Coal's Poisonous Legacy

Groundwater Contaminated by Coal Ash Across the U.S.

ENVIRONMENTAL INTEGRITY PROJECT

MARCH 4, 2019
Revised: July 11, 2019

ACKNOWLEDGEMENTS

Written and researched by Abel Russ and Courtney Bernhardt of the Environmental Integrity Project (EIP) and Lisa Evans of Earthjustice. Data gathering, analysis, and mapping by Keene Kelderman, Mariah Lamm, and Courtney Bernhardt (EIP) and Andrew Rehn of Prairie Rivers Network. Compliance monitoring assistance from Flora Champenois and Henry Weaver (Earthjustice). Data gathering assistance from Kira Burkhart, Flora Ji, Ben Kunstman, Camden Marcucci, Sammie McCormick, Hayley Roy, and Namratha Sivakumar (EIP); Akriti Bhargava, Katherine Clements, Tess Fields, Lauren Hogrewe, Harry Libarle, and Claire Pfitzinger (Sierra Club); Ricki Draper (Appalachian Voices); Susan Lee (NRDC); and Roland Rivera. Graphics and editing by Ari Phillips, with editing assistance by Lisa Evans, Earthjustice. Made possible with help from Earthjustice and the Sierra Club.

ENVIRONMENTAL INTEGRITY PROJECT

The Environmental Integrity Project (environmentalintegrity.org) is a nonprofit, nonpartisan organization that empowers communities and protects public health and the environment by investigating polluters, holding them accountable under the law, and strengthening public policy.

CONTACT:

For questions about this report, please contact: Tom Pelton, Environmental Integrity Project, (202) 888-2703 or tpelton@environmentalintegrity.org

PHOTO CREDITS: Cover photo and additional photos by J Henry Fair/SouthWings. Cover photo shows coal ash at the Cross Generating coal-fired power plant near Pineville, SC.

Other photos by US Fish and Wildlife Service.

Coal's Poisonous Legacy

Executive Summary

Coal contains a long list of toxic chemicals, including arsenic, radium, and other carcinogens, several metals that can impair children's developing brains, and multiple chemicals that are toxic to aquatic life. When coal is burned to produce electricity, these toxic chemicals become concentrated in the waste product – coal ash.

Coal-fired power plants in the U.S. produce around 100 million tons of coal ash every year. For much of the last century, power companies dumped this waste into unlined landfills and waste ponds, where the lack of a barrier between the coal ash and groundwater left them vulnerable to leaks and contamination of underground water supplies. Only in recent years has the true scope of coal ash's threat come into public view, spurred by several high-profile structural failures and spills. Most notably, a 2008 coal ash spill in Kingston, Tennessee, led to the release of over five million cubic yards of coal ash, destroying dozens of homes and allegedly contributing to the illness or deaths of scores of cleanup workers. Yet the most enduring legacy of coal ash disposal will undoubtedly be groundwater pollution.

Following the Kingston disaster and lawsuits against EPA by Earthjustice, the Environmental Integrity Project, and allied organizations, EPA in 2015 finalized the first federal regulation for the disposal of coal ash – often called the "Coal Ash Rule." Among other things, the Coal Ash Rule established groundwater monitoring requirements for coal ash dumps, and it required power companies to make the data available to the public starting in March 2018.

In 2015, EPA finalized the first federal regulation for the disposal of coal ash – often called the "Coal Ash Rule."

The nonprofit Environmental Integrity Project (EIP), in collaboration with Earthjustice, the Sierra Club, Prairie Rivers Network, and other organizations, obtained and analyzed all of the groundwater monitoring data that power companies posted on their websites in 2018. The data cover 265 coal plants or offsite coal ash disposal areas, including over 550 individual coal ash ponds and landfills that are monitored by over 4,600 groundwater monitoring wells. This represents roughly three quarters of the coal power plants across the U.S. The rest of the coal plants have not posted groundwater data either because they closed their ash dumps before the Coal Ash Rule took effect in 2015, or because they were eligible for an extension or exemption.

The Allen Steam Station, owned and operated by Duke Energy, is located in Belmont, NC, on the banks of the Catawba River (Lake Wylie). The coal ash dumps were built beneath the water table and are leaking toxic contaminants.

After comparing monitoring data to health-based EPA standards and advisories, our analysis confirmed that groundwater beneath virtually all coal plants is contaminated:

- 91 percent of coal plants have unsafe levels of one or more coal ash constituents in groundwater, even after we set aside contamination that may naturally occurring or coming from other sources.
- The groundwater at a majority of coal plants (52 percent) has unsafe levels of arsenic, which is known to cause multiple types of cancer. Arsenic is also a neurotoxin, and, much like lead, can impair the brains of developing children.
- The majority of coal plants (60 percent) also have unsafe levels of lithium, a chemical associated with multiple health risks, including neurological damage.
- The contamination at a given site typically involves multiple chemicals. The majority of coal plants have unsafe levels of at least four toxic constituents of coal ash.

The levels of contamination are often dramatically elevated. This report identifies the 10 sites with the worst contamination in the country. They are:

1) Texas: An hour south of San Antonio, beside the San Miguel Power Plant, the groundwater beneath a family ranch is contaminated with at least 12 pollutants leaking from coal ash dumps, including cadmium (a probable carcinogen, according to EPA) and lithium (which can cause nerve damage) at concentrations more than 100 times above safe levels.
2) North Carolina: At Duke Energy's Allen Steam Station in Belmont, the coal ash dumps were built beneath the water table and are leaking cobalt (which causes thyroid damage) into groundwater at concentrations more than 500 times above safe levels, along with unsafe levels of eight other pollutants.
3) Wyoming: 180 miles west of Laramie, at PacifiCorp's Jim Bridger power plant, the

groundwater has levels of lithium and selenium (which can be toxic to humans and lethal at low concentrations to fish) that exceed safe levels by more than 100 fold.

4) Wyoming: At the Naughton power plant in southwest Wyoming, the groundwater has not only levels of lithium and selenium exceeding safe levels by more than 100 fold, but also arsenic at five times safe levels.

5) Pennsylvania: An hour northwest of Pittsburgh, at the New Castle Generating Station, levels of arsenic in the groundwater near the plant's coal ash dump are at 372 times safe levels for drinking.

6) Tennessee: Just southwest of Memphis near the Mississippi River, at the TVA Allen Fossil Plant, arsenic has leaked into the groundwater at 350 times safe levels and lead at four times safe levels, threating the Memphis drinking water supply.

7) Maryland: 19 miles southeast of Washington, D.C., at the Brandywine landfill in Prince George's County, ash from three coal plants has contaminated groundwater with unsafe levels of at least eight pollutants, including lithium at more than 200 times above safe levels, and molybdenum (which can damage the kidney and liver) at more than 100 times higher than safe levels.

8) Utah: South of Salt Lake City, at the Hunter Power plant, the groundwater is contaminated with lithium at concentrations 228 times safe levels and cobalt at 26 times safe levels.

9) Mississippi: North of Biloxi, at the R.D. Morrow Sr. Generating Station, the groundwater is contaminated with lithium at 193 times safe levels, molybdenum at 171 times safe levels, and arsenic at three times safe levels.

10) Kentucky: At the Ghent Generating Station northeast of Louisville, lithium is in the groundwater at 154 times safe levels and radium at 31 times safe levels.

The threat to groundwater comes from both coal ash ponds and dry coal ash landfills. Monitoring data examined for this report revealed unsafe levels of contamination at 92 percent of ash ponds and 76 percent of ash landfills.

Monitoring data examined for the report revealed unsafe levels of contamination at 92 percent of ash ponds and 79 percent of ash landfills.

Finally, this reports shows that the problem is even worse than it appears at first glance. The Coal Ash Rule does not regulate older, closed coal ash dumps, even though they too are contaminating groundwater. There are hundreds of these older ash dumps across the country, and most coal plants have a mix of active (regulated) and inactive (unregulated) ash dumps on their property. Groundwater wells that are meant to provide a picture of "background" groundwater quality are often contaminated by these unregulated ash dumps, which makes it much harder to detect signs of contamination from regulated ash dumps.

Groundwater contamination poses a clear threat to drinking water supplies, and there are numerous examples of residential wells or public supply wells rendered unsafe by coal ash, some of which we identify in this report. Yet the Coal Ash Rule does not require the testing of drinking water wells near coal ash sites, so the scope of the threat is largely undefined.

Coal ash waste ponds at the Bull Run Fossil Plant near Clinton, TN, run up against the Clinch River and the north bank of Bull Run Creek.

Even as accumulating evidence shows the need for stronger coal ash monitoring and cleanup standards, the Trump Administration is rolling back protective requirements as part of a concerted effort to support coal-fired power at all costs. By weakening cleanup standards and pushing back ash pond closure deadlines, Trump's EPA is endangering communities and ecosystems near these toxic waste sites. Across the country, all it requires is a look at the evidence of contamination to see that more action is needed to protect public and environmental health. Instead, the Trump Administration is going all-in on a losing battle to save coal at a cost that grows steeper with every passing day.

Sooner or later, EPA and/or the states will have to reckon with the legacy of coal ash dumping. It would be far better for the environment, for public health, and for taxpayers to make a concerted effort now, before contamination gets worse and travels farther into the environment. A more successful regulatory program would:

- Regulate all coal ash dumps, not just the active ones. The groundwater at most coal plants is being poisoned by both regulated and unregulated ash dumps. The only way to restore groundwater quality, and to prevent risks to human health and aquatic life, is to control all sources of coal ash pollution at each site.
- Require all coal ash dumps – active and inactive, open and closed, impoundments and landfills – to be "high and dry." Leaving coal ash in groundwater, where there is nothing to prevent continuous leaching of toxic pollutants from the ash, is a recipe for disaster, rendering aquifers and nearby surface water unsafe for generations.
- Require more transparency. By law, the public must have access to the groundwater quality data generated by the Coal Ash Rule. But owners often bury the data in thick lab reports, or fail to post the data at all. EPA and the states should require electronic reporting, or at the very least require useful summaries of the data.

- Require more monitoring. EPA and the states should require the testing of all residential wells and surface water bodies that might be affected by coal ash. This is the only way to fully understand the threat to human health and aquatic life.
- Pay immediate and close attention to contamination impacting communities of color and low-income communities and provide timely assistance to ensure a safe source of drinking water, address cumulative impacts that accentuate harm, and provide technical oversight and enforcement, as necessary, to ensure adequate cleanup.
- Consider the cumulative impact of exposure to multiple coal ash pollutants. This report shows that affected groundwater often has elevated and unsafe levels of four or more pollutants. The total risks of cancer, neurological damage, and ecological damage are likely greater than the risk associated with any one pollutant.

Table of Contents

A. Background

When Americans started burning coal to generate electricity, we faced a waste disposal problem. After we burn coal, we are left with the ashes. At first, the coal ash was usually mixed with water and transported to unlined pits next to the coal plants – what we now call "ash ponds." As we burned more and more coal, we generated more and more coal ash. Today, coal-fired power plants generate roughly 100 million tons of coal ash every year.[1] Coal plants quickly outgrew their first ash ponds and had to expand existing ponds, build new ones, and create landfills. This was often done in simplistic, and in hindsight reckless, ways. Power companies built landfills on top of ash ponds once the ash ponds were full; dumped coal ash into streambeds, quarries, and mines; and built up unstable walls around existing ash ponds to contain even more coal ash.

The results of poor coal ash management have been, at times, dramatic and terrifying. Major spills have occurred every few years, threatening lives and causing massive environmental damage. In 1967, the catastrophic collapse of an ash pond at American Electric Power's Clinch River Power Plant in Cleveland, Virginia released 130 million gallons of toxic sludge into the Clinch River, killing an estimated 217,000 fish a distance of 90 miles downstream and leaving the river ecosystem damaged for 35 years.[2] In 2008, the collapse of a six-story earthen dam impounding 9 million tons of coal ash at the Tennessee Valley Authority's Kingston Fossil Plant in Harriman, Tennessee caused the largest toxic waste spill in U.S. history. More than a billion gallons (4.1 million cubic meters) of coal ash sludge released by the broken dam swept away houses, flooded 300 acres with toxic ash and poured 3,000 tons of heavy metals and other contaminants into the Clinch and Emory Rivers.[3] In 2011, a huge coal ash fill above Lake Michigan at the WE Energies Generating Station in Oak Creek, Wisconsin collapsed without warning, sending 25,000 tons of coal ash onto the shore and into the lake.[4] And on February 2, 2014, a break in the coal ash pond at Duke Energy's Dan River Steam Station in Eden, North Carolina sent 27 million gallons of coal ash sludge into the Dan River, impacting 70 miles of river in North Carolina and Virginia.[5] These are just a few high-profile examples of a larger problem.[6]

Over the long term, however, the most significant impact of unsafe coal ash disposal will likely be groundwater pollution. Since we started burning coal, we have learned that coal ash has high concentrations of the elements found in coal. These include a long list of toxic pollutants that can cause cancer, neurological damage, and other health effects. And unlined pits, which are often in periodic or sustained contact with groundwater, leak. More precisely, they "leach," meaning that the toxic pollutants in coal ash are rinsed out of the ash and into groundwater. The groundwater is then unsafe to drink. In addition, much of the contaminated groundwater eventually migrates to local rivers, streams, and lakes, where it threatens fish and other aquatic life, and creates health risks for anyone who eats the contaminated fish.

It took decades for the federal government to recognize this risk. In 2010, in the wake of the Kingston coal ash disaster, the Environmental Integrity Project, Earthjustice and the Sierra Club teamed up to publish an inventory of nearly seventy "damage cases" – documented examples of the environmental harm caused by coal ash.[7] In 2012, a coalition of environmental organizations including the Environmental Integrity Project, Earthjustice, and others sued the EPA, arguing that the Agency had a statutory duty to regulate coal ash disposal.[8] EPA ultimately agreed, leading to the 2015 Coal Ash Rule.[9]

While the EPA was studying the need for the rule, it conducted a risk assessment, in which the Agency tried to estimate the magnitude of the risk, and the pollutants posing the greatest risk, from coal ash dumps.[10] The EPA eventually determined that some pollutants were dangerous enough that they warranted routine monitoring, including the following:

- Arsenic causes many adverse health impacts, including multiple forms of cancer, neurological impairments in children, and skin conditions.[11] EPA's risk assessment predicted significant risks of both cancer and non-cancer health effects near unlined coal ash ponds and landfills.[12]
- Boron is associated with developmental and reproductive toxicity (e.g., low birthweight and testicular atrophy),[13] and is also toxic to aquatic life.[14] EPA's risk assessment predicted significant risks to both humans and aquatic plants and animals.[15]
- Cadmium causes kidney damage, and is, according to EPA, a "probable carcinogen."[16] In a preliminary screening analysis, EPA found potential risks to humans through both drinking water and contaminated fish.[17] Cadmium is also toxic to fish themselves,[18] and EPA's risk assessment predicted significant ecological risks from cadmium.[19]
- Cobalt is associated with blood disease, thyroid damage, and other endpoints.[20] EPA's risk assessment predicted significant cobalt risks in association with certain types of ash ponds.[21]
- Chromium, particularly the form known as hexavalent chromium, can cause cancer at low doses, and can also cause liver damage and other non-cancer health effects.[22]
- Fluoride is a neurotoxin[23] that can also cause tooth and bone damage,[24] and may be carcinogenic.[25]
- Lead is a well-known and potent neurotoxin. It is also, according to EPA, a "probable carcinogen,"[26] and can be toxic to aquatic life.[27] There is no truly "safe" level of lead exposure, especially for children.[28]
- Lithium can cause kidney damage, neurological damage, decreased thyroid function, and birth defects.[29] EPA's risk assessment predicted significant lithium risks to humans via drinking water.[30]
- Mercury is a potent neurotoxin that bioaccumulates in aquatic food chains.[31] EPA's risk assessment predicted significant mercury risks via fish consumption, but not through drinking water.[32] This is important because it suggests that mercury may

present a significant risk even where groundwater concentrations are below drinking water standards.

- Molybdenum has been associated with gout-like symptoms in humans, and reproductive toxicity in laboratory animals.[33] EPA's risk assessment predicted significant molybdenum risks.[34]
- Radium (specifically the radium isotopes radium-226 and radium-228) is a radioactive and cancer-causing metal. EPA's risk assessment did not look at radium, but EPA added radium to the list of groundwater monitoring constituents in the Coal Ash Rule "because there is evidence from several damage cases of exceedances of gross alpha [radiation], indicating that radium from the disposal of CCR may be problematic."[35]
- Selenium bioaccumulates in aquatic food chains, and is toxic to fish.[36] Selenium can also be toxic to humans, affecting skin, blood, and the nervous system.[37] In a preliminary screening analysis, EPA found that potential selenium risks to humans were greater through fish consumption than through drinking water.[38] EPA noted that selenium was the "most prevalent" constituent of concern in proven damage cases involving surface water impacts.[39] These damage cases typically involve fish kills or other fish toxicity, and have been "extensively studied" in places like North Carolina, South Carolina and Texas.[40]
- Thallium has been associated with a long list of adverse health effects including liver and kidney damage and hair loss.[41] EPA's risk assessment predicted significant risks via drinking water, and in a preliminary screening analysis also identified potential risks through the consumption of thallium-contaminated fish.[42]

EPA's 2014 Risk Assessment was based on a series of assumptions and models, because EPA did not yet have a database of groundwater quality data. However, the Coal Ash Rule required groundwater monitoring for all regulated coal ash disposal areas, and required that the data be publicly available. In March 2018, most[43] coal plant owners posted the results of their initial groundwater monitoring. These online postings were supposed to include at least eight rounds of monitoring, and owners were supposed to measure a specific group of coal ash pollutants, including those listed above. A handful of owners failed to provide all of the required data, but most owners complied.

We now have a comprehensive, internally consistent snapshot of groundwater at coal plants across the country. The database examined for this report includes over 4,600 monitoring wells at 265 coal plants or offsite coal ash dumps in 40 states and the territory of Puerto Rico. Most coal plants have multiple regulated ash dumps, and the total number of dumps includes 348 ash ponds and 210 ash landfills.

B. How the Coal Ash Rule Works

The 2015 Coal Ash Rule created location restrictions, operating and design standards, groundwater monitoring programs, and corrective action (cleanup) requirements for coal ash ponds and landfills.[44] The rule does not cover all coal ash dumps. Generally speaking, coal ash landfills and impoundments that stopped receiving waste before October, 2015 are exempt.[45] As explained below, this exemption is a severe impediment to groundwater restoration at most sites, because most sites have one or more older, unregulated ash dumps.

The groundwater monitoring programs established by the Coal Ash Rule include requirements related to the number and placement of wells, the constituents that must be measured, and the monitoring schedule.[46] Each monitoring network is required to have both upgradient and downgradient wells. Upgradient wells are like upstream wells, in terms of the flow of groundwater. The upgradient wells should theoretically show the quality of groundwater before it passes under or through an ash dump. According to the Coal Ash Rule, these wells must "[a]ccurately represent the quality of background groundwater that has not been affected by leakage from a [coal ash] unit."[47] As described in this report, many so-called upgradient wells fail this requirement, and show signs of coal ash contamination. Downgradient wells monitor the groundwater after it passes under or through an ash dump. Groundwater monitoring networks can be specific to individual coal ash ponds or landfills, or they can be "multiunit" systems, encircling two or more ash dumps.[48] Once a well network is established, groundwater monitoring proceeds in a series of stages:

- First, each owner must conduct a round of baseline monitoring, sampling each well at least eight times and measuring all 21 pollutants in the Coal Ash Rule.[49] For existing coal ash dumps, the Coal Ash Rule required completion of baseline monitoring by October 2017.
- Next, each owner must initiate "detection monitoring," looking for a short list of chemicals that are good indicators of coal ash pollution, including boron, sulfate, and a few others. The detection monitoring constituents are listed in Appendix III to the Coal Ash Rule, [50] and shown in Table B1 of this report.
- If detection monitoring finds significantly elevated concentrations of these pollutants compared to concentrations in upgradient wells, then owners must either (a) demonstrate that the pollution is coming from something other than the regulated coal ash unit, or (b) initiate "assessment monitoring."[51]
- In assessment monitoring, each owner must measure a longer list of fifteen pollutants that are likely to present significant risks to human health and the environment.[52] These include arsenic, cadmium, cobalt, lithium, molybdenum and others, and are found in Appendix IV to the Coal Ash Rule. They are also listed in Table B1 of this report.
- If these assessment monitoring pollutants are found to be significantly elevated above groundwater protection standards, and the owner cannot demonstrate that the pollution is coming from another source, then the owner must initiate corrective action.[53] In addition, if the contamination is downgradient of an unlined ash pond, then that ash pond must cease accepting waster within six months, and initiate closure or retrofit.[54]

The monitoring schedule described above takes place over a period of years. Generally, owners must post semi-annual groundwater monitoring results each year, in an annual report. Most of the detection monitoring and assessment monitoring took place after the first annual report was completed, so most of the detection monitoring and assessment monitoring data will not be made public until later in 2019.

This report is therefore based on the initial round of baseline monitoring and, in many cases, the first round of detection monitoring. With a few exceptions,[55] all sites completed baseline monitoring and posted the results in March 2018 (or earlier). The baseline monitoring data include both detection monitoring and assessment monitoring constituents (see Table B1), providing a comprehensive national snapshot of groundwater contamination at coal ash disposal sites.

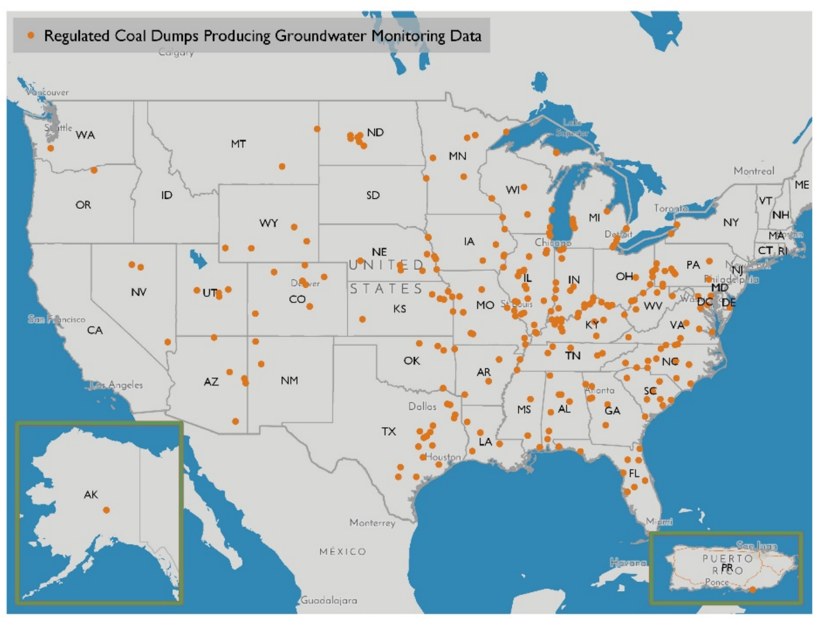
C. What the Data Reveal about Nationwide Groundwater Contamination

This section provides summary data and analysis. The full list of sites, and the pollutants that are present at unsafe levels at each site, is shown in **Appendix A**. The complete database of sampling results is available at http://www.environmentalintegrity.org/coal-ash-groundwater-contamination/.

