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Accidents Waiting to Happen

Coal Ash Ponds Put Our Waterways at Risk

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Executive Summary

Clean water is essential to America's health and welfare. Our lakes, rivers, streams and creeks provide us with water to drink, add character to our most beautiful natural places, and give us places to fish and swim.

Unfortunately, our waterways are under constant threat of pollution from dangerous facilities located along their banks. These facilities are accidents waiting to happen.

Coal ash ponds store billions of gallons of coal plant ash waste – residual from burning coal that is mixed with water for storage – which is often highly toxic.

Despite numerous instances of catastrophic damage resulting from coal ash spills, these toxic sites continue to put our waterways at risk of spills and accidents.

To protect our waterways from coal ash spills and contamination, policymakers must work to reduce our dependence on coal, while ensuring that coal ash ponds are highly regulated and kept far from the water's edge.

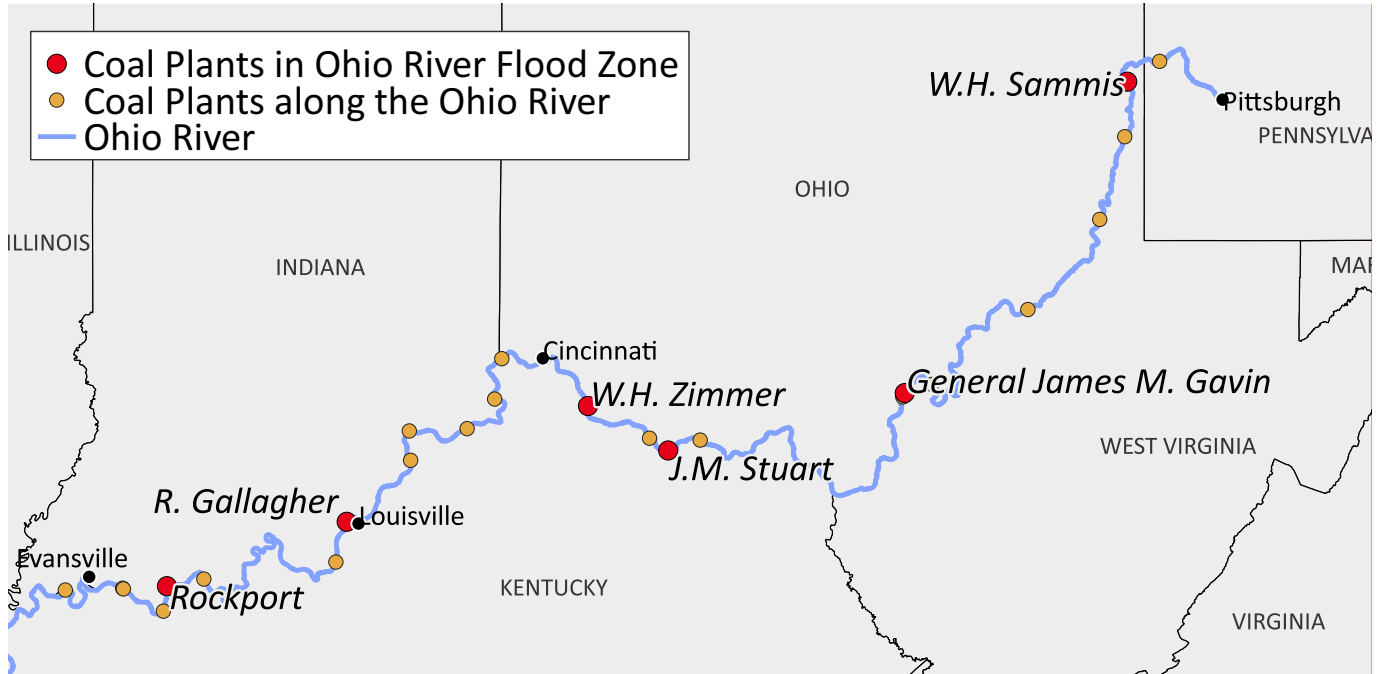
Toxic coal ash ponds pose acute threats to America's major rivers and lakes.

- **Coal ash ponds are inherently risky.**
 - Coal ash is highly toxic, containing pollutants that can damage the circulatory, respiratory and digestive systems and lead to neurological and reproductive problems. In the environment, pollutants in coal ash like selenium can bioaccumulate and cause long-term damage to wildlife populations.
 - As most coal-fired power plants are located next to bodies of water for cooling, coal ash

ponds are often located along rivers and lakes, sometimes separated from waterways by only a thin retaining wall.

- In 2016, coal plants produced 107 million tons of ash, of which nearly half (47 million tons) was left over as waste and not used for other industrial processes.¹
- **Coal ash ponds have a history of devastating spills and groundwater contamination.**
 - As of 2014, the organization EarthJustice had found evidence of 208 cases of coal ash spills and contamination in the U.S.²
 - In 2008, a coal ash pond at the Kingston Plant in Tennessee spilled 5.4 million cubic yards of coal ash waste. Following the spill, sediment samples were devoid of life, and fish were found with elevated levels of toxic selenium and mercury. Even after the completion of a seven-year, billion-dollar cleanup effort, more than 500,000 cubic yards of coal ash remained in the river.³
- **Coal ash ponds present active threats to American waterways.**
 - In the U.S., at least 14 coal plants with on-site coal ash ponds are located within Federal Emergency Management Agency (FEMA) 100-year flood zones, an indicator of proximity to water and potential for damage to waterways. These plants generate 8.4 million tons of coal ash each year. They are also home to at least 36 coal ash ponds, including eight that were found to be in poor condition according to a 2014 U.S. Environmental Protection Agency (EPA) assessment.

