanup of coal ash can create jobs in exactly the places where jobs are being lost as coal continues its decline. Clean closure simultaneously mitigates the harm caused by pollution begun in decades past and continuing to the present day by providing communities in the Appalachian region—and nationwide—a pathway forward as the shift toward clean energy continues.

TABLE ES.1. Projected Job Creation per Year in Kentucky and Ohio from Cleanup Options

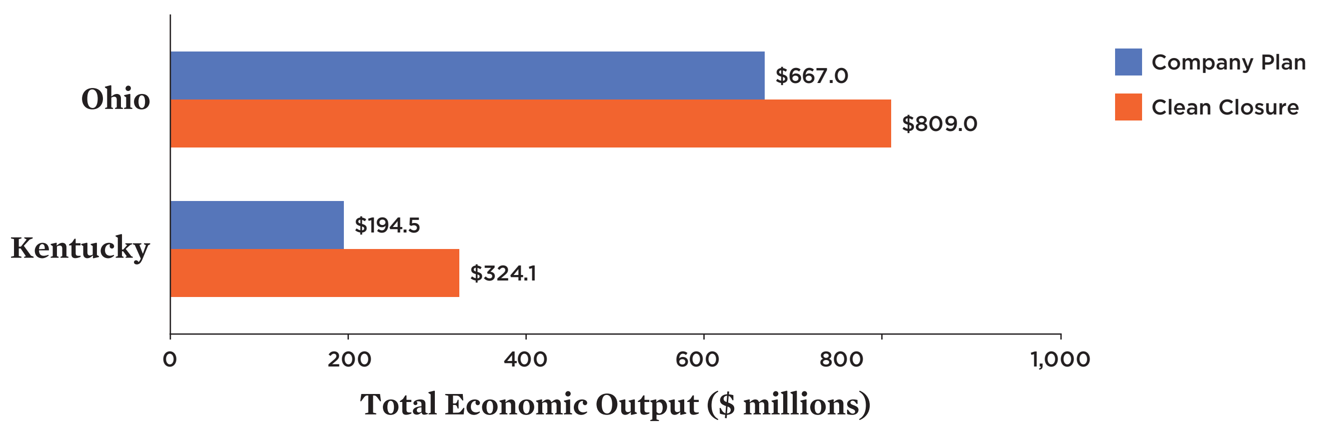
Construction Phase Job Creation per Year		
	Clean Closure	Company Plan
Kentucky	282	144
Ohio	314	252

During the construction phase, more jobs will be created per year with the clean closure plans compared to the owners' plans—in the case of Sebree, nearly twice as many. The construction phase is four years for Sebree and nine years for J. M. Stuart. The numbers represent the total jobs created (direct, indirect, and induced) including both full- and part-time employment.

Case Study Findings

Our analysis consists of an engineering assessment of each site and a cost analysis of two cleanup options—the owner's plan for closing the disposal sites and a proposed clean closure scenario that represents a complete set of actions to fully remediate the site, including excavation of coal ash ponds. Based on the cost estimates and direct job creation from the cleanup projects, we conducted an economic analysis of the impacts of the projects for each state's economy. We found that the clean closure of coal ash disposal sites offers superior protection for public health and ecosystems while offering better opportunities for local jobs and associated economic activity, consistent with similar evaluations for other sites in previous reports. The additional costs of clean closure are justified by the higher number of jobs, the wider economic benefits, and the potential for redevelopment that flow to the local communities. This is especially true for the Sebree plant, where the clean closure plan would generate nearly twice as many jobs as the utility's proposal during the project's construction phase, which refers to initial investments in infrastructure needed to excavate and safely store the coal ash waste. As shown in Table ES.1, the clean closure options would lead to the creation of 282 jobs in Kentucky during the four-year construction phase and 314 jobs in Ohio during the nine-year construction phase. At both sites, the clean closure scenario would drive significant economic impacts that would ripple through each state's economy, as shown in Figure ES.1. Relative to the owners' cleanup plans, the clean closure plans drive more than $100 million in additional economic output in each state.

FIGURE ES.1. Total Economic Output over Project Lifetime for Case Study Cleanup Options



For both projects, the clean closure plans would result in more than $100 million in additional economic activity in each state. Project lifetime is the construction phase plus 30 years of ongoing operations and maintenance. Output is an overall measure in dollars of the impact on the economy due to the investments in the project.

Recommendations

In addition to the job creation and local economic growth from cleaning up these two coal ash disposal sites, state and federal policymakers can take a number of actions to strengthen rules and increase funding to ensure that coal ash is cleaned up nationally.

- **Hold utilities and owners responsible for the clean closure of coal ash disposal sites.** Cleanup decisions are governed by state regulators, and rate-regulated utilities typically petition state public utility commissions for cost recovery—meaning ratepayers are on the hook to pay for the cleanup. Regulators should consider the long-term economic value of cleanup options to the local community—ratepayers should not bear the costs without reaping the economic value of full cleanup.
- **Robustly fund existing EPA programs that support communities.** EPA programs must be robustly funded to ensure that polluting coal ash disposal sites are identified and cleaned up. These programs include the Brownfields programs, enforcement divisions, and the Corrective Action Program within the Resource Conservation and Recovery Act.
- **Strengthen the enforcement of existing regulations that prohibit cap-in-place closure.** The EPA already has enforcement authority, and it can and should follow the plain language of the 2015 Coal Combustion Residuals Rule, requiring excavation when coal ash is in contact with groundwater or when coal ash ponds would remain in a floodplain when capped in place. States should also require excavation under state laws and regulations, as is being done in North Carolina, South Carolina, Virginia, and Illinois.
- **Ensure that frontline communities have a voice in cleanup decisions.** Residents and community leaders are often the strongest voices in holding utilities and site owners accountable for cleanup, and robust stakeholder processes are needed to ensure meaningful engagement. For example, the EPA's Technical Assistance Services for Communities Program offers grants that can empower fenceline communities and residents to participate in discussions about closure options. It is a valuable resource that should be robustly funded to drive better local outcomes, and additional programs supporting environmental justice communities may also be brought to bear.
- **Ensure strong labor standards and safety protections for cleanup workers and prioritize dislocated workers in hiring.** Local hiring requirements should be implemented to ensure that dislocated workers have access to cleanup jobs, and prevailing wages should be required to ensure that workers are paid fairly for their work. Because coal ash is toxic, workers must be protected during cleanup activities.
- **Prevent damage to communities and the environment from reuse of coal ash.** The EPA should cease classifying unencapsulated coal ash as an acceptable "beneficial use" and instead treat unencapsulated uses as a form of disposal.
- **Ensure that the extraction of rare earth elements is safe and is coupled with clean disposal of remaining coal ash.** A holistic assessment of risks and benefits should be applied to rare earth element extraction, and extraction programs should be informed by the community and unions.
- **Leverage existing federal programs or consider establishing new financial institutions or grant programs to ensure that all disposal sites nationally are fully cleaned up.** Existing federal programs like the Superfund program could be augmented through polluter-pays fees. Additional public financing may be needed to ensure complete removal of coal ash. These resources are critical for ensuring a fair transition to clean energy for communities and workers formerly dependent on coal-fired electricity production.

[CHAPTER 1]

One of the Nation's Largest Waste Streams

Although coal has powered the nation for generations and today offers well-paying jobs—often the best opportunities in more rural areas—coal negatively affects human health and the environment at every point in its life cycle: when it is mined, processed, transported, burned, and discarded (Freese, Clemmer, and Nogee 2008). Communities where coal-fired power plants are located—often low-income communities and/or communities of color—have for decades borne the brunt of these negative impacts, including air pollution, water pollution, and workplace injuries and fatalities. When coal is burned to produce electricity, not all of its components combust, and ash is left behind—massive amounts of it. Coal ash is one of the two largest industrial waste streams in the United States: From 1966 to 2017, US electric utility companies generated a total of 4.5 billion tons of coal ash and from 2015 to 2019 produced an average of 101 million tons of coal ash every year (ACAA 2021; Earthjustice 2019).

Coal Ash in the Ohio River Valley States

Coal ash is often mixed with water and stored in large surface impoundments, commonly called coal ash ponds. It can also be stored in dry form in landfills or reused in products like concrete. Many of the elements that make up coal ash—arsenic, boron, cadmium, chromium, lead, radium, and selenium, to name a few—are toxic, and exposure can cause a variety of severe health issues, including cancer, heart disease, reproductive failure, stroke, and even brain damage in children (Earthjustice 2020). Many coal ash constituents are also toxic to aquatic life, and coal ash ponds pose a risk of catastrophic spills that can contaminate soil, waterways, and groundwater. However, despite its being such a large waste stream with demonstrated serious impacts on human health and the environment (Gottlieb, Gilbert, and Evans 2010), only in 2015 did the Environmental Protection Agency (EPA) adopt rules under the Resource Conservation and Recovery Act that specifically address coal ash (*Federal Register* 2015).

Coal-fired power plants are often located along major rivers, because large amounts of water are needed for cooling (Rogers et. al. 2013), with many concentrated along the Ohio River. Of the 738[1] coal ash disposal sites nationwide, 161 (more than one out of five) can be found at operating or retired coal-fired power plants in the five states that make up the Ohio River Valley: Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia.[2] One assessment of documented groundwater contamination from coal ash disposal sites put two coal-fired power plants in the Ohio River Valley on the list of the top 10 most contaminated nationwide: the New Castle Generating Station in Pennsylvania (#5) and the Ghent Generating Station in Kentucky (#10) (Russ, Bernhardt, and Evans 2019).

These 161 disposal sites are located at 57 operating or retired coal-fired power plants in these five states. At 33 of the plants (58 percent), the surrounding community is considered low-income, meaning that the residents within a three-mile

1 *This figure includes only coal ash disposal sites where the owner is required to report information on groundwater contamination, which excludes "legacy" coal ash ponds that closed prior to 2015 as well as sites that are regulated but have received exemptions from reporting requirements.*

2 *Both operating and retired power plants often include multiple coal ash ponds and landfills, referred to in this report as coal ash disposal sites.*

> ***Cleaning up coal ash can create jobs in exactly the places where jobs are being lost while simultaneously mitigating the harm caused by ongoing pollution and providing communities a pathway forward.***

radius have an average income level at or below twice the federal poverty level in their state. Six of the 57 plants (nearly 11 percent) are located within three miles of a community with a disproportionate number of people of color; half are in Indiana (Earthjustice 2020). Nationally, 52 percent of communities near operating or retired coal-fired power plants are low-income—meaning that the Ohio River Valley disposal sites are more likely to affect low-income communities than the national average.