1. How many coal plants have unsafe groundwater?

The short answer is **91 percent** of coal plants.

To be clear, our analysis was looking at the 265 sites that were required to post groundwater monitoring data. Although almost all of these sites are coal plants, a few are actually offsite coal ash landfills that take coal ash from one or more coal plants. The rest of the report will refer to these 265 sites collectively as "coal plants." Most coal plants have multiple onsite coal ash landfills or ponds (ash dumps). In many cases, it is impossible to determine how much each onsite ash dump is contributing to groundwater contamination. Our analysis primarily focused on the quality of groundwater at each location (coal plant). We determined that 242 coal plants, or 91 percent, have unsafe levels of one or more coal ash constituents in downgradient wells that appear to be affected by onsite, regulated coal ash dumps.



In order to arrive at this number, we made an effort to identify groundwater monitoring data showing both (1) unsafe groundwater and (2) groundwater impacted by regulated coal ash dumps. Our methods are explained in detail in **Appendix B**. Briefly, to determine whether groundwater was unsafe, we compared average concentrations of each pollutant in each well to health-based thresholds (**Table 1**). These thresholds were generally identical to the groundwater protection standards in the Coal Ash Rule, with the exceptions being boron and sulfate (which do not have groundwater protection standards in the Coal Ash Rule), and molybdenum (for which we used a slightly more stringent health-based value).[56] An example of unsafe groundwater might be a well with a mean arsenic concentration of 20 micrograms per liter, which exceeds the Maximum Contaminant Level for arsenic of 10 micrograms per liter. These could be thought of as "exceedances," though they are not, in and of themselves, legal violations (under the Coal Ash Rule, a legal violation would occur if an owner found a statistically significant exceedance and failed to take the required corrective action).

Before we tallied up these "exceedances," we excluded examples that could have been caused by something other than the coal ash dump being monitored by the well in question. To do this, we excluded all downgradient mean values that were less than the highest mean value from wells designated as upgradient of the same coal ash dump. Consider, for example, hypothetical Ash Pond A, with three downgradient monitoring wells and two upgradient monitoring wells. If the highest mean concentration of arsenic in the downgradient wells is 20 micrograms per liter, and the mean arsenic values in the two upgradient wells are less than that, then the data suggest that Ash Pond A is causing the elevated arsenic levels in downgradient wells. We would retain this "exceedance" in our analysis. If, however, the mean arsenic concentration in one of the upgradient wells is 25 micrograms per liter, it would suggest that there was another source of contamination, upgradient of Ash Pond A. In this case, we would exclude the "exceedance" from our analysis.

This is not a perfect method, with uncertainties that cut both ways. On one hand, there may be instances where downgradient wells show higher levels of a pollutant than upgradient wells by chance, even if the monitored coal ash dump is not leaking. On the other hand, the opposite may also be true – there may be instances where downgradient wells show lower levels than upgradient wells even if the regulated unit is leaking. This can happen where, for example, an ash pond is leaking and there is an upgradient source of contamination. The 'signal' of the ash pond can be lost in the 'noise' of the other sources of contamination. Moreover, as described below, purportedly 'upgradient' wells are often contaminated by other onsite sources of coal ash, or they are not truly upgradient of the regulated unit. **All things considered, our approach will tend to underestimate the extent of coal ash contamination at coal plants.** If we include all data in our analysis – including upgradient wells and all downgradient data – then we find that 96 percent of coal plants have unsafe levels of coal ash pollutants in their groundwater.

Finally, we only looked at "exceedances" of health-based thresholds for constituents of coal ash that are monitored pursuant to the Coal Ash Rule – the constituents listed in Appendices III and IV of the Coal Ash Rule.[57] There are several other coal ash constituents that frequently exceed safe levels in groundwater, including neurotoxins like aluminum and manganese,[58] but they are not monitored pursuant to the Coal Ash Rule and we could not evaluate their prevalence in the environment.

Table 1 shows the extent to which coal ash has caused unsafe levels of pollution, according to our analysis. The table also shows the number of coal plants with unsafe levels of one or more constituents of coal ash.

Table 1: Unsafe groundwater caused by coal ash

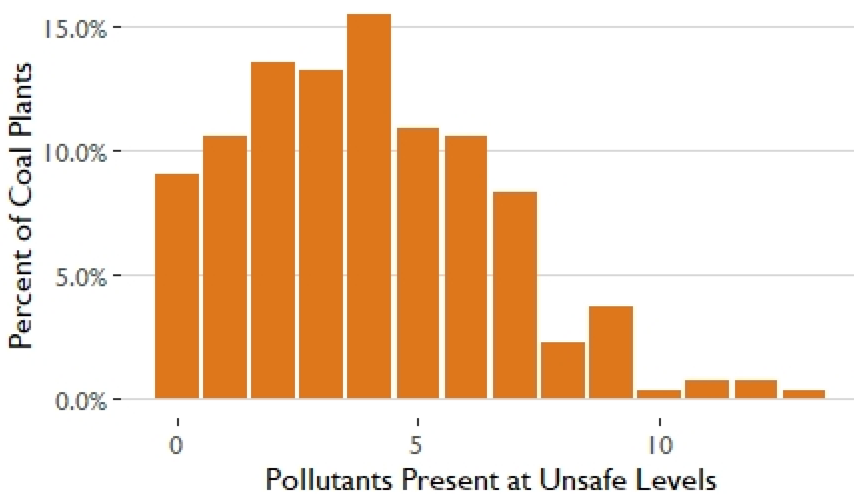
Constituent	Health-based threshold	Number of plants exceeding threshold	% of plants with unsafe levels of this constituent
Antimony	6 µg/L	13/256	5%
Arsenic	10 µg/L	133/257	52%
Barium	2 mg/L	6/257	2%
Beryllium	4 µg/L	27/256	11%
Boron	3 mg/L	128/265	48%
Cadmium	5 µg/L	15/257	6%
Chromium	100 µg/L	8/257	3%
Cobalt	6 µg/L	126/256	49%
Fluoride	4 mg/L	18/265	7%
Lead	15 µg/L	25/257	10%
Lithium	40 µg/L	154/256	60%
Mercury	2 µg/L	8/256	3%
Molybdenum	40 µg/L	128/256	50%
Radium	5 pCi/L	48/253	19%
Selenium	50 µg/L	34/257	13%
Sulfate	500 mg/L	145/265	55%
Thallium	2 µg/L	27/256	11%
Any of the above		241/265	91%
Four or more of the above		142/265	54%

NOTE: We consider a plant to exceed the threshold if one or more downgradient wells have mean values that exceed the threshold, after excluding downgradient means that are lower than relevant upgradient means. The total number of coal plants (the denominator in Table 1) varies by constituent, as not all constituents are monitored at all plants.

2. Groundwater at Coal Plants Is Frequently Contaminated with Unsafe Levels of Many Coal Ash Pollutants

As shown in **Table 1**, the majority of coal plants have unsafe levels of at least four coal ash pollutants. In fact, there are a significant number of coal plants with unsafe levels of seven, eight, or more constituents (see **Figure 1**). This means that a large number of sites pose significant cumulative risks to human health and the environment. In other words, the groundwater at many of these sites contains unsafe levels of multiple carcinogens, or multiple neurotoxins, or multiple chemicals that are toxic to aquatic life. The true risk experienced by any receptor, human or ecological, now or in the future, will be greater than the risk from any individual chemical.

Figure 1: Coal plants sorted by the number of pollutants present at unsafe levels



3. Coal Ash Landfills Are Contaminating Groundwater Nearly as Often as Coal Ash Ponds

In the 2015 Coal Ash Rule, and specifically in the risk assessment supporting the Rule, EPA made a series of assumptions about the movement of pollutants from coal ash dumps into the environment, modeling landfills and impoundments (ash ponds) separately. Through its modeling, EPA assumed that landfills pose a much lower risk than impoundments.[59]

The data suggest that EPA was wrong about the risks of contamination from landfills. We looked at monitoring wells near landfills and impoundments separately (excluding wells and well networks that jointly monitor both types of coal ash disposal area). **Table 2** shows the results for selected coal ash pollutants:

Table 2: Unsafe levels of coal ash pollutants at landfills and impoundments (percent of landfills or impoundments showing unsafe levels of each pollutant)

	Arsenic	Boron	Cobalt	Lithium	Molybdenum	Sulfate	One or more
Landfills (196)	29%	23%	33%	43%	27%	36%	**76%**
Ponds (273)	42%	45%	44%	47%	40%	46%	**92%**

The denominator for landfill contamination for cobalt and molybdenum is 195.

At the coal plant level, 76 percent of plants with regulated landfills have one or more leaking landfills, and 92 percent of plants with regulated ash ponds have one or more leaking ash ponds.

4. High Levels of Toxic Pollutants Are Not Naturally Occurring

Some of the constituents of coal ash can also occur, naturally, at elevated and unsafe levels. The groundwater monitoring program generally rules out naturally occurring contamination by requiring a comparison of downgradient data to upgradient data – if levels are higher in downgradient wells, then the coal ash dump is presumed to be leaking. But additional evidence can be gleaned by comparing levels of coal ash constituents to each other. Boron is generally considered to be one of the best indicators of coal ash contamination.[60] We looked at wells with elevated levels of arsenic, cobalt, lithium, and other constituents to see if these wells also had elevated boron concentrations. **Table 3** shows that they did. For each pollutant, we compared wells with mean values that exceed that pollutant's health threshold to wells with mean values ten times lower. Wells with unsafe levels of arsenic generally had significantly more boron than low-arsenic wells. The same was true for cobalt, lithium, molybdenum, and radium. To look at it another way, where wells have unsafe levels of arsenic, they tend to also have unsafe levels of boron (greater than 3 mg/L). Again, this is also true for cobalt, lithium, molybdenum, and radium. This confirms that even though some of these pollutants can be naturally occurring, the levels we are seeing at coal plants are largely from coal ash.

Table 3: Correlations between toxic coal ash constituents and boron

Constituent	Number of wells	Mean boron concentration in the same wells[61]
	Arsenic	
<1 µg/L	1,558	1.0 mg/L
>10 µg/L	577	3.1 mg/L
	Cobalt	
<0.6 µg/L	1,341	1.4 mg/L
>6 µg/L	810	4.0 mg/L
	Lithium	
<4 µg/L	877	0.8 mg/L
>40 µg/L	1,385	4.2 mg/L
	Molybdenum	
<4 µg/L	2,508	1.2 mg/L
>40 µg/L	538	6.9 mg/L
	Radium	
<0.5 pCi/L	849	1.4 mg/L
>5 pCi/L	221	4.7 mg/L

5. Where Ash Dumps Are Located Too Close to Groundwater, Contamination is Greater

Coal ash dumps in contact with groundwater are expected to have more frequent and more severe contamination, as coal ash constituents can be directly leached into groundwater. To avoid this heightened risk, the Coal Ash Rule requires existing ash ponds and new ash landfills to be separated from groundwater by a certain distance. Specifically, they must be built "with a base that is no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer" unless an owner can demonstrate that there is never any connection between a coal ash unit and the underlying groundwater aquifer.[62] This provision of the Coal Ash Rule is often described as the "aquifer restriction." Owners were required to document whether their coal ash unit(s) complied with the aquifer restriction by October 2018. The available documentation does not necessarily tell us which coal ash units are sitting in groundwater, but it does tell us which coal ash impoundments are dangerously close to groundwater. One could also look at this another way: Owners have the option of meeting the standard by showing that there is never any groundwater contact, so it may make sense to presume that owners who post notices of noncompliance have tried (and failed) to show that there is never any groundwater contact. In other words, noncompliant ponds presumably have some amount of groundwater contact.

Table 4 compares the prevalence of contamination at ash ponds based on their compliance with the aquifer restriction. The table shows more contamination near ponds that are too close to groundwater. This is particularly true for certain pollutants. Arsenic and molybdenum, for example, are much less likely to be a problem if ponds are at least five feet above groundwater.

Table 4: Unsafe groundwater at coal ash ponds that do or do not comply with the Coal Ash Rule's aquifer restriction

	Arsenic	Boron	Cobalt	Lithium	Molybdenum	Sulfate	One or more
Compliant ponds (87)	23%	37%	40%	41%	17%	40%	**87%**
Non-compliant ponds (126)	51%	48%	51%	54%	53%	48%	**95%**

D. The Most Contaminated Sites in the Country

The levels of contamination at many sites are off the charts – hundreds of times higher than what could be considered safe. For example, certain wells at the New Castle Generating Station in Pennsylvania and the Allen Fossil Plant in Tennessee have more than 3.5 mg/L of arsenic – enough to cause cancer in one out of six people.[63] In order to show how bad these problems can get, we tried to identify the sites with the most toxic groundwater. Our methods for ranking the sites are explained in **Appendix B**. To very briefly summarize, we created ranks based on the extent to which pollution – including all potentially unsafe pollutants – exceeded safe levels.

It is important to note that this is only one way to rank sites against each other, and other considerations might result in different rankings. For example, a ranking system that tried to account for the volume of unsafe groundwater at a site might give more weight to the massive Little Blue Run surface impoundment in Pennsylvania and West Virginia. Another ranking system might focus on the likelihood of a specific kind of harm, such as fish toxicity. Each hypothetical ranking system tries to answer a specific question. Our ranking system tried to answer the question, "how bad is the groundwater?"

We should also note that our ranking system, by only looking at contamination in downgradient wells if it exceeds the levels in corresponding upgradient wells, tends to underemphasize sites with upgradient contamination. Some of these lower-ranked sites may have severe contamination caused by onsite coal ash. For example, groundwater at NRG's Waukegan Station in Waukegan, Illinois has very high levels of arsenic (up to 21 mg/L), boron (up to 35 mg/L), and other pollutants, but the contamination is greatest in wells that are upgradient of the site's two regulated coal ash ponds. The groundwater is likely being affected by a large, unregulated coal ash landfill that is also upgradient of the ash ponds. But the Waukegan site ranks low in our list because the wells downgradient of the regulated ash ponds tend to show lower levels of contamination than the upgradient wells.

Lastly, it is important to note that the majority of the "ten most contaminated" coal ash sites impact communities of color and/or low-income communities.[64] These communities are unlikely to have the resources to test drinking water, are likely to be exposed to additional environmental toxins, and often do not have adequate access to medical care and legal resources to address the contamination.

Table 5 summarizes what we found, showing the pollutants that were present at unsafe levels, and the degree to which each pollutant exceeds a safe level. More site-specific detail is provided in the discussion that follows.

Table 5: The Ten Most Contaminated Sites in the Country

Rank	Site	Pollutants Exceeding Safe Levels
1	San Miguel Plant (TX)	Arsenic (x7), Beryllium (x138), Boron (x23), Cadmium (x124), Cobalt (x522), Fluoride (x3), Lithium (x93), Mercury (x3), Radium 226+228 (x6), Selenium (x8), Sulfate (x20), Thallium (x9)
2	Allen Steam Station (NC)	Arsenic (x6), Beryllium (x6), Cadmium (x1), Cobalt (x532), Fluoride (x1), Lithium (x12), Selenium (x7), Sulfate (x3), Thallium (x1)
3	Jim Bridger Power Plant (WY)	Antimony (x1), Arsenic (x5), Boron (x6), Cadmium (x4), Cobalt (x96), Fluoride (x3), Lead (x5), Lithium (x170), Molybdenum (x12), Radium 226+228 (x2), Selenium (x116), Sulfate (x131), Thallium (x13)
4	Naughton Power Plant (WY)	Arsenic (x5), Beryllium (x2), Boron (x1), Cobalt (x3), Lead (x1), Lithium (x195), Radium 226+228 (x1), Selenium (x159), Sulfate (x65), Thallium (x14)
5	New Castle Generating Station (PA)	Arsenic (x372), Boron (x3), Cobalt (x5), Lithium (x54), Molybdenum (x1), Sulfate (x4)
6	Allen Fossil Plant (TN)	Arsenic (x350), Boron (x2), Fluoride (x1), Lead (x4), Molybdenum (x9)
7	Brandywine Ash Management Facility (MD)	Arsenic (x5), Beryllium (x2), Boron (x16), Cobalt (x47), Lithium (x222), Molybdenum (x111), Selenium (x9), Sulfate (x10)
8	Hunter Power Plant (UT)	Boron (x9), Cobalt (x26), Lithium (x228), Molybdenum (x11), Radium 226+228 (x2), Sulfate (x66)
9	R.D. Morrow, Sr. Generating Station (MS)	Arsenic (x3), Boron (x12), Lead (x1), Lithium (x193), Molybdenum (x171), Sulfate (x6), Thallium (x1)
10	Ghent Generating Station (KY)	Antimony (x2), Arsenic (x2), Beryllium (x2), Boron (x4), Chromium (x3), Cobalt (x12), Lead (x3), Lithium (x154), Molybdenum (x16), Radium 226+228 (x31), Sulfate (x3), Thallium (x2)

NOTE: The number that follows each pollutant is the ratio of the highest onsite average concentration of that pollutant to the health-based thresholds that we identify in Table B1.

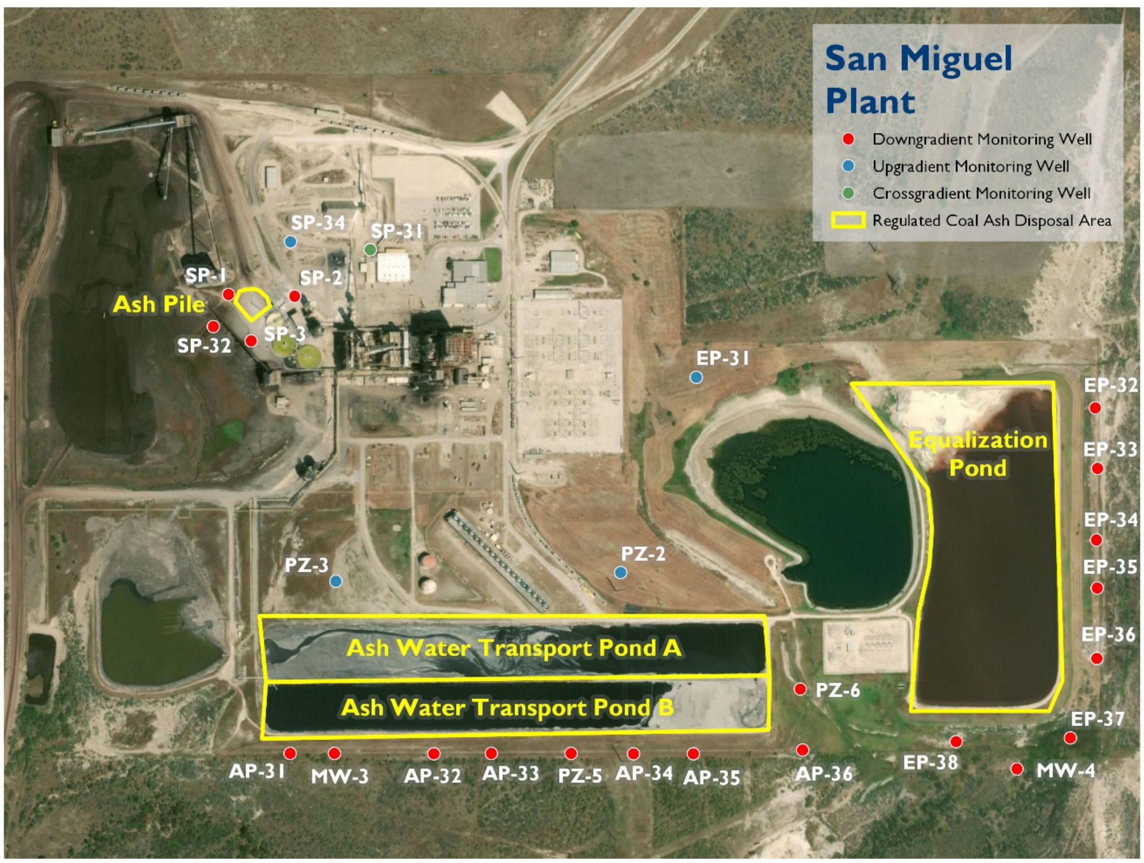
1. San Miguel Plant

The San Miguel Electric Plant, owned and operated by the San Miguel Electric Power Cooperative, is located in Atacosa County, Texas, south of San Antonio. The owners monitor three coal ash units pursuant to the Coal Ash Rule. The "Ash Pond" is actually a pair of adjacent ash ponds that store bottom ash transport water and other wastes. The "Equalization Pond" stores flue gas desulfurization (FGD) waste and treated sewage. The "Ash Pile" is a temporary storage area for fly ash and FGD scrubber sludge; the owner recently estimated that there were 130,000 cubic yards of coal ash in the ash pile area.[65]

The groundwater contamination at the San Miguel plant, and the effects of the plant on neighboring ranchers, were discussed in detail in a recent Environmental Integrity Project report about Texas coal ash sites.[66] Some of the highest levels of onsite contamination are found near the ash pile (for example, in wells SP-1 and SP-32). Yet contamination downgradient of the ash ponds and the equalization pond is nearly as bad.[67] The owners have initiated assessment monitoring at the ash pond area and the equalization pond.[68]

Table 6: Unsafe groundwater at San Miguel

Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Arsenic (µg/L)	SP-32	74	10
Beryllium (µg/L)	SP-1	550	4
Boron (mg/L)	EP-33	69	3
Cadmium (µg/L)	SP-1	621	5
Cobalt (µg/L)	SP-1	3,130	6
Fluoride (mg/L)	SP-1	11	4
Lithium (µg/L)	SP-32	3,703	40
Mercury (µg/L)	AP-35	6	2
Radium (pCi/L)	AP-35	29	5
Selenium (µg/L)	SP-32	411	50
Sulfate (mg/L)	SP-32	10,042	500
Thallium (µg/L)	SP-1	19	2



2. G.G. Allen Steam Station

The Allen Steam Station, owned and operated by Duke Energy, is located in Belmont, North Carolina on the banks of the Catawba River (Lake Wylie). Duke monitors groundwater around three coal ash units at the site, the “Active Ash Basin,” the “Retired Ash Basin,” and the “Retired Ash Basin Landfill.”[69] The highest levels of contamination are found on the northern edge of the retired ash basin. Duke has initiated assessment monitoring for all three units, and in December 2018, Duke acknowledged that the groundwater exceeds groundwater protection standards for arsenic, beryllium, cadmium, cobalt, lithium, and thallium.[70]

The coal ash at Allen is saturated with groundwater,[71] yet Duke is planning to close the ash units in place, leaving at least 13 million cubic yards of ash right where it sits today.[72] Duke cannot restore local groundwater and surface water quality unless it excavates the ash and moves it to lined, dry storage, elevated above groundwater and away from the river.

