BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

In the Matter of:	)	
STANDARD FOR THE DISPOSAL OF COAL COMBUSTION RESIDUALS IN SURFACE IMPOUNDMENTS: PROPOSED NEW 35 ILL. ADMIN. CODE 845	)	PCB 2020-019 (Rulemaking - Land)

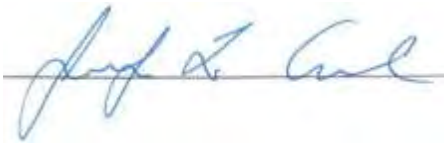
NOTICE OF ELECTRONIC FILING

To: Attached Service List

PLEASE TAKE NOTICE that on September 24, 2020, I electronically filed with the Clerk of the Illinois Pollution Control Board ("Board") the **PREFILED ANSWERS OF MARK HUTSON**, copies of which are served on you along with this notice. The attachments to Mr. Hutson's answers are being filed separately due to file size limitations.

Dated: September 24, 2020

Respectfully Submitted,



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BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)
	)
STANDARDS FOR THE DISPOSAL OF	) R 20-19
COAL COMBUSTION RESIDUALS IN	) (Rulemaking – Land)
SURFACE IMPOUNDMENTS: PROPOSED	)
NEW 35 ILL. ADM. CODE 845	)
	)

PREFILED ANSWERS OF MARK HUTSON

Questions from the Illinois Pollution Control Board

6. **On page 7, you state that the rules must not allow waste to be left in place at or below the highest seasonal zone of subsurface saturation. Please clarify whether this type of prohibition should apply to only CCR surface impoundments that are impacting groundwater above (exceeding) the groundwater protection standards (GWPS) or apply generally to all CCR impoundments under Part 845.**

Response: In my opinion, no CCR surface impoundments should be closed in a manner that leave groundwater continuously or intermittently in contact with the waste. Impoundments that are closed in place with groundwater flowing through the waste will continuously generate leachate that will flow downgradient of the impoundment. Wastes in intermittent contact with groundwater will be re-wetted with each high water event, causing episodic releases of CCR constituents to downgradient groundwater. In both cases CCR contaminants will flow with groundwater toward any downgradient discharge areas or receptors that might be present. Low concentration groundwater contaminants can accumulate to elevated concentrations in sediments even though there may be sufficient dilution that the contaminants cannot be detected in surface water. An example of this process is provided in sediment chemistry data[1] collected from sediments underlying the South Branch of the Elizabeth River, offshore of the Chesapeake Energy Center CCR impoundment in Virginia. Arsenic transported from the site in groundwater was detected in in porewater and sediments at the bottom of the river at concentrations up to 452.2 ug/l and 8.2 mg/l, respectively.

7. **On page 9, you recommend that the rules at Section 845.120 define the terms "uppermost zone of saturation" and "uppermost aquifer". Please clarify whether the definition of "uppermost aquifer" proposed by the Agency under Section 845.120 is acceptable. If not, propose language changes. Also, provide definitions of the terms "uppermost zone of saturation" and "highest seasonal zone of saturation".**

[1]AMEC Earth and Environment, 2010, Natural Attenuation of Arsenic Demonstration, Chesapeake Energy Center Ash Landfill, Chesapeake, Virginia, June 7, 2010 (attached hereto as Attachment 1).

Response: In my opinion, the definition of "uppermost aquifer" provided in the Section 845.120 is an acceptable definition. The point of my comment is that required closures of CCR impoundments should not be allowed to leave CCR in regular contact with groundwater, whether or not the geologic unit would qualify as an aquifer. Use of the word "aquifer" indicates that that the unit is capable of supplying usable quantities water. Water-bearing units not classified as an aquifer may still transmit water into buried CCR and carry leachate from buried CCR.

The elevation of water in the uppermost zone of saturation is the elevation of water in the highest saturated zone encountered in the subsurface. In the interest of simplicity, I suggest that I retract my use of the term "highest seasonal zone of saturation" and retain "uppermost zone of saturation." This change would also apply to the wording of my recommendations on page 9, and pages 21(bottom) and 22(top).