The Many Benefits of Coal Ash Cleanup

With the advent of cheap and abundant natural gas and the dramatic decrease in costs of renewable energy like wind and solar, coal-fired power plants have become increasingly uneconomic in the last decade. Coal-fired generation dropped from providing more than half of electricity generation in 2008 to about 20 percent in 2020, and around 90 gigawatts (GW) of coal-fired generating capacity was retired over that time (Storrow 2020). But the soil and water pollution often remains and continues to affect human health and the environment. As the transition away from coal accelerates, coal ash cleanup is a critical component of dealing with the legacy of coal-fired electricity generation. The good news is that remediating coal ash sites can drive multiple positive outcomes: creating jobs for workers facing job losses at retiring coal plants, correcting a serious and ongoing threat to human health and the environment, increasing the potential for redevelopment of the sites, and helping diversify local economies. Pollution cleanup is essential to ensuring that these areas are places where people want to live and work.

Generalizing the costs of coal ash cleanup nationally is difficult because the cleanup needs are site-specific, but case studies are useful in understanding costs and needs under specific conditions and in providing context for the problem nationally. New analysis by the Union of Concerned Scientists and the Ohio River Valley Institute evaluates the cleanup costs and job creation potential for two coal ash sites—the first two such case studies in the Ohio River Valley. One site, the J. M. Stuart plant in Appalachian Ohio, closed in 2018, along with another nearby coal plant, dealing a blow to the local economy (MacGillis 2018). The other site, the Sebree Generating Station, consists of three coal-fired power plants (one still in operation but slated for retirement) in western Kentucky. Our analysis evaluates site owners' plans for cleanup activities (both of which are in violation of federal regulations) and proposes a more complete "clean closure" plan for both. We find that clean closure would generate more economic activity and create more jobs. This is especially true for Sebree, where the clean closure plan would generate nearly *twice* as many jobs as the utility's proposed plan during the project's construction phase, which refers to initial investments in infrastructure needed to excavate and safely store the coal ash waste. Relative to the owners' cleanup plans, the clean closure plans drive more than $100 million in additional economic output in each state.

These case studies illustrate how investing in cleanup of coal ash can create jobs in exactly the places where jobs are being lost, while simultaneously mitigating the harm caused by ongoing pollution and providing communities in the Appalachian region—and nationwide—a pathway forward as the shift toward clean energy continues.

Pollution from Coal Ash

The combustion of coal yields a variety of waste streams including fly ash, bottom ash, boiler slag, and material from flue gas desulfurization, which are commonly called coal ash or coal combustion residuals (CCR) (EPA 2020). While coal ash can be diverted for reuse in products like concrete, it is typically disposed of on site at power plants, often mixed with water to create a slurry and piped for disposal to a nearby coal ash pond. Intended to contain many decades' worth of waste, coal ash ponds are typically large, averaging more than 50 acres in size and more than 20 feet deep (EPA 2018). Some are much larger. The McElroy's Run coal ash pond at the Pleasants Power Station in West Virginia, for example, is 253 acres—the area of about 192 football fields—and nearly 150 feet deep (Tetra Tech 2019). Coal ash can also be disposed of in dry form in landfills.

The unsafe disposal of coal ash is common given the historical lack of oversight and can lead to ongoing air and water pollution. Depending on how the ponds were constructed and where they were sited, coal ash ponds may allow toxic materials to seep into the groundwater and/or waterways. For coal-fired power plants located along rivers, the corresponding coal ash ponds are often located in the floodplain and often in places with shallow groundwater, increasing risk to aquatic life and drinking water. Furthermore, more than 95 percent of coal ash ponds are unlined or poorly lined, offering little to no barrier between the coal ash slurry and the groundwater below. Based on federal groundwater monitoring and reporting requirements that became mandatory after 2015, more than 90 percent of the 738 coal ash disposal sites nationwide are leaking at levels that render the underlying groundwater unsafe for drinking (Earthjustice 2020). And sometimes structural elements of coal ash impoundments can fail, leading to spills with catastrophic consequences for nearby residents, property, the environment, and cleanup workers (see Box 1).

Coal ash landfills are often similarly unlined, allowing precipitation to filter through the coal ash pile and leach contaminants directly into groundwater and into surrounding waterways through runoff. For example, on multiple occasions Kentucky state inspectors reported coal ash waste flowing from the Green Landfill at Sebree at rates of 60 gallons per minute (Van Velzer 2019). Just as with coal ash ponds, contamination from landfills can also occur when the ash is buried under the water table in direct contact with groundwater. Finally, wind can disperse coal ash dust if the landfill is uncapped, allowing uptake by soil and vegetation and inhalation by humans.

[More than 90 percent of the 738 coal ash disposal sites nationwide are leaking at levels that render the underlying groundwater unsafe for drinking.]

Impacts of Coal Ash Pollution

The EPA conducted an exhaustive assessment of the risks of coal ash to humans and ecological systems, evaluating a long list of contamination exposure mechanisms from both landfills and surface ponds and through soil, nearby flora and fauna, groundwater, drinking water, and air. The agency found risks to human health "primarily from exposures to arsenic and molybdenum in ground water used as a source of drinking water, but additional risks from boron, cadmium, cobalt, fluoride, mercury, and thallium were identified for specific subsets of national disposal practices." It also found risks to ecological systems "from exposures to aluminum, arsenic, barium, beryllium, boron, cadmium, chloride, chromium, selenium, and vanadium through direct exposure to impoundment wastewater" (EPA 2014c).

Other coal ash constituents can pose health risks, too. In its 2015 CCR Rule, the EPA defined a long list of constituents subject to monitoring based on their known risks to human health. Humans can come into contact with these pollutants by drinking contaminated water; swimming, boating, or fishing in contaminated lakes and rivers; eating animals and fish that have ingested the pollutants; and coming into direct contact with contaminated soil (Locke et al. 2020).

Contamination from coal ash can harm wildlife and have ecosystem-level impacts, such as reducing species abundance and diversity and even eliminating entire species (Lemly and Skorupa 2012; Rowe, Hopkins, and Congdon 2002). Trace elements from coal ash have been detected in algae, plankton, plants, insects, mollusks, crayfish, fish, amphibians, reptiles, birds, and mammals, and chronic exposure can cause reduced growth rates, deformities, and reproductive failure in some wildlife populations (Locke et al. 2020). Selenium is particularly dangerous because it is toxic to aquatic life even at low levels and has been detected at all levels of the food chain (Gottlieb, Gilbert, and Evans 2010).

BOX 1.

Kingston's Cautionary Tale

The structural elements containing the coal ash pond can sometimes fail, with catastrophic consequences that often compound burdens of environmental justice and systemic racism faced by low-income communities and communities of color. In late December of 2008, an earthen dike ruptured at the Tennessee Valley Authority's Kingston coal-fired power plant in Tennessee, spilling 1.1 billion gallons of coal ash waste—enough to fill 1,652 Olympic-sized swimming pools (Bourne 2019). The Kingston coal ash spill stands as the largest industrial disaster in US history, 10 times the size of the Deepwater Horizon oil spill in the Gulf of Mexico (Bourne 2019). In addition to the Kingston spill's destroying homes, devastating ecological systems, and contaminating the Emory and Clinch Rivers—the source of drinking water for hundreds of thousands of residents—in its immediate aftermath, workers were not provided any protective equipment during cleanup operations (Gaffney 2020). Of the nearly 900 workers who cleaned up the site, many became sick and at least 53 have died as a result of working on cleanup activities—a number that may grow (Knisley 2020; Sullivan 2019).

Short-term cleanup efforts led to the removal of almost 707 million gallons of waste from the river and surrounding areas. The next phase of cleanup relied on allowing the pollutants to dissipate naturally in the river ("monitored natural recovery") (SACE 2012), at least in part because dredging of the riverbed was stirring up additional contaminants from the history of nuclear testing at nearby Oak Ridge National Laboratory (Gaffney 2020). Most of the waste from the initial cleanup of the spill (to the tune of 4 million tons) was put on trains and trucks and shipped to a landfill in Uniontown, a small town in Perry County, Alabama. No modifications were made to the landfill to contain the coal ash; the ash was simply piled up in mounds as high as 60 feet (SACE 2013). Even today, residents report dust blowing from the coal ash piles and coating nearby homes, and runoff from the landfill pollutes local waterways (Engelman-Lado et al. 2021). Uniontown's population of just under 2,000 is predominantly Black, and more than half of its residents live below the poverty level.

The total cost of the Kingston cleanup was estimated to be $1.134 billion (Oak Ridge Today 2017). And that figure does not include the incalculable value of the cleanup workers who lost their lives or continue to suffer from chronic disease, the residents of Uniontown who face the lasting public health impacts of the waste and who saw their property values drop, or the effects of the spill and its disposal on the environment (Engelman-Lado et al. 2021). The legacy of the Tennessee Valley Authority's Kingston disaster, combined with decisions by the Alabama Department of Environmental Management and the Perry County Commission, which failed to properly protect or even consult with local residents, stands as a powerful example of the need to address environmental justice concerns in coal ash disposal.

J. Miles Cary/AP Photo/Knoxville News Sentinel

The largest industrial disaster in US history, the Kingston coal ash spill on December 22, 2008, destroyed homes, devastated ecological systems, and contaminated the Emory and Clinch Rivers. The spill was caused by the failure of a dike containing the coal ash pond, underscoring the threat of coal ash waste to human health and the environment.

Higher Risks in the Ohio River Valley States

In the five Ohio River Valley states, more than 162 billion gallons of coal ash waste is held in the 161 disposal sites (landfills or coal ash ponds) that are subject to the reporting requirements set forth by the EPA's CCR Rule. These sites are located at 57 operating or retired coal-fired power plants (see Table 1). Pennsylvania reported the highest volume of CCR waste of any of the five states, and Indiana has the most coal ash sites subject to reporting requirements. It is important to note that these totals do not include all coal ash sites in these states, because the numbers do not reflect coal ash sites that were closed prior to 2015 and therefore are not currently subject to EPA's coal ash regulations and reporting requirements; one analysis found dozens of additional unreported disposal sites in these states (Colman 2019).

The EPA has assigned hazard ratings to coal ash ponds based on the same criteria used by the Federal Emergency Management Agency and the Army Corps of Engineers to assess dam safety (ICDS 2004). The rating does not assess the likelihood of failure, but rather the potential for loss of life and damage if such a failure were to occur. A rating of "high" means that loss of life would likely occur in the event of failure; "significant" means that loss of life is not likely, but that a failure would result in economic losses and environmental damage. The five states have 16 sites rated as high hazard and

[In the five Ohio River Valley states, more than 162 billion gallons of coal ash waste is held in the 161 disposal sites that are subject to EPA reporting requirements.]