Table 7: Unsafe groundwater at G.G. Allen Steam Station

Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Arsenic (μg/L)	CCR-4SA	60	10
Beryllium (μg/L)	CCR-4SA	25	4
Cadmium (μg/L)	CCR-4SA	6	5
Cobalt (μg/L)	CCR-4SA	3,190	6
Fluoride (mg/L)	CCR-4SA	4.1	4
Lithium (μg/L)	CCR-3D	485	40
Selenium (μg/L)	CCR-4SA	337	50
Sulfate (mg/L)	CCR-4SA	1,547	500
Thallium (μg/L)	CCR-6S	2.6	2

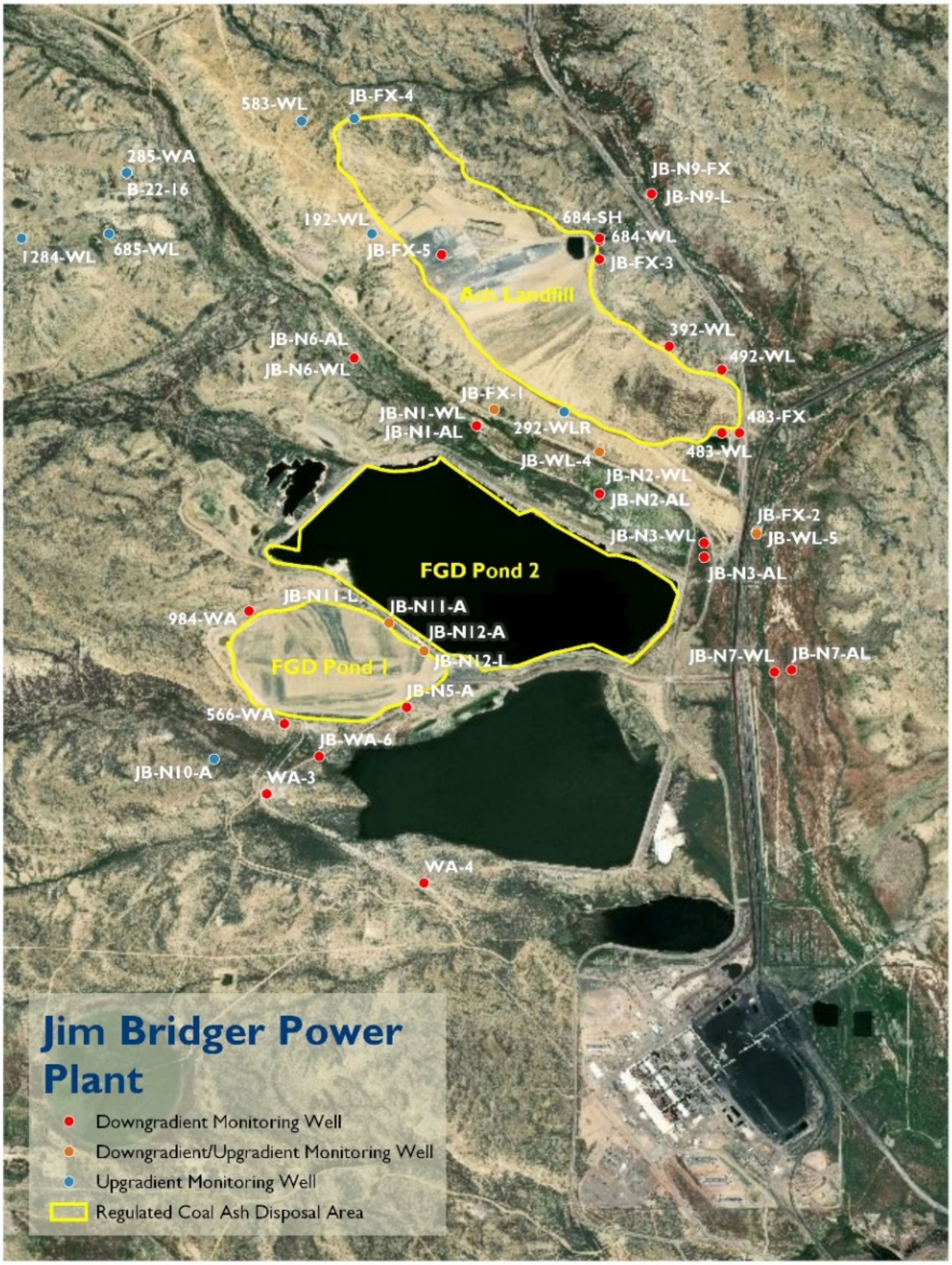

Allen Steam Station
Downgradient Monitoring Well
Upgradient Monitoring Well
Regulated Coal Ash Disposal Area
CCR-1D
CCR-1DA
CCR-1S
CCR-2S
CCR-2D
CCR-3S
CCR-3D
CCR-3DA
CCR-4D
CCR-4DA
CCR-4SA
CCR-5S
CCR-5D
CCR-8S
CCR-8D
CCR-9D
CCR-9S
GWA-5BR
GWA-5D
GWA-5BRA
GWA-5S
CCR-BG-1DA
CCR-BG-1S
CCR-6D
CCR-6S
CCR-7D
CCR-7S
Retired Ash Basin
CCR-11S
CCR-11D
CCR-11DA
Ash Landfill
GWA-4S
GWA-4D
GWA-4BR
AB-9D
AB-9S
CCR-14S
CCR-14D
GWA-21S
GWA-21D
GWA-21BR
GWA-21DA
GWA-3BR
GWA-3D
GWA-3S
GWA-3BRA
CCR-16D
CCR-16S
Active Ash Basin
CCR-17D
CCR-17S
CCR-18D
CCR-18S
CCR-20S
CCR-20D
CCR-21S
CCR-21D
CCR-22D
CCR-22S
CCR-22DA
CCR-23S
CCR-23D

3. Jim Bridger Power Plant

The Jim Bridger Power Plant is located in Point of Rocks, Wyoming. The owner of the plant, PacifiCorp, is a subsidiary of Berkshire Hathaway. PacifiCorp monitors the groundwater around three coal ash units at the site, including a 234-acre landfill and two unlined flue gas desulfurization (FGD) ponds with a combined surface area of roughly 350 acres.[73] In 2018, PacifiCorp acknowledged that onsite groundwater near FGD Pond 1 exceeds groundwater protection standards for arsenic, cadmium, cobalt, fluoride, lead, lithium, molybdenum, radium, and selenium.[74] PacifiCorp is currently planning to leave all of the onsite coal ash in place when it closes the disposal units.[75]

Table 8: Unsafe groundwater at Jim Bridger

Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Arsenic (µg/L)	566-WA	54	10
Boron (mg/L)	JB-N9-FX	17	3
Cadmium (µg/L)	566-WA	18	5
Cobalt (µg/L)	WA-4	577	6
Fluoride (mg/L)	WA-4	11	4
Lead (µg/L)	JB-N12-L	79	15
Lithium (µg/L)	JB-N11-L	6,788	40
Molybdenum (µg/L)	JB-N12-A	482	40
Radium (pCi/L)	JB-N5-A	8	5
Selenium (µg/L)	JB-N12-L	5,819	50
Sulfate (mg/L)	JB-N11-L	65,288	500
Thallium (µg/L)	JB-WL-4	25	2


583-WL
JB-FX-4
285-WA
B-22-16
1284-WL
685-WL
192-WL
JB-FX-5
JB-N9-FX
JB-N9-L
684-SH
684-WL
JB-FX-3
Ash Landfill
392-WL
492-WL
JB-N6-AL
JB-N6-WL
JB-FX-1
JB-N1-WL
JB-N1-AL
292-WLR
483-FX
483-WL
JB-WL-4
JB-N2-WL
JB-N2-AL
JB-FX-2
JB-WL-5
JB-N3-WL
JB-N3-AL
FGD Pond 2
JB-N11-L
JB-N11-A
984-WA
JB-N12-A
JB-N12-L
FGD Pond 1
JB-N7-WL
JB-N7-AL
JB-N5-A
566-WA
JB-WA-6
JB-N10-A
WA-3
WA-4
Jim Bridger Power Plant
Downgradient Monitoring Well
Downgradient/Upgradient Monitoring Well
Upgradient Monitoring Well
Regulated Coal Ash Disposal Area

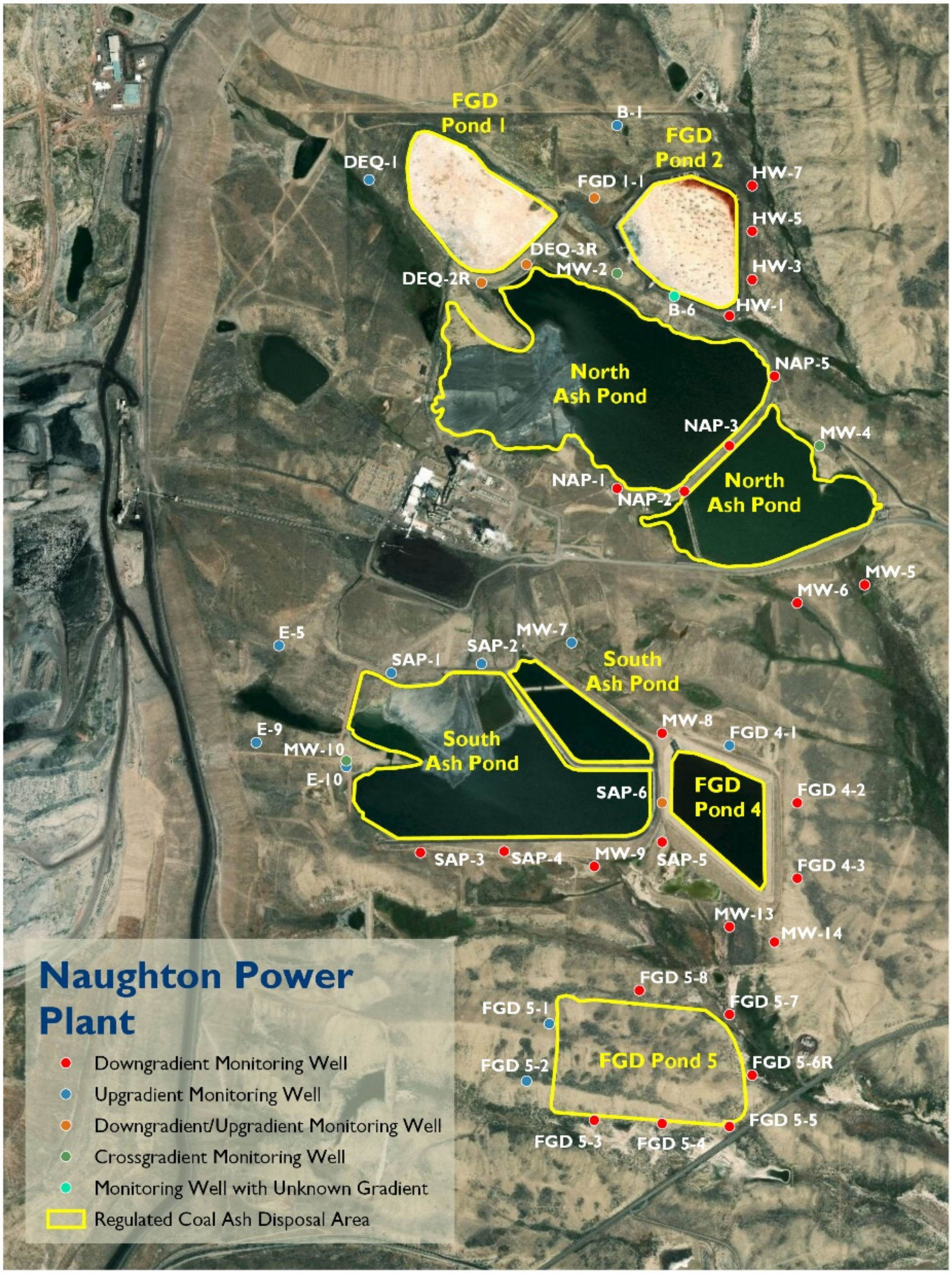
4. Naughton Power Plant

PacifiCorp's Naughton Power Plant is located outside of Kemmerer, Wyoming. There are six regulated coal ash units at the site, including two lined FGD ponds, two unlined FGD ponds, and two unlined ash ponds. The six ponds have a combined surface area of roughly 400 acres.[76]

In 2018, PacifiCorp acknowledged that onsite groundwater near FGD Pond 1 exceeds groundwater protection standards for lithium and selenium, and that groundwater near FGD Pond 2 exceeds standards for cobalt, lithium, radium, and selenium.[77] PacifiCorp is planning to close all six ash ponds in place.

Table 9: Unsafe groundwater at Naughton

Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Arsenic (µg/L)	SAP-6	53	10
Beryllium (µg/L)	MW-8	7	4
Boron (mg/L)	SAP-4	5	3
Cobalt (µg/L)	NAP-2	20	6
Lead (µg/L)	FGD 5-3	17	15
Lithium (µg/L)	B-6	9,675	40
Radium (pCi/L)	FGD 5-8	7	5
Selenium (µg/L)	MW-8	7,959	50
Sulfate (mg/L)	HW-3	32,513	500
Thallium (µg/L)	SAP-5	28	2


FGD
Pond 1
B-1
FGD
Pond 2
DEQ-1
FGD 1-1
HW-7
HW-5
DEQ-3R
DEQ-2R
MW-2
HW-3
B-6
HW-1
North
Ash Pond
NAP-5
NAP-3
MW-4
NAP-1
NAP-2
North
Ash Pond
MW-5
MW-6
E-5
MW-7
SAP-2
South
Ash Pond
SAP-1
MW-8
FGD 4-1
E-9
MW-10
South
Ash Pond
E-10
SAP-6
FGD
Pond 4
FGD 4-2
SAP-3
SAP-4
MW-9
SAP-5
FGD 4-3
MW-13
MW-14
Naughton Power
Plant
FGD 5-8
FGD 5-1
FGD 5-7
FGD Pond 5
FGD 5-2
FGD 5-6R
FGD 5-3
FGD 5-4
FGD 5-5
Downgradient Monitoring Well
Upgradient Monitoring Well
Downgradient/Upgradient Monitoring Well
Crossgradient Monitoring Well
Monitoring Well with Unknown Gradient
Regulated Coal Ash Disposal Area

5. New Castle Generating Station

The New Castle Generating Station in West Pittsburg, Pennsylvania is operated by NRG Energy. The plant stopped burning coal in 2016. The site has one 57-acre coal ash landfill and a smaller, 2-acre coal ash pond.[78] It appears that the landfill was built in stages, with a certain amount of ash buried in an unlined pit before a second, lined landfill was constructed on top.[79]

The highest levels of onsite contamination are found in wells downgradient of the landfill. Monitoring data clearly show that the landfill should be in assessment monitoring. For example, downgradient concentrations of boron and sulfate are much higher than upgradient concentrations.[80] Yet it appears that NRG has not initiated assessment monitoring. This is a violation of the Coal Ash Rule.

The landfill is almost certainly causing very high levels of groundwater contamination, including arsenic that exceeds safe levels by more than 300-fold. NRG is currently planning to close the landfill by leaving the ash in place,[81] a reckless decision that will cause ongoing pollution problems for generations.

Table 10: Unsafe groundwater at New Castle

Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Arsenic (µg/L)	MP-12	3,724	10
Boron (mg/L)	MP-10R	10	3
Cobalt (µg/L)	MP-10R	27	6
Lithium (µg/L)	MP-12	2,143	40
Molybdenum (µg/L)	MP-15	49	40
Sulfate (mg/L)	MP-12	2,217	500

6. Allen Fossil Plant

The Tennessee Valley Authority's Allen Fossil Plant, outside of Memphis, Tennessee, stopped burning coal in 2018. There is still one regulated coal ash pond at the site, now known as the "East Ash Disposal Area," and an inactive ash pond that was dewatered in 1992. Groundwater contamination near both ash ponds was detailed in a 2013 Environmental Integrity Project report.[82]

Groundwater data show extremely high levels of arsenic in the shallow aquifer beneath the East Ash Disposal Aquifer, particularly in well ALF-203, where the average arsenic concentration is 350 times higher than the MCL. A recent report from the U.S. Geological Survey revealed that this contaminated shallow groundwater is connected to the Memphis Sand aquifer, Memphis's drinking water source.[83]

The East Ash Disposal Area contains 2.3 million cubic yards of coal ash,[84] and is unlined. TVA has failed to post location restriction documentation,[85] in violation of the Coal Ash Rule, but the coal ash is presumably sitting in groundwater. TVA has been planning to close the ash pond in place.[86] This would do nothing to restore groundwater quality, and will instead guarantee chronic pollution problems for generations.

The unregulated, abandoned ash pond on the west side of the site is also presumably contaminating groundwater (and McKellar Lake), though TVA and state regulators have been ignoring that area for years.

TVA is now in the process of re-evaluating its closure plans, and deciding whether to excavate the ash from both onsite ash ponds or leave the ash in place.[87]

The Tennessee Valley Authority's Allen Fossil Plant, outside of Memphis, TN, stopped burning coal in 2018. TVA is deciding whether to excavate the ash or leave it in place.

Table 11: Unsafe groundwater at Allen Fossil Plant

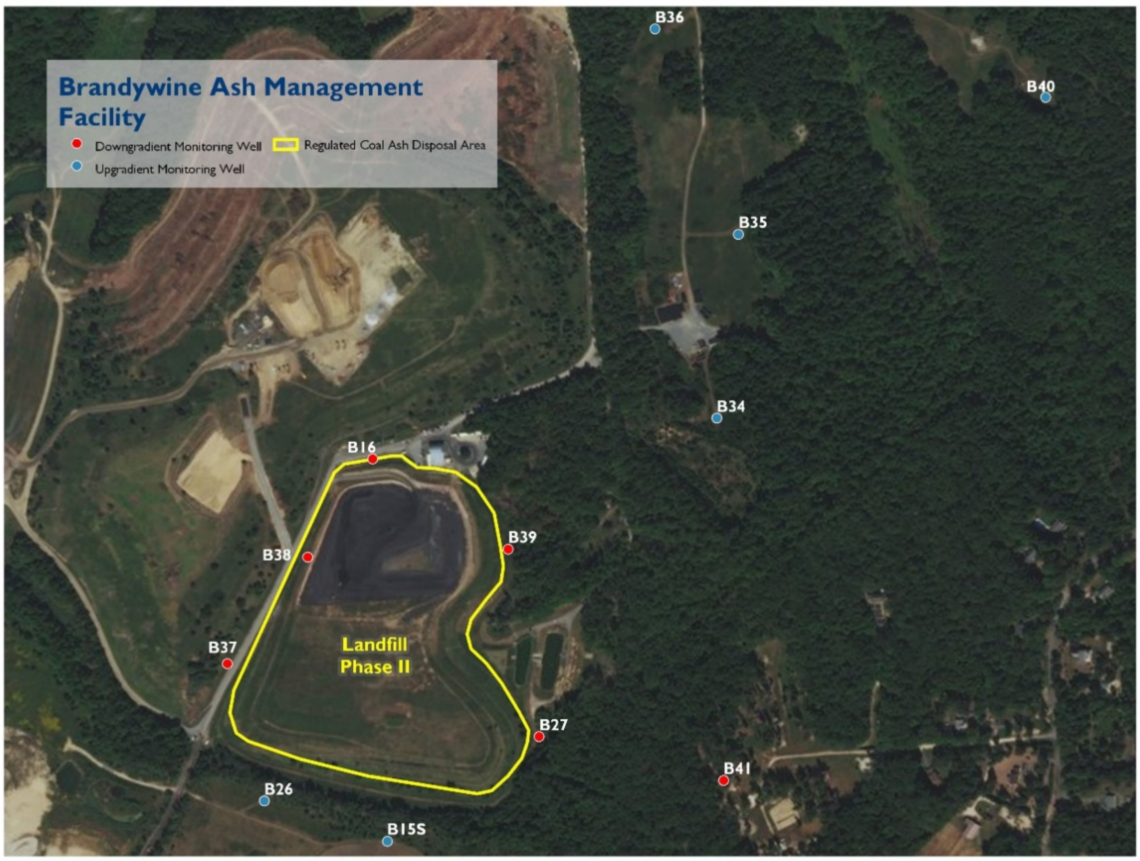
Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Arsenic (µg/L)	ALF-203	3,500	10
Boron (mg/L)	ALF-205	7	3
Fluoride (mg/L)	ALF-203	5	4
Lead (µg/L)	ALF-203	54	15
Molybdenum (µg/L)	ALF-202	346	40

7. Brandywine Landfill

The Brandywine Ash Management Facility in Brandywine, Maryland is a 217-acre, largely unlined coal ash landfill operated by GenOn (a subsidiary of NRG).[88] The landfill has been accepting coal ash from three local coal plants since the early 1970s, and now contains nearly 8 million tons of ash.[89] The Brandywine landfill has contaminated local groundwater, including groundwater within a geologic stratum that is supposed to block the migration of contaminants to a deeper aquifer used for drinking water.[90] The landfill is also contaminating local surface water through baseflow (contaminated groundwater flowing into streams),[91] discrete surface water discharges from onsite leachate collection systems,[92] and the physical erosion of ash into streams.[93] Boron in baseflow is 3,000 times higher than the level that is safe for aquatic life,[94] and instream toxicity testing shows that coal ash contamination is making local streams toxic.[95]

Table 12: Unsafe groundwater at Brandywine

Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Arsenic (μg/L)	B39	53	10
Beryllium (μg/L)	B39	6	4
Boron (mg/L)	B16	49	3
Cobalt (μg/L)	B37	282	6
Lithium (μg/L)	B38	8,878	40
Molybdenum (μg/L)	B38	4,423	40
Selenium (μg/L)	B27	448	50
Sulfate (mg/L)	B16	5,076	500



8. Hunter Power Plant

PacifiCorp's Hunter Power Plant is located near Castle Dale, Utah. The only regulated coal ash unit at the site is a 340-acre landfill.[96] The risk assessment for EPA's 2015 Coal Ash Rule described the Hunter site as having two coal ash units – a 280-acre landfill and a 104-acre surface impoundment.[97] It is unclear whether these two units are both within the footprint of the regulated landfill. If the former impoundment was outside of the landfill area and closed in place, then it is another, separate source of contamination.

Groundwater contamination is generally more severe at the downgradient, northeastern corner of the landfill. However, the purportedly upgradient wells also show elevated levels of coal ash indicators. In well ELF-2, for example, the mean boron concentration is 3.3 mg/L, and the mean selenium concentration is 0.433 mg/L. This well (and the other upgradient wells) are located right on the edge of the landfill, and may be affected by contamination from the landfill, or from a different, upgradient coal ash source. In any case, the downgradient groundwater has even higher levels of coal ash pollutants, which shows that the landfill is an active source of contamination.

PacifiCorp has acknowledged that cobalt, lithium and molybdenum all exceed groundwater protection standards at the site.[98]

Table 13: Unsafe groundwater at Hunter

Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Boron (mg/L)	ELF-8	28	3
Cobalt (µg/L)	ELF-8	157	6
Lithium (µg/L)	ELF-6	9,131	40
Molybdenum (µg/L)	ELF-8	426	40
Radium (pCi/L)	ELF-6	11	5
Sulfate (mg/L)	ELF-3	33,000	500

9. R.D. Morrow, Sr. Generating Station

The Morrow Generating Station, also known as "Plant Morrow," is owned by Cooperative Energy and located near Purvis, Mississippi. Cooperative Energy is currently in the process of converting the plant from coal to natural gas. There are three regulated and monitored coal ash units at the site – a 72-acre landfill and a pair of smaller (2 acres total) unlined ash ponds. Onsite groundwater is most contaminated near the landfill, particularly in well MW-5, on the western edge of the landfill. It is not clear whether Cooperative Energy has initiated assessment monitoring at the site.

