UNITED STATES DISTRICT COURT
MIDDLE DISTRICT OF TENNESSEE
NASHVILLE DIVISION

TENNESSEE CLEAN WATER NETWORK and TENNESSEE SCENIC RIVERS ASSOCIATION,	)	
Plaintiffs,	)	
v.	)	**NO. 3:15-cv-00424**
	)	**CHIEF JUDGE CRENSHAW**
TENNESSEE VALLEY AUTHORITY,	)	
Defendant.	)	

FINDINGS OF FACT & CONCLUSIONS OF LAW

The Tennessee Clean Water Network and Tennessee Scenic Rivers Association ("Plaintiffs") filed a Complaint against the Tennessee Valley Authority ("TVA") alleging numerous violations of the Clean Water Act ("CWA") related to TVA's operation of a coal-fired power plant about five miles south of the city of Gallatin, Tennessee ("Gallatin Plant"). (Doc. No. 1.) On September 9, 2016, the Court dismissed a portion of Plaintiffs' claims on the merits and a portion of the claims on the ground that the Court was barred from considering the allegations at issue in light of an ongoing State of Tennessee enforcement proceeding. (Doc. No. 139.) On January 30 through February 2, 2017, the Court held a bench trial on the remaining claims.

For the reasons discussed herein, the Court will direct the Clerk to enter judgment for the Plaintiffs on Claims A, C, D, E.b, and E.e. It will direct the Clerk to enter judgment for TVA on Claims E.c and E.d, as well as Claims B and E.a, which were dismissed by earlier Order of the Court. (Doc. No. 140.) TVA shall be ordered to excavate the Ash Pond Complex and Non-Registered Site and move the coal ash waste currently therein to a lined impoundment. In light of

the substantial costs TVA is likely to incur in remediating its ash pond disposal areas, the Court declines to assess penalties on top of its injunctive relief.

I. CLAIMS

1. The following claims are before the Court:

- **Claim A** alleges generally that TVA unlawfully discharged pollutants into the waters of the United States from a point source or point sources through hydrologic flow from its ash ponds to the Cumberland River.
- **Claim C** alleges specifically that TVA is responsible for unpermitted point source discharges from the abandoned ash pond area known as the "Non-Registered Site."
- **Claim D** alleges specifically that TVA is responsible for unauthorized point source discharges from its currently active ash pond complex, known as the "Ash Pond Complex."
- **Claim E.b** alleges that TVA violated Part I.A(c) of its NPDES permit.
- **Claim E.c** alleges that TVA violated Part II.A(4.a) of its NPDES permit.
- **Claim E.d** alleges that TVA violated Part II.C(2) of its NPDES permit.
- **Claim E.e** alleges that TVA violated Part II.C(3.b) of its NPDES permit.

2. In light of the Court's September 9, 2016 ruling and the ongoing State proceedings, the above claims are limited to two types of alleged discharges from the Gallatin Plant: discharges from the Non-Registered Site into the Cumberland River; and discharges from the Ash Pond Complex via hydrologic flows that are not seeps alone. By the terms of the Court's Order, this limitation applies not only to claims A, C, and D—which explicitly allege unauthorized discharges—but also to claims E.b through E.e, insofar as those claims are premised on allegations related to leaks. (Id.)

II. NATURE OF FINDINGS AND CONCLUSIONS

3. After reviewing the parties' proposed findings and conclusions, their arguments, the record, the exhibits received in evidence, and the testimony of the witnesses and consideration of their interests and demeanor, the Court enters the following Findings of Fact and Conclusions of Law in accordance with Rule 52(a) of the Federal Rules of Civil Procedure. Except where the Court discusses differing testimony on a specific issue, any contrary testimony on that matter has been considered and rejected in favor of the specific fact found. Finally, to the extent that a finding of fact constitutes a conclusion of law, the Court so concludes; to the extent that a conclusion of law constitutes a finding of fact, the Court so finds.

III. FINDINGS OF FACT

4. Trial in this case involved the presentation of the often conflicting testimony of numerous experts on a number of closely related topics. The Court's Findings of Fact, below, are a reflection of the information presented as well as the Court's contemporaneous observation and assessment of the witnesses' credibility. The omission of any particular detail from the below findings of fact should not be construed as the Court's failure to consider that detail or inferences it would support, but rather merely an indication that, in the process of condensing a voluminous record, some details were omitted in the interest of conveying a manageably concise presentation of the relevant evidence and limiting the Findings of Fact to the details that the Court considered ultimately dispositive.

A. Background

1. General Principles of Hydrology[1]

5. This case is about water. Water comes in various forms and can be found in various places.

6. In its liquid form, water may pool or flow on top of the surface of the earth—for example, in the Cumberland River. Because these bodies of water can be found on the surface of the earth, they are categorized as "surface waters." SURFACE WATER, Merriam-Webster Dictionary (online ed. 2017).

7. Water is also present below the surface of the earth, in what is known as "groundwater." GROUNDWATER, Merriam-Webster Dictionary (online ed. 2017). Liquid groundwater tends to flow through the earth, from places of high elevation to places of lower elevation, eventually joining surface waters and flowing to the sea. (See Doc. No. 227-1 (Groves Wr. Test.) at ¶ 27.)

8. Not all earth, though, is created equal when it comes to the flow of groundwater. In some types of earth, such as gravel or loose soil, water may seep broadly through pores. In other types of earth, such as fractured rock, water may instead pass quickly but narrowly through fissures. In yet other types of earth, such as tightly packed clay, water may not pass well at all, because there is no space for the water to occupy. Portions of earth that readily transmit water are called "aquifers." Portions of earth that do not readily transmit water are called "aquitards." Most

[1] Hydrology is "a science dealing with the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere." HYDROLOGY, Merriam-Webster Dictionary (online ed. 2017). Numerous experts in this matter testified regarding relevant hydrological matters. Although they sometimes differed in their conclusions and terminology, the Court has been able to identify a number of core principles of hydrology that underlie the issues in this case. The Court will present those general principles here in a highly simplified form. The Court's statement of general principles is not intended to disregard or negate any complicating details set forth in individual witnesses' testimony.

groundwater environments include a mixture of the two. (See Doc. No. 230-1 (Perry Wr. Test.) at 4–5.)

9. Generally speaking, water that penetrates the earth will, due to the pull of gravity, flow downward until it penetrates what is known as the "water table." (See Doc. No. 227-1 (Groves Wr. Test.) at ¶ 27.) The water table is the top of an area of earth totally saturated with groundwater. Beneath the water table, at least as relevant to this case, is the continuous flow of groundwater through the earth toward surface waters. (Id.) The particular elevation of the water table in any given area may fluctuate over time in response to precipitation. (See Doc. No. 230-1 (Perry Wr. Test.) at 14.)

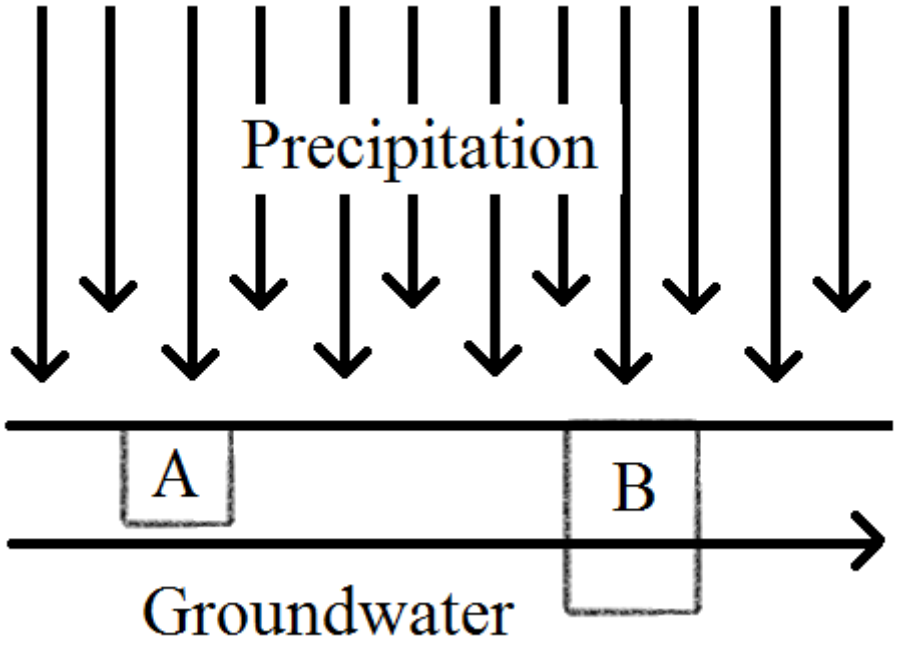
10. Liquid or solid water falls to the earth in the form of precipitation—rain, sleet, or snow. If precipitation falls immediately upon a preexisting surface water, the precipitation will join that surface water. Water that falls upon the earth will either pool there—as surface water—or it will penetrate the earth and join the groundwater. (See Doc. No. 227-1 (Groves Wr. Test.) at ¶ 45.)

11. As water passes through the earth on its way to surface waters, it may pick up chemicals from the material it passes through and then carry those chemicals with it on its path to surface waters. (See Doc. No. 230-1 (Perry Wr. Test.) at 6.) If the water passes through an area filled with pollutants—for example, a large impoundment of coal ash waste—it may pick up some of those pollutants and then convey them to nearby surface waters.

12. Water that penetrates a particular patch of earth directly from above—such as rain penetrating directly into the earth it fell upon—is said to have penetrated that earth *vertically*. Water that penetrates a particular patch of earth via groundwater flow, on the other hand, is said to have penetrated it *laterally*. Generally speaking, if a particular patch of earth is wholly above the water table, it will be penetrated only vertically, when precipitation falls upon it or immediately

near it. If the patch of earth extends past the water table and into a continuous groundwater flow, however, the patch will be penetrated both vertically, by immediate precipitation, and also laterally, by groundwater that could include water that first fell to earth a significant distance away. (See Doc. No. 227-2 (Quarles Wr. Test.) at ¶ 45.)

13. For example, the below figure shows one zone of earth penetrated only vertically, and one penetrated both vertically and laterally:



14. Because zone A terminates before breaching the water table, it is penetrated only vertically. Precipitation enters zone A at the surface of the earth, passes through it, then eventually joins the groundwater level below zone A's lower boundary.

15. But because zone B extends past the water table, zone B is penetrated both vertically and laterally. Some water penetrates via precipitation at the surface, then flows down and joins the groundwater. Yet other water, already part of the groundwater flow, penetrates zone B from the side.

16. Although both hypothetical zones are penetrated by water, and the water from each eventually ends up in the same groundwater flow, a key difference exists in how one might shield the respective zones from future water flow. A simple surface cap would largely protect zone A by blocking precipitation. Pollutants from zone A then would be unlikely to join the groundwater flow in significant levels. A cap alone, however, would not keep out pollutants from zone B, because the cap would do nothing to impede the lateral flow of groundwater through those pollutants, even in the absence of penetration by immediate precipitation. If one truly wished to keep the pollutants from zone B out of the groundwater, one would need to either install a lining around its entire perimeter or permanently excavate the pollutants.

17. In summary, these basic principles form the foundation of this case: (1) water, in the form of precipitation, penetrates the ground and becomes groundwater; (2) groundwater generally flows through the earth toward surface waters that ultimately connect to the sea; (3) as waters pass through the earth, they pick up chemicals, including potentially harmful pollutants, that they then convey to the surface waters; and (4) passage of water through a particularly toxic area can be prevented either by blocking the water or removing the toxins.

2. The Gallatin Plant

18. The Gallatin Plant is a four-unit coal-fired power plant located in Sumner County, Tennessee, about five miles south of the city of Gallatin on the Odom's Bend Peninsula formed by the Old Hickory Lake portion of the Cumberland River between River Miles 242.5 and 246. (Doc. No. 226 (J. Stip.) at ¶ 1.) Old Hickory Lake is a reservoir created by the construction of the Old Hickory Lock and Dam. (Id. at ¶ 5.)

19. Odom's Bend Peninsula is situated over some karst geological features, with sinking streams, shallow bedrock, and sinkholes. (Id. at ¶ 17.) The Central Basin, in which the Gallatin

Plant is located, is one of several major areas of karst development in Tennessee. (Doc. No. 227-1 (Groves Wr. Test.) at ¶ 32.)

20. The Gallatin Plant commenced operation in 1956. (Doc. No. 226 (J. Stip.) at ¶ 3.)

21. From 1956 until 1970, the Gallatin Plant sluiced coal combustion residual ("CCR") material to a 65-acre surface impoundment on the western edge of the plant site known then as Ash Disposal Areas No. 1 and No. 2 but now typically referred to as the Non-Registered Site. The Non-Registered Site has been out of operation since 1970. (Id. at ¶ 7.)

22. TVA constructed the Non-Registered Site with unlined perimeter containment dikes made of earth and ash. (Id. at ¶ 11.)

23. In the mid-1990s, the Tennessee Department of Environment & Conservation ("TDEC") asked TVA to formulate a closure plan for the Non-Registered Site, which TVA did. (Id. at ¶ 8.) Construction work related to the closure was apparently completed in or around 1998. (Doc. No. 234 (Tr. Day 1) at 192.)

24. Since April 1970, TVA has been sluicing coal ash waste to the approximately 476-acre Ash Pond Complex, which is also unlined. (Doc. No. 226 (J. Stip.) at ¶ 12.) The Ash Pond Complex is located just to the north and to the northeast of the Non-Registered Site along the bank of the Cumberland River. (Id. at ¶ 13.)

25. The Ash Pond Complex consists of the following ponds: Ash Pond A, Ash Pond E, Bottom Ash Pond, Middle Pond A, and a stilling pond complex consisting of Stilling Ponds B, C, and D. In 2015, TVA ceased sluicing ash to Ash Pond E and began dewatering that pond. Stilling Pond D discharges effluent into the Cumberland River at a site known as Outfall 001. (Id. at ¶¶ 14–16.)

3. The Gallatin Plant's Permit

26. On April 30, 1976, the U.S. Environmental Protection Agency ("EPA") issued the first NPDES Permit to TVA for Gallatin (Permit No. TN0005428). (Id. at ¶ 19.) The Tennessee Department of Environment and Conservation ("TDEC"), which now administers Tennessee's NPDES system on delegation from the federal government, re-issued the Gallatin Plant's NPDES Permit No. TN0005428 on January 1, 2006. (Id. at ¶ 21.)

27. In May 2009, TVA submitted to TDEC an application for renewal of Gallatin's NPDES Permit No. TN0005428. TDEC reissued the Gallatin Plant's NPDES Permit No. TN0005428 for a five year period beginning July 1, 2012, and ending May 31, 2017. (Id. at ¶¶ 22–23.) When the permit recently expired, it was administratively continued until the issuance of a new permit, currently under consideration. (Doc. No. 251 at 2 (citing Tenn. Comp. R. & Regs. 0400-40-05-.05(3)(b)-(4), 0400-40-05-.11(2)).)

28. The current permit expressly authorizes the discharge of coal ash waste from one location, Outfall 001. (J. Ex. 102 at 1.)

29. Part I.A(c) of the NPDES permit, known as the "Removed Substances" provision, provides:

> Additional monitoring requirements and conditions applicable to Outfalls 001 . . . include:
>
> [. . . .]
>
> c. Sludge or any other material removed by any treatment works must be disposed of in a manner, which prevents its entrance into or pollution of any surface or subsurface waters. Additionally, the disposal of such sludge or other material must be in compliance with the Tennessee Solid Waste Disposal Act, TCA § 68-31-101 et seq. and the Tennessee Hazardous Waste Management Act, TCA 68-46-101 et seq.

(Id. at 11.)

30. Part II.A(4.a) requires TVA to "at all times properly operate and maintain all facilities and systems (and related appurtenances) for collection and treatment which are installed or used by the permittee to achieve compliance with the terms and conditions of the permit." (Id. at 19.)

31. Part II.C.2 creates an obligation to inform regulators within twenty-four hours of certain events:

> In the case of any noncompliance which could cause a threat to public drinking supplies, or any other discharge which could constitute a threat to human health or the environment, the required notice of non-compliance shall be provided to the Division of Water Pollution Control in the appropriate regional Field Office within 24-hours from the time the permittee becomes aware of the circumstances.

(Id. at 22.)

32. Part II.C.3.b forbids "Sanitary Sewer Overflows" at the Gallatin Plant, which the permit defines as "the discharge to land or water of wastes from any portion of the collection, transmission, or treatment system other than through permitted outfalls." (Id.)

4. Plaintiffs' Notice and State Court Proceedings

33. On November 10, 2014, Plaintiffs, through counsel, issued a 60-day Notice of Violation Letter to TVA, TDEC, and the EPA under the citizen suit provision of the Clean Water Act, 33 U.S.C § 1365 ("CWA" or "Act"), alleging multiple violations of the Act at the Gallatin Plant. See 33 U.S.C §§ 1251-1387. The Notice stated that Plaintiffs intended to file a complaint in federal court against TVA to enforce requirements of the CWA and the Permit. (Doc. No. 226 (J. Stip.) at ¶ 24.)

34. On January 7, 2015, the State of Tennessee ("State") and TDEC filed an original enforcement action against TVA in Davidson County Chancery Court under applicable state statutes ("State Enforcement Action"). (Doc. No. 13-5 at PageID 320-21.) The complaint in the

State Enforcement Action specifically refers to ten seeps from the Ash Pond Complex, and the parties have identified those ten seeps to the Court. (Doc. No. 234 (Tr. Day 1) at 14.).

35. As part of the State Enforcement Action, which remains pending, TVA is in the process of completing and executing an Environmental Investigation Plan ("EIP") that is intended to better investigate and understand the environmental features of the Gallatin Plant site. Plaintiffs, who are intervenors in the State Enforcement Action, as well as TDEC have been involved in the process of reviewing the EIP.

5. Proceedings in this Court

36. Plaintiffs filed their Complaint in this action on April 14, 2015. (Doc. No. 1.)

37. The parties filed various dispositive motions, and on September 9, 2016, the Court issued an Order dismissing Plaintiffs' Claims B and E.a. The Court also dismissed the remaining claims except as they applied to two sets of allegations: "discharges from the Non-Registered Site into the Cumberland River; and discharges from the Ash Pond Complex via hydrologic flows that are not seeps alone." (Doc. No. 140 at 1.) Finally, the Court struck Plaintiffs' demand for a jury trial, on the ground that, because TVA is a creature of the federal government, the Seventh Amendment does not guarantee Plaintiffs a right to a jury trial. (Id.)

38. Accordingly, the claims that had not been dismissed were considered by the Court in a bench trial held from January 30 through February 2, 2017. By agreement of the parties and pursuant to Local Rule 39.01(c)(6), direct testimony of expert witnesses was provided in written form, which was accepted into evidence. Key portions of the written testimony were read in Court, after which the expert witnesses were made subject to cross examination.

B. Plaintiffs' Evidence at Trial

1. Testimony of Dr. Chris Groves

39. Dr. Chris Groves holds the position of University Distinguished Professor of Hydrogeology at Western Kentucky University ("WKU"). He has a B.S. degree in Geology and an M.S. degree in Geography from WKU, as well as a Ph.D. in Environmental Sciences (Geology) from the University of Virginia. He is currently serving as a member of the steering committee of the Karst Commission of the International Geographic Union and has amassed a lengthy resume of professional service, honors, grants, and publications indicative of accomplishment and expertise in the field of hydrogeology. (Doc. No. 163-1 (Groves CV).) Groves is licensed as Kentucky Professional Geologist No. 2585. (Doc. No. 227-1 (Groves Wr. Test.) at ¶ 3.)

40. Groves described hydrogeology as the science of how underground water is distributed and how it moves through the soil as soil water, and through rocks beneath the surface as groundwater. (Id. at ¶ 28.)

41. Hydrogeology includes examination of issues related to water quality and how water's chemical composition is impacted by interactions with rocks, gases, biological processes, surface waters, and human sources of contamination. (Id.)

42. Groves testified that he has more than thirty years of professional experience in the study of landscape and aquifer systems, and that this case was the first matter in which he had been retained as an expert witness in a lawsuit or testified in court as an expert witness. (Id. at ¶¶ 2–3.)

43. The parties have stipulated and agreed that Groves is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

44. Groves stated his opinion that, based on his review of historic maps, borings, and TVA's own internal reports, as well as his own knowledge and understanding of hydrogeological formations in the Central Basin and Odom's Bend Peninsula, he considered the Gallatin Plant coal ash disposal sites "unsuitable for the containment of coal ash." (Id. at ¶ 7.)

45. Specifically, he opined that the Ash Pond Complex does not and cannot effectively contain coal ash waste, and in particular was constructed on top of highly porous limestone with numerous existing sinkholes and an associated underground karst flow system. He stated that these features permit the waste to migrate into groundwater and to the adjacent and hydrologically connected Cumberland River. (Id. at ¶ 8.)

46. Groves testified that, in his opinion, both the Non-Registered Site and the Ash Pond Complex were constructed at least partially below the water table and are thus in contact with the groundwater. (Id. at ¶ 9.)

47. Groves testified that, in general, water flows from high areas to low areas of the water table, and that, in this case, the groundwater flows from the peninsula, including from the Ash Pond Complex, to the Cumberland River. (Id. at ¶ 27.) Groves presented a 2012 water table map showing the water table reducing in level from the interior of Odom's Bend Peninsula toward the river, tending to suggest that, generally speaking, water flows radially from the interior of the peninsula to the river, passing through both the Ash Pond Complex and Non-Registered Site. (Id. at ¶¶ 106–07.) Groves noted that TVA's historical documents acknowledged this general groundwater flow pattern numerous times. (Id. at ¶ 110.)

48. He described the Central Basin as a relatively simple geologic setting consisting of nearly horizontal sedimentary rock layers, with each rock layer being distinguishable by various properties, including porosity and permeability. (Id. at ¶ 33.) The nearly horizontal aquifers that

underlie the Central Basin include layers of Carters and Ridley Limestones. Water flows relatively easily through these rocks because, compared to the adjacent layers, they are purer limestones, which dissolve easily and thus contain fractures that have been enlarged by dissolution as groundwater moves through. (Id. at ¶ 35.)

49. Groves discussed in particular an April 2008 document prepared by TVA titled "Final Environmental Impact Statement Rutherford-Williamson-Davidson Power Supply Improvement Project Rutherford Williamson and Maury Counties Tennessee, TVA Project Number 2005-107" ("2008 FEIS"). (Id. at ¶¶ 36–37 (discussing J. Ex. 49)).

50. Groves approvingly cited the 2008 FEIS's statement that, in the Central Basin aquifer system, "most of the groundwater resides in and flows through fractures, bedding planes, small solution openings, and large open conduits." (Id. at ¶ 37 (quoting J. Ex. 49 at 67)).

51. The 2008 FEIS further states that "[l]imestone is susceptible to erosion and dissolution, which produces fissures, sinkholes, underground streams, and caverns forming vast karst areas." (J. Ex. 49 at 67.) It states that the "project area" is located in karst terrain, and that

> [k]arst landforms result from mildly acidic rainwater dissolving bedrock such as limestone or dolostone. Over time, these fractures enlarge as the bedrock continues to dissolve. Openings in the rock increase in size, and an underground drainage system begins to develop, allowing more water to pass through and accelerating the formation of underground karst features.

(Id.)

52. Groves testified that in karst landscapes, tributary networks combine with one another, leading to larger and larger flows. (Doc. No. 227-1 (Groves Wr. Test.) at ¶ 39.) Consistently with Groves' assessment, the 2008 FEIS states that

> Groundwater flows from the recharge areas through fractures and conduits and eventually discharges to springs and gaining streams. Large conduits or interconnected conduit systems may consolidate groundwater flow similar to the way surface water flows from small tributaries to larger streams. These

> interconnected, open conduits (the groundwater conduit system) can transmit water rapidly and can act as important local and regional drains of the groundwater system.

(Id. (quoting J. Ex. 49 at 67).) "Recharge" refers to water that has infiltrated into the ground. (Id. at ¶ 38.)

53. The 2008 FEIS further observes that "[g]roundwater in karst terrains is readily susceptible to contamination, as the water can travel long distances through conduits with no chance for the natural filtering processes of soil or bacterial action to diminish the contamination. . . . Karst features in the project area include sinkholes, disappearing streams, reappearing streams (springs), and caves." (J. Ex. 49 at 68.)

54. Groves described the aquifer framework in karst landscapes as "colander-like" due to the abundance of passages through which water can move. (Doc. No. 227-1 (Groves Wr. Test.) at ¶ 41.) He testified that the hydrogeological literature describes many examples of situations where karst limestone aquifers of Tennessee's Central Basin, and the rivers into which they drain, have been polluted by accidental spills and other releases of contaminants. (Id. at ¶ 43.)

55. Groves testified to his opinion, based on his review of literature and case materials, that at the Gallatin Fossil Plant, underground water primarily flows through openings that have been enlarged by the flow of water within the purer limestones. (Id. at ¶ 44.) In particular, the Carters Limestone that underlies the Ash Pond Complex transmits groundwater comparatively easily and rapidly through fractures and other conduits that have been enlarged by dissolution of the limestone bedrock by groundwater flowing through it. (Id. at ¶ 46.)

56. Groves explained that the karst-enabled drainage in the ash ponds themselves was obscured from view by coal ash waste, but that if the area had not been covered by coal ash waste,

one would expect to see rainfall landing on the ground and quickly sinking underground into the highly porous bedrock. (Id. at ¶ 45.)