Figure ES-1. Coal Plants in 100-Year Flood Zones Along the Ohio River



Six coal plants lie in FEMA 100-year flood zones along the Ohio River. All have coal ash ponds on site, including four with coal ash ponds rated as “significant” hazards by a 2014 EPA assessment. Many more coal plants not in flood zones also sit along the banks of the Ohio River.

- Six coal plants lie in FEMA flood zones along the Ohio River, including five with coal ash ponds that the EPA found pose a “high” or “significant” hazard.

To protect our waterways, all levels of governments should strictly regulate activities that involve the production and storage of coal ash, and ensure that, to the extent those activities occur, they take place far from water. Policymakers should:

- Establish a moratorium on all new or expanded coal ash ponds.
- Close existing coal ash ponds as quickly as is safely possible, putting highest priority on coal ash ponds that pose a threat to waterways and coal ash ponds that are unlined.
 - Coal ash ponds should be excavated and their contents stored in lined, monitored landfills located away from waterways.
- Ensure that, until they are closed, coal ash ponds are tightly regulated to protect against spills and contamination, and that such regulations are diligently enforced. Regulations should ensure that:
 - Coal ash ponds meet strict standards for leak prevention and structural integrity.
 - Surrounding groundwater and waterways are continuously monitored for contamination.
 - Coal ash ponds are frequently checked for leaks and problems with structural integrity.
 - The public is kept informed of any threats to drinking water or waterways.
 - All coal ash pollution is tightly regulated and monitored, whether it flows directly into surface waters or into groundwater.
- Work to rapidly replace coal-fired and other fossil fuel power plants with clean energy sources like solar panels, wind turbines and improvements in energy efficiency.

Introduction

Early in the morning of December 22, 2008, a dike burst at the Kingston Fossil Plant in Harri- man, Tennessee. The dike was the only barrier preventing coal ash – waste produced by burning coal – from spilling out into the Emory River just a few feet away.⁴

When the dike broke, more than 5.4 million cubic yards of ash – 1.1 billion gallons, more than the amount of oil spilled during the BP Deepwater Ho- rizon oil spill – came pouring out, flowing into the Emory and nearby Clinch rivers, damaging 15 homes and rendering three others permanently uninhabit- able.⁵ Coal ash contains dangerous substances like arsenic, lead, chromium, manganese and barium which threaten human health and wildlife.⁶

Video footage revealed large numbers of dead fish washed up on the shore downstream from the spill, despite assurances from the Tennessee Valley Author- ity that contaminants in water samples were within acceptable levels.⁷ The next year, samples from the river were devoid of life.⁸ “It looks like something you would have got off the moon,” Appalachian State University biologist Shea Tuberty told National Public Radio in 2009.⁹

In the years since the spill, its long-term consequences for human health have become clearer. In 2017, nine years after the spill, 17 people who had worked to clean up the spill had died of illness.¹⁰ Their survivors, along with sick workers, filed a lawsuit in 2017 against the company that handled the cleanup, alleging that exposure to coal ash led to illness and death.¹¹



At the Kingston Fossil Plant, Ash Pond C contained decades worth of toxic coal ash waste. When the coal ash pond's dike failed, more than 1 billion gallons of coal ash waste flowed into the nearby Emory and Clinch rivers.¹² Image: U.S. EPA

Storing billions of gallons of toxic coal ash so close to a major river makes little sense. Yet the Kingston Fos- sil Plant is far from alone. Across the country, dozens of similar coal ash ponds lie on the banks of vulner- able waterways. Many of those coal ash ponds pose a similar risk of catastrophic failure.

For these reasons, we need to transition to a world without coal ash ponds. And in the meantime, we need the most stringent safeguards and enforce- ment possible to reduce the risks to waterways and human health.

Deteriorating Coal Ash Ponds Lie on the Banks of Major Rivers

There Are Hundreds of Coal Ash Ponds in the U.S.



Often, coal ash ponds are separated from water by only a thin retaining wall, as was the case for a pond at the Kingston Fossil Plant in Tennessee, the site of one major spill. Credit: Skytruth via Flickr (CC BY-NC-SA 2.0)

Coal is still one of America's main sources of energy for electricity.¹³ In 2015, there were 427 coal-fired power plants in the U.S., and in 2016, coal power plants produced 30.4 percent of U.S. electricity.¹⁴

When coal is burned, it leaves behind waste called coal combustion residuals, more commonly referred to as ash. In 2016, coal plants produced 107 million tons of ash, of which nearly half (47 million tons) was left over as waste and not used for other industrial processes.¹⁵

Approximately one-third of coal plants store coal ash on-site in a surface impoundment, sometimes known as a coal ash pond (other coal plants store ash in dry landfills).¹⁶ In a coal ash pond, which is often dug into the land surrounding the coal plant, ash is mixed with water for storage. The ash eventually settles out of the water and is deposited at the bottom of the pond.¹⁷ The ash can then be collected and recycled in industrial or construction projects. As of 2012, there were at least 735 coal ash ponds, located at 169 different coal plants.¹⁸

Coal Ash Ponds Are Inherently Risky

Coal ash ponds pose a great risk to waterways because coal ash is highly toxic, the ponds are often located near waterways, and coal ash ponds are susceptible to failure.