Table 14: Unsafe groundwater at R.D. Morrow

Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Arsenic (µg/L)	MWI-2	30	10
Boron (mg/L)	MW-5	37	3
Lead (µg/L)	MW-3	22	15
Lithium (µg/L)	MW-5	7,728	40
Molybdenum (µg/L)	MW-5	6,821	40
Sulfate (mg/L)	MW-5	2,943	500
Thallium (µg/L)	MW-5	3	2


Emergency
Scrubber
Pond
MWI-1
Scrubber
Supply Pond
MWI-2
MWI-3
MWI-4
MW-2
MW-6
MW-5
CCR Landfill
MW-4
MW-3
R.D. Morrow, Sr.
Generating
Station
Downgradient Monitoring Well
Upgradient Monitoring Well
Crossgradient Monitoring Well
Regulated Coal Ash Disposal Area

10. Ghent Generating Station

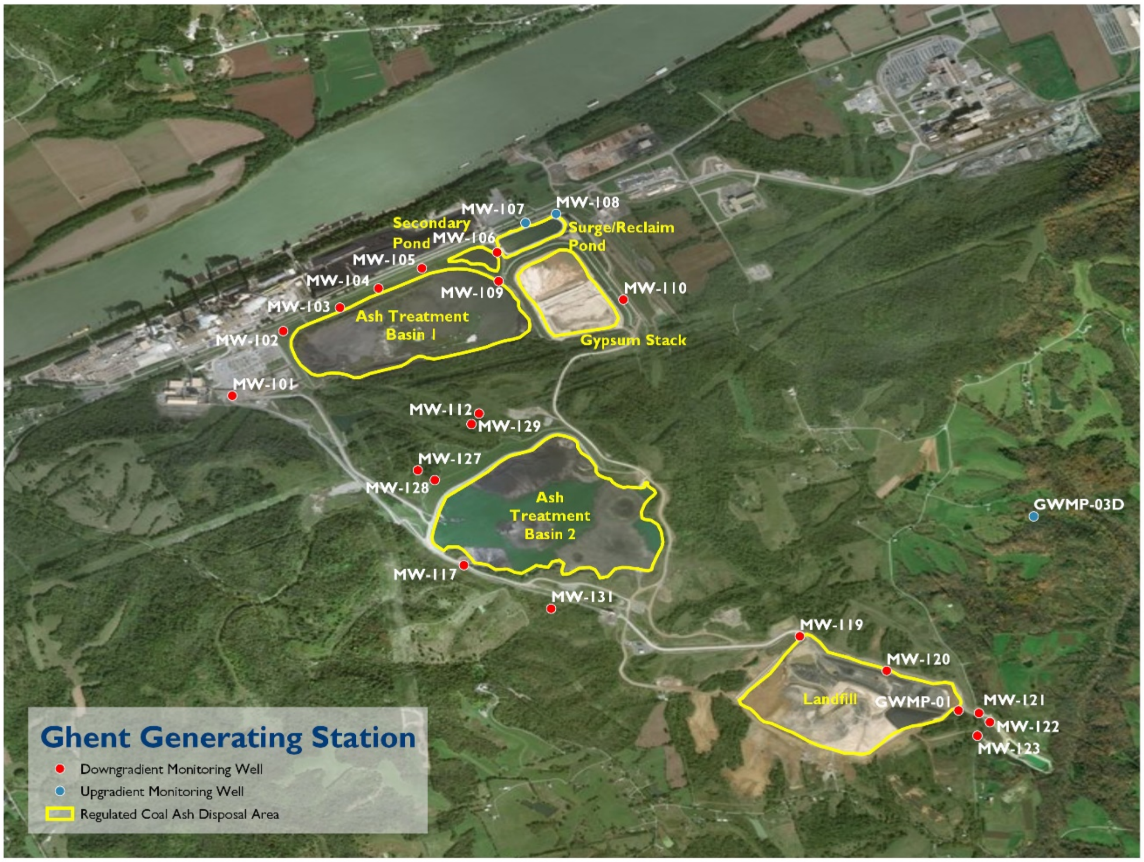
The Ghent station near Ghent, Kentucky is operated by Kentucky Utilities, a subsidiary of PPL Corporation. There are six regulated coal ash units at the site.[99] Four of these units are clustered on the south bank of the Ohio River and monitored with a single, multi-unit well network. These are Ash Treatment Basin #1, the Gypsum Stack, the Reclaim Pond, and the Secondary Pond; the four units have a combined surface area of roughly 220 acres. Another ash pond, the 146-acre Ash Treatment Basin #2, is located south of the first four units and monitored separately. There is also a 426-acre ash landfill south of Ash Treatment Basin #2.

All three well networks show evidence of leakage. Kentucky Utilities has initiated assessment monitoring at the ash ponds, and has acknowledged that the groundwater exceeds groundwater protection standards. However, it does not appear that Kentucky Utilities has initiated assessment monitoring at the landfill, despite the fact that boron concentrations in downgradient wells are plainly elevated above background. This is a violation of the Coal Ash Rule. Kentucky Utilities must conduct assessment monitoring at the landfill, and take action to restore groundwater quality.

The ash ponds at the site are unlined, and Ash Treatment Basin #2 is in direct contact with groundwater.[100] Kentucky Utilities is planning to leave all of the coal ash in place when these units are closed. This is problematic, particularly for Ash Treatment Basin #2. Leaving ash in that basin, waterlogged, will virtually guarantee ongoing groundwater pollution for generations to come. The only responsible and environmentally protective way to close this ash pond is to excavate the ash and move it to a lined, dry landfill.

Table 15: Unsafe groundwater at Ghent

Pollutant (units)	Well with highest average concentration	Mean concentration in that well	Safe level
Antimony (µg/L)	MW-117	9	6
Arsenic (µg/L)	MW-131	25	10
Beryllium (µg/L)	MW-131	8	4
Boron (mg/L)	MW-106	13	3
Chromium (µg/L)	MW-131	327	100
Cobalt (µg/L)	MW-131	74	6
Lead (µg/L)	MW-121	49	15
Lithium (µg/L)	MW-117	6,167	40
Molybdenum (µg/L)	MW-128	659	40
Radium (pCi/L)	MW-117	157	5
Sulfate (mg/L)	MW-106	1,350	500
Thallium (µg/L)	MW-118	3	2



E. Discussion

1. Flaws in the Coal Ash Rule and in the Groundwater Reports

The 2015 Coal Ash Rule suffered from a number of critical weaknesses, some of which the Environmental Integrity Project, Earthjustice and others successfully challenged. For example, the original rule waived most requirements – including groundwater monitoring requirements – when owners committed to closing impoundments by April, 2018. This was in effect an exemption or loophole for 'early closure' ash ponds. After being challenged in federal court, EPA voluntarily rescinded that loophole. The 2015 Rule also failed to include boron in the list of assessment monitoring pollutants (which, when elevated, can trigger corrective action), despite the fact that boron was one of the leading risk drivers in EPA's risk assessment, with significant risks to both humans and aquatic life. Environmental organizations challenged that omission, and EPA agreed to revisit the issue. In 2018, EPA proposed to add boron to Appendix IV.

Another problem with the 2015 Coal Ash Rule was that it allowed unlined surface impoundments to remain open until they showed statistically significant evidence of contamination. In 2018, the U.S. Court of Appeals for the D.C. Circuit found that unlined impoundments are inherently dangerous, and ruled that they should all be closed.[101]

Despite these successes, the Coal Ash Rule continues to suffer from critical weaknesses that affect the interpretation of groundwater monitoring data. In addition, the ways in which power companies have implemented the Coal Ash Rule make interpreting the groundwater data more complicated.

Unmonitored coal ash dumps

Perhaps the single most important gap in the Coal Ash Rule is the fact that it only applies to some coal ash dumps at each site. Specifically, the requirements of the rule only apply to coal ash landfills that continued to receive coal ash after October, 2015, and to coal ash ponds that "still contain[ed] both CCR [coal ash] and liquids on or after" October, 2015. The requirements of the rule do not apply to older, inactive landfills and ash ponds. Most coal plants have a mix of coal ash dumps that fall on either side of that divide, meaning some are regulated and monitored, and some are not.

By ignoring a large subset of coal ash dumps, the Coal Ash Rule will allow some groundwater contamination to continue indefinitely. This makes the restoration of groundwater quality at most sites very difficult or impossible to achieve.

For example, Luminant monitors the groundwater around one coal ash landfill at its Sandow Steam Electric Station in Rockdale, Texas, about an hour northeast of Austin.[102] Yet there appear to be several onsite coal ash disposal areas. In its 2014 Risk Assessment for the Coal Ash Rule, EPA identified six distinct coal ash dumps at Sandow, including one surface impoundment and five landfills.[103] Some or all of these older ash dumps were probably closed in place, and they are likely to be current and future sources of contamination.

The Reid Gardner Generating Station in Moapa, Nevada provides another graphic example of this problem. According to its Coal Ash Rule compliance website, the owner of Reid Gardner – NV Energy – believes that one landfill and six impoundments are covered by the Rule. The regulated ash ponds are named B1, B2, B3, E1, M1, and M2. So far, NV Energy has only posted groundwater monitoring information for the landfill and two of the impoundments (M1 and M2), with a total of seventeen monitoring wells. In all three cases, NV Energy has observed higher levels of contamination in upgradient wells and claimed that the groundwater contamination is coming from something else. NV Energy has not posted any data for the Appendix IV constituents, as required by the rule, so we have no information about onsite concentrations of arsenic, cobalt, lithium, and other toxic Coal Ash Rule pollutants.

Based on everything described above, one might conclude that coal ash from Reid Gardner is not contaminating groundwater. Yet Reid Gardner is one of EPA's "damage cases" and its multiple coal ash dumps have caused groundwater contamination, surface water contamination, and other "offsite impacts."[104] This is consistent with the Environmental Integrity Project's Ashtracker database (ashtracker.org), which reveals dramatically elevated levels of several coal ash constituents, including:

- Arsenic concentrations as high as 997 µg/L, nearly 100 times higher than the MCL for arsenic (10 µg/L);
- Boron concentrations as high as 545 mg/L, more than 100 times higher than the EPA Child Health Advisory of 3 mg/L;
- Cadmium concentrations as high as 560 µg/L, more than 100 times higher than the MCL for cadmium (5 µg/L);
- Selenium concentrations as high as 3.5 mg/L, 70 times higher than the selenium MCL (0.05 mg/L).

NV Energy's reporting under the Coal Ash Rule is just a partial snapshot of the site. So far, the company has posted groundwater data for just seventeen wells. Yet we know that there have been over 120 groundwater monitoring wells at the site in recent years. In addition, EPA's Risk Assessment identified three ash ponds not monitored under the CCR Rule. These may have been excavated and closed, but any contamination caused by these ash dumps could persist onsite.

In order to successfully restore groundwater quality and protect public health, coal ash regulations must address all sources of coal ash pollutants at every site.

Upgradient wells contaminated by coal ash

The coal ash rule requires that groundwater monitoring networks "accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit."[105] Many coal plant owners have ignored this requirement, and many 'upgradient' wells are affected by leakage from a coal ash unit. For example:

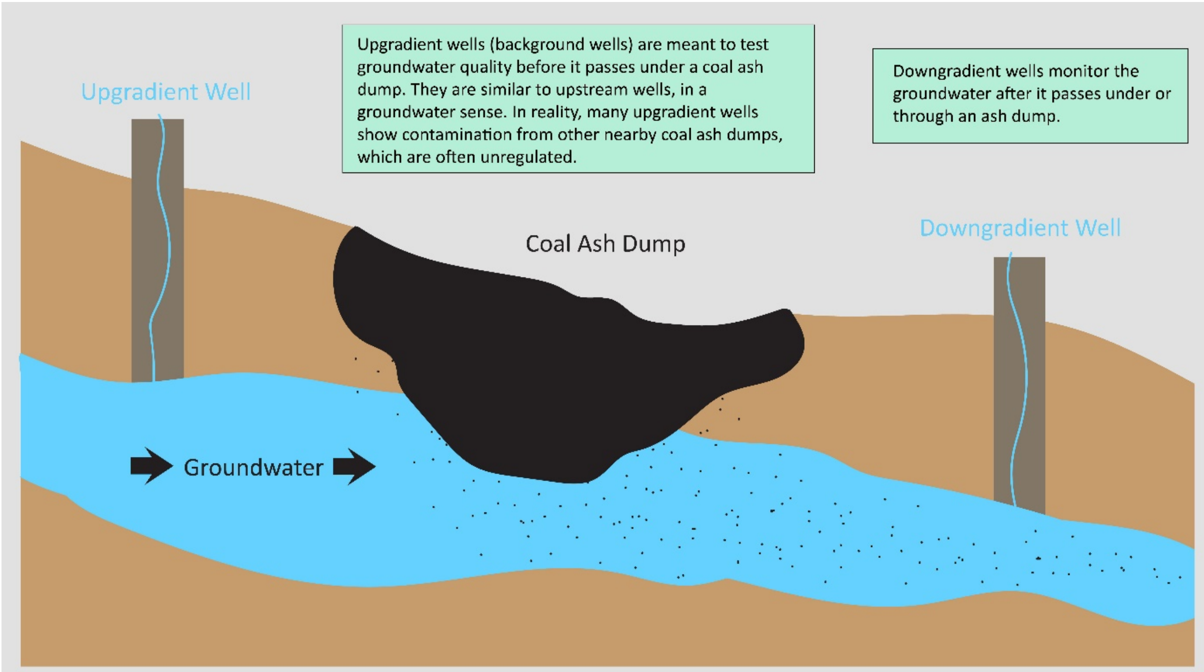
- At the Sandow and Reid Gardner sites described above, there appear to be multiple unregulated coal ash dumps at each site, and the 'upgradient' wells (upgradient of the regulated, monitored coal ash dumps) often show more contamination than the downgradient wells. As a result, there is very little statistical evidence of contamination from the regulated dumps, even though they may very well be leaking. The contamination in upgradient wells is likely to be coming from unregulated coal ash dumps. In short, although the groundwater at Sandow and Reid Gardner has unsafe levels of coal ash constituents, almost certainly caused by onsite coal ash, the owners of these two sites may never have to restore groundwater quality.
- In other cases, the purportedly 'upgradient' wells are not upgradient at all. At Georgia Power's Plant Bowen, near Euharlee, Georgia, 50 miles northwest of Atlanta, several wells on the southwest corner of the onsite ash pond complex have been designated 'upgradient'[106] even though (a) Georgia Power concedes that there is

"a component of [groundwater] flow to the southwest" in that area,[107] and (b) some of these wells show signs of coal ash contamination, including high boron and sulfate concentrations. To be fair, it appears that Georgia Power is aware of this problem and may be seeking to correct it. But the first annual report treats these wells as upgradient, and this is unfortunately an example of a common problem.

- In some cases we see both problems. For example, the Will County Generating Station in Romeoville, IL has two regulated coal ash ponds.[108] But there are also two unregulated ash ponds immediately north of the two regulated ponds.[109] The owner stopped using the unregulated ponds before the Coal Ash Rule came into effect, but they still contain coal ash. In addition, one of the two 'upgradient' wells at Will County was installed in several feet of coal ash fill.[110] And the two 'upgradient' wells may not be upgradient at all – they are installed just feet from the edge of the regulated ash ponds, and groundwater may be flowing radially (in all directions) away from the ash ponds.[111] The two 'upgradient' wells generally have higher concentrations of boron and sulfate than the downgradient wells, which could be used to argue that the downgradient wells are not being contaminated by the regulated ash ponds. In reality, however, the data are perfectly consistent with contamination coming from all three sources—ash fill, unregulated ash ponds, and regulated ash ponds. In any case, it is clear that the groundwater at Will County has unsafe levels of coal ash constituents from one or more of these sources.

In short, purportedly 'upgradient' wells are often impacted by onsite coal ash. If we had included upgradient wells in our analysis, then the number of sites showing unsafe levels of one or more constituents of coal ash would be even higher: 96 percent of sites have unsafe levels of coal ash constituents in up- or downgradient wells.

Upgradient and Downgradient Well Illustration



Inadequate water quality tests

In some cases, coal plant owners are not using sufficient laboratory methods. If a test cannot detect a concentration as low as the groundwater protection standard, then it cannot provide any assurance that the groundwater is 'safe.' For example, at the Cholla Power Plant in Joseph City, Arizona, lithium is frequently reported as undetected ("ND" or "nondetect").[112] The laboratory reports do not provide a method detection limit, but do show a reporting limit of 0.2 mg/L.[113] The monitoring results must be treated as "less than 0.2 mg/L." Lithium is unsafe at concentrations of more than 0.04 mg/L. Lithium concentrations of "less than 0.2 mg/L" could be above or below that threshold. When averaging data, we assume that nondetects are present at one-half of the detection limit, or, when the detection limit is not provided, one-half of the reporting limit. In this case, our algorithm assumes a lithium concentration of 0.1 mg/L. This shows up as 'unsafe' in our analysis. In truth, we really don't know what the lithium concentration is, or whether it is safe or unsafe. But the uncertainty is due to the owner's failure to use appropriate test methods, and so we err on the side of caution.

Multiple plants are using detection limits or reporting limits that far exceed the safe levels of harmful coal ash contaminants. This practice must stop. Data generated using inadequate laboratory methods do not inform the public or regulators about potential pollution, and allow owners and operators to evade cleanup requirements. EPA and/or the states must formally require all owners and operators to use laboratory methods that are sensitive enough to detect pollutants at levels as low as their respective groundwater protection standards.

Failure to monitor all constituents

The owners and operators of coal ash dumps are required to conduct eight rounds of baseline monitoring, during which they are supposed to measure all of the pollutants listed in Appendices III and IV of the Coal Ash Rule.[114] A number of sites have failed to meet this requirement, either by conducting less than eight rounds of sampling, or by failing to collect data on certain constituents.

- The sites posting less than eight rounds of baseline data include the James DeYoung Power Plant in Michigan, the Brickhaven structural fill site in North Carolina, the Big Fork Ranch site in Oklahoma, the Grand River Dam Authority landfill in Oklahoma, the Sunnyside cogeneration site in Utah, and the TransAlta Centralia Mine site in Washington.
- Five sites have failed to post data for Appendix IV pollutants (arsenic, cobalt, molybdenum, radium, etc.). These include the Plum Point Energy Station in Arkansas, the Reid Gardner and Valmy Generating Stations in Nevada, and the Limestone and W.A. Parish plants in Texas.

Other Noncompliance

Many of the regulated coal plants in the U.S. have failed to follow the core requirements of the Coal Ash Rule, a fact that has been exhaustively tracked by Earthjustice. See earthjustice.org/coalash/data and earthjustice.org/coalash/map. For example, ten coal plants are claiming that they are eligible for the deadline extensions applicable to "early closure" ponds (see note 43), even though they failed to properly post the prerequisite notice of intent to close by the regulatory deadline. Four plants have not posted the requisite closure plans. Eight-five units have failed to demonstrate whether they comply with the "aquifer restriction" in 40 C.F.R. § 257.60.

In addition, over 60 units have websites that require users to sign in and provide an email address. While this is not a formal violation of the Coal Ash Rule, it certainly violates Rule's goals of transparency and public participation.

Unrecognized risks

Our evaluation, like the Coal Ash Rule, focused on health-based thresholds for drinking water. These values miss the mark in several ways, and fail to capture the true scope of the threat.

Arsenic. The groundwater standard for arsenic in the Coal Ash Rule is set at the same level as the MCL for arsenic – 10 µg/L. But the arsenic MCL is not a purely health-based value. The EPA set the MCL at this level in 2001 based on the cost of removing arsenic and based on the science available at the time.[115]

A purely health-based limit would be much lower. In most cases the EPA will reduce exposure to carcinogens to a level of 'acceptable risk,' something between 10^{-6} (1 in 1,000,000) to 10^{-4} (1 in 10,000).[116] The cancer risk associated with arsenic at the level of the MCL (10 μg/L) is well above this acceptable risk range, at 1 in 2,000.[117]

In reality, the cancer risk may be even higher. EPA is in the process of revising its cancer potency estimates for arsenic, and according to a recent draft Toxicological Review, arsenic is 17 times more carcinogenic than previously thought.[118] Using the more recent estimates, the cancer risk from drinking arsenic at 10 μg/L is **1 in 136**.[119]

In short, the groundwater at many coal ash sites has unsafe levels of arsenic, even if it falls below the MCL. An alternative health-based threshold for arsenic is the EPA Regional Screening Level of 0.052 μg/L.[120] Using this threshold, 81 percent of sites would have unsafe levels of arsenic in groundwater.

Mercury. The Coal Ash Rule evaluates whether mercury exceeds a level that is safe for drinking (the mercury MCL of 2 μg/L). However, EPA's 2014 Risk Assessment suggests that mercury in drinking water is less of a concern than mercury in fish tissue.[121] Mercury bioaccumulates in aquatic food chains, meaning that relatively low levels in surface water can be associated with unsafe levels in fish.[122] While only 4 percent of sites appear to have mercury levels that present a drinking water risk (as shown in Table 1, above), many more sites may present a fish ingestion risk.

Selenium. As with mercury, selenium in drinking water is less of a concern than the damage it can cause when it bio-accumulates in the aquatic food chain.[123] Selenium presents potential risks, both to fish and to people who eat fish, at concentrations well below the MCL of 50 μg/L. For example, researchers have found dangerous levels of selenium in fish tissue in coal ash-impacted lakes even when surface water concentrations are less than 1.5 μg/L.[124] Not surprisingly, the list of "damage cases" that EPA compiled for the Coal Ash Rule includes over 20 instances of surface water damage involving selenium.[125] While only 13 percent of sites have groundwater levels of selenium that are unsafe for drinking, there may be a larger number of sites with surface water impacts.

Other constituents. The Coal Ash Rule does not require monitoring of all constituents of coal ash, including some ubiquitous and dangerous pollutants. Aluminum and manganese, for example, are both neurotoxins that are often elevated at coal ash sites.[126]

Cumulative risk. Finally, the Risk Assessment for the Coal Ash Rule evaluated the risk for each constituent independently, and did not consider cumulative risks. The constituents of coal ash include multiple known or potential carcinogens, several neurotoxins, and multiple chemicals that are toxic to aquatic life. The cumulative risk of cancer, neurological damage, or ecological damage at a given site is therefore likely to be substantially higher than the risk associated with any single constituent.

In short, groundwater contaminated by coal ash presents a diverse spectrum of risks, only some of which are addressed by requiring attainment of the drinking water standards in the

Coal Ash Rule. This underscores the necessity of cleaning up coal ash sites and restoring groundwater quality, even if no one happens to be drinking the groundwater. EPA is required by federal law to ensure that "there is no reasonable probability of adverse effects on health or the environment from disposal of [coal ash]."[127] One could argue that the Coal Ash Rule does not go far enough – it requires the restoration of groundwater, but only to levels that meet drinking water standards. The states must treat the Coal Ash Rule as a "floor," the minimum set of protections that might meet EPA's statutory mandate. In order to truly protect health and the environment, states should consider additional requirements, such as residential well testing, stricter groundwater standards for arsenic and other pollutants, and the monitoring of water quality and biological conditions in nearby streams and lakes.