57. Groves discussed TVA's historical documentation of the geology of the area before TVA built the ash pond disposal sites. The documentation showed numerous limestone sinkholes in the area that is now the Ash Pond Complex. It also showed numerous lineaments—naturally occurring, linear features of the landscape that provide insight into the subsurface fracture patterns and magnitude. (Id. at ¶¶ 48–52.) Based on Groves' review of TVA's map, he concluded that the subsurface fractures in Odom's Bend Peninsula are extensive and would allow water and any waste in the water to drain into the groundwater. (Id. at ¶ 53.) Groves stated that he had never seen any TVA documentation that these fractures were repaired, and that he believed any such repair to be nearly impossible in light of the fractures' extensive nature. (Id.)

58. Based on the foregoing, Groves stated that it was his professional opinion that fractures and related solutionally enlarged conduits under the coal ash disposal areas transport coal ash waste to the groundwater. (Id.)

59. Groves also noted that his review of the Tennessee Cave Survey showed at least nine explorable caves in the area including Odom's Bend Peninsula, and that it was his opinion that because there are so many caves in this area, there is a high probability that other caves were present on Odom's Bend that have been covered by coal ash waste and slurry water. (Id. at ¶ 55.)

60. Groves next discussed logs of borings performed by TVA and its contractors in the vicinity of the Ash Pond Complex. As Groves read the logs, the borings identified at least seventy "voids" or "apparent voids" in the earth, ranging from 4 to 18.6 feet in height, many of which were connected to the groundwater flow system. (Id. at ¶ 59.)

61. Groves also opined that, based on his review of historical documents, the Ash Pond Complex was located on top of a sinking stream referred to as "Sinking Creek." Sinking streams are streams that sink underground into the highly permeable limestone beneath and drain through the karst aquifer system to the nearest base level river, in this case the Cumberland River. Groves described sinking streams as among the most classic of karst features. (Id. at ¶¶ 60–65.)

62. Sinking streams disappear underground at "swallets"—holes into which the stream disappears into the subsurface. The water continues flowing underground to the relevant river, here the Cumberland. Groves' opinion, based on the historical documentation, was that the swallets of Sinking Creek are currently underneath the Ash Pond Complex. (Id. at ¶¶ 63–65.)

63. Groves opined that, because the former surface of the valley of Sinking Creek is, based on his reading, now the base of the Ash Pond Complex, he would assume that the coal ash waste water now moves directly into the subsurface under the Ash Pond Complex to the Cumberland River, just as water moved through the bottom of Sinking Creek to the Cumberland River before it held the Ash Pond Complex. (Id. at ¶ 101.)

64. Groves reviewed numerous TVA findings and reports regarding the groundwater and/or geology around the Gallatin Plant, including reports from 1982, 1987, 1989, 1992, 1999, 2002, and 2009. (Id. at ¶ 68.) He testified that many of the reports reached conclusions supportive of or similar to his own. (Id. at ¶ 69.) For example, the "1982 Groundwater Report" stated, "In the vicinity of Gallatin Steam Plant, most of the surface streams flow a short distance across the ground, then disappear into sinkholes and drain into underground channels in the limestone bedrock." (J. Ex. 44 at 35.)

65. The 1982 Groundwater Report also states that "[w]ater-table elevations are probably within the ash disposal pond." (J. Ex. 44 at 35.)

66. The 1987 Groundwater Report similarly acknowledges that the "[w]ater table is believed to be within the waste pond." (J. Ex. 45 at 27).

67. Groves' review showed that during the early years of the Ash Pond Complex's operation, as TVA does not appear to dispute, the complex suffered significant leakage through hydrological connections to the Cumberland River. (Doc. No. 227-1 (Groves Wr. Test.) at ¶¶ 74–79.) By Groves' estimate, between April 1970 and December 1978, approximately 27 billion gallons of coal ash wastewater flowed directly from the Ash Pond Complex into the karst aquifer and then into the Cumberland. (Id. at ¶ 79.)

68. Based on his review of TVA studies, Groves believed that this early leakage was occurring through some number of sinkholes—variously reported from between 59, 101, and 111—but that TVA had ultimately been unable to identify the actual number of sinkholes that were leaking. (Id. at ¶ 86.)

69. In 1977, a TVA research engineer produced a report titled "Magnitude of Ash Disposal Pond Leakage Problem—Gallatin Steam Plant" ("1977 Leakage Memorandum"), which discussed TVA's understanding, at the time, of the leakage from the pond. (J. Ex. 41.) The 1977 Leakage Memorandum explains:

> The actual number of sinkholes which are presently leaking to the subsurface cannot be determined without extensive field studies . . . . Based on examination of topography of the pond which was taken in 1952 (before the impoundment of Old Hickory Lake), 1963 and 1977, several sink holes were wet weather ponds or were termination points for streams that flowed into the area now covered by the pond. Therefore it is likely that several sink holes in the present ash disposal pond leak to the subsurface.
>
> If the present leaks from the pond were plugged and the water level in the pond rose to the elevation of the outfall weir, one or more of another 52 sink holes could begin to leak. In addition, sink holes which are not presently leaking could begin to leak because of increased hydrostatic pressure.

> From the previous discussion, it can be concluded that the network of solution cavities and crevices in the groundwater system under the pond is extensive. Therefore, identification of the sink holes which presently leak to this system would require extensive field studies. In addition, plugging the presently leaking sinkholes would give no assurance that other sink holes would not begin to leak, as previously discussed.

(Id. at TVGF_008091–92.)

70. Groves described steps taken to repair the Ash Pond Complex after its early leakage. As Groves described it, some sinkholes under the Ash Pond Complex were plugged, which caused the water level to rise to the outfall. The water rising, however, did not demonstrate that all leaks had been eliminated. The water level rising only meant that the inflow rate into the ponds exceeded the outflow rate. That outflow rate could still have included outflow through karst drainage. (Doc. No. 227-1 (Groves Wr. Test.) at ¶ 89.)

71. TVA's 1992 Groundwater Report echoes the conclusion that rising waters show only a reduction, not necessarily an elimination, of leakage: "Following the plugging of several sinkholes in the northwest end of the pond in 1978, the leakage rate was reduced and a point source discharge was established at the pond outfall." (J. Ex. 47 at 5.)

72. Based on his review and the foregoing, Groves opined that most of the conduits below the Ash Pond Complex were never plugged or repaired and that, accordingly, coal ash waste is still within the groundwater and likely still flowing into the river. That drainage, however, cannot be directly seen because it is obscured by the coal ash waste itself. (Doc. No. 227-1 (Groves Wr. Test.) at ¶ 90.)

73. Groves' expert opinion was that, given the hydrogeological conditions of Odom's Bend, the evidence of leakage into the Cumberland River, and that groundwater on Odom's Bend Peninsula is expected to flow into the Cumberland River, any suggestion that coal ash waste water

is not currently going to the Cumberland River, or is going anywhere other than the Cumberland River, is implausible. (Id. at ¶ 102.)

74. Groves performed an analysis based on historical groundwater flow reports and maps, as well as evidence from nearby ground wells, purporting to demonstrate that there is a major conduit and underground river parallel to, and north of, the axis of the Ash Pond Complex, likely terminating at a flow outlet into the Cumberland River. (Id. at ¶¶ 116–26.)

75. Groves also opined that dewatering and capping the ash disposal areas without a liner will not prevent contamination of groundwater or the Cumberland River by coal ash waste, because such steps would not eliminate ongoing drainage through karst features. (Id. at ¶ 132.)

76. On cross examination, Groves admitted that he had never personally been on the site of the Gallatin Plant. (Doc. No. 234 (Tr. Day 1) at 53.)

77. Groves further conceded that, in some portions of the Ash Pond Complex, there was a layer of clay between the ash and the karst underneath. (Id. at 65.)

78. TVA pointed out that a 2010 report created for TVA by Stantec Consulting Services Inc. ("2010 Stantec Report") (J. Ex. 67) included the statement that "[t]he thickness of the native soils above the bedrock across the pond complex range from as little as about one foot or less to as much as twenty feet." (Doc. No. 234 (Tr. Day 1) at 66–67.) Groves acknowledged the statement in the Report, but argued that it was inconsistent with the Report's own data, which showed that there were some places in the Ash Pond Complex where waste was in direct contact with bare rock. (Id. at 67.) TVA also pointed out select borings that showed substantial clay cover at specific locations in the Ash Pond Complex. (Id. at 67-69.)

79. The 2010 Stantec Report also states that the Gallatin Plant "ha[d] not experienced any known . . . karst-related problems within the ponds in recent years" other than the following: an

area designated for the expansion of Pond E contained known sinkholes, which were mitigated during construction; a recent rain event had revealed a sinkhole to the north of Pond C; and in 1990, a sinkhole that had previously been isolated by a dike was repaired. (Id. at 70; J. Ex. 67 at 8.)

80. TVA's cross examination also established that there are a number of techniques and mechanisms for identifying the relevant hydrogeology in karst systems that Groves, who relied primarily on historical documentation, did not rely on in this case. (Doc. No. 234 (Tr. Day 1) at 81–86.) On re-direct, Groves explained that he was confident in his conclusions despite not having used such methods. (Id. at 101.)

81. Finally, Groves admitted that the Non-Registered site was not located atop karst features, but rather alluvial deposits, defined as "unconsolidated sediment that has been deposited by a surface stream or river." (Id. at 55–57.)

82. Based on its direct observation of Groves' demeanor, candor, and responsiveness, the Court found Groves to be generally credible. The Court did, however, evaluate Groves' opinions in the context of his having been retained by the Plaintiffs. His opinions, moreover, were rendered somewhat less persuasive because they were based primarily on his review of past literature and general understanding of karst terrains, rather than direct analysis of the coal ash disposal areas themselves. That deficiency, though relevant to the weight of his testimony, did not wholly negate its persuasive and explanatory value.

2. Testimony of Mark Quarles

83. Mark Quarles is a Tennessee-licensed professional geologist with a B.S. degree in Environmental Engineering Technology from WKU. He characterizes himself as a "[p]ublic interest environmental consultant." Quarles testified that he has approximately thirty years of

experience as an environmental consultant, including a substantial amount of experience consulting for industrial sector clients. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶¶ 1, 3, 5.)

84. Quarles' consulting company, Global Environmental, LLC, ("Global Environmental") was retained by Plaintiffs to evaluate the conditions of the Gallatin Plant. (Id. at ¶ 1.)

85. Quarles testified that he has been trained in and is experienced in taking samples to determine the existence of and extent of contamination. (Id. at ¶ 3.) He claimed extensive experience evaluating groundwater movement in karst environments, particularly in Middle Tennessee, including work involving sinking creeks and sinkholes. (Id. at ¶ 5.)

86. Quarles also stated that he has many years of experience conducting hydrogeological investigations related to siting and design of municipal and industrial waste landfills, developing closure plans for industrial landfills, designing and implementing groundwater monitoring programs for industrial landfills, completing investigations to define the nature and extent of industrial contamination in the environment, and completing coal combustion waste investigations. He has performed coal combustion-related investigations at over seventy sites located in twelve states. (Id. at ¶¶ 6–7.)

87. The parties have stipulated and agreed that Quarles is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

88. Quarles echoed Groves' assessment that the Sinking Creek stream valley rendered the area of the Ash Pond Complex a poor choice for the disposal of coal ash waste, due to its karst features and the connectivity of the groundwater. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶¶ 9–10.)

89. Quarles gave his opinion that both the Ash Pond Complex and the Non-Registered Site contain coal ash waste that extends below the groundwater level. (Id. at ¶ 12)

90. Quarles testified that Global Environmental was able, through visual inspection and manual probing, to identify solid coal combustion wastes several feet thick in the Cumberland River along the shoreline of both the Ash Pond Complex and the Non-Registered Site. (Id. at ¶ 18.)

91. Quarles' review of historical maps yielded conclusions similar to Groves': that the Gallatin Plan was built on an area of significant karst activity, including sinkholes and sinking streams on the Plant property. (Id. at ¶¶ 32–33.)

92. Quarles also echoed Groves' conclusion that the Ash Pond Complex was constructed over a sinking stream known as Sinking Creek. (Id. at ¶ 34.)

93. Quarles also identified a large sinkhole complex northeast of the Plant ("Neighboring Sinkhole Complex"). (Id. at ¶ 33.) Quarles opined that, because the Neighboring Sinkhole Complex does not have an obvious resurgence point where any flows reach the ground surface or discharge into a surface water stream, the Neighboring Sinkhole Complex may be connected by groundwater to the Ash Pond Complex. (Id. at ¶ 40.)

94. Quarles discussed the larger drainage basin from which natural precipitation runoff flows through the main discharge channel from the Ash Pond Complex and into the Cumberland River. Quarles cited a 2013 TVA report (J. Ex. 71) for the conclusion that the drainage basin is approximately 4,000 acres, with surface drainage flowing from at least three miles to the North of the Gallatin Plant. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶ 41.)

95. For example, surface water overflow from the Neighboring Sinkhole Complex flows across TVA property, flows into a catch basin,[2] and discharges into the Ash Pond Complex.

[2] A catch basin is "a reservoir or well into which surface water may drain off." CATCH BASIN, Merriam-Webster Dictionary (online ed. 2017).

Quarles provided photographic evidence appearing to depict offsite drainage flowing into the Ash Pond Complex. (Id. at ¶ 43; J. Ex. 73 & 140.)

96. Global Environmental developed conceptual models for both the Non-Registered Site and the Ash Pond Complex, based on 1930 and 1952 topographic maps and the sites' pre-development ground elevations. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶ 44.) Those models were presented in the form of cross-sectional diagrams designed to demonstrate certain features of the sites and relevant hydrogeology. (J. Ex. 141 & 142.) The Court did not construe the models as presenting literal, to-scale representations of the ponds, but rather as conceptual illustrations intended to assist the Court in its understanding of Quarles' analysis.

97. Quarles testified that, although the conceptual models relied on some information from 1930 and 1952, he believed them to accurately reflect current conditions, in particular with regard to the elevation of the underlying bedrock and the level of the river. Quarles testified that he would not expect those values to have changed in the relevant intervening years. (Doc. No. 235 (Tr. Day 2) at 9–10.)

98. The conceptual model of the Ash Pond Complex depicts, among other things, waste escaping through sinkholes in the bottom of the pond into a conduit flow through the underlying limestone. The model also illustrates coal ash waste below the groundwater elevation as of May 23, 2012. (J. Ex. 141.)

99. The conceptual model of the Non-Registered Site depicts submerged coal ash waste below the groundwater level, and groundwater passing through the Site to the Cumberland River. (J. Ex. 142.)

100. Quarles' conceptual analysis concluded that the area's elevated aquifer, the hydraulic connectivity of the underlying bedrock to the Cumberland River, and the original ground

topography have resulted in solid wastes in both disposal areas that are saturated under natural groundwater and river water flow conditions. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶ 45.) Quarles testified that his review of TVA's historical studies substantiates the conclusions of his conceptual models, in particular his conclusions that ash is buried within the groundwater at both the Ash Pond Complex and the Non-Registered Site; that the groundwater is hydrologically connected to the Cumberland River; and that TVA has discharged and will continue to discharge pollutants from the waste to the river. (Id. at ¶ 61.)

101. Quarles cited the 2010 Stantec Report (J. Ex. 67) and more recent studies performed for TVA by Arcadis U.S., Inc., ("2014 Arcadis Report") (J. Ex. 59) as supporting his conclusion that both the Ash Pond Complex and Non-Registered Site contain coal combustion wastes that are saturated with water. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶¶ 71–72.) The 2010 Stantec Report based its analysis on a geotechnical exploration plan involving borings at more than thirty locations. (J. Ex. 67 at 8.) The 2014 Arcadis Report assessed the Non-Registered Site through a combination of groundwater monitoring wells, soil data, and other hydrogeologic information. (J. Ex. 59 at TVGF_004702.)

102. According to Quarles, that the Non-Registered Site still contains saturated ash forty-five years after waste placement ended demonstrates that groundwater continues to recharge the wastes from topographically and hydraulically upgradient areas that flow into the wastes. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶ 121.)

103. According to Quarles, Arcadis concluded that contaminated groundwater discharges into the Cumberland River along the Non-Registered Site shoreline. (Id. at ¶ 100.)

104. The 2014 Arcadis Report includes a figure titled "Site-Wide Potentiometric Contours" that depicts the "Inferred Flow Direction" of groundwater on Odom's Bend Peninsula.

(Id. at ¶ 74 (citing J. Ex. 59 at TVGF_004759 (Fig. 7)).) The figure depicts water flowing from a high point in the center-east of the peninsula toward the river, including passage through both the Ash Pond Complex and the Non-Registered Site areas. The groundwater flows depicted include the flow of water through the Ash Pond Complex area toward a location near or upstream from the sediment sampling locations identified below as East Side 1 and East Side 2. (J. Ex. 59 at TVGF_004759 (Fig. 7).) Groundwater is also depicted as flowing through the Non-Registered Site in the direction of points near or upstream from the sediment sampling locations identified below as NRS 1 through NRS 6. (Id.)

105. Quarles also summarized the 2014 Arcadis Report's conclusions regarding the Non-Registered Site. Quarles interpreted the Report as concluding that coal ash waste constituents, often in high concentrations, remain in the Non-Registered Site, migrating towards and beneath the main channel of the Cumberland River. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶¶ 80–81.)

106. On cross examination, however, Quarles conceded that the 2014 Arcadis Report concluded that the uppermost groundwater at the Non-Registered Site occurred in alluvial deposits and residuum soil, not in ash. Quarles explained the conflict between his analysis and Arcadis's as a result of Arcadis having relied on wells around the perimeter of the area, whereas his model relied on wells and borings through the ash. (Doc. No. 234 (Tr. Day 1) at 197–98.)

107. Quarles also conceded that the 2010 Stantec Report had stated that the Plant "ha[d] not experienced any known additional karst-related problems in recent years." (Id. at 200.)

108. Quarles identified a March 2015 PowerPoint presentation by TVA contractor AECOM stating that "[a] portion of the ash [in Ash Pond E] is below (up to 10 feet below) the elevation of the Cumberland River." (Doc. No. 227-2 (Quarles Wr. Test.) at ¶ 73 (citing J. Ex. 113 at 7).) The presentation also acknowledges the possibility that the Pond could be hydrologically

connected to the river, and specifically cites the possibility of karst activity, including sinkholes. According to the slide, if the Pond is hydrologically connected to the river, it would be effectively impossible to wholly dewater the Pond due to that connection. (J. Ex. 113 at 7.)

109. Quarles evaluated TVA's groundwater monitoring program. Although he identified a number of what he considered deficiencies in the program, he nevertheless concluded that TVA's monitoring had demonstrated/corroborated contamination of the groundwater with coal ash waste. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶¶ 83–98.)

110. Quarles and Global Environmental also conducted a field investigation, with the cooperation of Barry Sulkin and others. (Id. at ¶ 46.) Quarles and others inspected the shoreline of the Cumberland River along the Gallatin Plant peninsula, looking for signs of coal and coal combustion waste, targeting portions of the shoreline that were (1) hydraulically downgradient of groundwater flow from ash disposal areas; (2) along bedrock joint trend lines that could be preferential groundwater flow pathways; (3) former valleys and hollows that are now fully or partially submerged by the impounded Cumberland River; and/or (4) areas of past impoundment dike failures. (Id.)

111. Global Environmental performed boat-based inspections of identified target sites, including sediment and water sampling, in October 2014 and August 2015. Quarles testified chiefly about the sediment sampling, leaving Barry Sulkin to discuss the water sampling. (Id. at ¶ 50.)

112. Quarles identified fourteen sampling locations, which he characterized as follows:

- **East Side 1**—We observed a diffuse flow spring located on the eastern peninsula at a public boat ramp along the shoreline of the Cumberland River. This site is hydraulically downgradient of the eastern portion of Ash Pond A and along the secondary bedrock joint pattern, and is located in a pre-impoundment valley. The sample was collected from an opening in a submerged channel in fill material.

- **East Side 2**—We observed a diffuse flow spring also located on the eastern peninsula at the shoreline of the Cumberland River. This site is downgradient of the northeastern portion of Ash Pond A along the secondary bedrock joint pattern and is in the vicinity of former (apparently closed or no longer sampled) well GAF 13—a well with demonstrated coal combustion waste constituents and up to 2,100 mg/L sulfate. The sample was collected where the spring flows into the river.

- **Barton's Creek Reference**—This sample site is located off TVA property south of the Cumberland River along the shoreline of Barton's Creek, an upstream tributary of the Cumberland River. The shoreline sediment sample was collected at the Barton's Creek Boat Ramp, a public boat ramp on the tributary to Old Hickory Lake, located off of Coles Ferry Pike.

- **NRS 4**—This shoreline sediment sample was collected from the small southerly embayment adjacent to the NRS. It was collected outside of the submerged zone but below the high water mark of the river and within approximately 1 foot of the waterline of the Cumberland River.

- **NRS 3**—This submerged sediment sample was collected approximately 50 feet from the shoreline (approximately 3-foot water depth) from the same southerly embayment adjacent to the NRS. It consisted of an undetermined mixture of black sludge-like material and mud sediments that was at least 2 feet thick.

- **NRS 2**—This shoreline sample was collected from the southerly embayment adjacent to the NRS, but from the area nearest well 27. It consisted of a coarse, reddish-brown to black, clayey sand. It was collected outside of the submerged zone but below the high water mark and within 1 foot of the waterline of the Cumberland River.

- **NRS 1**—This submerged sample (approximately 3-foot water depth) was collected in the northerly embayment adjacent to the NRS, located approximately 10 feet from the shoreline. Consisted of an undetermined mixture of black sludge-like material and mud sediments that was at least 2 feet thick.

- **APC 1**—This western shoreline sample was collected adjacent to a rip-rap[3] repair of Ash Pond E. It was collected outside of the submerged zone but below the high water mark of the Cumberland River.

- **APC 4**—This submerged sample (approximately 3-foot water depth) was collected approximately 75 feet from the shoreline adjacent to Ash Pond E. It consisted of black sludge-like material that was at least 2 feet thick.

[3] "Rip-rap" or "riprap" is "a foundation or sustaining wall of stones or chunks of concrete thrown together without order (as in deep water)." RIPRAP, Merriam-Webster Dictionary (online ed. 2017).

- **NRS 5**—This submerged sample (approximately 3-foot water depth) was collected from the northerly embayment near "NRS 1" sample. It is located approximately 60 feet from the shoreline near the barge unloaded conveyor belt. The sample consisted of black sludge-like material.

- **NRS 6**—This submerged sediment sample was collected approximately 20 feet from the shoreline (approximately 1.5 foot water depth) of the NRS. It consisted of a black sludge-like material that was at least 4 feet thick.

- **APC 2**—This submerged sediment sample was collected approximately 40 feet from the shoreline of the Ash Pond Complex (approximately 3 to 4 feet of water). It consisted of a black sludge-like material that was approximately 2 feet thick.

- **NRS 1a**—This submerged sediment sample was collected approximately 50 feet from the eastern shoreline (approximately 3 to 4 feet of water) of the northwest corner of the NRS and south of the Ash Pond Complex barge conveyor. It consisted of a black sludge-like material that was at least 2 feet thick.

- **NRS 4a**—This submerged sediment sample was collected from the small embayment along the south end of the NRS (approximately 1.5 feet of water). It consisted of black sludge-like material that was mixed with tan silt. The black sludge was at least 2 feet thick.

(Id. at ¶ 51.) The locations of the sampling sites were identified for the Court on the Agreed Map filed by the parties for use at trial, as were the locations of the ten seeps referred to in the complaint in the State Enforcement Action. (Doc. No. 220-1.) APC 1, APC 2, and APC 4 were in the general vicinity of two seeps at issue in the State Enforcement Action. (Id.)

113. The samples were analyzed for constituents considered to be good indicators of the presence of coal ash waste. Quarles conceded that the sampling program was designed to identify the presence of contamination, not to measure the extent of that contamination. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶ 55.)

114. Quarles testified that constituents that are commonly associated with coal combustion wastes were detected in all solid waste and sediment samples that were collected from the eastern, southern, and western portions of the peninsula. Those indicators included silicon, boron,

manganese, sulfate, iron, aluminum, barium, calcium, chromium, strontium, arsenic, chloride, cobalt, lithium, selenium, sodium, and sulfur. (Id. at ¶ 57.)

115. By way of example, East Side 1—located to the east of Ash Ponds A and B, not in the vicinity of any of the ten seeps mentioned in Tennessee's State Enforcement Action complaint—exhibited what Quarles identified as elevated levels of aluminum, barium, boron, lithium, sodium, strontium, and sulfur. Among other chemicals, East Side 1 showed a boron concentration of 52 mg/kg, whereas the Bartons Creek Reference sample showed a boron concentration of <1.3 mg/kg. (Id. at ¶ 58.)

116. East Side 2—located downstream from East Side 1 and to the southeast of Ash Pond A, not in the vicinity of any of the ten seeps mentioned in Tennessee's State Enforcement Action complaint—exhibited what Quarles identified as elevated levels of aluminum, barium, boron, chromium, iron, lithium, manganese, and strontium. For example, the Bartons Creek Reference sample showed a manganese concentration of 360 mg/kg, whereas East Side 2 showed a manganese concentration of 700 mg/kg. (Id.)

117. NRS 4—located immediately adjacent to the Non-Registered Site, not in the vicinity of any seep mentioned in the State Enforcement Action complaint—exhibited what Quarles identified as elevated levels of arsenic, barium, boron, iron, sulfur, and sulfate. For example, the Bartons Creek Reference sample showed an iron concentration of 26,000 mg/kg, whereas NRS 4 showed an iron concentration of 230,000 mg/kg. (Id.)

