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DOING IT RIGHT

COLSTRIP'S BRIGHT FUTURE WITH CLEANUP

A joint research effort between Northern Plains Resource Council and International Brotherhood of Electrical Workers (Local 1638)

ABOUT

This study was authored by the Northern Plains Resource Council and International Brotherhood of Electrical Workers Local Union 1638 (in Colstrip, Montana), a partnership rooted in a shared philosophy that community and watershed health are interdependent and indispensable.

Northern Plains Resource Council (Northern Plains) is a grassroots conservation and family agriculture non-profit that organizes Montana citizens to protect our water quality, family farms and ranches, and unique quality of life. The organization was founded in 1972 by local ranchers, including ranchers in the Colstrip area, and community members who wanted to address the impacts that coal development would have on the water quality and livelihoods of central and eastern Montanans. Northern Plains continues to advocate for clean water and the health of the entire community.

International Brotherhood of Electrical Workers Local Union 1638 (IBEW Local 1638) represents the skilled, full-time maintenance and operation employees working at the Colstrip Power Plant. Most of its members reside in Colstrip and Rosebud County, and thus have a vested interest in the proper cleanup of the power plant site; reclamation of the land, and long-term watershed viability. The IBEW represents a workforce with a skillset available to remediate environmental impacts caused by the leaking ash ponds at the power plant site, which is timely given the impending shuttering of Units 1 & 2.

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I. Executive Summary

1.1 Introduction

Coal ash waste is polluting the groundwater in Colstrip, but cleaning it up could provide many jobs and other economic benefits while protecting community health.

This study was conducted to analyze the job-creation potential of cleaning up the groundwater in Colstrip, Montana, that has been severely contaminated from leaking impoundments meant to store the coal ash from the power plants (Colstrip Units 1, 2, 3 and 4). Unless remediated, this contamination poses a major threat to public health, livestock operations, and the environment for decades.

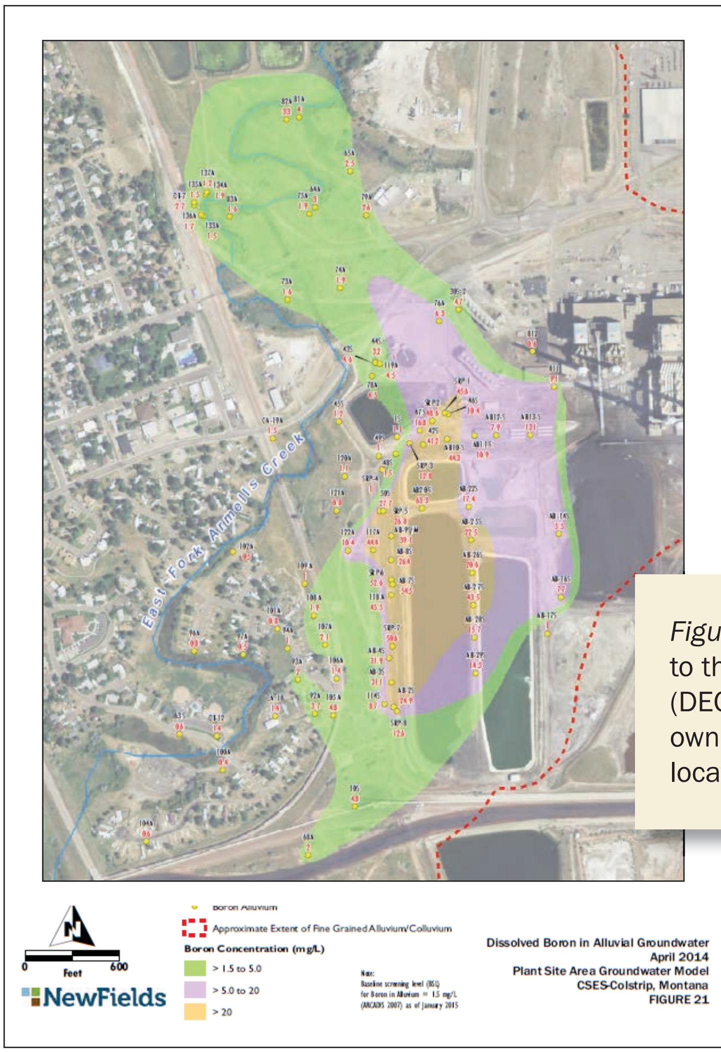
Communities benefit from coal ash pond cleanup but the positive impacts of cleanup can vary widely depending on the remediation approach followed. Certain strategies like excavating coal ash ponds and building a water treatment facility lead to more jobs, stabilized property values, and effective groundwater cleanup while others accomplish only the bare minimum for legal compliance.

This study demonstrates that, with the right cleanup strategies, job creation and environmental protection can go hand-in-hand, securing the future of the community as a whole.

UNLINED ASH PONDS LEAK

With 32 ponds totaling over 800 acres, the ***Colstrip ash pond complex is one of the largest in the United States*** and contains millions of tons of coal combustion residuals (or CCR), more commonly referred to as coal ash[1].

The ponds leak contaminated water into the ground at a rate of 367 gallons per minute, or 200,000,000 gallons per year[2]. Hundreds of wells currently pump this polluted water out of the ground and back to the ponds in an effort to keep the pollution plume from expanding further.



(Credit: Talen Montana LLC/Geosyntec Consultants, 2017)

> **"*THE ASH PONDS LEAK 367 GALLONS PER MINUTE, OR 200 MILLION GALLONS A YEAR. THEY HAVE BEEN LEAKING SINCE THEIR CONSTRUCTION MORE THAN 30 YEARS AGO.*[2]**

Figure 1: Groundwater contamination map submitted to the Montana Department of Environmental Quality (DEQ) by Colstrip plant owners. According to plant owners, boron serves as an indicator of the plume's location and concentration.

COAL ASH HEALTH RISKS

Coal ash introduces heavy metals and other pollutants like arsenic, hexavalent chromium, radium, selenium, and lead into the groundwater[3]. Arsenic, which causes bladder and kidney cancer as well as birth defects, is found in especially high levels in the groundwater surrounding many coal ash ponds[4,5]. Elevated exposure to other pollutants like selenium, molybdenum, sulfates and boron all pose dangers to livestock health.

COLSTRIP UNITS 1 & 2 TO CLOSE BY 2022

Pursuant to a series of lawsuits, the Colstrip plant owners will retire Units 1&2 by July 2022, close the associated Units 1&2 ash ponds (approximately 278 acres), convert to dry ash storage for the remaining Units 3&4, and remediate the groundwater contamination by 2049 [6,7].

Colstrip plant co-owner Talen Energy is in the process of submitting cleanup proposals for approval with the state of Montana. Thus far, they have proposed to cover the ponds with the coal ash left inside—also known as ***cap-in-place***—rather than remove the waste and contaminated soil, and expand its current groundwater capture system, augmented with freshwater injection wells[8,9,10]. Talen has not indicated whether it will hire the existing workforce to do the cleanup work or contract it out to non-local companies.

STOP THE LEAK, CLEAN IT UP

Fixing the pollution from leaking coal ash ponds involves two processes: stopping the source of pollution and remediating the impacted groundwater.

Point source control involves stopping the source of pollution, usually via **cap-in-place** (leaving coal ash waste material in the pond and covering the pond with a cap or final cover) or **excavation** (removing the ash and moving it off-site either to a secure landfill or to be recycled into concrete). Cap-in-place is the cheaper option, but many experts consider this an impermanent solution because seepage and contamination can still occur, and has at numerous sites, including the closed Stage One Evaporation Pond at Colstrip[11,12]. Excavation is costlier because it requires more labor-intensive stops, but is generally considered more effective at stopping further groundwater contamination quickly and permanently[13,14,15].

Groundwater remediation describes mechanisms for cleaning up existing contamination. At sites with massive leakage problems like Colstrip, **capture of the contaminated water** is often done with a series of wells that pump contaminated water to the surface for storage or reuse in the plant. Another approach is utilizing a **water treatment facility**, in which pollutants like heavy metals are removed from the contaminated groundwater; at Colstrip, this would be done in conjunction with groundwater capture[16].

WHAT HAVE OTHER STATES DONE?

This study looked at cleanup efforts at four other contaminated coal ash pond sites in the U.S. to evaluate the outcomes of different cleanup strategies in terms of job creation and cleanup efficacy.

As displayed in the table below (*Figure 2*), **cleanup operations at sites in North Carolina and South Carolina employed 50% - 90% of the plant's operating workforce.** Although this data set is limited, these findings reflect general industry knowledge and research that excavation, in particular, requires a large workforce.

Plant Name/ Location	Pond Size	Cleanup Jobs	Existing Plant Jobs	Cleanup Strategies
Riverbend Station (North Carolina)	69 acres	75	145	Excavation + Transport + New Treatment Plant + Water Treatment
Asheville Plant (North Carolina)	76 acres	190	200	Excavation + Transport + Water Treatment
Belews Creek[206] (North Carolina)	283 acres	163	300	Cap-in-place + New Treatment Plant
Colstrip Station (Montana)	~800 acres	Unknown	388	Cap-in-place + Expand Capture System

Figure 2: Comparison of ash pond size, cleanup strategies, and workforce size. For background on these numbers, please refer to sections 2.1, 5.1, and 5.2.

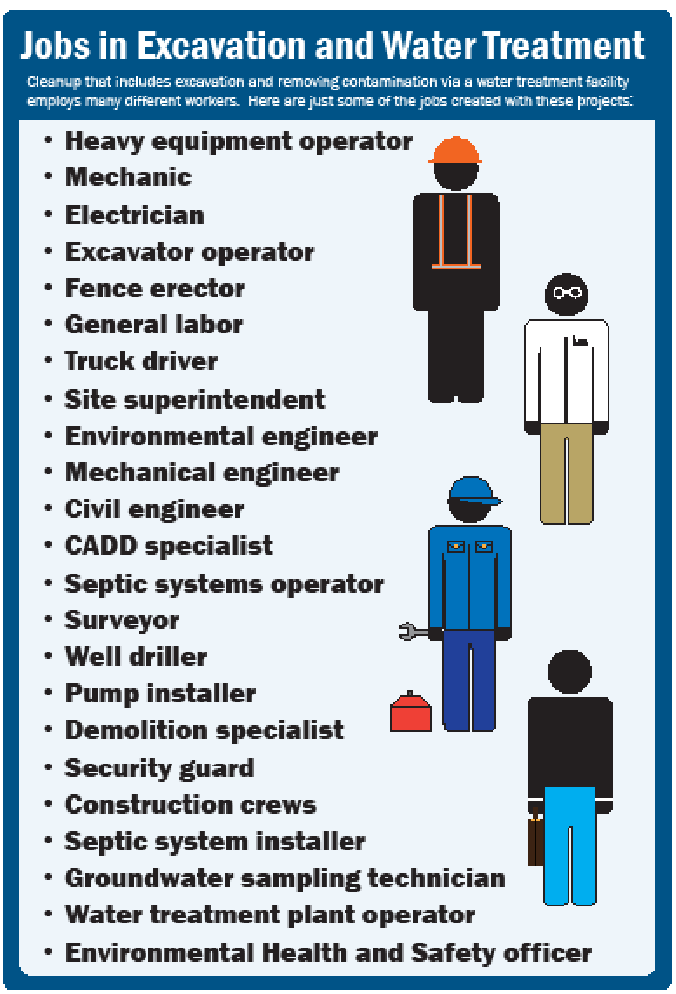
RESPONSIBLE CLEANUP CREATES THE MOST JOBS

Effective cleanup means not just removing contamination from the environment, but also doing so in as short a timeframe as possible. Many plant sites in North and South Carolina are closing their ash ponds using excavation because it reduces contamination quickly. For example, excavation at some South Carolina plant sites has reduced arsenic contamination in the groundwater by 80% to 90% in under five years[17]. A new water treatment plant at the Riverbend Station in Gaston County, North Carolina, is effectively removing heavy metals and other pollutants from coal ash pond water so it can be safely discharged into the drinking water source for Charlotte, North Carolina[18].

Shorter cleanup timelines do not indicate reduced job creation. The sites in North and South Carolina, which are much smaller than the surface area at Colstrip, are projected to take more than five years to complete just the dewatering and excavation steps. Active cleanup strategies employ a significant number of workers. Excavation, in particular, requires a larger workforce and achieves responsible cleanup goals in a shorter timeframe.

REMEDIATION JOBS

Not all cleanup is the same. More robust protocols that include **excavation and water treatment employ more workers than a strategy that relies on cap-in-place and groundwater capture**.



(Credit: Graphic designed by Northern Plains Resource Council, ©2018)

Similarly, this report's case study analysis finds that coal ash excavation projects require a diverse range of skills. *Figure 3* highlights some of the jobs created for those remediation projects.

The local workforce in Colstrip already has many of the skills required for this remediation project, although additional training will probably be needed as workers shift from plant operations to remediation work. While some of these jobs are shorter-term in nature, like the construction jobs associated with building a landfill, others are highly-skilled professions that will be needed for decades, such as a water treatment plant operator.

Figure 3: Heavy metal and industrial contamination cleanup sites in Montana utilize a wide range of skilled workers. This is a selection from an analysis of required jobs for recent mine reclamation and heavy metal remediation projects in Montana. (see "Natural resource and environmental restoration in Montana: Case studies in restoration and associated workforce needs" by Swanson, L. and Janssen, H. (2012)).

Pictured: IBEW Local 1638 President, Brett Bowen

LOCAL WORKERS IN COLSTRIP ALREADY HAVE MANY OF THE SKILLS REQUIRED FOR REMEDIATION.

RESPONSIBLE CLEANUP IS GOOD FOR WORKERS AND PROPERTY VALUES

Effective cleanup of industrial pollution provides positive economic impacts for local communities. A recent analysis of 797 brownfield sites showed that remediation resulted in an average 5% to 11.5% increase in property values, with increases up to 15% observed[20]. This increase in property values also leads to stabilized or increased tax revenue for local governments[21,22]. The sooner cleanup efforts begin and goals are reached, the sooner property values and associated tax benefits will be realized.

Research shows that existence of contamination—or even the *perception* of contamination due to proximity or history—can seriously hamper new commercial investment in an area[23]. Communities that recognize this fact and swiftly address contamination while working with local businesses and government agencies can ameliorate many of the investment disincentives associated with pollution[24,25].

More effective cleanup also increases the supply of useable, clean water for agricultural producers and other industries in the area[26].

Furthermore, an isolated community like Colstrip is especially affected by a plant closure due to the smaller number of local businesses that could hire laid-off workers[27]. Hiring non-local, contract labor to conduct remediation work exacerbates this problem. Remediation projects that hire the local workforce instead of non-local, contracted labor will yield more economic benefits for the community in terms of local employment and wages.

THE COST OF POOR CLEANUP

At 937 acres, the pond at the **Little Blue Run** plant in Beaver County, PA, and Hancock County, WV, is the nation's largest coal ash pond; leakage from the impoundment has devastated nearby communities[28,29]. Neighbors filed a lawsuit against the company after leaks polluted drinking water wells, cracked home foundations, and left yards constantly soggy[30].

The plant's solution has included buying out dozens of homeowners so it can operate the properties as groundwater capture sites[31]. As a result, property values have plummeted in the area. Some homeowners have abandoned their houses while others remain stuck with properties that won't sell[32].

The plant is slated for cap-in-place closure in 2028. Pennsylvania state officials expect groundwater leakage to continue indefinitely and the company plans to simply continue pumping it back into the same impoundment, essentially allowing the problems to continue even after closure[33].

Little Blue Run—on the border of West Virginia and Pennsylvania—leaks more than 400 gallons per minute into the local groundwater, causing nearby property values to plummet. *(Photo credit: Terry Cullinan/Smithsonian Magazine, 2016)*

LEAKAGES FROM LITTLE BLUE RUN'S ASH POND HAVE POLLUTED NEARBY WELLS, DAMAGED HOME FOUNDATIONS, AND DESTROYED YARDS DUE TO OVERSATURATION.

NO PERFECT SOLUTIONS

For all the benefits of thorough remediation, there is no perfect solution for managing coal ash. Even landfills that comply with the new federal Coal Combustion Residuals rule will have to be monitored and maintained for many decades assure communities that they are safe. Transporting coal ash for disposal poses risks as well, and must be done very carefully to protect community and environmental safety. Furthermore, handling coal ash without proper protections has sickened and even killed workers[34]. It is imperative that worker safety is a top priority for all cleanup efforts and disposal operations, including adequate protective gear, proper training, and rigorous project oversight.

KEY TAKE-AWAYS

1 ***The best cleanup strategies achieve cleanup goals in a short timeframe, permanently stop point-source pollution, and utilize the local workforce.***

2 ***Excavation and water treatment create more jobs and remediate existing contamination in a shorter timeframe than methods that rely on cap-in-place, groundwater capture, and natural attenuation strategies.***

3 ***Effective cleanup leads to economic benefits, such as:***

- Increased property values
- Increased local tax revenue
- Greater potential for future business development
- Higher rates of local employment

4 ***The current Colstrip power plant workforce has many of the skills required for a thorough cleanup strategy that includes excavation and water treatment.*** While some additional training would be needed, this modest additional effort and cost would lead to many long-term benefits of keeping these jobs in the community.

5 ***Agricultural users will benefit from plans that remediate the existing groundwater plume more quickly since they rely on the area's groundwater for livestock and crop production.***

6 ***Excavation is allowed -- but not specifically required -- by federal coal ash regulation, and therefore Talen could legally avoid excavating its coal ash ponds.***

7 ***Other states and utilities have adopted excavation cleanup strategies because it is a more permanent and thorough method to stopping contamination.*** North Carolina passed a law in 2014 requiring excavation of the state's most polluting wet ash ponds. All three of South Carolina's utility companies voluntarily agreed to close their unlined wet ash ponds via excavation and two of these companies are not seeking ratepayer increases for these closures.

8 ***Decision-makers should take all these impacts into account when analyzing various cleanup options and should advocate for the solutions that best meet the community's needs.***

CASES ANALYZED IN THIS STUDY SUGGEST THAT RESPONSIBLE CLEANUP AT THE COLSTRIP SITE CAN LEAD TO HIGH JOB CREATION AND OTHER WIDESPREAD COMMUNITY BENEFITS.