2. Drinking Water Impacts near Coal Ash Sites

While there is ample evidence of groundwater contamination from wells on power plant property, determining the quality of drinking water in nearby communities is much more difficult. Most often, neither power companies nor state regulators test private drinking water wells. As a result, we cannot at this time determine the safety of drinking water near the hundreds of coal ash dumps analyzed in this report.

That said, there are many known instances of offsite drinking water being contaminated by coal ash. The most widespread drinking water contamination occurred in Town of Pines, Indiana, from coal ash in a landfill and used as structural fill throughout the town.[128] As a result of the contamination, EPA declared Town of Pines a Superfund site in 2001, and NIPSCO, the utility responsible, eventually provided municipal water to most residents and removed coal ash and contaminated soil from the town. Additional examples include:

- The Lincoln Stone Quarry in Joliet, Illinois. After boron and possibly other pollutants migrated offsite to residential wells, the owner of the quarry offered to dig deeper wells for affected residents and installed a groundwater pumping system to keep the contamination plume closer to the source.[129]
- Gibson Generating Station in Princeton, Indiana. Duke Energy had to supply bottled water after finding elevated levels of boron in offsite residential wells.[130]
- Gambrills, Maryland, coal ash landfill. Coal ash dumped in an old sand and gravel mine caused unsafe levels of arsenic, beryllium, lithium, and other pollutants in multiple offsite residential wells.[131] Constellation Energy had to provide an alternative source of clean water and install a pump-and-treat system.
- Colstrip Power Plant in Colstrip, Montana. Unsafe levels of boron, sulfate and possibly other pollutants migrated into a residential neighborhood. The owners of the plant had to provide clean water, and settled a lawsuit with 57 Colstrip residents for $25 million in damages.[132]

- Asheville Generating Station in Arden, North Carolina. At least one residential well has been contaminated by the site's ash ponds, and Duke Energy had to supply alternative drinking water.[133]
- G.G. Allen Steam Station in Belmont, North Carolina. As described above, this is one of the most contaminated sites in the country, and Belmont residents believe that the plant's pollution is impacting their drinking water wells. Duke Energy claims innocence while acting guilty, offering the residents alternative drinking water supplies – and money – if they waive their right to sue the company.[134]
- Little Blue Run surface impoundment in Greene Township, Pennsylvania. The Little Blue Run impoundment is in reality a huge, 1,300-acre valley fill that has contaminated multiple offsite drinking water wells. First Energy has purchased several affected properties and has had to provide alternative sources of clean water.[135]
- Trans-Ash landfill in Camden, Tennessee. A former gravel quarry filled with coal ash from the Tennessee Valley Authority's Johnsonville coal plant caused mercury contamination in a neighboring residential well. EPA had to connect that resident to municipal water through an Emergency Removal Action.[136]
- Yorktown Power Station in Yorktown, Virginia. Sand and gravel pits were filled with fly ash between 1957 and 1974, and in 1980 several nearby residential wells became contaminated with arsenic, beryllium, chromium, manganese, selenium and other pollutants. EPA ultimately listed the disposal area as a Superfund site and replaced the water supply for "55 homes with contaminated well water."[137]
- Battlefield Golf Course in Chesapeake, Virginia. According to EPA, "[a]bout 25" drinking water wells had elevated levels of boron that may be coming from coal ash used as structural fill at a golf course.[138] Some of these wells also had elevated levels of manganese and thallium.
- Edgewater power station in Sheboygan, Wisconsin. A set of coal ash ponds has caused elevated iron and sulfate concentrations in offsite water supply wells.[139]
- Port Washington facility in Ozaukee County, Wisconsin. A quarry filled with coal ash has contaminated at least one downgradient private well with boron, selenium and sulfate. Wisconsin Electric Power Company purchased and retired the contaminated well, replacing it with a deeper well.[140]
- WE Energies landfill in Waukesha, Wisconsin. A former gravel quarry was filled with coal ash between 1969 and 1978. Nearby residential wells became contaminated within the next ten years. The coal ash was excavated in 1999, but residential wells continued to show unsafe, and in some cases increasing, levels of boron, molybdenum and sulfate up to fifteen years after excavation.[141]
- Oak Creek Power Plant in Oak Creek, Wisconsin. This site has multiple coal ash landfills including one – the Caledonia landfill – that has received coal ash from five local coal plants. The landfills appear to be responsible for elevated boron and, in 33 drinking water wells, unsafe levels of molybdenum. Wisconsin Energy provided

> bottled water to "several dozen" residents. The company also purchased at least 25 homes around the site, demolishing several of them.[142]

The location of coal-ash contaminated sites often increases the likelihood of harm to human health. At many of the sites listed above, such as the Lincoln Stone Quarry in Joliet, Illinois, and the Town of Pines, Indiana, the impacted communities are disproportionately poor and non-white.[143]As stated above, these communities are unlikely to have the resources to routinely test their drinking water, and they often lack access to adequate medical care and legal assistance. In addition, these communities frequently confront multiple toxic threats and lack the political clout necessary to garner the attention and assistance of regulatory agencies and elected officials. In short, coal ash creates issues of environmental injustice, where harm falls disproportionately on our nation's most vulnerable communities.

3. Cleanup Requirements of the Coal Ash Rule

The vast majority of coal plants have unsafe levels of coal ash contamination in their groundwater, and most of them will have to take corrective and remedial action to restore groundwater quality. However, the timeline in the Coal Ash Rule is flexible, and many sites may attempt to avoid cleanup altogether.

Not all contaminated groundwater will trigger corrective action. In assessment monitoring, each owner must measure the fifteen pollutants found in Appendix IV to the Coal Ash Rule, including arsenic, cobalt, lithium, and others. If these assessment monitoring constituents are found to be significantly elevated above groundwater protection standards, and the owner cannot demonstrate that the pollution is coming from another source, then the owner must initiate corrective action.[144]

This provides three ways in which unsafe levels of contamination might escape corrective action. First, only assessment monitoring constituents can trigger corrective action. Boron and sulfate are not listed in Appendix IV of the Coal Ash Rule, so unsafe levels of boron or sulfate will not trigger corrective action.

Second, groundwater protection standards are set at the health-based levels shown in Table B1 of this report or at the background concentration, whichever is greater.[145] This means that contamination in downgradient wells will only trigger corrective action if it is greater than the presumptive health-based standards and also greater than upgradient or background concentrations.

Third, the Coal Ash Rule gives owners an opportunity to shift the blame: Contamination will not trigger corrective action if an owner can "[d]emonstrate that a source other than the [coal ash] unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality."[146]

However, if assessment monitoring constituents exceed groundwater protection standards, and the contamination cannot be explained away, then the owners must proceed with corrective action. This begins with an assessment of corrective measures, in which an owner must evaluate alternative remedial strategies.[147] The owner must complete the assessment of corrective measures within 180 days of finding significant evidence of contamination. Next, the owner must hold a public meeting to discuss the assessment.[148] Then the owner must select a remedy that, among other things, restores groundwater quality, controls further releases, and removes from the environment "as much of the contaminated material that was released from the [disposal unit] as is feasible."[149] The cleanup must eventually result in groundwater that meets groundwater protection standards. The Coal Ash Rule does not set a deadline for selecting a remedy (it must be selected "as soon as feasible").[150] Nor does the rule set a deadline for completing the remedy, saying instead that it must be completed "within a reasonable period of time."[151]

So far, implementation of the Coal Ash Rule has not yet reached the corrective measures stage. Some sites are in assessment monitoring, many have determined that groundwater exceeds the Coal Ash Rule's groundwater protection standards, and over 70 plants are now required to complete cleanup plans in 2019. But at most sites, we still do not know whether or how the owners plan to remediate any onsite contamination.

4. EPA and States Must Provide Meaningful Regulatory Oversight and Enforcement

EPA's Coal Ash Rule was originally self-implementing – owners and operators are not required to obtain permits, but they do have to follow the rules. If they fail to do so, then then they can be sued by citizens in federal court. State agencies have the legal authority to enforce the rule, but the burden largely falls on impacted communities. In 2016, with the passage of the Water Infrastructure Improvements for the Nation (WIIN) Act, Congress amended RCRA to provide EPA with authority to enforce the Coal Ash Rule.[152] The WIIN Act also authorized EPA to formally approve state coal ash programs that are "as protective as" the federal rule.[153] To date, however, only one state (Oklahoma) has received such authorization. Currently, it does not appear that either EPA or states are monitoring or enforcing the requirements of the Coal Ash rule.

State or federal agency review, oversight and enforcement are critical to ensuring that operators are complying with important technical requirements of the Coal Ash Rule. The following are only a few of the many ways an agency can help communities achieve the health and environmental protections intended by the rule:

(1) **Ensuring accurate groundwater monitoring systems:** As described in this report, there are numerous disposal sites where operators have installed "upgradient" wells that are either (a) impacted by another source of coal ash, or (b) not upgradient at all. This makes it much harder to detect statistically significant evidence of

contamination, and therefore makes cleanup less likely. EPA or state oversight of these groundwater monitoring schemes is necessary to ensure an honest appraisal of groundwater impacts.

(2) **Evaluation of Alternative Source Demonstrations:** Operators can avoid cleanup obligations if they can demonstrate that there is an "alternative source" of groundwater contamination. These demonstrations are likely to be highly technical and complex, and thus difficult for the public to evaluate. Consequently, EPA and/or state regulators should carefully evaluate each alternative source demonstration to ensure that coal ash is not the source. In the event that an unregulated coal ash dump is the source of contamination, EPA or state agencies can use alternative authority to require cleanup of the groundwater, such as RCRA's imminent and substantial endangerment authority.[154]

(3) **Ensuring effective cleanup plans:** The vague cleanup requirements of the Coal Ash Rule may open the door to half measures. Cleanup plans are likely to be highly technical and hard to decipher. Evaluation by EPA and/or state regulators is needed to ensure that such plans meet the goal of stopping the source of contamination and restoring groundwater.

(4) **Guaranteeing safe closure:** Many operators are currently taking action to close coal ash disposal units, particularly unlined surface impoundments. Impoundments must be closed safely to ensure that hazardous substances do not continue to leak after closure. Operators are currently seeking to close the majority of impoundments in place, and are not paying adequate attention to ash that may be sitting in groundwater. Closure of groundwater-saturated ash in place is a recipe for failure, as the groundwater will continue to leach toxic chemicals out of the ash for decades. Regulatory oversight of closure plans is essential to prevent this practice.

In addition to detailed technical review of monitoring, cleanup and closure plans, EPA and/or state regulators must monitor websites and ensure that compliance documents are posted on time, and that they comply with the relevant requirements. There are many instances where obvious violations are occurring, yet there is no EPA or state enforcement.

5. The Critical Role for Impacted Communities

As mentioned above, citizens have the authority to sue in federal court to enforce the requirements of the Coal Ash Rule. Such involvement is particularly important in the context of groundwater monitoring, closure and cleanup. For example, citizens can take legal action when a plant owner fails to complete the required monitoring (or fails to share the data), when coal ash is left in contact with groundwater, or where cleanup plans fail to guarantee timely and effective groundwater remediation.

In addition, the Coal Ash Rule provides important opportunities for citizens to participate in the cleanup planning process.[155] To ensure effective cleanup and groundwater restoration, it is essential that the public weigh in on the scope and timing of the proposed remediation.

This is best accomplished early in the process, and consequently the public must insist on a transparent, fair and meaningful public dialogue.

While the Coal Ash Rule does not provide resources to the public to carry out such engagement, it may be possible to negotiate with the responsible operator for provision of funds for independent technical assistance, similar to the funds typically available to impacts communities under the Superfund program. If communities have the opportunity to work with a technical advisor, they will be better able to understand the complex issues involved in a cleanup, navigate the large volumes of technical information, and meaningfully participate in the decision making process. The programs applicable to Superfund cleanups include EPA's Technical Assistance Services for Communities (TASC) Program, the Partners in Technical Assistance Program (PTAP), the Technical Assistant Grant (TAG) Program, and the Technical Assistance Plan (TAP).[156] Local governments who seek technical help should be able to appeal to EPA for assistance under section 2003 of RCRA, 42 U.S.C. § 6913.[157] Affected communities can keep informed of the conditions and cleanup obligations at contaminated sites by consulting the comprehensive map and database of all regulated coal ash disposal units found on this website: earthjustice.org/coalash/map.

F. Conclusions and Recommendations

This report shows that virtually all coal plants (and offsite coal ash dumps) are contaminating groundwater. The vast majority of sites show contamination coming from active, regulated ash dumps. Other sites show elevated coal ash contaminants in upgradient or background wells; these contaminants are typically coming from older, unregulated and unmonitored ash dumps. It is important to understand that this is an early stage of the pollution problem at these sites. According to EPA models, offsite levels of contamination could continue to increase for hundreds of years.[158] It is therefore critically important to address the sources of contamination now, before more of the toxic constituents in the coal ash leak into the environment. To protect human health and the environment, EPA and/or the states should strengthen protections against coal ash in the following ways:

First, EPA and the states should regulate <u>all</u> coal ash dumps, not just the ones that happened to be accepting coal ash in 2015. The groundwater at most coal plants is being contaminated by both regulated and unregulated ash dumps. The only way to effectively restore groundwater quality, and to prevent risks to human health and aquatic life, is to control all sources of coal ash pollution at each site.

Second, the states (and/or EPA) should require all coal ash dumps—active and inactive—to be "high and dry." Leaving coal ash in groundwater, where there is nothing to prevent continuous leaching of toxic pollutants from the ash, is a recipe for disaster that will render aquifers and nearby surface water unsafe for generations. The Coal Ash Rule allows ash dumps to be closed in place, but not if the coal ash is sitting in groundwater. Specifically, the Coal Ash Rule requires owners to "control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of [coal ash], leachate, or contaminated run-off to the ground or surface waters…"[159] Many site owners have ignored this provision, and plan to close their ash dumps in place regardless of any groundwater infiltration. Furthermore, since the Coal Ash Rule does not regulate older, inactive ash dumps, it does not require excavation of these ash dumps, even if they are sitting in groundwater. This is an area where state agencies can and should step in to protect their natural resources from a long-term, serious threat.

Third, owners often fail to make their monitoring data transparent, and EPA should step in to fix that problem. Some owners are not measuring pollutants with sufficiently sensitive laboratory methods, making it impossible to know whether groundwater is safe or unsafe. Other owners have failed to post all of the required monitoring data. More generally, owners are posting data in a variety of ways that render the data very difficult to use. For example, many sites post documents in which the data are buried in hundreds of pages of laboratory reports. EPA should require electronic reporting, or at the very least require useful, concise and accurate summaries of the data.

Fourth, EPA and/or states should require testing of all drinking water wells within a certain radius of coal ash dumps, both active and inactive. If coal ash contamination is found above health standards, safe drinking water must be provided. The Coal Ash Rule only requires on-site testing of groundwater, but contamination from coal ash dumps can flow miles off-site and threaten the safety of residential drinking water wells. Unless private drinking water wells are tested, it is impossible to determine if the health of local communities is protected.

Fifth, EPA and/or states should require sampling of adjacent surface waters, including streams, rivers, lakes and reservoirs. Many common coal ash contaminants are bioaccumulative. The only way to ensure that coal ash does not pose a threat to aquatic life and the health of those consuming fish and wildlife is to test local waterways. Ideally this would include biological sampling (e.g., benthic macroinvertebrate surveys and fish tissue tests) and sediment testing. At the very least, surface water should be tested.

Sixth, federal and state authorities should help affected communities by performing oversight of technical compliance documents, particularly those concerning groundwater monitoring, closure, and cleanup. When noncompliance is discovered, regulatory authorities should pursue timely enforcement actions.

Lastly, federal and state authorities should pay immediate and close attention to contamination impacting communities of color and low-income communities and provide timely assistance to ensure a safe source of drinking water, address cumulative impacts that accentuate harm, and provide technical oversight and enforcement, as necessary, to ensure adequate cleanup.

Finally, EPA should consider the cumulative impact of exposure to multiple coal ash pollutants. As indicated in this report, groundwater is often contaminated by multiple pollutants from coal ash. The threat to health and the environment from these chemical cocktails is likely to be significantly greater than the threat from any single pollutant.

Appendix A: Nationwide Summary Table

Table A1 lists all of the coal plants or offsite coal ash landfills in our database, and shows the pollutants present at unsafe levels at each site. We generated the lists of pollutants according to the methods outlined in Appendix B. To briefly summarize, we first calculated a mean concentration for each pollutant in each well. We then excluded upgradient wells and all downgradient means that were lower than corresponding upgradient means. We then compared the highest downgradient mean concentration for each pollutant to the health-based thresholds shown in **Table B1**. The numbers following the names of pollutants in **Table A1** show the factor by which the highest mean concentration exceeds that pollutant's safe level.

For example, "Molybdenum (x53)" would mean that the highest molybdenum value at a site (the highest well-specific mean concentration) is 53 times higher than the health-based threshold for molybdenum.

Table A1 also shows the number of regulated ash ponds and ash landfills at each site.

It is important to note that **Table A1** underestimates the extent of the problem in two related ways.

- **First, Table A1 omits contamination coming from unregulated ash dumps**. As we discuss in the report, many sites have a number of older, unregulated coal ash dumps on their property. These older dumps are likely causing onsite contamination, but they are not monitored. We did not count contamination that appeared to be coming from something other than a regulated coal ash dump, even though this contamination is also caused by onsite coal ash.
- **Second, Table A1 undercounts leaks from regulated ash dumps.** The upgradient wells at many sites show signs of coal ash contamination. If we determined that the wells around a given ash pond or ash landfill showed more contamination in upgradient wells than in downgradient wells, we excluded those pollutants from our analysis. But sometimes downgradient levels of contamination will be lower than upgradient levels due to natural dilution and attenuation, even if the coal ash dump is leaking. Our approach therefore undercounted the downgradient wells affected by regulated units.

For purposes of clarity, **Table A1** distinguishes the twelve sites that show signs of coal ash contamination, but have higher levels of contamination in upgradient wells, from the eleven sites that appear to be truly "clean," with no pollutants present at unsafe levels.

APPENDIX A

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
AK	Healy Power Plant	Antimony (x2), Arsenic (x8), Fluoride (x4), Lithium (x1), Molybdenum (x7), Radium (x3), Selenium (x2), Sulfate (x1)	0	4
AL	Charles R. Lowman Power Plant	Arsenic (x5), Beryllium (x1), Boron (x4), Cobalt (x165), Lithium (x4), Molybdenum (x5), Sulfate (x2)	0	3
AL	Colbert Fossil Plant	Arsenic (x3), Boron (x1), Cobalt (x4), Molybdenum (x2)	0	1
AL	E.C. Gaston Steam Plant	Arsenic (x3), Boron (x1), Lithium (x15), Molybdenum (x53), Radium (x3), Sulfate (x1)	0	2
AL	James H. Miller, Jr., Electric Generating Plant	Arsenic (x1), Boron (x1), Cobalt (x14), Lithium (x6), Molybdenum (x2), Sulfate (x3)	0	1
AL	James M. Barry Electric Generating Plant	Arsenic (x7), Cobalt (x4)	0	2
AL	Plant Greene County	Arsenic (x37), Cobalt (x9), Lithium (x17), Sulfate (x2)	0	1
AL	William C. Gorgas Electric Generating Plant	Arsenic (x19), Beryllium (x1), Boron (x1), Lithium (x11), Molybdenum (x4), Sulfate (x6)	3	2
AR	Flint Creek Power Plant	Arsenic (x1), Cobalt (x1), Molybdenum (x1)	1	1
AR	Independence Plant	Boron (x1)	0	1
AR	John W. Turk Power Plant	Lithium (x3)	1	0
AR	Plum Point Energy Station	No pollutants present at unsafe levels	1	0
AR	White Bluff Plant	Beryllium (x2), Boron (x2), Cobalt (x5), Lithium (x6), Molybdenum (x4), Sulfate (x1)	1	0
AZ	Apache Generating Station	Cobalt (x8), Lithium (x2)	0	5
AZ	Cholla Power Plant	Arsenic (x3), Boron (x12), Cobalt (x8), Fluoride (x1), Lithium (x17), Molybdenum (x9), Radium (x2), Selenium (x2), Sulfate (x23)	1	3
AZ	Coronado Generating Station	Lithium (x14)	1	0
AZ	Navajo Generating Station	No pollutants present at unsafe levels	1	0
AZ	Springerville Generating Station	Lithium (x26), Sulfate (x3), Thallium (x1)	1	0

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
CO	Cherokee Station	Boron (x1), Lithium (x3), Molybdenum (x2), Sulfate (x3)	0	3
CO	Clear Spring Ranch	Boron (x1), Selenium (x4)	1	0
CO	Hayden Station	Boron (x16), Lithium (x16), Molybdenum (x34), Sulfate (x10)	1	0
CO	Nucla Generating Station	Arsenic (x3), Fluoride (x1), Lithium (x83), Molybdenum (x1), Sulfate (x4)	1	0
CO	Pawnee Station	Lithium (x4), Sulfate (x2)	1	0
CO	Rawhide Energy Station	Cobalt (x2), Lithium (x7), Molybdenum (x2), Selenium (x2), Sulfate (x7)	1	1
CO	Valmont Station	Arsenic (x2), Boron (x5), Cobalt (x4), Lithium (x5), Molybdenum (x6), Selenium (x5), Sulfate (x11)	1	2
DE	Indian River Generating Station	Arsenic (x1), Beryllium (x1), Boron (x2), Cobalt (x4), Lithium (x14), Molybdenum (x6), Sulfate (x1)	1	0
FL	Big Bend Power Station	Molybdenum (x2), Radium (x7)	0	1
FL	C.D. McIntosh Power Plant	Arsenic (x11), Lithium (x63), Radium (x12), Sulfate (x3)	1	0
FL	Crystal River Energy Complex	Arsenic (x144), Boron (x2), Cobalt (x1), Lithium (x9), Molybdenum (x6), Radium (x3), Sulfate (x2)	1	1
FL	Deerhaven Generating Station	Boron (x2), Lithium (x2), Molybdenum (x3), Radium (x1), Sulfate (x1), Thallium (x2)	1	1
FL	OUC Stanton Energy Center	Unsafe groundwater, but more contamination in upgradient wells	1	0
FL	Plant Crist	Boron (x26), Cadmium (x2), Cobalt (x15), Mercury (x3), Molybdenum (x42), Radium (x6), Sulfate (x1)	3	0
FL	Plant Smith	Arsenic (x3), Boron (x6), Lithium (x5), Radium (x8), Sulfate (x2)	0	1
FL	Seminole Generating Station	Boron (x1), Molybdenum (x2), Radium (x2), Sulfate (x2)	1	0
FL	St. Johns River Power Park	Boron (x10), Molybdenum (x1), Radium (x2), Sulfate (x3)	1	0
GA	Plant Bowen	Antimony (x1), Boron (x9), Cobalt (x2), Molybdenum (x2), Radium (x1), Sulfate (x1)	3	1
GA	Plant Crisp	No pollutants present at unsafe levels	0	1
GA	Plant Hammond	Arsenic (x36), Boron (x6), Cobalt (x30), Molybdenum (x12), Sulfate (x2)	1	3
GA	Plant McIntosh	Boron (x1), Cobalt (x1), Lithium (x3), Selenium (x6)	1	1
GA	Plant Scherer	Boron (x1), Cobalt (x44)	2	1