Coal ash is highly toxic, typically containing arsenic, mercury, selenium, lead, cadmium, boron and bro-

mides.¹⁹ These pollutants can damage the circulatory, respiratory and digestive systems and lead to neurological and reproductive problems. Additionally, arsenic and cadmium are known carcinogens.²⁰ These pollutants can also cause long-term damage to the environment. For example, the chemical element selenium can bioaccumulate, or build up in concentration, as it moves up the aquatic food chain, eventually becoming toxic to animals including fish and aquatic invertebrates.²¹ Selenium is fatal to fish at high doses, and at lower doses it can lead to decreased growth, weight changes, deformities, and reproductive problems.²² Because coal can contain trace amounts of uranium and thorium, coal ash is also often radioactive.²³ In combustion waste, these elements can reach 10 times their original concentration in unburned coal.²⁴

In addition to the toxicity of coal ash, coal ash spills can also physically degrade the environment. Coal ash deposited after a spill can blanket and smother riverbeds and wildlife.²⁵ This physical degradation is particularly damaging to animals that live in the riverbed, including mussels, clams and insects.²⁶

Coal ash ponds are often located on the edges of waterways, in order to access water for filling the pond and because coal plants tend to be located next to water for cooling.²⁷ Sometimes coal ash ponds are separated from waterways by only a thin retaining wall, as was the case for a pond at the Kingston Fossil Plant in Tennessee, the site of one major spill. These ponds are large, averaging over 50 acres in area with depths of 20 feet, containing the equivalent of 130 Olympic swimming pools worth of wastewater.²⁸

Coal ash ponds are susceptible to spills. During floods or heavy rains, uncovered coal ash ponds

can overflow and spill into nearby waterways.²⁹ The biggest spills have occurred because of retaining wall failures.³⁰ The hazard is increased for aging or poorly constructed ponds. In the case of the Kingston Fossil plant spill that resulted from a collapsed ash pond, the pond was more than 20 years old, and the retaining wall had been built on a layer of “slimes” consisting of old ash, river silt and clay runoff.³¹ When the slimes liquified after a heavy rain, the wall collapsed.³²

Many coal ash ponds are deteriorating or in poor condition, according to a February 2014 EPA assessment of 559 coal ash ponds.³³ Of these, one in five were rated in poor condition, and more than half were rated as being in either fair or poor condition. The assessment also included an analysis of the level of hazard presented by each site, based on the potential for economic loss, environmental damage, or damage to infrastructure if the site fails. Of the sites assessed, 81 were found to have a “high” hazard level and another 250 presented “significant” hazard.³⁴

Coal Ash Ponds Are Poorly Regulated

Despite the many risks associated with coal ash ponds, they are poorly regulated.

Coal ash itself is not listed as a hazardous substance by the EPA.³⁵ Rather, it is categorized as “solid waste,” meaning it is regulated similarly to household garbage.³⁶ And while some states regulate coal ash ponds to some degree, for example by requiring pit liners, many unlined pits remain as a result of grandfather clauses.³⁷

Coal Ash Leaks and Spills Are Common

Coal ash ponds frequently spill and leak, often resulting in severe damage to bodies of water. Damage can occur, however, even in the absence of a major spill.

Coal ash sites frequently contaminate groundwater. Reports released by electric utilities in March 2018, revealed evidence of coal ash contamination of groundwater at more than 70 coal ash disposal sites in at least eight states.³⁸ These findings were the result of a U.S. EPA requirement that coal plant owners install test wells to monitor for groundwater pollu-

tion. EarthJustice, in a separate 2014 analysis, found evidence of 208 sites where coal ash ponds and landfills polluted waterways or groundwater, from either single spills or long-term leakage.³⁹

Coal ash groundwater contamination poses a threat to drinking water. In a lawsuit against the Tennessee Valley Authority, the Southern Environmental Law Center (SELC) presented evidence that unlined coal ash pits were hydrologically linked to – and therefore likely responsible for contamination of – the Cumberland River, which provides drinking water to



Coal ash spill into the Dan River in North Carolina, 2014. Photo credit: Waterkeeper Alliance/Rick Dove on Flickr (CC BY-NC 2.0)

one million Tennessee residents.⁴⁰ That study helped convince a federal judge to rule that the Tennessee Valley Authority's storage of coal ash waste in unlined pits violated the Clean Water Act.⁴¹

When major spills do occur, damage to nearby waterways can be catastrophic.

In February 2014, 39,000 tons of coal ash and 27 million gallons of coal ash pond water spilled into the Dan River in Eden, North Carolina, after a pipe burst at Duke Energy's Dan River Steam Station, located at the river's edge.⁴² Although the plant had recently transitioned from coal to natural gas, the plant still stored more than one million tons of coal ash waste in ponds that were separated from the river by an earthen dam.⁴³ The coal ash contained arsenic, cadmium, chromium, mercury, selenium and other toxic substances.⁴⁴ The Dan River is home to two endangered species (the Roanoke logperch and the James spiny-mussel), is used for livestock watering and crop irrigation, and is a source of drinking water for residents in North Carolina and Virginia. In the wake of the spill, dead turtles were found onshore.⁴⁵ In an interview with the local Fox affiliate, Jenny Douglas of the Dan River Basin Association said "[t]urtles should be hibernating this time of year. It's cold. They hibernate down in the mud. The fact that they're crawling up on the bank and dying, even if it's not in mass numbers... It's highly unusual."⁴⁶ After the spill, indications of coal ash contamination were also detected in nearby wells.⁴⁷

After the previously mentioned Kingston Fossil Plant spill (see page 3), river water near the site tested positive for mercury and arsenic, and contained levels of lead and thallium in excess of safety limits.⁴⁸ Elevated levels of selenium and mercury were found in several fish species near the site, creating the potential for long-term bioaccumulation and ecosystem damage.⁴⁹ Two years after the spill, only half of the spilled coal ash had been removed.⁵⁰ By 2017, nine years after the spill, 17 people who had worked to clean up the spill had died of illness.⁵¹ Their survivors, along with sick workers, filed a lawsuit in 2017 against the company that handled the cleanup, alleging that exposure to coal ash led to illness and death.⁵² Following the completion of a seven-year, billion-dollar cleanup effort, more than 500,000 cubic yards of coal ash remained in the river.⁵³



Overhead view of ash ponds at the Dan River Steam Station. Imagery ©2018 Google

Threat Spotlight: Coal Ash Ponds in Flood Zones

An analysis of coal plant location data finds that at least 14 U.S. coal plants with on-site coal ash ponds lie in FEMA 100-year flood zones. While hundreds of coal plant sites across the country likely put water at risk, those with coal ash ponds located in flood zones may pose an elevated threat, as being in a flood zone indicates both proximity to water and risk of flooding. (The estimate of coal plants in flood zones is likely conservative. See Methodology for details.)