118. The other sampling locations similarly showed what Quarles identified as elevated levels of chemicals tending to indicate the presence of coal ash waste. The particular chemicals present in elevated levels and not present in elevated levels varied from location to location. (Id.) Boron, however, was present at elevated levels in all of the Gallatin Plant shoreline sediment

samples, but was virtually nonexistent in the Bartons Creek Reference sample. Arsenic concentrations from the TVA shoreline samples were higher than the reference sample in over two-thirds of the on-site sediment samples. (Id. at ¶ 59.)

119. Sulfate concentrations from TVA shoreline samples were, in some instances, up to 180 times higher than the reference sample. Sulfur concentrations from TVA shoreline samples were, in some instances, up to 15 times higher than the reference sample. Iron concentrations from TVA shoreline samples were, in some instances, up to 10 times higher than the reference sample. (Id.)

120. Quarles also presented February 2015 aerial photography depicting reddish-brown coloration in the Cumberland River adjacent to the Non-Registered Site. Quarles testified that such coloration can be indicative of coal combustion waste contaminants. (Id. at ¶ 49 & J. Ex. 78.)

121. Quarles concluded, based on the sediment sampling, that coal ash waste has been released from the Gallatin Plant at areas adjacent to both the Ash Pond Complex and the Non-Registered Site. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶ 60.)

122. Quarles testified that he had reviewed and agreed with the written testimony of Groves and Sulkin. (Doc. No. 235 (Tr. Day 2) at 7.).

123. On cross examination, Quarles conceded that his sampling could not determine how long the materials he obtained had been in the river or how they reached the river. (Doc. No. 234 (Tr. Day 1) at 186.)

124. Quarles also conceded that the flows he observed at East Side 1 and 2 were exiting to the river through porous soil, as opposed to a bedrock conduit visible from his vantage point. (Id. at 186−87.) He further conceded that he had previously referred to those locations as "seeps." (Id. at 187−88.)

125. Regarding the Non-Registered Site, Quarles conceded that sampling locations NRS 2 and 6 were in the vicinity of a documented 1974 escape of coal ash. (Id. at 191.)

126. TVA also directed Quarles to a 1978 TVA memorandum discussing the repairs to the leaking Ash Pond Complex, which stated, "No correlation between the [water] levels or with rainfall could be found since early June 1978, apparently indicating that no hydraulic connection between the pond and the river presently exists. Similar data obtained for August 1977 (prior to the repair work) showed a strong correlation between pond and lake water levels." (J. Ex. 89 at TVA_GAF_0011333.) Quarles conceded that he did not include that conclusion in his testimony. (Doc. No. 234 (Tr. Day 1) at 207.).

127. Similarly, a 1979 letter from the Director of Power Production for either TVA or the Plant, describing the 1978 repairs, claimed that "all the holes or low areas where leakage might be suspected were filled with either rock and clay or coarse ash or a combination of these materials," and that ultimately "the progressive rising of the water . . . leads us to believe the complete sealing of the pond has been achieved." (J. Ex. 88 at TVA_GAF_0011330.) The same letter did, however, acknowledge the need to "closely watch the pond for any signs of further leakage." (Id. at TVA_GAF_0011331.) Quarles conceded that he did not acknowledge the letter's assessment in his testimony. (Doc. No. 234 (Tr. Day 1) at 207.). On re-direct, he went into more detail and echoed Groves' assessment that the 1978 repairs would have been inadequate to prevent additional sinkholes from forming. He also suggested that water could potentially bypass the repairs. (Doc. No. 235 (Tr. Day 2) at 20–21.).

128. Finally, Quarles conceded that he had, in the past, used derogatory language to refer to TVA and its attitude toward its environmental stewardship, including characterizing one TVA statement as suggesting TVA personnel were "[e]ither . . . idiots or . . . lying." (Doc. No. 234 (Tr.

Day 1) at 214.) TVA also sought to undermine Quarles' credibility with citation to details surrounding other litigation in which he was involved, but, without sufficient context, the Court was unable to give significant weight to that evidence. (Id. at 220–28.)

129. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Quarles to possess some credibility, albeit with the caveats that (1) the Court considered his opinions in the context of his having been retained by Plaintiffs in this matter, and (2) the Court acknowledges Quarles' apparent history of frustrations with and hostility toward TVA. The Court also notes that TVA demonstrated that Quarles' testimony failed to cite some aspects of TVA's historical studies and records that could be read as undermining aspects of his conclusions. Quarles' omissions, though relevant to the credibility and completeness of his opinions, did not wholly undermine his conclusions. Given the extensive nature of TVA's historical documentation, it is not necessarily fatal that his analysis failed to include all relevant citations.

130. TVA did not significantly undermine or contradict Quarles' testimony that his sediment tests established the presence of heightened concentrations of chemicals associated with coal ash waste.

3. Testimony of Vojin Janjic

131. Vojin Janjic is a manager of the water-based systems unit of TDEC. Janjic's responsibilities include overseeing the preparation and review of NPDES permits. (Doc. No. 235 (Tr. Day 2) at 30–31.).

132. Janjic received his chemical engineering degree from the University of Belgrade before studying environmental and water resources at Vanderbilt University. After completing his education, Janjic began work at TDEC, where he did field work for four years before moving to the agency's central office. (Id. at 31.)

133. Janjic testified that he has been involved in the evaluation and issuance of thousands of NPDES permits. (Id. at 33.)

134. Janjic described the permitting process for NPDES permits issued to individual permittees. The applicant first submits an application based on EPA-designed forms providing the required information to begin the permit application process. TDEC then prepares a draft permit, which it publishes publicly for comments. A permit is accompanied by a permit rationale, a separate document that explains TDEC's process and reasoning for the terms of the permit. If there are public comments in response to the draft permit, TDEC issues an addendum to rationale, which summarizes and responds to the comments, and makes any permit revisions that it deems necessary or justified based on the comments. (Id. at 33–34.)

135. Janjic testified that the rationale and addendum to rationale do not modify the terms of the permit. Rather, they merely describe the process and basis for the permit. (Id. at 35.) On cross examination, in particular, Janjic repeatedly stressed that the addendum to rationale was distinct from the permit and was not itself an "enforceable" legal document, but rather merely an explanation of the reasoning and process behind the actually enforceable terms of the permit. (Id. at 56.)

136. The Gallatin Plant's most recent NPDES Permit went into effect on July 1, 2012, and was set to expire on May 31, 2017. (J. Ex. 102 at 001.) Its previous permit had gone into effect on January 1, 2006, and was set to expire on November 29, 2009 (J. Ex. 136 at TSRA-GAF011526), but the terms of the permit were administratively continued from November 29, 2009, until the effective date of the 2012 permit (Doc. No. 235 (Tr. Day 2) at 38).

137. Janjic was involved in reviewing TVA's permit renewal application for the Gallatin Plant, as well as drafting the permit itself. (Id. at 36.)

138. Janjic described generally the waste treatment anticipated to be performed at the Ash Pond Complex under the permit. Water mixed with coal ash waste is sluiced to the Complex. As it passes through the Complex, a process of settling occurs, whereby coal ash constituents settle out of the water. Finally, water is released at Outfall 001—the only outfall identified by the NPDES permit as being authorized for the discharge of coal ash wastewater. (Id. at 39–40.) Neither the 2012 nor the 2005 version of the permit authorizes discharge of coal ash wastewater from anywhere other than Outfall 001. (Id. at 41–42, 48.)

139. It is undisputed that the leaks and seeps at issue in this case are not discharges from Outfall 001.

140. Janjic was asked how, if at all, the 2012 permit addresses the issue of seeps. Janjic pointed to a section of the permit labeled "Other Requirements," and its subsection labeled "Dike Inspections." (J. Ex. 102 at 025.) That subsection requires daily inspections including "observations of dams, dikes, and toe areas for obvious changes in erosion, cracks, or bulges, subsidence, seepage, wet or soft soil, changes in geometry, the depth in the elevation of the impounded water, sediment or slurry, freeboard, changes in vegetation such as overly lush, obstructive vegetation and trees, outlet controls, drains, and any other further changes which may indicate a potential compromise to impoundment integrity." (Id. at 026.) Janjic characterized this requirement as at least in part directed toward identifying and addressing seeps. He explained that seeps raise two sets of concerns: first, that they could signify a compromise of the structural integrity of the impoundment; and second, that the seeps themselves could negatively affect water quality. (Doc. No. 235 (Tr. Day 2) at 43−45.)

141. The 2012 permit requires TVA to begin remediation procedures within twenty-four hours of discovering changes that indicate a potential compromise of the structural integrity of the impoundment. (J. Ex. 102 at 026.)

142. The 2006 permit was less demanding with regard to self-inspection, requiring TVA only to visually inspect the dikes for seepage on at least a quarterly basis. (J. Ex. 136 at TSRA-GAF011550.)

143. Janjic was asked whether he considered either permit to authorize discharges from seeps. He responded first that the permit speaks for itself, but added that the permits do not permit any "discharges from seeps that would be discernible flow of water." (Doc. No. 235 (Tr. Day 2) at 46–48.)

144. Janjic did testify, however, that "[e]very impoundment that is not [a] lined impoundment is going to have a certain amount of seepage . . . . So we realize that any earthen impoundment[s] are going to have a certain amount of seepage." Janjic added, though, that "that seepage per se is not authorized or identified in an NPDES permit." (Id. at 48.)

145. On cross examination, Janjic confirmed that, when the 2012 permit was issued, TDEC was aware that the Ash Pond Complex experienced seeps. (Id. at 55.)

146. Janjic testified that the anticipated seepage to which he referred did not include flows through sinkholes and fissures. (Id. at 49.) He testified that the seepage foreseen at the time of the 2012 permit's issuance was de minimis, with inconsequential impacts. (Id. at 62.)

147. Janjic was asked about Part I.A(c) of the 2012 permit, which addresses removal of sludge or other materials removed from treatment works. (J. Ex. 102 at 011.) He confirmed that the "sludge" referred to included coal ash that settled as part of the ash pond process, and that the 2006 permit contained a similar provision. (Doc. No. 235 (Tr. Day 2) at 49–50.)

148. Janjic was next asked about the sanitary sewer overflow provision of the 2012 permit, Part II.C(3.b). (J. Ex. 102 at 022.) Janjic explained that, in the context of the Gallatin Plant, that provision referred to "any wastewater at the facility that is authorized by this permit." (Doc. No. 235 (Tr. Day 2) at 51–52.) He conceded that the definition of the term as used in the Gallatin Plant's permit differs from the definition used in the EPA's NPDES Permit Writers' Manual (J. Ex. 251), which is narrower. (Doc. No. 235 (Tr. Day 2) at 265.)

149. On cross examination, Janjic was asked about the Non-Registered Site. Janjic testified that the Non-Registered Site and the closed ash disposal area therein are "not a part of the NPDES permit." (Id. at 57.) He agreed, though, that if the Non-Registered Site hypothetically discharged pollutants into navigable waters, that discharge would need to be authorized by TDEC. (Id. at 57–58.)

150. The 2012 addendum to rationale, in response to a comment, states, "Seepage is more similar to a nonpoint source discharge, as it is diffused over a wide area." It is difficult to tell from the statement whether TDEC is referring to seepage from the Ash Pond Complex, seepage from the Non-Registered Site, or seepage generally. (J. Ex. 102 at 048.)

151. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Janjic to be credible and to credibly present his understanding of TVA's permits and the permitting process.

4. Testimony of Barry Sulkin

152. Barry Sulkin is a self-employed environmental consultant. He holds a B.A. from the University of Virginia with a major in Environmental Science, and an M.S. in Environmental Engineering from Vanderbilt University. Sulkin has worked as a consultant for over twenty-five years, prior to which he held several positions at the Tennessee Department of Health and

Environment (now TDEC), including statewide manager of enforcement investigations for the Division of Water Pollution Control. (Doc. No. 161-1 (Sulkin CV) at 1–3.) He has amassed numerous publications on topics related to water pollution. (Id. at 5–9.)

153. Sulkin testified that he has significant experience and expertise in collecting and evaluating water samples. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶¶ 11–12.)

154. He also has significant training and experience related to the NPDES permitting system. (Id. at ¶¶ 13−14.)

155. Sulkin was retained by Plaintiffs to perform water and sediment sampling, as well as provide his opinion, in this case. (Id. at ¶ 1.)

156. The parties have stipulated and agreed that Sulkin is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

157. Sulkin took part in the collection of water and sediment samples on various dates from May 7, 2014, to August 3, 2016. He testified that all samples were collected in accordance with standard and customary state and EPA protocols for investigating leaking waste or unpermitted discharges. Samples were collected in laboratory-provided containers, with supplied preservatives included as specified by the lab. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶¶ 18–19.)

158. The purpose of Sulkin's sampling was to identify the existence and composition of leaks—not, for example, to determine the ambient water quality of the Cumberland River as a whole. Accordingly, samples were taken at locations close to the suspected leaks. Sulkin identified this as the proper protocol for his stated objective. (Id. at ¶ 21.)

159. Sampling locations were identified by analysis of historic maps and drainage patterns, as well as visual observations and conductivity readings. Conductivity—that is, the ability of water

to pass an electrical current—is an indication of mineral or pollutant content of water, and commonly used as a reliable scientific method to identify potential areas of contamination such as from the ash disposal areas. Sulkin described the visual observations that led to sampling as the presence of an observable flowing discharge, wet soil, and discolored water or sediment. (Id. at ¶¶ 33–36.)

160. Sulkin testified that background or uncontaminated areas generally have conductivity in the range of 50 to 250 µS/cm,[4] while water contaminated by an ash waste discharge would have conductivity of greater levels. (Id. at ¶ 38.)

161. Sulkin's characterization of the relationship between an NPDES permit and its rationale mirrored Janjic's: in particular, that the permit is binding and not modified by the rationale. (Id. at ¶ 61.)

162. Sulkin first discussed sampling he performed at locations identified as APC 1 and APC 2. APC 1 and 2 are on the western bank of the peninsula adjacent to Pond E, near two seeps identified as part of the State Enforcement Action. (Id. at ¶ 62.) Sulkin has provided a photo of APC 2 (J. Ex. 10) that he characterizes as depicting a discharge into the river. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 63.)

163. As part of his sampling, Sulkin took a baseline conductivity reading at a location across the river, away from any alleged coal ash discharges, and found a conductivity of 209 µs/cm. The conductivity at APC 1 was 768 µs/cm, and at APC 2 was 1,019 µs/cm. (Id. at ¶¶ 63–64.) Later testing showed still elevated, but lower, conductivity levels. (Id. at ¶ 65.)

[4] Microsiemens per centimeter. A Siemens is a unit of electric conductance. SIEMENS, Merriam-Webster Dictionary (online ed. 2017).

164. Eventually, after Plaintiffs filed their 60-day notice of violation in this case, TVA apparently covered the allegedly visible discharge at APC 2 with rip-rap. Sulkin's expert opinion was that this coverage did not stop the discharges, but instead merely made them harder to document and observe. (Id. at ¶¶ 66–67.) Testing showed continued elevated conductivity near the rip-rap cover. (Id. at ¶ 67.) When cross-examined about his assessment of the addition of the rip-rap, however, Sulkin conceded that he was not a professional engineer. (Doc. No. 235 (Tr. Day 2) at 122.)

165. Sulkin tested a third site in that general vicinity, APC 3. APC 3 was further from the shore and corresponded with a cloudiness and white coloration observed by Sulkin. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 65.)

166. Constituent testing from APC 1, 2, and 3 showed numerous chemicals suggestive of coal ash contamination at levels above background values, including several at APC 2 that exceeded TDEC's Domestic Water Supply Criterion. (Id. at ¶ 71; Pl. Ex. 1.) Background values were calculated using the average values of publicly available state data from two water quality monitoring stations located 19.9 miles upstream of the Gallatin Fossil Plant. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 71.) TDEC has conducted regular testing to determine the ambient water quality of the Cumberland River, including the Old Hickory Lake area. (Id. at ¶ 41.)

167. A May 7, 2014 sample from APC 1 showed the following contaminants at levels elevated compared to background: chloride, cobalt, iron, manganese, nickel, sulfate, and vanadium. An APC 2 sample from the same date showed elevated levels of chloride, cobalt, iron, manganese, nickel, and sulfate. (Id. at ¶ 74.)

168. An August 25, 2014 sample from APC 2 showed even greater evidence of contamination, with elevated levels of aluminum, arsenic, barium, cadmium, calcium, chloride,

chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, selenium, sodium, sulfate, thallium, vanadium, and zinc. Of these, arsenic, barium, cadmium, lead, nickel, selenium, and thallium all exceeded TDEC's Domestic Water Supply Criterion. (Id. at ¶¶ 76–77.)

169. For example, water upstream from the plant showed an average arsenic concentration of 0.00045 mg/L. The Domestic Water Supply Criterion for arsenic is 0.01 mg/L. Sampling at APC 2 on August 25, 2014, showed arsenic at a concentration of 0.13 mg/L, thirteen times the criterion level. (Pl. Ex. 1.)

170. At sample location APC 3 on August 25, 2014, the following parameters exceeded background levels: aluminum, arsenic, barium, cadmium, chloride, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, sodium, sulfate, and zinc. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 78.)

171. Most recently, on August 3, 2016, a sample collected adjacent to the rip-rap that had been placed over top of the visible discharge identified as location APC 2 contained the following parameters above background: aluminum, antimony, arsenic, barium, calcium, chloride, cobalt, copper, iron, lead, manganese, nickel, sodium, sulfate, vanadium, and zinc. (Id. at ¶ 79.)

172. Samples taken from East Side 1 and East Side 2 also showed elevated levels of several contaminants. An August 25, 2014 sample from East Side 1 showed concentrations of the following contaminants in excess of the average upstream background levels: aluminum, arsenic, barium, calcium, chloride, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, sodium, sulfate, vanadium, and zinc. Compared to background levels, a sample taken from East Side 2 on the same date showed elevated levels of arsenic, calcium, chloride, manganese, and molybdenum. (Pl. Ex. 1.)

173. For example, the East Side 1 sample showed an arsenic concentration of 0.0019 mg/L, over four times the background average of 0.00045 mg/L. The East Side 2 sample showed an arsenic concentration of 0.001 mg/L, over twice the average upstream level. (Id.)

174. Sulkin testified that, in his expert opinion, the surface water samples and the sediment samples from the waters adjacent to the Ash Pond Complex demonstrate continuing leakage from the ash storage facilities at the Ash Pond Complex. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 83.)

175. He also testified that, in his expert opinion, this leakage is not the result of a slow seep from the walls of the ash ponds, but rather is the continuing flow of drainage and waste water through the natural drainage channel of Sinking Creek and outlets of the former Sinking Creek embayment of the lake, as well as through discharge of contaminated groundwater to the river. (Id. at ¶ 84.) On cross examination, however, Sulkin conceded that he was not a geologist or expert on karst. (Doc. No. 235 (Tr. Day 2) at 112.)

176. Sulkin testified that he considered the leaks from the Gallatin Plant's coal ash storage facilities to be a significant threat to public drinking water, because there is a drinking water facility a mile and a half down river from the Plant. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 86.) He also testified that the Old Hickory Lake area is heavily used for recreation. (Id. at ¶ 40.)

177. In addition to the sampling from the Cumberland River, Sulkin reviewed groundwater monitoring reports from four groundwater monitoring wells in the vicinity of the Ash Pond Complex, identified as wells 17, 23, 24, and 25. (Id. at ¶ 92.) Sulkin testified that, based on TVA's reports, all four of these wells are downgradient of the groundwater flow from the Ash Pond Complex. (Id. at ¶ 94.)

178. Sulkin testified that TVA's historical groundwater monitoring data showed elevated levels of several chemical indicators in each of the wells. (Id. at ¶¶ 94–97; see Pl. Ex. 2.)

179. Sulkin, TVA, and TDEC took part in joint sampling of the wells in July and September of 2015. This testing also showed elevated contaminant levels that, in Sulkin's opinion, were indicative of groundwater contamination. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 98; see Pl. Ex. 3.)

180. Data from offsite drinking wells was, in Sulkin's analysis, similarly corroborative of groundwater contamination. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶¶ 103–08; see Pl. Ex. 3.)

181. Like Quarles, Sulkin testified that aerial photography of the Cumberland River near the Non-Registered Site showed coloration indicative of coal ash contamination. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 115.)

182. In February of 2015, Sulkin performed water and sediment sampling at NRS 1 and NRS 4, adjacent to the Non-Registered Site. He sampled NRS 4 and NRS 6 in August of 2016. (Pl. Ex. 1.) Sulkin compared the constituent levels in the water samples to the same upstream values he used for his analysis of the samples taken from adjacent to the Ash Pond Complex. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 122.)

183. NRS 1, 4, and 6 all had several contaminants in concentrations greater than the upstream average. The 2015 NRS 4 sample also had lead in a concentration exceeding the domestic water supply criterion. (J. Ex. 1.)

184. The 2015 NRS 4 sample showed the following contaminants at levels above the comparison level: aluminum, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, sodium, sulfate, vanadium, and zinc. The sample level for aluminum was 10 mg/L—100 times the average background level. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 124.)

185. A 2016 NRS 4 sample showed the following contaminants at levels above the comparison level: aluminum, antimony, calcium, cobalt, copper, iron, magnesium, manganese, nickel, selenium, sulfate, and zinc. (Id. at ¶ 125.)

186. The 2016 NRS 6 sample showed the following contaminants at levels above the comparison level: aluminum, antimony, arsenic, barium, calcium, copper, iron, manganese, vanadium, and zinc. (Id. at ¶ 126.) Sulkin also examined material from the river bottom at NRS 6 with a microscope. He observed cenospheres, which he testified demonstrated the presence of coal ash in the river. (Id. at ¶¶ 129−30.) On cross examination, however, Sulkin conceded that he had offered no opinion with regard to when that ash was deposited. (Doc. No. 235 (Tr. Day 2) at 115.)

187. Sulkin's expert opinion was that the elevated contaminant levels in the River adjacent to the Non-Registered Site were the result of continuing discharge of contaminated groundwater into the river or of possible direct discharge into the Cumberland River from the Site. (Doc. No. 227-3 (Sulkin Wr. Test.) at ¶ 144.)

188. Sulkin also reviewed TVA's groundwater monitoring data for the area surrounding the Non-Registered Site and took part in further groundwater sampling. The sampling found a number of contaminants in levels higher than TVA's comparison wells. (Id. at ¶¶ 138–39.)

189. Sulkin's expert opinion was that the elevated contaminant levels in the groundwater surrounding the Non-Registered Site were the result of leaks and discharges from the unlined sides and bottom of the Site. (Id. at ¶ 143.)

190. On cross examination, Sulkin conceded that, prior to the Court's ruling that it would not consider claims based on purely seep-based discharges, he had referred to his sampling locations as "seeps." By the time of trial, he did not use that terminology. Sulkin explained that he had been using "seep" to refer generically to discharges. (Doc. No. 235 (Tr. Day 2) at 114–15.)

Although the Court notices this discrepancy, it also notes that, prior to the Court's ruling, there had been little reason for Plaintiffs' experts to draw express distinctions between discharges that were seeps alone and those that were not. Accordingly, the Court finds Plaintiffs' experts early use of imprecise terminology relevant but not dispositive. The Court also notes that, as TVA itself has emphasized, Sulkin is not a geologist or expert in karst.

191. TVA's cross examination also focused on Sulkin's decision to use "judgmental sampling"—targeted sampling based on professional judgment—as opposed to "probabilistic sampling," which would have been more conducive to drawing broad inferences from the resultant data, such as inferences about the general ambient water quality of the river in the relevant area. Sulkin explained that he had used his professional judgment to design a sampling methodology with his particular objective—identifying discharges—in mind. (Id. at 118–20.) The Court found Sulkin's explanation convincing, but notes that that explanation does significantly limit the uses to which his sampling can be put. Because Sulkin's samples were targeted and not part of a probabilistic model, they provide only snapshots of particular moments and particular locations on the river.

192. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Sulkin to be generally credible, albeit with the caveat that the Court considered his opinions in the context of his having been retained by Plaintiffs in this matter. The Court also noted that TVA effectively demonstrated that Sulkin's sampling strategy was targeted at the narrow purpose of identifying or confirming leaks, and therefore provided limited basis for drawing conclusions about the extent or severity of the leaks, or their effect on the water quality of the river.

5. Testimony of Albert Hudson, Jr.

193. Albert Hudson, Jr., is a retired pipefitter living on Odom's Ben Road, near the Gallatin Plant. He testified that he relies on well water. Hudson testified that he was made aware that his well had become contaminated and would require filtration. (Doc. No. 235 (Tr. Day 2) at 125–30.) The Court found Hudson credible, although his testimony had minimal relevance to the contested issues in this case.

6. Testimony of Dr. Avner Vengosh

194. Dr. Avner Vengosh is a tenured professor in the Division of Earth and Ocean Sciences of the Nicholas School of Environment at Duke University, where he teaches courses including Introduction to Hydrogeology and International Water Resources. He holds a Ph.D. in Environmental Geochemistry from Australian National University and previously received M.Sc. and B.Sc. degrees from Hebrew University of Jerusalem. He serves on the editorial board of the international journal *Environmental Science and Technology* and as an associate editor of the international journal *Applied Geochemistry*. (Doc. No. 160-1 (Vengosh CV) at 1–2, 24.) Vengosh has amassed a body of honors, grants, and publications indicative of significant expertise in the fields of hydrogeology, geochemistry, and environmental science. (Id. at 2–29.)

195. Vengosh was asked by Plaintiffs to provide analysis and opinion related to this proceeding. Vengosh stated that he has never testified as an expert witness in a legal proceeding before and was not compensated for his opinions in this case. He stated that his motivation for involvement in the matter was to conduct scientific research for publication. Counsel for Plaintiffs did, however, contribute funding to Vengosh's laboratory that was used to compensate graduate students for their work under his supervision and to pay laboratory costs for the research. (Doc. No. 228-1 (Vengosh Wr. Test.) at ¶¶ 1–6.)