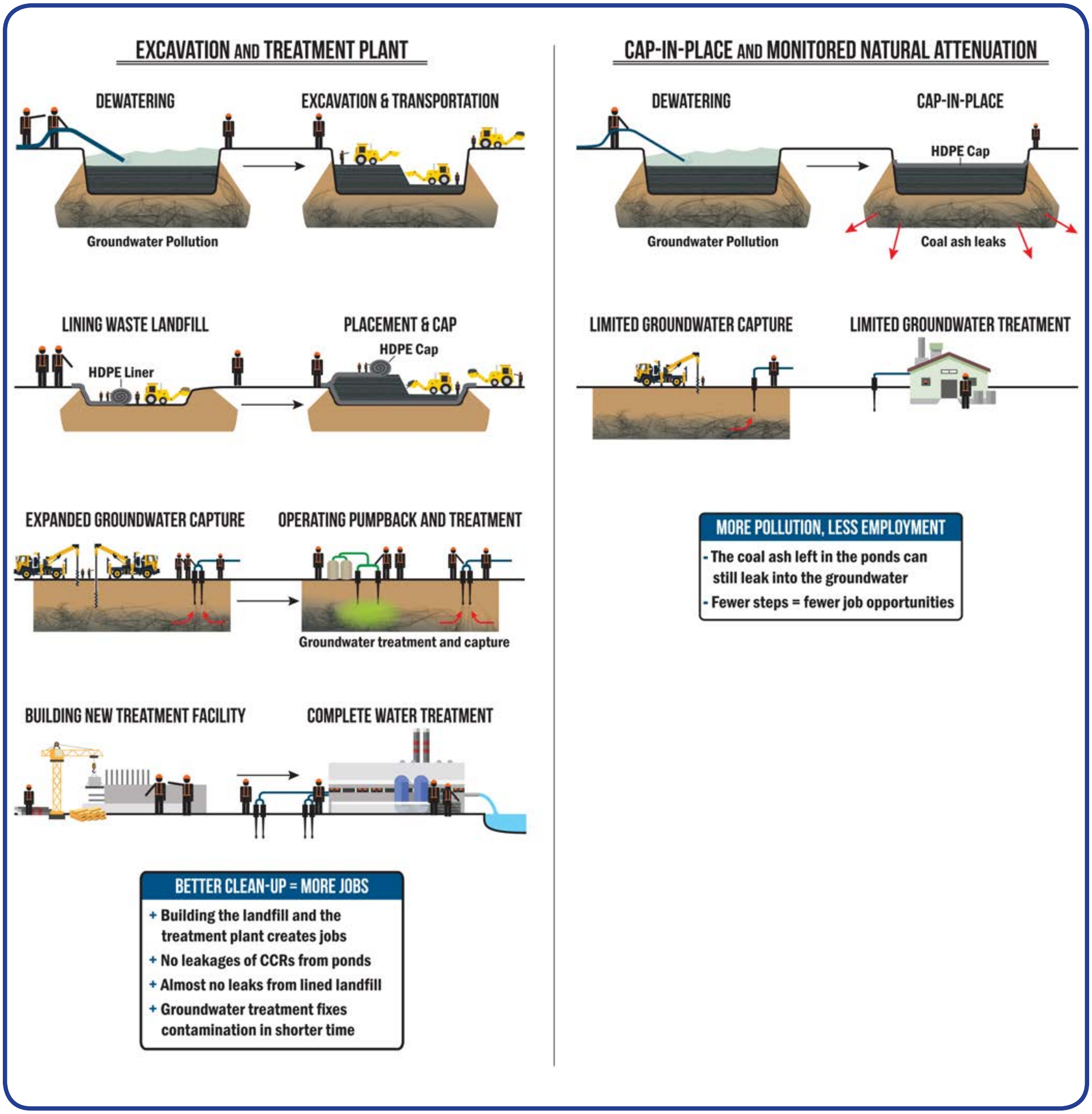


Figure 4: Cleanup strategies that permanently stop future contamination and quickly fix existing pollution of the groundwater are big job creators. Capping ash in the same pond location leaves open the possibility for future groundwater contamination, and creates fewer jobs.

II. COLSTRIP

2.1 POWER PLANT BACKGROUND

POWER PLANT HISTORY: 1975 TO PRESENT

The Colstrip Steam Electricity Station is located in Colstrip, Rosebud County, Montana. It began operations with Units 1 & 2 in 1975 and 1976 with a combined capacity of 614 MW. Units 3 & 4 were brought online in 1984 and 1986 at a combined generating capacity of 1,480 MW [megawatts]. All four units are currently in operation and have a total nameplate capacity of 2,272 MW, providing electricity to Montana as well as out-of-state customers, primarily on the West Coast[35]. The Colstrip plant is a mine-mouth operation, and the nearby Rosebud Mine supplies all its coal to the plant. Plant operations employ 388 workers while the mine employs 373 workers[36].

In addition to the electrical generating units, Colstrip has a number of coal ash disposal sites including both effluent (wet) and dry storage ponds (or impoundments). The plant actively sluices coal ash and other wastewater to specific ponds associated with each of the units. Altogether, the ponds have a surface area of approximately 837 acres[37]. Initial calculations from data reported by Talen Energy indicate a lifetime maximum inventory of coal combustion residuals at roughly 40 million tons for ponds that fall within CCR regulation[38,39]. At this point, Talen has not released an estimation of the current total tonnage in all the Colstrip ponds.

The town of Colstrip has a population of 2,290 and is located in a rural and remote area of southeast Montana, approximately 2 hours from Billings[40]. While the town is perhaps most recognized for its coal industry, there is a long tradition of ranching in the area as well. There are also two nearby Native American reservations, the Crow Reservation and the Northern Cheyenne Reservation. Rosebud County has a population of 9,352[41]. Although the plant and mine do not account for all the economic activity in the area, the employment, property values, and tax revenue of the Colstrip plant operations have a large impact on this fairly isolated county and region.

Units 1 & 2 are slated for retirement by July 2022 and their associated coal ash ponds will be closed in conjunction with shut-down[41]. Units 3 & 4 are being converted to dry storage for both bottom and fly ash; this conversion will be done by 2023[43]. There is no retirement planned for Units 3 & 4, though the owners still have to establish a closure and remediation procedure for the ponds that will take effect if or when the units are eventually retired[44].

There are six owners of the Colstrip power plant: Talen Energy, Puget Sound Energy, Portland General Electric, Avista Corporation, PacificCorp, and NorthWestern Energy. Talen Energy is owned by Riverstone Holdings, LLC, a privately run power producer, and the other owners are all public utility companies. As the managing operator, Talen Energy runs the plants under a service agreement in place with the other owners. ***Talen Energy is also the entity responsible for administering compliance with cleanup and retirement requirements[45].***

OWNERSHIP BREAKDOWN :

- Units 1 & 2: Puget Sound Energy (50%), Talen Energy (50%)
- Unit 3 & 4: Puget Sound Energy (25%), Portland General Electric (20%), Avista Corp. (15%), PacificCorp (10%), Talen Energy (30%).
- Unit 4 Only: NorthWestern Energy (30%)

COLSTRIP ASH POND BASICS

(Credit: Talen Montana LLC / Geosyntec Consultants, 2017)

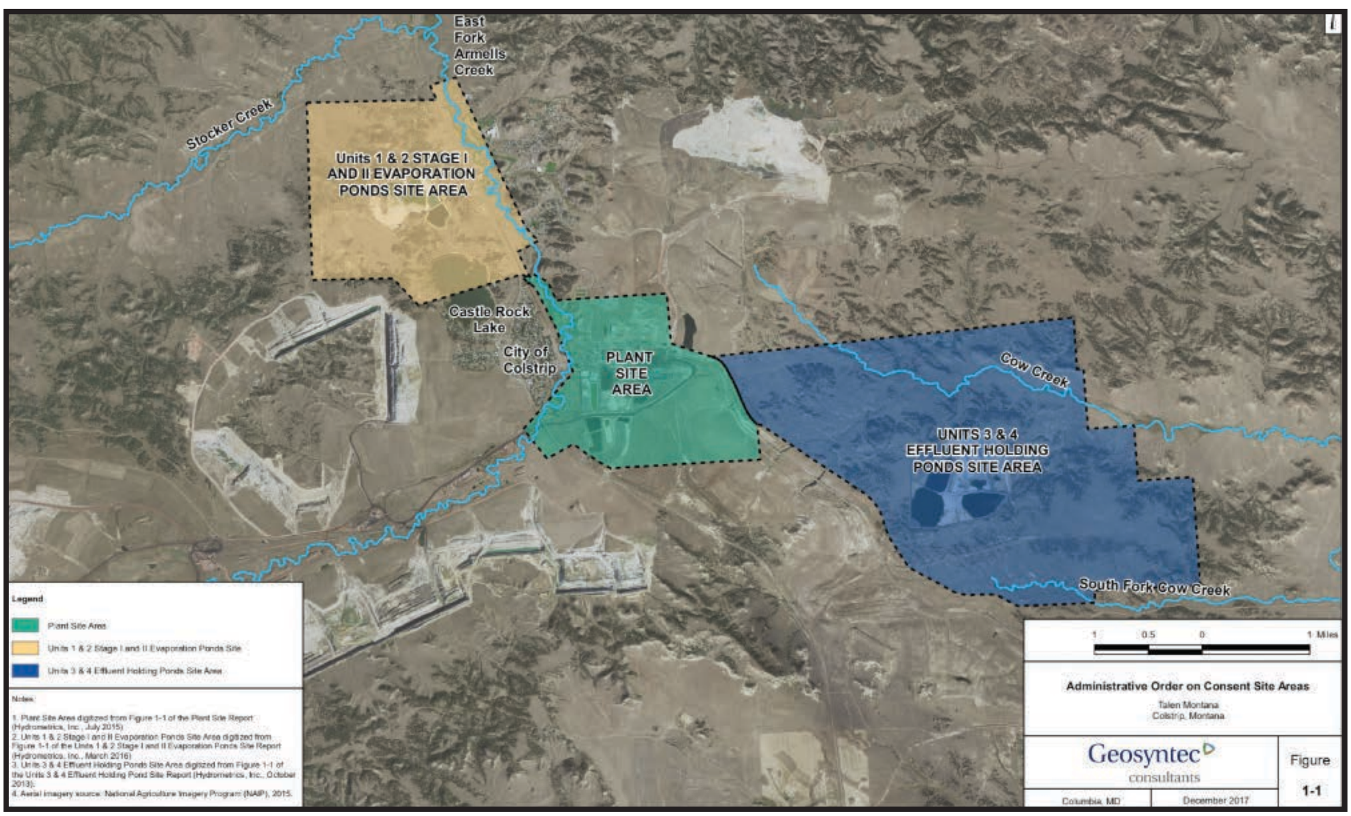


Figure 5: This map highlights the three areas of the Colstrip ash pond complex. Colstrip's 32 ash ponds cover a total of approximately 837 surface acres, making it one of the largest ash pond complexes in the United States.

THE COLSTRIP SITE IS DIVIDED INTO THREE DISTINCT AREAS:

Units 1 & 2 Stage One Evaporation Pond and Stage Two Evaporation Pond (SOEP/STEP):

These ponds are northwest of the plant site and will be closed upon the retirement of Units 1 & 2 in 2022. The STEP has 216 surface acres in total and the capped SOEP has 114 surface acres[47].

Plant Site:

This area is in the Colstrip town limits and includes the plant itself, along with several coal ash ponds and other waste facilities. The ponds at this site total 91.53 surface acres[48].

Units 3 & 4 Effluent Holding Ponds (EHP):

These ponds are southeast of the plant site and are the largest ponds in the site. Colloquially, they are referred to as the 5 & 6 ponds, or less often, the 3 & 4 ponds. The ponds at this site total 416.7 surface acres[49].

Each area has a number of distinct cells or ponds. For instance, individual ponds at the EHP site are identified as A cell, New Clearwell, B cell, C cell, D/E cell, F cell, G cell, G-1 cell, J cell, and J-1 cell. There are a total of 32 ponds (not counting the new cells installed on top of old cells).

THE COLSTRIP ASH POND COMPLEX HAS A TOTAL OF 837.53* SURFACE ACRES, MAKING IT ONE OF THE LARGEST IN THE UNITED STATES. A BREAKDOWN OF THE POND CONTENTS BY SURFACE ACREAGE IS AS FOLLOWS[50]:

- 686.2 acres with CCR materials, including coal ash, untreated water from plant processes, and/or contaminated groundwater.
- 37.3 acres of ponds containing other wastes or stormwater runoff.
- 114 acres at the closed Stage One Evaporation Pond (SOEP) with CCRs capped in place.

A few notes regarding the pond contents are worth mentioning for clarification. This data was compiled from Talen's Administrative Order of Consent reports wherein basic details about history, current usage, and future plans are provided for each pond[51]. However, some of this data is limited and may not capture the entire usage history or contents of each pond. Several ponds have switched functions over the years, perhaps swapping between containing coal ash and then receiving plant process water. From Talen's descriptions, it is clear that most of these ponds still contain their original contents – in other words, they were not fully excavated before switching to storing other materials or effluent. Finally, the SOEP was capped with the CCR materials left in place, but this closed pond still leaches contamination into the groundwater[52].

** Some sources report inconsistent numbers when referencing the surface area of Colstrip's coal ash complex. However, while some of these numbers have minor fluctuations, the entire complex is around 837 surface acres.*

POND LINERS

The ponds currently have a variety of cell liners, ranging from clay to multi-layered geosynthetic liners that comply with current CCR regulations. Many of the ponds are unlined and, in these cases, compacted soil and clay is the only barrier between the effluent slurry and the surrounding soil. The liner types as categorized by Talen are as follows: High Density Polyethylene (HDPE), double-lined Reinforced Polyethylene with leachate collection (beneath the liner), hypalon (sometimes with an underdrain system), partial clay, clay-lined, and a compacted bentonite/soil mixture[53]. Depending on the complexity of the liner system, the first two liner types comply with the new CCR rules. The latter 4 methods are largely considered inadequate. The hypalon was used in the original pond construction and has since been replaced in many ponds[54].

The 1 & 2 and plant site ponds were originally constructed with a mixture of clay, compacted soil, and hypalon liners. Some of these liners have since been replaced with doubled-lined geomembrane liners and leachate collection systems[55].

The 3 & 4 ponds were originally constructed without liners under the assumption that the leachate collection system installed beneath the pond and the concrete slurry wall would capture all the seepage[56].

PLANT WORKFORCE

The plant workforce includes employees at both the plant itself and the associated disposal sites. The workforce is comprised of the unionized labor force, non-union workers, and Talen Energy management. The International Brotherhood of Electrical Workers (IBEW) Local 1638 is the local union for the entire plant. Though workers at the plant may be members of other unions, only the IBEW has a negotiating contract with Talen Energy and represents the plant's unionized workforce[57].

ASH PONDS LEAK 200 MILLION GALLONS PER YEAR FOR DECADES

The Colstrip ponds are an inadequate storage solution for the coal ash produced at the plant. They have a multi-decade history of leaking into the groundwater, impacting residents and agricultural users. The remediation of the contamination is no simple task due to the extent of pollution and incomplete information on the chemical composition of the plume.

The ash ponds leak 367 gallons per minute [gpm], or 200 million gallons a year[58] . These ponds have been leaking since their construction more than 30 years ago. About 190 wells capture and pump back approximately 688 gallons of groundwater per minute back to the plant site where it is either reused in plant operations or stored in the effluent ponds again[59] .

In terms of geographic location, the plume of leaked water has expanded significantly through the years. Current groundwater capture wells seem to be holding the plume at its present boundaries for the most part, but the wells do not capture all of the leakage, as evidenced by the fact that new wells are being installed and new contamination sites are still being discovered. Talen has also acknowledged that not all leakage is contained by the current capture system[60]. As DEQ describes:

"

AS A RESULT OF THE GEOLOGICAL COMPLEXITIES, IT IS DIFFICULT TO ACCURATELY DETERMINE HOW FAR AND FAST THE CONTAMINATION WILL SPREAD.

EXTENSIVE CONTAMINATION AT EACH SITE

The most comprehensive information available from the utility and the Department of Environmental Quality about groundwater contamination concerns boron and sulfate contamination. Talen is using those two pollutants as the bookends of cleanup compliance, because there are high concentrations of both these constituents in the contaminated groundwater and Talen contends that these move at very different speeds through the ground[62]. Thus, close monitoring of these two constituents will theoretically provide a view into the location and concentration of the contamination plume as a whole. The well monitoring as reported in the maps is the best source for plume information for the present time. From these maps, it is clear there is significant pollution in the alluvium, which is the closest geologic layer to the surface[63,64,65]. Because of the contamination in the alluvium beneath nearby creeks (such as East Fork Armells and South Cow Creek) residents are also concerned about the potential for this groundwater contamination to affect surface water. Contamination is not limited to layers closest to the Earth's surface, however, and is present in much deeper geologic layers as well[66].

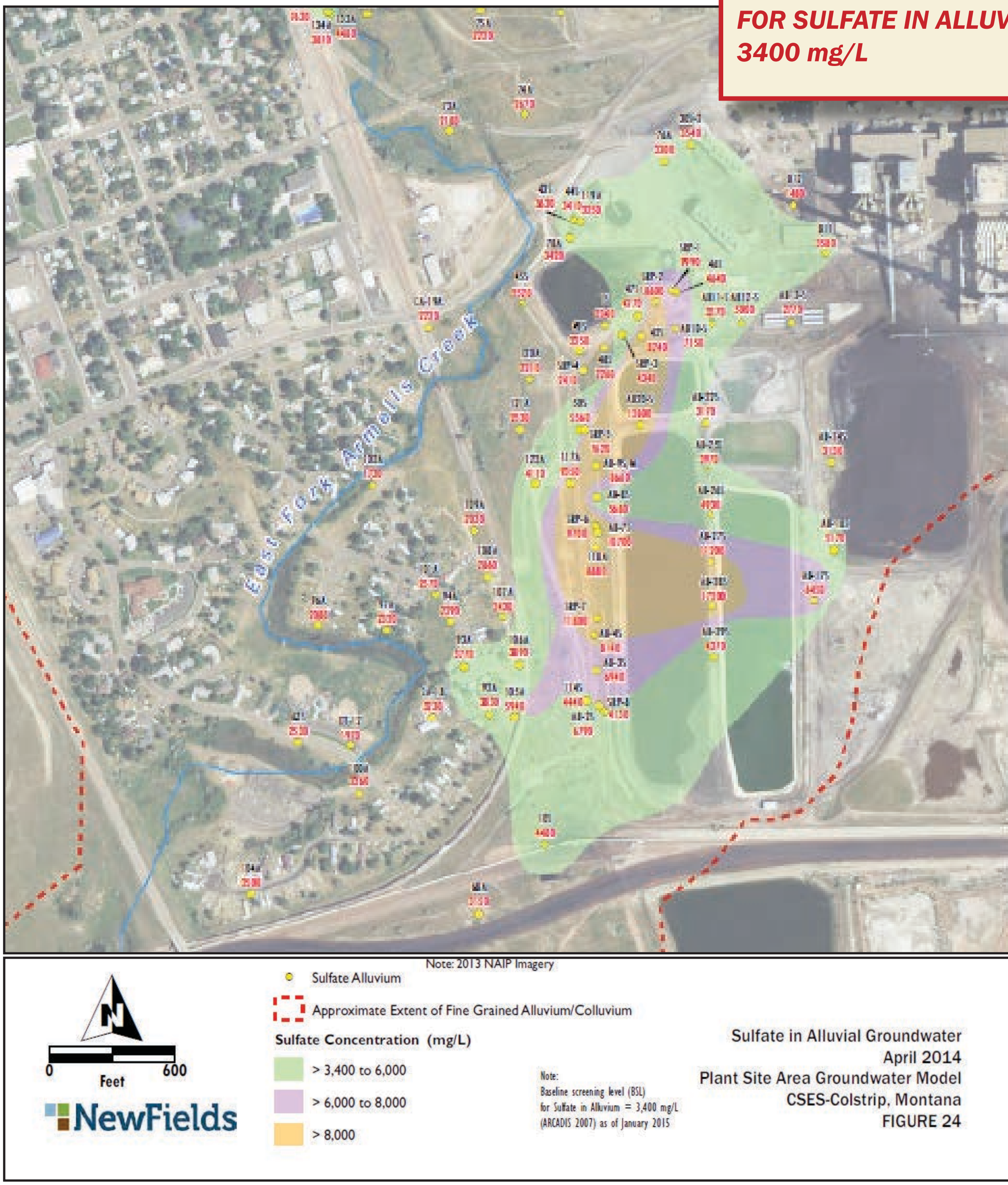
While contamination at all the sites is problematic, leakage from the Effluent Holding Ponds site is the most significant. Compounding this issue is the fact that the underground hydrology and geological complexities of this area make predicting the location and movement of the plume very challenging.

PLANT SITE:

Monitoring reports at the plant site have shown boron levels to be 33 times greater than what is found in the regional background screening levels (.818 - 4 mg/L generally, 1.5 mg/L according to Talen's map); this sampling site is just outside the pond wall in the alluvium groundwater. A bit farther from the plant site and directly next to East Fork Armell's Creek, contamination has been detected at 4 mg/L or 2.67 times the background screening level. While this is the upper limit of the EPA's tap water regional screen level (RSL), it is illustrative of how far afield the contamination has spread. Monitoring reports at the plant site have shown sulfates levels to be 3.4 times greater than what is found regionally in the alluvium groundwater (3,000 mg/L). Where the plume has extended beneath the townsite, the monitoring report shows sulfate levels to be 4,300 mg/L[67] (*See Figure 6 on the following page).*

SULFATE LEVELS IN ALLUVIAL GROUNDWATER AT THE PLANT SITE ARE 3.4 TIMES GREATER THAN THOSE IN NEARBY REGIONS.