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
GA	Plant Wansley	Boron (x2), Cobalt (x24), Lithium (x1), Radium (x1), Sulfate (x1)	1	1
GA	Plant Yates	Beryllium (x4), Boron (x4), Cobalt (x5), Sulfate (x2)	0	3
IA	Burlington Generating Station	Arsenic (x8), Boron (x9), Lithium (x1), Molybdenum (x4), Sulfate (x1)	0	4
IA	Lansing Generating Station	Arsenic (x4), Boron (x1), Molybdenum (x1)	1	1
IA	Louisa Generating Station	Molybdenum (x1)	1	1
IA	Muscatine Power & Water CCR Landfill	Barium (x30), Boron (x7), Sulfate (x2), Thallium (x2)	1	0
IA	Neal North Energy Center	Arsenic (x8), Cobalt (x1), Lithium (x6), Molybdenum (x2), Selenium (x5), Sulfate (x2)	1	1
IA	Neal South Energy Center	Arsenic (x5), Boron (x2), Molybdenum (x1), Selenium (x1)	1	0
IA	Ottumwa Generating Station	Cobalt (x2), Sulfate (x2)	1	1
IA	Prairie Creek Generating Station	Arsenic (x2), Boron (x1), Molybdenum (x7)	1	6
IA	Walter Scott Jr. Energy Center	Arsenic (x12), Lithium (x4), Molybdenum (x1), Sulfate (x2)	1	1
IL	Baldwin Energy Complex	Lithium (x3), Molybdenum (x2), Sulfate (x1)	0	2
IL	Coffeen Power Station	Arsenic (x3), Boron (x4), Cadmium (x1), Cobalt (x47), Lead (x2), Lithium (x2), Sulfate (x5)	1	4
IL	Dallman Power Generating Station	Antimony (x2), Arsenic (x16), Boron (x7), Sulfate (x1), Thallium (x7)	0	2
IL	Duck Creek Power Station	Arsenic (x2), Cobalt (x6), Lead (x6), Lithium (x2)	1	2
IL	Edwards Power Station	Arsenic (x2), Cobalt (x7), Lead (x3), Lithium (x4)	0	1
IL	Havana Power Station	No pollutants present at unsafe levels	0	4
IL	Hennepin Power Station	Arsenic (x3), Boron (x3), Lithium (x2), Molybdenum (x8), Selenium (x1)	1	4
IL	Joliet #29 Generating Station	Cobalt (x1)	0	1
IL	Joliet #9 Generating Station	Arsenic (x11), Boron (x4), Lithium (x4), Molybdenum (x25), Sulfate (x1)	0	1
IL	Joppa Power Station	Cobalt (x3), Lead (x1)	1	1
IL	Kincaid Power Station	No pollutants present at unsafe levels	0	1

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
IL	Newton Power Station	Arsenic (x7), Cobalt (x1)	1	1
IL	Powerton Generating Station	Arsenic (x23), Molybdenum (x2), Sulfate (x1), Thallium (x2)	0	3
IL	Prairie State Generating Company, LLC	Arsenic (x4), Cobalt (x3), Lead (x2)	1	0
IL	SIPC Marion Power Plant	Arsenic (x4), Boron (x5), Cobalt (x67), Selenium (x3), Sulfate (x1), Thallium (x48)	0	1
IL	Waukegan Station	Sulfate (x1)	0	2
IL	Will County	Arsenic (x2), Molybdenum (x2)	0	2
IL	Wood River Power Station	Arsenic (x4), Boron (x20), Molybdenum (x13), Sulfate (x1)	0	4
IN	A.B. Brown Generating Station	Arsenic (x2), Boron (x4), Cobalt (x1), Lithium (x2), Molybdenum (x34), Radium (x1), Sulfate (x26)	1	2
IN	Bailly Generating Station	Arsenic (x2), Cadmium (x2), Lithium (x2), Molybdenum (x2), Thallium (x5)	0	4
IN	Cayuga Generating Station	Antimony (x2), Arsenic (x1), Boron (x3), Cobalt (x2), Lithium (x11), Molybdenum (x60), Sulfate (x2)	1	3
IN	Clifty Creek Station	Arsenic (x7), Boron (x3), Lithium (x13), Molybdenum (x64), Sulfate (x2)	0	2
IN	Eagle Valley Generating Station	Arsenic (x10), Boron (x3), Lithium (x4), Molybdenum (x6)	0	1
IN	F.B. Culley Generating Station	Arsenic (x8), Boron (x18), Cobalt (x3), Lithium (x3), Molybdenum (x8), Sulfate (x3)	0	1
IN	Gallagher Generating Station	Arsenic (x5), Boron (x7), Cobalt (x2), Lithium (x2), Molybdenum (x3), Sulfate (x2)	1	2
IN	Gibson Generating Station	Arsenic (x12), Boron (x8), Cobalt (x2), Lithium (x29), Molybdenum (x39), Selenium (x2), Sulfate (x3)	1	1
IN	Harding Street Generating Station	Antimony (x2), Arsenic (x48), Boron (x12), Lithium (x12), Molybdenum (x16), Sulfate (x3)	0	1
IN	Merom Generating Station	Unsafe groundwater, but more contamination in upgradient wells	1	0
IN	Michigan City Generating Station	Arsenic (x2), Thallium (x2)	0	1
IN	Petersburg Generating Station	Arsenic (x6), Beryllium (x1), Boron (x12), Cadmium (x2), Cobalt (x68), Lithium (x50), Molybdenum (x68), Sulfate (x2), Thallium (x12)	1	1

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
IN	R.M. Schahfer Generating Station	Arsenic (x7), Boron (x8), Cobalt (x7), Fluoride (x11), Lithium (x7), Molybdenum (x76), Radium (x2), Sulfate (x15)	1	4
IN	Rockport Plant	Arsenic (x2)	1	1
IN	Wabash River Generating Station	Arsenic (x1), Boron (x15), Lithium (x5), Molybdenum (x37), Sulfate (x3)	0	1
KS	Holcomb Common Facilities, LLC	Unsafe groundwater, but more contamination in upgradient wells	1	0
KS	Jeffrey Energy Center	Lithium (x2), Molybdenum (x13), Sulfate (x4)	3	1
KS	La Cygne Generating Station	Antimony (x1), Cobalt (x1), Lithium (x20), Sulfate (x10)	1	3
KS	Lawrence Energy Center	Unsafe groundwater, but more contamination in upgradient wells	1	0
KS	Nearman Creek Power Station	Arsenic (x2)	0	1
KS	Tecumseh Energy Center	Arsenic (x11), Cobalt (x3), Sulfate (x2)	1	1
KY	Big Sandy Plant	Arsenic (x1), Beryllium (x4), Cobalt (x16), Lithium (x6), Radium (x3), Sulfate (x1)	0	2
KY	Cooper Power Station	Lithium (x5), Molybdenum (x1)	1	0
KY	D.B. Wilson Generating Station	Cobalt (x19), Lithium (x1), Sulfate (x4)	1	0
KY	E.W. Brown Generating Station	Arsenic (x1), Boron (x1), Lithium (x4), Molybdenum (x4), Sulfate (x3)	1	2
KY	East Bend Electric Plant	Lithium (x9), Sulfate (x2)	2	1
KY	Elmer Smith Station	Boron (x4), Chromium (x12), Cobalt (x5), Lithium (x1), Molybdenum (x64), Selenium (x1), Sulfate (x1), Thallium (x1)	0	3
KY	Ghent Generating Station	Antimony (x2), Arsenic (x2), Beryllium (x2), Boron (x4), Chromium (x3), Cobalt (x12), Lead (x3), Lithium (x154), Molybdenum (x16), Radium (x31), Sulfate (x3), Thallium (x2)	1	2
KY	H.L. Spurlock Power Station	Boron (x1), Molybdenum (x3), Sulfate (x1)	1	1
KY	J.K. Smith Power Station	Lithium (x12), Radium (x1), Sulfate (x2)	1	0
KY	Mill Creek Generating Station	Arsenic (x41), Boron (x2), Lithium (x14), Molybdenum (x18), Sulfate (x3)	1	4
KY	Paradise Fossil Plant	Arsenic (x9), Boron (x12), Cobalt (x6), Lithium (x4), Molybdenum (x1), Sulfate (x4)	0	5

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
KY	Sebree Generating Station	Arsenic (x2), Lithium (x34), Mercury (x219), Sulfate (x5)	1	2
KY	Shawnee Fossil Plant	Boron (x1), Molybdenum (x3)	0	2
KY	Trimble County Generating Station	Arsenic (x4), Boron (x39), Fluoride (x1), Lithium (x53), Molybdenum (x68), Selenium (x9), Sulfate (x2)	0	2
LA	Big Cajun II Power Plant	Boron (x1), Sulfate (x2), Thallium (x1)	0	2
LA	Brame Energy Center	Cobalt (x2), Lead (x3)	0	2
LA	Dolet Hills Power Station	Boron (x2), Cobalt (x2), Lithium (x21), Radium (x1), Sulfate (x8)	1	2
LA	Roy S. Nelson Plant	Unsafe groundwater, but more contamination in upgradient wells	1	0
MD	Brandywine Ash Management Facility	Arsenic (x5), Beryllium (x2), Boron (x16), Cobalt (x47), Lithium (x222), Molybdenum (x111), Selenium (x9), Sulfate (x10)	1	0
MD	Fort Armistead Road	Unsafe groundwater, but more contamination in upgradient wells	1	0
MD	Westland Ash Management Facility	Boron (x3), Cobalt (x1), Lithium (x20), Molybdenum (x30), Selenium (x6), Sulfate (x3)	1	0
MI	BC Cobb Power Plant	Arsenic (x2), Cobalt (x1), Molybdenum (x2)	0	2
MI	Belle River Power Plant	Cobalt (x1), Lithium (x2), Molybdenum (x2)	1	2
MI	DE Karn Power Plant	Arsenic (x48), Cobalt (x1), Molybdenum (x1), Sulfate (x2)	0	1
MI	James DeYoung Power Plant	Fluoride (x1), Lithium (x3), Sulfate (x2)	0	1
MI	JB Sims Power Generation Plant	Boron (x41), Cobalt (x1), Sulfate (x2)	0	1
MI	JC Weadock Power Plant	Arsenic (x7), Beryllium (x4), Cobalt (x2), Lithium (x6), Sulfate (x5)	1	1
MI	JH Campbell Power Plant	Antimony (x3), Arsenic (x29), Cobalt (x2), Lithium (x2), Thallium (x1)	1	3
MI	JR Whiting Power Plant	Cobalt (x1), Lithium (x2)	0	1
MI	Monroe Power Plant	Lithium (x3), Sulfate (x3)	0	1
MI	Presque Isle Power Plant	Unsafe groundwater, but more contamination in upgradient wells	1	0
MI	River Rouge Power Plant	Arsenic (x4), Lithium (x2), Molybdenum (x2)	1	0
MI	Shiras Steam Plant	Cobalt (x2), Lead (x2)	0	1

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
MI	St. Clair Power Plant	Lithium (x2)	0	1
MI	Trenton Power Plant	Arsenic (x38), Lithium (x6), Radium (x9), Sulfate (x7)	1	0
MN	Boswell Energy Center	Arsenic (x3), Boron (x2), Molybdenum (x1), Sulfate (x3)	0	3
MN	General Waste & Recycling, LLC	Sulfate (x4)	1	0
MN	Hoot Lake Plant	No pollutants present at unsafe levels	1	0
MN	Sherburne County Generating Plant	Beryllium (x2), Cobalt (x1), Lithium (x1)	1	2
MN	Taconite Harbor Energy Center	No pollutants present at unsafe levels	1	0
MO	Iatan Generating Station	Arsenic (x2), Cadmium (x2), Lithium (x1)	1	0
MO	James River Power Station	Molybdenum (x1)	1	0
MO	John Twitty Energy Center	Antimony (x1), Molybdenum (x1)	1	0
MO	Labadie Energy Center	Arsenic (x3), Boron (x5), Lithium (x1), Molybdenum (x15)	1	2
MO	Meramec Energy Center	Arsenic (x2), Boron (x8), Lithium (x3), Molybdenum (x10), Sulfate (x2)	0	1
MO	Montrose Generating Station	Arsenic (x1), Boron (x2), Cadmium (x1), Cobalt (x18), Lithium (x8), Sulfate (x7)	1	1
MO	New Madrid Power Plant	Boron (x6), Cobalt (x1), Molybdenum (x85)	1	2
MO	Rush Island Energy Center	Arsenic (x24), Boron (x5), Molybdenum (x20)	0	1
MO	Sibley Generating Station	Arsenic (x20), Boron (x2), Molybdenum (x30)	1	2
MO	Sikeston Power Station	No pollutants present at unsafe levels	0	1
MO	Sioux Energy Center	Boron (x9), Cobalt (x2), Lithium (x1), Molybdenum (x181), Sulfate (x2)	1	3
MO	Thomas Hill Energy Center	Sulfate (x4)	0	1
MS	Choctaw Generation Limited Partnership, LLLP - Red Hills Operations	Cobalt (x1), Lithium (x1)	1	0
MS	Plant Victor Daniel	Lithium (x5)	2	1
MS	R.D. Morrow, Sr. Generating Station	Arsenic (x3), Boron (x12), Lead (x1), Lithium (x193), Molybdenum (x171), Sulfate (x6), Thallium (x1)	1	1

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
MT	Colstrip Steam Electric Station	Boron (x26), Cobalt (x11), Lithium (x28), Molybdenum (x9), Radium (x2), Sulfate (x27), Thallium (x2)	0	7
MT	Lewis & Clark Station	Boron (x8), Cobalt (x1), Lithium (x6), Molybdenum (x3), Selenium (x2), Sulfate (x12)	1	2
NC	Allen Steam Station	Arsenic (x6), Beryllium (x6), Cadmium (x1), Cobalt (x532), Fluoride (x1), Lithium (x12), Selenium (x7), Sulfate (x3), Thallium (x1)	1	2
NC	Asheville Steam Electric Plant	Boron (x3), Cobalt (x7), Radium (x14)	0	2
NC	Belews Creek Steam Station	Arsenic (x5), Beryllium (x1), Boron (x4), Cobalt (x37), Lithium (x24), Molybdenum (x8), Radium (x1)	2	1
NC	Brickhaven No. 2 Mine Tract "A"	Lithium (x4)	1	0
NC	Buck Steam Station	Cobalt (x12), Lithium (x9), Molybdenum (x1), Sulfate (x1)	0	3
NC	Cliffside Steam Station	Arsenic (x9), Beryllium (x2), Cobalt (x30), Selenium (x2), Sulfate (x1), Thallium (x1)	1	3
NC	Dan River Steam Station	Arsenic (x3), Cobalt (x2), Lithium (x3), Molybdenum (x1)	1	1
NC	H.F. Lee Energy Complex	Arsenic (x62), Boron (x1), Cobalt (x4), Lithium (x10), Molybdenum (x2)	0	1
NC	L.V. Sutton Energy Complex	Arsenic (x44), Boron (x1), Cobalt (x4), Lithium (x16), Molybdenum (x7)	1	1
NC	Marshall Steam Station	Arsenic (x4), Barium (x1), Beryllium (x1), Boron (x2), Cobalt (x23), Lithium (x2), Radium (x3), Thallium (x1)	1	1
NC	Mayo Steam Electric Plant	Arsenic (x1), Boron (x1), Cobalt (x1), Lithium (x5), Molybdenum (x2), Radium (x2)	1	3
NC	Roxboro Steam Electric Plant	Arsenic (x2), Boron (x16), Cobalt (x6), Fluoride (x1), Lithium (x14), Molybdenum (x58), Radium (x2), Selenium (x2), Sulfate (x7)	1	4
NC	W.H. Weatherspoon Power Plant	Radium (x2)	0	1
ND	Antelope Valley Station	Cadmium (x100), Molybdenum (x1)	1	0
ND	Coal Creek Station	Arsenic (x2), Boron (x9), Chromium (x1), Cobalt (x6), Lead (x2), Lithium (x15), Sulfate (x10)	1	3

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
ND	Coyote Station	Arsenic (x1), Cobalt (x5), Selenium (x2), Sulfate (x10)	1	3
ND	Leland Olds Station	Unsafe groundwater, but more contamination in upgradient wells	1	0
ND	Milton R. Young Station	Lithium (x1)	1	1
ND	R.M. Heskett Station	Lithium (x54), Sulfate (x21)	1	0
ND	Stanton Station	Arsenic (x18), Lead (x1), Molybdenum (x2)	1	1
NE	Gerald Gentleman Station	No pollutants present at unsafe levels	1	0
NE	Lon D. Wright Power Plant	No pollutants present at unsafe levels	1	0
NE	Nebraska City Generating Station	Arsenic (x6), Boron (x1), Lithium (x1), Molybdenum (x2)	2	0
NE	North Omaha Station	Arsenic (x22), Boron (x1), Cobalt (x2), Lithium (x3), Molybdenum (x21), Selenium (x2), Sulfate (x2)	1	0
NE	Platte Generating Station	Cobalt (x3)	1	0
NE	Sheldon Station	Lithium (x3), Sulfate (x3)	1	0
NE	Whelan Energy Center	Molybdenum (x1)	0	1
NM	Escalante Generating Station	Arsenic (x2), Lithium (x15)	1	0
NM	Four Corners Power Plant	Arsenic (x1), Boron (x42), Chromium (x1), Cobalt (x45), Fluoride (x5), Lead (x2), Lithium (x20), Molybdenum (x4), Radium (x5), Selenium (x2), Sulfate (x21)	1	4
NV	North Valmy Generating Station	Boron (x2), Fluoride (x2)	1	0
NV	Reid Gardner Generating Station	Boron (x3), Sulfate (x6)	1	1
NV	TS Power Plant	Arsenic (x1), Lithium (x2)	1	0
NY	Dunkirk Generating Station	Antimony (x4), Cobalt (x4), Thallium (x2)	1	0
NY	Huntley Generating Station	Antimony (x4), Arsenic (x3), Boron (x2), Cobalt (x4), Lead (x2), Lithium (x2), Sulfate (x4), Thallium (x14)	1	1
OH	Cardinal Plant	Arsenic (x5), Boron (x2), Lithium (x5), Molybdenum (x9), Sulfate (x3)	1	2
OH	Conesville Plant	Arsenic (x14), Beryllium (x1), Boron (x4), Cobalt (x7), Fluoride (x2), Lead (x1), Lithium (x4), Molybdenum (x15), Radium (x2)	1	1

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
OH	Gavin Power Plant	Arsenic (x3), Boron (x2), Chromium (x2), Cobalt (x23), Fluoride (x2), Lead (x3), Lithium (x17), Molybdenum (x6), Sulfate (x1)	1	2
OH	JM Stuart Station	Arsenic (x10), Barium (x1), Boron (x5), Cobalt (x4), Lithium (x4), Molybdenum (x25), Radium (x2), Selenium (x2), Sulfate (x1)	2	5
OH	Killen Station	Boron (x2), Lithium (x20), Molybdenum (x32)	0	2
OH	Kyger Creek Station	Arsenic (x10), Barium (x37), Boron (x5), Cobalt (x1), Fluoride (x1), Lithium (x11), Molybdenum (x4), Radium (x2), Sulfate (x1)	1	2
OH	Miami Fort Power Station	Arsenic (x4), Boron (x6), Cobalt (x2), Molybdenum (x13), Sulfate (x2)	1	2
OH	Richmond Mill, Inc.	Boron (x10), Cobalt (x1), Lithium (x116), Molybdenum (x38), Radium (x15), Sulfate (x3)	1	0
OH	W.H. Sammis Power Station	Arsenic (x2), Cobalt (x2), Sulfate (x4)	1	1
OH	Zimmer Power Station	Arsenic (x1), Boron (x2), Cobalt (x1), Lithium (x6), Sulfate (x2), Thallium (x1)	1	3
OK	Big Fork Ranch	Arsenic (x2), Boron (x1), Lead (x1), Sulfate (x2)	1	0
OK	Grand River Energy Center	Sulfate (x7)	1	0
OK	Hugo Power Station	Boron (x3), Lithium (x9), Molybdenum (x13), Sulfate (x4)	1	1
OK	Northeastern 3&4 Power Station	Boron (x3), Fluoride (x1), Lithium (x8), Molybdenum (x16), Radium (x3), Sulfate (x2)	1	1
OR	Boardman Power Plant	No pollutants present at unsafe levels	1	0
PA	Bruce Mansfield Plant	Arsenic (x3), Barium (x13), Boron (x1), Lead (x1), Lithium (x8), Molybdenum (x1), Sulfate (x5)	0	1
PA	Brunner Island Steam Electric Station	Arsenic (x23), Cobalt (x14), Lithium (x5), Molybdenum (x8), Sulfate (x1)	1	1
PA	Cheswick Generating Station	Lithium (x1), Molybdenum (x2)	1	1
PA	Conemaugh Generating Station	Cobalt (x18), Sulfate (x2)	1	1
PA	Hatfield's Ferry Power Station	Boron (x5), Cobalt (x38), Sulfate (x4)	1	0

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
PA	Homer City Generating Station	Lithium (x4)	1	0
PA	Keystone Generating Station	Unsafe groundwater, but more contamination in upgradient wells	2	1
PA	Montour Steam Electric Station	Cobalt (x3), Lithium (x4), Sulfate (x3)	1	1
PA	New Castle Generating Station	Arsenic (x372), Boron (x3), Cobalt (x5), Lithium (x54), Molybdenum (x1), Sulfate (x4)	1	1
PR	AES Puerto Rico	Boron (x1), Lithium (x22), Molybdenum (x11), Selenium (x5), Sulfate (x31)	1	0
SC	Cope Generating Station	Unsafe groundwater, but more contamination in upgradient wells	1	0
SC	Cross Generating Station	Beryllium (x4), Boron (x7), Cobalt (x16), Lithium (x2), Radium (x3), Sulfate (x4)	1	1
SC	H.B. Robinson Steam Electric Plant	Arsenic (x11), Lithium (x2), Molybdenum (x1), Radium (x4)	0	1
SC	W.S. Lee Steam Station	Arsenic (x2), Cobalt (x11), Lithium (x2), Molybdenum (x4), Radium (x2)	0	1
SC	Wateree Generating Station	Arsenic (x118), Cobalt (x3), Lithium (x2), Radium (x1)	1	2
SC	Williams Generating Station	Arsenic (x2), Boron (x1), Cobalt (x1), Radium (x2)	1	1
SC	Winyah Generating Station	Arsenic (x47), Boron (x5), Lithium (x11), Molybdenum (x5), Radium (x1), Sulfate (x2)	0	4
SD	Big Stone Plant	Boron (x1), Cobalt (x1), Sulfate (x3)	1	1
TN	Allen Fossil Plant	Arsenic (x350), Boron (x2), Fluoride (x1), Lead (x4), Molybdenum (x9)	0	1
TN	Bull Run Fossil Plant	Lithium (x2), Sulfate (x1)	1	0
TN	Cumberland Fossil Plant	Arsenic (x1), Boron (x14), Cobalt (x2), Sulfate (x3)	0	4
TN	Gallatin Fossil Plant	Arsenic (x2), Boron (x4), Cobalt (x1), Lithium (x41), Molybdenum (x2), Sulfate (x1)	1	1
TN	Johnsonville Fossil Plant	Boron (x3), Cadmium (x1), Cobalt (x10), Sulfate (x1)	0	1
TN	Kingston Fossil Plant	Arsenic (x1)	1	0
TX	Big Brown Steam Electric Station	Arsenic (x1), Cobalt (x2), Selenium (x3)	1	1
TX	Calaveras Power Station	Beryllium (x4), Boron (x2), Cadmium (x2), Cobalt (x24), Lead (x1), Lithium (x2), Radium (x1), Selenium (x4), Thallium (x1)	1	3