196. The parties have stipulated and agreed that Vengosh is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

197. Vengosh testified that it is his expert opinion, based on review of data regarding groundwater and surface water quality, on the analyses performed by his laboratory under his supervision, and on his knowledge and experience, that coal ash from both seeps and groundwater conduits has contaminated water at the Gallatin Fossil Plant and is discharging to surface water and into the groundwater at the site at locations other than Outfall 001. (Doc. No. 228-1 (Vengosh Wr. Test.) at ¶ 7.)

198. Vengosh testified that the presence of boron has been utilized in many studies as a reliable indicator of coal ash pollution. There are, however, other potential sources of boron. Accordingly, Vengosh explained, identifying coal ash contamination can be aided by identifying certain isotopic ratios that are in particular indicative of coal ash. (Id. at ¶¶ 11–22.)

199. Vengosh's laboratory has sampled coal ash effluents from ten coal fired power plants in North Carolina and Tennessee. All of the coal ash effluents exhibited elevated boron concentrations and similar ratios between the two naturally occurring stable isotopes of boron, B-10 and B-11. (Id. at ¶¶ 14, 24.)

200. Vengosh and co-authors have published their research on boron and strontium isotopic fingerprints of coal combustion residuals. (Id. at ¶¶ 27–28 & n.1.)

201. Under Vengosh's direction, a member of his laboratory collected surface water samples from the area around the Gallatin Plant in June of 2015. One groundwater sample was also collected from Hudson's private well. (Id. at ¶¶ 32–33.) A member of Vengosh's lab also trained Sulkin in taking groundwater samples, and Sulkin sent groundwater samples to Vengosh

for analysis. (Id. at ¶ 34.) All samples were analyzed at Vengosh's laboratory, under his supervision and consistently with EPA methodology. (Id. at ¶ 35.)

202. One of Vengosh's samples, which he referred to as GT-6, was in the location of East Side 2. Based on its low strontium and boron levels, as well as its boron and strontium isotopic ratios, Vengosh concluded that this sample was unimpacted by coal ash and adopted it as a reference sample. (Id. at ¶ 43.)

203. Another sample, GT-7, was in the location of East Side 1. It also had a low boron concentration, leading Vengosh to conclude that the sample showed no evidence of contamination from coal ash. (Id. at ¶ 53.)

204. Sample GT-2 was taken on the west side of the peninsula, significantly to the north of/downstream from most of the samples taken in this case, but still to the south of/upstream from Outfall 001. Its boron concentration was also low, which Vengosh concluded showed no evidence of contamination from coal ash. (Id.)

205. Vengosh's samples GT-3 and GT-4 were close to APC 1 through 4 and the two nearby seeps included in the State Enforcement Action. These samples showed very high concentrations of boron and strontium, as well as boron isotopic ratios indicating the presence of coal ash. (Id. at ¶¶ 45–46.)

206. Vengosh's sample GT-5 was collected from a discharge in the area of the Non-Registered Site, near NRS 3 and NRS 4. It showed high concentrations of boron and strontium, as well as boron and strontium isotopic ratios indicating the presence of coal ash. (Id. at ¶ 47.)

207. In addition to the elevated concentrations of boron and strontium, GT-3, GT-4, and GT-5 had relatively high levels of other elements known to be associated with coal ash, including sulfate, calcium, manganese, and iron. GT-4 was also high in arsenic. (Id. at ¶ 48.)

208. Vengosh's analysis also found elevated levels of coal ash constituents in sampled wells. (Id. at ¶ 63.) Boron concentrations and isotopic rations indicating coal ash contamination were particularly pronounced in wells associated with the Non-Registered Site. (Id. at ¶¶ 66, 70.)

209. Vengosh's results were published in an article entitled "Evidence for Coal Ash Ponds Leaking in the Southeastern United States" in the peer-reviewed journal *Environmental Science & Technology* in 2016. (Id. at ¶ 73.)

210. Based on his results, Vengosh concluded that water contaminated by coal ash from the Ash Pond Complex and the Non-Registered Site is discharging into the groundwater and surface water at the Gallatin Fossil Plant. (Id. at ¶ 100.)

211. Finally, at the direction of the Court, Vengosh testified about the natural variability of water sampling. He explained, "Every day, every minute of sampling would you get absolute different concentration. It's reflecting the different mixing relationship, mixing—[the] different dilution at the time of the sampling. It's not like you get always the same number. You can get different variation even the same site if you come back tomorrow . . . ." (Doc. No. 235 (Tr. Day 2) at 163.) The attenuation of pollutants by the river itself can also account for significant differences in concentrations: "[W]e have a huge dilution [by] the river. So because one sample had a half a percent more of river water in this blend, you would have totally different numbers, totally different values." (Id.) What is key, Vengosh explained, is to identify significant differences between a sample and the background sample. (Id.)

212. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Vengosh to be highly credible.

7. Testimony of Dr. Dennis Lemly

213. Dr. Dennis Lemly holds M.S. and Ph.D. degrees in Biology from Wake Forest University ("Wake Forest"). Until his retirement in 2016, he held dual appointments as a Research Fisheries Biologist with the United States Forest Service and as a Research Associate Professor of Biology at Wake Forest. Lemly has amassed a number of publications tending to demonstrate significant expertise in the impacts of pollution on aquatic life. (Doc. No. 162-1 (Lemly CV) at 1–27.)

214. Lemly was retained by the Plaintiffs to review and analyze information, provide his opinion, and testify in this matter. (Doc. No. 228-2 (Lemly Wr. Test.) at ¶ 1.)

215. The parties have stipulated and agreed that Lemly is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

216. Lemly reviewed the following documents: (1) TVA's 2010-2012 Biological Monitoring Studies reports (J. Ex. 56, 57); (2) the Gallatin Fossil Plant NPDES Permit issued in 2012; (3) TVA's Discharge Monitoring Reports for the Gallatin Fossil Plant, submitted to TDEC under its NPDES permit for the years 2005 through 2015; (4) TVA's Gallatin Fossil Plant groundwater monitoring data for the year 2015, as submitted to TDEC; (5) the 2012 Groundwater Monitoring Report issued by ARCADIS (J. Ex. 55); (6) surface water, groundwater, and sediment sampling data provided by SELC (J. Ex. 8); and (7) a 2013 Environmental Integrity Project report titled "TVA's Toxic Legacy," which compiles public domain pollutant data for coal ash sites, including the Gallatin Fossil Plant. (Doc. No. 228-2 (Lemly Wr. Test.) at ¶ 6.)

217. Lemly testified that it was his expert opinion, based on review and analysis of the available data, that selenium is being released at the Gallatin Fossil Plant to surface waters and

groundwater, and that there is a high likelihood that selenium toxicity is occurring in fish and aquatic life at the Gallatin Fossil Plant. (Id. at ¶ 9.)

218. Selenium is recognized by the United States Environmental Protection Agency as a primary pollutant in coal ash. (Id. at ¶ 11 (citing Fact Sheet, Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater 2016 ("EPA Fact Sheet") (J. Ex. 58).)

219. The EPA has stated that that selenium "bioaccumulates in the aquatic food chain and chronic exposure in fish and aquatic invertebrates can cause reproductive impairments (e.g., larval deformity or mortality). Selenium can also adversely affect juvenile growth and mortality." (J. Ex. 58 (EPA Fact Sheet) at TSRA-GA076499–500.)

220. Lemly testified that the EPA has been influenced by his own research related to coal ash contamination in North Carolina. Those studies showed that concentrations of waterborne selenium less than 5 ug/L, released from coal ash, accumulates in lakes and poisons fish. Lemly explained that this bioaccumulation continued after the selenium discharges themselves had ceased. Lemly's research was published in the journal *Ecotoxicology and Environmental Safety*. He credits the research as a major factor in the EPA's 2016 decision to impose more stringent freshwater criteria for selenium. (Doc. No. 228-2 (Lemly Wr. Test.) at ¶¶ 14–15.)

221. Bioaccumulation occurs when an organism absorbs a substance at a rate faster than the rate at which the organism excretes the substance. Once consumed, dietary selenium readily accumulates in tissues, sometimes to levels several thousand times the initial waterborne concentration to which the organisms are exposed. Selenium is also passed from parent fish to their offspring in the eggs as a consequence of the contaminated diet the parent fish consume. Selenium then accumulates in the egg yolk of the fish embryo. Once eggs hatch, the selenium is absorbed into tissues, where it alters the formation of proteins, resulting in distorted and misshapen

bones and other tissues. Affected embryos may die before they can hatch, or they may hatch alive but with identifiable deformities. (Id. at ¶¶ 21–26.)

222. Lemly presented photographic examples of fish with skeletal deformities typical of selenium toxicity. Those examples, however, did not come from any waters affected by the Gallatin Plant. (Id. at ¶¶ 28–35.) On cross examination, he confirmed that he had not identified any deformed fish at Old Hickory Lake. (Doc. No. 235 (Tr. Day 2) at 201.)

223. The examples Lemly provided did, however, provide general background about the potential risks associated with coal ash contamination in certain levels. For example, Lemly discussed coal ash contamination from unlined pits in North Carolina's Belews Lake. He produced photographs of fish from Belews Lake with significant skeletal deformities apparent to the naked eye. According to Lemly, the selenium toxicity at Belews Lake caused the total elimination from the lake of nineteen species of fish. Only three species remained. (Doc. No. 228-2 (Lemly Wr. Test.) at ¶¶ 30–34.)

224. Lemly explained that a large-scale dying off of fish due to selenium toxicity often manifests subtly at first, because the deaths of unhatched embryos or newly hatched fish goes unnoticed. Accordingly, a fish population may be suffering significantly from selenium exposure without there ever being a large-scale, easily noticed fish kill event, such as the appearance of large numbers of dead fish on the surface of the water. (Id. at ¶ 38.)

225. Lemly testified that it is difficult to draw inferences about fish population levels in the Old Hickory Lake area, because it is an open aquatic system—meaning that fish pass freely into, through, and out of it—as well as due to the effect of state and/or federal fish stocking programs intended to augment the population of sport fish. (Id. at ¶¶ 41–45.)

226. Lemly identified Old Hickory Lake as a "lentic" system, meaning a water habitat with slow-moving or standing water. In contrast, a "lotic" system is a system with more rapidly flowing water. Bioaccumulation of selenium is facilitated by lentic systems. For this reason, the EPA has imposed a more stringent selenium criterion for lentic systems than for lotic systems (Id. at ¶¶ 55–59.)

227. Lemly described an appropriate methodology for determining the impact of selenium on fish in Old Hickory Lake based on detailed studies of newly hatched fish. It does not appear, however, based on Lemly's testimony, that such an investigation had been performed at the time of his analysis. (Id. at ¶ 48.)

228. Lemly has, however, developed a hazard rating model for the evaluation of the aquatic hazard posed by selenium. That model has been published in peer-reviewed scientific literature. (Id. at ¶ 60.) As relevant to this case, Lemly evaluated the aquatic ecological hazard of selenium being discharged at the Gallatin Fossil Plant by comparing the concentrations of selenium measured in site sampling data with toxic threshold values and biological effects criteria for fish and other aquatic life and aquatic-dependent wildlife. (Id. at ¶ 62.) Because the EPA and the states have not established biological effects criteria for wildlife, Lemly relied on peer-reviewed scientific literature for wildlife toxicity data. (Id. at ¶ 65.)

229. On cross examination, TVA pressed Lemly on whether his analysis in this case truly conformed to the peer-reviewed methodology that he had previously developed. In particular, Lemly admitted that his protocol called for data not only from water and sediment but also certain organisms and both fish and bird eggs. While the model may still be used if only one of those three additional data sources is missing, a lack of two or more contemplated data sources means that the analysis, under Lemly's published model, is not complete. The analysis in this case relies only on

surface water, groundwater, and sediment sampling, which does not comply with Lemly's published model. (Doc. No. 235 (Tr. Day 2) at 194–95.) On re-direct, Lemly explained that, although the published model does call for reliance on several factors, each factor does have its own hazard rating scale, and thus the factors are capable of being applied independently. (Id. at 217.)

230. Lemly's model characterizes the degree of hazard for a particular area as Low, Moderate, or High. These hazard ratings reflect Lemly's assessment of the expected effects of acute and chronic waterborne exposure and acute and chronic dietary exposure to contaminants. A "Low Hazard" rating reflects contaminant concentrations that at least equal or exceed one-fourth of the chronically toxic concentration. A "Moderate Hazard" rating reflects concentrations that at least equal or exceed one half of the chronically toxic concentration. A "High Hazard" rating reflects concentrations that at least equal or exceed acutely or chronically toxic levels. (Doc. No. 228-2 (Lemly Wr. Test.) at ¶¶ 66–68.)

231. Lemly's analysis designated selenium as High Hazard in the area of the Gallatin Plant—meaning that he considered the selenium concentration to equal or exceed acutely or chronically toxic levels. He testified that this concentration of selenium would be expected to cause toxicity in a wide range of animals at all levels of the area's ecosystem, including fish such as minnows, darters, sunfish, and bass; amphibians including toads, frogs, and salamanders; crustaceans such as amphipods and crayfish; mollusks such as mussels, clams, and snails; and insects and worms. (Id. at ¶¶ 85–86.)

232. Specifically, Lemly concluded that selenium is present in the surface water discharges from the Gallatin Fossil Plant at up to 75 parts per billion, 50 times what he identified as the threshold value for bioaccumulation to toxic levels in the tissues of aquatic life. (Id. at ¶ 84.)

233. He similarly designated selenium as High Hazard in the area's groundwater, concluding that the groundwater concentrations exceed up to 45 times the threshold for bioaccumulation in fish and aquatic life. (Id. at ¶¶ 90–92.)

234. In Lemly's expert opinion, the polluted groundwater at the Gallatin Fossil Plant poses a grave threat to aquatic life when it reaches the surface. (Id. at ¶ 93.)

235. Finally, Lemly's analysis also gave a High Hazard designation to selenium in the sediment samples. Selenium is present in sediment at the Gallatin Fossil Plant at concentrations up to 130 parts per million, 65 times higher than the threshold concentration for toxic bioaccumulation in aquatic life. (Id. at ¶¶ 96–97.) Sediment, Lemly explained, is a significant route by which fish and aquatic life are exposed to coal ash pollutants, in particular for sediment-dwelling creatures such as catfish, frogs, and crayfish. (Id. at ¶ 98.)

236. On cross examination, Lemly confirmed that, in reaching his conclusions, he relied on the highest available concentration readings, not average or median concentration levels based on all of the available sampling. (Doc. No. 235 (Tr. Day 2) at 198.)

237. Lemly also conceded that the toxic concentration values he identified and relied upon were more stringent than Tennessee's water quality criteria. (Id. at 199–200.)

238. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Lemly to possess some general credibility on the foundational question of whether selenium presents risks of bioaccumulation and toxicity in fish and aquatic life, although the Court does note that Lemly appears to take an aggressive view of when that risk becomes significant. Although the Court did find Lemly's hazard analysis relevant to this case, the Court found that the reliability of his conclusions was undermined significantly by the lack of corroborating data from fish tissues

or eggs, as well as the lack of evidence from the morphology of any fish or aquatic life taken from the Old Hickory Lake area.

8. Testimony of Britton Dotson

239. Dotson is an environmental fellow at TDEC's Division of Water Resources. He described his responsibilities as varied, but generally drawing on his experience and knowledge related to geology and/or waste management. Dotson has a bachelor's degree in Geology and a master's in Geography from WKU. (Doc. No. 236 (Tr. Day 3) at 4–5.) He testified that his education included an emphasis in karst, in particular in WKU's graduate program, where Dotson worked with Dr. Nicholas Crawford at the Center for Cave and Karst Studies. (Id. at 6.)

240. In the six months preceding the trial, the majority of Dotson's work for TDEC involved TVA, with the bulk of it consisting of work related to the Gallatin Plant. He estimated that he had visited the Plant twenty to thirty times. (Id. at 6.)

241. When asked if he had "seen karst features at the Ash Pond Complex," Dotson replied, "I've seen karst features in that part of the facility." (Id. at 7.)

242. Dotson testified that he had seen karst features both to the north of the Ash Pond Complex and to the south of the Ash Pond Complex. (Id.) When asked if these features included sinkholes, fissures, vertical joints, or caves, he replied, "All of the above." (Id. at 8.)

243. When asked if he had seen karst features within the Ash Pond Complex, he responded:

> I have seen indications of solutionally developed bedrock in the western portion of Pond E. So—that's not to say that I've seen open features or that sort of thing, but—but rock that develops in that form is typical of a karst process. So I have observed that within the—within Pond E.

(Id.) He testified that it would be difficult to directly observe karst features within the Ash Pond Complex because it is covered with ash. (Id. at 11.)

244. Dotson testified that in November of 2016, he was at the Gallatin Plant and observed a geologic feature that concerned him in an exposed area of Pond E. Dotson described what he observed as a "scarp"—a type of feature formed by an abrupt change or drop in materials. (Id. at 15–17.) He characterized the feature as "indicative of what I would expect if there's been a collapse of material." (Id. at 16.) Dotson testified that it is common, in karst areas, for a void to develop underneath surface material, and for that material then to collapse into the void, leaving a "telltale scarp." (Id. at 17.)

245. When asked if, to his knowledge, karst features had developed in the Ash Pond Complex in the past, Dotson replied that they had. When asked if those features had been repaired, he replied, "Some of them." (Id. at 19.)

246. Dotson testified that he had been informed by TVA that some recent groundwater testing had found arsenic levels that exceeded EPA maximum contaminant levels ("MCLs") in multiple wells. (Id. at 23–24.)

247. Dotson also testified about recent well water data he had reviewed. He testified that the water levels in the wells showed a "very immediate response" to changes in the Cumberland River suggestive of a direct hydrological connection such as a conduit, rather than merely through porous material.[5] (Id. at 29–30.)

248. On cross examination, Dotson conceded that he does not know whether or not Pond E is losing any water, from the potential karst feature he identified or otherwise. (Id. at 33.)

[5] Although TVA objected to some questions posed by Plaintiffs to Dotson on the ground that they improperly called for expert opinion or speculation, or were based on information that the Court had previously excluded, TVA lodged no objection to this portion of Dotson's testimony. Nevertheless, the Court will consider the fact that Dotson was not qualified as a Rule 702 expert when determining the amount of weight to give to his testimony.

249. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Dotson to be generally credible.

C. TVA's Evidence at Trial

1. Testimony of Gabriel Lang

250. Gabriel Lang is a program manager and senior engineer with TVA contractor AECOM. He has a Bachelor of Science degree from the University of South Florida, with a major in civil and geotechnical engineering, and has performed graduate studies in geotechnical engineering at the University of Pittsburgh. He is a licensed civil engineer in a number of states, including Tennessee. Lang has substantial professional experience with projects involving coal combustion residual impoundments and landfills. Among the issues Lang has experience addressing is karst mitigation. (Doc. No. 229-1 (Lang Wr. Test.) at 1–2.)

251. Lang currently serves as the program manager of the coal combustion product management program for TVA. Lang's job responsibilities include oversight of a team of civil and geotechnical engineers providing engineering services related to CCR storage, closure, and management. He has been working at the Gallatin Plant since 2009, and his job duties at Gallatin have included serving as a lead engineer, project manager, and engineer of record for projects including CCR operations, stability improvements, dry storage, and impoundment closure evaluations. (Id. at 1.)

252. In connection with this case, Lang was asked by TVA to provide his professional evaluations as a civil/geotechnical engineer regarding the CCR management and treatment facilities at Gallatin and to evaluate Plaintiffs' Experts' reports and allegations. (Id. at 3.) Lang relied on his personal observations and experience, as well as TVA, AECOM, and U.S. Army Corps of Engineers records. (Id. at 4.)

253. The parties have stipulated and agreed that Lang is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

254. Lang testified that, according to the records he reviewed, TVA reported erosion of minor amounts of ash from one spillway associated with the ponds in the area now known as the Non-Registered Site. In 1975, TVA closed the spillway, sealed it with concrete and covered the area in vegetation to prevent further erosion. (Doc. No. 229-1 (Lang Wr. Test.) at 5.)

255. Photographs taken in connection with the 1978 inspection of the Non-Registered Site documented continued erosion of the perimeter dikes adjacent to the Cumberland River, and references to potential erosion continue to appear in records into at least the early 1980s. (Id. at 6.)

256. Lang testified that it is his expert opinion, based upon the available historical information, that the presence of localized ash in the river near the NRS spillway is related to that historical erosion and is not related to TVA's current operations at Gallatin. (Id. at 5.)

257. However, according to the documents on which Lang relied, the Non-Registered Site simultaneously experienced both erosion and percolation of water into groundwater. He quoted a 1981 inspection as follows:

> These areas are abandoned. The only water into these areas is rainfall. There is no discharge from these areas. All rainfall is evaporated **or percolates into the groundwater**.
>
> The steep outside slopes have no vegetation. Erosion of these slopes is being controlled by the construction of a ridge along the outside edge of the top of the dike and sloping the top of the dike to the inside.

(Id. at 6 (quoting J. Ex. 176 at 2) (emphasis added).) Lang's discussion of efforts to remediate the erosion problem did not suggest that they would have also eliminated the percolation of rainfall

through the Non-Registered Site and into the groundwater. (Doc. No. 229-1 (Lang Wr. Test.) at 4–5.)

258. Lang testified that TVA's implementation of the 1997 Non-Registered Site closure plan included improving drainage and regrading portions of the site to prevent ponding and "excess infiltration" from surface runoff. (Id. at 7.) He conceded in his direct testimony, however, that, under current engineering standards, the 1997 closure plan would not be considered sufficient to reduce surface water infiltration of the Non-Registered Site. (Id.)

259. He also conceded that there are saturated conditions within the subsurface of the Non-Registered Site as a result of groundwater and surface water infiltration/percolation, and that, under these conditions, it is possible for seepage to occur from the Non-Registered Site. Any earthen dam structure would be expected to experience some seepage, he explained. (Id. at 8.)

260. He also explained that seepage from the Non-Registered Site fluctuates seasonally, primarily due to the varied intensity of rainfall events. (Id.)

261. AECOM, Lang testified, has identified a total of twenty-two seep locations at Gallatin, including nine which are on or adjacent to the embankments of the Non-Registered Site. (Id. (citing J. Ex. 157 at 13–21).) Lang characterized those nine seeps as what AECOM refers to as "Level 1" seeps, meaning that they do not represent an imminent danger to the embankment in terms of erosion but may require additional monitoring. (Id. at 8–9.) None of the seeps, however, are currently flowing, according to Lang. (Id. at 9.)

262. Lang also testified that there is no record of coal ash flowing through an embankment seep directly into the Cumberland River. (Id.)

263. Lang discussed a September 2011 assessment of the structural stability of the dams at the Ash Pond Complex, performed by EPA contractors at Dewberry Consultants LLC

("Dewberry"). The assessment, presented in final form in 2013, rated Pond E as "SATISFACTORY" and Ponds A, B, C, and D as "FAIR," meaning that they would not be considered satisfactory unless certain remedial measures were taken. (Id. at 9-10 (quoting J. Ex. 126 at 1-3).)

264. The Dam Assessment Report also noted that "seepage areas are minor and are adequately monitored." (J. Ex. 126 at 7-11.)

265. Lang testified that the EPA issued a "Request for Action Plan" regarding the recommendations in the 2013 report, and that TVA has since formulated and completed such a plan. (Doc. No. 229-1 (Lang Wr. Test.) at 11.)

266. Lang testified that TVA's NPDES Permit for the Gallatin Plant required it to submit a closure plan for the Ash Pond Complex. (Id. (citing J. Ex. 102, Ex. 6 at 23).) TVA submitted the required closure plan on September 25, 2012. (Id. (citing J. Ex. 151).) Lang served as the engineer in charge of the Preliminary Ash Pond Closure Plan. (Id.)

267. The Preliminary Ash Pond Closure Plan calls for "closure in place" of Ponds A and E, meaning that they would be closed without the underlying coal ash waste being removed and relocated. Ponds B, C, and D would remain in operation for the management of storm water runoff from upstream drainage areas. (Id. at 12.)

268. Closure in place is one of two options for the closure of surface coal ash impoundments potentially available under the EPA's Rule for Disposal of Coal Combustion Residuals from Electric Utilities ("CCR Rule"). See 80 Fed. Reg. 21,302 (Apr. 17, 2015). The other is "closure by removal," which, as its name suggests, involves removal of waste and decontamination of the area. (Doc. No. 229-1 (Lang Wr. Test.) at 12.)

269. According to Lang, the Gallatin Plant's Closure Plan estimates that closure of Pond E will be completed in 2021 and closure of Pond A will be completed in 2025. Each closure will be followed by a thirty-year Post-Closure Period during which the Plan calls for certain regular monitoring and maintenance. (Id. at 14–15.)

270. In contrast, Lang estimated that closure by removal, with the excavated coal ash being moved to an on-site landfill, would take twenty-four or more years before closure would be completed. (Id. at 23.) Closure by removal would also, according to Land, require a thirty-year post-closure monitoring period. (Doc. No. 236 (Tr. Day 3) at 146.)

271. On re-direct, Lang elaborated about the potential sites to which excavated coal ash could be moved. He said that the use of the on-site landfill had been considered, but that it presented some challenges. He testified that a landfill in or near Murfreesboro had also been considered, but that it was "a distance away." He described the truck traffic necessary to use an offsite landfill as substantial, specifically offering the figure of fifty to one hundred trucks on the road a day for a period of twenty years. (Id. at 134.)