8. **On page 10, you recommend that the Board consider floodplains as unstable locations for the purposes of the CCR rule. Please comment on whether all floodplain locations meet the proposed definition of "unstable area" under Section 845.120. If not, please explain why the rules should explicitly list floodplains as unstable area.**

Response: I recommended that floodplains be included as unstable areas because over time, many river channels are known to migrate and shift, eventually undercutting and endangering structures used to contain CCR. However, migration of the channel is far from being the only hazard associated with disposal of wastes in unlined pits on a floodplain. CCR units located on floodplains are potentially subject to a variety of natural events or forces capable of impairing the ability of a surface impoundment to prevent releases. The obvious potential impairment is that floodwaters have the potential to erode surface structures, including berms and cap systems. The not-so-obvious problem is that these are generally shallow groundwater locations under normal conditions and groundwater elevations increase along with rising surface water, sometimes to elevations above ground surface. The combination of normally high groundwater and episodically high groundwater and surface waters during flood events enhances the potential for rewetting of disposed CCR and stimulation of renewed leachate generation. Not all sites located on floodplains will be subject to all of these issues but, in my opinion, the issues associated with leaving waste buried on floodplains should make floodplains unacceptable locations for establishing permanent waste disposal facilities.

I will also take this opportunity to say that as a professional geologist approaching the end of a 40+ year career working on waste disposal and groundwater contamination sites starting in Illinois and extending across the country, I find it disheartening that we are having this debate. After all of this time we are essentially discussing whether rules regulating disposal of industrial wastes containing soluble metals, should allow that waste to be disposed in unlined pits, submerged in groundwater, and located on a floodplain. I do not believe that the young geologist working for IEPA in the 1970's would have believed that this would even be a topic of conversation in the year 2020**.**

9. **Regarding measurement of porewater elevation on page 11, you note, "[t]he elevation of liquid and/or porewater inside all CCR impoundments and landfills**

must be reliably and regularly measured." Please comment on whether you are aware of CCR landfills being subject to the Board's chemical waste landfill regulations under 35 Ill. Adm. Code 810-815, and whether those regulations require the leachate head over the liners to be maintained at less than a foot over the liner. See 35 [sic] 35 Ill. Adm. Code 811.307 and 814.402. If so, should the Board consider your recommendation as it applies to only CCR surface impoundments and not landfills.

Response: I am aware of the requirement to maintain leachate head over liners at less than a foot at chemical waste landfills. I do recommend that a requirement to measure and report porewater elevations be included for both impoundments and landfills. I make this recommendation based on my experience of having reviewed groundwater monitoring data and reports at many CCR facilities. One very common problem with the monitoring systems is that the elevation of liquid inside of impoundments and/or landfills is not identified, nor is this information considered in preparing water table or potentiometric surface maps, even though these facilities are typically unlined and waste is often in direct contact with groundwater. Failure to measure and incorporate internal porewater elevation means that potential mounding of groundwater beneath a facility might not be identified. In some cases, mounding associated with leakage out of an impoundment can cause assumed upgradient monitoring wells to be impacted by unidentified flow from the CCR unit. Monitoring of porewater elevations inside a disposal unit might also prove useful in providing early warning of problems associated with increased leakage through liner or cap system, when present.

10. **On page 17, you recommend that the rules require the alternative source demonstration (ASD) to be submitted as permit modification to facilitate public disclosure of the submission. Please comment on whether the inclusion of the ASD report in the operating record under Section 845.800, and the subsequent posting on the publicly accessible website under Section 845.810 achieves the same purpose of public disclosure.**

Response: I believe that this might serve the same purpose, but there would need to be an established process that included notification of interested parties that the ASD has been submitted. The schedule would also have to allow for outside groups and the public to provide input and feedback to the Agency prior to making its decision.

11. **On page 20, you recommend that Section 845.750(c)(1) (Final Cover System) be modified to "specify that the alternative cover system be protected from environmental and human damage, and that the cap system performs as well or better, and the expected life of the cover system is expected to be as long or longer, than the cover system described in the proposed rules."**

    a. **Please clarify whether you are referring to the alternative "low permeability layer construction technique or material" allowed under Section 845.750(c)(1).**

Response: Yes, I am referring to the alternative "low permeability layer construction technique or material."

b. If so, the rules already require such use of alternative layer to provide equivalent or superior performance than the low permeability layer required by the rules. Further, the alternative low permeability layer is subject to all other requirements under Section 845.750(c), including standards for final protective layer. In light of this, please clarify whether additional modifications are necessary to the final cover system provisions. If so, specify such modifications.