These plants are home to at least 36 coal ash ponds and generate 8.4 million tons of coal ash each year.⁵⁴ Of the ponds that were included in a 2016 EPA survey, nine ponds were found to be in “fair” condition and eight in “poor” condition. Only seven of the ponds were found to be in “satisfactory” condition. Twelve of the ponds represented “significant” hazard potential in case of failure, indicating that impoundment failure would cause economic loss, environmental damage, or damage to infrastructure.⁵⁵

Figure 1. 14 U.S. Coal Plants with Coal Ash Ponds Lie in 100-Year Flood Zones

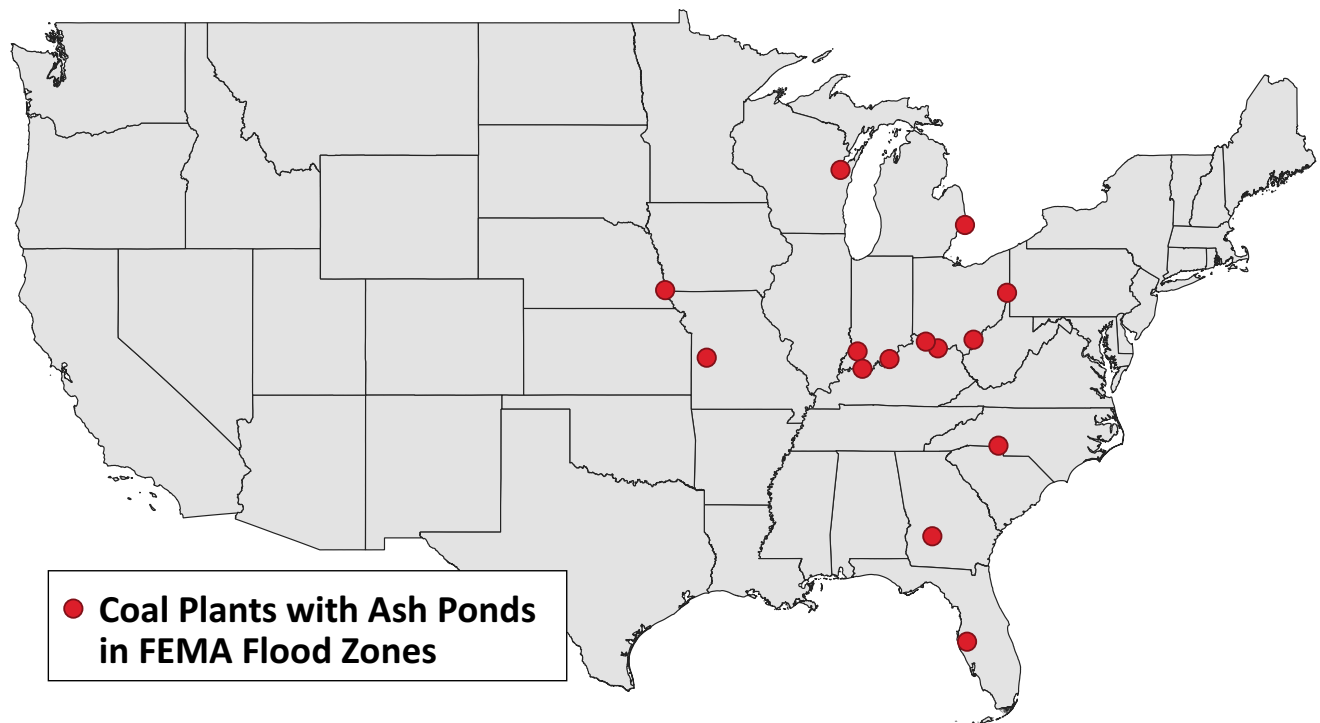
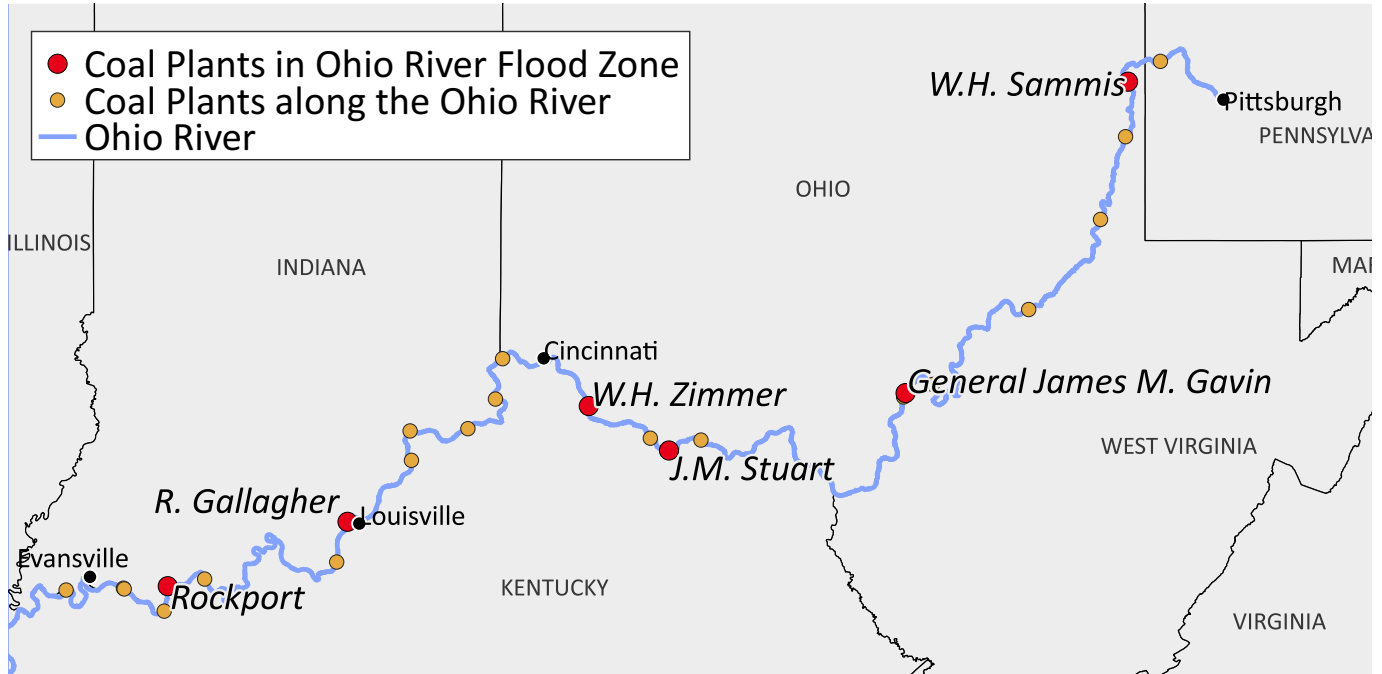