BASELINE SCREENING LEVEL FOR SULFATE IN ALLUVIUM = 3400 mg/L

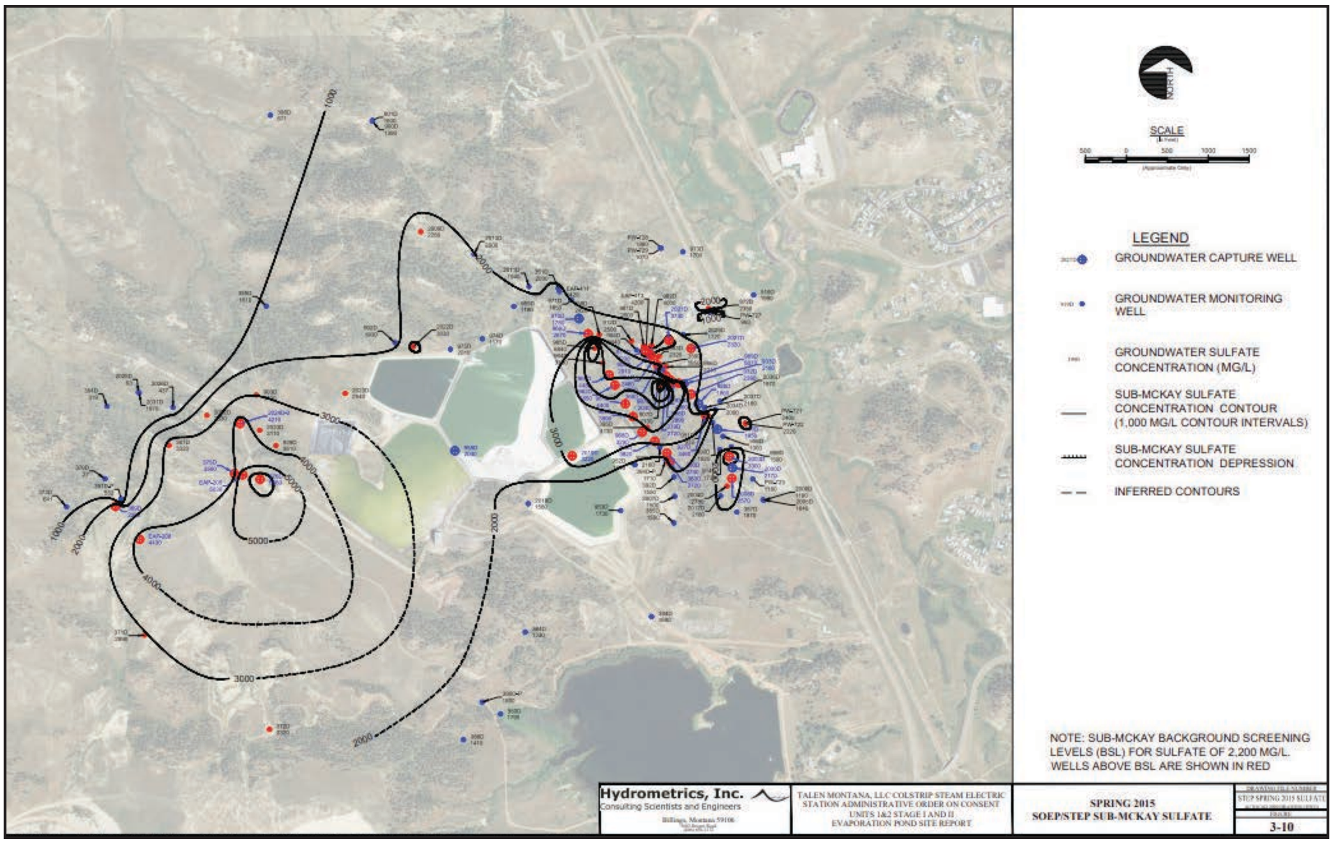


(Credit: Geosyntec consultants/Talen LLC, 2017)

Figure 6: Contamination at the Plant Site[75]. Two constituents—boron and sulfate—serve as indicators of the entire plume's location and concentration.

SOEP / STEP:

Groundwater contaminant plumes with very high levels of boron, total dissolved solids, and sulfates extend more than 1,000 feet from the currently closed SOEP to the northwest part of the town[68]. The contaminant plume affected multiple private water wells, but information about the contamination was not publically known until residents who were made ill by drinking the contaminated water filed a lawsuit in 2003. **In 2008, the plant's owners paid a $25 million settlement to 57 Colstrip residents whose well-water was rendered undrinkable by the leaking waste ponds.** The original Moose Lodge in Colstrip also had to be abandoned because of the water contamination and structural impacts of leakage[69].



(Credit: Hydrometrics/Talen LLC, 2013)

Figure 7: Contamination at the Units 1 and 2 ponds (SOEP/STEP). The red dots indicate monitoring wells where sulfate exceeds 2,200 mg/L, which is within the region's typical level of sulfates in groundwater. Even though the Stage One Evaporation Pond is closed and capped, it is still leaking contamination into the groundwater. Monitoring wells also show groundwater contamination from the Stage Two ponds[47].

"

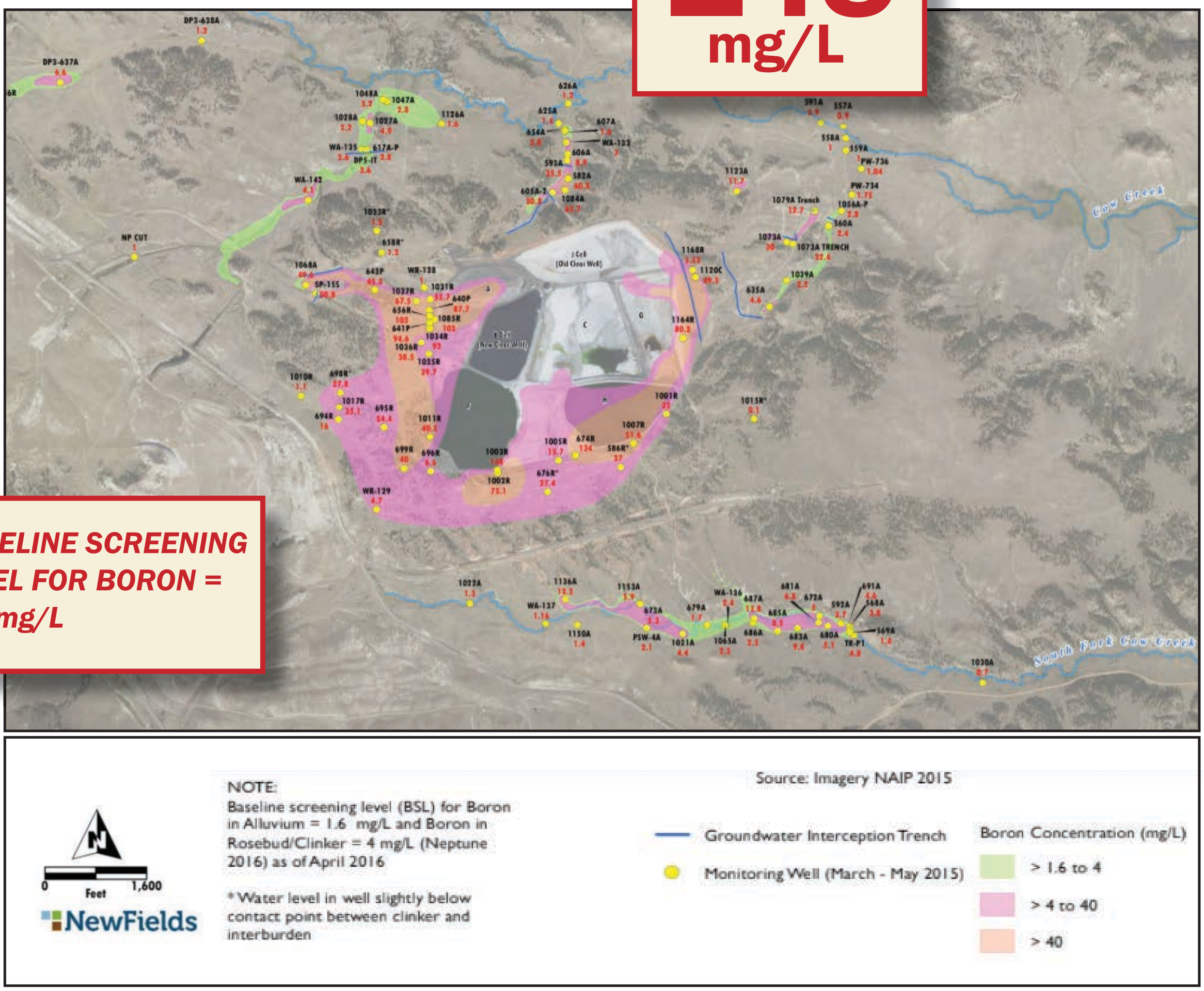
IN 2008, COLSTRIP'S OWNERS PAID $25 MILLION TO 57 COLSTRIP RESIDENTS WHOSE WELL-WATER WAS RENDERED UNDRINKABLE.

EHP:

Impacted (polluted) groundwater has been identified in several downgradient locations from the Units 3 & 4 EHP ponds, including in the alluvium of South Cow Creek. Wells just outside the EHP walls have shown boron levels at 75 mg/L and have been observed as high as 148 mg/L in the alluvium. Monitoring wells along the south fork of Cow Creek (south of the ponds) have shown boron levels up to 13.3 mg/L. Again, background screening levels for boron in the area's groundwater is .818 - 4 mg/L. Sulfates have also been observed at above-background screening levels (3,000 mg/L) at several areas around the EHP site. Just south of H Cell, sulfates have been observed at 19,900 mg/L and at the south fork of Cow Creek, sulfates have been observed at 4,630 mg/L[70].

BORON LEVELS OUTSIDE THE EHP WALLS HAVE BEEN AS HIGH AS:

148 mg/L



BASELINE SCREENING LEVEL FOR BORON = 1.6 mg/L

Figure 8: Contamination at the Units 3 and 4 ponds (Effluent Holding Ponds, or EHP). Although these units are converting to dry ash storage, there is still significant groundwater contamination that must be remediated. It is yet to be determined how the old ponds (not being converted to dry storage) will be closed[49]. (*Credit: Hydrometrics/Talen LLC, 2016*).

CONSTITUENTS OF CONCERNS:

Talen Energy monitors and reports on the presence of ***Constituents of Concern*** (COC's) in the groundwater surrounding the site.Talen Energy has been reporting on boron, sulfate, selenium, potassium, sodium, magnesium, and manganese.The company also measures salinity and ***total dissolved solids*** (TDS). As described earlier, more extensive data is provided for boron and sulfates because they serve as "indicators" of the overall plume. According to Talen Energy, these constituents both have a high magnitude of exceedance over background levels and they also move at very different speeds through the ground. Thus, Talen proposed a range for cleanup times with sulfate at the low end of mobility and boron on the high end. The cleanup criteria for the COCs are as follows[71]:

COI/ COPC	Groundwater DEQ-7	USEPA Tapwater RSL	Ecological (Livestock) Cleanup Criterion	BSL Range	Proposed Cleanup Criteria [1]				
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Alluvium (mg/L)	Spoils (mg/L)	Clinker (mg/L)	Coal-related (mg/L)	Sub-McKay (mg/L)
CCR Rule Appendix III Constituents									
Boron	NA	4	39 [2]	0.818 - 4	4 (RSL)	4 (RSL)	4 (RSL)	4 (RSL)	4 (RSL)
Sulfate	NA	NA	3,000 [3]	2,061 - 3,160	3,000 (Livestock)	3,045 (BSL)	3,160 (BSL)	3,000 (Livestock)	3,000 (Livestock)
CCR Rule Appendix IV Constituents									
Cobalt	NA	0.006	0.03 [2]	.00066-.0232	0.02 (BSL)	0.0232 (BSL)	0.0232 (BSL)	0.006 (RSL)	0.006 (RSL)
Lithium	NA	0.04	NA [4]	0.072 - 0.092	0.092 (BSL)	0.09 (BSL)	0.09 (BSL)	0.072 (BSL)	0.072 (BSL)
Molybdenum	NA	0.1	NA [4]	0.004 - 0.048	0.1 (RSL)	0.1 (RSL)	0.1 (RSL)	0.1 (RSL)	0.1 (RSL)
Selenium	0.05	0.1	0.28 [2]	0.0023 - 0.01	0.05 (DEQ-7)	0.05 (DEQ-7)	0.05 (DEQ-7)	0.05 (DEQ-7)	0.05 (DEQ-7)
Other Potential Plant Site Constituents									
Manganese	NA	0.43	61 [2]	0.27 - 2.79	0.6 (BSL)	2.79 (BSL)	0.67 (BSL)	0.54 (BSL)	0.43 (RSL)

Figure 9: Table of constituent levels in the groundwater surrounding the Colstrip ash pond complex.
(*Credit: Geosyntec Consultants/Talen LLC*[62,75])

(Table definitions available on the following page)

CONSTITUENTS OF CONCERN (CONTINUED):

COI - Constituents of Interest; identified in Article IV of the Administrative Order on Consent regarding wastewater facilities at Colstrip (AOC; Montana Department of Environmental Qualtiy [MDEQ] and PPL Montana, 2012).

COPC - Chemicals of Potential Concern; identified in the Cleanup Criteria and Risk Assessment Report (CCRA; Marietta Canty, 2017).

DEQ-7 - Department of Environmental Quality Circular; DEQ-7 contains numeric water quality standards for Montana's surface and ground waters (MDEQ, 2012).

mg/L - milligrams per liter.

USEPA - United States Environmental Protection Agency.

RSL - Regional Screening Level (USEPA, 2015).

BSL - Background Screening Level determined by CCRA.

NA - Not applicable/not available.

[1] Proposed cleanup criteria for groundwater provided in the CCRA for use in the Remedy Evaluation. The CCRA was submitted to MDEQ on 8 June, 2017 and has not yet been approved.

[2] Calculated Cleanup Criterion protective of livestock (calf) provided in the CCRA.

[3] Upper limit of "marginal" sulfate range for livestock (USDA-ARS, 2009).

[4] According to the CCRA, Cleanup Criterion could not be calculated because no mammalian Toxicity Reference Value (TRV) is available.

Talen Energy has been conducting detection monitoring for other potential constituents pursuant to the new federal Coal Combustion Residuals (CCR) rule. This is to determine if there are other COCs that will need to be addressed in the cleanup process. If detection monitoring shows that there are other constituents present which exceed CCR trigger levels, then Talen Energy has to undertake assessment monitoring to evaluate this expanded list of COCs[72]. Depending on what COCs are identified during this process, other remediation strategies might be needed to address these constituents. Potentially problematic COCs might be arsenic, cobalt, and/or selenium. It is anticipated that Talen Energy will release its assessment monitoring report in 2019.

ATTEMPTS TO KEEP CONTAMINATION AT BAY

A complex of monitoring wells and groundwater collection systems is intended to address the contamination plume. It is currently assumed that this system is mostly holding the plume "at bay," as it is neither expanding nor contracting significantly.

In addition to groundwater capture wells, contaminated water is also collected by trenches, leachate collection systems between and below the pond liners, and in-dam toe and chimney drains. Captured water is pumped to process cells for evaporation, or is piped to the Plant Site and treated for re-use via the Vibratory Shear Enhanced Process (VSEP). The captured water is returned to existing ponds (or process cells), many of which leak into the groundwater[73,74].

2.2 TALEN's PROPOSAL:

CLEANUP REQUIRED; STRATEGY UNDECIDED

The proposed coal ash pond's cleanup strategy has not yet been approved by DEQ (see AOC [Administrative Order on Consent] section of the "Policy Context"), but Talen Energy has submitted portions of its preferred cleanup strategy to DEQ and these are available to the public. The most comprehensive account of Talen Energy's cleanup proposal is the Plant Site Remedy Evaluation Report[75]. More general information regarding the cleanup approach is found in the final closure plans Talen Energy submitted to DEQ in 2017 and 2018[76,77].

In terms of timelines, the ponds need to be closed in conjunction with unit closures, though ponds can be closed earlier if DEQ finds violations of the CCR rule or other infractions. Post-closure care, like groundwater monitoring and groundwater remediation actions, is to continue for 30 years after closure. The site and contamination are supposed to be fully remediated by 2049[78].

The basic design of Talen Energy's plan is to cap ponds with CCR in place, continue utilizing pump-back wells, install injection wells to "flush out" contaminants, and utilize institutional controls. These strategies and actions are considered in three categories: point source control, groundwater/plume treatment, and institutional controls.

With regard to point source control, Talen Energy is not planning to reline the vast majority of the ponds. Additionally, the dewatering plan for many of the ponds is unclear, leaving open the possibility of closure with effluent in place. Excavating CCR material is only proposed for a handful of small ponds. Capping in place is the dominant strategy for both effluent and dry storage areas[79,80,81].

For groundwater contamination, Talen Energy plans mainly to continue with its current approach of pump-back wells with the possible addition of fresh-water injection wells. Beyond treating captured groundwater for plant processes, no further water treatment is proposed[82].

Talen Energy has also left open the option of institutional controls, which essentially allows the company to close off areas to public access. This may include condemning property and/or rezoning certain areas[83].

Each of these strategies is considered in more detail.

Cap-in-Place: Talen Proposes to Leave Coal Ash in Ponds

The SOEP/STEP ponds will be closed by July 2022 when Units 1&2 cease operations. Talen Energy proposes closing ponds with the CCR residuals in place[84]. The problem with this method, of course, is that the liners underneath the ponds are permeable (as evidenced by the documented groundwater contamination near these ponds) and it is quite possible that the pond floors are below groundwater level. Talen has not proposed excavating these impoundments. It is unclear which ponds Talen plans to dewater and the planned degree of dewatering (if it's included at all in their closure plans).

The EHP ponds will be converted to dry storage, the existing effluent ponds will be dewatered, and the remaining CCR materials will be stored via dry stacking – all before 2023[85]. When the time comes for these ponds to be closed, Talen has proposed capping this dry ash in place and not excavating the impoundments. Although conversion to dry ash is a positive step, the old ponds at the site – especially the G and J cells underneath the new G-1 and J-1 cells – are likely to be a continuing source of contamination into the groundwater. It is unclear if the non-dry stacked cells have been or will be dewatered prior to capping or closure[86].

Dry storage requires that as much water as possible is decanted and the resultant paste, after a few days, hardens into a cement-like substance. Talen Energy is already utilizing the paste plant, but the paste is watery and the process will likely require some upgrades to comply with regulations. The decanted water is processed, piped back to the plant, and reused in plant activities. The water is processed using the Vibratory Sheer Enhancement Processer (or VSEP) and Talen Energy proposes to utilize a Brine Concentrator and Crystalizer in future cleanup. These two processes restore the water to the point that it can be used at the plant again. The VSEP has a "limited fouling resistance" meaning that, at a certain point, the processed water cannot be reused in the plant and must be stored or evaporated[87,88].

At the Plant Site, Talen Energy has proposed considering dewatering and fully excavating one of the ponds of CCR material (Units 1 & 2 A pond) prior to closure[89].

In its Facility Closure Plans, Talen Energy proposes to construct new ponds over existing CCR material in unlined or clay-lined ponds[90]. In essence, the company would build another pond on top of an existing pond with only a liner in-between the two layers. This system has already been implemented at the EHP site where the J-1 and G-1 cells sit above the original J and G cells, both of which are unlined[91]. This strategy may lead to further leakage, especially due to the added hydraulic head pressure and the fact that the original, underlying ponds are not lined.

For the final liner and closure systems, Talen proposes the use of CCR materials in some liner and/or cap materials[92]. While geosynthetic and composite liners are typically much more effective than the clay or compacted soil liners, the inclusion of subgrade CCR in the construction has raised concerns at DEQ[93].

DECADES OF SLOW TREATMENT: TALEN'S PROPOSAL TO FIX EXISTING GROUNDWATER CONTAMINATION

Talen Energy has proposed groundwater cleanup that achieves Cleanup Criteria levels by 2049 using four main actions: monitored natural attenuation, increasing pump-back well rates, utilizing injection wells, and treating captured groundwater to levels acceptable for re-use in plant operations[94].

Most of these actions relate to monitoring and stopping the contamination plume, or as Talen Energy describes it, Distal Migration Management. Most of these actions are typical for hazardous contamination sites; however, the only last option of treating captured groundwater with the Brine Concentrator and Crystalizer (BCC) or the VSEP, addresses groundwater treatment directly. The BCC and VSEP would treat water to the extent that it can be re-used in plant processes. It is unclear if they are designed to remove contaminants to the point of AOC groundwater compliance or if they have the capacity to treat the all of the captured groundwater plus the decanted pond water in a timely manner[95].