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
TX	Coleto Creek Power Station	Boron (x3), Molybdenum (x3)	0	1
TX	Fayette Power Project	Lithium (x3), Sulfate (x3)	1	0
TX	Gibbons Creek Steam Electric Generating Station	Antimony (x3), Arsenic (x1), Beryllium (x28), Boron (x3), Cadmium (x19), Cobalt (x99), Lead (x2), Lithium (x20), Mercury (x1), Sulfate (x5), Thallium (x3)	1	2
TX	H.W. Pirkey Power Plant	Arsenic (x2), Beryllium (x2), Boron (x1), Cadmium (x1), Cobalt (x49), Lithium (x5), Mercury (x5), Radium (x2), Sulfate (x2)	2	2
TX	J. Robert Welsh Power Plant	Arsenic (x3), Beryllium (x3), Cobalt (x133), Lead (x2), Lithium (x49), Radium (x3), Sulfate (x10)	1	2
TX	Limestone Electric Generating Station	Boron (x2), Sulfate (x2)	1	4
TX	Martin Lake Steam Electric Station	Arsenic (x1), Beryllium (x2), Boron (x7), Cobalt (x32), Lithium (x5), Mercury (x12), Sulfate (x5)	1	2
TX	Monticello Steam Electric Station	Arsenic (x3), Beryllium (x8), Boron (x2), Cadmium (x4), Cobalt (x55), Lithium (x1), Selenium (x2)	0	1
TX	Oak Grove Steam Electric Station	Chromium (x2), Cobalt (x5), Lithium (x3), Selenium (x1)	1	1
TX	San Miguel Plant	Arsenic (x7), Beryllium (x138), Boron (x23), Cadmium (x124), Cobalt (x522), Fluoride (x3), Lithium (x93), Mercury (x3), Radium (x6), Selenium (x8), Sulfate (x20), Thallium (x9)	0	3
TX	Sandow Steam Electric Station	Chromium (x2), Lithium (x13)	1	0
TX	Sandy Creek Energy Station	Arsenic (x2), Cobalt (x2), Lead (x2), Lithium (x19), Selenium (x3), Sulfate (x6)	1	0
TX	Twin Oaks Power Station	Unsafe groundwater, but more contamination in upgradient wells	1	0
TX	W.A. Parish Electric Generating Station	Fluoride (x1), Sulfate (x3)	4	2
UT	Hunter Power Plant	Boron (x9), Cobalt (x26), Lithium (x228), Molybdenum (x11), Radium (x2), Sulfate (x66)	1	0
UT	Huntington Power Plant	Boron (x17), Chromium (x1), Cobalt (x2), Lithium (x102), Molybdenum (x1), Selenium (x3), Sulfate (x10)	1	0
UT	Intermountain Generating Facility	Arsenic (x4), Boron (x3), Lithium (x38), Mercury (x11), Molybdenum (x4), Sulfate (x9)	1	2

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
UT	Sunnyside Cogeneration Associates Facility	Arsenic (x1), Lithium (x26), Selenium (x3), Sulfate (x14)	1	0
VA	Bremo Power Station	Lithium (x2), Molybdenum (x2), Sulfate (x1)	0	1
VA	Chesterfield Power Station	Arsenic (x15), Beryllium (x1), Cobalt (x35), Lithium (x3), Molybdenum (x2), Radium (x2), Sulfate (x1)	1	3
VA	Clover Power Station	Lithium (x2)	1	1
VA	Possum Point Power Station	Cobalt (x1)	0	1
VA	Virginia City Hybrid Energy Center	Unsafe groundwater, but more contamination in upgradient wells	1	0
VA	Yorktown Power Station	Cobalt (x1)	1	0
WA	TransAlta Centralia Mine	Arsenic (x1), Cobalt (x15), Lithium (x4), Sulfate (x5)	1	0
WI	Caledonia Ash Landfill	Molybdenum (x1)	1	0
WI	Columbia Energy Center	Arsenic (x2), Molybdenum (x2)	1	1
WI	Dairyland Power Cooperative	No pollutants present at unsafe levels	1	0
WI	Edgewater Generating Station	Arsenic (x2), Boron (x3), Cobalt (x1), Lithium (x1), Molybdenum (x55)	1	4
WI	Nelson Dewey Station	Boron (x1), Molybdenum (x1), Thallium (x1)	0	1
WI	Pleasant Prairie Power Plant	Molybdenum (x4)	1	0
WI	Weston Power Plant Disposal Site	Cobalt (x2)	1	1
WV	Ft. Martin Power Station	Arsenic (x1), Boron (x1), Lithium (x1), Molybdenum (x2), Sulfate (x2)	2	0
WV	Harrison Power Station	Arsenic (x1), Mercury (x1), Molybdenum (x5), Sulfate (x2)	1	0
WV	John E Amos Plant	Cobalt (x4)	1	1
WV	Mitchell Plant	Arsenic (x1), Boron (x4), Molybdenum (x2)	1	1
WV	Mount Storm Power Station	Beryllium (x2), Cobalt (x10), Lithium (x2), Molybdenum (x3)	2	1
WV	Mountaineer Plant	Boron (x3), Lithium (x3), Molybdenum (x2), Sulfate (x3)	1	1
WV	Pleasants Power Station	Arsenic (x16), Barium (x2), Cobalt (x1), Radium (x6)	1	1

State	Site Name	Pollutants Exceeding Safe Levels (and by how much)	No. of Regulated Landfills	No. of Regulated Impoundments
WY	Dave Johnston Power Plant	Arsenic (x1), Boron (x2), Cobalt (x4), Lead (x2), Lithium (x2), Molybdenum (x4), Sulfate (x2)	1	1
WY	Jim Bridger Power Plant	Antimony (x1), Arsenic (x5), Boron (x6), Cadmium (x4), Cobalt (x96), Fluoride (x3), Lead (x5), Lithium (x170), Molybdenum (x12), Radium (x2), Selenium (x116), Sulfate (x131), Thallium (x13)	1	2
WY	Laramie River Station	Lithium (x3), Molybdenum (x5), Sulfate (x10)	1	4
WY	Naughton Power Plant	Arsenic (x5), Beryllium (x2), Boron (x1), Cobalt (x3), Lead (x1), Lithium (x195), Radium (x1), Selenium (x159), Sulfate (x65), Thallium (x14)	0	6

Appendix B: Methods

According to the terms of the Coal Ash Rule, most coal plants were required to post their "background monitoring" results in March, 2018, as part of their first annual groundwater monitoring reports. The Environmental Integrity Project teamed up with Earthjustice, the Sierra Club, Prairie Rivers Network, and dozens of volunteers to enter the data from these reports starting in March, 2018. The process was resource-intensive, as described below, and only concluded in January, 2019.

The first step was identifying the universe of regulated coal plants using the US EPA's "List of Publicly Accessible Internet Sites Hosting Compliance Data and Informatiion Required by the Disposal of Coal Combustion Residuals Rule."[160] We visited the websites for each site and downloaded annual groundwater monitoring reports after March 1, 2018. There are actually more reports than coal plants, because some owners posted reports for each onsite monitoring network. In the end, we reviewed at 443 annual reports from 265 regulated sites.

Next, we extracted groundwater monitoring results and well characteristics (including whether they were designated upgradient or downgradient) from the reports. We chose methods for each report that would minimize the potential for data entry errors. This was sometimes relatively straightforward. For example, some reports contained summary tables that could be easily converted into a spreadsheet. In most cases, however, the reports were difficult to work with. Certain summary tables did not include all of the necessary information. For example, they sometimes reported "nondetects" (described in more detail below) as "ND," without reporting the detection limit of the laboratory method. Other summary tables contained inaccurate information because of typos or other data entry issues on the part of the report author. There were many reports that listed reporting limits, but not method detection limits. Finally, a large number of reports omitted summary tables altogether, and we had to go through thousands of pages of laboratory reports to find the monitoring results. If we were lucky, we could automate the process of extracting data from lab reports and make manual corrections as necessary. In many cases, the lab reports were not amenable to automated data extraction, and we had to hand-enter each sampling result.

Once all of the data were entered, we had to look for and correct errors. Some of the errors originated with the groundwater reports (mainly typos), and in some cases there were errors in data entry (e.g., someone entered the wrong units of measurement).

The data analysis proceeded in several steps. First, we had to deal with "nondetects." When a chemical cannot be detected using a given laboratory method, the technician will record the result as "<" the detection or reporting limit of the laboratory method—the lowest concentration that can be reliably detected. When a chemical is not detected, that does not mean that it is absent. For example, a lithium result of "<0.2 mg/L" means that there was less than 0.2 mg/L of lithium in that sample. The true lithium concentration is unknown, but could be as low as zero or as high as 0.19 mg/L. We followed a conventional approach to this problem and assumed that nondetects were present at one-half of the detection limit or reporting limit.[161]

Next, we calculated an average (mean) concentration for each constituent in each well across all sampling rounds. We excluded data that were potentially attributable to something other than the regulated coal ash unit by (a) removing upgradient wells and (b) removing any downgradient mean concentrations that were lower than the highest upgradient mean concentration for that pollutant and disposal area. What remained was a set of downgradient mean concentrations that were greater than "background" levels.

We then compared the average downgradient values to health-based thresholds. For constituents with EPA Maximum Contaminant Levels (MCLs), we used the MCL as the health threshold. For other constituents, we used EPA drinking water advisories or Regional Screening Levels. For the most part, the thresholds we used are identical to the groundwater protection standards in the Coal Ash Rule. The only exceptions are boron, molybdenum and sulfate. Boron and sulfate do not currently have groundwater protection standards in the rule.[162] For molybdenum, which has a groundwater protection standard of 100 micrograms per liter, we chose to use EPA's lifetime health advisory of 40 micrograms per liter. The thresholds we used, and the corresponding groundwater protection standards in the Coal Ash Rule, are shown in Table B1 below.

Table B1: Groundwater monitoring pollutants and thresholds used in this report

	Health-based threshold	Presumptive groundwater protection standard under CCR rule[163]
Detection monitoring constituents (40 CFR Part 257, Appendix III)		
Boron	3 mg/L[164]	
Calcium		
Chloride		
Fluoride		
pH		
Sulfate	500 mg/L[165]	
Total Dissolved Solids (TDS)		
Assessment monitoring constituents (40 CFR Part 257, Appendix IV)		
Antimony	6 µg/L	6 µg/L
Arsenic	10 µg/L	10 µg/L
Barium	2 mg/L	2 mg/L
Beryllium	4 µg/L	4 µg/L
Cadmium	5 µg/L	5 µg/L
Chromium	100 µg/L	100 µg/L
Cobalt	6 µg/L	6 µg/L
Fluoride	4 mg/L	4 mg/L
Lead	15 µg/L	15 µg/L
Lithium	40 µg/L	40 µg/L
Mercury	2 µg/L	2 µg/L
Molybdenum	40 µg/L[166]	100 µg/L
Selenium	50 µg/L	50 µg/L
Thallium	2 µg/L	2 µg/L
Radium 226 and 228	5 pCi/L	5 pCi/L

In order to identify the nation's most contaminated sites, we looked at the extent to which each pollutant exceeded safe levels at each site, and then combined results for all pollutants at each site. This analysis started with the average (mean) concentration of each pollutant in each monitoring well. We then excluded upgradient wells, and also excluded downgradient wells with mean levels that were lower than corresponding upgradient levels (as described above). We then identified, for each site, the well(s) with the highest mean concentration of each pollutant. For example, the highest average arsenic concentration at the San Miguel plant in Texas was 74 micrograms per liter. This was the average concentration in monitoring well SP-32, a downgradient well. We then calculated the ratios of these 'highest average' concentrations to their respective health-based thresholds. For arsenic at San Miguel, the ratio would be 7.4 (74 μg/L divided by the arsenic MCL of 10 μg/L). Finally, we added the pollutant-specific ratios together to create a composite score for each site. These composite scores allowed us to rank the sites from most contaminated to least.

Notes

[1] *See, e.g.*, U.S. EPA, Coal Ash (Coal Combustion Residuals, or CCR), https://www.epa.gov/coalash ("In 2012, 470 coal-fired electric utilities generated about 110 million tons of coal ash").

[2] Environmental Integrity Project, Earthjustice and Sierra Club, In Harm's Way: Lack of Federal Coal Ash Regulations Endangers Americans and their Environment (Aug. 26, 2010) at xxii.

[3] U.S. Environmental Protection Agency, Damage Case Compendium, Technical Support Document, Volume I: Proven Damage Cases (Dec. 18, 2014) at pp. 140-154.

[4] *Id.* at pp. 202-207

[5] *Id.* at pp. 79-82.

[6] Some spills were less massive, but equally devastating to local ecosystems. For example, in 2002, a sinkhole in a coal ash pond at Plant Bowen in Georgia released over 280 tons of ash into a tributary of the Euharlee creek, depositing 8 inches of ash over 1,850 square feet of streambed and killing most of the aquatic life in that area. *Id.* at pp. 4-7.

[7] Environmental Integrity project and Earthjustice, Out of Control (Feb. 2010), http://www.environmentalintegrity.org/wp-content/uploads/2016/11/2010-02_Out_of_Control.pdf; Environmental Integrity Project, Earthjustice, and the Sierra Club, In Harm's Way (Aug. 2010), http://www.environmentalintegrity.org/wp-content/uploads/2016/11/2010-08_In_Harms_Way.pdf.

[8] *See, e.g.*, Environmental Integrity Project press release, EPA Agrees to Deadline for First-Ever US Coal Ash Regulations in Response to Groups' Lawsuit (Jan. 31, 2014), http://www.environmentalintegrity.org/news/news-epa-agrees-to-deadline-for-first-ever-us-coal-ash-regulations-in-response-to-groups-lawsuit/.

[9] *Id*.

[10] U.S. EPA, Human and Ecological Risk Assessment of Coal Combustion Residuals (Final, Dec. 2014), hereinafter "EPA Risk Assessment."

[11] U.S. EPA (1998), Integrated Risk Information System, Inorganic Arsenic, available at https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=278; ATSDR (2007), Toxicological Profile for Arsenic; Grandjean and Landrigan (2014), Neurobehavioural Effects of Developmental Toxicity, Lancet Neurol. 13:330-338. One recent study in Maine found significant reductions in IQ and other neurological endpoints in children exposed to 5-10 micrograms per liter, a level that is below the current drinking water standard. Wasserman et al. (2014), A Cross-Sectional Study of Well Water Arsenic and Child IQ in Maine Schoolchildren, Environ Health 13:23-32.

[12] EPA Risk Assessment at 5-5 to 5-6. In a preliminary screening analysis, EPA also identified a potential cancer risk associated with the consumption of arsenic-contaminated fish. Id. at 3-20.

[13] *See, e.g.*, U.S. EPA, Toxicological Review of Boron and Compounds (June 2004); Agency for Toxic Substances and Disease Registry , Toxicological Profile for Boron (November 2010); U.S. EPA, Drinking Water Health Advisory for Boron (May 2008).

[14] 83 Fed. Reg. at 11,589 ("[T]he 2014 risk assessment shows that boron can pose developmental risks to humans when released to groundwater and can result in stunted growth, phytotoxicity, or death to aquatic biota and plants when released to surfacewater bodies").

[15] *Id.*; EPA Risk Assessment at 5-8.

[16] U.S. EPA, Integrated Risk Information System, Cadmium, https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=141.

[17] EPA Risk Assessment at 3-20.

[18] *See, e.g.*, U.S. EPA, Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric power Generating Point Source Category at page 3-3 (Sep. 2015).

[19] EPA Risk Assessment at 5-8.

[20] *See, e.g.*, ATSDR, Toxicological Profile for Cobalt (Apr. 2004). The most sensitive endpoint for intermediate oral exposure in the ATSDR analysis was the blood disorder polycythemia, which has been observed in humans. *See also* U.S. EPA, Provisional Peer Reviewed Toxicity Values for Cobalt (2008). The EPA document notes that polycythemia and thyroid effects occur at similar levels of exposure, but derives a health-based threshold from thyroid toxicity data.

[21] EPA Risk Assessment at 5-8.

[22] *See, e.g.*, California EPA, Public Health Goal for Hexavalent Chromium (Cr VI) in Drinking Water (July 2011), https://oehha.ca.gov/media/downloads/water/chemicals/phg/cr6phg072911.pdf

[23] *See, e.g.*, P. Grandjean and P.J. Landrigan, Neurobehavioral Effects of Developmental Toxicity, Lancet Neurol 13:330-38 (2014); A.L. Choi et al., Developmental Fluoride Neurotoxicity: A Systematic Review and Meta-Analysis, Environ Health Perspect 120:1362-1368 (2012); M. Bashash et al., Prenatal Fluoride Exposure and Cognitive Outcomes in Children at 4 and 6-12 Years of Age in Mexico, Environmental Health Perspectives 125(9):097017 (2017).

[24] *See generally* NAS (National Academy of Sciences), Fluoride in Drinking Water: A Scientific Review of EPA's Standards (2006).

[25] *See, e.g.*, E.B. Bassin et al., Age-specific fluoride exposure in drinking water and Osteosarcoma (United States), Cancer Causes Control 17:421-428 (2006); NAS (National Academy of Sciences), Fluoride in Drinking Water: A Scientific Review of EPA's Standards at 134 (2006) ("Perhaps the single clearest effect of fluoride on the skeleton is its stimulation of osteoblast proliferation … Because fluoride stimulates osteoblast proliferation, there is a theoretical risk that it might induce a malignant change in the expanding cell population").

[26] U.S. EPA, Integrated Risk Information System, Lead and Compounds (inorganic), https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=277.

[27] *See, e.g.,* U.S. EPA, Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric power Generating Point Source Category at page 3-3 (Sep. 2015) ("Lead contamination can delay embryonic development, suppress reproduction, and inhibit growth in fish").

[28] *See* World Health Organization, "Lead Poisoning and Health," August 23, 2018, http://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health

[29] U.S. EPA, Provisional Peer Reviewed Toxicity Values for Lithium (2008).

[30] EPA Risk Assessment at 4-17, 5-5, 5-8.

[31] *See, e.g.*, U.S. EPA, Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric power Generating Point Source Category page 3-4 (Sep. 2015).

[32] EPA Risk Assessment at 3-20, 5-8.

[33] *See, e.g.*, U.S. EPA, Integrated Risk Information System, Molybdenum, https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0425_summary.pdf#nameddest=rfd; ATSDR, DRAFT Toxicological Profile for Molybdenum (2017).

[34] EPA Risk Assessment at 4-17.

[35] U.S. EPA, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule, 80 Fed. Reg. 21302, 21404 (Apr. 17, 2015) (hereinafter "2015 Coal Ash Rule").

[36] *See, e.g.*, U.S. EPA, Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric power Generating Point Source Category page 3-4 (Sep. 2015).

[37] *See, e.g.*, U.S. EPA, Integrated Risk Information System, Selenium, https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=472. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0425_summary.pdf#nameddest=rfd

[38] EPA Risk Assessment at 3-20.

[39] 2015 Coal Ash Rule, 80 Fed. Reg. 21456.

[40] *Id*.

[41] *See, e.g.*, U.S. EPA, Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric power Generating Point Source Category page 3-4 (Sep. 2015).

[42] EPA Risk Assessment at 5-5 and 3-20.

[43] Some coal ash ponds are eligible for an extension, and not required to complete baseline monitoring until April 17, 2019. 40 C.F.R. § 257.100(e)(5). Under the terms of the original 2015 Coal Ash Rule, if an owner or operator committed to closing an ash pond by April 17, 2018, then that "early closure" pond was exempt from other requirement of the Coal Ash Rule, including groundwater monitoring requirements. After being challenged in court, EPA voluntarily vacated this loophole in August, 2016. U.S. EPA, Hazardous and Solid Waste Management Systems: Disposal of Coal Combustion Residuals from Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur, Direct Final Rule, 81 Fed. Reg. 51802 (Aug. 5, 2016). EPA also extended many compliance deadlines in order to give these "early closure" owners time to catch up with all of the regulatory requirements to which they were not previously subject. For all "early closure" ponds, the first annual groundwater monitoring report must be completed by August 1, 2019, and posted online by August 31, 2019. 40 C.F.R. §§ 257.100(e)(5), 90(e), 105(h)(1), 107(d), and 107(h)(1).

[44] 40 CFR Part 257.

[45] Strictly speaking, the rule exempts landfills that stopped receiving waste before October 2015, and ash ponds that both (a) stopped receiving waste and (b) were dewatered before October 2015. Ash ponds that stopped receiving waste before October 2015 but continued to hold ash and water are regulated as "inactive surface impoundments." 40 CFR § 257.50 (c) and (d), 257.53 (definition of "inactive surface impoundment").

[46] 40 CFR §§ 257.90-257.98.

[47] 40 CFR § 257.91(a)(1).

[48] 40 CFR § 257.91(d).

[49] 40 CFR § 257.94(b).

[50] 40 CFR Part 257 Appendix III.

[51] 40 CFR § 257.94(e).

[52] 40 CFR § 257.95.

[53] 40 CFR § 257.96.

[54] 40 CFR § 257.101(a)(1).

[55] *See supra* note 43.

[56] The groundwater protection standard for molybdenum is 100 µg/L, which is equal to EPA's Regional Screening Level for molybdenum. 40 C.F.R. § 257.95(h)(iv). EPA has also published a different health-based value for molybdenum, namely a "Lifetime Health Advisory," which is "[t]he concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure." U.S. EPA, 2018 Edition of the Drinking Water Standards and Health Advisories Tables (March, 2018). EPA's Lifetime Health Advisory for molybdenum is 40 µg/L. We used this threshold in our analysis.

[57] 40 C.F.R. Part 257, Appendices III and IV.

[58] EPA Risk Assessment at Appendix E, Table E-1.

[59] *See, e.g.*, EPA Risk Assessment at ES-5 (showing that cancer risks from landfills are 40-140 times lower than from surface impoundments, and showing a lack of noncancer risks associated with landfills).

[60] See, e.g., 2015 Coal Ash Rule, 80 Fed. Reg. at 21,456 (noting that "[t]he high mobility of boron and sulfate explains the prevalence of these constituents in damage cases that are associated with groundwater impacts.").