272. Lang testified that closure in place was selected because it presented the most feasible means of expediting the closure of the ash ponds. (Doc. No. 229-1 (Lang Wr. Test.) at 15.) He noted in particular that the significant amounts of deeply buried ash in the Ash Pond Complex would present safety and environmental challenges for closure by removal. (Id. at 15.) In particular, Lang testified that excavation of coal ash would create increased potential for the formation of new sinkholes during the excavation process. (Id. at 25.) The need to bring in outside soil would also give rise to the ordinary environmental and safety risks associated with increased truck traffic, such as increased greenhouse gas emissions and risk of traffic accidents. (Id. at 24.)

273. Lang testified that closure by removal was not, in his opinion, feasible, in light of the size and conditions of the Ash Pond Complex. Lang cited both the risk of increased karst activity during the excavation process as well as the lengthy period of time that he estimated would be required for closure to be completed. He testified that AECOM was not aware of any completed ash pond removal projects of the magnitude that would be required for the Gallatin Plant, with the exception of the efforts required after the massive 2008 coal ash spill near Kingston, Tennessee. (Id. at 26–27.) On cross examination, however, he conceded that as many as 70% of the individual surface impoundments in South Carolina were being closed by removal. (Doc. No. 236 (Tr. Day 3) at 109.)

274. Lang echoed EPA guidance that the choice between closure in place and closure by removal must be made on a case-by-case basis. He testified that it was his opinion, within a reasonable degree of scientific certainty, that closure in place via *inter alia* placement of a geosynthetic cap would, in this instance, meet the minimum requirements of the CCR Rule. (Doc. No. 229-1 (Lang Wr. Test.) at 18–19.)

275. Lang testified that AECOM had developed a conceptual plan for further closure of the Non-Registered Site, intended to remedy deficiencies in the Site's prior capping and closure. The centerpiece of that plan is the placement of a geosynthetic cap that, Lang estimated, would reduce surface water infiltration by 99.8%. (Id. at 30–31.)

276. On cross examination, Lang conceded that recent sampling of wells in the area of the Gallatin Plant showed some exceedances of MCLs for arsenic. (Doc. No. 236 (Tr. Day 3) at 110–11.) He also conceded that there was a history of sinkholes in the Ash Pond Complex. (Id. at 113.)

277. Lang admitted that the assumptions underlying his analysis of closure in place of the Ash Pond Complex assumed water infiltration only through direct vertical infiltration of rain from

directly above the closed ponds or via runoff of stormwater from immediately adjacent areas. He did not, in other words, contemplate the potential for lateral infiltration of water via groundwater flowing from farther away coming into contact with coal ash because the ash itself was in contact with or below the water table. (Id. at 118–19.)

278. Lang conceded, on cross examination, that a March 2015 document created by AECOM, on which he had worked, including the following statements regarding Ash Pond E: "A portion of the ash is below (up to 10 feet below) the elevation of the Cumberland River"; and "If the Pond is hydraulically connected to the Cumberland River, dewatering below river level would be virtually impossible (you cannot pump the river down)[.]" The latter of these two statements was identified as a "Potential Fatal Flaw" to the dewatering process. (Id. at 128−29; J. Ex. 113 at 7.)

279. Lang stressed, however, that, based on subsequent investigation from wells on the Gallatin Plant site, there was no evidence of a hydrologic connection between the Pond and the Cumberland River. (Doc. No. 236 (Tr. Day 3) at 130.)

280. On re-direct, Lang discussed the potential scarp feature that Dotson had observed. He stated that the feature appeared to him to be an "erosional feature" rather than a sinkhole. (Id. at 135.) He testified that the feature was being monitored photographically and that some photographs depicted standing water atop the feature. (Id. at 136–39.)

281. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Lang to be generally credible, with the caveat that it has considered his testimony in light of his close professional relationship with TVA and his past responsibility for TVA's development of closure strategies for the ash ponds.

2. Testimony of Dr. Neil Carriker

282. Dr. Neil Carriker has a B.S. degree in Chemistry from the University of North Carolina-Charlotte and M.S. and Ph.D. degrees in Environmental Engineering from the University of Florida. He performed post-doctoral research at the University of Minnesota. He currently works as a contractor for TVA in matters related to environmental investigations at the Gallatin Plant. (Doc. No. 158-6 (Carriker Wr. Test.) at 2; J. Ex. 273 (Carriker CV).)

283. Carriker worked directly for TVA from 1979 to his retirement in 2009, holding various positions related to water quality and management. He currently holds the title of Program Manager in Environment and Technology Special Projects for the Gallatin Plant. Carriker has primary responsibility for coordinating TVA's preparation of the EIP arising out of the State Enforcement Action. Prior to his work in this matter, Carriker developed and managed TVA's environmental investigations of the Kingston coal ash spill. He has authored or reviewed a number of peer-reviewed papers related to the Kingston investigations, and has served as an associate editor of the journal of the North American Lake Management Society. His professional experience is broadly indicative of significant expertise in the area of water resource management, with a particular perspective related to TVA's operations. (Doc. No. 158-6 (Carriker Wr. Test.) at 2; J. Ex. 273 (Carriker CV).)

284. In connection with this case, Carriker was asked by TVA to provide testimony about the process and results of environmental compliance activities at the Gallatin Plant, including issues related to sampling procedures, standards, and results. Carriker relied on his own observations, TVA records, various expert reports, a summary of invertebrate sampling from 2014 and 2015, and information obtained in the development of the EIP. (Doc. No. 158-6 (Carriker Wr. Test.) at 4–5.)

285. The parties have stipulated and agreed that Carriker is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

286. Carriker testified that he believed that, at the time of trial, there was insufficient information available concerning the current hydrology and geology at the Gallatin Plant to form an accurate understanding of current conditions. He stated that the EIP—which still required substantial work to be performed—was intended to create the basis for forming a more accurate, contemporary picture of the conditions of the site. (Doc. No. 158-6 (Carriker Wr. Test.) at 6.)

287. Carriker contrasted TVA's ongoing data collection sampling with the data collection and sampling relied upon by Plaintiffs. He took fault with what he characterized as Sulkin's failure to adequately document the procedures surrounding his collection of samples and his reliance instead on a general claim to have followed "standard state and EPA protocol." (Id. at 9–10.)

288. Carriker also opined that Sulkin had inadequately documented his analysis of the cenospheres he observed in a sediment sample. (Id. at 10.)

289. Carriker went on to disagree with Vengosh's analysis and conclusions, in particular his reliance on elevated salinity levels as supportive of identifying improper discharges. Carriker testified that elevated conductivity due to increased salinity is common for waters in close contact with soil. Carriker also opined that, even if Vengosh's analysis is correct with regard to identifying discharges, his data do not establish any effect on the adjacent surface waters. (Id. at 13.)

290. Carriker also criticized Vengosh's reliance on manganese as an indicator of contamination, on the ground that manganese is plentiful in the earth's crust itself. (Id.)

291. Carriker next took issue with the wide variances in the Plaintiffs' experts' measurements of certain chemicals that provide stronger indications of contamination, such as

arsenic, boron, and strontium. These variances, Carriker explained, make it difficult to draw definitive conclusions about the sources of the contaminants or their potential to adversely affect the waters. (Id.)

292. Carriker faulted Lemly's analysis for ignoring important variables and improperly relying on maximum measured contaminant values to the exclusion of lower measurements. (Id. at 14–15.)

293. Carriker also discussed fish tissue testing performed at Plaintiffs' behest after Lemly's analysis, which Carriker characterized as showing selenium toxicities well below EPA criteria. (Id. at 18.)

294. On cross examination, Carriker conceded that there is coal ash in the Cumberland River in the area surrounding the Gallatin Plant, as shown by TVA's own testing. (Doc. No. 236 (Tr. Day 3) at 166.)

295. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Carriker to be generally credible, albeit with the caveat that his longstanding professional association with TVA could be reasonably likely to predispose him to positions favorable to its actions and positions. The Court found many of Carriker's critiques of Plaintiffs' analyses persuasive, but also notes that Plaintiffs' experts, in particular Sulkin and Vengosh, had already qualified their conclusions in ways that lessen the impact of many of Carriker's complaints. In particular, while it is clear that Plaintiffs have not presented evidence adequate to fully and accurately assess the extent or impacts of any unauthorized discharges, its experts in many respects preemptively conceded as much, focusing instead on the binary question of verifying the existence or nonexistence of those discharges. Carriker's testimony was less persuasive in undermining that aspect of Vengosh, Quarles, and Sulkin's analyses.

3. Testimony of Dr. Walter G. Kutschke

296. Dr. Walter G. Kutschke is a senior geotechnical engineer and geotechnical department manager with AECOM, where he has been employed for over twenty-two years. He has a B.S. degree in Civil Engineering and M.S. degree in Geotechnical Engineering from the State University of New York at Buffalo, as well as a Ph.D. in Geotechnical Engineering from the University of Pittsburgh. He is a licensed civil engineer in several states, including Tennessee. (Doc. No. 229-2 (Kutschke Wr. Test.) at 1–2; J. Ex. 196 (Kutschke CV).)

297. Kutschke has published twenty-one peer-reviewed papers involving geotechnical engineering projects as well as geotechnical research projects. He is a member of the American Society of Civil Engineers ("ASCE"), the Geo-Institute, and a committee member in the ASCE Grouting Committee and ASCE Earth Retaining Structures Committee, as well as a member of the Society of Military Engineers. Kutschke also served as an elected officer (three terms) in the ASCE Earth Retaining Structures Committee. Kutschke's experience establishes substantial expertise in the area of geotechnical engineering. (Doc. No. 229-2 (Kutschke Wr. Test.) at 2–3.)

298. Kutschke has been involved with work at the Gallatin Plant since 2011. His duties have included assisting with TVA's work pursuant to the EIP and responding to Plaintiffs' allegations related to karst at the Ash Pond Complex in this litigation. Kutschke has been onsite at Gallatin more than twenty times, and he currently serves as the lead karst engineer for TVA's ongoing work at the Gallatin Plant. (Id. at 2.)

299. Kutschke's opinions are based on his personal observations, experience, and knowledge, as well as data and TVA, AECOM, and Army Corps of Engineers records made available for his review. (Id. at 3–4.)

300. The parties have stipulated and agreed that Kutschke is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

301. Kutschke testified that, according to TVA records, TVA conducted a transit and tape survey of Odom's Bend peninsula in 1952, which TVA used to prepare a Land Acquisition Map for the Gallatin facility. That map, Kutschke testified, does not show an intermittent drainage feature identified as Sinking Creek. (Doc. No. 229-2 (Kutschke Wr. Test.) at 5 (citing J. Ex. 68; J. Ex. 211; J. Ex. 212).)

302. Kutschke discussed TVA records' documentation of the 1977 repairs to sinkholes in the floor of the Ash Pond Complex. He testified that the records show that the repairs succeeded in sealing the particular sinkholes identified and allowing the ash sluice water to leave the pond through the spillways, as designed. (Id. at 7.) He testified that, to his knowledge, and based upon his review of TVA records, the sinkholes that were leaking in the 1970s were all repaired by TVA. (Id. at 8.)

303. Kutschke testified that his review of more recent records showed that there were no known additional sinkholes in the Ash Pond Complex. (Id. at 8–9.) Kutschke admitted that, in 2005, TVA found and repaired suspected sinkholes during the expansion of Ash Pond E, but that these repairs were made while the Pond was out of service for expansion. He also admitted that, in May 2010, following flooding, TVA identified four sinkholes on the Gallatin Plant property: one to the north of Pond C and three additional sinkholes that were not in the immediate pond area. (Id. at 9.) He testified that no unlawful discharges would have been made through the sinkholes discovered in 2005 or 2010 because the 2005 sinkhole was found early during construction and the 2010 sinkholes were found outside the Ash Pond Complex itself. (Id.)

304. Kutschke's description of karst terrain generally confirmed Plaintiffs' experts' descriptions. He testified that the Ash Pond Complex is situated primarily over Carters Limestone (with some Lebanon Limestone), and that published geologic mapping suggests that, at the Ash Pond Complex, karst activity is generally associated with the Carters Limestone. (Id. at 10.)

305. Kutschke also echoed the conclusion that passage of water through karst tends to occur through voids and fractures, rather than solely through slow seepage through porous matter. As he explained it, groundwater drains downward and pools along the limestone surface, at which point lateral water flow typically will reach a fracture, bedding, or joint feature, which allows the continued migration of water downward. (Id. at 11.)

306. Karst, as he explained it, is characterized by water flow through large voids, including enlarged fissures and tubular tunnels. He explained that sinkholes occur in karst settings where geologic conditions have created solution pathways in the underlying soluble rock where water can cause subsurface erosion of the overlying sediment. (Id.)

307. Kutschke testified that 2015 borings in the area of the Ash Pond Complex did not encounter cavernous features that would suggest a "high relative risk" of roof collapse and immediate sinkhole development. (Id.)

308. He further testified that borings in the alleged Sinking Creek area did not encounter subsurface conditions indicative of a sinking creek. (Id. at 11–12.)

309. Kutschke testified that relevant hydrograph data—that is to say, data tracking water level and flow rates—did not indicate rapid conductivity suggestive of emptying of water through karst features. (Id. at 13.) The hydrograph data, he explained, suggested a relatively low risk of sinkhole development because, without sufficient water flow through the karst features, there would not be significant progressive erosion giving rise to new sinkholes. (Id. at 13.)

310. Kutschke also testified that the volume of water discharging from Outfall 001 and the water level in Pond D suggest that the Complex is operating as designed, supporting an inference that it is not losing water through karst features. (Id.) On cross examination, however, he conceded that water could reach and discharge through the outfall even in the presence of leaks. (Doc. No. 237 (Tr. Day 4) at 12.)

311. In summary, Kutschke testified to his opinion that the available boring log and hydrograph data, as well as his personal observations, suggest minimal, if any, subsurface water loss. Any such loss, he opined, is likely diffuse, rather than through a direct karst connection between the Ash Pond Complex and the Cumberland River. (Doc. No. 229-2 (Kutschke Wr. Test.) at 14.)

312. Finally, Kutschke testified that, in his opinion, the karst terrain under and around the Ash Pond Complex would not preclude closure in place from being an appropriate method of closure. (Id. at 14−15.)

313. On cross examination, Kutschke admitted that TVA reports from 1972 through 1976 purported to find no evidence of loss of ash from the Ash Pond Complex, despite the fact that the ponds were eventually discovered to be releasing what would eventually amount to twenty-seven billion gallons of sluice water. (Doc. No. 237 (Tr. Day 4) at 10.)

314. On cross examination, he was also pressed in greater detail on AECOM's 2015 boring logs. Plaintiffs successfully demonstrated that boring logs did, in fact, show evidence of significant fractures, apparent voids, and water-bearing features in the Gallatin Plant's karst terrain. (Id. at 24–26.) The specific examples raised by Plaintiffs, however, were not immediately within the boundaries of the Ash Pond Complex. (Id. at 28–29.)

315. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Kutschke to possess some credibility, with the caveat that AECOM's relationship to TVA could be reasonably likely to predispose him to interpretations favorable to TVA's practices and interests. The Court also notes that, on cross examination, Kutschke repeatedly failed to give yes-or-no answers to yes-or-no questions, in particular with regard to whether there are continuing unrepaired karst features in the Ash Pond Complex. For example, counsel for Plaintiffs asked, "So there are a dozen unrepaired karst features in Ash Pond A, correct?" Rather than simply replying "Yes," "No," or "I don't know," Kutschke responded, "Again, that's not a yes-or-no answer. Just because—TVA has documentation that they repaired leaking sinkholes. The leaking sinkholes were repaired. Just because it's a karst feature doesn't necessarily have to have a repair done to it if it's not a leaking feature." (Id. at 17.) Plaintiffs also effectively impeached Kutschke based on apparently inconsistent prior deposition testimony with regard to whether such unrepaired features were capable of conduit flow. (Id. at 20.) The Court considered Kutschke's evasive answers and impeachment relevant to, but not wholly undermining of, his credibility.

4. Testimony of Elizabeth Perry

316. Elizabeth Perry is a Senior Hydrogeologist at AECOM, where she has worked for seventeen years. She has a B.A. degree in Mathematics and Geology from Hamilton College and an M.S. degree in Engineering Geology from Drexel University. She is a professionally licensed geologist in Tennessee and two other states and a member of the National Groundwater Association and the International Association of Hydrogeologists. Perry has more than thirty years of experience practicing geology and hydrogeology, and she has authored or co-authored several publications and presentations on related subjects. Her credentials demonstrate substantial expertise in hydrogeology. (Doc. No. 230-1 (Perry Wr. Test.) at 1–2; J. Ex. 230 (Perry CV).)

317. Perry has been working for AECOM at the Gallatin Plant since 2014. Her job duties have included: supervising matters related to the Plant's groundwater monitoring network; reviewing historical and regional studies and information related to groundwater at and in the vicinity of the Gallatin Plant; developing and reviewing work plans related to various geologic, hydrogeological, and environmental chemistry investigations; interpreting and supervising the interpretation of data and results from various investigations on site with respect to groundwater; providing expert witness support related to groundwater; and communicating status, progress, information, and findings to TVA and to TDEC. (Doc. No. 230-1 (Perry Wr. Test.) at 2.)

318. In connection with this case, Perry was asked by TVA to render her professional opinion regarding the groundwater system at Gallatin with a specific focus on the groundwater system beneath the Ash Pond Complex and the Non-Registered Site. Her opinions were based on personal experience, review of data, and review of TVA, AECOM, TDEC, and U.S. Geological Survey records. (Id. at 3–4.)

319. The parties have stipulated and agreed that Perry is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

320. Perry took issue with some of the assumptions underlying Quarles' earlier testimony regarding water levels in wells in the vicinity of the Ash Pond Complex. In particular, she focused on the inferences that could be drawn from those water levels. Perry explained that groundwater in confined aquifers is under pressure—known as the "hydraulic head." A well that penetrates an aquifer with a high hydraulic head will see the well water rise, due to hydraulic head, to a level that may not accurately reflect the level of the water in the aquifer itself. If an aquifer is not tightly

confined, however, there will not be pressure increasing the height of water in the well, and the well presumably will give a more accurate picture of the actual groundwater level. (Id. at 5–6.)

321. Perry testified that only one portion of the Gallatin Plant site, the vicinity of the North Rail Loop ("NRL") Landfill, had been subject to an extensive study of its hydrogeology. That study found that fractures in the Lebanon limestone formed a confined aquifer with a significant hydraulic head. (Id. at 10–11.) The study of the NRL Landfill area did not identify any karst features, such as sinkholes, within the landfill limits. (Id. at 11) Perry testified that 2015 drilling suggested that the bedrock features of the NRL Landfill area extended to areas along the south and east of the ash ponds. (Id. at 11–12.)

322. Perry admitted that bedrock is visible at the ground surface in much of the area surrounding the Ash Pond Complex, which suggests that there may not be significant alluvial deposits overlying the bedrock. (Id. at 12.)

323. According to Perry, most of the groundwater flow in the area of the Ash Pond Complex is expected to take place through the underlying bedrock. (Id.)

324. Perry further conceded that 2015 drilling in the vicinity of the Ash Pond Complex discovered water-bearing zones in both shallow and deeper depths of the limestone. They did not, however, encounter what Perry characterized as open, cavernous conditions indicative of potential conduit flow. (Id. at 13.)

325. Perry testified that, according to the hydrograph data, some of the groundwater wells in the vicinity of the Ash Pond Complex exhibit groundwater fluctuations that are highly correlated with Cumberland River water levels, while the water levels in other wells are independent. This would suggest that some but not all of the wells are hydrologically connected to the river. (Id. at 15.)

326. Water levels in the Ash Pond Complex, however, appeared to be independent of changes in the groundwater level, which Perry characterized as strong evidence of a lack of connection between the Complex and the underlying groundwater. (Id.)

327. Based on the water levels, Perry testified that her opinion, based on available information and to a reasonable degree of scientific certainty, was that there are no open conduits providing direct connection between the water in the Ash Pond Complex and the Cumberland River. (Id. at 16.)

328. Perry next discussed the Non-Registered Site. She testified that the alluvium beneath the Non-Registered Site is a porous medium allowing groundwater to percolate slowly through the tiny pore spaces between grains of sand and clay. Water in the Non-Registered Site, she explained, exits by percolating slowly vertically downward into the underlying alluvium. Groundwater in the alluvium and bedrock beneath the Non-Registered Site is diffuse and percolating as it migrates toward and discharges into the Cumberland River. (Id. at 16–17.) When asked whether groundwater passed laterally through the Non-Registered Site, she testified that it might, but that TVA was still in the process of examining the question. (Doc. No. 237 (Tr. Day 4) at 86.) She admitted that some water had also percolated laterally through the Non-Registered Site's dikes. (Doc. No. 230-1 (Perry Wr. Test.) at 18.)

329. She testified, however, that the total amount of groundwater reaching the Cumberland River from beneath the Non-Registered Site is very small compared to the volume of flow in the river itself. (Id. at 17.)

330. Finally, Perry testified that capping the Non-Registered Site would result in substantial decrease in the groundwater flow through it. (Id. at 21–22.)

331. On cross examination, Perry admitted that, unlike in the NRL Landfill area, there are karst features in the vicinity of the Ash Pond Complex. (Doc. No. 237 (Tr. Day 4) at 59.)

332. She also conceded that karst features have historically been mapped beneath the Ash Pond Complex. (Id.)

333. Perry also confirmed that recent samples from some wells in the vicinity of the Ash Pond Complex showed arsenic levels in excess of MCLs. (Id. at 74–79.)

334. Based on its direct observation of her demeanor, candor, and responsiveness, the Court found Perry to be generally credible, albeit with the caveat that her professional association with AECOM could be reasonably inferred to predispose her to a favorable view of TVA's positions and practices.

5. Testimony of Robert Alexander

335. Robert Alexander is a TDEC official involved in the drafting of NPDES permits. (Doc. No. 237 (Tr. Day 4) at 95−96.) Alexander reports to Janjic. (Id. at 102.) He holds a bachelor's degree in Civil Engineering from Tennessee Tech and a master's degree in Engineering from North Carolina State. (Id. at 95.)

336. Alexander was not the principal author of the Gallatin Plant's 2012 renewed permit, but he did perform work on it in the status of senior reviewer. (Id. at 96.)

337. Alexander testified that a 2016 TDEC inspection of the Gallatin Plant formally found no violations and noted a lack of problems with or observed seeps in the Ash Pond Complex's dykes. (Id. at 97–99 (discussing J. Ex. 249; J. Ex. 250).)

338. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Alexander to be credible on the limited topic of his testimony.

6. Testimony of John Kammeyer

339. John Kammeyer is TVA's Vice President of Civil Projects, Coal Combustion Products Management, and Equipment Support Services. He has a broad range of responsibilities related to the management of coal ash waste at the Gallatin Plant and other facilities, including overseeing the closure of the Ash Pond Complex. He has a bachelor's degree in Mechanical Engineering from the Ohio State University and is a licensed professional engineer in the State of Tennessee. (Doc. No. 237 (Tr. Day 4) at 104; Doc. No. 230-2 (Kammeyer Wr. Test.) at 1–2; J. Ex. 264.)

340. The parties have stipulated and agreed that Kammeyer is qualified as an expert by knowledge, skill, experience, training, or education pursuant to Federal Rule of Evidence 702. (Doc. No. 221.)

341. Kammeyer testified that, in 2011, TVA initiated a $730 million project at the Gallatin Plant for the construction of facilities and equipment that would allow TVA to convert the Plant's management of coal ash waste from wet storage—that is, storage in ponds—to dry storage at the NRL landfill. (Doc. No. 230-2 (Kammeyer Wr. Test.) at 6.)

342. Kammeyer then described TVA's 2012 preliminary closure plan for the Ash Pond Complex, which called for the dewatering and closure of ponds A and E, accompanied by the placement of a geosynthetic cap. (Id. at 6−7.)

343. Kammeyer next detailed TVA's process for evaluating closure in place versus closure by removal, as published in 2016. (Id. at 10 (discussing J. Ex. 268).) The rationale provided by Kammeyer generally echoed the reasoning provided earlier by Lang. (Id.)

344. Kammeyer explained that TVA had already devoted substantial resources and efforts to the closure of the Ash Pond Complex and will continue to do so. (Id. at 11.)

345. Kammeyer offered cost estimates for both closure in place and closure by removal, suggesting that the costs of closure by removal would be substantially higher. Similarly, he estimated that merely performing improvements on the closure currently in place for the Non-Registered Site would be substantially less expensive than excavating the site. (Id. at 14–15.)

346. On cross examination, Kammeyer testified that TVA's operating revenue for the 2016 fiscal year was around $10.6 billion, and that TVA had paid out bonuses and incentives to a large number of employees. (Doc. No. 237 (Tr. Day 4) at 131.)

347. Based on its direct observation of his demeanor, candor, and responsiveness, the Court found Kammeyer to credibly express the position of TVA. By virtue of his position, however, the Court afforded greater weight to other experts' discussions of the relative merits and demerits of the closure possibilities.

IV. CONCLUSIONS OF LAW

A. The CWA

348. "In 1972, Congress enacted the Clean Water Act ('CWA' or 'Act') 'to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.'" Yadkin Riverkeeper, Inc. v. Duke Energy Carolinas, LLC, 141 F. Supp. 3d 428, 434–35 (M.D.N.C. 2015) (quoting 33 U.S.C. § 1251(a)). The CWA "is the principal legislative source of the [Environmental Protection Agency's ("EPA")] authority—and responsibility—to abate and control water pollution." Waterkeeper Alliance, Inc. v. EPA, 399 F.3d 486, 491 (2d Cir. 2005).