Figure 2. Coal Plants in 100-Year Flood Zones Along the Ohio River



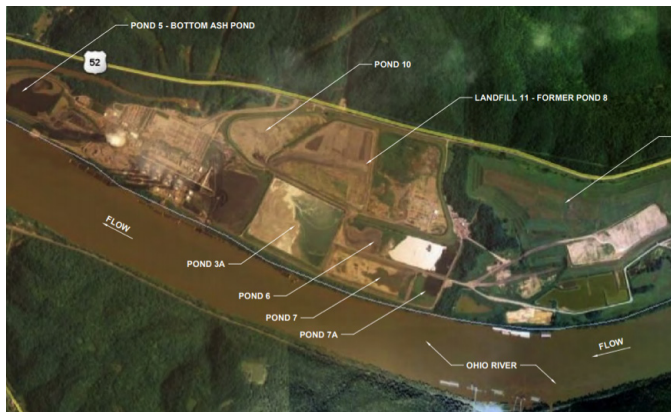
Six coal plants lie in FEMA 100-year flood zones along the Ohio River. All have coal ash ponds on site, including four with coal ash ponds rated as “significant” hazards by a 2014 EPA assessment. Many more coal plants not in flood zones also sit along the banks of the Ohio River.

Many of these plants sit along the Ohio River. The Ohio River runs 981 miles, beginning in Pittsburgh, traversing the Appalachian coal region and providing the borders of Ohio, West Virginia, Indiana, and Kentucky until it flows into the Mississippi River in Illinois. Along the way, it supplies drinking water for more than 3 million people.⁵⁶ It also sustains hundreds of animal species, including 47 species of mussel (eight of which are endangered) and nearly 200 species of birds, and supports vibrant and unique riparian forests, including those of the Ohio River Islands National Wildlife Refuge.⁵⁷ The Ohio River also hosts more than 20 coal plants on its shores, which use the river’s water for cooling – and to fill coal ash ponds.

Of the 14 coal plants with ash ponds in flood zones nationwide, six are located along the Ohio River – four in Ohio and two in Indiana. Five of them – with a total of 11 coal ash ponds – were included in the EPA’s coal ash assessment report. Of those 11 ponds, the EPA found that only three were in “satisfactory” condition, and four posed either a “high” or “significant” hazard. The J.M. Stuart Station in Aberdeen, Ohio, had five coal ash ponds assessed, three of which were in “poor” condition. An analysis from 2009 showed that J.M. Stuart ranked 11th in the country for coal ash releases to surface impoundments, with 2.5 million pounds of coal ash stored in ponds.⁵⁸

Table 1. Coal Ash Ponds in Ohio River Flood Zones⁵⁹

Plant Name	Location	Number of Coal Ash Ponds	Condition of Ash Ponds by Number of Ponds	Potential Hazard from Spill ⁶⁰
General James Gavin Power Plant	General James Gavin Power Plant	2	Fair - 2	High
Rockport Power Station	Rockport Power Station	1	Satisfactory - 1	Low
J.M. Stuart Station	J.M. Stuart Station	5	Satisfactory – 1 Fair – 1 Poor – 3	Significant
R. Gallagher Power Station	R. Gallagher Power Station	2	Fair -2	Significant
W.H. Zimmer Generating Station	W.H. Zimmer Generating Station	1	Satisfactory -1	Significant
W.H. Sammis Coal Plant	W.H. Sammis Coal Plant	2	(Not included in EPA assessment)	(Not included in EPA assessment)



EPA-labeled aerial imagery of the J.M. Stuart coal plant on the Ohio River. Only one of the five coal ash ponds assessed was in “satisfactory” condition.⁶¹ Image: EPA



Sluice lines entering “Pond 5” at the J.M. Stuart Station, located in an Ohio River flood zone. Pond 5 was found by an EPA assessment to be in “Poor” condition, and to pose a “Significant” hazard to the surrounding area. Image: EPA

Conclusion and Policy Recommendations

America's lakes, rivers and streams are an essential part of our country's landscape, and we depend on them for drinking water, recreation and sustaining wildlife. Coal ash ponds are often located on the banks of critical waterways. They are poorly regulated and have a history of suffering catastrophic failures that have done immense damage to the environment and to communities. Today, many ponds – including those in poor condition – continue to be sited in areas where they pose an immense risk to our most special places.