Monitored natural attenuation, recharge barriers, expanding the existing capture system, and installing a permeable reactive barrier are, for the most part, fairly typical groundwater remediation strategies[96]. The final remediation strategy pursued will likely be multi-faceted and most, if not all, of these actions will need to be utilized. For instance, if more pump-back wells are installed, additional water injections into the aquifer may be required to help the wells to function properly. So the question isn't whether any individual strategy is sufficient, but whether the combination of these strategies will adequately remediate the groundwater contamination.

A related concern is that some of these actions require more advanced planning, vigilant oversight, and coordination with the other remediation departments. For example, the actions included in "proposed recharge barrier" section – via injection wells or infiltration basins – are utilized at some contamination sites, but it is not a very straight-forward strategy and will require ample monitoring to be done successfully. First, the hydrologic and geologic complexity of the area already poses several obstacles for current plume management. As noted earlier, neither DEQ nor Talen know exactly where the plume exists, thus new areas of contamination are still being found and new pump-back wells are installed with some regularity. Adding recharge barriers that do not exacerbate the plume's movement may be a very complicated endeavor that will require vigorous examination and oversight. Additionally, further analysis of the monitoring well reports will need to be conducted in order to ensure that injections are not resulting in dilution rather than actual mitigation. Without careful additional analysis, monitoring well reports would not distinguish between these outcomes.

Finally, the groundwater remediation strategy does not address one critical shortcoming of the current plume management: many pump-back wells return water to leaking ponds where CCR material is still stored[97]. By continuing to pump contaminated groundwater back into the CCR ponds where they would probably leak back into the ground (due to faulty and inadequate liners), these actions are likely bringing uncontaminated water into the wastewater cycle, further impacting the groundwater reserves for the area.

ACCEPTING THE POLLUTION: INSTITUTIONAL CONTROLS

Talen Energy includes several institutional controls in the Plant Site Remedy Evaluation Report that allows the company to condemn certain areas to limit human exposure to contamination. These institutional controls include: alternate water supply, city ordinances, deed restrictions, easements, reservations (as it pertains to real estate transactions), covenants, controlled groundwater areas, and zoning[98]. According to Talen, these actions "contribute to controlling potential exposure to groundwater constituents until such time that the remedy has achieved the PCC [Proposed Cleanup Criteria]. The RAO [Remedial Action Objective] for institutional controls is to alert potential receptors to the presence of groundwater constituents and to reduce or eliminate potential exposure"[99]. In the report, all these actions are retained for each alternative considered and can be considered potentially substantial components of Talen Energy's overall approach to cleanup.

However, it should be noted that institutional controls are sometimes used to avoid implementing remedial actions in a timely manner or enacting those actions at all. For example, at Little Blue Run in Pennsylvania and West Virginia, plant owners bought several properties in order to limit public exposure to groundwater contamination or to install groundwater capture mechanisms, but avoided making substantial changes to actually stop the source of pollution for decades *(see Little Blue Run, section 5.4).*

Additionally, if institutional controls are used for a substantial amount of property, this could effectively alter the boundaries for the point of compliance [POC] and therefore the time at which the Cleanup Criteria must be achieved for those areas. While *limited* institutional controls may be a necessary tool for the remedy plan, overreliance on such methods may lead to inadequate cleanup for large parcels in the Colstrip area.

2.3 WHO PAYS?

COLSTRIP OWNERS' CLEANUP COSTS

Through the AOC, Talen Energy is required to estimate the costs of all its remediation and closure activities. The bonding for these activities would come in three phases to address planning, closure, and remediation[100].

The planning phase bond of $7.5 million has already been paid. The much larger closure and remediation estimated bonds are currently being calculated, along with cleanup strategy proposals[101].

With regard to the closure costs, Talen Energy has previously estimated it would require $137.84 million to just close the entire facility[102]. However, this estimate was presented as part of a Facility Closure

Plan that the DEQ has not yet approved. The agency is currently re-evaluating Talen's estimates. For context, these reports estimate the closure costs of SOEP/ STEP to be $35 million; the plant site to be $18 million; and the EHP to be $84.84 million[103,104,105]. While those precise amounts cannot be considered final, the differences between the estimates indicates the magnitude of cleanup costs at each site relative to each other.

For the long-term remediation amounts, there are very few estimates available. In the later released plant site Remedy Evaluation Report, Talen Energy estimated the financial cost of remediation for just the plant site at $113 million[106]. There have been no estimates provided for the other two—much larger—sites.

Through its recent rate case, Puget Sound Energy (PSE) estimated its company's portion of costs at $395 million[107]. It is worth noting that PSE owns one-third of the Colstrip power plant.

At this time, there is no cost breakdown that would show the cost of the design, engineering, and labor phases of the project.

III. COAL ASH BASICS

3.1 WHAT IS COAL ASH?

Coal ash is the material left over after burning coal for electricity at power generating plants. Much of it has been pulled from the plant exhaust by air pollution controls. This material is also referred to as coal combustion residuals (CCR) or coal combustion waste (CCW). The easiest and cheapest way for power plants to manage these waste materials has been to combine them with wastewater and store in ponds, also known as impoundments or basins[107].

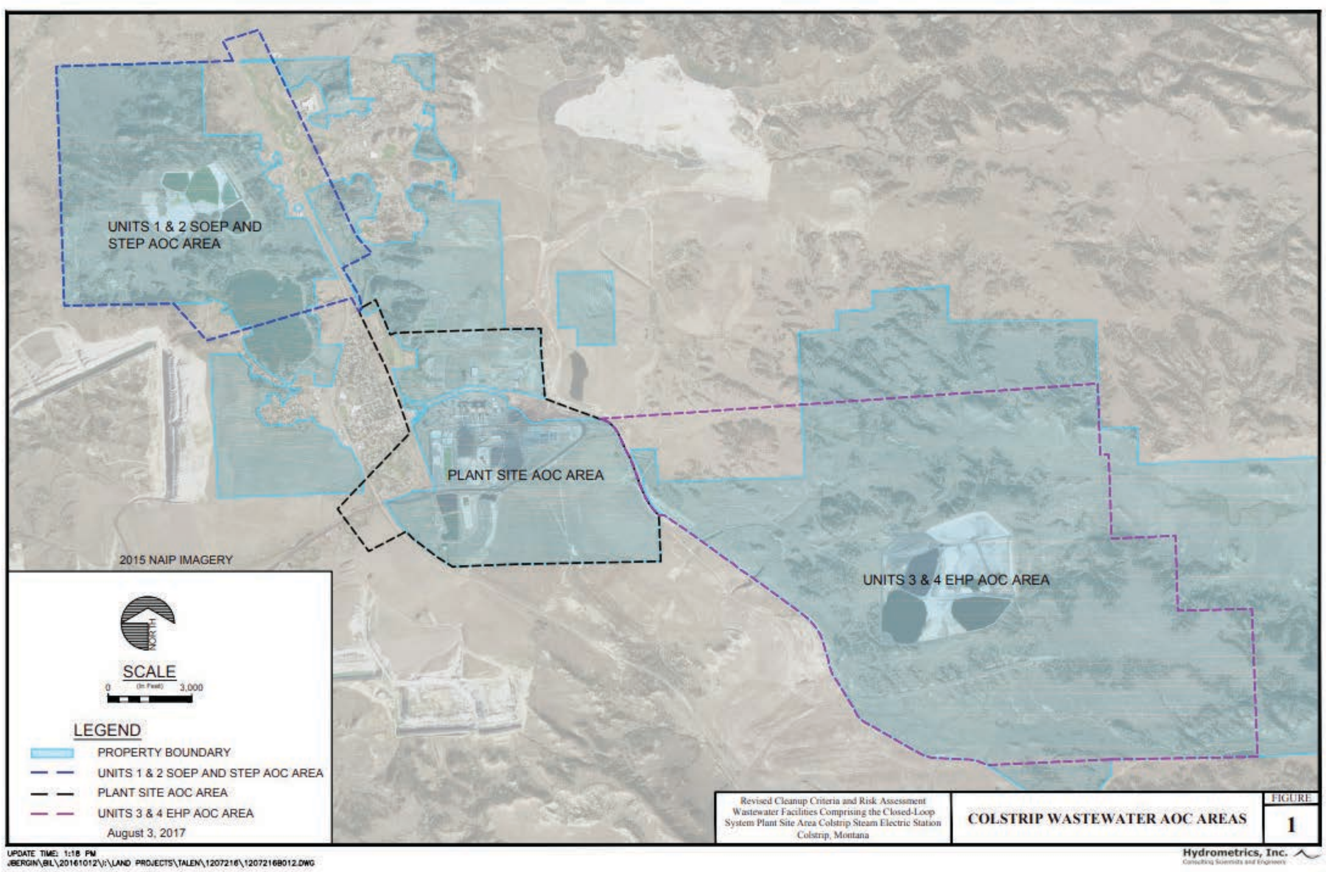


Figure 10: Aerial map of the entire coal ash pond complex at Colstrip. Coal ash easily leaches contamination into water. Extensive reports from plants utilizing wet coal ash ponds around the country show ponds leaching arsenic, selenium, radium, chromium, and boron into groundwater. (*Credit: Hydrometrics/Talen LLC, 2016)*

There are ***four primary types of coal ash:*** Fly ash, bottom ash, boiler slag, and flue gas desulfurization material.

- ***Fly ash*** is a fine, powdery substance made up primarily of silica.
- ***Bottom ash*** is made of much coarser, angular particles that gather at the bottom of the power plant's furnace.
- ***Boiler slag*** is molten bottom ash that has turned into the shape of pellets.
- ***Flue gas*** desulfurization material is created by pollution control technology that reduces sulfur dioxide emissions[108].

The material is stored as either a sludge or in a powdered form. While these types of ash are often stored separately, they are sometimes stored together or co-managed.

Burning coal for power is a very water-intensive process and much of this water is mixed with the coal ash itself, producing a slurry of CCRs. When effluent or wet storage is used at a site, this slurry is pumped to holding ponds onsite[109]. For many decades, the industry standard was to build ponds without liners, or with liners that are extremely permeable, resulting in leaking contamination. Several ponds are constructed with earthen dams; and where the dams have failed—for instance, at the Tennessee Valley Authority (TVA) plant in Kingston, Tennessee—the physical devastation of the flood was accompanied by widespread contamination by heavy metals and other toxins[110].

The devastation of coal ash berm failures is striking, but unlined ash ponds are no less dangerous. The vast majority of ponds leak, contaminating the surrounding environment. Surface and groundwater pollution is a common and dangerous problem observed at coal ash ponds around the country. Drinking water sources have been polluted with arsenic, boron, chromium, and selenium to the point of being undrinkable; many communities are supplied with bottled water by the local utility[111,112]. With over 1,000 coal ash ponds in the US, this is an issue affecting nearly every state[113].

HEALTH RISKS OF COAL ASH CONTAMINATION IN WATER

Several studies show that ***coal ash carries a high health risk when people and other animals are exposed to it***. Although coal ash is not regulated federally as a hazardous waste material, it is well documented that prolonged and/or high exposure to coal ash contamination is highly dangerous. Coal ash has a high propensity to leach heavy metals and other pollutants into water; this is a potent exposure pathway for people, livestock, and plants. In fact, handling coal ash without adequate protective gear has led to sickness and death in workers.

(Photo credit: © Mariia Boiko, 123rf.com)

Colstrip's municipal drinking water is supplied by the unimpacted Yellowstone River, however wildlife and livestock are still vulnerable to contamination from leaking ash ponds.

Although the Environmental Protection Agency (EPA) determined that coal ash is not technically a hazardous material, several of the constituents commonly found in coal combustion residuals (CCRs) are very dangerous in small concentrations to human, livestock, and ecological health. Contaminants typically found in coal ash pollution include arsenic, lead, radium, molybdenum, hexavalent chromium, selenium, thalium, boron, and sulfates[114]. Exposure to many of these contaminants causes damage to the nervous system, heart, lungs, and reproductive systems; some are additionally carcinogenic or lethal in high doses[115].

Although several of these constituents are naturally occurring in coal, coal ash contains exceptionally high concentrations of each constituent, due to "enrichment" by the combustion of coal. When stored as slurry, water provides a pathway for soil contamination and ingestion that otherwise would not occur[116]. Additionally, effluent or wet storage can pose acute risks to aquatic organisms and contamination can even persist up the food chain[117].

A brief overview of some of these constituents and their potential health impacts is included below. Regional screening levels for drinking water standards are indicated by Regional Screening Level (RSL) or Maximum Contaminant Level (MCL), as determined by EPA. Ecological or livestock drinking standards are indicated by "Livestock", and background screening levels for the southeast Montana region are indicated by BSL.

Arsenic: This heavy metal is extremely hazardous to human health and is lethal in high doses. Lower levels of arsenic contamination can result in vomiting, decreased blood cell production, irregular heart rhythm, and blood vessel damage. At high levels, it is carcinogenic and can cause death in humans. Likewise, high levels of arsenic are very dangerous to animals and can lead to neurological disorders, cancers, and death[118,119,120.] MCL: 0.01 mg/L2 is acceptable but 0 is the goal[121].

Selenium: This heavy metal is found at many coal ash contamination sites (52). Short-term exposure can cause nausea, vomiting, and diarrhea. Long-term exposure to high levels can result in hair loss and can affect the liver (53). Selenium in the environment is problematic because it is a neurotoxin to aquatic life and persists in the food chain (i.e. it is passed on from prey to predator) (55). In livestock, high levels of selenium can cause "blind staggers" wherein animals suffer impaired vision and even paralysis (56). Selenium can also act as an "accelerator" for other constituents, creating more toxic compounds in combination[122,123,124,125]. RSL: 0.1 (mg/L), BSL: 0.0023 - .01 (mg/L)[126]

Hexavalent Chromium: This is a known carcinogen that is toxic in even small doses, affecting the respiratory system, kidneys, liver, and skin. While there are two forms of chromium: trivalent which is not harmful to human health and hexavalent which is very toxic. The EPA recently found that almost 100% of the chromium found at coal ash sites was the hexavalent version. The federal drinking water standard for chromium is 100 parts per billion (ppb), but California has proposed a much lower limit of .02 ppb for their state due to the constituent's toxicity[127,128,129.]

Boron: Low levels of boron exposure have not been shown to be deleterious to human health. Long-term exposure to high boron levels can lead to fingernail loss, digestive issues, and potential reproductive health effects in humans. In animals, boron has been shown to affect reproductive systems and developing fetuses[130,131]. RSL: 4 (mg/L), LDS: 39 (mg/L)[132]

Sulfates: Exposure to sulfate levels above livestock drinking standards will lead to serious digestive issues for cattle, as well as blindness and even lethal brain softening. Even low levels of sulfate can lead to dehydration because livestock—especially those unaccustomed to sulfur in water—will avoid drinking it due to the taste even when there might not be any other water available. Higher levels (greater than 3,000 ppm) of exposure can lead to polioencephalomalacia, which is brain tissue softening; this condition is quickly lethal[133,134].BSL: 2,061 – 3,160 (mg/L), LDS: 3,000 (mg/L)[135]

WHAT CONSTITUENTS ARE IN THE GROUNDWATER PLUME AT COLSTRIP?

Talen has not done extensive groundwater monitoring or reporting of all the possible constituents typically found at coal ash contamination sites. Monitoring of these constituents was only recently required by federal law with the passage of the Coal Combustion Residuals rule in 2015 and the results from this latest monitoring report will be reported in 2019[136].

However, Talen and previous owners have conducted monitoring for some constituents and have released selected data to the public. These monitoring reports show that boron, sulfates, selenium, molybdenum, lithium, manganese, and cobalt exceed regional background levels (64). Of these, the most data has been released about boron and sulfates [see "Nature of Contamination"][137.]

When coal ash is stored as a slurry as is the primary storage method at Colstrip, the ash itself leaches contaminants into the wastewater and – where the ponds are leaking – into the groundwater. Although much is unknown about the constituents present in the Colstrip groundwater contamination, the public should be aware that dangerous levels of arsenic, chromium, and selenium (among others) are especially commonplace at similar contamination sites[138].

"

ALTHOUGH MUCH IS UNKNOWN ABOUT THE CONSTITUENTS PRESENT IN THE COLSTRIP GROUNDWATER CONTAMINATION, THE PUBLIC SHOULD BE AWARE THAT DANGEROUS LEVELS OF ARSENIC, CHROMIUM, AND SELENIUM ARE COMMONPLACE AT SIMILAR CONTAMINATION SITES.

3.2 CLEANUP STRATEGIES:

THOROUGH CLEANUP IS GOOD FOR COLSTRIP

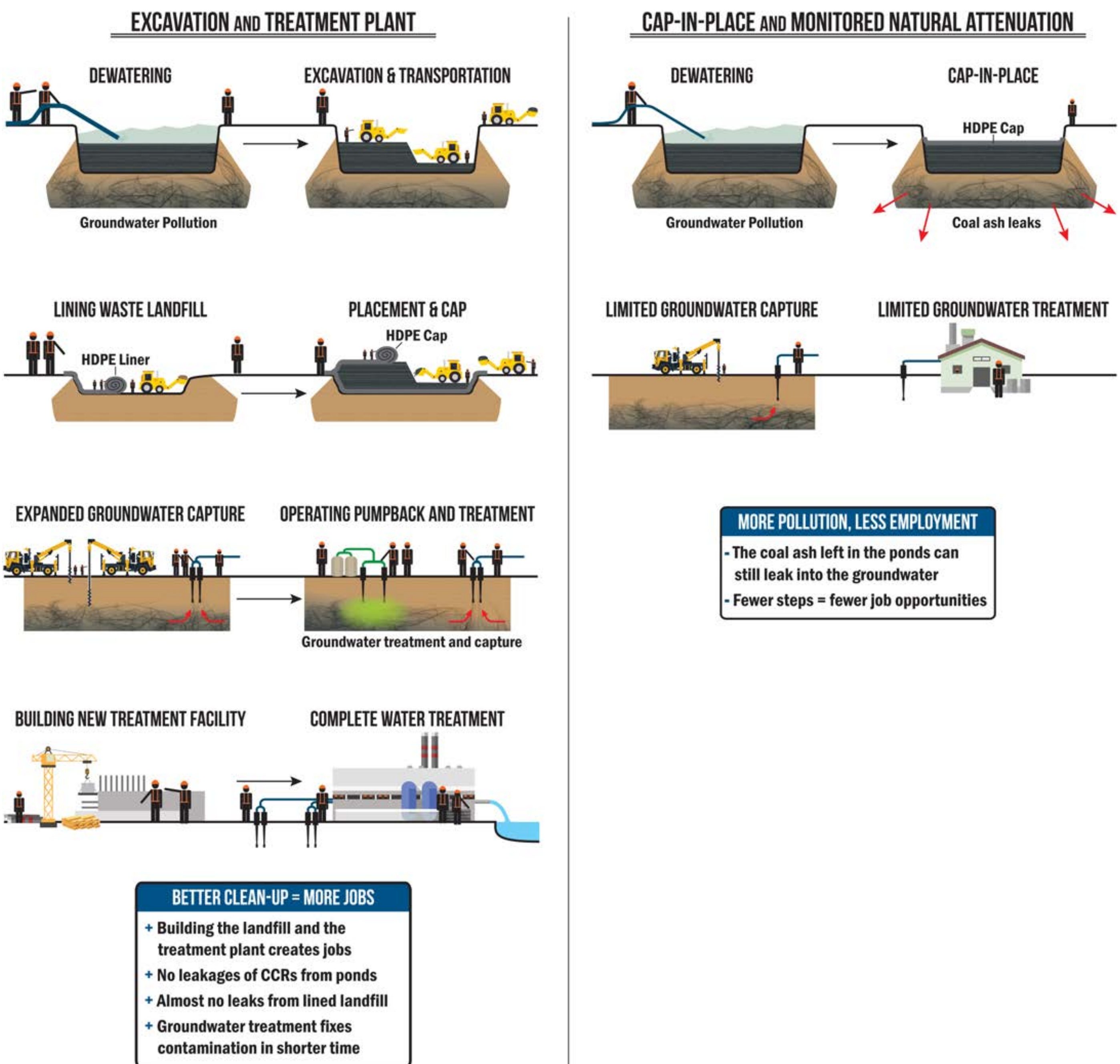
To clean up coal ash pond pollution, ***two areas*** must be addressed:

- Stopping the source of pollution (point-source control).
- Remedying the existing contamination in the environment (in the Colstrip case, this primarily means groundwater remediation).