TABLE 1. Overview of Coal Ash Disposal Sites in the Ohio River Valley

State	Power Plants	Disposal Sites	Landfills	Coal Ash Ponds	Total CCR Volume (cubic yards)	Above Average Proportion of Residents Who Are People of Color	Above Average Proportion of Residents Who Are Low-Income
Indiana	16	50	9	41	49,995,320	3	8
Kentucky	15	43	15	28	173,881,205	2	10
Ohio	10	33	11	22	153,173,418	0	7
Pennsylvania	9	21	8	13	257,037,684	0	6
West Virginia	7	14	8	6	169,141,078	1	2
Total	**57**	**161**	**51**	**110**	**803,228,705**	**6**	**33**

The Ohio River Valley states host 57 operating or retired coal-fired power plants that are subject to EPA reporting requirements (a number that does not include unregulated disposal sites). The rightmost columns list the number of disposal sites where the surrounding community within a three-mile radius is above the state average for people of color or low-income households.

SOURCES: RUSS, BERNHARDT, AND EVANS 2019; EARTHJUSTICE 2020.

58 rated as significant (see Table 2). In West Virginia, five of the six coal ash ponds are rated as high or significant hazards, and in Ohio, 19 of the 22 are rated as either high or significant.

Published analysis of utility data required by the CCR rule indicates that 91 percent of coal-fired power plants nationally are contributing to unsafe groundwater via contamination from coal ash, where "unsafe groundwater" is defined as having at least one of the 17 substances subject to monitoring exceeding health-based standards (Russ, Bernhardt, and Evans 2019; Earthjustice 2020). Nationally, 54 percent of the sites exceed health-based thresholds of at least four of these pollutants, and the Ohio River Valley states show higher contamination rates than the nation as a whole. Of the 55 coal-fired power plants subject to monitoring requirements in the five states, 96 percent (53 plants) exceed the threshold for at least one pollutant, and 65 percent (36 plants) exceed standards for at least four pollutants (see Table 3, p. 10). In Ohio, eight out of the 10 plants show contamination above safe levels for at least four pollutants. Indiana has the greatest number of plants showing contamination of at least four pollutants, at 12. In three states, all coal plants in the state exceed safe levels of at least one pollutant.

TABLE 2. Summary of Disposal Site Hazard Ratings for the Ohio River Valley States

State	Total Sites	Hazard: High	Hazard: Significant	Total, High Plus Significant	% High or Significant
Indiana	50	1	26	27	54%
Kentucky	43	7	13	20	47%
Ohio	33	5	14	19	58%
Pennsylvania	21	1	2	3	14%
West Virginia	14	2	3	5	36%
Total	**161**	**16**	**58**	**74**	**46%**

Nearly half of the coal ash disposal sites in the Ohio River Valley states could lead to a loss of life ("high risk") or economic losses and environmental damage ("significant risk") in the event of structural failure.

Note: One site in Pennsylvania is rated "high/significant" and is counted in the "significant" column.

SOURCES: RUSS, BERNHARDT, AND EVANS 2019; EARTHJUSTICE 2020.

TABLE 3. Higher Contamination Rates in the Five States in the Ohio River Valley Than the Nation as a Whole

Substance	IN	KY	OH	PA	WV	Total
Antimony	2	1	0	0	0	**3**
Arsenic	14	7	8	3	4	**36**
Barium	0	0	2	1	1	**4**
Beryllium	1	2	1	0	1	**5**
Boron	11	8	9	3	3	**34**
Cadmium	2	0	0	0	0	**2**
Chromium	0	2	1	0	0	**3**
Cobalt	7	5	8	5	3	**28**
Fluoride	1	1	3	0	0	**5**
Lead	0	1	2	1	0	**4**
Lithium	12	12	8	6	3	**41**
Mercury	0	1	0	0	1	**2**
Molybdenum	12	9	8	4	5	**38**
Radium	2	3	4	0	1	**10**
Selenium	1	2	1	0	0	**4**
Sulfate	10	12	8	6	3	**39**
Thallium	3	2	1	0	0	**6**
Any Substance	**14**	**14**	**10**	**8**	**7**	**53**
At Least 4 Substances	**12**	**8**	**8**	**3**	**5**	**36**
Total Plants*	15	14	10	9	7	**55**
% Plants with at least 1	93%	100%	100%	89%	100%	**96%**
% Plants with at least 4	80%	57%	80%	33%	71%	**65%**

These 17 pollutants are subject to monitoring requirements and/or health-based standards by the CCR Rule. The values in the table indicate the number of current or former coal-fired power plant sites in each state that have exceeded health-based thresholds of each pollutant. Nationally, 54 percent of coal-fired power plants reported exceedances of at least four pollutants, and 91 percent reported exceedances of at least one, compared to 65 percent and 96 percent, respectively, for the Ohio River Valley states.

* Note: One plant in Indiana and one in Kentucky are excluded from the plant totals because contamination levels are unknown.

SOURCE: RUSS, BERNHARDT, AND EVANS 2019.

[CHAPTER 3]

Weak Federal Coal Ash Regulations

Although coal ash is one of the largest industrial waste streams in the United States and has been produced for many decades, the EPA did not adopt specific regulations governing it until recently. Spurred in part by the Tennessee Valley Authority's Kingston disaster (see Box 1, p. 7) and recognizing the potential for groundwater contamination from surface coal ash ponds and landfills, the EPA conducted a risk assessment that kicked off a rulemaking process to regulate the disposal of coal ash waste, concluding that it does pose a threat to human health and the environment (EPA 2018; 2014c). The agency finalized the Coal Combustion Residuals Rule in 2015 (*Federal Register* 2015).

The initial 2015 CCR Rule aimed to reduce risks of groundwater contamination, airborne transport of coal ash dust, and structural failure of surface coal ash ponds (EPA 2018). It established minimum criteria for new and existing coal ash ponds and landfills that include location restrictions, design and operating criteria, requirements for groundwater monitoring and corrective action, closure requirements, and public disclosures (EPA 2020). The rule regulates coal ash under the Resource Conservation and Recovery Act, the primary federal statute governing both hazardous and nonhazardous solid waste disposal.

The 2015 CCR Rule placed a first-time federal requirement on owners and operators of coal ash disposal sites to monitor groundwater. As noted above, the EPA's comprehensive risk assessment identified a set of constituents present in coal ash that pose significant risks to human health or ecosystems (EPA 2014c), and the 2015 CCR Rule identified pollutants for detection and assessment (*Federal Register* 2015). Importantly, the risk assessment found that composite liners installed in landfills and surface ponds provide the best protection, reducing risks to human health and ecological impacts by maintaining contaminant levels well within a safe range. Unlined disposal sites present the greatest risk, while clay-lined sites, although safer than unlined sites, can still allow contaminant levels that exceed the risk criteria (EPA 2014c).

The rule requires the closure of any unlined coal ash pond that is leaking toxic contaminants at levels above federal standards or any pond that cannot meet location restrictions or minimum structural requirements. Nearly all coal ash ponds are unlined or poorly lined (having been constructed at lowest cost and prior to federal oversight), and, based on subsequent disclosures from groundwater monitoring, 91 percent are leaking (Earthjustice 2020). However, during the Trump administration the EPA weakened the rule by extending the deadline for closure of these coal ash ponds under some circumstances. Also, although the 2015 CCR Rule required that all new disposal sites install composite liners, during the Trump administration the EPA amended the rule to allow some existing unlined and clay-lined impoundments to continue receiving coal ash, provided they are not contaminating groundwater (EPA 2018).

Inadequacies of the EPA's 2015 Coal Combustion Residuals Rule

Even before the rollbacks by the Trump administration, the original 2015 rule was widely considered inadequate by environmental and public health advocates as well as community groups (Earthjustice, n.d.). First and foremost, both cap-in-place and excavation are allowable closure methods under the rule, even though cap-in-place provides inferior protection from contamination relative to excavation because unlined ponds can continue to contaminate groundwater even when covered (see below for more on closure methods). Utilities can also apply for waivers to delay compliance and can avoid cleanup of groundwater by inappropriately attributing coal ash contamination to other sources and avoiding monitoring requirements (*Federal Register* 2015). Advocates argued that coal ash should be subject to more stringent rules applied to hazardous waste.

In addition, the EPA chose to exempt landfills that closed prior to 2015 and inactive ash ponds at facilities no longer generating electricity, leaving many potentially harmful sites unregulated. This also created a perverse incentive that led many utilities to close disposal sites before the rule was finalized and thus escape regulation and monitoring requirements. There is little information and no comprehensive database of these legacy ponds and landfills, many of which continue to pose threats to human health and the environment. Nearby residents are not able to ascertain whether or to what extent their drinking water is affected, and the absence of monitoring data hinders any efforts to initiate citizen enforcement.

The current federal regulations require monitoring groundwater only at the coal ash pond, not at nearby sources of drinking water. The extent of groundwater pollution was not well understood until after utilities were required to monitor for pollution (*Federal Register* 2015); therefore, we do not have comprehensive data about groundwater contamination at a distance from the pollution source. But despite the lack of comprehensive data, at least 24 sites have been identified where private wells were contaminated by coal ash; two are in Indiana, and two are in Pennsylvania (Earthjustice 2020). And finally, more than 100 coal ash ponds and landfills (including both unregulated legacy sites and those subject to current reporting requirements) are sited in locations considered at a high risk for flooding (Colman 2019). Hurricanes Matthew and Florence in 2016 and 2018 demonstrated the danger of flooding to coal ash ponds in

Rick Dove/Waterkeeper Alliance

The rupture of a stormwater pipe at a former coal-fired power plant owned by Duke Energy spilled 27 million gallons of contaminated water and 39,000 tons of coal ash into the Dan River in February 2014. The disaster exposed the utility's negligence and drove policymakers to ensure all coal ash ponds in the state close safely by 2029.

North and South Carolina, and this threat will only increase with more frequent extreme weather events driven by climate change (Colman 2019; Hayhoe et al. 2018; Northey and Wittenberg 2018).

Given the rule's inadequacy from an environmental and public health perspective, litigation followed the finalization of the initial CCR Rule, and in 2018, the United States Court of Appeals for the District of Columbia Circuit vacated and rejected three important parts of the 2015 rule, affirming some of the claims presented by environmental advocates. The court found that (1) the EPA had no grounds to allow only non-leaking unlined ponds to continue to receive waste (because of the risk of continued contamination); (2) the EPA had no grounds to classify "clay-lined" ponds as lined, as these liners still pose a risk of contamination; and (3) the EPA had no grounds to exempt legacy coal ash ponds from the requirements outlined in the rule (Kirn 2020). Instead of addressing these deficiencies, the Trump-era EPA weakened the rule by providing compliance extensions and making it easier for owners and operators to delay compliance. On the question of legacy ponds, the agency delayed and simply issued another request for information instead of amending the rule, sidestepping the required revisions to the rule in response to the court ruling (Frank and Maloney 2020). Litigation is ongoing (EELP 2017).