349. The bedrock of the CWA is "a default regime of strict liability," whereby the discharge of any covered pollutant from a point source into the Nation's waters amounts to a violation of the statute unless subject to a specific exception. Sierra Club v. ICG Hazard, LLC, 781 F.3d 281, 284 (6th Cir. 2015) (quoting Piney Run Pres. Ass'n v. Cty. Comm'rs of Carroll Cty.,

268 F.3d 255, 265 (4th Cir. 2001)). In relevant part, the CWA provides that "except as in compliance with [certain sections] of this title, the discharge of any pollutant by any person shall be unlawful." 33 U.S.C. § 1311. "The term 'discharge of a pollutant' . . . means (A) any addition of any pollutant to navigable waters from any point source, [or] (B) any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft." 33 U.S.C. § 1362(12).

350. The chief means of qualifying for an exception to the CWA's strict liability regime is compliance with a permit issued under the NPDES. ICG Hazard, 781 F.3d at 284. The NPDES is "a federal permit program designed to regulate the discharge of polluting effluents." Int'l Paper Co. v. Ouellette, 479 U.S. 481, 489 (1987). "Generally speaking, the NPDES requires dischargers to obtain permits that place limits on the type and quantity of pollutants that can be released into the Nation's waters." S. Fla. Water Mgmt. Dist. v. Miccosukee Tribe of Indians, 541 U.S. 95, 102 (2004). Discharge of pollutants into the waters of the United States from a point source without an NPDES permit, or in violation of the terms of an NPDES permit, is a violation of the CWA. 33 U.S.C. §§ 1311(a), 1342(a), 1365(f)(6).

351. "NPDES permits impose limitations on the discharge of pollutants, and establish related monitoring and reporting requirements, in order to improve the cleanliness and safety of the Nation's waters." Friends of the Earth, Inc. v. Laidlaw Envtl. Servs. (TOC), Inc., 528 U.S. 167, 174 (2000). "Noncompliance with a permit constitutes a violation of the Act." Id.; see 40 C.F.R. § 122.41(a) (2015).

352. As the system is currently designed, "[t]he [EPA] initially administers the NPDES permitting system for each State, but a State may apply for a transfer of permitting authority to state officials." Nat'l Ass'n of Home Builders v. Defs. of Wildlife, 551 U.S. 644, 650 (2007) (citing

33 U.S.C. §§ 1251(b), 1342). In December of 1977, the EPA authorized the State of Tennessee to issue some types of NPDES permits, which the State grants and enforces through TDEC. See 56 Fed. Reg. 21,376 (1991). In 1986, the EPA expanded that authorization to include the authority to issue and oversee permits for federal facilities such as the Gallatin Plant. 51 Fed. Reg. 32,834 (1986).

B. The Permit Shield

353. The "permit shield" provision of the CWA provides that "[c]ompliance with a permit issued pursuant to [the NPDES] shall be deemed compliance" with the relevant portions of the CWA. 33 U.S.C. § 1342(k). The purpose of the permit shield is "to relieve [permit holders] of having to litigate in an enforcement action the question whether their permits are sufficiently strict." ICG Hazard, 781 F.3d at 285 (quoting E.I. du Pont de Nemours & Co. v. Train, 430 U.S. 112, 138 n.28 (1977)).

354. The Sixth Circuit has adopted a two-pronged analysis for determining whether the permit shield will apply to the discharges alleged in a particular action: "[f]irst, the permit holder must comply with the CWA's reporting and disclosure requirements"; and, "[s]econd, . . . the discharges must be within the permitting authority's 'reasonable contemplation.'" Id. (quoting Piney Run, 268 F.3d at 268).

355. The question of "reasonable contemplation" focuses in particular on whether the alleged discharges were "within the reasonable contemplation of the permitting authority *during the permit application process*." Id. (quoting Piney Run, 268 F.3d at 267) (emphasis added). The question of reasonable contemplation is closely tied to a review of what the permittee itself disclosed, because "the scope of the permit as well as the discharge limitations contained therein

are based largely on information provided by the permit applicant." In Re Ketchikan Pulp Co., 7 E.A.D. 605, 1998 WL 284964, at *10 (E.P.A. May 15, 1998).

356. As this Court held on September 9, 2016, "the Court should evaluate every feature of an alleged violation to determine if the relevant discharge or possibility thereof was adequately disclosed and reasonably contemplated," including "the pollutants at issue . . . the location of discharge, its magnitude, or any other relevant trait." (Doc. No. 139 at 30.)

357. In its September 9, 2016 ruling, the Court concluded that TVA may be able to rely on the permit shield doctrine with regard to seeps from the Ash Pond Complex if the "specific seeps [at issue] were only of the type contemplated by the [NPDES] permit, and that the seeps' detection, monitoring, reporting, disclosure, and, if necessary, remediation, were handled in full compliance with the permit." (Id. at 32.)

C. Groundwater under the CWA

358. The CWA "prohibits the discharge of pollutants into 'navigable waters' except as in compliance with the Act's provisions." Cape Fear River Watch, Inc. v. Duke Energy Progress, Inc., 25 F. Supp. 3d 798, 805 (E.D.N.C. 2014) (citing 33 U.S.C. §§ 1311(a), 1362(12)(A)). "The term 'navigable waters' means the waters of the United States, including the territorial seas." 33 U.S.C. § 1362(7). It is undisputed that the Cumberland River is a water of the United States and that discharges to the river therefore can give rise to liability under the CWA. (Doc. No. 226 (J. Stip.) at ¶ 2.)

359. The Cumberland River—like most, if not all, natural bodies of water—is hydrologically connected to the groundwater in the area surrounding it, and therefore it is possible for materials, including pollutants, to be transmitted to the river through that groundwater. Courts, however, have differed with regard to whether the CWA reaches such discharges. Some have held

that the Act regulates discharges through hydrologically connected groundwater just as it would any other ordinary discharges. See, e.g., N. Cal. River Watch v. City of Healdsburg, 496 F.3d 993, 1000 (9th Cir. 2007) (holding that the CWA applied based on hydrologic connection to waters of the United States); Haw. Wildlife Fund v. Cty. of Maui, 24 F. Supp. 3d 980, 995 (D. Haw. 2014) (concluding "that Congress sought to include sufficiently 'confined and discrete' groundwater conduits as 'point sources' under the Act"); Raritan Baykeeper, Inc. v. NL Indus., Inc., No. 09-CV-4117 JAP, 2013 WL 103880, at *15 (D.N.J. Jan. 8, 2013) ("Plaintiffs have sufficiently pleaded that groundwater is a point source because it is hydrologically connected to the river."); Nw. Envtl. Def. Ctr. v. Grabhorn, Inc., No. CV–08–548–ST, 2009 WL 3672895, at *11 (D. Or. Oct. 30, 2009) (concluding, in light of the EPA's regulatory pronouncements, that "the CWA covers discharges to navigable surface waters via hydrologically connected groundwater"); Hernandez v. Esso Standard Oil Co. (P.R.), 599 F. Supp. 2d 175, 181 (D.P.R. 2009) (holding that "the CWA extends federal jurisdiction over groundwater that is hydrologically connected to surface waters that are themselves waters of the United States"); Idaho Rural Council v. Bosma, 143 F. Supp. 2d 1169, 1180 (D. Idaho 2001) (finding that "the CWA extends federal jurisdiction over groundwater that is hydrologically connected to surface waters that are themselves waters of the United States"); Mutual Life Ins. Co. v. Mobil Corp., No. Civ. A. 96–CV1781, 1998 WL 160820, at *3 (N.D.N.Y. 1998) (finding complaint alleging "a hydrological connection between the contaminated groundwater and navigable waters" sufficient to state a claim); Williams Pipe Line Co. v. Bayer Corp., 964 F. Supp. 1300, 1319 (S.D. Iowa 1997) (observing that "[t]he majority of courts have held that groundwaters that are hydrologically connected to surface waters are regulated waters of the United States, and that unpermitted discharges into such groundwaters are prohibited under section 1311"); Wash. Wilderness Coal. v. Hecla Mining Co., 870 F. Supp. 983,

990 (E.D. Wash. 1994) (reasoning that "since the goal of the CWA is to protect the quality of surface waters, any pollutant which enters such waters, whether directly or through groundwater, is subject to regulation by NPDES permit").

360. Other courts, however, have been skeptical of or outright rejected claims that the CWA reaches discharges through groundwater, typically on the ground that groundwater itself is not navigable waters. See, e.g., Rice v. Harken Exploration Co., 250 F.3d 264, 272 (5th Cir. 2001) ("In light of Congress's decision not to regulate ground waters under the CWA/OPA, . . . we hold that a generalized assertion that covered surface waters will eventually be affected by remote, gradual, natural seepage from the contaminated groundwater is insufficient to establish liability under the OPA."); Vill. of Oconomowoc Lake v. Dayton Hudson Corp., 24 F.3d 962, 965 (7th Cir. 1994) (holding that CWA jurisdiction does not extend to groundwater contamination caused by drainage from an artificial pond because "[n]either the Clean Water Act nor the EPA's definition asserts authority over ground waters, just because these may be hydrologically connected with surface waters"); Tri–Realty Co. v. Ursinus Coll., 124 F. Supp. 3d 418, 459 (E.D. Pa. 2015) (explaining that the "discharge of pollutants into navigable waters occurring only through migration of groundwater and uncontrolled soil runoff" is beyond the scope of the CWA because it represents "nonpoint source" pollution); Cape Fear River Watch, Inc., 25 F.Supp.3d at 810 (holding that "Congress did not intend for the CWA to extend federal regulatory authority over groundwater, regardless of whether that groundwater is eventually or somehow 'hydrologically connected' to navigable surface waters"); Umatilla Waterquality Protective Ass'n, Inc. v. Smith Frozen Foods, Inc., 962 F. Supp. 1312, 1320 (D. Or. 1997) (holding that "discharges of pollutants into groundwater are not subject to the CWA's NPDES permit requirement even if that groundwater is hydrologically connected to surface water"); Cooper Indus., Inc. v. Abbott Labs.,

No. 93-CV-193, 1995 WL 17079612, at *3 (W.D. Mich. May 5, 1995) ("Even assuming that the migration of ground water led to the pollution of the Fawn River, which further led to the pollution of the Site, such allegations are insufficient to state a cause of action under the FWPCA.").

361. The Court agrees with those courts that "view[] the issue not as whether the CWA regulates the discharge of pollutants into groundwater itself but rather whether the CWA regulates the discharge of pollutants to navigable waters via groundwater." Yadkin, 141 F. Supp. 3d at 445. "[I]t would hardly make sense for the CWA to encompass a polluter who discharges pollutants via a pipe running from the factory directly to the riverbank, but not a polluter who dumps the same pollutants into a man-made settling basin some distance short of the river and then allows the pollutants to seep into the river via the groundwater." N. Cal. River Watch v. Mercer Fraser Co., No. C-04-4620 SC, 2005 WL 2122052, at *2 (N.D. Cal. Sept. 1, 2005).

362. Construing the CWA to reach at least some discharges through groundwater is also consistent with guidance from the EPA. See, e.g., Nat'l Pollutant Discharge Elimination Sys. Permit Regulation and Effluent Limitations Guidelines and Standards for Concentrated Animal Feeding Operations, 66 Fed. Reg. 2960, 3017 (Jan. 12, 2001) ("As a legal and factual matter, EPA has made a determination that, in general, collected or channeled pollutants conveyed to surface waters via ground water can constitute a discharge subject to the Clean Water Act."); Reissuance of NPDES General Permits for Storm Water Discharges From Constr. Activities, 63 Fed. Reg. 7858, 7881 (Feb. 17, 1998) ("EPA interprets the CWA's NPDES permitting program to regulate discharges to surface water via groundwater where there is a direct and immediate hydrologic connection"); Amendments to the Water Quality Standards Regulation That Pertain to Standards on Indian Reservations, 56 Fed. Reg. 64876, 64892 (Dec. 12, 1991) ("[T]he Act requires NPDES permits for discharges to groundwater where there is a direct hydrological connection between

groundwaters and surface waters. In these situations, the affected groundwaters are not considered 'waters of the United States' but discharges to them are regulated because such discharges are effectively discharges to the directly connected surface waters.").

363. Nevertheless, the Court agrees that "a generalized assertion that covered surface waters will eventually be affected by remote, gradual, natural seepage from the contaminated groundwater is insufficient to establish liability" under the CWA. Rice, 250 F.3d at 272. Another judge of this Court has considered the CWA's treatment of groundwater and concluded that discharges through groundwater may be actionable, but with the crucial caveat that a plaintiff must be able to "prove a link between contaminated ground waters and navigable waters" through which the plaintiff can "trace pollutants from their source to surface waters." Ass'n Concerned Over Res. & Nature, Inc. v. Tenn. Aluminum Processors, Inc., No. 1:10-00084, 2011 WL 1357690, at *18 (M.D. Tenn. Apr. 11, 2011). The Court agrees with Judge Haynes' general formulation.

364. The Court notes, however, that the requirement that a plaintiff be able to trace pollutants' passage from their source to navigable waters does not require that the plaintiff be able map every inch of that path with perfect precision. To some degree, a hydrologic connection's traceability is a feature not of the connection itself, but the physical and technological limitations surrounding the parties' observation of it. In a world of perfect knowledge, all hydrologic connections, no matter how general or attenuated, would be traceable—but that does not mean that Congress intended to reach all such connections with the CWA. By the same token, in the considerably more technologically primitive world of the past, one presumably could not trace water flows that could not be seen with the naked eye, but those invisible hydrological connections were no less real or substantial than they are today. Perfect traceability is ultimately a technological and epistemological issue, not a legal one. As long as a connection is shown to be real, direct, and

immediate, there is no statutory, constitutional, or policy reason to require that every twist and turn of its path be precisely traced. See, e.g., Reissuance of NPDES General Permits for Storm Water Discharges From Constr. Activities, 63 Fed. Reg. at 7881 (interpreting the NPDES program to "regulate discharges to surface water via groundwater where there is a direct and immediate hydrologic connection"); Tenn. Aluminum Processors, Inc., 2011 WL 1357690, at *17 ("[O]f those courts that find that CWA jurisdiction applies to groundwater, the groundwater must have a direct hydrologic connection to surface waters that are waters of the United States.").

365. Accordingly, the Court concludes that a cause of action based on an unauthorized point source discharge may be brought under the CWA based on discharges through groundwater, if the hydrologic connection between the source of the pollutants and navigable waters is direct, immediate, and can generally be traced.

D. Point Source vs. Nonpoint Source Discharges

366. The CWA divides "the sources of water pollution into categories: 'point source,' 33 U.S.C. § 1362(14); and 'nonpoint source' 33 U.S.C. § 1288." Nat'l Wildlife Fed'n v. Consumers Power Co., 862 F.2d 580, 582 (6th Cir. 1988).

The CWA defines "point source" as

> any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.

33 U.S.C.A. § 1362(14).

367. "Nonpoint source" is a catch-all category encompassing any water pollution problems that do not involve a discharge from a point source. Consumers Power Co., 862 F.2d at 582; Nat'l Wildlife Fed'n v. Gorsuch, 693 F.2d 156, 165-66 & n.28 (D.C. Cir. 1982). "Nonpoint sources

include pollution from diffuse land use activities such as agriculture, construction and mining that enter the waters primarily through indiscrete and less identifiable natural processes such as runoffs, precipitation and percolation." Cordiano v. Metacon Gun Club, Inc., 575 F.3d 199, 220 (2d Cir. 2009) (quoting Frank P. Grad, Treatise on Environmental Law § 3.03 (updated 2009)).

368. With regard to point source pollution, the CWA "generally prohibits the discharge of any effluent into a navigable body of water unless the point source has obtained an NPDES permit." Int'l Paper, 479 U.S. at 489. "Where the source of a pollutant is a point source, and the pollutant is discharged into navigable waters, the source must obtain [an NPDES] permit limiting and controlling both the amount and type of pollutants which can be lawfully discharged." Consumers Power Co., 862 F.2d at 582.

369. In contrast, the CWA "leaves the regulation of nonpoint source pollution to the states." Cordiano, 575 F.3d at 219; see also Consumers Power Co., 862 F.2d at 587–88 ("Although an essential element in a national effort to control water pollution, the NPDES permit program stands alongside of the system controlling 'nonpoint sources' of pollution . . . . State water quality standards are the basis of the 'nonpoint source' program.").

370. The Ash Pond Complex, as a series of discernible, confined, and discrete ponds that receive wastewater, treat that wastewater, and ultimately convey it to the Cumberland River, is a point source. See Yadkin, 141 F. Supp. 3d at 443–44 ("The coal ash lagoons . . . are surface impoundments designed to hold accumulated coal ash in the form of liquid waste. . . . As such, the coal ash lagoons appear to be confined and discrete. . . . As confined and discrete conveyances, the lagoons fall within the CWA's definition of 'point source.'"); United States v. Alpha Nat. Res., Inc., No. 2:14-11609, 2014 WL 6686690, at *1 (S.D. W.Va. Nov. 26, 2014) (referring to "various

impoundments and settlement ponds . . . and other conveyances that qualify as 'point sources' emitting 'pollutants' as those two terms are defined under federal law for [CWA] purposes").

371. Discharges from the Ash Pond Complex are therefore point source discharges on which CWA liability may be premised.

372. TVA argues that the Non-Registered Site, as a largely dewatered former ash pond system that is exposed to water primarily through runoff and rainfall, is not a point source. (Doc. No. 242 at ¶ 311.)

373. "The concept of a point source was designed [to embrace] the broadest possible definition of any identifiable conveyance from which pollutants might enter the waters of the United States." Residents Against Indus. Landfill Expansion (R.A.I.L.E.) v. Diversified Sys., Inc., 804 F. Supp. 1036, 1038 (E.D. Tenn. 1992) (quoting United States v. Earth Scis., Inc., 599 F.2d 368, 373 (10th Cir. 1979)).

374. 33 U.S.C. § 1314(f) grants "the EPA the power to issue guidelines for identifying and evaluating the nature and extent of nonpoint sources of pollutants," Consumers Power Co., 862 F.2d at 583, and to issue "processes, procedures, and methods to control pollution resulting from . . . the disposal of pollutants in . . . subsurface excavations." 33 U.S.C. § 1314(f)(D).

375. The EPA has described nonpoint source pollution as follows:

> [Nonpoint source pollution] is caused by diffuse sources that are not regulated as point sources and normally is associated with agricultural, silvicultural and urban runoff, runoff from construction activities, etc. Such pollution results in the human-made or human-induced alteration of the chemical, physical, biological, and radiological integrity of water. In practical terms, nonpoint source pollution does not result from a discharge at a specific, single location (such as a single pipe) but generally results from land runoff, precipitation, atmospheric deposition, or percolation.

Cordiano, 575 F.3d at 220 (quoting EPA Office of Water, Nonpoint Source Guidance 3 (1987)).

376. Nevertheless, pollution enabled by runoff, precipitation, and/or percolation of water can, in some instances, qualify as point source pollution. For example, the EPA has provided that point source pollution "includes additions of pollutants into waters of the United States from . . . surface runoff which is collected or channelled by man." 40 C.F.R. § 122.2(b); see also Sierra Club v. Abston Const. Co., 620 F.2d 41, 45 (5th Cir. 1980) ("Gravity flow, resulting in a discharge into a navigable body of water, may be part of a point source discharge if the miner at least initially collected or channeled the water and other materials.").

377. TVA suggests that, because the EPA has expressly defined point source discharges to include discharges from "surface runoff which is collected or channelled by man," then the CWA, by implication, cannot reach any discharges enabled by infiltration of rainwater that was *not* channeled by human action. See Cordiano, 575 F.3d at 221 ("By implication, surface water runoff which is neither collected nor channeled constitutes nonpoint source pollution and consequentially is not subject to the CWA permit requirement."). That argument, however, fails to resolve this matter for a number of reasons. First, discharges from the Non-Registered Site involve not merely surface runoff but groundwater. Second, the regulation cited by TVA is expressly a non-exhaustive list of regulated discharges. See 40 C.F.R. § 122.2(b).

378. Most importantly, 40 C.F.R. § 122.2, when understood in the context of the definition of point source itself, clearly does not support such a broad implication. The regulation's reference to channeling of runoff in 40 C.F.R. § 122.2(b) reflects the fact that, where runoff is channeled by human action, channeling in and of itself satisfies the requirement of a discernible, confined, and discrete conveyance. In other words, unless surface runoff is directed into some kind of discrete drainage channel, the requirement for a discernible, confined, and discrete conveyance has not yet been satisfied. That requirement, though, can still be satisfied by some other vessel that gives rise

to the ultimate discharge. Here, Plaintiffs do not rely on any alleged drainage channel as their point source, but rather a wholly separate discernible, confined, and discrete conveyance—the entire abandoned ash pond system itself.

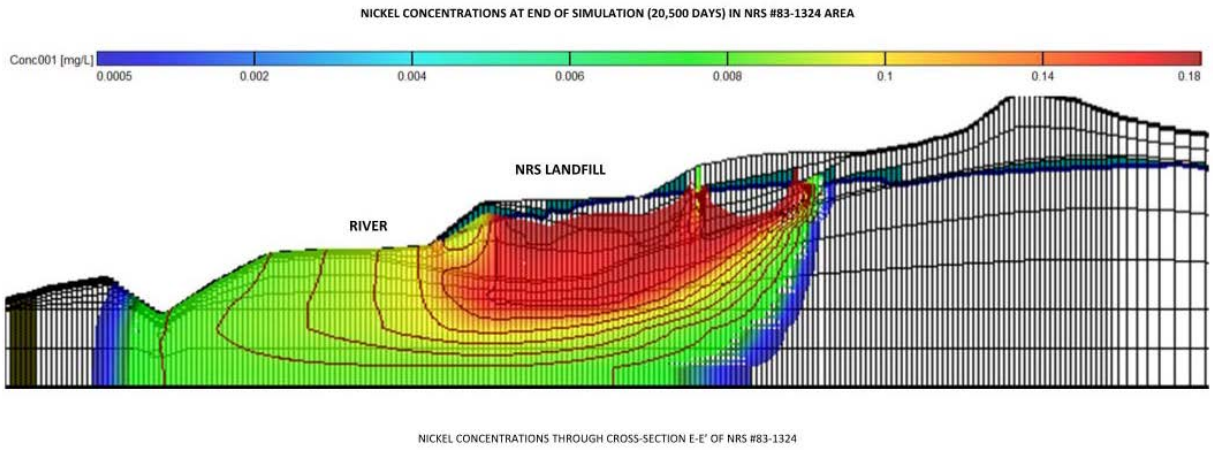
379. When a preexisting discrete container of pollutants "fails because of flaws in the construction . . . , with resulting discharge, . . . the escape of liquid from the confined system is from a point source. [Even if] the source of the excess liquid is rainfall or snow melt, this is not the kind of general runoff considered to be from nonpoint sources . . . ." Earth Scis., Inc., 599 F.2d at 374. The Non-Registered Site presents just such a case: pollutants have already been confined, and infiltration by outside water is merely the catalyst for the unauthorized discharges.

380. In other words, while TVA has admittedly not actively sought to channel the flow of *precipitation*, the Non-Registered Site meets the definition of "point source" because TVA has "channel[ed] the flow of pollutants" themselves, Va. Elec. & Power Co., 2017 WL 1095039, at *8, by forming a discrete, unlined concentration of coal ash. Nothing in the CWA requires that every component passing through a point source be channeled by human action, as long the source itself meets the threshold requirements of a point source.

381. Because EPA regulations do not definitively resolve whether the Non-Registered Site should be considered a point source, the Court must be guided by the language of the statutory definition, which requires that point source pollution be tied to a "[1] discernible, [2] confined and [3] discrete [4] conveyance." In other words, "the ultimate question is whether pollutants were discharged from discernible, confined, and discrete conveyance[s] [by any] means." Va. Elec. & Power Co., 2017 WL 1095039, at *7 (quoting Ohio Valley Envtl. Coal., Inc. v. Hernshaw Partners, LLC, 984 F. Supp. 2d 589, 599 (S.D. W.Va. 2013)).

382. Prior to 1970, when the Non-Registered Site was a functioning ash pond wastewater treatment system, it would have met the current definition of point source for reasons similar to those that apply to the Ash Pond Complex today. The purpose of a coal ash pond is "to concentrate coal ash, and its constituent pollutants, in one location. That one location channels and conveys [pollutants] directly into the groundwater and thence into the surface waters. Essentially, they are discrete mechanisms that convey pollutants from the . . . power plant to the river." Va. Elec. & Power Co., 2017 WL 1095039, at *7.

383. Although the Non-Registered Site has been largely dewatered, TVA has presented no evidence to suggest that the dewatering process would change the fact that the former ash pond system is discernible, discrete, and confined. All of the evidence presented to the Court suggests that the Non-Registered Site is still the home of a discrete, man-made area that was filled, by TVA, with concentrated and still-present coal ash waste. Recent documentation confirms that assessment. For example, a depiction of predicted nickel contamination from the 2014 Arcadis Report depicts a discernible, discrete area of high concentration bounded plainly by areas of low concentration—in other words, a discernible, discrete, confined and manmade concentration of waste:



(J. Ex. 59 at TVGF_004976.) The requirement that the relevant vessel be discernible, discrete, and confined plainly continues to be met.

384. TVA argues next that the Non-Registered Site cannot be a point source because it is no longer a "conveyance." However, where a discernible, discrete, and confined impoundment is "unlined and leaking pollutants" it is also, by definition, "*conveying* pollutants" through those leaks. Yadkin, 141 F. Supp. 3d at 444 (emphasis added). A discrete conveyance "'need only convey the pollutant to navigable waters' for it to be a point source discharge." Sierra Club v. BNSF Ry. Co., No. C13-967-JCC, 2016 WL 6217108, at *8 (W.D. Wash. Oct. 25, 2016) (quoting S. Florida Water Mgmt. Dist., 541 U.S. at 105). Accordingly, if Plaintiffs are able to establish ongoing unauthorized discharges from the Non-Registered Site, they will also have established that it is a conveyance.