For point-source control, utilities generally prefer the method of ***cap-in-place*** which is cheaper and easier than excavating the coal ash. ***Excavation*** is a more involved and more permanent approach to actually stopping the point source pollution. In terms of groundwater remediation, numerous strategies may be employed including capturing the existing groundwater and pumping it back to the ponds. Further treatment of the captured groundwater would significantly expedite the cleanup timeline. The current proposed timeline for Colstrip aims to have groundwater cleanup goals reached by 2049. Talen, like most power plant operators, is proposing a cap-in-place and remediation strategy that relies on monitored natural attenuation and groundwater capture. Citizen groups and lawmakers in certain states advocate for more permanent, more effective strategies like excavation and active groundwater treatment[139,140,141].

These general strategies to point-source control and groundwater remediation are briefly analyzed on the following page *(see Figure 11)*, along with a look at dewatering and institutional controls.

Figure 11: This diagram compares two different approaches to coal ash pond closure and groundwater cleanup. The most permanent and efficient methodologies (specifically excavation and robust water treatment) tend to create more jobs than impermanent and and less expensive methodologies.



(*Graphic designed by Northern Plains Resource Council, © 2018)*

DEWATERING – A FUNDAMENTAL STEP TO PREVENT FUTURE CONTAMINATION

Dewatering can encompass a wide range of activities involved in coal ash storage. The reason for dewatering is that dry storage of coal ash poses much less of an environmental hazard than effluent storage. One type of dewatering occurs when water is removed from ponds holding coal ash slurry; this is typically one of the first steps taken before ash pond closure via cap-in-place or excavation[142].

It is worth noting that the dewatering process involved in converting to dry ash storage (wherein the CCR material is dewatered *prior* to storage) is different from dewatering existing effluent ash ponds. Therefore, dewatering associated with dry ash conversion is not a major focus of this analysis.

Ash ponds at the Riverbend Plant site in North Carolina being dewatered in preparation for full ash excavation. Full dewatering is a critical first step in stopping future contamination.

(Photo credit: Sam Perkins, Catawba Riverkeeper, 2017)

The CCR rule requires that ponds be dewatered before excavation or capping-in-place. Removing the water from existing effluent ponds is a multi-step process done over a period of time. ***Decanting***, or bulk dewatering, is when the majority of a pond's water is removed, usually by pumping it out of the pond and/or consolidating the material to separate the water from the CCRs. This water typically has lower concentrations of the CCR materials; a few feet of water over the remaining CCR material is normally left during this step. The second step is ***Dewatering***, wherein the remaining pore water is removed. This can involve pumping and/or draining, as well as allowing the coal ash to dry out via evaporation[143]. The utility may need to construct or utilize other ponds as settling ponds during this process, which again requires a trained workforce.

Part of the dewatering process is ensuring that storm water does not enter the ponds during this process. Thus, closure plans typical involve building structures to reroute storm water flows and potentially constructing new facilities to hold storm water. Groundwater inflows can also pose a problem, so facilities sometimes need to divert or block this water from seeping into the pond through the existing liner[144].

Once water is removed from the ponds, it must be managed so as to ensure the contaminants are not released into the environment. Many facilities reuse the water for plant operations *(see Wateree and Asheville plants in the Case Studies section (5.1, 5.3))* which involves rerouting the water back to the plant and may involve treating it to a useable level. Other facilities need to treat the water more aggressively to ensure the water is safe for discharge *(see "Water Treatment" on pages 38-39).*

Utilities that plan to cap-in-place need to carefully consider the moisture content of any CCRs left in place because of construction and contamination concerns. Likewise, very dry ash can pose its own problems due to air pollution, which is especially important when considering worker safety and fugitive dust created by the transportation of CCR materials over long distances. Operators are thus tasked with finding the right balance of dehydration at each stage to meet engineering, worker safety, and public safety needs[145].

Regardless of how dewatering is performed, common dewatering processes are effective at removing free water from ponds and the residual moisture from CCR materials.

QUICK LOOK AT DEWATERING:

WORKFORCE ANALYSIS:
Labor-intensive process that can take years depending on the pond size and complexity of water management.

COST ANALYSIS:
Variable, depending on the pond size and complexity of water management.

ENVIRONMENTAL ANALYSIS:
Very important fundamental step for preventing future contamination.

CAP-IN-PLACE: A HIGHER RISK, TEMPORARY PROPOSITION

This solution is an ***in-situ*** approach wherein an impermeable cover is installed over the coal ash pond, leaving the CCR material stored in the pond. Utilities tend to prefer the cap-in-place over excavation because it is less expensive upfront and relatively fast. It is also logistically simpler in the short term than building new storage facilities and/or transporting CCR materials. However, groundwater is complex and cleaning it up well requires a thorough strategy that removes the hazardous coal ash material and cleans up the water that is leaking underground. A company strategy that values costs savings above thorough cleanup may come at the price of continued contamination and an ongoing community health hazard[146,147].

Capping-in-place is allowed by the CCR rule, but it is very difficult to do this successfully. The most thorough cap-in-place closure would require that:

- Ponds be dewatered
- Pond floor does not intercept groundwater sources
- Ponds are located far from surface waters
- Pond liners are impermeable (or, as impermeable as current technology allows)

Most of the ponds at the Colstrip site do not meet all these criteria. A majority of the ponds are either unlined or have inadequate liners that do not meet CCR requirements for new impoundments. Additionally, it is unclear whether Talen has fully dewatered ponds prior to capping or if they plan to fully dewater ponds in the future. If ponds are capped without full dewatering, they have a higher potential for future contamination and should be closely monitored. Without the explicit inclusion of dewatering in Talen's cleanup proposals it is unwise to assume the company will undertake this step. It is also unclear which ponds are in contact with the uppermost aquifer or the water table and to what degree the current rate of groundwater capture affects the water table.

According to the CCR rule, the final cover, or cap, must consist of geomembrane and a two-foot layer of compacted soil—installed in direct and uniform contact with one another; however, an alternative system can be used as long as it proves equally effective as the prescribed cover[148].

Although capping in place seems quite straight-forward, it can be done very poorly for a variety of reasons. For instance, leaving standing water or excess moisture in the pond can compromise the integrity of the cover system[149]. At Colstrip, the Units 1&2 Stage One pond was closed and capped in place over ten years ago, but significant contamination is still leaking from this site into the groundwater[150].

The fundamental problem with the cap-in-place method is that it leaves the coal ash and contaminated soils in the environment[151]. Eventually, all liners and caps are assumed to be somewhat permeable. Granted, ponds with new liners, multi-layered caps, and those that are located far above the water table will likely have fewer seepage problems. Even those cannot be considered entirely impermeable. For instance, the CCR rule dictates that even new ponds with state-of-the-art liners must have a leachate collection system because of the assumed seepage[152].However, most ponds do not have state-of-the-art liners (or any liners at all) and thus capping is only a temporary solution to the leakage problem.

Also, a CCR-compliant final cover or cap may prevent surface water from entering the closed pond, but it will not stop groundwater from seeping into the pond. Thus, even though the coal ash is dewatered prior to capping, this seepage *into* the pond essentially recreates the original effluent slurry -- and if groundwater can seep *into* the pond, the contaminated water can of course leach *out* into the ground. This outcome is even more likely where the ash ponds are in contact with the water table and in ponds with either very inadequate liners or no liner at all. Many of the Colstrip ash ponds are indeed unlined or have outdated liners and therefore, capping in place is even riskier at these sites.
Due to these drawbacks, many researchers and analysts consider capping-in-place an

impermanent solution with many potential long-term risks[153,154].

QUICK LOOK AT CAP-IN-PLACE:

WORKFORCE ANALYSIS:
Typically, less construction needed than excavation.

COST ANALYSIS:
Typically, less expensive and faster than excavation.

ENVIRONMENTAL ANALYSIS:
Many consider this an impermanent solution because the coal ash is still in the environment, and possibly still in contact with the groundwater.

Excavation – More Jobs, More Effective, Less Risky

Full removal of the CCR materials and potentially contaminated soils from the pond is a more involved and effective process than capping-in-place. This solution requires complete dewatering of the coal ash material and physically removing it from the existing pond. Removal can be accomplished via conventional excavation methods, stationary pump and wash-down systems, and dredge operations[155]. Excavation work can also include removal of associated pond materials (such as liners) and soil. Closure via excavation is costlier and more time-consuming than a cap-in-place approach, mostly due to additional construction needs[156].

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> ***LAWMAKERS IN NORTH CAROLINA AND UTILITIES IN SOUTH CAROLINA DETERMINED THAT EXCAVATION WAS THE MOST EFFECTIVE METHOD FOR STOPPING POINT SOURCE POLLUTION, AND IN THESE AREAS, MANY OF THE MOST POLLUTING ASH PONDS ARE BEING EXCAVATED PRIOR TO CLOSURE.***

This method has the distinct advantage of taking the CCR materials out of contact with a permeable liner, soils, and/or groundwater[157]. Lawmakers in North Carolina and utilities in South Carolina determined that excavation was the most effective method for stopping point source pollution, and in these areas, many of the most polluting ash ponds are being excavated prior to closure[158].

There are two basic options available for excavated coal ash: disposal and/or reuse. A new CCR landfill must follows the CCR rule guidelines for siting, liners, construction, and final closure[159]. Essentially these new landfills are not as deep as previous ponds, have special construction requirements, and only accept dry CCR material, making them a much more secure long-term storage option from an ecological perspective. Beneficial re-use includes coal ash that is recycled into concrete materials, used as structural fill for construction projects, or used as structural fill at former clay mines[160]. Some citizen groups are skeptical about this process, however, and are analyzing and considering the overall risks and benefits of reuse. Additionally, there may be limited facility capacity for recycling.

Utilities that undertake excavation must analyze the best final storage solution that meets the site's space limitations while ensuring proper procedures are in place to protect worker and community safety. While some sites have the land available onsite to build a CCR-compliant landfill, others must transport their material elsewhere to be re-used or disposed of in an approved landfill. Utilities are tasked with implementing adequate procedures and oversight to minimize problems associated with coal ash transport. For instance, policies can be put into place to ensure both excavation workers and drivers are certified in hazardous waste material handling.

Overall, citizen groups have pushed for excavation as it is a more permanent solution than leaving the material in the very ponds that failed to prevent contamination in the first place.

QUICK LOOK AT EXCAVATION:

WORKFORCE ANALYSIS:
Typically, excavation requires more construction and is more labor-intensive than capping-in-place.

COST ANALYSIS:
Usually more costly because of additional construction required and longer project timelines.

ENVIRONMENTAL ANALYSIS:
Considered a more permanent solution because it removes the material from point-of-contamination; environmental and safety concerns associated with long-haul transportation can be addressed.

WATER TREATMENT: LONG-TERM JOBS, LONG-TERM WATER SAFETY

The vast majority of water treatment for coal ash pond closure is undertaken in order to comply with the requirements of surface water discharge permits. Many of the plants analyzed and reviewed during this study discharge wastewater into nearby waterways in accordance with their NPDES [National Pollution Discharge Elimination System] permits. Treatment commonly requires a facility equipped to perform a variety of functions (including precipitation, chemical oxidation, reduction, and other operations) to remove or neutralize the contaminants in exceedance of allowable limits[161]. Some plants—such as the Wateree Site—may be able to utilize a multi-step outfall system that filters out sediments and contaminants over a long period of time; this may not be feasible at all sites though[162]. The Wateree site is relatively small and could filter its decanted water, through a series of settling ponds and other filtration systems, but sites with larger ponds may not be able to utilize this method. Constructed wetlands or other biological treatments can also be used, though these are less common[163]. These treatment options can address contamination from heavy metals as well as volatile organics.

Treatment is also required if decanted water from ponds is to be re-used in plant activities. However, this treatment is not as extensive as the process required to treat water to acceptable discharge levels. All case studies in this analysis that involve excavation required water treatment to achieve discharge-level water quality standards. Some of the cases included treatment for plant purposes.

The goal of treatment is to address contaminants of concern, not just to adjust pH levels or remove dissolved solids. Robust water treatment is approached in a multi-faceted manner. Given the complexity of coal ash contamination and the varying amounts of CCR material at each site, no one treatment process applies to all cleanup scenarios. Additionally, some pollutants require a very different treatment process than others, so a treatment plan usually includes several separate steps to ensure each contaminant is addressed properly[164].

Most facilities analyzed in these case studies required a constructed water treatment facility to treat water for discharge into public waterways. Building a new water treatment facility, as was done at the Riverbend site, is a labor-intensive process requiring upfront investment. After construction, these plants still require workers to operate the facility for years – perhaps for decades depending on the size of the project. These water treatment facilities have a track record of effectively removing contaminants from CCR pond water and eliminates the need to build additional contaminated-water storage facilities[165].

The cases presented in this analysis only included treatment of water decanted directly from coal ash ponds and not captured groundwater. However, apart from the water collection step, the basic process for water treatment would sill apply in either scenario.

QUICK LOOK AT WATER TREATMENT:

WORKFORCE ANALYSIS:
Building a new water treatment facility to treat water for discharge-level quality is labor intensive. Fewer workers are needed for plant operations, but these are more highly-skilled, long-term jobs.

COST ANALYSIS:
Higher costs upfront, may eliminate compliance costs later down the road.

ENVIRONMENTAL ANALYSIS:
Very effective at treating contaminated water from CCR ponds.

Figure 12: This table compares ash pond cleanup strategies and associated worker numbers at four sites. Coal plants across the country have only recently begun the process of closing their ash ponds and a small number of them are closing their ponds via excavation, leaving very few cases to look at for comparison. However, these cases are illustrative of general industry knowledge and research into coal ash pond closure and heavy metal remediation; namely, that excavation and multi-faceted groundwater remediation strategies tend to employ more people than a cap-in-place and passive water treatment approach. Additionally, where excavation is nearly completed, groundwater contamination of arsenic—in particular—has dropped precipitously *(See Wateree case study, section 5.3)*.

Plant Name/ Location	Pond Size	Cleanup Approach	Cleanup Jobs	Existing Plant Jobs	Jobs/ Pond Acre	Estimated Cleanup Costs	Notes
Riverbend Station (North Carolina)	69 acres	Excavation	75	145	1.08	$419 million	Water treatment facility construction included in job numbers.
Asheville Plant (North Carolina)	76 acres	Excavation	190	200	2.5	$422 million	Overall numbers have stayed the same but currently, 140 jobs are in trucking CCR materials.
Belews Creek (North Carolina)	283 acres	Cap-in-place	163	300	.58	$410 million	Fewer workers required relative to plant size.
Colstrip Station (Montana)	~800 acres	Cap-in-place	Unknown	388	Unknown	Unknown	NA

IV. POLICY CONTEXT

THIS POLICY CONTEXT OVERVIEW ADDRESSES THE MAJOR POLICIES AND REGULATORY ACTIONS CONCERNING THE COLSTRIP COAL ASH POND CLOSURE AND REMEDIATION.

4.1 AOC AND AIR QUALITY LAWSUIT SETTLEMENT

Colstrip is subject to the requirements of Montana's Major Facility Siting Act and Water Quality Act[166]. Due to the leaking ash ponds and ensuing contamination which violated these laws, the Montana DEQ and PPL Montana (now Talen Energy) negotiated an Administrative Order on Consent in 2012. The agreement stipulated more extensive groundwater monitoring, investigation of the pond seepage, corrective actions, and financial assurances[167]. This enforcement action is being overseen by DEQ and compliance with the AOC is being administered by Talen Energy. While the AOC required corrective actions, many found that enforcement of the regulation was inadequate to address the full extent of the contamination.

In 2016, a settlement was reached in an air quality lawsuit filed by the Sierra Club and the Montana Environmental Information Center against all six plant owners. The Consent Decree stipulated a conversion to dry storage for all 3 & 4 ponds by 2022 (the "final conversion date"), dewatering of bottom ash units at the plant site by December 2018, and retirement of Units 1 & 2 by July 1, 2022[168]. Additionally, the Units 1&2 ponds will be closed according to the federal CCR rule along with the unit closures[169].

Compliance with both the AOC and the 2016 Consent Decree closure requirements are being overseen by DEQ and are referred to singularly in this analysis as the AOC process. Talen Energy, as the operating manager for the plants, is responsible for submitting compliance reports to DEQ and for ensuring approved actions are carried out at the site[170]. Apart from broad requirements and compliance dates, the Consent Decree is not exceptionally prescriptive regarding decommissioning, dry ash conversion, and remediation actions. The owners of the plant consequently have great discretion in terms of implementation. Importantly, MDEQ has broad regulatory authority over the coal ash pond cleanup to ensure compliance with the AOC and Consent Decree, even if those actions are more stringent than CCR rule requirements.

There are ***four major reports*** mandated by the AOC process:

- Site Characterization
- Cleanup Criteria and Risk Assessment
- Remedy Evaluation
- Remedial Design[171].

Separate reports are required for each of the site areas: The plant site, SOEP and STEP Site, and the EHP Site. Talen Energy is in the process of submitting reports for the Remedy Evaluations, which outline the cleanup work plan alternatives for each area. DEQ will select the plan that best addresses the cleanup requirements of the AOC and other relevant regulations[172]. It is anticipated that these plans will be reviewed and approved by DEQ by early 2019.

4.2 COAL COMBUSTION RESIDUALS RULE

The Coal Combustion Residuals [CCR] rule went into effect in 2015 and establishes technical requirements for landfills and surface ponds under Subtitle D of the Resource Conservation and Recovery Act (RCRA), the nation's primary law for regulating solid waste. While this rule dictates the management of many coal ash disposal sites around the country, it does not apply to ponds that stopped receiving CCR materials before 2015[173].

The CCR rule is quite prescriptive in its liner, cap, and closure requirements. New ponds and CCR landfills are required to have a composite liner with two components—geomembrane and a two-foot layer of compacted soil—installed in direct and uniform contact with each other. An alternative or existing liner must demonstrate equal effectiveness as that prescribed design. Closure requirements for ponds include dewatering of the coal ash pond and installation of an impermeable final cap to reduce water seepage. There are additional siting restrictions for new ponds and landfills as well, in order to ensure that ponds will be located away from surface waterways and the water table.

Additionally, this rule established recordkeeping and reporting requirements, including the online posting of annual groundwater monitoring and corrective action reports, CCR fugitive dust control plans, and closure completion notifications[174]. Colstrip is unique because the state's siting permit required monitoring well installation, so there are years of data on groundwater pollution that other sites are only now obtaining.

The CCR rule allows closure of ash ponds by either cap-in-place or excavation, but does not require one method or another. Additionally, new liners are not necessarily required for existing ponds[175].

As indicated on the previous page, the rule does not apply to ponds that stopped receiving CCR materials prior to 2015. At the Colstrip site, a number of ponds fall into this category. For instance, some ponds, such as Units 1&2 Fly Ash A Pond, were converted to hold other materials and effluent like storm water, but this pond still contains CCR materials. Additionally, some ponds, were taken out of service (e.g. the STEP Cell A) or closed prior to 2015 (e.g., the SOEP)[176]. While AOC oversight should theoretically cover this gap, the DEQ may not call for the same prescriptive liners, caps, or final closure actions as the CCR rule.

In terms of contamination, the CCR rule requires monitoring of specific constituents of concern. There are two classifications of constituents within the rule: Appendix III and Appendix IV pollutants. Exceedances of the Appendix IV pollutants can trigger the closure of a pond[177]

- ***APPENDIX III CONSTITUENTS FOR DETECTION MONITORING:***[178]
  Boron, Calcium, Chloride, Fluoride, pH, Sulfate, and Total Dissolved Solids (TDS)

- ***APPENDIX IV CONSTITUENTS FOR ASSESSMENT MONITORING:***
  Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Fluoride, Lead, Lithium, Mercury, Molybdenum, Selenium, Thallium, and Radium 226 and 228 combined[179]

More extensive monitoring and reporting of Appendix IV constituents are not required at all sites – this action depends on the degree of exceedances observed in earlier monitoring. At the Colstrip site, for the time being, there is not extensive data publicly available for Appendix IV constituent monitoring.