In one of his executive orders his first day in office, President Biden designated 50 EPA rules for review, including the regulations weakening the CCR Rule promulgated by the Trump administration. The agency is now headed by the former head of North Carolina's Department of Environmental Quality, who is credited for issuing directives and entering into an agreement that required Duke Energy to fully clean up coal ash ponds by excavation (see Box 2) (Marshall 2021). However, the Biden EPA chose not to challenge the Trump EPA's weakening of the rule, instead concluding that the most environmentally responsible action was to implement the rules rather than risk delay through additional rulemaking (Yohannan 2021).

BOX 2.

A Big Wake-Up Call Leads to the Nation's Largest Coal Ash Cleanup

On February 2, 2014, a stormwater pipe burst at a coal ash pond owned by Duke Energy in Eden, North Carolina, at the site of a retired coal-fired power plant. The breach, which took more than a week to repair and stem the flow of contaminated water, ultimately spilled 39,000 tons of coal ash and 27 million gallons of contaminated water into the Dan River near the border with Virginia (Appalachian Voices 2021). The spill reached more than 70 miles downstream and is the third-largest coal ash spill in US history. And yet it could have been much worse; Duke's problems were widespread, and the Eden coal ash pond was the company's smallest in the state, holding only 1 percent of the company's waste stored in 14 sites statewide (Wireback 2015). In just the six months following the spill, one estimate of the costs of the ecological damage, recreational impacts, and effects on human health totaled almost $300 million (Lemly 2015).

Political interference at the state's environmental regulator, the Department of Environment and Natural Resources (now the Department of Environmental Quality), resulted in lax enforcement prior to the spill and weak penalties in the immediate aftermath (Gabriel 2014). Ultimately, the Justice Department prosecuted Duke Energy. The company was found to be criminally negligent for the disaster and Clean Water Act violations at other coal ash sites in the state and agreed to pay $103 million in fines (CBS/AP 2015). The company also agreed to pay $3 million in cleanup costs to the EPA (EPA 2014a), and the North Carolina Department of Environmental Quality eventually fined the company $6.6 million (CBS/AP 2016). Even though community groups had fought for years to force Duke Energy to clean up leaks from coal ash ponds, the disaster provided the needed leverage to hold the company accountable.

The spill's impact reverberated through state politics, leading to legislation that forced the closure of all coal ash ponds in North Carolina by 2029 (Smith 2014). Litigation and negotiations continued for years, but eventually Duke Energy agreed to excavate waste from all of its coal ash ponds at 14 plants rather than cap the ponds in place, and transferred almost 126 million tons of coal ash to lined landfills or for recycling into concrete (Bonner 2020). And finally, the utility agreed to cover a portion of the costs of coal ash cleanup through 2030, saving electricity users more than $1 billion (Weinstein 2021).

North Carolina exemplifies how pressure from community groups can lead to positive outcomes—though, in this case, only after years of litigation and in the wake of a major environmental disaster that exposed both the utility's negligence and the state government's failure to hold the utility accountable.

How Coal Ash Is Regulated in Ohio River Valley States

Prior to the 2015 CCR Rule, states applied different levels of stringency to regulating coal ash ponds. In the five Ohio River Valley states, coal ash regulations ranged from inadequate to nonexistent. Four states had no groundwater monitoring requirements, and no states required composite lining to protect leaching of contaminants into the water table. Indiana and Ohio were among the worst in the nation: Indiana did not even require dams containing coal ash ponds to be designed by a professional engineer, and Ohio exempted coal ash from its solid waste definition that applies to most industrial waste streams and household garbage.

Following the finalization of the 2015 CCR Rule, only a handful of states have passed laws that require owners and operators of coal ash ponds to excavate the coal ash and dispose of it in a lined landfill. In North Carolina, litigation settlements and agency directives under the state's 2014 Coal Ash Management Act included requirements that all coal ash ponds be excavated, and in South Carolina, litigation settlements and utility decisions have resulted in excavation of all coal ash ponds. Virginia passed laws requiring its utilities to excavate unlined ponds near waterways (Frank and Maloney 2020). However, Kentucky regulators are hamstrung by state law that prevents regulations more stringent than federal requirements (Blau 2019). Pennsylvania adopted the initial CCR Rule and amended water pollution permits to require stronger standards for 10 coal-fired power plants in the state, but the weakened requirements at the federal level and ongoing litigation have thrown those requirements into question (Frazier 2020). Indiana, the state with the most coal ash ponds, requires excavation for coal ash ponds covered by the 2015 rule that are in contact with groundwater, but allows capping in place for older ponds not currently regulated (Frank and Maloney 2020). West Virginia similarly declined to enforce the federal standards, sticking with its own weaker groundwater standards (Chambers 2016).

[CHAPTER 4]

Coal Ash Cleanup Methods

When a coal-fired power plant is retired, the utility must decide what to do with the leftover coal ash waste, and its choices have implications for the potential for ongoing pollution, human health impacts, and future economic development opportunities. With the disposal method called cap-in-place, once the coal ash pond is full or no longer needed, the surface liquid is removed, the top edge of the pond structure is graded to provide for drainage, and a low-permeability covering is placed over it and sealed. This largely prevents precipitation from leaching contaminants into the surrounding soil, but it cannot prevent leaching due to direct groundwater contact with the coal ash under the covering (Russ, Bernhardt, and Evans 2019). Since most coal ash ponds are unlined and many have millions of tons of ash sitting in groundwater, this leaching problem is common, and the risk of pollution continues indefinitely. At a minimum, cap-in-place closure requires long-term monitoring systems to detect groundwater contamination and guide cleanup activities.

Another disposal solution is excavation—draining the pond and removing the coal ash for disposal in a properly designed landfill. From an environmental standpoint, disposal in properly designed landfills is a better solution than capping in place because there is much lower risk of leaching into groundwater. Proper design includes ensuring the landfill is sited above the water table, lining the landfill, installing collection systems to capture any pollution runoff or leaching, installing groundwater monitoring systems, and capping the landfill to prevent fugitive dust, precipitation infiltration, and runoff (*Federal Register* 2015). Properly sited landfills also eliminate the risk of catastrophic structural failures from remaining coal ash ponds, as happened at Kingston (see Box 1, p. 7), that lead to massive pollution of adjacent rivers, streams, and lakes.

Finally, coal ash can be diverted or removed from coal ash ponds and from landfills for reuse. Trade groups suggest that a majority of coal ash is reused for beneficial purposes (ACAA 2021), but the reality is more complicated. Some applications for coal ash reuse are not truly beneficial, and some are themselves harmful (see Box 3, p. 16). The EPA has developed a methodology for assessing whether an application qualifies as a "beneficial use" (EPA 2016). An emerging reuse concept is to extract rare earth elements (REEs) for use in the manufacturing of clean energy components and electronics (see Box 4, p. 17). While extracting REEs may have some utility in reducing shortages of critical minerals, many elements of the coal ash will remain after the REEs are extracted. Reusing REEs will not significantly reduce the volume of coal ash waste, and its potential is therefore limited.

Although some coal ash may be diverted for legitimate beneficial uses, excavation is needed to ensure "clean

[Disposal of coal ash in properly designed landfills is a better solution than capping in place, because there is a much lower risk of leaching into groundwater.]

> ***Extracting and reusing rare earth minerals from coal ash will not significantly reduce the volume of coal ash waste.***

closure." Utilities often propose cap-in-place as a solution for closure of coal ash ponds because it is generally the least expensive and easiest solution. However, although draining the ponds and moving the coal ash waste to landfills can be more expensive, it ensures safer disposal that protects groundwater and surface waters and eliminates the risks posed by waterfront and floodplain coal ash storage—risks that are increasing due to more frequent and severe flooding and extreme weather (Hayhoe et al. 2018). Excavation is also more labor intensive and thus leads to more job creation and local economic activity. And the removal of coal ash and clean closure of the site provides greater development and/or recreational opportunities for the local community and can allow the restoration of the ecosystem.

BOX 3.

When Is Coal Ash Reuse Truly "Beneficial"?

Reuse is categorized by the form of the coal ash—encapsulated or unencapsulated. Encapsulated coal ash is defined as reuse that "binds CCR into a solid matrix that minimizes its mobilization into the surrounding environment" (EPA 2016). According to the EPA, beneficial use of encapsulated coal ash must (1) provide a functional benefit, (2) replace virgin material, and (3) meet existing civil society or governmental production or design standards relevant to the reuse application (*Federal Register* 2015). The EPA has determined two beneficial uses of encapsulated coal ash: the use of fly ash (fine particles that are carried off in the gases released from coal combustion and captured by pollution control devices) in concrete, and the use of synthetic gypsum (flue gas desulfurization sludge) in drywall. Fly ash can create measurably stronger, more durable, and more pumpable concrete than that made with Portland cement alone and avoids emissions of heat-trapping gases by reducing the production of Portland cement. Reusing synthetic gypsum in drywall avoids mining virgin gypsum (Gardner and Greenwood 2017; Seidler and Malloy 2020). These represent the two most common reuse applications, but only accounted for approximately 29 percent of coal ash waste in 2019 (ACAA 2021; USGS 2014).

Unencapsulated coal ash can be used for mine reclamation and for structural fills, and these types of reuse are much more controversial. The EPA defines unencapsulated coal ash as being in "a loose or unbound particulate or sludge form and involves the direct placement of the secondary material on the land" (EPA 2016). The EPA does not disallow unencapsulated applications from qualifying as beneficial uses per se, but an application of unencapsulated coal ash greater than 12,400 tons must meet a fourth criterion under the EPA's test for beneficial reuse: It must not result in more environmental releases than analogous material that does not contain coal ash (i.e., clean fill). Any pollutant releases must be below relevant human health and ecological benchmarks (EPA 2014b; Seidler and Malloy 2020).

When coal ash is used as a filler for mine pits, contouring landscapes, and leveling uneven surfaces for transportation or construction projects, there is risk of leaching into groundwater or surface water, as well as a concern that unencapsulated reuse as filler is a backdoor means of coal ash disposal that avoids regulation (Seidler and Malloy 2020; Earthjustice 2019). For example, unencapsulated coal ash was widely used as construction fill in the Town of Pines, Indiana; the entire town was later declared a Superfund site after high levels of boron and molybdenum linked to coal ash reuse were found in drinking water wells (EPA 2021). Earthjustice and other environmental groups argue that the use of coal ash as fill should be banned (Earthjustice 2019). More detail on coal ash reuse can be found in Appendix C, online at www.ucsusa.org/resources/coal-ash-cleanup-benefits.