385. In sum, this Court concludes, based on the entire trial record, that Plaintiffs have proven by a preponderance of the evidence that any ongoing discharges of pollutants from the Ash Pond Complex and Non-Registered Site are discharges from discernible, confined, and discrete conveyances, and therefore are point source discharges under the CWA.

E. Citizen Enforcement and the Diligent Prosecution Bar

386. "Although the primary responsibility for enforcement [of the CWA] rests with the state and federal governments, private citizens provide a second level of enforcement and can serve as a check to ensure the state and federal governments are diligent in prosecuting Clean Water Act violations." Sierra Club v. Hamilton Cty. Bd. of Cty. Comm'rs, 504 F.3d 634, 637 (6th Cir. 2007). Accordingly, any citizen with constitutional standing to do so may file an action "against any person . . . who is alleged to be in violation of . . . an effluent standard or limitation" of the CWA. 33 U.S.C. § 1365(a)(1).

387. The statute of limitations applicable to a citizen enforcement suit under the CWA is five years. 28 U.S.C. § 2462; see Pub. Interest Research Grp. of N.J., Inc. v. Powell Duffryn Terminals Inc., 913 F.2d 64, 74-75 (3d Cir. 1990) (holding that the five-year statute of limitations, 28 U.S.C. § 2462, applies to citizen suits under the CWA); Frilling v. Honda of Am. Mfg., Inc., No. C-3-96-181, 1996 WL 1619348, at *8-9 (S.D. Ohio Oct. 21, 1996) (same).

388. Before filing suit alleging a CWA violation, the citizen must provide sixty days' notice to the alleged violator, the EPA, and the State in which the alleged violation occurred. 33 U.S.C. § 1365(b)(1)(A). "The 60-day notice provides federal and state governments with the time to initiate their own enforcement actions." Hamilton Cty. Bd. of Cty. Comm'rs, 504 F.3d at 637. If the United States or relevant state government does commence proceedings, the proposed citizen suit may be blocked by what is known as the "diligent prosecution bar."

389. The diligent prosecution bar provides that a citizen cannot file an enforcement suit "if the Administrator or State has commenced and is diligently prosecuting a civil or criminal action in a court of the United States, or a State to require compliance with the standard, limitation, or order" on which the violation is premised. 33 U.S.C. § 1365(b)(1)(B). "Section 1365(b)(1)(B) does not require government prosecution to be far-reaching or zealous. It requires only diligence. Nor must an agency's prosecutorial strategy coincide with that of the citizen-plaintiff." Karr v. Hefner, 475 F.3d 1192, 1197 (10th Cir. 2007). "[A] CWA enforcement action will be considered diligent where it is capable of requiring compliance with the Act and is in good faith calculated to do so." Piney Run Pres. Ass'n v. Cty. Comm'rs of Carroll Cty., Md., 523 F.3d 453, 460 (4th Cir. 2008) (citation omitted).

390. "[A] diligent prosecution bar only applies to those issues sought to be addressed in a citizen action that overlap with those issues sought to be addressed by the government's

suit." United States v. Bd. of Cty. Comm'rs of Hamilton Cty., Ohio, No. 1:02 CV 00107, 2005 WL 2033708, at *11 (S.D. Ohio Aug. 23, 2005) (citing Frilling v. Vill. of Anna, 924 F. Supp. 821, 836 (S.D. Ohio 1996)).

391. The question of whether certain allegations are subject to the diligent prosecution bar is "normally determined as of the time of the filing of a complaint." Id. at *12 (quoting Chesapeake Bay Found. v. Am. Recovery Co., 769 F.2d 207, 208 (4th Cir. 1985)); see also Ohio Valley Envtl. Coal. v. Maple Coal Co., 808 F.Supp.2d 868, 883 (S.D. W.Va. 2011) ("First, a court must determine whether a prosecution by the state (or the EPA Administrator) to enforce the same 'standard, order, or limitation' was pending on the date that the citizens' suit commenced. Second, if the answer to the previous question is affirmative, a court must also determine whether the prior pending action was being 'diligently prosecuted' by the state at the time that the citizens' suit was filed."). Such a rule frees the Court from the burden of having to audit and re-assess the relevant government's enforcement actions throughout the pendency of the citizen action.

392. Basing the Court's application of the diligent prosecution bar on the status of litigation at the time of the filing of the citizen complaint is also the reading most consistent with the language of the bar itself, which is expressly addressed to whether an action "may be commenced." 33 U.S.C. § 1365(b).

393. In its ruling of September 9, 2016, the Court considered the diligent prosecution bar in the context of the State Enforcement Action. The Court concluded that, based on the information before it, the State's prosecution of the State Enforcement Action appeared to have been diligent at the time of the filing of the Complaint in this matter. The Court therefore concluded that the allegations in this matter that directly overlapped with the allegations raised in the State's complaint would be dismissed. (Doc. No. 139 at 20.)

394. The Court based its ruling only on the conclusion that the State's enforcement efforts appeared to have been diligent as of the April 14, 2015 filing of the Complaint in this matter. The Court did not and will not make any determination that the State's subsequent activities in the State Enforcement Action have amounted to diligent prosecution. The Court's prior ruling moreover should not be read as creating any inference or presumption that the eventual resolution of the State Enforcement Action will itself reflect diligent prosecution, or that a claim filed after April 14, 2015, should be subject to the diligent prosecution bar.

395. In the September 9, 2016 ruling, the Court identified two sets of allegations in the federal Complaint that were not barred by the pendency of the State Enforcement Action or otherwise subject to dismissal: (1) TVA's "discharges from the Non-Registered Site into the Cumberland River," as opposed to merely into surrounding groundwater; and (2) its "discharges from the Ash Pond Complex via hydrologic flows that are not seeps alone." (Id. at 42.) As the Court used the term, "seeps" refers to "slow pore-space seepage of contaminants," as opposed to "conduit flow . . . that provides rapid connectivity with little to no pollutant attenuation." (Id. at 6 (quoting Doc. No. 1 at ¶ 152).) All claims, under any theory of liability, that did not arise out of those two classes of allegations were dismissed. (Id. at 42.)

396. No evidence presented at trial, however, suggests that the Court should expand its application of the diligent prosecution bar beyond the substantial body of claims already dismissed. TVA has argued that the Court should dismiss the remaining claims because the Plaintiffs did not present evidence at trial to establish a lack of diligent prosecution. (Doc. No. 242 at 14.) TVA, however, presented no evidence to suggest that the surviving federal claims—which remained in the case specifically because they did not appear to be encompassed by the complaint in the State

Enforcement Action—were being prosecuted by the State at all, let alone diligently. The Court will not simply assume that claims are barred absent any evidence to the contrary.

397. Accordingly, the Court will not dismiss any additional aspects of Plaintiffs' claims pursuant to the diligent prosecution bar. In light of the Court's September 9, 2016 ruling, Plaintiffs may prevail if they can establish actionable CWA violations premised on one or both of the allegations still pending before the court: discharges from the Non-Registered Site into the Cumberland River; and discharges from the Ash Pond Complex via hydrologic flows that are not seeps alone.

F. Ongoing or Intermittent vs. Wholly Past Violations

398. The citizen suit provision of the CWA does not permit a plaintiff to bring suit for "wholly past violations" of the statute. Gwaltney of Smithfield, Ltd. v. Chesapeake Bay Found., Inc., 484 U.S. 49, 64 (1987). "[T]he harm sought to be addressed by the citizen suit [must] lie[] in the present or future, not in the past." Id. at 59. "[O]nce the polluter ceases his active pollution, the violation is wholly past." Crigler v. Richardson, No. 3:08-681, 2010 WL 2696506, at *5 (M.D. Tenn. July 7, 2010).

399. In order to state a claim for citizen enforcement of the CWA, then, a plaintiff must rely on "a good-faith allegation of continuous or intermittent violation" of the CWA, including "a reasonable likelihood that a past polluter will continue to pollute in the future." Ailor v. City of Maynardville, Tenn., 368 F.3d 587, 597−98 (6th Cir. 2004) (quoting Gwaltney, 484 U.S. at 57).

400. At trial, "[a] citizen-plaintiff may establish that a violation was ongoing either '1) by proving violations that continue on or after the date the complaint is filed, or 2) by adducing evidence from which a reasonable trier of fact could find a continuing likelihood of a recurrence in intermittent or sporadic violations.'" Allen Cty. Citizens for Env't, Inc. v. BP Oil Co., 966 F.2d

1451 (6th Cir. 1992) (unpublished) (quoting Chesapeake Bay Found., Inc. v. Gwaltney of Smithfield, Ltd., 844 F.2d 170, 171-72 (4th Cir. 1988)).

G. Burden of Proof

401. "[A] party who brings a citizens' suit pursuant to the CWA is acting in the role of a private attorney general, based on the government's lack of enforcement action, in order to vindicate the rights of society as a whole, rather than to vindicate his own private rights." DP Marina, LLC v. City of Chattanooga, Tenn., 41 F. Supp. 3d 682, 689 (E.D. Tenn. 2014).

402. As the party bringing suit, Plaintiffs bear the burden of establishing the elements of a CWA violation. See Gwaltney, 484 U.S. at 66 ("If [the CWA] case proceeds to trial on the merits . . . the plaintiff must prove the allegations in order to prevail.").

403. "To succeed on a § 1365 citizen suit to enforce § 1311, a plaintiff must establish three elements: (1) that the defendant unlawfully discharged or is discharging a 'pollutant'; (2) that the discharge emanated or is emanating from a 'point source'; and (3) that the pollutant was discharged or is being discharged into 'navigable waters.'" Apalachicola Riverkeeper v. Taylor Energy Co., LLC, 954 F. Supp. 2d 448, 454 (E.D. La. 2013).

404. Because one element of the cause of action is that the discharge be unlawful, Plaintiffs bear the initial burden of demonstrating that the discharge at issue is of the type prohibited by the CWA.

405. TVA argues that Plaintiffs therefore also bear the burden of establishing that their claim is not barred by the permit shield provision. Insofar as TVA's invocation of the permit shield is based on the argument that TVA is in compliance with all of the express terms of its NPDES permit, TVA is correct: in such cases the question of whether there is a CWA violation and whether the permit shield applies are one and the same.

406. As part of their prima facie case, Plaintiffs must prove any alleged violation of the permit. See Tamaska v. City of Bluff City, Tenn., 26 F. App'x 482, 485 (6th Cir. 2002) ("A citizen may establish that a violation is ongoing . . . by *proving violations* that continue on or after the date the complaint is filed . . . ."). Where the application of the permit shield is premised on the discharge being wholly lawful under the express terms of the permit, the applicability of the shield is therefore subsumed by Plaintiffs' initial burden to show the unlawfulness of the discharge.

407. As the Sixth Circuit has interpreted the CWA's permit shield provision, however, it protects more than merely discharges that are lawful under the terms of the relevant NPDES permit, but all "discharges . . . within the permitting authority's 'reasonable contemplation'" when the permit was issued. ICG Hazard, 781 F.3d at 286 (quoting Piney Run, 268 F.3d at 268). Plaintiffs' prima facie CWA case requires no such showing regarding the behind-the-scenes details of the permitting process.

408. The structure of the CWA further suggests that invocation of the permit shield goes beyond the mere threshold question of lawfulness encompassed by a plaintiff's prima facie case. Section 1311(a) forbids point source discharges other than those "in compliance with" certain other sections of the CWA, including 33 U.S.C. § 1342. Section 1342(a) empowers the EPA—or, in this case, its designee TDEC—to "issue a permit for the discharge of any pollutant." Accordingly, discharging pollutants as authorized by a permit is already lawful pursuant to section 1342(a)'s incorporation into section 1311—without the need to rely on a separate permit shield provision. Congress, however, did enact such a separate provision, 33 U.S.C. § 1342(k), suggesting that Congress intended to provide a defense beyond that afforded by the permit alone.

409. The language of section 1342(k) confirms that its permit shield involves matters beyond prima facie unlawfulness. A polluter who successfully invokes section 1342(k) is "deemed

[in] compliance" with section 1311. To "deem" something as possessing a particular quality as a matter of law—here, compliance—is to rule that it should be "treat[ed] . . . as if . . . it has qualities that it does not have." DEEM, Black's Law Dictionary (10th ed. 2014). There is no need to "deem" a discharge to be lawful unless the discharge is otherwise *unlawful*. In other words, the permit provision, by its own language, protects some polluters whose actions are on their face in violation of the CWA. The most obvious such class of persons is those protected by the permit shield because their point source discharges of pollutants, though not authorized by permit, were within the permitting authority's reasonable contemplation.

410. The structure, language, and substance of the permit shield therefore all support the conclusion that it cannot merely be subsumed by the Plaintiffs' burden of showing unlawfulness, but instead calls for an additional, separate inquiry into issues involving the permitting process that extend well beyond the Plaintiffs' prima facie case.

411. Because invocation of the permit shield based on "reasonable contemplation" raises a matter beyond the scope of the prima facie case, it presents a classic affirmative defense. See Ford Motor Co. v. Transp. Indem. Co., 795 F.2d 538, 546 (6th Cir. 1986) ("An affirmative defense raises matters extraneous to the plaintiff's prima facie case; as such, they are derived from the common law plea of 'confession and avoidance.'" (quoting 5 C. Wright & A. Miller, Federal Practice & Procedure § 1270, at 289 (1969))); see also Jones v. Bock, 549 U.S. 199, 212 (2007) (holding that exhaustion requirement amounted to an affirmative defense because it involved matters beyond what petitioner was required to establish to show entitlement to relief).

412. The defendant "has the burden of proof on all affirmative defenses." Fonseca v. Consol. Rail Corp., 246 F.3d 585, 590 (6th Cir. 2001). Accordingly, insofar as TVA argues that a facially unlawful discharge is covered by the permit shield merely because it was contemplated by

TDEC at the time of the issuance of the NPDES permit, TVA bears the burden of establishing the underlying facts. See Fed. R. Civ. P. 8(c).

413. In summary, Plaintiffs have the initial burden of establishing that TVA (1) discharged and is reasonably likely to continue discharging a pollutant in violation of the CWA and the facial terms of its NPDES permit; (2) that the discharge emanated from a point source; and (3) that the discharges were/are into 'navigable waters'—which, where the discharges alleged involve hydrologically connected groundwater, requires Plaintiffs to show that the hydrologic connection between the source of the pollutants and navigable waters is direct, immediate, and can generally be traced. In light of the Court's earlier dismissal of a portion of Plaintiffs' claims under the diligent prosecution bar, the Plaintiffs can only meet their burden with evidence related to two classes of discharge: discharges from the Non-Registered Site into the Cumberland River; and discharges from the Ash Pond Complex via hydrologic flows that are not seeps alone, with "seeps alone" being defined as "leaks consisting solely of slow pore-space seepage of contaminants." If Plaintiffs meet their initial burden, Defendants bear the burden of establishing that the discharges at issue were within the reasonable contemplation of TDEC at the time of the issuance of TVA's NPDES permit.

V. FINDINGS & CONCLUSIONS ON PLAINTIFFS' CLAIMS

A. The Non-Registered Site

414. Testing and analysis by Sulkin, Quarles, and Vengosh conclusively establishes that coal ash constituents have historically been discharged into the Cumberland River from the Non-Registered Site.

415. The Non-Registered Site, as discussed *supra*, is a point source insofar as it conveys pollutants to the Cumberland River via leaks.

416. Coal ash and its constituents fall under the Clean Water Act definition of "pollutants." See 33 U.S.C § 1362(6) ("The term 'pollutant' means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water").

417. The Cumberland River is a navigable water of the United States.

418. Neither the text of TVA's NPDES permit, nor the permit rationale, nor the evidence at trial regarding the permitting process supports a reading of the permit that authorizes discharges from the Non-Registered Site. Consistently with Janjic's testimony, the Court construes the permit as authorizing and reasonably contemplating coal ash wastewater discharges from the Ash Pond Complex only. TVA is not entitled to protection from the permit shield provision with regard to the Non-Registered Site.

419. The extent of TVA's historical pollution creates difficulties in determining whether unauthorized discharges are continuing or wholly past. Ultimately, however, Plaintiffs have carried their burden of demonstrating that the unauthorized discharges from the Non-Registered Site are either ongoing or intermittent and likely to reoccur. It is apparent that the Site has leaked historically, and there is no evidence in the record that would permit the Court to infer that the leakage has stopped.

420. While some of the pollution around the Non-Registered Site may be attributable to historical slides rather than leaks, the evidence before the Court convincingly establishes that leaks have historically contributed to contamination. Indeed, it appears that the design of the now-closed ash ponds would have rendered leakage inevitable.

421. There is no evidence to suggest that the 1970 abandonment of the area wholly stopped the area from leaking. Rather, there is significant evidence that it continued to do so thereafter.

422. There is moreover no evidence to suggest that the "closure" of the site decades later wholly stopped the leaking, and in fact at least one of TVA's own experts conceded that the 1998 closure would be considered insufficient to prevent infiltration of rainwater under currently prevailing standards and that seeps from the Non-Registered Site have continued. (See Doc. No. 229-1 (Lang Wr. Test.) at 7−8.)

423. Faced with an impoundment that has leaked in the past and no evidence of any reason that it would have stopped leaking, the Court has no choice but to conclude that the Non-Registered Site has continued to and will continue to leak coal ash waste into the Cumberland River, through rainwater vertically penetrating the Site, groundwater laterally penetrating the Site, or both.

424. Plaintiffs accordingly have established an ongoing violation of the CWA with regard to the Non-Registered Site. Because this allegation involves discharges to the Cumberland River, it is not barred by the pendency of the State Enforcement Action.

B. The Ash Pond Complex

425. Testing and analysis by Sulkin, Quarles, and Vengosh conclusively establishes that coal ash constituents have historically been discharged into the Cumberland River from the Ash Pond Complex at locations other than the single authorized discharge point at Outfall 001.

426. As discussed *supra*, the Ash Pond Complex is a point source, coal ash waste is a pollutant, and the Cumberland River is a navigable water of the United States.

427. Accordingly, whether Plaintiffs can succeed on their Ash Pond Complex claims depends on the following four issues: (1) whether the discharges are wholly past or ongoing/intermittent and recurring; (2) whether the discharges are of a type that survived the

Court's earlier ruling on the diligent prosecution bar; (3) whether Plaintiffs have identified a sufficiently direct connection between relevant groundwater leaks and the waters of the United States; and (4) whether the discharges are entitled to protection under the permit shield doctrine.

1. Continuing Violations

428. It is undisputed that the Ash Pond Complex has historically leaked, and that coal ash waste has historically escaped through those leaks. As with the Non-Registered Site, TVA's history of allowing pollutants to escape from the Ash Pond Complex complicates the investigation of whether any such leaks continue to take place. Although the Court was presented with a great deal of expert evidence regarding the presence of pollutants associated with coal ash in the Cumberland River and the nearby groundwater, none of the science presented was capable of definitively identifying when the relevant pollutants entered the water.

429. The record is silent with regard to detailed, credible evidence of whether the undisputed historical leakage is capable of justifying pollutant concentrations in the amounts observed today.

430. On balance, however, the evidence preponderates toward concluding that the discharges from the Ash Pond Complex are either ongoing or intermittent and recurring. The ponds continue to be unlined. The terrain continues to be karst. There is substantial evidence that the surrounding groundwater is hydrologically connected to the Cumberland River and that some of that groundwater contains coal ash pollutants in significant levels. While the Ash Pond Complex has undergone some repairs, none of those repairs were of the sort that would have negated the fundamental features of the Complex that make it so prone to leak.

431. Accordingly, the Court concludes, based on the preponderance of the evidence, that the evidence of coal ash pollution in the areas of the Cumberland River near the Ash Pond Complex

is indicative of ongoing or intermittent and recurring leaks that occurred during the CWA statute of limitations and are expected to continue in the future.

2. Diligent Prosecution Bar/'Seeps Alone'

432. As discussed *supra*, none of the evidence at trial justified expanding upon the Court's earlier ruling dismissing some, but not all, of Plaintiffs' allegations under the diligent prosecution bar. Accordingly, the fundamental question before the Court now is whether the allegations on which Plaintiffs rely fall within the narrow class of claims that survived its earlier Order, or whether they instead fall solely within the allegations already dismissed.

433. The Court defined the Ash Pond Complex claims that survived its Order as those arising out of "discharges from the Ash Pond Complex via hydrologic flows that are not seeps alone." (Doc. No. 140 at 1.) Plaintiffs therefore must demonstrate that the discharges on which they rely are not "seeps alone." The Court's use of the qualifier "alone" reflects an acknowledgment that geological complexity may cause some leaks, on their path to the river, to include both seepage and non-seepage flow. For example, a theoretical leak might involve water seeping first through a thin layer of soil cover, then reaching and passing through a fissure in rock. Conversely, water might first escape from the pond by way of a karst conduit, but then travel the final few feet to the river by way of slow-pore seepage through soil. The Court's Order of September 9, 2016, dismissed only claims based on seeps *alone*.

434. Because the ten seeps expressly identified in Tennessee's state court complaint are unambiguously part of the State Enforcement Action, those seeps cannot form the basis of liability here.[6] The Court acknowledges, however, that the nature of flowing water is that segregating

[6] TVA points out that some additional leaks, including two on the east side of Odom's Bend Peninsula, were mentioned by Plaintiffs in their Complaint in Intervention in the State Enforcement Action. (J. Ex. 152 at ex. 1.) TVA urges the Court to treat those leaks in the same

pollutants that discharged through one particular source—such as a State Enforcement Action seep—from pollutants that discharged through a separate, nearby source may be difficult or even impossible.

435. Accordingly, it is possible that some sampling locations may include both pollutants attributable to a State Enforcement Action seep and pollutants attributable to other leaks. The mere presence of some contamination relevant to the State Enforcement Action does not necessarily render the pollution identified at a particular site irrelevant—as long as there is evidence to suggest an additional source that is not part of the State Enforcement Action.

436. The evidence presented suggests that, in a body of water the size of the Cumberland River, pollutants become attenuated even a short distance from the initial leak. (See Doc. No. 235 (Tr. Day 2) at 163.) That fact is confirmed by, for example, comparing Vengosh's GT-2 sample with his GT-3 and GT-4 samples. GT-3 and GT-4 show boron concentrations indicative of significant coal ash contamination, but GT-2 is essentially pristine—despite being downstream from that contamination. (Doc. No. 228-1 (Vengosh Wr. Test.) at ¶¶ 45−53.)

437. Accordingly, The Court concludes that it is generally reasonable to infer that a sample showing a high concentration of a pollutant is indicative of an immediately upstream or adjacent discharge.

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manner as it treats the ten seeps named in the State's Complaint. The Court, however, does not construe the Complaint in Intervention as sufficient to expand the scope of what the Court held the State to have been diligently prosecuting at the time the Complaint in this case was filed. In any event, even if the Court did treat those additional seeps in the same manner as it is treating the ten State-identified seeps, it would not affect the Court's ultimate factual and legal conclusions *infra*. At most, the relevant portions of the Court's analysis of the alleged east side leaks would more closely echo its analysis of the west side leaks.

438. If sampling locations can give the Court an idea of where leaks occurred, however, they provide little help in determining what type of leak was involved. For this question, the Court must look to what it knows about the Ash Pond Complex itself and the underlying terrain.

439. The Court's conclusions about the nature of the Ash Pond Complex discharges, then, are based on an analysis of two sets of information: (1) evidence about the features of the Complex itself and the surrounding terrain that would tend to predict or describe the types of leaks expected to arise; and (2) the location and content of tested samples.

a. Features of the Ash Pond Complex

440. At the time of trial, the process of completing the EIP that arose out of the State Enforcement Action was ongoing. The Court, therefore, was unable to benefit from the more detailed study of the area's hydrology and geology that the EIP process is apparently intended to yield. Nevertheless, the parties did present a wealth of contemporaneous and historical assessments of the Complex and the surrounding terrain that were relevant to the question of whether the ongoing leaks are likely to involve conduit flows or merely seepage alone.

441. TVA's assessments of the Complex made in connection with this litigation tended to play up the continued uncertainty about the area's geological properties. Its pre-litigation pronouncements, however, tell a somewhat less uncertain story. Even decades ago, TVA was candid and unambiguous in its understanding of the extensive karst activity immediately below the Ash Pond Complex and its understanding that isolated repairs could not be expected to simply render those karst conditions a thing of the past. It was TVA itself that wrote, in 1977, that "the network of solution cavities and crevices in the groundwater system under the pond is extensive." (J. Ex. 41 at TVGF_008092.) It was TVA that admitted, in the same document, that "plugging the

presently leaking sinkholes would give no assurance that other sink holes would not begin to leak." (Id.)

442. As TVA has pointed out, Plaintiffs have nevertheless been unable to identify specific sinkholes or other leaking karst features in the Ash Pond Complex in the present day. That failure to identify specific leaks within the ponds, however, has a simple explanation: as Plaintiffs' experts explained, any such features are currently obscured by a thick layer of coal ash. Although it would make the Court's job easier to have concrete evidence of karst-related drainage features or concrete evidence of their absence, the realities of the site call for a more searching review, based on what we can and do know.

443. The parties agree—and indeed it appears to be beyond dispute—that the Ash Pond Complex was built upon terrain riddled with potential karst-related leaks, and that those leaks did in fact result in substantial discharge of pollution into the Cumberland River. While there may be some question about the historical records, it appears at least likely that some of this leaking was tied to the geographic feature known as Sinking Creek.