LEGAL COMPLIANCE AND DOING THE BARE MINIMUM

For Colstrip, meeting legal and regulatory requirements may not adequately fix the persistent and significant contamination from the leaking ash ponds.

The 2015 federal CRR rule established some important new requirements for coal ash ponds, but it is also inadequate in many areas. For instance, the rule does not explicitly require excavation of ponds that continue to pollute after closure, nor does it apply to impoundments that stopped receiving coal ash prior to 2015[180]. The current EPA administration has also proposed several modifications to the rule which would effectively render the rule meaningless[181].

While the AOC requires remediation, it is not very prescriptive regarding which corrective actions should be taken. The DEQ must interpret and decide how remediation should actually be implemented, which is a very sizeable task. This approach also gives the company significant leeway in terms of proposing their preferred remediation strategies, regardless of those strategies' efficacy.

Therefore, it is possible that Talen can meet the requirements of applicable regulations and agreements by capping-in-place and expanding its groundwater capture system. But meeting the bare minimum for legal compliance may not adequately address the contamination problems in Colstrip.

COLSTRIP'S REMEDIATION STRATEGY DETERMINED AN ONGOING PROCESS: OTHER ACTIONS AND POLICIES

Owners of the plant are addressing their responsibilities related to decommissioning and remediation in relation to the impending retirement of Units 1 & 2. Most of these owners are not Montana-based utilities so they are additionally subject to policies in their home state. Because the AOC process is ongoing and remedy strategies have not yet been approved by DEQ, there are no firm cost estimates for remediation or decommissioning.

Nevertheless, the utilities are beginning to approach these issues through rate cases. The PSE rate case is the first to address financial liabilities tied to Colstrip cleanup and retirement. The other utilities will be engaged in similar rate cases in the coming years and may be using this case as a template. In their 2015 investigation report to the Washington State Utility Commission, PSE estimated remediation costs for Units 1 & 2 between $85 million and $142.7 million; this cost includes 30 years of post-closure maintenance. They also estimated decommissioning costs for those units at $50 million in total. Because PSE is a 50% owner in these units, they are responsible for half that cost. PSE has estimated their overall financial liability for cleanup at $395 million for all four Colstrip units, of which PSE is a 1/3 owner. As part of the 2017 settlement agreement of the rate case, PSE also established a $10 million "Community Transition Fund" and Montana's governor created a local "stakeholder's table" to develop a guiding plan for how those funds will be spent[182].

These rate cases also require the utilities to estimate a useful life for the remaining units. PSE is the first utility to estimate a deadline for Units 3 & 4 at 2027[183].

IMPLICATIONS FOR UNITS 3 & 4

Although there is no date established for the retirement of Units 3 & 4, the ash ponds from these units need a pollution reduction and cleanup strategy as well. The AOC and CCR rules still pertain to these units and associated disposal facilities. First, these policies stipulate how existing contamination should be addressed during the operating life of the facility. This concerns how and where new ponds should be constructed as well as remediation needs for the existing contamination. To this latter point, Talen Energy may need to install new capture wells, engage in additional constituent monitoring, or begin treating more captured groundwater.

Additionally, these policies will establish how final cleanup and closure will be done, no matter how far into the future that is required. Preparing that plan now does not determine a retirement date, but rather assists the owners, community, and other stakeholders in their various planning processes.

V. CASE STUDIES

5.1 CASE STUDY #1:

ASHEVILLE PLANT, NORTH CAROLINA

EXCAVATING & RECYCLING COAL ASH

CLEANUP APPROACH:	Excavation
NUMBER OF WORKERS REQUIRED FOR CLEANUP:	190
NUMBER OF WORKERS AT PEAK GENERATION:	200
CAPACITY (COAL UNITS):	376 MW
PLANT OWNER:	Duke Energy
STATUS:	In Use
PONDS:	2
EPA Hazard rating:	*High*
Surface area of ponds:	*76 Acres*
CCR materials (millions of tons):	*Began with 7.8; 2.5 as of August 2017*
Lined/Unlined:	*Unlined*
ESTIMATED TOTAL COST OF CLOSURE:	**$422 million*** *(Excavation 2007 - 2019)*

**Duke Energy's estimated cost of pond closure and cleanup. This number does not represent an "actual cost", nor has it been verified by a state agency or regulatory body.*

SITE DESCRIPTION

The ***Asheville Station Steam Electric Generating Plant*** is located 8 miles south of Asheville, North Carolina. The plant consists of two coal-fired units that were built in 1964 and 1971 and two natural gas and oil combustion turbines. Current generating capacity of the coal-fired units is 376 MW. There are two main coal ash ponds on site (the 1964 pond and the 1982 pond) both of which are unlined, as well as a rim ditch system, engineered wetlands, and unlined pond for decanted water[184].

Duke Energy is excavating all of the coal ash at the Asheville plant.In 2014, North Carolina passed a law requiring four plants with a history of water contamination to close their ash ponds via excavation. The Asheville ash is both being re-used in airport construction projects and is also being transported to transported to a secure landfill. The power plant is still in operation. (*Photo credit: Zen Sutherland via Wunc.org.)*

Wastewater and CCR material is sluiced to the concrete rim ditch system within the 1964 pond along with stormwater drainage. This water is then routed to the unlined pond (the Duck Pond) and a settling pond outside of the 1964 pond. Thus, neither the 1964 pond nor the 1982 pond have a permanent pool of water technically. Engineered wetlands were constructed in 2005 within the 1964 pond footprint in order to treat flue gas desulfurization process water[185.]

As of 2007, there were a total of 7.8 million tons of CCR material in the pond complex[186]. The total surface area of the ponds is 76 acres[187]. Due to the relatively small size of the property, there is no room to build a landfill or additional ponds onsite.

The site is authorized to discharge treated wastewater into the nearby French Broad River and Lake Julian, which serve as drinking water supplies for the Asheville area[188].

NATURE OF CONTAMINATION

Cleaning up the Asheville site has been a high priority for local citizens and environmental groups because of the extensive recorded contamination. Eventually, the state's Department of Environmental Quality filed a lawsuit against Duke Energy for unpermitted discharges and polluting drinking water sources[189]. In 2013, the company pleaded guilty to nine violations of the Clean Water Act for illegal discharges at five of its North Carolina plants and paid $102 million in fines[190].

These illegal discharges resulted in water contamination for a number of nearby residents who rely on private wells. The contamination is mostly from arsenic, selenium, chromium, manganese, and sulfates[191,192]. In 2015, 87 of 117 wells tested near the plant did not meet state groundwater standards; those residents were notified that they could not use their water for consumption or cooking[193]. The state DEQ has issued numerous warnings to residents for similar contamination in recent years[194]. As part of the pond closure plan, residents with private wells are now being supplied with city water[195].

CCR reports in 2018 indicate that high levels of radium and hexavalent chromium were detected in off-site groundwater monitoring wells[196]. Duke Energy disputes that this is a direct result of the Asheville ash ponds, but these contaminants are typical for coal ash contamination[197].

While the illegal discharges are problematic, this isn't the only source of pollution from the site. The unlined ponds themselves are leaking into the groundwater. Boron plume modeling demonstrated that without excavation, the groundwater contamination plume would reach the French Broad River, which is connected to Lake Julian[198].

Considering the large population center of Asheville and the documented contamination of private wells near the plant, this site became a top priority for cleanup at the state level. In 2014, the state passed the Coal Ash Management Act (CAMA) that requires full CCR excavation at four plant sites with unlined effluent ponds: Asheville, Sutton, Riverbend, and Dan River[199].

CLEANUP STRATEGY

Per the CAMA regulation, the Asheville site ponds must be fully excavated and closed by August 2019. ***Duke Energy is taking the following steps for closure[200]:***

- Decommission engineered wetlands and commission alternate FGD [flue gas desulfurization] wastewater treatment system: ***Completed***
- Dewater and remove engineered wetlands: ***Completed***
- At active facilities, end storm water discharge into ponds: ***Goal - Dec. 2019***
- 1964 Rim Ditch demolition and excavation of 1964 Ash Pond: ***Goal - May 2020***
- Permanently close ponds: ***Goal - Aug. 2022***

As of 2015, the closure plan for the ponds was initiated. Excavation of the 1982 pond was completed in 2016 and was turned over for dam decommissioning. Work has also started on the 1964 pond where there is still 2.5 million tons of coal ash left to be excavated[201].

Because there is already a water treatment facility onsite at the Asheville plant, a new one did not have to be constructed. Much of the decanted water from the ponds was utilized in the plant's ongoing operations and some was processed via the existing treatment facility onsite for discharge[202].

Duke Energy has some experience with dewatering, excavation, and CCR transportation at the Asheville site because of its 2007 beneficial reuse project. In 2007, the 1982 pond reached maximum capacity

Figure 13 & 14: Duke Energy analyzed the impact of excavation versus cap-in-place in terms of reducing groundwater contamination that was impacting the French Broad River. These diagrams from Duke show that contamination (indicated in yellow) from the coal ash (indicated in purple) is dramatically reduced with excavation.

Figure 13: Pre-excavation

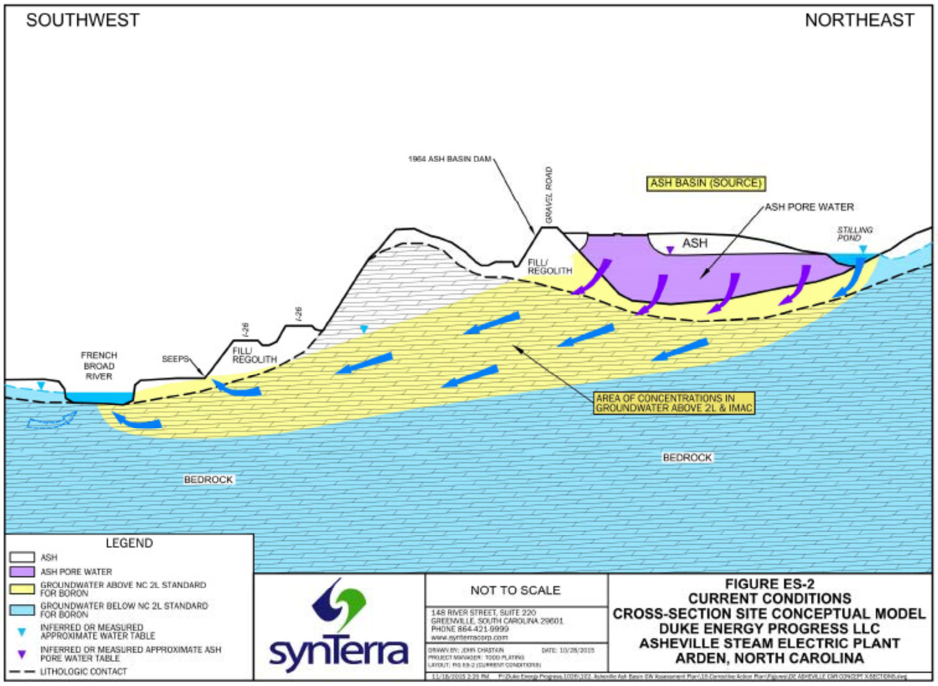
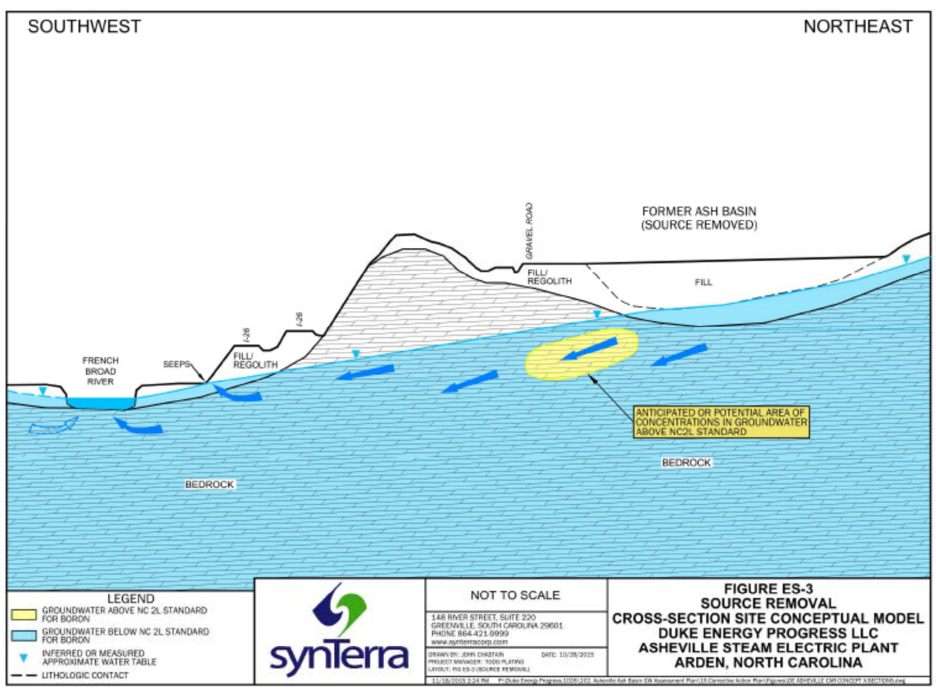


Figure 14: Post-excavation



(Credit: SynnTerra/Duke Energy, 2015)

so a plan was developed for the coal ash to be removed, transported to the nearby Asheville airport, and utilized as structural fill for runway construction. The pond was completely dewatered during this process and 4.1 million tons were used in the airport project. The airport is only a few miles away, which minimized transportation pollution and safety concerns[203].

For this latest excavation, Duke Energy is utilizing a couple of different final disposal sites. There is not enough space at the site location to build a CCR landfill so Duke has two disposal locations for the remaining ash. The regional airport can accept an additional 3.2 million tons of coal ash for a new airport project. Additionally, Duke Energy is transporting much of the coal ash over to a Class III landfill in Georgia, which has capacity for 1.5 million tons. The distance to the Georgia landfill is 120 miles, and the coal ash is being transported by truck[204].

Duke Energy is planning to build an additional natural gas-fired power plant in the footprint of the 1982 pond[205].

NATURE OF THE CLEANUP WORK

Since 2015, preparations and actual cleanup has employed approximately 190 people. This has been a fairly steady number each year, though the job types have fluctuated. Currently, 140 to 150 of those employees are truck drivers. Other job types include managers, supervisors, environmental health and safety managers, large equipment operators, mechanics, and electrical workers. Duke Energy has one full-time employee for the cleanup project and utilizes a number of sub-contractors to perform the rest of the jobs[206].

The full cost of cleanup and pond closure will be $422 million[207]. Duke Energy expects to pay for some of the costs for all of its coal ash pond closures across the Carolinas through rate increases. In February 2018, the North Carolina Utility Commission allowed Duke Energy to raise rates to partially cover these costs by 10% while also issuing a $30 million fine on the company for mismanagement of its coal ash facilities[208].

FUTURE OF THE PLANT

While Duke Energy is retiring most of its coal-fired generating fleet, the Asheville coal-burning units will remain in service as third-level dispatch. In other words, they will remain in operation as back-up generation. Duke Energy is in the process of developing bottom dry ash conversion as well as implementing dry fly ash conversion for their remaining coal facilities, including at the Asheville site[209].

5.2 CASE STUDY #2:

RIVERBEND PLANT, NORTH CAROLINA

EXCAVATION & WATER TREATMENT

CLEANUP APPROACH:	Excavation
NUMBER OF WORKERS REQUIRED FOR CLEANUP:	75
NUMBER OF WORKERS AT PEAK GENERATION:	145
CAPACITY (COAL UNITS):	454 MW
PLANT OWNER:	Duke Energy
STATUS:	Retired as of 2013
PONDS:	2 ponds + dry ash stack area + cinder pit storage area
EPA Hazard rating:	*High*
Surface area of ponds:	*69 Acres*
CCR materials (millions of tons):	*Began with 5.5; 2.7 remaining as of August 2017*
Lined/Unlined:	*Unlined*
ESTIMATED TOTAL COST OF CLOSURE:	$419 million* *(Excavation 2015 - 2019)*

**Duke Energy's estimated cost of pond closure and cleanup. This number does not represent an "actual cost", nor has it been verified by a state agency or regulatory body.*

(Photo credit: Sam Perkins, Catawba Riverkeeper, 2017)

Even though the Riverbend Plant was retired in 2013, contamination from the coal ash ponds is still an issue. To address the problem, Duke Energy built a water treatfment facility to remove contaminants from the pond water. This water is then safely discharged into Mountain Lake.

SITE DESCRIPTION

The ***four-unit Riverbend Plant*** is located just west of Charlotte, North Carolina on the Catawba River. The Riverbend site had been generating power since 1929 and was retired in 2013. While it was operating, Riverbend was a cycling station brought online to supplement supply during peak-energy demand[210].

The original effluent coal ash pond was constructed in 1957 and was expanded in 1979 then divided into what are now known as the primary and secondary coal ash ponds. Until 2007, coal ash was periodically excavated and stored as dry stack ash on the property. The ponds are unlined[211].

In addition to the coal units, the plant also utilized four gas-fired turbine units which were retired in 2012. Throughout the plant's many decades, new units were constructed while old units were repurposed or abandoned, but the plant's final retirement came in 2013[212].

NATURE OF CONTAMINATION

In 2013, the Riverbend site was found to have an unpermitted discharge channel where water containing arsenic, chromium, and other contaminants flowed into the Catawba River. This river feeds into Mountain Lake which provides drinking water for Charlotte, among other population centers. Riverbend did not have a water treatment facility nor a discharge permit for these discharges prior to closure activities, so these discharges were not only untreated, but also illegal[213].

Between 2011 and 2013, the North Carolina Department of Environmental Quality (NCDEQ) reported that monitoring wells revealed 38 exceedances of groundwater standards for manganese (50 μg/L). During that same time period, there were 21 exceedances of the groundwater standards for iron (300 μg/L)[214]. Through their own monitoring in 2013, the Catawba Riverkeeper found that the discharges into Mountain Island Lake contained arsenic at twice the level of applicable standards, cobalt at 52 times the standard, and manganese at 128 times the standard[215]. A Duke University study in 2012 showed elevated levels of arsenic in the waters tested downstream from the plant[216]. Hexavalent chromium was also found in the Riverbend monitoring wells and in private wells, though the source of the contaminant in the private wells is a hotly disputed issue.

Private wells in the area have also been contaminated and residents living near the county's coal-fired plants were notified by the state's Department of Environmental Quality to not consume their water[217]. For many residents with private wells who live within half-mile of the plant, Duke Energy now provides bottled water for use in cooking and for drinking. For some residents within that half-mile radius of the plant, Duke Energy provided a hook-up to the public water supply[218].

In 2016 and 2017, nearby residents and the state DEQ were concerned that contamination may be migrating from the plant site. As of summer 2016, approximately one million tons of CCR material had been excavated, but 4.5 million tons remained. During that time, arsenic levels were measured at a 10-year high at one area in Mountain Island Lake and the source of the contamination was traced back to the Riverbend site[219].

CLEANUP STRATEGY

As part of the aforementioned lawsuit, Duke Energy admitted to unpermitted discharges from the Riverbend facility. Additionally, Riverbend was identified in the state's 2014 CAMA law as one of four high priority sites that was required to close its ponds via coal ash excavation[220].

Between the dry stack storage and other ponds, the Riverbend site had 5.5 million tons of coal ash stored onsite when cleanup planning began[221]. Initial excavation plans were submitted for approval in November 2014 and excavation began in May 2015. The cleanup was structured to occur in three phases. ***Each phase included the following objectives***[222]:

PHASE 1:
- Install site erosion and sedimentation control measures.
- Begin dewatering coal ash ponds and initiate coal ash removal.
- Prepare and install truck load-out and truck wash for transportation by truck.
- Begin pilot programs to haul coal ash to off-site disposal location by truck.