BOX 4.

Can Coal Ash Help Meet Growing Demand for Rare Earth Elements?

The potential of reusing rare earth elements (REEs) in coal ash has garnered significant attention in recent years. REEs refer to 16 elemental metals (the lanthanide series plus scandium and yttrium) that are found abundantly but generally in low concentrations and non-isolated forms throughout Earth's crust (Seidler and Malloy 2020). REEs require considerable energy to extract and process for commercial applications, but their magnetic, phosphorescent, and catalytic properties make them critical for clean energy and electronics end uses. The manufacture of Apple's iPhone, for example, requires nine REEs (Seidler and Malloy 2020).

The concentration of REEs found in coal ash from US coal basins is two orders of magnitude lower than that found in conventional ore (Taggart et al. 2016). However, *critical* REEs—which are rarer and more commercially useful—make up a much larger share of the total REE content in coal ash. This could be advantageous because REEs that are abundant in conventional ore but not commercially useful are a significant waste stream of conventional mining operations; extracting critical REEs from coal ash would therefore reduce the waste generated per unit of critical REEs (Taggart et al. 2016). Extracting REEs from coal ash avoids environmental damage from new mining and reduces production costs by avoiding processing steps such as crushing ore.

Large-scale extraction of REEs from coal ash is currently uneconomical, and only small-scale projects have been operational thus far, but that could change with advances in extraction technology or increasing prices in existing REE markets (Gaffney 2021). In recent years, the Department of Energy has invested at least $19 million in projects to research and support the production and separation of REEs from coal ash, coal waste, acid mine drainage, and coal refuse. Extracting REEs from coal ash is most likely to be economical when paired with commercial reuse of other minerals in coal ash.

There are other potential benefits to extracting REEs from coal ash: While REEs are a small share of total coal ash content, and thus extracting them will have a negligible impact on reducing the total volume of coal ash waste, REE extraction could generate economic value for coal dependent communities (Seidler and Malloy 2020). Extracting REEs will not be universally viable, because the specific REEs in coal ash depend on both the geologic makeup of the source coal and the emissions controls of the power plant where it was burned. However, according to one analysis, coal in the Appalachian basin has the greatest REE concentration of the US coal basins (Taggart et al. 2016), although the same analysis suggests that extracting REEs from Appalachian coal ash may require more intensive chemical processes, thus raising concerns about introducing new chemical waste streams into nearby communities.

It remains an open question whether benefits of the extraction of REEs would accrue to nearby communities and to workers. The process of extraction is an industrial process that could present risks of environmental contamination and risks to worker health and safety. Depending on the technology, it may require toxic chemicals to isolate REEs, and, once REEs are extracted, most of the coal ash waste will still remain. Strong stakeholder processes that include local unions and nearby residents are critical to ensuring good outcomes.

Coal Ash Cleanup as Economic Opportunity

Case studies help paint a picture of the national needs for coal ash cleanup by considering different kinds of problems at different coal ash disposal sites. Prior analyses of coal ash cleanup have compared the two closure methods (cap-in-place and excavation) to evaluate the estimated costs and potential for job creation. Since it is difficult to generalize cleanup costs (especially if they involve groundwater remediation), case studies such as these are a solid approach to addressing these questions. Each coal ash pond or landfill has a different set of issues, including the location (arid vs. dry, in the floodplain or not), whether there is contact with groundwater, and the design standards of the site. Case studies offer a glimpse of the costs of clean closure and the potential for job creation and resulting economic activity. Previous case studies of coal ash disposal sites have included an independent analysis of utility plans for closure and have armed advocates with alternative plans that quantify both the environmental and economic benefits of the different options (Evans and French 2021). Each of these case studies has shown greater job creation and positive impacts to the economy from clean closure plans (see Table 4).

The seminal reports on coal ash cleanup focused on the Colstrip Steam Electric Station, located in rural Rosebud County, Montana. The town of Colstrip is home to one of the largest coal-fired generating stations in the west, with two generating units that retired in early 2020 and two remaining units with a combined generating capacity of 1,480 megawatts (MW). The Colstrip coal ash pond complex is enormous: 20 ponds hold 38 million cubic yards of coal ash waste and cover more than 800 acres (Evans and French 2021), and groundwater contamination is widespread (Montana DEQ 2016; NPRC and IBEW 2018). Researchers found that a comprehensive cleanup—fully excavating the coal ash ponds that remain in contact with groundwater, moving the dry ash to properly designed landfills, and aggressively remediating the groundwater contamination—would lead to the creation of 218 direct jobs (full-time equivalents) each year over the first 10 years (2020–2029) and that ongoing operations and maintenance would create 66 jobs annually for 40 years beyond that initial construction phase (2030–2069) (French 2019). While the cost of the plan was higher than the plant operator's (Talen Montana's) originally proposed plan, which would have simply capped the ponds in place (NPRC and IBEW 2018), the analysis was so compelling that the Montana

TABLE 4. Total Jobs Created from Closure Options in Previous Case Studies

Previous Case Study	Clean Closure (# jobs)	Cap-in-Place (# jobs)
Colstrip (2020–2029)	404	158
Michigan City (2021–2034)	70	10
Grainger (2013–2020)	97	24

The three previous case studies of coal ash cleanup found that clean closure plans created from 2.5 to 7 times more jobs than the original cap-in-place plans.

Note: Jobs reported are in terms of full-time equivalents. The numbers above are not directly comparable to our new results presented below because a full-time equivalent is calculated using the total hours needed to complete the work, whereas our results represent total jobs, which includes both full- and part-time positions.

SOURCE: EVANS AND FRENCH 2021, FIGURE 3.

Department of Environmental Quality ultimately adopted the plan to excavate the five ash ponds associated with the two generating units that have already been taken out of service (Kohn 2020).

Two additional sites have been assessed for economic opportunities of clean closure options: the Grainger Generating Station in South Carolina and the Michigan City Generating Station in Indiana (Evans and French 2021). Grainger was a 170 MW coal-fired power plant that closed in 2012, leaving behind two 40-acre unlined coal ash ponds. After pressure from the community and litigation, the utility agreed to excavate the ponds and restore the area to wetlands. Analysis of the clean closure plan compared to a potential cap-in-place plan showed that the clean closure led to four to five times greater economic benefits to the surrounding area (Evans and French 2021). The Michigan City Generating Station currently hosts a 469 MW coal-fired power plant scheduled to close in 2028, but the site has been home to coal-fired power plants—and coal ash ponds—since 1931. An analysis of a clean closure option—one that includes excavating all historical coal ash fill and ponds in addition to the most recent and active ones—shows that clean closure would produce eight times the economic benefits of the utility's less comprehensive proposal that does not adequately protect public health and the environment (Evans and French 2021).

Two Case Studies in the Ohio River Valley States

The present analysis looks at two sites in the Ohio River Valley and uses a similar methodology. The sites evaluated here represent different physical characteristics and geology than previous case studies and include the first landfill remediation considered (see Table 5). The chosen locations help to quantify the benefits of cleanup in Appalachia and the Ohio River Valley, places that are reeling from the decline of coal over the last decade. Site selection criteria included availability of utility closure plans, volume of CCR waste publicly reported, known contamination problem or problematic location (i.e., floodplain or groundwater contact), non-compliance with aquifer requirements, and potential for community engagement. The two sites are the J. M. Stuart Station in Ohio and the Sebree Generating Station in Kentucky.

Methodology

Our analysis has two parts. First, using public documents typically available from utility closure plans and mandatory reporting required by the federal CCR Rule and state regulatory agencies, we assessed the site conditions at the two generating stations, including the sources and extent of contamination and the status and condition of coal ash ponds and landfills on site. Based on this evaluation we identified those disposal sites that, if no or inadequate remediation were completed, pose a long-term risk of ongoing groundwater pollution or even catastrophic failure. We then developed alternative closure plans that address those problems in a comprehensive way. For each location we quantified and compared the two alternatives for corrective action (the owner's proposal and the clean closure option), providing estimates of the cleanup costs and direct jobs required for each option. In contrast to the Colstrip study, our study does not evaluate the cost of cleaning up groundwater pollution (French 2019; NPRC and IBEW 2018).

Second, using the estimated direct jobs and costs from the first part of the analysis, we conducted an economic impact analysis of the two cleanup alternatives at each site using the IMPLAN input-output model.[3] We refined the existing industry definitions in the IMPLAN model to align with the type of economic activity created by the cleanup scenarios. The model uses the estimated direct effects (from the investment in the projects) to quantify the total impacts on the economy, which include indirect and induced effects from the investment specified. Direct effects are the costs and jobs required by the actual projects, indirect effects are regional upstream activities (e.g., purchases of goods and services needed to conduct the projects), and induced effects are follow-on impacts on the regional economy (such as workers spending their wages and state and local governments spending the additional fees and tax revenues). For each of these effects, the model estimates full- and part-time employment, economic output, and four measures of gross regional product: employee compensation, proprietor's income, indirect business taxes, and other profits. For more details on the methodology and assumptions for the two analyses, see Appendix A and Appendix B, online at www.ucsusa.org/resources/coal-ash-cleanup-benefits.

3 *IMPLAN is an input-output model, which is a form of economic analysis based on the interdependencies between economic sectors. Input-output models are commonly used to estimate the impacts of "shocks" to an economy and to analyze their resulting ripple effects. See IMPLAN.com.*

Proper cleanup of coal ash sites creates jobs as well as improves health and safety for people who live and work near the disposal sites.

Coal ash cleanup creates jobs for skilled laborers including heavy equipment operators and truck drivers, as well as professional jobs including environmental engineers and project managers. Some workers at the coal plant will be able to transfer into the skilled laborer positions needed for cleanup activities (e.g., heavy equipment operators), but others may require training. Cleanup projects also have knock-on effects in the regional economy, creating more jobs in wholesale and retail trade as well as transportation, for example, and boosting spending in restaurants and health care. Proper cleanup also addresses longstanding environmental justice concerns and improves health and safety for communities of color and low-income residents near the disposal sites (see Box 5, p. 23). All of this leads to greater tax revenue to support state and local budgets.