444. Contemporary TVA documentation from the time of the Ash Pond Complex's extensive repairs, in particular the 1977 Leakage Memorandum, leaves substantial reason to doubt that TVA ever wholly cataloged and definitively repaired all of the potential leaks present at the time. Plaintiffs have convincingly demonstrated that—as common sense would confirm—the simple fact that the Complex became capable of holding some water does not show that it was wholly repaired, but only that it was at least leaking more slowly than it was receiving fresh waste.

445. Despite the history of extensive leakage in the Complex, TVA has insisted that there is a lack of affirmative evidence demonstrating specific *current* leaks through karst features. But if one had asked the TVA of 1972 or 1976, it likely would have said the same thing, according to

its own inspections—despite the fact that its ponds were in the process of losing over twenty-five billion gallons of sluice water through precisely such features. (See Doc. No. 237 (Tr. Day 4) at 9–10; Doc. No. 229-2 (Kutschke Wr. Test.) at 7.) The lack of detailed contemporaneous awareness of specific leaks is not persuasive evidence of their absence.

446. Just as the historical leaking is undisputed, it is likewise beyond dispute that sinkholes have been recently discovered in the areas of the Gallatin Plant site that were not obscured by a vision-blocking layer of thick coal ash. TVA's witnesses admit that sinkholes were discovered around the Gallatin Plant in 2010. They admit that sinkholes were known and repaired in the site of the expansion of Ash Pond E in 2005.

447. Perhaps most importantly, the unanimous expert testimony is that sinkholes and other drainage features in karst terrain are not mere relics of some past geologic event. Rather, the physical properties of the terrain itself make such areas prone to the continued development of ever newer sinkholes or other karst features. While Kutschke's testimony suggests that the karst terrain of the Ash Pond Complex is perhaps less sinkhole-prone than some other karst landscapes, that testimony falls short of negating the ponds' general proclivity to leak. It matters little whether this karst is less sinkhole-prone *relative to other karst*. What matters, for the purposes of the Court's ruling on the diligent prosecution bar, is whether the Complex's leaks involve non-seepage flows at all.

448. Dotson's observation of an apparent scarp further supports an inference that the Ash Pond Complex continues to suffer from the volatile, leak-prone realities of karst.

449. Boring logs showing substantial apparent voids similarly support the inference that leaks through conduits, fissures, or other open areas are likely.

450. Admittedly, the lack of demonstrable rapid connectivity between the Complex and the River suggests that whatever leaks do exist in the floors of the ponds are limited in size and rate of outflow. Under the strict liability framework of the CWA, however, the threshold question is whether leaks exist, not whether they are large enough to be easily observed by one particular method.

451. Groves' characterization of the Ash Pond Complex as a colander is perhaps overly simplistic—there is no evidence that the ponds contain leaks as extensive and uniform as that metaphor might suggest. But a container with a few holes is just as surely leaking as one with a hundred. It is simply implausible, based on the evidence before the Court, that the Complex has not continued to, and will not continue to, suffer at least some leaking through karst features.

452. In short, the features of the Ash Pond Complex strongly suggest that it has continued to, and will continue to, leak through karst features that cannot be characterized as "seeps alone."

b. Sampling

453. The sampling locations suggesting that the Ash Pond Complex may be leaking can be classified into two groups: (1) locations on the east side of Odom's Bend Peninsula; and (2) locations tightly grouped on the portion of the west side of Odom's Bend Peninsula that also includes Seeps 4 and 5 from the State Enforcement Action.

454. The evidence of leaking near the east side locations is mixed. Quarles and Sulkin's sampling showed contaminants suggestive of leaks at East Side 1 and East Side 2. (Doc. No. 227-2 (Quarles Wr. Test.) at ¶ 58; Pl. Ex. 1.) Samples taken by Vengosh at the same locations, however, suggested that the water was not impacted by coal ash waste. (Doc. No. 228-1 (Vengosh Wr. Test.) at ¶¶ 43, 53.)

455. The different results could be the result of the different methodologies used by the experts or could reflect leaking that was only intermittent. Vengosh himself testified that he would expect contaminant levels to vary greatly depending on situational factors. (Doc. No. 235 (Tr. Day 2) at 163.) His conclusion that the East Side locations happened to be pristine at the time of his sampling, therefore, does not preclude the possibility that intermittent leaking was nevertheless occurring at other times.

456. The west side sampling is less ambiguous—Vengosh, Sulkin, and Quarles all find evidence of contamination. However, because these sampling sites—APC 1 through 4—were in the general vicinity of Seeps 4 and 5 from the State Enforcement Action, the question arises of whether the contamination detected can be attributed to leaks still cognizable in this case.

457. On close inspection, Plaintiffs' west side sampling locations, though close to Seeps 4 and 5, are nevertheless distinct sites. APC 4 is seventy-five feet from the shoreline. APC 2 is forty feet. APC 1 is the site of a shoreline sample that appears to be over a hundred feet downstream from the nearest State Enforcement Action seep.

458. It is entirely possible that some contamination from the State Enforcement Action seeps also showed up in these samples. The question before the Court, however, is whether the preponderance of the evidence suggests that the State Enforcement Action seeps can account for the entirety of that contamination.

459. TVA's attempt to attribute all of the pollution to the seeps is belied somewhat by its own insistence that the seeps are minor or even, in many cases, inert. AECOM identified a number of seeps, but TVA's 2016 seep inspection report indicated that all of those seeps are currently "non-flowing" and that most of them are no longer active at all. (Doc. No. 229-1 (Lang Wr. Test.) at 9; J. Ex. 157 at TVGF_100719–29, -45.) EPA contractor Dewberry's 2013 Dam Assessment

Report had similarly characterized the Ash Pond Complex's seeps as "minor and adequately monitored." (J. Ex. 126 at 7-11.)

460. Throughout this litigation, TVA has vehemently insisted that the Ash Pond Complex seeps have leaked no more than anticipated during the 2012 permit renewal process. TDEC, though, anticipated only seeps so minor that they would be difficult to quantify or measure empirically. (J. Ex. 102 at PageID 105.) The Court is therefore skeptical that these ostensibly de minimis seeps could also be solely responsible for the incriminating pollutant concentrations to be found a meaningful, if admittedly not great, distance away. The Ash Pond Complex seeps are either de minimis or they are not; TVA cannot convincingly argue that the seeps discharge however much or however little is convenient for the particular defense at hand.

461. Ultimately, the west side sampling, at least as it has been presented to the Court, is consistent with either of two mutually exclusive explanations: (1) that it merely reflects contamination from State Enforcement Action seeps and wholly past leakage; or (2) that it consists, in whole or some part, of contamination from additional leaks, including leaks through the floor of the ponds and including non-seepage flows.

462. Given the inconclusive nature of the sampling, the evidence of the pond's leak-prone construction and history carries the day. While the contamination demonstrated in the Cumberland River may come from multiple sources, it is implausible to suggest that none of the contamination came from a non-seepage flow. The Court therefore concludes, by a preponderance of the evidence, that at least some portion of the unambiguous contamination of the Cumberland River near the Ash Pond Complex is caused by leaks that are not seeps alone. Accordingly, Plaintiffs have demonstrated leaks that fall within the boundaries of the claims not dismissed by the Court's September 9, 2016 Order.

3. Connection to the Waters of the United States

463. As the Court has explained, Plaintiffs must show that the pollutants at issue migrated along a generally traceable, direct connection to the waters of the United States, but they need not be able to set forth every twist or turn on the water's path. Plaintiffs have satisfied this burden.

464. The purpose of requiring a direct, traceable connection between contaminated groundwater and the waters of the United States is to weed out claims that improperly rely on "a generalized assertion that covered surface waters will eventually be affected by remote, gradual, natural seepage from the contaminated groundwater." Rice, 250 F.3d at 272.

465. The leaks here, though, are anything but remote in their connection to the Cumberland River. The Ash Pond Complex is situated directly next to the shores of that river, arguably even on top of one of its former tributaries. While the fractured nature of karst terrain may mean that some groundwater takes a few unexpected detours on its way to the Cumberland, the water's general path is simple, clear, and direct. The fact that the demonstrated discharges to the River involve a short trip through the groundwater first is in no way fatal to Plaintiffs' claims.

4. Permit Shield Doctrine

466. Nothing in the text of the Gallatin Plant's NPDES permit expressly authorizes the continuing discharge of pollutants from leaks in the Ash Pond Complex. Accordingly, Plaintiffs have satisfied their initial burden of demonstrating that the discharges were not authorized. TVA argues that it is nevertheless entitled to protection under the permit shield provision, because those discharges were within TDEC's reasonable contemplation when the permit was issued. As the Court has held *supra*, TVA's argument amounts to an affirmative defense on which it bears the burden of persuasion. It has not met that burden.

467. At most, TVA has demonstrated that, when TDEC issued the NPDES permit for the Gallatin Plant, TDEC was aware that the unlined ponds would continue to experience some ongoing seepage through its dikes. Any claims based purely on minor dike seepage, however, were already dismissed from this case pursuant to the diligent prosecution bar. TVA has not carried its burden of establishing that leaks of the types demonstrated by Plaintiffs were considered by TDEC to be within the scope of what was considered and authorized under the permit.

5. Conclusion

468. In summary, Plaintiffs have established that TVA has discharged and is reasonably likely to continue discharging pollutants from a point source, the Ash Pond Complex, into the Cumberland River in violation of the CWA and the terms of its NPDES permit. They have further demonstrated that those discharges do not consist solely of slow-pore seepage of contaminants and therefore may give rise to relief in this Court. TVA has failed to carry its burden of establishing that the discharges were reasonably contemplated by TDEC as part of the Gallatin Plant NPDES permit. Plaintiffs have therefore established liability under the citizen suit provision of the CWA.

C. Specific Permit Violations

1. Part I.A(c)

469. Part I.A(c), known as a "removed substances" provision, provides that "material removed by any treatment works must be disposed of in a manner . . . which prevents its entrance into or pollution of any surface or subsurface waters." (J. Ex. 102 at 11.) "[T]he removed substances provision aims to ensure the integrity of wastewater treatment and control systems." Yadkin, 141 F. Supp. 3d at 446.

470. Plaintiffs' demonstration of unauthorized discharges from the Ash Pond Complex also resolves their allegation under this provision. As the sluiced waste water undergoes a settling

process, ash is removed from the water. Some of that ash simply remains on the bottom of the pond. Other ash is removed by TVA and reused. Some ash waste, though, escapes to the Cumberland River, creating a violation of the facial terms of Part I.A(c).

471. Plaintiffs are therefore entitled to judgment on Claim E.b.

2. Part II.A(4.a)

472. Part II.A(4.a) requires TVA to "properly operate and maintain all facilities and systems (and related appurtenances) for collection and treatment which are installed or used by the permittee to achieve compliance with the terms and conditions of the permit." (J. Ex. 102 at 19.) Plaintiffs argue that the ongoing leaking of the Ash Pond Complex establishes that the Complex was not properly operated and maintained.

473. Plaintiffs' arguments, however, are in tension with their own proof, which establishes that the leak-prone nature of the Complex is a likely inevitable feature of its siting and design. Indeed, the record before the Court would seem to strongly suggest that there may, in fact, be no way to operate and maintain a wholly unlined coal ash pond in the relevant terrain without giving rise to leaks. Because Part II.A(4.a) expressly concerns itself with operation and maintenance—rather than siting, design, or construction—the Court construes the provision to refer to failures in the day-to-day operation and care of the Complex. TVA's failures in this case, however, were not related to day-to-day operation and care, but to deep systemic flaws in its coal ash waste treatment system.

474. Accordingly, the Court will enter judgment in TVA's favor on Claim E.c.

3. Part II.C(2)

475. Part II.C(2) requires TVA to give notice to TDEC within twenty-four hours of "any noncompliance which could cause a threat to public drinking supplies, or any other discharge

which could constitute a threat to human health or the environment." (J. Ex. 102 at 22.) Because this obligation imposes a time-sensitive requirement, Plaintiffs cannot succeed on this claim without identifying a particular qualifying instance of noncompliance with a time certain. They have failed to do so. While Plaintiffs have demonstrated that the Ash Pond Complex likely leaked continuously or intermittently throughout the period within the state of limitations in this case, they have not identified a particular triggering event creating a threat to human health or the environment that would give rise to an obligation under this provision.

476. Accordingly, the Court will enter judgment in TVA's favor on Claim E.d.

4. Part II.C(3.b)

477. Part II.C(3.b) forbids "the discharge to land or water of wastes from any portion of the collection, transmission, or treatment system other than through permitted outfalls." (Id.) As with Part I.A(c), this allegation is resolved by Plaintiffs' demonstration that TVA improperly discharged coal ash waste through leaks to the Ash Pond Complex. The only permitted outfall for such discharges under the permit was Outfall 001, and therefore any additional leaks, by definition, violated this provision.

478. Plaintiffs are therefore entitled to judgment on Claim E.e.

VI. FINDINGS OF FACT & CONCLUSIONS OF LAW – REMEDIES

479. A party that is held to have committed ongoing violations of the CWA may be subject to both civil penalties and injunctive relief. "Under [the citizen suit provision of the CWA], the district court has discretion to determine which form of relief is best suited, in the particular case, to abate current violations and deter future ones." Laidlaw, 528 U.S. at 192. A court is not automatically required to issue injunctive relief merely because the plaintiff has demonstrated a violation of the law and a risk of future violations. Id. Rather, injunctive relief under the CWA

remains "an equitable remedy" that must be fashioned to the circumstances of the case. Weinberger v. Romero-Barcelo, 456 U.S. 305, 311 (1982).

A. Penalties

480. "The Court has discretion whether to impose civil penalties in a citizen suit under the CWA." Va. Elec. & Power Co., 2017 WL 1095039, at *8 (citing Gwaltney of Smithfield, Ltd. v. Chesapeake Bay Found., Inc., 484 U.S. 49, 52–53 n.1 (1987)). "In determining the amount of a civil penalty the court shall consider the seriousness of the violation or violations, the economic benefit (if any) resulting from the violation, any history of such violations, any good-faith efforts to comply with the applicable requirements, the economic impact of the penalty on the violator, and such other matters as justice may require." 33 U.S.C. § 1319(d).

481. Plaintiffs have demonstrated that TVA has unlawfully discharged pollutants into the Cumberland River, and that those pollutants carry with them particular risks. But the evidence is scant of concrete harm beyond mere risk and the presence of pollutants in and of itself.

482. Moreover, Plaintiffs' own experts characterize their sampling strategy as designed to identify the existence of leaks and not calculated to establish their extent or severity. The record is therefore largely bereft of evidence that would lead the Court to conclude that TVA's violations are particularly severe, in terms of the harm done or the amount of pollutants released.

483. Accordingly, the severity of TVA's violations ultimately counsels against an award of penalties.

484. Also weighing against the imposition of penalties is the fact that TVA has already incurred, and is likely to continue to incur, very substantial costs in remediating the risks from the Ash Pond Complex and Non-Registered Site. TVA may have benefitted some from putting off

remedial action as long as it has, but that delay is coming to an end, at considerable expense. The Court perceives no need for additional penalties on top of those costs.

485. The strongest factor favoring penalties is the long-running nature of TVA's violations. But that factor is mitigated somewhat by the fact that, for much if not all of the period within the statute of limitations, TVA appears to have been at least working towards resolving some or all of its ash pond problems, often with direct involvement of TDEC itself.

486. While TVA has not demonstrated that it is excused from liability by the permit shield doctrine, there is undeniable equitable weight to the fact that TVA likely reasonably believed itself to be working with the agency charged with regulating its discharges. Every indication is that TVA perceived itself as participating in a long-running, collaborative process of addressing its ash waste disposal issues with TDEC.

487. Accordingly, the Court will not assess penalties against TVA under the CWA.

B. Injunctive Relief

488. Generally speaking, a plaintiff seeking permanent injunctive relief "must demonstrate: (1) that it has suffered an irreparable injury; (2) that remedies available at law, such as monetary damages, are inadequate to compensate for that injury; (3) that, considering the balance of hardships between the plaintiff and defendant, a remedy in equity is warranted; and (4) that the public interest would not be disserved by a permanent injunction." eBay Inc., 547 U.S. at 391. "The grant of jurisdiction to ensure compliance with a statute hardly suggests an absolute duty to do so under any and all circumstances, and a federal judge sitting as chancellor is not mechanically obligated to grant an injunction for every violation of law." Weinberger, 456 U.S. at 312 (citing TVA v. Hill, 437 U.S. 153, 193 (1978)). "An injunction should issue only where the

intervention of a court of equity 'is essential in order effectually to protect . . . against injuries otherwise irremediable.'" Id. (quoting Cavanaugh v. Looney, 248 U.S. 453, 456 (1919)).

489. Plaintiffs have easily cleared the initial hurdle of demonstrating that injunctive relief is necessary. The injury here is the unlawful contamination of the river. The strict liability regime adopted by Congress makes clear that unauthorized contamination itself is a harm warranting remediation. The only adequate remedy is one that addresses and mitigates that unlawful contamination. Such a remedy would moreover plainly be in the public interest, and it is only appropriate that TVA—which is already going to bear responsibility for closing the ash ponds regardless of what happens in this case—shoulder the cost.

490. The question of what sort of injunctive relief is appropriate, however, is considerably more difficult. It is apparent from the record that, at the very least, the Ash Pond Complex should be closed as an ash waste treatment facility and the Non-Registered Site must, at a minimum, be improved. Some steps in that direction, in fact, appear to be inevitable regardless of what the Court orders. Considerably less clear is whether these bare minimum actions would be adequate to protect the rights of Plaintiffs and all of the other members of the public who, under the Clean Water Act, possess a right to enjoy the many benefits of the Cumberland River free of any unlawful discharges of pollutants.

491. Although the Court has searched in vain for a compromise position, the parties have consistently presented the question of how to proceed with closure as a binary choice between two options: closure in place versus closure by removal—that is, closure by capping the coal ash impoundments where they are versus closure by excavating and placing the coal ash waste in a new, more secure impoundment. In choosing between these options, the Court must not mechanically select the harsher or more lenient choice, but instead exercise "[f]lexibility rather

than rigidity" to "mould [its] decree to the necessities of the particular case." Id. (quoting Hecht Co. v. Bowles, 321 U.S. 321, 329 (1944)).

492. Closure in place has the clear benefits of being both faster and less expensive than closure by removal. TVA has also persuasively argued that there are some risks associated with excavation of coal ash on the scale that would be required here. The contamination from the Gallatin Plant has, at least in recent years, apparently been mild compared to what could result from a catastrophic event such as a spill during removal or the accidental triggering of a larger failure in the pond floor of the Ash Pond Complex. The Court, therefore, does not take the possibility of closure by removal lightly—and, if the Court were convinced that closure in place would be adequate, that is the relief that the Court would order.

493. The evidence before the Court, however, offers no such assurances—and in fact offers ample reason to doubt that closure in place can actually put an end to the inadvertent discharges that have plagued the Gallatin Plant for the entirety of its existence.

494. For example, it is apparent to the Court that a key issue regarding the efficacy of closure in place is whether, and to what extent, the coal ash waste at the Gallatin Plant penetrates the water table. The testimony on this issue at trial was uncertain and at times contradictory, but, on balance, it does appear more likely than not that some portions of the ponds penetrate the water table. The extent and depth of that penetration, however, remains unclear. Accordingly, giving the Court's blessing to closure in place at this juncture would amount to nothing less than rolling the dice and hoping that reality bears out TVA's understandably self-interested contention that closure in place will be adequate. Closure by removal, in contrast, would resolve the risk of leaking regardless of the impoundments' relationship to the water table.

495. If closure in place did prove inadequate, the likely, if not inevitable, result would be yet more litigation—and, of course, decade after decade of the public simply having to hope that whatever unplanned, incidental leakage that was coming from the impoundments was not enough to do them significant harm.

496. The history of the Non-Registered Site offers a grim preview of what it means to leave an abandoned unlined coal ash waste pond in place next to a river. The Non-Registered Site has not been a waste treatment facility for over forty-five years. It has been "closed" for almost twenty. Still, water infiltrates it. Still, it leaks pollutants. Still, counsel for TVA and counsel for environmental groups are locked in conflict about what can and should be done about it. The Non-Registered Site, moreover, is not even located in karst terrain—meaning that the risks associated with the Ash Pond Complex will likely be even greater. As long as the ash remains where it is in either site, there is every reason to think that the dangers, uncertainties, and conflicts giving rise to this case will survive another twenty years, forty-five years, or more. While the process of closure by removal would not be swift, it would, at least, end.

497. In its search for possible remedies in this case, the Court considered a third possibility: allowing TVA to choose closure in place if it also took certain specific steps to work with TDEC to bring its treatment of the leaks into compliance with the law. The specter that has haunted every aspect of this case is that, while the Gallatin Plant's NPDES permit and accompanying materials deal passingly with the issue of seeps, they adopt no stringent, unambiguous, and comprehensive framework for addressing those seeps or any other leaks under the permit. The Court wondered if one way to prevent future unlawful leaks might be not to wholly stops the leaks—but to bring those leaks within the boundaries of what is lawful.

498. TVA's recent permit renewal activities, however, demonstrate the ultimate unworkability of this method. According to publicly available permit application documents, [7] TVA recently requested terms that would expressly acknowledge that the permit anticipates some coal ash waste seeps from the Gallatin Plant. Letter from Chuck Head to Terrence E. Cheek 2 (May 15, 2017) (available at http://environment–online.tn.gov:8080/pls/enf_reports/f?p=9034:34051:::NO:34051:P34051_PERMIT_NUMBER:TN0005428). TDEC rejected the proposal, explaining why it could not grant a blanket authorization of future seeps:

> When wastewater or partially treated wastewater continually flows through a seep, the seep may become a new point source discharge. However, the seep is not identified in the NPDES permit as a point source discharge, the rate of discharge from the seep is unknown, the chemical, biological and physical characteristics of the seep are unknown, and the seep may discharge to the nearest surface water.
>
> The discharge of wastewater or partially treated wastewater through a seep in a dike is not authorized in existing NPDES permits.

Id. at 2−3. In other words, the NPDES system, at least as understood by TDEC, simply does not envision the kind of blanket indulgences that TVA would need in order to boast a regulatory blessing of its preferred status quo. The Court sees no reason to think that this logic would apply any differently to leaks that are not purely seeps.

499. This most recent correspondence between TDEC and TVA suggests that the lack of an adequate, unambiguous NPDES permit framework for addressing leaks is not simply an oversight that can be rectified—but rather, that TVA's insistence that its ponds be allowed to

[7] Federal Rule of Evidence 201(b) permits the Court to take judicial notice of a fact that "(1) is generally known within the trial court's territorial jurisdiction" or "(2) can be accurately and readily determined from sources whose accuracy cannot reasonably be questioned." "[G]overnment documents available from reliable sources on the Internet" are generally appropriate for judicial notice. U.S. ex rel. Dingle v. BioPort Corp., 270 F. Supp. 2d 968, 972 (W.D. Mich. 2003).

continue leaking cannot be reconciled with the Gallatin Plant's obligations under the CWA or NPDES. Any hope for a purely regulatory solution to the dilemmas facing the Court, therefore, was illusory.

500. Ultimately, then, the Court is confronted with two possible futures, each unpalatable in its own way. In one future, TVA closes the ponds in place and all of the uncertainty that has characterized the first sixty years of the Gallatin Plant's operation continues, in modified form, in perpetuity. In the other future, TVA expends significantly more money and effort, but the coal ash waste is finally removed to an impoundment that is not plagued by the intractable flaws of its ponds' current design. Faced with these two unappealing options, the Court is impelled to select the one that actually reliably promises to put an end to this saga.

501. Accordingly, the Court will order TVA to fully excavate the coal ash waste currently located in the Ash Pond Complex and Non-Registered Site and move the waste to a lined site that offers reasonable assurances that it will not discharge waste into the waters of the United States. The Court understands that the technical challenges of such a process are significant and that finalizing a plan for closure may take a great deal of time. Accordingly, the Court will order TVA to file a report one month from the entry of the Court's order providing a timeline and itemized description of the process for complying with the Court's Order, and TVA will be required to file periodic updates thereafter.

502. The Court is fully cognizant of the costs its chosen remedy will impose on TVA and has taken those costs into consideration when deciding, in its discretion, not to assess penalties in this matter.

503. While the burden of closure by removal may be great, it is the only adequate resolution to an untenable situation that has gone on for far too long. From the Court's privileged vantage

point in 2017, and based on all of the evidence presented at trial, it is difficult to imagine why anyone would choose to build an unlined ash waste pond in karst terrain immediately adjacent to a river. The Court, however, understands that it is now the beneficiary of technical knowledge and environmental concerns that may not have informed the decision-making of half a century ago. The futility of second-guessing such decades-old actions is one reason the CWA has a statute of limitations. Nevertheless, while the decision to build the Ash Pond Complex is in the past, the consequences of that decision continue today, and it now falls on the Court to address them. The way to do so is not to cover over those decades-old mistakes, but to pull them up by their roots. TVA, as the entity responsible for the ponds, must be the entity to do so.

VII. CONCLUSION

For the foregoing reasons, the Court will direct the Clerk to enter judgment for the Plaintiffs on Claims A, C, D, E.b, and E.e. It will direct the Clerk to enter judgment for TVA on Claims B, E.a, E.c and E.d. TVA will be ordered to excavate the coal ash waste impounded at the Gallatin Plant and remove it to an appropriate lined site that does not pose a substantial risk of discharges into the waters of the United States. In light of the substantial costs TVA is likely to incur in remediating its ash pond disposal areas, the Court declines to assess penalties on top of its injunctive relief.

The court will issue an appropriate Order.

WAVERLY D. CRENSHAW, JR.
CHIEF UNITED STATES DISTRICT JUDGE