PHASE 2:
- Prepare and install rail out-spur for transportation by rail.
- Excavate and transport approximately 1.8 million tons of coal ash from the ash stack and ponds to an approved storage site.
- Engineer plan to stop water inputs into the coal ash ponds.
- Initiate rerouting of inflows to the coal ash ponds.
- Construct a wastewater treatment system to facilitate dewatering discharge requirements.

PHASE 3:
- Complete activities to stop pond inflows
- Complete pond dewatering.
- Excavate and transport the remaining ash from Riverbend to an approved landfill or structural fill location.

Duke Energy finished bulk dewatering of the ponds in February 2017—most of the water was drained from the ponds, down to approximately 3 feet above the CCR material. The company is currently in the second stage of the dewatering process to make sure the coal ash is left almost entirely dry. As part of the closure plan, a water treatment facility was constructed onsite to treat the decanted water. This decanted water and any storm-water that comes into contact with the ponds is treated at the facility and then discharged into Mountain Island Lake. The water is treated via a 9-step process that removes the heavy metals, filters out constituents and solids, and eventually discharges the water into Mountain Island Lake[224].

As of the end of August 2017, 2.8 million tons of CCR material had been excavated from the site and 2.7 million tons were left for removal. By December, 1.1 million more tons had been excavated and the site currently has 1.6 million tons of CCR material remaining[225].

Initially, the coal ash was transported by truck, but soon thereafter a rail system was installed to expedite the transportation process. The coal ash is currently being transported to the Brickhaven site, a former clay mine in North Carolina that has been approved to use coal ash as structural fill[226].

Part of the cleanup plan also includes demolition of the plant and associated structures. Those activities began during phase II of the cleanup and are happening concurrent to the coal ash pond cleanup[227].

According to Duke Energy, they are analyzing groundwater monitoring reports during the cleanup process at all of their facilities. While the environmental team has not found any major trends, they have reported that there are some reductions in particular constituents at this phase of cleanup. A spokesperson for Duke Energy indicated that there are likely several factors working in combination that may be linked to this reduction in constituent levels. Those factors could include the pond dewatering and coal ash excavation themselves, and/or the fact that the plant is no longer adding new coal ash to the ponds. According to the spokesperson, among those factors, Duke Energy finds that dewatering is a strong contributor to declining pollution levels in the groundwater[228].

NATURE OF THE CLEANUP WORK

Since 2015, preparations and actual cleanup employs approximately 75 people. This has been a fairly steady number each year, although the job types have fluctuated. Because the ash is being hauled by rail, some transportation jobs—like truck drivers—are no longer part of the cleanup workforce. Current job types include managers, supervisors, laborers, large equipment operators, and water treatment system operators. Of the 75 jobs, Duke employs 7 people full-time for the cleanup project and subcontractors employ approximately 68 people[229]. Some former plant employees have been rehired to do cleanup work, though it is unclear how many people have been rehired[230].

In addition to excavating the ponds and moving the coal ash, the Riverbend Site has had notable additional projects associated with cleanup. These include constructing a water treatment facility onsite and demolishing the plant structures. The full cost of cleanup and pond closure will be $419 million[231].

FUTURE OF THE PLANT

The plant was retired in 2013 and is currently being demolished[232].

Photo credit: Sam Perkins, Catawba Riverkeeper, 2017

EXCAVATION AND WATER TREATMENT AT THE RIVERBEND PLANT HAVE EMPLOYED 50% OF ITS FORMER OPERATING PLANTWORKFORCE.

5.3 CASE STUDY #3:

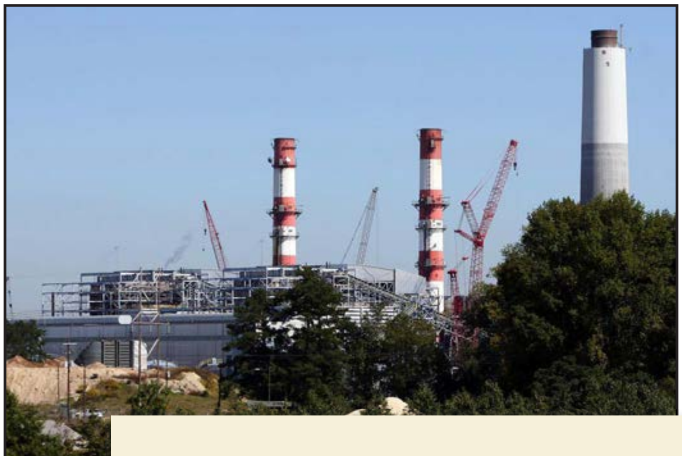
WATEREE STATION, SOUTH CAROLINA

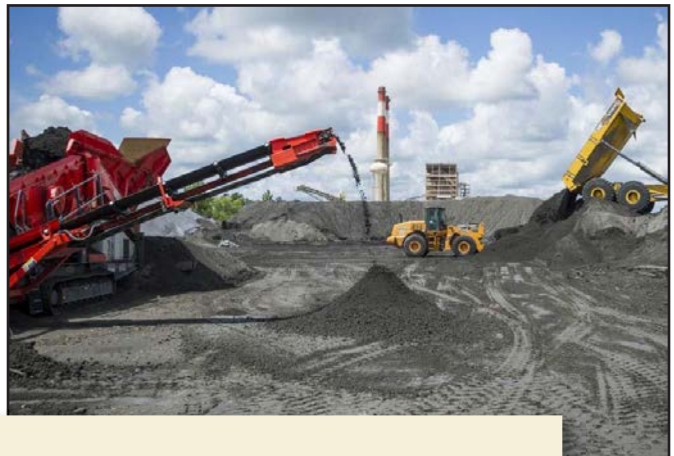
STOPPING ARSENIC CONTAMINATION WITH EXCAVATION

CLEANUP APPROACH:	Excavation
NUMBER OF EMPLOYEES REQUIRED FOR CLEANUP:	Unknown
NUMBER OF PLANT EMPLOYEES AT PEAK GENERATION:	Unknown
CAPACITY (COAL UNITS):	685 MW
PLANT OWNER:	South Carolina Electric & Gas
STATUS:	In Use
PONDS:	9 ponds *(2 being excavated)* dry ash stack area + cinder pit storage area
EPA Hazard rating:	*Low*
Surface area of effluent ponds:	*80 Acres*
CCR materials (millions of tons):	*Began with 2.4; 1.8 remaining as of August 2017*
Lined/Unlined:	*Unlined*
TOTAL COST OF CLOSURE:	~$40 million

SITE DESCRIPTION

The ***700 MW Wateree plant is located on the Wateree River, approximately 25 miles southeast of Columbia, South Carolina***. Originally built in 1970, the plant started with an 80-acre unlined coal ash pond. The coal ash pond stored sluiced fly ash, bottom ash, and other plant wastewaters[233].





The Wateree Plant in South Carolina is still in operation and has nearly completed excavating their old wet ash ponds. This has resulted in dramatic decreases in groundwater arsenic contamination in under 5 years – up to 90% in certain areas. (*Photo credit: Warren Wise/Post & Courier, 2012)*

A second pond was permitted and constructed in 2009 to accept wastewater from the flue gas desulfurization scrubber system. This pond was lined with compacted soil, a geosynethetic clay liner, HDPE geomembrane, cushion and protective cover. It is divided into four units: Two settling ponds and two forebays[234].

In 2013, the plant switched to coal ash dry storage technology. However, this did not fully address the ongoing problems caused by the effluent ponds[235].

NATURE OF CONTAMINATION

The Wateree plant has been the subject of lawsuits through the years for groundwater contamination stemming from the coal ash ponds. In 2001, SCE&G admitted to state regulators that the coal ash pond leaks were polluting the Wateree River but the agencies did not stop the plant from continuing these activities[236]. In 2009, a local farmer challenged the plant's future ash disposal plans because of the damage the ponds were already causing to their land and water[237].

It was revealed in trial that arsenic contamination in the groundwater exceeded drinking water standards[238]. Additionally, that plume was found to be polluting the nearby Wateree River[239]. This is important because the Wateree River is part of the Catawba-Wateree river pond which supplies drinking water to 2 million people[240].

SCE&G was sued again in 2012 by the Catawba Riverkeepers who had found arsenic contamination coming from the site at five times the legal limit for drinking water standards[241]. In a precedent-setting decision, SCE&G entered into a voluntary agreement with the state to begin a coal ash excavation process to address the contamination process. The 2012 lawsuit settlement made this agreement legally binding[242].

> ***THE PHILOSOPHY GOES BACK TO ONE SIMPLE POINT—THE MOST IMPORTANT THING WE CAN DO IS REMOVE THE SOURCE MATERIAL FROM THE UNLINED PONDS THAT ARE IMPACTING AQUIFERS.***
>
> *- JIM LANDRETH,*
> *VICE PRESIDENT, FOSSIL HYDRODIVISION, SCE&G*

CLEANUP STRATEGY

The vice president of SCE&G's fossil hydro division, Jim Landreth, explained that the fundamental principle of this site's cleanup was to remove the source material. As he describes it: "The philosophy goes back to one simple point—the most important thing we can do is remove the source material from the unlined ponds that are impacting the aquifers"[243]. After analyzing the alluvial soil types, depth of the aquifer, and proximity of the ponds to the Wateree River, SCE&G determined that excavation was the most prudent cleanup approach. Once the source material is removed, the utility determined that monitored natural attenuation would address the existing groundwater contamination[244].

The Wateree Station's cleanup is being approached in three phases[245]:

1. ***ENGINEERING AND PERMITTING:*** *2013 – 2015*
2. ***CONSTRUCTION:***
   - **Landfill:** Finished in 2016
   - **New wastewater management facility:** Finished in 2016
   - **Initial excavation and removal of CCR materials from ponds:** Ongoing
3. ***ASH POND CLOSURE:***
   - **Cease all wastewater flows to the ponds:** 2016
   - **Final excavation of CCR materials:** 2017 - 2020

The general steps for ash pond closure are as follow: inflow diversion, CCR removal, pond demolition, sampling of pond subsoil, site restoration, and groundwater monitoring. The ponds are scheduled to be closed by the end of 2020[246]. To date, one-third of the ash ponds have been certified as being clean-closed[247].

The Wateree Station began excavation of its effluent coal ash storage ponds in 2013 and the work is ongoing. Excavation of CCR materials also includes removal of two feet of soil that acted as a liner for the ponds then storing that material in the onsite landfill. Continued soil testing was included in the cleanup plan to determine if more soil will need to be removed prior to final closure[248].

Building the onsite Class-III landfill was a time-consuming process and planning for this project had to be initiated early. The site already had a Class-III landfill, but the excavation project necessitated adding three more cells to the landfill. After acquiring the necessary permits, the utility started the expansion process very quickly. Through a competitive bid process, the company found a subcontractor to build the landfill and construction took approximately 12 to 15 months[249].

The landfill facility currently consists of 18 landfill cells across 141 acres. The landfill is lined and only accepts dry CCR materials. When the facility reaches maximum capacity, it will be closed and capped according to CCR regulations with a multi-layered final cover system. SCE&G estimated that construction and closure costs for the landfill would total $21,706,014[250].

Dewatering the ash ponds was another lengthy process. The utility had to dewater, then excavate sections of the pond progressively. Because the facility is a closed loop system and does not have a discharge permit, other methods of processing and storing the decanted water had to be pursued. The facility utilizes an outfall system wherein the decanted water is held in a collection of sediment ponds so solids naturally settle over time. A series of check dams was also constructed to aide in this filtration and sedimentation process. Much of the excess water from the dewatering process is then held in a storage tank onsite and then used for ongoing plant processes. Additionally, quite a bit of water is evaporated while in the settling ponds. The material in the ponds is dewatered very slowly over many months to ensure it is completely dry before excavation and placement in the landfill. At this point, there is no standing water in the ash ponds[251,252].

The dewatering step also included diverting storm water sources and groundwater inflows. A new lined wastewater pond was constructed to receive new sluiced materials from the plant so that it was no longer added to the old ash ponds[253].

The plant has utilized dry ash storage technology to accommodate the site’s ongoing generation since 2013. Two ponds are used for the decanting process and the ash is also excavated to be stored at the onsite landfill. According to SCE&G, there is one pond for the FGD wastewater that meets CCR regulations, as well as “three ponds at the site for management of coooling waters and stormwater runoff, but these ponds do not contain CCR.”[254]

When cleanup efforts began in 2012, the ponds held approximately 2.4 million tons of CCR material[255]. As of the end of August 2017, SCE&G reported that approximately 1.8 tons remain[256].

As indicated, arsenic contamination in the groundwater was historically the chief problem at the Wateree plant, but excavation efforts have already had a very positive effect on remedying the issue in a shorter timeframe than expected. In 2016, SCE&G released a report indicating precipitous drops in arsenic levels at some of its groundwater monitoring wells[257]. The arsenic contamination measured at monitoring wells had dropped up to 80% and monitoring in the river showed a drop in arsenic levels of up to 90%[258]. At one monitoring well, arsenic had previously contaminated the groundwater at 43 times the legal limit (432 ppb was recorded and 10 ppb is the federal legal limit)[259]. A report in 2016 from the same well showed that arsenic contamination had dropped to 2.9 ppb, which is a 99 percent decrease[260]. Monitoring wells located along a road 150 yards from the ponds now show groundwater has reached drinking water standards[261].

NATURE OF THE CLEANUP

An early estimate of the ash pond closure project at Wateree came to between $30 and $40 million overall. The ponds are on schedule to close by 2020 and the cost is anticipated to be near these original estimates[262].

In addition to typical excavation and dewatering activities, this cleanup project also included building a landfill facility on-site and constructing new pond facilities to accommodate ongoing produced wastes. The site was large enough to accommodate an onsite landfill, which eliminates the public health and safety concerns associated with transporting the material long distances by rail or truck. As indicated earlier, the landfill construction, maintenance, and closure is a large project and is projected to cost over $21 million altogether.

The plant did not have to build a water treatment facility to treat water for discharge, but construction of the additional wastewater ponds and outfall system did require engineering and construction workers[263].

While a final count of job numbers could not be provided, other details about the nature of the work were described by a spokesperson familiar with the cleanup process. The labor-intensive steps of the cleanup involved landfill construction, excavation processes, and creating new systems to divert water flows. These required earthmoving and other construction-related activities. Specialized equipment did make the earthmoving phases more efficient, but that also requires more highly-specialized operators. SCE&G hired a subcontractor for the landfill expansion, but utilized members of the current plant workforce to conduct the cleanup work at the actual ponds and run the water monitoring systems[264].

As described, dewatering is a long and carefully monitored process, requiring tight coordination between the operational, analytical, and management teams. As monitoring is conducted, the cleanup team consistently makes small adjustments in the dewatering and outfall system. Keeping their own workers on staff for these activities ensures they have a workforce experienced in not just the technical aspects of the cleanup but also the organizational coordination required for the cleanup[265].

FUTURE OF THE PLANT

The Wateree plant is continuing operations.

WHY DID SOUTH CAROLINA DECIDE TO EXCAVATE ALL COAL ASH PONDS?

In response to a series of lawsuits brought by the Southern Environmental Law Center and other advocacy organizations between 2012 and 2015, South Carolina's three power utilities—South Carolina Electric and Gas, Duke Energy, and Santee-Cooper—voluntarily agreed to excavate all coal ash from unlined, effluent ponds throughout the state. This amounts to a total of approximately 20 million tons of CCR material slated to be excavated. All materials are either being transported to lined, Class-III landfills away from waterways or being used in concrete manufacturing[267].

Santee-Cooper is fully excavating ponds from three of its plant sites: Grainger, Jeffries, and Winyah. At the Grainger plant, arsenic levels measured in the groundwater have dropped between 60 and 90 percent since excavation begain in 2013[268]. At their Cross Station, some of the ponds have been excavated for ash to recycled and eventually closed. The combined cleanup and closure costs for the Winyah and Cross Stations have been estimated at $250 million total[269].

SCE&G reports that the much of the ash being produced at their other sites is being sold to concrete recyclers as well[270]. Over recent decades, recycling efforts have eliminated the need to construct additional ash ponds. An SCE&G representative estimated that selling coal ash for concrete manufacturing had averted the creation of approximately six 100-acre ponds[271].

SCE&G has also publicly stated that the coal ash excavation efforts "have had a positive impact on groundwater"[272]. It is worth noting that SCE&G is not looking to close any of its effluent ponds via cap-in-place. Another South Carolina utility company undertaking similar excavation cleanup measures, Santee-Cooper, stated that ***"It's good for the environment, it's good for our customers and it's good for the economy because it's providing and sustaining jobs"***[273].

These two utilities also have not sought a ratepayer hike to pay for these ash pond closures. SCE&G has additionally stated that they do not anticipate seeking a rate hike for cleanup costs in the future[274]. And as some of the South Carolina state regulators see it, most of coal ash cleanup costs are included in the depreciation rates that customers pay for in the electricity bills[275]. Dukes Scott, executive director of the South Carolina Office of Regulatory Staff, an agency commissioned to act in the public's interest in regulating utilities, stated that: "The customers have been paying for the retirement of the plant and for the closing of those ash ponds since the thing started to generate electricity"[276].

5.4 CASE STUDY #4:

LITTLE BLUE RUN (BRUCE MANSFIELD PLANT), PENNSYLVANIA

CAP-IN-PLACE:
The High Cost of Cheap Cleanup

CLEANUP APPROACH:	Cap-in-Place
NUMBER OF EMPLOYEES REQUIRED FOR CLEANUP:	Unknown
NUMBER OF PLANT EMPLOYEES AT PEAK GENERATION:	145
CAPACITY (COAL UNITS):	2490 MW
PLANT OWNER:	FirstEnergy
STATUS:	In Use
PONDS:	Large man-made lake with dam
EPA Hazard rating:	*High*
Surface area of effluent ponds:	*937 Acres*
CCR materials (millions of tons):	*~180*
Lined/Unlined:	*Unlined*
TOTAL COST OF CLOSURE:	**$169 million** *(Closure 2017 - 2029)*

SITE DESCRIPTION

At 937 acres, ***Little Blue Run is the nation's largest coal ash pond site.*** It holds approximately 20 billion gallons of coal ash and smokestack scrubber slurry sluiced from the Bruce Mansfield power plant in Shippingport, Pennsylvania[277]. Little Blue Run expands across the Pennsylvania and West Virginia border. When it was first constructed in 1975, the company advertised that eventually Little Blue Run could become a recreational site where people could fish and boat[278]. The "lake" was created by constructing a massive earthen dam (400 ft. tall, 900 ft wide, and 1300 ft base width) in a valley to block the water[279].

(Photo credit: West Virginia Public Broadcasting, 2013)

Little Blue Run—the largest coal ash pond in the United States—has devastated nearby communities. However, state regulators approved a cap-in-place closure for 2028 that will not stop the seepage. It's a much less expensive method for the utility, but it comes at a high price for neighboring communities struggling with damaged properties, contaminated wells, and vacated houses.

Between 1975 and 2003, the pond had an ***unnatural bright blue color due to metals and chemical contaminants in the water***. While the pond is still visible from space, it has taken on a grey or whitish hue[280]. The pond has expanded over the years so that the property is now 1,700 acres in total including the current 937-acre recently active pond[281].

As part of a 2012 settlement with Pennsylvania Department of Environmental Protection over groundwater pollution, FirstEnergy agreed to close Little Blue Run and convert plant operations to dry storage for both bottom and fly ash by 2017. FirstEnergy stopped sluicing coal ash to the pond at the end of 2016 and the impoundment will be closed by 2028[282].

NATURE OF CONTAMINATION

Residents living downstream of Little Blue Run noticed water seeping in strange places along hillsides. Testing showed that it was water seeping through the ground from Little Blue Run and gushing out in springs[283]. Soon thereafter, private well monitoring showed elevated arsenic levels that was a result of Little Blue Run contamination[284]. First Energy's recent monitoring reports confirm that the pond does indeed leak into the groundwater at a rate of 500 gallons per minute[285]. Numerous towns have been affected by this seepage including Georgetown, PA; Greene Township, PA; and Lawrencetown, WV[286].