Case Study: Sebree Generating Station

The Sebree Generating Station is an informal name given to a collection of three operating or retired coal-fired power plants in Webster County, Kentucky: the currently operating 454 MW Robert D. Green Generating Station that burns coal; the Robert A. Reid Generating Station, a 46 MW combustion turbine that was converted from coal to natural gas in

TABLE 5. Comparison of the Physical Characteristics of Disposal Sites Evaluated in Case Studies

Facility	State	Total Number of Disposal Sites*	Volume of CCR Waste (cubic yards)	Surrounding Community Disproportionately People of Color	Surrounding Community Disproportionately Low-Income	Pollution Exceedances**	Additional Characteristics
Colstrip	Montana	13	18,351,212	No	No	7	Extensive groundwater contamination, ~200 million gal of leakage per year; arid location
Grainger	South Carolina	2	Unknown	Yes	Yes	1	Previously closed; cleanup is an example of positive environmental and economic outcomes
Michigan City	Indiana	2	49,000	Yes	Yes	2	Decades of legacy coal ash from previously closed ponds; located on shore of Lake Michigan
J. M. Stuart	Ohio	12	26,000,000	No	Yes	9	Recent, high-profile coal plant closures in rural area; along Ohio River
Sebree	Kentucky	3	23,977,238	Yes	Yes	4	Public attention to pollution in Green River; only case study to date that evaluates improvements to a coal ash landfill

The characteristics of the five coal ash cleanup case studies conducted to date, including the two new ones described in this report. The volume of CCR waste is uncertain in part because previously closed sites do not report data.

* These numbers represent the number of disposal sites subject to federal reporting requirements and exclude unregulated legacy sites.

** Number of pollutants whose levels exceed health-based standards (see Table 3, p. 10)

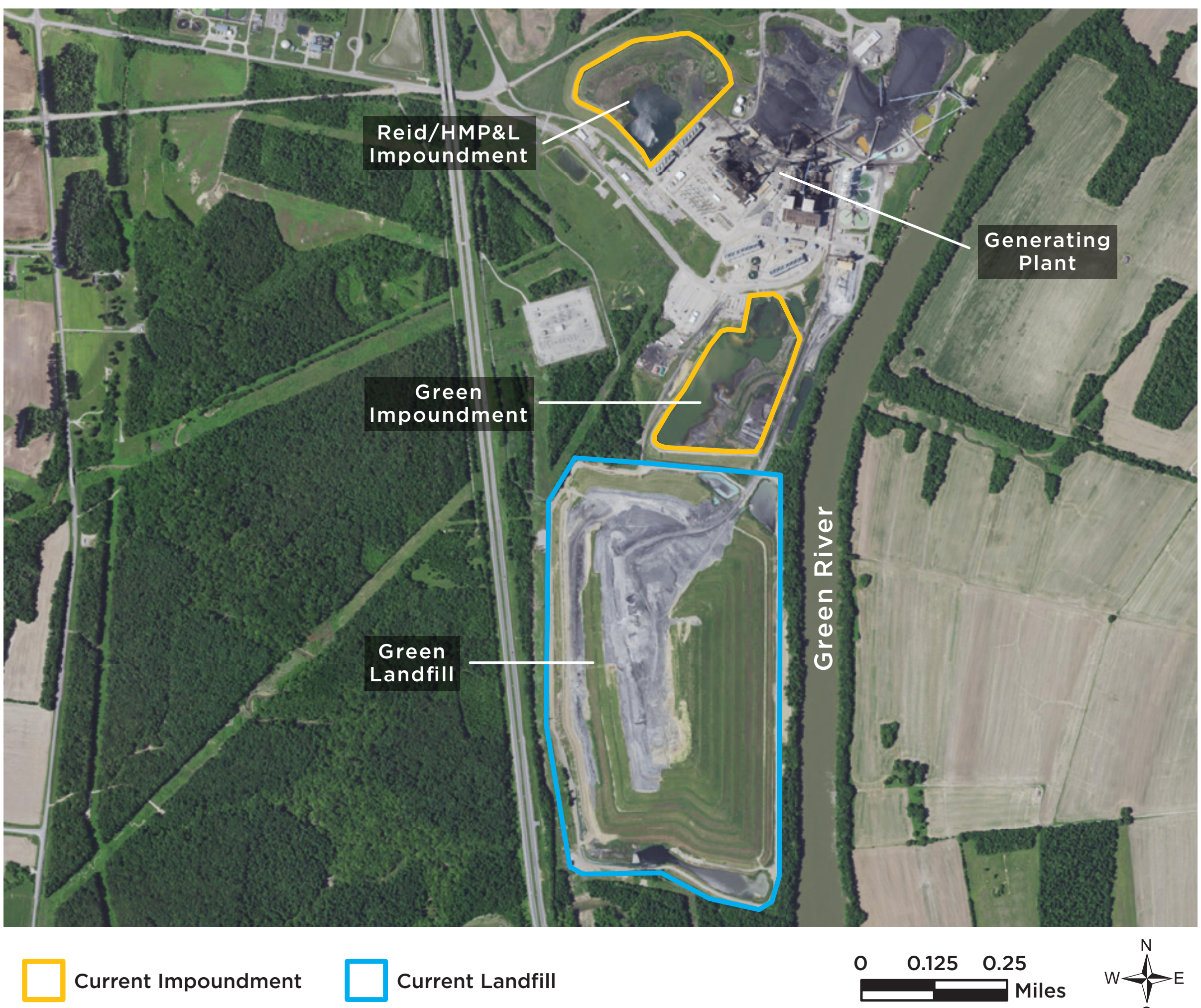
SOURCES: EARTHJUSTICE 2020, FRENCH 2019, AND NPRC AND IBEW 2018 (COLSTRIP); EVANS AND FRENCH 2021 (GRAINGER AND MICHIGAN CITY).

2016; and Henderson Station Two, a 365 MW coal-fired plant that closed in May 2019. The plants are owned by Big Rivers Electric Corporation, a joint organization created by three Kentucky rural electric cooperatives (BREC 2017).

In addition to suffering the loss of jobs from the retirement of the coal-fired power plants, Webster County has also been affected by the decline of the coal mining industry, with a drop in coal production of about 78 percent from 2015 to 2019 and the loss of 475 coal mining jobs over that time (Richardson and Anderson 2021). Coal mining and coal-fired power plant jobs represented 2 percent of jobs in the county of almost 13,000 residents in 2019 (Richardson and Anderson 2021). Webster County's unemployment rate and poverty rate were above the national average from 2015 to 2019, with a five-year average unemployment rate of 4.9 percent and a five-year average poverty rate of 23 percent (Richardson and Anderson 2021). The residents living within a three-mile radius of Sebree are both disproportionately low-income and disproportionately people of color relative to Kentucky as a whole (Earthjustice 2020).

As shown in Figure 1, the Sebree Generating Station houses three coal ash disposal sites that together contain 24.4 million cubic yards of coal ash. The vast majority of this waste (22.8 million cubic yards) is held in in the Green

FIGURE 1. Site Layout of the Sebree Generating Station



This aerial view of the Sebree Generating Station shows the locations of the plants' landfill and coal ash ponds along the Green River.

IMAGE CREDIT: WWC ENGINEERING.

Landfill, which has received attention from the media and the Kentucky Energy and Environment Cabinet's Division of Waste Management due to contaminated seeps that flowed into the Green River (Van Velzer 2019).[4] The two coal ash ponds, the Green and Reid Impoundments, are unlined, rated as significant hazards (see Table 2, p. 9), and in non-compliance with location restrictions for contact with the aquifer (Earthjustice 2020).

THE UTILITY'S MONITORING AND MITIGATION ACTIONS

Groundwater at the site is polluted by a wide range of contaminants associated with coal ash. It is difficult to identify exactly which parameters exceed standards at the individual monitoring wells at Sebree because Big Rivers has not complied with requirements for monitoring and reporting groundwater quality. To determine whether contamination exists requires a comparison between a monitoring well at the site of potential contamination and an uncontaminated well located nearby. The utility argues that there are no groundwater impacts from the Green coal ash pond; however, the well to which it compares its measurements, located in close proximity to the site of potential contamination, appears likely to itself be contaminated by the coal ash pond. By claiming no contamination, the utility is not required to monitor the Green coal ash pond for toxic CCR contaminants or to evaluate the need for groundwater corrective action.

A similar story plays out for the Green Landfill. Here, the utility has chosen not to consider the uppermost (shallow) groundwater to be "usable." Because only the uppermost usable groundwater is subject to federal monitoring requirements, the utility monitors only next highest groundwater level, within the deeper bedrock below. However, the shallow groundwater is directly underneath the landfill, is highly contaminated, and is the source of contaminated seeps and runoff.

Big Rivers has begun to address some of these issues after media scrutiny of the pollution flowing into the Green River. Kentucky regulators required action to address the source of pollution to the river, which led to the construction of large-scale hydraulic controls and landfill perimeter drains that capture contaminated groundwater and seepage around the landfill. If the landfill is closed with an adequate final cover system and seepage of precipitation into the landfill is mostly eliminated, the groundwater and seep remedy will likely be effective.

The utility plans to close the Green Landfill and both coal ash ponds using cap-in-place between 2022 and 2024. Under its closure plan, it will finish capping the landfill with a low-permeability clay cover, which is likely less effective in preventing seepage of precipitation into the landfill than the protection provided by a composite liner. Groundwater and seepage capture from the landfill will continue and will be treated and discharged to the Green River in line with state permitting. However, capping in place the two coal ash ponds will not address the groundwater contamination issues described above, and is illegal because the CCR Rule prohibits capping in place when coal ash is in contact with groundwater. The contamination from the ponds will continue indefinitely, and without proper monitoring, corrective action will not be required. Lastly, Big Rivers' delay in selecting a remedy and initiating groundwater cleanup for the Reid Impoundment violates the CCR Rule.

BOX 5.

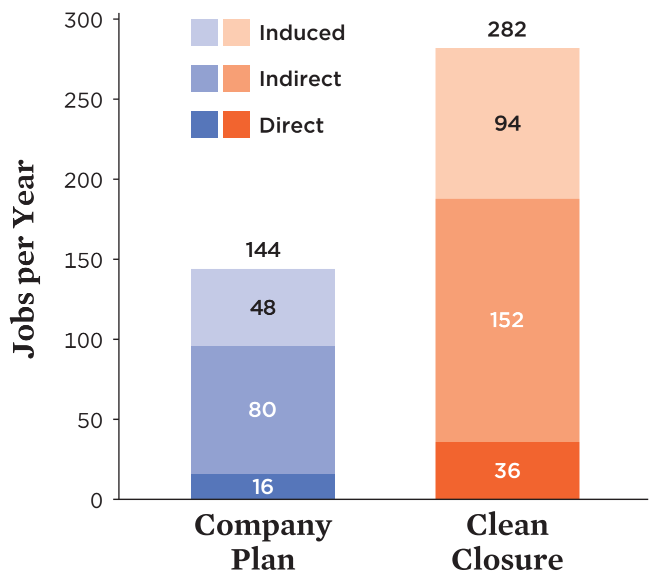
Why Coal Ash Pollution Is an Environmental Justice Issue

Historical and ongoing air pollution from burning coal harms public health, particularly in overburdened and underserved communities—fenceline communities whose residents are often people of color or have low incomes (Johnston and Cushing 2020; Sergi et al. 2020; Thind et al. 2019). These same communities face the detrimental impacts and risks from coal ash disposal and improper cleanup, and, worse, often cope with pollution from other industries, lack access to medical care and legal help, and do not have resources to test groundwater for contamination (Evans and French 2021).