Fortunately, policymakers can take action to protect our waterways. Doing so requires first acknowledging that burning coal is no longer necessary and is no longer worth its consequences.

To protect water from coal ash spills and contamination, policymakers should:

- Establish a moratorium on all new or expanded coal ash ponds.
- Close existing coal ash ponds as quickly as is safely possible, putting highest priority on coal ash ponds that pose a threat to waterways and coal ash ponds that are unlined.
 - Coal ash ponds should be excavated and their contents stored in lined, monitored landfills located away from waterways.
- Ensure that, until they are closed, coal ash ponds are tightly regulated to protect against spills and contamination, and that such regulations are diligently enforced. Regulations should ensure that:
 - Coal ash ponds meet strict standards for leak prevention and structural integrity.
 - Surrounding groundwater and waterways are continuously monitored for contamination.
 - Coal ash ponds are frequently checked for leaks and problems with structural integrity.
 - The public is kept informed of any threats to drinking water or waterways.
 - All coal ash pollution is tightly regulated and monitored, whether it flows directly into surface waters or into groundwater.
- Work to rapidly replace coal-fired and other fossil fuel power plants with clean energy sources like solar panels, wind turbines and improvements in energy efficiency.

Methodology

To find coal plants in flood zones, coal plant locations were overlaid with flood map geographic data from the Federal Emergency Management Agency. Coal plant locations were downloaded from the U.S. Energy Information Administration's mapping data page.⁶² Coal plants assessed include all electricity generating facilities, including industrial power facilities, with a capacity of more than one megawatt.⁶³ Plants do not include coal-burning facilities do not produce electricity (for example, coal furnaces that produce heat for industry). National flood zone data were downloaded from

FEMA's data server.⁶⁴ Only flood zones with a code corresponding to 100-year flood zones were used in the analysis.

The estimate of coal plants in flood zones is likely conservative. Coal plant location data were only available as single points representing each plant property. Many coal plants are both located near flood zones and also cover a large area (approximately 19 acres per megawatt, according to the Department of Energy).⁶⁵ Therefore, some plants that this analysis determined were outside the limits of a flood zone may in fact overlap with a flood zone.

Appendix

Table A-1. Coal Plants with Ash Ponds in FEMA 100-Year Flood Zones⁶⁶

Plant Name	City	State	Number of Coal Ash Ponds	Annual Tons of Coal Ash Generated
Big Bend	Apollo Beach	Florida	8	1,307,400
Crisp Plant*	Warwick	Georgia	1	N/A
Rockport	Rockport	Indiana	1	580,600
R. Gallagher	New Albany	Indiana	2	17,400
AES Petersburg	Petersburg	Indiana	4	1,040,700
Belle River	China Twp.	Michigan	1	181,000
Montrose	Clinton	Missouri	3	57,900
Nebraska City	Nebraska City	Nebraska	2	420,400
G.G. Allen	Belmont	North Carolina	3	169,500
W.H. Zimmer	Moscow	Ohio	1	855,800
General James M. Gavin	Cheshire	Ohio	2	1,751,900
J.M. Stuart	Aberdeen	Ohio	5	1,639,100
W.H. Sammis	Stratton	Ohio	2	338,700
Pulliam	Green Bay	Wisconsin	1	32,000

* The Crisp Plant no longer burns coal and began closing and excavating its coal ash pond in 2017. ⁶⁷

Notes

- 1 American Coal Ash Association, *2016 Coal Combustion Product (CCP) Production & Use Survey Report*, archived at <https://web.archive.org/web/20171228210104/https://www.aaa-usa.org/Portals/9/Files/PDFs/2016-Survey-Results.pdf> , 28 December 2017.
- 2 EarthJustice, *Coal Ash Contaminated Sites & Hazard Dams*, accessed at <https://earthjustice.org/features/map-coal-ash>, 28 December 2017.
- 3 Carol Eimers, Tennessee Valley Authority, *Completion Report for TVA Kingston Fossil Plant Fly Ash*, 22 April 2015, archived at <https://web.archive.org/web/20180316203434/https://semspub.epa.gov/work/04/11015838.pdf>.
- 4 Shaila Dewan, "At Plant in Coal Ash Spill, Toxic Deposits by the Ton", *The New York Times*, 29 December 2008.
- 5 Samira J. Simone, "Tennessee Sludge Spill Runs Over Homes, Water," *CNN*, 24 December 2008.
- 6 NASA Earth Observatory, *Coal Ash Spill, Tennessee*, archived at <https://web.archive.org/web/20171228200542/https://earthobservatory.nasa.gov/NaturalHazards/view.php?id=36352>, 28 December 2017. 2
- 7 Shaila Dewan, "Coal Ash Spill Revives Issue of Its Hazards," *The New York Times*, 24 December 2008.
- 8 Adam Hochberg, "Tenn. Coal Ash Spill Devastates Recovering River," *NPR*, 10 January 2009.
- 9 Ibid.
- 10 Jamie Satterfield, "DA: Treatment of Kingston Coal Ash Workers Needs State, Federal Probe," *Knox News*, 28 July 2017.
- 11 Ibid.
- 12 U.S. Environmental Protection Agency, "Coal Combustion Residue Impoundment Round 11 – Dam Assessment Report: Kingston Fossil Plant," September 2012.
- 13 Charles D. Kolstad, Stanford Institute for Economic Policy Research, *What is Killing the US Coal Industry?*, March 2017.
- 14 U.S. Energy Information Administration, *Count of Electric Power Industry Power Plants, by Sector, by Predominant Energy Sources within Plant, 20016 through 2016*, archived at https://web.archive.org/web/20171228204310/https://www.eia.gov/electricity/annual/html/epa_04_01.html, 28 December 2017; U.S. Energy Information Administration, *Frequently Asked Questions*, archived at <https://web.archive.org/web/20171228205859/https://www.eia.gov/tools/faqs/faq.php?id=427&t=3>, 28 December 2017.
- 15 American Coal Ash Association, *2016 Coal Combustion Product (CCP) Production & Use Survey Report*, archived at <https://web.archive.org/web/20171228210104/https://www.aaa-usa.org/Portals/9/Files/PDFs/2016-Survey-Results.pdf> , 28 December 2017.
- 16 Federal Register, *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities* (EPA rule), 17 April 2015.