Nearby residents eventually filed suit against the utility for the danger posed by the pond as well as for the loss in property values. In the 2013 lawsuit, neighbors reported that they endured "constantly wet yards, shifting foundations, mold contamination, and a noxious odor"[287]. The odor came from the hydrogen sulfide gas emitted from the pond water. These conditions have led to plummeting property values in the area, especially where the dam breach would likely result in a loss of life. Property owners reported that they wanted to be compensated for the associated decline in their property values and FirstEnergy eventually settled the suit with an undisclosed settlement amount[288,289].

"

ALTHOUGH FIRSTENERGY IS PAYING PROPERTY TAXES ON THE LAND IT OWNS, IT'S LIKELY THE COMPANY'S PROPERTY WILL NEVER BE DEVELOPED AGAIN.

- CHAIR, GREENE TOWNSHIP'S BOARD OF SUPERVISORS

Over the decades, FirstEnergy has bought nearby houses and property to both expand the pond site and to try to contain the contamination plume. Through the 1990s, FirstEnergy bought significant amounts of property in the neighboring Greene Township so that they now own approximately 20% of the Township's private property[290]. FirstEnergy has stated publicly that they have bought property in other neighboring communities in order to address seepage problems, among other business reasons[291]. In the 2013 lawsuit brought by citizens, it was noted that FirstEnergy had purchased 12 homes in the area, however the "Hancock County Assessor's Office records suggest the number of purchased homes is closer to 40, dating back to 2003"[292]. At various purchased properties, FirstEnergy has installed pumping stations and pipelines in an effort to contain the water seepage[293].

In addition to the FirstEnergy buy-outs, other residents have moved out and abandoned their homes, leaving towns with even more vacant properties and compounding the problem of precipitously dropping home values[294]. While the pond is scheduled to be closed in 2028, the economic future of these areas looks bleak. The chairman of Greene Township's board of supervisors expressed that "Although FirstEnergy is paying property taxes on the township land it owns, it's likely that the company's property will never be developed again"[295].

CLEANUP STRATEGY

FirstEnergy has begun cleaning up the site using a cap-in-place approach. At 937 acres, this will be the largest pond ever to be capped. The site will be dewatered and closed in phases. It is unclear how the decanted water will be handled, but it is possible that it will be treated at the same facility constructed for dry ash storage decanting. According to FirstEnergy, the final cover will consist of "a 40-mil geomembrane, a cushion/drainage geotextile, and 1-ft thick soil layer as cover"[296].

In its initial plans, FirstEnergy proposed addressing the leakage via dam improvements and groundwater well pumping. They proposed continuing to use a water treatment that simply adjusts the pH of the contamination utilizing sulfuric acid or sodium hydroxide, but does not remove any contaminating constituents[297]. FirstEnergy indicated that it might use this modest treatment after pond closure as well, but posited that it likely wouldn't be necessary. The company estimated a bond amount of $133 million for the entire closure and post-closure care[298]. Pennsylvania regulators cited numerous deficiencies in the initial plan, increased the required bond amount to $169 million, and required an earlier closure deadline of 2028[299].

The final plan approved by the Pennsylvania Department of Environmental Protection also follows a cap-in-place strategy, but FirstEnergy must also conduct quarterly seepage reconnaissance, institute corrective action when seepages are found, and pursue groundwater remediation measures. Seepages are expected to continue until closure in 2028 and even afterwards, hopefully at a reduced rate. According to the Pennsylvania DEP, the seepage from the ponds into the groundwater is anticipated to reduce dramatically once the ponds are closed in 2028. However, after that time, the DEP sees that the groundwater capture system will continue indefinitely. This is due to the fact that water will likely enter pond via groundwater infiltration and/or through the cap. Exact remediation strategies to address arsenic contamination are not outlined in the closure plans thus far[300,301] .

Although the closure of Little Blue Run is a positive step forward for much of the surrounding area, these actions are coming too late. Towns have been emptying out for decades and the groundwater pollution has already reached many private wells. Neighbors will additionally have to contend with the current rate of seepage for the next ten years before the pond is actually closed, and even after closure—hopefully at a lesser rate—since the seepage will likely continue indefinitely. Local communities will have to cope with diminished tax revenue due to depreciating home values, abandoned properties, and limited future business development.

Little Blue Run is the least expensive closure and cleanup project of all the case studies. However, this low cost to the company is coming at a devastatingly high cost to the surrounding communities.

VI. ECONOMICS OF REMEDIATION

6.1 COST ANALYSIS

The costs of closing a coal ash pond site utilizing an excavation approach vs. capping in place are not well-established. Among the country's 700 active coal disposal sites and an estimated total of more than 1,400 sites including inactive sites, only a small number of sites are being closed using full excavation[302]. A brief comparison of cleanup costs provides a general look at costs associated with various pond closures.

Site Area	Pond Size	Cleanup Cost	Source Control	Groundwater Remediation
Wateree Station	80 acres	~$40 million	Excavation	Monitored Natural Attentuation (MNA)
Cross Station & Winyah Plant	633 acres	$250 million	Excavation	Unknown
Riverbend Plant	69 acres	$419 million	Excavation	Water Treatment Facility
Asheville Plant	76 acres	$422 million	Excavation	Water Treatment Facility
Belews Creek	283 acres	$410 million	Cap-in-place	Unknown
Little Blue Run	976 acres	$169 million	Cap-in-place	MNA; Groundwater Capture
Colstrip Plant	800 acres	Unknown	Cap-in-place	MNA; Groundwater Capture

Figure 15: Comparison of reported costs for ash pond closure and remediation. Some costs are estimates provided from the utility companies themselves (namely, Riverbend, Asheville, and Wateree) which are unverified by state regulators. Some cost estimates have been set through a bonding process with state regulators (namely, Little Blue Run).

It is worth noting that the Little Blue Run closure via capping-in-place is exceptionally inexpensive for the utility, but that this type of pond closure will not completely stop the leakage that has led to depressed property values, abandoned homes, and drinking water pollution.

Cost projections are calculated by the utility companies. For the time being, none of these sites have been fully excavated and—for the most part—regulators have not weighed in on the overall accuracy of any cost estimate. Overall, cleanup costs are a concern for lawmakers, ratepayers, tax payers, and utility companies, especially when it comes down to exactly who will pay for the cleanup.

For a short time after the CAMA law passed, Duke Energy was required to close ponds at 14 North Carolina sites by excavation. During that time, Duke Energy estimated their closure costs at $10 billion[303]. Subsequent amendments to that law reduced the number to four plant sites requiring excavation: Dan River, Sutton, Riverbend, and Asheville. Altogether, Duke Energy operates two sites in South Carolina and four plant sites in North Carolina undertaking excavation cleanup[304]. In both states, the utility is seeking rate increases to pay for coal ash pond cleanup. They currently project the overall cleanup tab for the Carolinas at more than $5 billion which includes capping in place for most of their plant ponds. This is a multi-billion dollar reduction from previous estimates that included more extensive excavation across their fleet. These numbers suggest that capping-in-pace is a less expensive closure option for the utility, a finding that supports conventional wisdom on the topic[305].

Some environmental groups have theorized that Duke Energy is inflating their cleanup cost estimates in order to justify rate increases and/or to pressure North Carolina lawmakers into easing back new regulations[306].

These cases also demonstrate that ratepayers or taxpayers do not need to pay the entire bill for cleanup In South Carolina, neither Santee Cooper nor SCE&G has petitioned for a rate increase with the utility commission to cover ash pond closure and remediation. These utilities have stated that they do not plan on raising rates, though they have left the door open to that possibility in the future[307]. Duke Energy is involved in a series of rate cases, and in the most recent case the utility commission approved a 10% increase rather than Duke Energy's requested 13.4% increase[308]. In other words, the generators and utilities are footing at least some of the bill for cleanup.

The pertinent take-away from this general comparison chart is that more data is needed to accurately compare the costs of excavation and capping-in-place. In these cases, excavation work does require more steps and it is reasonable to assume that a larger project will incur larger costs. However, many other factors play into the overall cleanup costs for both methods, such as the need to build an onsite landfill, other needed demolition work, transportation of CCR material, and/or if building a new water treatment facility is required. Associated with these additional labor-intensive projects is job creation potential.

Finally, while costs are an important part of the equation, cleanup strategies ought to be evaluated in terms of their full socio-economic and environmental impacts. This next section analyzes those other impacts.

BENEFITS OF REMEDIATION

At all of these sites, private and public drinking water supplies were contaminated by leaking coal ash ponds. Numerous violations of the Clean Water Act were found, private wells were contaminated with toxic heavy metals, and hundreds of residents have had to rely on bottled water supplies due to this pollution.

The ***ecotoxilogical impacts of this water contamination are widespread***. It is well-documented that some contaminants, notably selenium, can move through the food chain[309]. Additionally, plants will absorb contaminants like selenium and this can affect grazing animals[310]. Reducing the constituent levels in a shorter amount of time and in a more long-term manner will have numerous health benefits for the public, livestock, and the environment.

The Wateree site's success at reducing arsenic levels in a relatively short period of time is a testament to the efficacy of excavation and storage in a Class-III, CCR-compliant landfill. Other sites in South Carolina are seeing similar drops in arsenic levels measured in the groundwater. Regulators and citizens' groups also prefer this solution because of its proven efficacy at reducing contamination at other toxic cleanup sites within a reasonable timeframe.

Colstrip's drinking water is pumped in from the Yellowstone River, 30 miles from town. People living outside the city limits—as well as livestock and wildlife—are especially impacted if coal ash continues to contaminate the area's groundwater.

Photo credit: Tom Tietz ©, 123rf.com

The potential for pond or dam failure is also a major threat to public health and well-being. The devastating pond failures at the TVA site in Tennessee and at the Dan River site in North Carolina damaged homes, forced residents to evacuate, and killed wildlife[311]. Dewatering the ash ponds is a sensible and long-term solution to this threat; ultimately, however, excavation may offer the best protection.

It is worth mentioning that Colstrip's municipal drinking water source is Castle Lake, and the water for this reservoir is piped in from the Yellowstone River; it is thus not impacted by the coal ash ponds[312]. However, residents and agricultural producers outside the city limits must contend with the implications of contaminated groundwater, since this is often their only source of water. The presence of contaminated groundwater—even if it's not the source of drinking water—can have other negative effects on the community in terms of public perception. This may negatively affect home valuations and the willingness of businesses to locate in Colstrip *(see section 6.2 for more details)*.

Figure 16: Irresponsible cleanup vs. responsible cleanup.
(Credit: Graphic designed by Northern Plains Resource Council © 2018)

6.2 CLEANUP RAISES LOCAL TAX REVENUE

PROPERTY VALUES

Property Values Impacted Both Up and Down

Industrial contamination and effective remediation both have profound, direct impacts on nearby property values. As noted in the Little Blue Run case, the risk the 900-ft dam poses to human life and property is linked to the area's drop in property values. Additionally, the ongoing property damage—including constantly wet yards and shifting foundations—and likelihood of drinking water contamination also contributed to depressed home values for many residents.

Cleanup Improves Property Values Quickly

However, adequate cleanup can yield positive results in a relatively short time frame. Researchers DeSousa, Wu, and Westphal have also found that "[B]rownfield projects not only generate desirable economic outcomes themselves but also have spillover effects on surrounding home values that are significant in both quantity and geographic scope"[313]. A recent report analyzing the effects of 797 brownfield remediation sites showed that "With cleanup we find that property values increase by an average of 5.0% to 11.5%" and even up to 15.2%[314]. These impacts easily passed a cost-benefit analysis when compared to cleanup investment and were found to provide "unambiguous" positive net benefits to communities. This report found that the property value effect was fairly limited geographically, but was still quite significant[315].

Thus, adequately and fully remediating an industrial contamination site has a direct positive benefit on nearby home and other property values. Ostensibly, dewatering Little Blue Run will reduce the impact of a dam failure, but it may not address all the problems. If the Little Blue Run continues to contaminate water supplies, damage home foundations, and emit noxious odors in nearby residential areas, it is reasonable to expect property values will remain depressed despite the cap-in-place cleanup.

Cleanup Raises Local Tax Revenue

The increase in property values also has a positive effect on local tax revenue. As researchers found in an analysis of home values and tax revenue, "Public investment in brownfield redevelopment, regardless of type, does help erase the negative effect imposed by deindustrialization and helps cities restore and raise their property tax base on and around brownfield sites"[316].

In a study looking at residential property tax revenue, researchers found that "The estimated increase in residential property tax revenue for a single tax year from remediating 48 brownfields properties was between $29 million and $97 million"[317].

OVERCOMING CONTAMINATION'S STIGMA FOR COMMERCIAL DEVELOPMENT

Research shows that the existence of contamination can seriously hamper new commercial investment in an area—and extends to areas *perceived* to be contaminated[318]. This is especially detrimental to an area where attracting new local businesses is part of long-term planning efforts. However, there are a few actions that local governments and citizens can take to counteract these negative impacts. The first thing to do is swiftly fix contamination; concurrently, local governments and businesses can identify an appropriate set of incentives and strategies to communicate the efficacy of this remediation work[319,320]. Some of these tools may include third-party liability protection for developers provided by either public or private sources.

The thoroughness of a cleanup efforts matters greatly. Developers are reticent to invest in an area where remediation efforts may meet the bare legal minimum but don't permanently address the full extent of contamination. As researchers Wernstedt, Meyer, and Alberini state, "[O]ur finding that developers highly value cleanup and third-party liability protection highlights some of the hidden costs of brownfield redevelopment practice that may leave contamination on site as part of a risk-based cleanup strategy. Future liability for such residual contamination clearly remains a concern of many developers"[321].

6.3 REMEDIATION JOBS

HONORABLE, DIGNIFIED, AND HIGH-PAYING

It is well documented that remediation can be a significant contributor to job creation in natural resource extraction communities[322]. In Montana, research shows that 10.7 direct jobs are created for every $1 million spent on restoration projects; adding in related jobs, this number jumps to 31.53 jobs per every $1 million spent[323].

This analysis found preliminary data on job numbers *(see Figure 17 on the following page)* and workforce profiles associated with cleanup efforts; these numbers suggest that cleanup is a significant source of job creation at these case sites. While additional data will facilitate a clearer understanding of the jobs associated with cleanup at these particular sites, the initial findings are informative, and create a solid foundation for collecting further data.

Figure 17: According to industry experts, excavation tends to create more jobs than cap-in-place ash pond closure. There are more steps involved with an excavation strategy, all of which are labor intensive. While the job numbers found in these case studies cannot be generalized, they do reflect this remediation industry knowledge and research.

Plant Name/ Location	Pond Size	Cleanup Approach	Cleanup Jobs	Existing Plant Jobs	Cleanup Jobs/ Pond Acre	Estimated Cleanup Cost	Notes
Riverbend Station (North Carolina)	69 acres	Excavation	75	145	1.08	$419 million	Water treatment facility constrution included in job numbers.
Asheville Plant (North Carolina)	76 acres	Excavation	190	200	2.5	$422 million	Overall numbers have stayed the same but currently, 140 jobs are in trucking CCR materials.
Belews Creek (North Carolina)	283 acres	Cap-in-place	163	300	.58	$410 million	Fewer workers required relative to plant size.
Colstrip Station (Montana)	~800 acres	Unknown	Unknown	388	Unknown	Unknown	No plans to hire local workforce.

As noted in the case studies, the excavation projects involve more phases, components, and distinct projects. The cleanup jobs described in the case studies include both the short-term work (e.g., facility demolition, pond dewatering, etc.) and longer term jobs like groundwater monitoring.

A recent workforce analysis of mining and heavy metal cleanup projects utilizing excavation in Montana showed that a diverse range of jobs and skills are required for such projects[324]. Between those findings and the job types highlighted in the preceding case studies, this analysis finds that cleanup projects involving excavation and/or groundwater treatment often require the following jobs:

QUICK LOOK AT COMMON REMEDIATION JOBS

- *Heavy equipment operator*
- *Mechanic*
- *Electrician*
- *Fence erector*
- *General labor*
- *Truck driver*
- *Site superintendent*
- *Environmental engineer*
- *Mechanical engineer*
- *Civil engineer*
- *CADD (computer aided design and drafting) specialist*
- *Septic systems operator*
- *Surveyor*
- *Drilling specialist*
- *Demolition specialist*
- *Security guard*
- *Construction crews*
- *Septic system installation*
- *Water sampling technician*
- *Groundwater well technician*
- *Water treatment plant operator*
- *Environmental Health and Safety officer*

The local workforce in Colstrip already has many of these skills. Additional training will probably be required as workers shift from plant operations to remediation work. However, Talen has indicated that they do not intend to use the local workforce for cleanup and that they do not envision Colstrip's cleanup effort requiring many workers at all[325]. This analysis finds that Talen's assumption is mistaken and—with adequate planning—cleanup can be a very significant job creator for Colstrip.

More research into the specific types of jobs, employment duration, wages, workforce makeup, and training required, as well as data on job numbers at the other cleanup sites, would help round out this analysis.

The key finding of this study is that remediation creates a significant number of jobs at coal ash cleanup sites and that better remediation strategies likely require a larger workforce. As a spokesperson for Duke Energy, Erin Culbert, explained, "Ash basin closure is going to create jobs. It's a whole body of work that's going to happen across the nation and it's huge opportunity for all of us"[326]. However, the economic benefits of this cleanup to Colstrip will vary widely depending on which cleanup strategies are utilized and whether the local workforce is hired to do the work.

VII. CONCLUSION

THOROUGH CLEANUP—A THREE LEGGED STOOL

Coal ash pond cleanup has the potential to create many jobs for the local workforce while fixing harmful groundwater contamination in the Colstrip area. The success of this cleanup effort, both in terms of job creation and remediation efficacy, depends heavily on the techniques utilized—specifically choosing a plan that includes excavation and fully treats existing contamination. Talen Energy is still crafting their cleanup proposal, but thus far, it is clear they plan to close ponds using cap-in-place and expand their existing groundwater capture system. Furthermore, they are not proposing to hire the local workforce to do this labor. A better solution exists, one that permanently removes the source of pollution and more rapidly removes heavy metals and other contaminants from the groundwater.

(Photo credit: Boyd Norton © 1973, courtesy of the Environmental Protection Agency/National Archives and Records Administrationl)

RESPONSIBLE CLEANUP CREATES GOOD-PAYING UNION JOBS, SECURES COLSTRIP'S FUTURE, AND PROTECTS THE LOCAL RANCHING COMMUNITY.

KEY FINDINGS FROM THIS ANALYSIS SUPPORT THE FOLLOWING CONCLUSIONS:

Excavation of coal ash ponds and operating a water treatment facility are more effective cleanup strategies than cap-in-place and running a groundwater capture system alone. *These more robust remediation actions are likely to create more jobs, stabilize local property values, and help future commercial development efforts. The local Colstrip workforce already has many of the skills needed for this cleanup labor, but additional training would help prepare more of the workforce to transition to these new jobs.*

In North and South Carolina, the most polluting ash ponds are closed via full excavation of CCR materials from ponds. *Lawmakers in North Carolina and three utility companies in South Carolina all adopted this strategy where contamination had become problematic from a human health and ecological perspective[327,328]. Citizen groups advocate for this approach for its long-term efficacy in remediating groundwater contamination.*

In South Carolina, excavation has proven to drastically increased groundwater quality in a relatively short amount of time. *Arsenic levels monitored in groundwater have dropped 90% in some areas since excavation began in 2013[329].*

Cleanup strategies that include excavation are more multi-faceted and labor intensive. *Additional steps must be taken over the cap-in-place approach, potentially including more thorough dewatering, additional earthmoving, transportation, and/or constructing a new CCR-compliant landfill. These longer, more labor-intensive phases create more jobs than a cap-in-place strategy. These findings support general research and industry knowledge on heavy metal site remediation.*

Since excavation involves more workers while reducing groundwater contamination more permanently and quickly, there are more economic benefits to community. *These include increased property values, increased local tax revenue, and higher rates of local employment—as well as helping reduce the stigma of contamination for future commercial developers and businesses.*

Treating and monitoring wastewater creates jobs. *These jobs range from building and operating a water treatment facility to monitoring leachate water at a landfill site.*

Public and worker safety must be a top priority for operators and regulators. *Handling coal ash requires adequate protective wear for workers, proper training, and rigorous project oversight. Transporting coal ash additionally must be done with the utmost concern for public safety and health.*

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