Nationally, 52 percent of communities near coal-fired plants are low-income, and almost 24 percent are disproportionately people of color. The Ohio River Valley states overall have a greater proportion of low-income communities near these plants (at 58 percent), but a lower proportion of communities of color nearby (at nearly 11 percent) (Earthjustice 2020). Both of our case studies are in low-income communities, and the Sebree Generating Station is also located in a community whose residents are disproportionately people of color.

4 The unlined Green Landfill, constructed in 1980, uses a patented technique to stabilize fly ash called Poz-o-Tec™ involving a mixture of lime, flue gas desulfurization scrubber sludge, and coal fly ash. The makers of Poz-o-Tec™ claimed that it produced a non-leachable, stabilized product. But the landfill sits as one example that the process is not capable of preventing leaching and other impacts to groundwater.

FIGURE 2. Total Job Creation per Year During the Construction Phase of Sebree Closure



The bars represent the total number of jobs created (full- and part-time positions) for both cleanup options. The totals include direct jobs created by the project as well as secondary jobs (indirect and induced jobs in the economy).

Note: These numbers exclude operations and maintenance.

ALTERNATIVE CLEAN CLOSURE PLAN

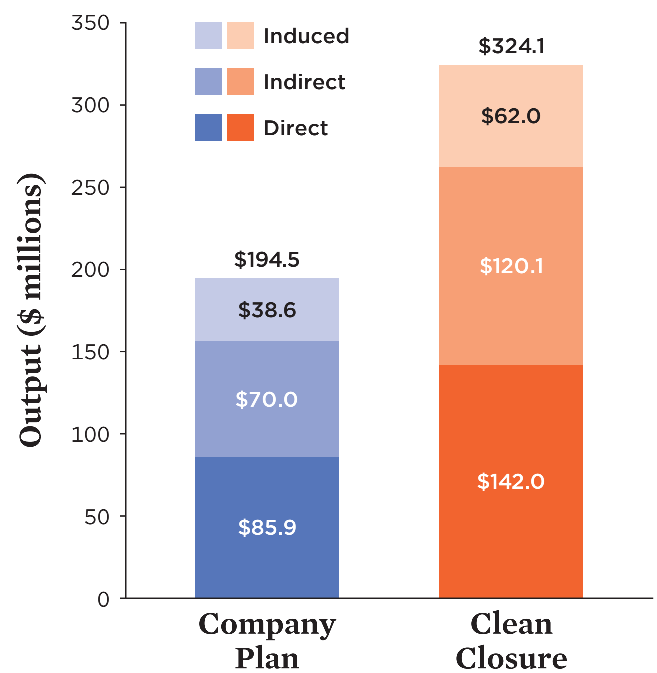
Our proposed alternative clean closure plan includes complete excavation of the Green and Reid coal ash ponds and improvements to the Green Landfill, including the construction of a composite cap that includes a geomembrane that should further reduce infiltration and leachate generation, and a flood control levee to protect the landfill from rising floodwater in the Green River (see Appendix A).

We found that the clean closure plan leads to almost double the economic impact of the utility owner's plan. Total costs over 34 years (four years of construction plus 30 years of continued operations) amount to $145 million for the clean closure option compared to $88 million for the utility's plan; however, the clean closure option leads to significantly more job creation. During the four-year construction phase, clean closure creates an average of 282 jobs per year, compared to 144 for the utility's plan. The impact on Kentucky's economy would be approximately $324 million in output over 34 years, compared to $195 million for the utility's plan. See Figures 2 and 3.

Case Study: J. M. Stuart Station

The J. M. Stuart coal-fired power plant is located in Adams County, Ohio, along the Ohio River in rural Appalachia, home to approximately 27,700 people in 2019. All 3,100 MW of coal-fired generating capacity supplied by the J. M. Stuart plant and the nearby Killen plant went offline in 2018. The closures led to the loss of at least 400 jobs (up to as many as 800, including contractors), hurting the local economy and sending workers scrambling to find new work in a region where the power plants were the largest employers and provided significant municipal tax revenue (MacGillis 2018). The five-year average unemployment rate from 2015 to 2019 was 7.3 percent, and the average poverty rate over the same time was 20.7 percent, both of which are above the national average (Richardson and Anderson 2021). Residents living within a three-mile radius of the plant are disproportionately low-income relative to Ohio as a whole (Earthjustice 2020).

FIGURE 3. Economic Output for Kentucky for the Two Sebree Generating Station Closure Options

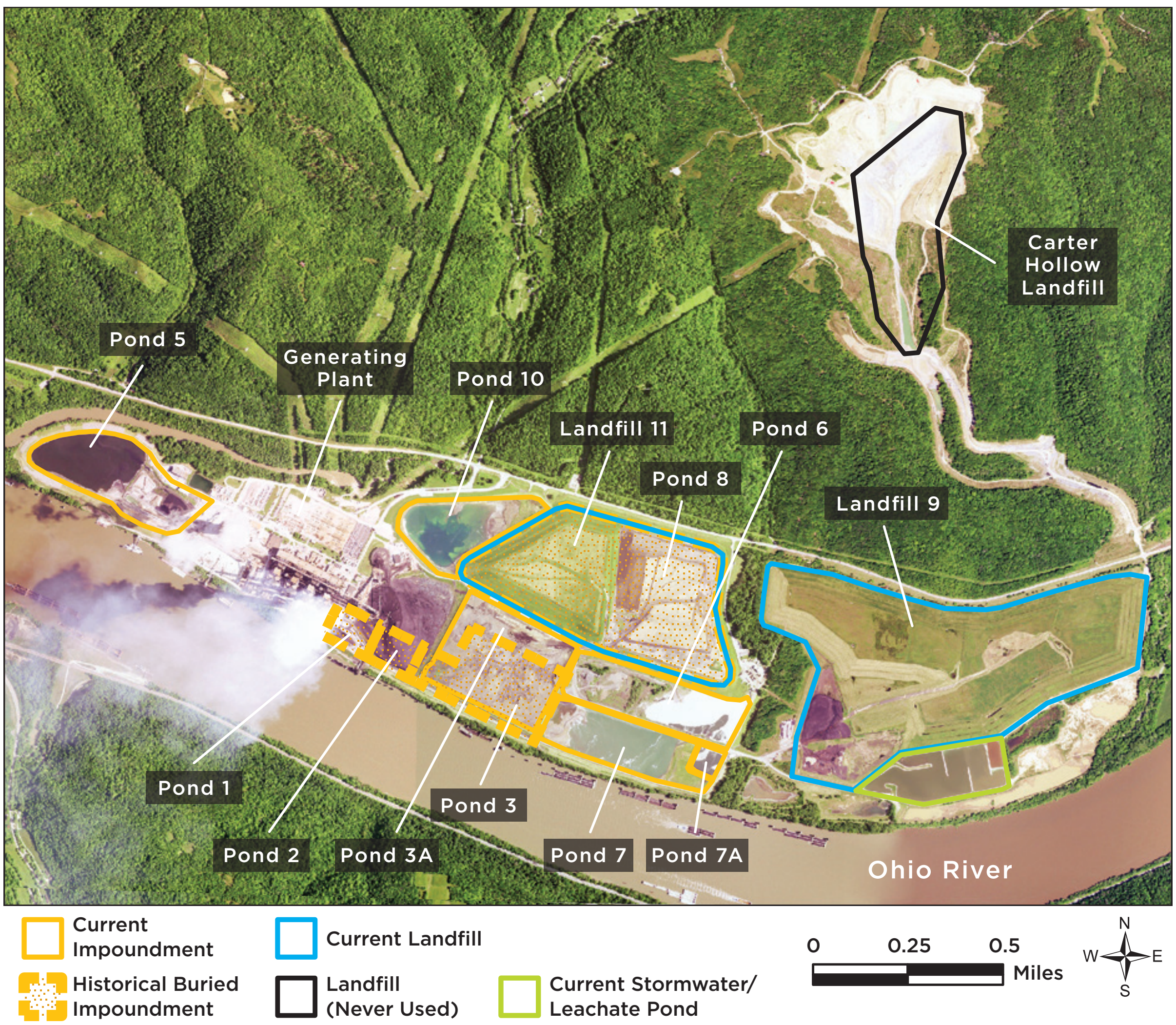


These numbers represent the value of construction, cleanup, and monitoring activities for the four-year construction phase and an additional 30 years of operations and maintenance. Output is an overall measure in dollars of the impact on the economy due to the investments in the project. The clean closure option leads to $324 million in economic output over 34 years, compared to $195 million for the owner's plan.

THE OWNER'S MONITORING AND MITIGATION ACTIONS

At J. M. Stuart, more than 26 million cubic yards of CCR waste (the majority of the waste) is held in two landfills and five remaining coal ash ponds (none of which meet the liner criteria of the federal CCR rule and all of which are rated as significant hazards) (Earthjustice 2020), and four older ponds that are buried under current features at the site (see Figure 4). Three of the ponds are in non-compliance with location restrictions based on their proximity to the aquifer. Groundwater reporting from 2017 indicates contamination from the following substances at levels higher than the maximum allowable to protect public health: arsenic, barium, boron, cobalt, lithium, molybdenum, radium, selenium, and sulfate (Russ, Bernhardt, and Evans 2019). However, non-compliance with monitoring requirements has resulted in critical data gaps on the rate and direction of groundwater flow and uncertainty about the nature and extent of onsite and offsite contamination. The owner assessed groundwater cleanup measures and closure options and originally proposed to cap-in-place all coal ash ponds except one. In 2019, the

FIGURE 4. Site Layout of the J. M. Stuart Station

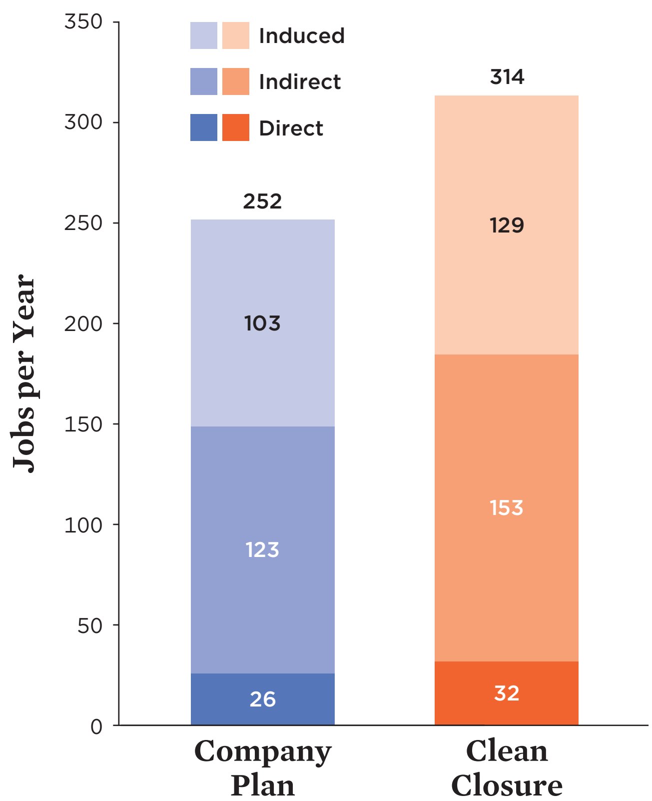


This aerial view of the J.M Stuart Station shows the locations of the plants' landfills and coal ash ponds along the Ohio River.