17 University of Kentucky Center for Applied Energy Research, *Coal Combustion By-Products [sic]*, archived at <https://web.archive.org/web/20171228211553/http://www.caer.uky.edu/kyasheducation/whathappens.shtml>, 28 December 2017.

18 Federal Register, *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities - 80 FR 21301* (EPA rule), 17 April 2015.

19 Jennifer Duggan and Craig Segall, EarthJustice and Environmental Integrity Project, *Closing the Floodgates*, no date given.

20 U.S. Environmental Protection Agency, *Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category - 3-22*, September 2015.

21 Ibid.

22 Ibid.

23 Mara Hvistendahl, "Coal Ash Is More Radioactive Than Nuclear Waste," *Scientific American*, 13 December 2007.

24 Ibid.

25 A. Dennis Lemly, "Damage Cost of the Dan River Coal Ash Spill," *Environmental Pollution*, 197(2015):55-61, doi 10.1016, 30 November 2014.

26 Ibid.

27 Shaila Dewan, "Hundreds of Coal Ash Dumps Lack Regulation," *The New York Times*, 6 January 2009.

28 U.S. Environmental Protection Agency, *Frequent Questions about the Coal Ash Disposal Rule*, archived at <https://web.archive.org/web/20171228213108/https://www.epa.gov/coalash/frequent-questions-about-coal-ash-disposal-rule>, 28 December 2017.

29 Samantha Page, "Watchdog Group Uncovers a Coal Ash Spill After Hurricane Flooding," *ThinkProgress*, 21 October 2016. /

30 Shaila Dewan, "Tennessee Ash Flood Larger than Initial Estimate", *The New York Times*, 26 December 2008.

31 Ibid.

32 Ibid.

33 U.S. Environmental Protection Agency, *Coal Combustion Residuals Impoundment Assessment Reports*, archived at <https://web.archive.org/web/20171228214804/https://archive.epa.gov/epawaste/nonhaz/industrial/special/fossil/web/html/index-4.html>, 24 June 2016; United States Commission on Civil Rights, *Environmental Justice: Examining the Environmental Protection Agency's Compliance and Enforcement of Title VI and Executive Order 12,898*, September 2016; nationwide there are more than 1,400 coal ash ponds and landfills in 47 states: EarthJustice, *Coal Ash Contaminated Sites & Hazard Dams*, accessed at <https://earthjustice.org/features/map-coal-ash>, 28 December 2017.

34 EarthJustice, *Coal Ash Contaminated Sites & Hazard Dams*, accessed at <https://earthjustice.org/features/map-coal-ash>, 28 December 2017.

35 U.S. Environmental Protection Agency, *Frequent Questions about the Coal Ash Disposal Rule*, archived at <https://web.archive.org/web/20171228213108/https://www.epa.gov/coalash/frequent-questions-about-coal-ash-disposal-rule>, 28 December 2017.

36 Emily Atkin, "EPA Will Not Declare Coal Ash A Hazardous Waste," *ThinkProgress*, 19 December 2014.

37 See note 27.

38 72 sites were revealed just by Duke Energy and American Electric Power: Matthew Brown and Sarah Rankin, "US Utilities Find Water Pollution at Coal Ash Dumps," *Associated Press*, 2 March 2018.

39 EarthJustice, *Coal Ash Contaminated Sites & Hazard Dams*, accessed at <https://earthjustice.org/features/map-coal-ash>, 28 December 2017.

40 The judge in the case ruled that “There is substantial evidence that the surrounding groundwater is hydrologically connected to the Cumberland River and that some of that groundwater contains coal ash pollutants in significant levels.” Findings Of Fact & Conclusions Of Law, *United States District Court Middle District Of Tennessee Nashville Division*, 4 August 2017; Emily Atkin, “Is Coal Waste Leaching Into America’s Drinking Water?,” *New Republic*, 12 March 2018; Southern Environmental Law Center, *Judge Orders TVA To Excavate And Move Its Coal Ash From Leaking* (press release), 4 August 2017, archived at <https://web.archive.org/web/20180403205043/https://www.southernenvironment.org/news-and-press/press-releases/victory-for-clean-water-and-communities-in-coal-ash-law-suit-against-tva>.

41 Ibid.

42 U.S. Department of the Interior, *Dan River Coal Ash Spill*, accessed at https://www.cerc.usgs.gov/orda_docs/CaseDetails?ID=984, 28 December 2017; U.S. Environmental Protection Agency, *Duke Energy Coal Ash Spill in Eden NC: History and Response Timeline*, accessed at <https://www.epa.gov/dukeenergy-coalash/history-and-response-timeline>, 28 December 2017; distance from water: Data from Google Maps, accessed at <https://www.google.com/maps/place/Dan+River+Steam+Station/@36.4915111,-79.7217537,17z/data=!3m1!4b1!4m5!3m4!1s0x8852c0152f81ec7b:0x6a917c4c533c58a8!8m2!3d36.4915111!4d-79.7195704>.