[61] All differences significant at $p<0.0001$

[62] 40 CFR §257.60.

[63] U.S. EPA, Integrated Risk Information System; Arsenic, inorganic, CASRN 7440-38-2, https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=278 (setting a "Drinking Water Unit Risk" (cancer risk estimate) of 5×10^{-5} per µg/L.

[64] The percent low-income and/or minority population estimates within three miles of six of the ten sites are higher than corresponding state averages. *See* EPA, EJSCREEN, https://www.epa.gov/ejscreen (incorporates 2012-2016 American Community Survey data). EJSCREEN was designed in the context of EPA's environmental justice policies and is a screening tool that can help identify areas that may warrant additional consideration, analysis, or outreach.

[65] AECOM, CCR Annual Groundwater Monitoring Report § 257.90, for the Equalization Pond, Ash Pond, and Ash Pile at the San Miguel Plant, Revision 1 (Jan. 31, 2018); ERM, CCR Unit Closure and Post-Closure Plan, San Miguel Electric Power Cooperative, Inc. (Oct. 18, 2016), http://www.smeci.net/CCR/UnitClosureandPost-ClosurePlan.pdf.

[66] Environmental Integrity Project, Groundwater Contamination from Texas Coal Ash Dumps: New Data Reveal Pollution Leaking from 100 Percent of Coal Power Plants With Available Records (Jan. 17, 2019), available at http://www.environmentalintegrity.org/reports/groundwater-contamination-from-texas-coal-ash-dumps/.

[67] Environmental Integrity Project, Groundwater Contamination from Texas Coal Ash Dumps: New Data Reveal Pollution Leaking from 100 Percent of Coal Power Plants With Available Records (Jan. 17, 2019), available at http://www.environmentalintegrity.org/reports/groundwater-contamination-from-texas-coal-ash-dumps/.

[68] San Miguel Electric Power Cooperative, 40 CFR §257.94(e)(3) NOTIFICATION FOR ESTABLISHMENT OF ASSESSMENT MONITORING PROGRAM - SAN MIGUEL ELECTRIC COOPERATIVE, INC., http://www.smeci.net/CCR/NoticeAssessmentMonitoring.pdf.

[69] SynTerra, CCR Annual Groundwater Monitoring and Corrective Action Report, Active Ash Basin/Retired Ash Basin/Retired Ash Basin Landfill, Allen Steam Station (Jan. 10, 2018), available at https://www.duke-energy.com/_/media/pdfs/our-company/ash-management/all-annl-gmcar-aab.pdf?la=en.

[70] Duke Energy, Notice of Groundwater Protection Standard Exceedance, 40 C.F.R. § 257.95(g), Allen Steam Station, available at https://www.duke-energy.com/_/media/pdfs/our-company/ash-management/20181214/all-gwps-exceed-notice-aab-2018.pdf?la=en. This notification does not identify the wells or disposal areas that are exceeding groundwater protection standards.

[71] See, e.g., HDR Engineering, Corrective Action Plan Part 1, Allen Steam Station Ash Basin, at 64 (Nov. 20, 2015), available at https://edocs.deq.nc.gov/WaterResources/DocView.aspx?dbid=0&id=320424&page=1&cr=1. Coal ash in the active basin is buried up to 55 feet below the ground surface, while groundwater is as high as 3 feet below the surface and has a median elevation of 9 feet below the surface. The inactive ash basin is similar, with ash buried up to 57 feet below the surface and groundwater elevations of 2-41 feet below the surface.

[72] See, e.g., AECOM, Closure Plan, Allen Steam Station Active Ash Basin and Retired Ash Basin (Oct. 10, 2016), available at https://www.duke-energy.com/_/media/pdfs/our-company/ash-management/ccr-all-close-pln-imp.pdf?la=en.

[73] *See generally* Coal Ash Rule compliance documents for Jim Bridger at http://www.berkshirehathawayenergyco.com/ccr/ppw.html. Surface area statistics are provided in the closure plans for each disposal unit.

[74] PacifiCorp, Jim Bridger FGD pond 1 CCR Assessment Monitoring Appendix IV Ground Water Protection Standard Notification (Dec. 12, 2018), available at http://www.berkshirehathawayenergyco.com/ccr/assets/pdf/ppw/JB/JB_FGD_Pond_1/GW_monitoring_corrective_action/Notify_App_IV_exceedances/Notification%20of%20Appendix%20IV%20Exceedance.pdf.

[75] *See* closure plans for Jim Bridger at PacifiCorp's Coal Ash Rule compliance website: http://www.berkshirehathawayenergyco.com/ccr/ppw.html.

[76] *See generally* Coal Ash Rule compliance documents for Naughton at http://www.berkshirehathawayenergyco.com/ccr/ppw.html. Surface area statistics are provided in the closure plans for each disposal unit.

[77] *See id.*, "Notification of Appendix IV exceedances" for FGD Ponds 1 and 2.

[78] There was once a second coal ash pond (the "South Bottom Ash Pond"), but that pond was closed by removing the coal ash prior to 2015. *See* Risk Assessment attachment A-2; *see also* Civil & Environmental Consultants, Inc., Closure Plan, New Castle Station North Ash Pond, West Pittsburg, Lawrence County,

Pennsylvania (Oct. 2016), available at http://3659839d00eefa48ab17-3929cea8f28e01ec3cb6bbf40cac69f0.r20.cf1.rackcdn.com/NCP_NBAP_CPCIV.pdf.

[79] Civil & Environmental Consultants, Inc., Closure & Post-Closure Plans, New castle Station Ash Landfill, West Pittsburg, Lawrence County, Pennsylvania (Oct. 2016), available at http://3659839d00eefa48ab17-3929cea8f28e01ec3cb6bbf40cac69f0.r20.cf1.rackcdn.com/NCP_NCPLF_CPCIV.pdf.

[80] See Aptim Environmental & Infrastructure, Inc., CCR COMPLIANCE, GROUNDWATER MONITORING AND CORRECTIVE ACTION ANNUAL REPORT, NORTH ASH POND AND ASH LANDFILL, at Table 3 (Jan. 2018), available at http://3659839d00eefa48ab17-3929cea8f28e01ec3cb6bbf40cac69f0.r20.cf1.rackcdn.com/NCP_NCPLF_GMI.pdf.

[81] Civil & Environmental Consultants, Inc., Closure & Post-Closure Plans, New castle Station Ash Landfill, West Pittsburg, Lawrence County, Pennsylvania (Oct. 2016), available at http://3659839d00eefa48ab17-3929cea8f28e01ec3cb6bbf40cac69f0.r20.cf1.rackcdn.com/NCP_NCPLF_CPCIV.pdf.

[82] Environmental Integrity Project, TVA's Toxic Legacy: Groundwater Contaminated by Tennessee Valley Authority Coal Ash (Nov. 2013), available at http://www.environmentalintegrity.org/reports/tvas-toxic-legacy-groundwater-contaminated-by-tennessee-valley-authority-coal-ash/.

[83] J.K. Carmichael et al., Preliminary Evaluation of the Hydrogeology and Groundwater Quality of the Mississippi River Valley Alluvial Aquifer and Memphis Aquifer at the Tennessee Valley Authority Allen Power Plants, Memphis, Shelby County, Tennessee, USGS Open-File Report 2018-1097 (2018), https://pubs.er.usgs.gov/publication/ofr20181097.

[84] Stantec, Closure and Post-Closure Plan, East Ash Disposal Area, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Allen Fossil Plant (Oct. 12, 2016), https://ccr.tva.gov/Plants/ALF/Surface%20Impoundment%20-%20East%20Ash%20Disposal%20Area/Closure%20-%20Post-Closure%20Plan/Closure%20Plan/257-102(b)_Written%20Closure%20Plan_ALF_East%20Ash%20Disposal%20Area.pdf

[85] *See* TVA, Allen Fossil Plant Location Restriction Demonstrations, https://ccr.tva.gov/Plants/ALF/Surface%20Impoundment%20-%20East%20Ash%20Disposal%20Area/Location%20Restrictions/Placement%20Above%20the%20Uppermost%20Aquifer/ALF_Location%20Restriction%20Posting.pdf

[86] Stantec, Closure and Post-Closure Plan, East Ash Disposal Area, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Allen Fossil Plant (Oct. 12, 2016), https://ccr.tva.gov/Plants/ALF/Surface%20Impoundment%20-%20East%20Ash%20Disposal%20Area/Closure%20-%20Post-Closure%20Plan/Closure%20Plan/257-102(b)_Written%20Closure%20Plan_ALF_East%20Ash%20Disposal%20Area.pdf

[87] TVA, Allen Ash Impoundment Closure, https://www.tva.com/Environment/Environmental-Stewardship/Environmental-Reviews/Allen-Ash-Impoundment-Closure.

[88] A detailed site evaluation can be found in a "Nature and Extent of Contamination" report prepared by consultants to the owners of the landfill. See Geosyntec Consultants, Inc., Nature and Extent of Contamination Study, Final Report, Brandywine Ash Management Facility, Brandywine, Maryland (June, 2018). The size and volume of the landfill is described on pages 1-1 and 4-1 of this report.

[89] *Id*.

[90] *Id*. at 4-9 to 4-10.

[91] *Id*. at 4-20 to 4-23 ("[G]roundwater seepage along the Mataponi Creek [is] adding CCB [coal ash] constituents to the surface water").

[92] *Id*. at Tables 6-3a and 6-3b.

[93] *Id*. at 4-5.

[94] *Id*. at Tables 6-3a and 6-3b.

[95] *Id*. at 4-21 to 4-24.

[96] Water & Environmental Technologies, Groundwater Monitoring & Corrective Action Report, CCR Landfill – Hunter Power Plant, Castle Dale, Utah at 4 (Jan. 31, 2018).

[97] EPA Risk Assessment, Attachment A-2.

[98] PacifiCorp, Hunter CCR Landfill Assessment Monitoring Appendix IV Ground Water Protection Standard Notification (Dec. 12, 2018), http://www.berkshirehathawayenergyco.com/ccr/assets/pdf/ppw/Htr/Htr_CCR_Landfill/GW_monitoring_corrective_action/Notify_App_IV_exceedances/Notification%20of%20Appendix%20IV%20Exceedance.pdf

[99] AECOM, First Annual Groundwater Monitoring and Corrective Action Report, 2016-2017, Ghent Generating Station (Jan. 29, 2018), https://ccr.lge-ku.com/sites/default/files/ccr/documents/W_GH_GNST_GMCA_ANGWCA_013118.pdf.

[100] Liner design documentation and location restriction documentation can be found at the following Kentucky Utilities website: https://ccr.lge-ku.com/GH. Of particular note here is Kentucky Utilities' admission that "[u]nder ATB2, the aquifer is likely in direct contact with the base of the unit except where the aquifer materials have been removed by construction of the basin and the impoundment dam." *LOCATION RESTRICTIONS DEMONSTRATIONS FOR EXISTING CCR SURFACE IMPOUNDMENT REV B– 11/08/2018, https://ccr.lge-ku.com/sites/default/files/ccr/documents/W_GH_ATB2_LOC_ALL_110818.pdf*.

[101] *Util. Solid Waste Activities Grp. v. Envtl. Prot. Agency*, 901 F.3d 414, 430 (D.C. Cir. Aug. 21, 2018) ("[W]e vacate 40 C.F.R. § 257.101, which allows for the continued operation of unlined impoundments"). The court also struck down a provision allowing for ash ponds with only clay liners to be treated as lined. Id. at 432 ("[W]e vacate the Rule insofar as it treats "clay-lined" units as if they were lined"). At this point, all liners must be "composite," with a lower clay component and an upper plastic component, or an "alternative composite liner" with similar characteristics. 40 C.F.R. § 257.70(b), (c); 40 C.F.R. § 257.71(a)(1)(ii)-(iii), 40 C.F.R. § 257.72.

[102] Luminant, CCR Rule Compliance Data and Information, https://www.luminant.com/ccr/.

[103] EPA Risk Assessment at A-1-6.

[104] *See, e.g.*, U.S. EPA, Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric power Generating Point Source Category at Tables A-3 and A-4 (Sep. 2015); U.S. EPA, Damage Case Compendium, Technical Support Document, EPA-HQ-RCRA-2009-0640-12118, page 64 (Dec. 14, 2014).

[105] 40 CFR § 257.91(a)(1).

[106] Anchor QEA, 2017 Annual Groundwater Monitoring and Corrective Action Report, Plant Bowen Ash Pond (AP-1) (Jan. 31, 2018), https://www.georgiapower.com/content/dam/georgia-power/pdfs/company-pdfs/plant-bowen/20180131-annualgwreport-bow-ap-final.pdf

[107] *Id*. at 9.

[108] See, e.g., KPRG and Associates, Annual Groundwater Monitoring and Corrective Action Report, 2017 (Jan. 24, 2018), available at http://3659839d00eefa48ab17-3929cea8f28e01ec3cb6bbf40cac69f0.r20.cf1.rackcdn.com/WIL_SAP2_GMI.pdf.

[109] See Patrick Engineering Inc., Hydrogeologic Assessment Report, Will County Generating Station, Figures 1 and 2 (Feb. 2011).

[110] *Id*. at Appendix A (boring log for well MW-6 shows fill mixture including "black coal cinders" in the top 8 feet of soil.

[111] Email from Richard Frendt, Patrick Engineering, to Maria Race, Midwest Generation, re: Data Tables for Ash Pond Investigations (Jan. 7, 2011) ("At Will County, for example, there is strong hydraulic evidence to suggest that *everything* is downgradient, that the ponds may be draining in multiple directions…").

[112] *See, e.g.*, Montgomery & Associates, Annual Groundwater Monitoring and Corrective Action Report for Cholla Power Plant, Appendix A (Jan. 30, 2018), https://www.aps.com/en/ourcompany/ratesregulationsresources/environmentalcompliance/CCRDocuments/CH_GW_AnCAR_20_20180131_Appendix%20A.zip

[113] *See, e.g.*, *id*. at Monitor Round #3_Reduced, PDF page 10, sample date 5/5/16, well M63A

[114] 40 C.F.R. § 257.94(b).

[115] *See* U.S. EPA, National Primary Drinking Water Regulations; arsenic and Clarifications to Compliance and New Source Contaminants Monitoring; Final Rule (Jan. 22, 2001), 66 Fed. Reg. 6976, 7022 ("Rationale for the Final MCL").

[116] *See, e.g.*, U.S. EPA (1990), National Oil and Hazardous Substances Pollution Contingency Plan, 55 FR 8666, 8616 ("EPA's risk range of 10^{-4} to 10^{-6} represents EPA's opinion on what are generally acceptable levels.").

[117] *See, e.g.*, U.S. EPA (1998), Integrated Risk Information System, Inorganic Arsenic, available at https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=278 (showing a drinking water unit risk of 5×10^{-5} per µg/L).

[118] U.S. EPA (2010), Draft Toxicological Review of Inorganic Arsenic in Support of Summary Information on the Integrated Risk Information System (IRIS) (increasing the cancer potency estimate from 1.5 cases per mg/kg-d to 25.7 cases per mg/kg-d).

[119] U.S. EPA (2010), Draft Toxicological Review of Inorganic Arsenic in Support of Summary Information on the Integrated Risk Information System (IRIS), pages 131 – 132.

[120] *See* U.S. EPA, Regional Screening Levels (RSLs), Generic Tables, https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables.

[121] *See, e.g.*, EPA Risk Assessment at 3-20 (showing screening-level mercury risk estimates (Hazard Quotients) of <0.01 for drinking water and 7 for fish ingestion).

[122] *See, e.g.*, U.S. EPA, Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric power Generating Point Source Category at page 3-4 (Sep. 2015).

[123] *See, e.g.*, Risk Assessment at 3-20 to 3-23 (showing screening-level selenium risk estimates (Hazard Quotients) of 1 for humans exposed via drinking water, 10 for humans exposed via fish ingestion, and 60 for aquatic life in surface water).

[124] J.E. Brandt et al., Selenium Ecotoxicity in Freshwater Lakes Receiving Coal Combustion Residual Effluents: A North Carolina Example, 51 Environ. Sci. Technol. 2418-2426, 2423 (2017) ("At Mayo Lake, 27% of fish muscle samples also exceeded the protective threshold level even though dissolved surface water concentrations did not [exceed the 1.5 μg/L chronic criterion for freshwater lakes].").

[125] *See, e.g.*, U.S. EPA, Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric power Generating Point Source Category at 3-4 to 3-5 and Table A-6 (Sep. 2015).

[126] *See, e.g.*, EPA Risk Assessment at Table E-2 (showing the "target organ" for both aluminum and manganese to be "neurological"); Environmental Integrity Project's ashtracker database (https://www.ashtracker.org), showing high levels of manganese at many sites; Environmental Integrity Project, TVA's Toxic Legacy: Groundwater Contaminated by Tennessee Valley Authority Coal Ash at pages 102-103 (Nov. 2013), http://www.environmentalintegrity.org/reports/tvas-toxic-legacy-groundwater-contaminated-by-tennessee-valley-authority-coal-ash/ (showing very high aluminum concentrations in groundwater impacted by coal ash at TVA's Johnsonville plant).

[127] 42 U.S.C. § 6944(a).

[128] U.S. EPA, Damage Case Compendium, Technical Support Document, EPA-HQ-RCRA-2009-0640-12118, pages 17-26 (Dec. 18, 2014).

[129] U.S. EPA, Damage Case Compendium, Technical Support Document, EPA-HQ-RCRA-2009-0640-12118, 12119, 121120, 12121 (Dec. 14, 2014) (hereinafter "**EPA Damage Cases**"). A description of the Lincoln Stone Quarry can be found at Vol. IIb, Part One, page 43. *See also* Environmental Integrity Project, Earthjustice and Sierra Club, In Harm's Way: Lack of Federal Coal Ash Regulations Endangers Americans and their Environment, at 41 (Aug. 26, 2010), http://www.environmentalintegrity.org/wp-content/uploads/2016/11/2010-08_In_Harms_Way.pdf (hereinafter "**In Harm's Way**").

[130] EPA Damage Cases, Vol. I, page 11; Environmental Integrity project and Earthjustice, Out of Control: Mounting Damages from Coal Ash Waste Sites, at 19 (Feb. 2010), http://www.environmentalintegrity.org/wp-content/uploads/2016/11/2010-02_Out_of_Control.pdf (hereinafter "**Out of Control**").

[131] EPA Damage Cases, Vol. I, page 25; Anne Arundel County Department of Health, Gambrills Well Water Investigation, Last updated: October 25, 2017, https://www.aahealth.org/gambrills-well-water-investigation/.

[132] EPA Damage Cases, Vol. I, page 51; Out of Control at 31.

[133] See, e.g., Clarke Morrison, Groups Seek to Join Duke Coal Ash Lawsuits, Citizen Times (Jan. 17, 2014), https://www.citizen-times.com/story/news/nation/2014/01/17/groups-seek-to-join-duke-coal-ash-lawsuits-/4544517/.

[134] See, e.g., Elizabeth Ouzts, Duke Energy's coal ash offer causing confusion, concern; *Energy News Network* (Feb. 16, 2017), https://energynews.us/2017/02/16/southeast/duke-energys-coal-ash-offer-causing-confusion-concern/.

[135] EPA Damage Cases, Vol. I, page 95; In Harm's Way at 161.

[136] EPA Damage Cases, Vol. I, page 157.

[137] EPA Damage Cases, Vol. I, page 182.

[138] EPA Damage Cases, Vol. IIa, page 127.

[139] EPA Damage Cases, Vol. IIa, page 138.

[140] *Id*. at page 150.

[141] EPA Damage Cases, Vol. I, page 199.

[142] EPA Damage Cases, Vol. IIb, Part Two, page 125.

[143] EPA, EJSCREEN, https://www.epa.gov/ejscreen (percent minority and low-income estimates within 3-mile buffers are above corresponding stage averages).

[144] 40 CFR § 257.96.

[145] 40 CRR § 257.95(h).

[146] 40 CFR § 257.95(g)(3)(ii).

[147] 40 CFR § 257.96.

[148] 40 CFR § 257.96(e).

[149] 40 CFR § 257.97.

[150] 40 CFR § 257.97(a)

[151] 40 CFR § 257.97(d).

[152] 42 U.S.C. § 6945(d)(4).

[153] 42 U.S.C. § 6945(d)(1)(B).

[154] 42 U.S.C. § 6973.

[155] 40 C.F.R. § 257.96(e).

[156] *See, e.g.*, Technical Assistance Services for Communities (TASC) Program, https://www.epa.gov/superfund/technical-assistance-services-communities-tasc-program. This program provides services through a national EPA contract. Under the contract, a contractor provides scientists, engineers and other professionals to review and explain information to communities. TASC services are determined on a project-specific basis and provided at no cost to communities. Partners in Technical Assistance Program (PTAP), https://www.epa.gov/superfund/partners-technical-assistance-program-ptap. The Partners in Technical Assistance Program (PTAP) expands opportunities for cooperation between EPA and colleges and universities, with the shared goal of assessing and addressing the unmet technical assistance needs of impacted communities near Superfund sites. Techical Assistant Grant (TAG) Program, https://www.epa.gov/superfund/technical-assistance-grant-tag-program. TAGs are awarded to non-profit incorporated community groups. With TAG funding, community groups can contract with independent technical advisors to interpret and help the community understand technical information about their site. The TAG recipient group is responsible for managing their grant funds and contributing a 20 percent award match. Most groups meet this requirement through in-kind contributions such as volunteer hours toward grant-related activities. Technical Assistance Plan (TAP), https://www.epa.gov/superfund/technical-assistance-plan-tap. A TAP is funded by potentially responsible parties through provisions in a negotiated settlement agreement. A

TAP enables community groups to retain the services of an independent technical advisor and to provide resources for a community group to help other community members learn about site decisions.

[157] Section 2003 of RCRA, 42 U.S.C. § 6913, states:

> The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as ''Resource Conservation and Recovery Panels'') to provide Federal agencies, States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

[158] EPA Risk Assessment at 5-36.

[159] 40 CFR § 257.102(d)(i).

[160] U.S. Environmental Protection Agency, "List of Publicly Accessible Internet Sites Hosting Compliance Data and Information Required by the Disposal of Coal Combustion Residuals Rule." Available at: https://www.epa.gov/coalash/list-publicly-accessible-internet-sites-hosting-compliance-data-and-information-required.

[161] *See, e.g.*, U.S. EPA, Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, EPA 530-R-09-007 at 6-36 to 6-37 (Mar. 2009).

[162] EPA has proposed adding boron to Appendix IV, the list of pollutants that must be monitored during assessment monitoring, but has not taken any action on that proposal. *See* U.S. EPA, Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Amendments to the National Minimum Criteria (Phase One); Proposed Rule, 83 Fed. Reg. 11584 (Mar. 15, 2018).

[163] The groundwater standard for each pollutant is either this presumptive standard or the site-specific background value, whichever is greater.

[164] U.S. EPA, 2018 Edition of the Drinking Water Standards and Health Advisories Tables (March, 2018) (showing a Child Health Advisory of 3 mg/L for boron).

[165] *Id*. (showing a Drinking Water Advisory of 500 mg/L for sulfate).

[166] *Id*.; see also *supra* note 56.