Note: Ponds 1, 2, 3, and 8 (dotted lines) are buried. Landfill 9 is located in the floodplain of the Ohio River.

IMAGE CREDIT: WWC ENGINEERING.

FIGURE 5. Total Job Creation per Year During the Construction Phase of J. M. Stuart Closure



The bars represent the total number of jobs created (full- and part-time positions) for both cleanup options. The totals include direct jobs created by the project as well as secondary jobs (indirect and induced jobs in the economy).

Note: These numbers exclude operations and maintenance.

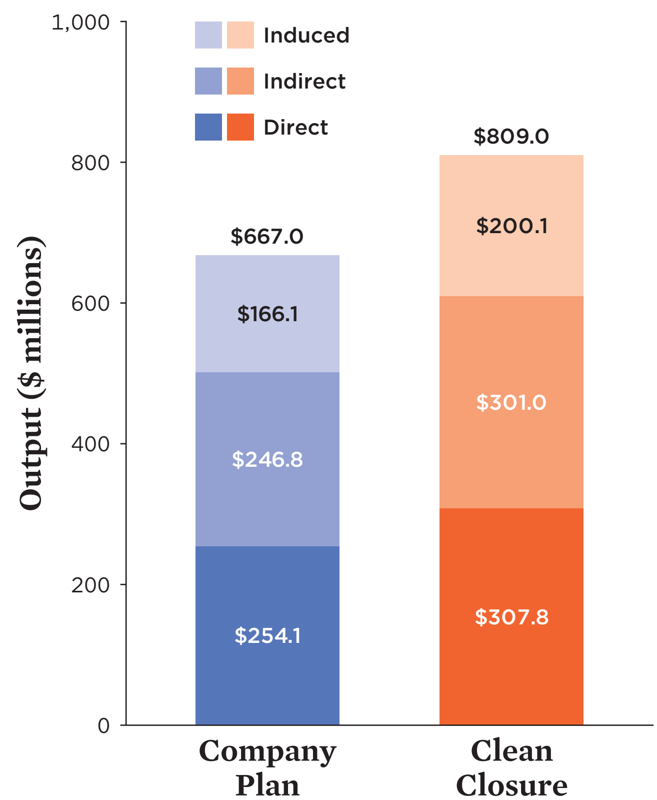
utility sold the site along with the cleanup and closure liability. Although the new owner has not yet finalized overdue cleanup plans, it has indicated a preference for a more comprehensive cleanup and closure, including excavating all five current coal ash ponds, removing only a portion of the buried coal ash from past ponds, and using one of the landfills for disposal. Updated groundwater cleanup assessments by the owner would rely on removal of coal ash along with "monitored natural attenuation" as the groundwater remedy. Pursuant to the CCR Rule, the plant should have initiated groundwater cleanup, but the owner has not yet selected a remedy.

ALTERNATIVE CLEAN CLOSURE PLAN

Our proposed alternative (the clean closure plan) includes excavation of all accessible coal ash (including portions underground) to more fully protect groundwater from contamination, and construction of a flood-control levee to protect the landfill that is located within the floodplain of the Ohio River (see Appendix A).

The economic impacts and job creation are better for the clean closure scenario, although the owner's current closure proposal is relatively robust. We estimate construction costs at $224 million over nine years for the owner's plan compared to $279 million over nine years for the clean closure plan. During the nine-year construction phase, we estimate the clean closure plan would create 314 jobs per year, compared to 252 jobs per year for the owner's plan. The clean closure plan would lead to $809 million in additional economic output in the state over 39 years, compared to $667 million for the utility's plan (see Figures 5 and 6).

FIGURE 6. Economic Output for Ohio for the Two J. M. Stuart Station Closure Options



These numbers represent the value of construction, cleanup, and monitoring activities for the four-year construction phase and an additional 30 years of operations and maintenance. Output is an overall measure in dollars of the impact on the economy due to the investments in the project. The clean closure plan would lead to $809 million in additional economic output in the state, compared to $667 million for the utility's plan.

[CHAPTER 7]

Policy Recommendations

Our analysis of two case studies in Ohio and Kentucky shows that the clean closure of coal ash disposal sites offers superior protection for public health and ecosystems while offering better opportunities for local jobs and associated economic activity. This analysis is consistent with similar evaluations for other sites in previous reports (Evans and French 2021; French 2019). The costs of clean closure are somewhat higher than the costs of owners' cleanup plans, but these costs are justified by the substantial benefits that flow to the local communities. Based on our findings, we offer the following recommendations to federal and state policymakers to ensure effective and complete cleanup of coal ash sites.

- **Hold utilities and owners responsible for the clean closure of coal ash disposal sites.** Cleanup decisions are governed by state regulators, and rate-regulated utilities typically petition state public utility commissions for cost recovery—meaning ratepayers are on the hook to pay for the cleanup. Regulators should consider the long-term economic value of cleanup options to the local community—ratepayers should not bear the costs without reaping the economic value of full cleanup.
- **Robustly fund existing EPA programs that support communities.** EPA programs must be robustly funded to ensure that polluting coal ash disposal sites are identified and cleaned up. These programs include the Brownfields programs, enforcement divisions, and the Corrective Action Program within the Resource Conservation and Recovery Act.
- **Strengthen the enforcement of existing regulations that prohibit cap-in-place closure.** The EPA already has enforcement authority, and it can and should follow the plain language of the 2015 CCR Rule, requiring excavation when coal ash is in contact with groundwater or when coal ash ponds would remain in a floodplain when capped in place. States should also require excavation under state laws and regulations, as is being done in North Carolina, South Carolina, Virginia, and Illinois.
- **Ensure that frontline communities have a voice in cleanup decisions.** Residents and community leaders are often the strongest voices in holding utilities and site owners accountable for cleanup, and robust stakeholder processes are needed to ensure meaningful engagement. For example, the EPA's Technical Assistance Services for Communities Program offers grants that can empower fenceline communities and residents to participate in discussions about closure options. It is a valuable resource that should be robustly funded to drive better local outcomes, and additional programs supporting environmental justice communities may also be brought to bear.
- **Ensure strong labor standards and safety protections for cleanup workers and prioritize dislocated workers in hiring.** Local hiring requirements should be implemented to ensure that dislocated workers have access to cleanup jobs, and prevailing wages should be required to ensure that workers are paid fairly for their work. Because coal ash is toxic, workers must be protected during cleanup activities.

- **Prevent damage to communities and the environment from reuse of coal ash.** The EPA should cease classifying unencapsulated coal ash as an acceptable "beneficial use" and instead treat unencapsulated uses as a form of disposal.
- **Ensure that the extraction of rare earth elements is safe and is coupled with clean disposal of remaining coal ash.** A holistic assessment of risks and benefits should be applied to rare earth element extraction, and extraction programs should be informed by the community and unions.
- **Leverage existing federal programs or consider establishing new financial institutions or grant programs to ensure that all disposal sites nationally are fully cleaned up.** Existing federal programs like the Superfund program could be augmented through polluter-pays fees. Additional public financing may be needed to ensure complete removal of coal ash. These resources are critical for ensuring a fair transition to clean energy for communities and workers formerly dependent on coal-fired electricity production.

When coal plants close, nearby communities face the fallout from lost jobs, lost local tax revenue, and an economic slump. Many of these communities are disproportionately low-income or communities of color and have faced the negative public health impacts of coal-fired electricity generation for decades. When coal ash disposal sites are not sufficiently and safely cleaned up, these communities continue to bear the ongoing costs—lower property values, persistent water pollution, and the risk of catastrophic failures of inadequate containment structures—but receive no economic benefits. Remediation of coal ash ponds and landfills is an essential element of a fair transition to a clean energy economy.

Ensuring that the disposal of coal ash is complete and as safe as possible not only protects human health and the environment but also creates jobs—in the very places where jobs are being lost as coal continues its decline. Comprehensive cleanup increases property values, eliminates pollution, and positions communities to diversify their economies, helping attract new industries that will not inherit the cleanup liability and making these communities places where more people want to live and work.

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Repairing the Damage

Cleaning Up Hazardous Coal Ash Can Create Jobs and Improve the Environment

Comprehensive coal ash cleanup can address longtime inequities, ensure lasting environmental benefits, generate new jobs for displaced workers, and broaden opportunities for community redevelopment.

The burning of coal to produce electricity leaves behind coal ash, one of the largest industrial waste streams in the United States. Coal ash contains more than a dozen toxic substances that threaten human health and ecosystems, and weak regulations and lack of enforcement have allowed the ongoing pollution of our air, soil, and waterways. Disadvantaged communities, where many disposal sites are located, are disproportionately affected. The comprehensive cleanup of coal ash waste ensures long-lasting environmental benefits and addresses environmental justice issues, while driving local job creation in communities facing the closure of coal-fired power plants and improving opportunities for community redevelopment.

www.ucsusa.org/resources/coal-ash-cleanup-benefits
www.ohiorivervalleyinstitute.org/coal-ash-report

Union of Concerned Scientists

Ohio River Valley Institute

The Union of Concerned Scientists puts rigorous, independent science to work to solve our planet's most pressing problems. Joining with people across the country, we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future.

The Ohio River Valley Institute's mission is to support communities in the region working to advance a more prosperous, sustainable, and equitable Appalachia. The Institute produces data-driven research and proposes policies to improve the economic performance and standards of living for the greater Ohio River Valley, with a focus on shared prosperity, clean energy, and equitable democracy.

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