43 Margaret Talbot, “Dirty Politics,” *The New Yorker*, 2 April 2018.

44 Craig Jarvis, “Dan River Coal Ash Spill Damage Could Top \$300 Million,” *The News & Observer*, 26 November 2014.

45 U.S. Fish and Wildlife Service, *U.S. Fish and Wildlife Service Responds to Coal Ash Release to the Dan River in North Carolina and Virginia* (factsheet), no date given; Carter Coyle, “Dead Turtles Found on Dan River Bank After Coal Ash Spill,” *Fox8*, 17 February 2014.

46 Ibid.

47 David Hurst, “February Makes 3rd Anniversary of Dan River Coal Ash Spill,” *CBS South Carolina*, 2 February 2017.

48 See note 30.

49 Gideon Bartove et al., “Environmental Impacts of the Tennessee Valley Authority Kingston Coal Ash Spill. 1. Source Apportionment Using Mercury Stable Isotopes,” *Environmental Science & Technology*, [no page number], doi/10.1021, 16 November 2012; Scott Barker, “Fly Ash Spill Study Finds Selenium in Fish,” *Knoxville News Sentinel*, 19 May 2009.

50 Pam Sohn, “2 Years Later, Effects from Kingston Ash Spill Being Felt,” *Times Free Press*, 22 December 2010.

51 Jamie Satterfield, “DA: Treatment of Kingston Coal Ash Workers Needs State, Federal Probe,” *Knox News*, 28 July 2017.

52 Ibid.

53 Carol Eimers, Tennessee Valley Authority, *Completion Report for TVA Kingston Fossil Plant Fly Ash*, 22 April 2015, archived at <https://web.archive.org/web/20180316203434/https://semspub.epa.gov/work/04/11015838.pdf>.

54 The number of coal ponds at each plant is based on two sources; when the number of ponds reported differed, the larger number was used; coal ash generated at each plant is sourced from the Regulatory Impact Analysis: U.S. Environmental Protection Agency, *Coal Combustion Residuals Impoundment Assessment Reports*, archived at <https://web.archive.org/web/20171228214804/https://archive.epa.gov/epawaste/nonhaz/industrial/special/fossil/web/html/index-4.html>, 24 June 2016; U.S. Environmental Protection Agency, *Regulatory Impact Analysis: EPA’s 2015 RCRA Final Rule Regulating Coal Combustion Residual (CCR) Landfills and Surface Impoundments At Coal-Fired Electric Utility Power Plants – Appendix H-3*, December 2014.

55 U.S. Environmental Protection Agency, *Coal Combustion Residuals Impoundment Assessment Reports*, archived at <https://web.archive.org/web/20171228214804/https://archive.epa.gov/epawaste/nonhaz/industrial/special/fossil/web/html/index-4.html>, 24 June 2016.

56 Ohio River Foundation, *Ohio River Factsheet (factsheet)*, accessed at http://www.ohioriverfdn.org/about_the_river/documents/ohioriverfactsversion2.pdf.

57 U.S. Fish and Wildlife Service, *Ohio River Islands: Life and Habitat*, accessed at https://www.fws.gov/refuge/ohio_river_islands/wildlife_and_habitat/index.html.

58 Sue Sturgis, "Coal's Ticking Timebomb: Could Disaster Strike a Coal Ash Dump Near You?", *Facing South*, 5 January 2009.

59 For coal ash ponds by plant other than Sammis, see note 55; Sammis plant: Geosyntec, *History of Construction: W.H. Sammis Coal Plant North and South Ponds, Stratton, Ohio*, no date given.

60 Hazard level given is for highest hazard of any of the ponds assessed for that coal plant.

61 U.S. Environmental Protection Agency, *Assessment of Dam Safety Coal Combustion Surface Impoundments (Task 3) Final Report*, 26 March 2010.

62 U.S. Energy Information Administration, *Layer Information for Interactive State Maps*, accessed at <https://www.eia.gov> on 24 August 2017.

63 One generating facility located in a flood zone – the coal plant at the Morton Salt industrial facility in Rittman, Ohio – was not included in the final count, because U.S. Energy Information Administration data indicates that the plant no longer operates, and no ponds were listed in the EPA coal ash survey cited in note 54: U.S. Energy Information Administration, *Form EIA-923 for January 2018*, available at <https://www.eia.gov/electricity/data/eia923/>. Another plant that no longer burns coal – the Crisp Plant in Warwick, Georgia – was included, because the site did have a coal ash pond included in the EPA survey, although news reports indicate the pond is in the process of being closed and excavated: Crisp County Power Commission, *Environment – CCR Rule Compliance Data and Information*, archived at <https://web.archive.org/web/20180419204615/> <https://crispcountypower.com/ccr-rule>.

64 Federal Emergency Management Agency, *FEMA Cloud GIS Infrastructure Production Site - National Flood Hazard Layer*, downloaded from https://data.femadata.com/FIMA/Risk_MAP/NFHL/ on 12 December 2017.

65 U.S. Department of Energy, *Geothermal Power Plants — Minimizing Land Use and Impact*, archived at <http://web.archive.org/web/20161102015155/http://energy.gov:80/eere/geothermal/geothermal-power-plants-minimizing-land-use-and-impact>.

66 Flood zone location calculation: see Methodology; coal ash pond count: see note 54; annual coal ash produced: U.S. Environmental Protection Agency, *Regulatory Impact Analysis: EPA's 2015 RCRA Final Rule Regulating Coal Combustion Residual (CCR) Landfills and Surface Impoundments At Coal-Fired Electric Utility Power Plants – Appendix A*, December 2014.

67 Crisp County Power Commission, *Environment – CCR Rule Compliance Data and Information*, archived at <https://web.archive.org/web/20180419204615/https://crispcountypower.com/ccr-rule>.