Response: I do not believe that modifications are necessary if it is clearly understood by the Board and Agency that the standards for the final protective layer apply to closures utilizing an alternative low permeability construction technique or material.

Questions from Illinois EPA

1. On Page 9 of your testimony you suggest that Part 845 should be amended so as to protect groundwater in general and not just aquifers. You propose changing the definition from "uppermost aquifer" to "uppermost zone of saturation."

a. Does Part 845.630(a)(1) and (2) require the installation of groundwater monitoring wells that will accurately reflect groundwater quality that has not been impacted by a CCR landfill or CCR surface impoundment and also to reflect the quality of groundwater passing the waste boundary of a CCR surface impoundment, respectively?

Response: Yes, that is what the text of the proposed rule says. The goal of my comment is to make clear that water bearing units, not only those designated as aquifers, are to be monitored and protected.

b. Does either 845.630(a)(1) or (2) mention aquifers, or is the term "groundwater quality" used?

Response: These specific sections use the term "groundwater quality". Other sections of Part 845 such as Section 845.300 use the term "Uppermost Aquifer."

c. Does the definition of Groundwater in Part 845.120 include water below the land surface in a *zone of saturation*?

Response: Yes.

d. Wouldn't that include what you might be proposing as the uppermost zone of saturation?

Response: The definition of "groundwater" is fine. I am proposing that the term "Uppermost Aquifer" as it is used in section 845.300, be replaced with a more inclusive term that does not restrict monitoring to units designated as aquifers.

2. **Also, on Page 9 of your testimony, you propose that closure with a final cover system should only be permitted if the owner demonstrates that there will be no intermittent, recurring, or sustained hydraulic connection between CCR and groundwater following closure.**

    a. **Do the location restrictions listed in Part 845.300 require closure under Part 845.700 when they are not met?**

Response: The location restriction listed in part 845.300 requires closure under Part 845.700, which requires closure when there is less than five feet of separation between the base of the impoundment and the upper limit of the "uppermost aquifer," or where there is intermittent, recurring, or sustained hydraulic connection between the base of the CCR impoundment and the "uppermost aquifer." I am suggesting that the disposed CCR should not be in contact with saturated geologic materials whether or not those materials as classified as an aquifer.

    b. **Does the requirement for closure under 845.700(c) include the requirement for closure alternative analysis of 845.710?**

Response: Closure Alternative Analysis is included under Section 845.710.

    c. **Do the requirements of closure alternatives in 845.710 determine whether the closure will be by removal or with final cover?**

Response: The closure alternatives analysis described in 845.710 is a part of the process for determining the closure method that would also include achieving the closure performance standards identified in Section 845.750 if closure will be with final cover.

    d. **If the closure alternatives in Part 845.710 already govern the inevitable closure procedure, whether removal or final cover, does that already take into account the location restrictions listed in 845.300 which include Placement Above the Uppermost Aquifer by way of Part 845.700(a) and 845.700(c)?**

Response: This appears to be a question better suited for a lawyer. But I can say that the closure alternatives analysis described in 845.710 is a part of the process for determining the closure method that would also include achieving the closure performance standards identified in Section 845.750 if closure will be with a final cover. My suggested changes to 845.300 include changing "Placement Above the Uppermost Aquifer" to "Placement Above the Uppermost Zone of Saturation."

3. **For Section 845.220(b)(1), you suggest no new CCR surface impoundments should be allowed in the area of inundation.**

a. Can engineering be used to protect structures in floodplains from the impacts of flooding?

Response: Engineered structures to protect facilities located in floodplains have been used for many decades to attempt to control damage from floodwaters with generally favorable, but occasionally spectacularly poor, results. One of the basic problems that I see with locating permanent waste disposal facilities on floodplains is that the processes attacking engineered flood protection structures require regular inspection and maintenance for as long as flood protection is required. The post-closure care period for waste disposal facilities is generally intended to extend only for thirty years past facility closure. Potential damage to waste containment and protection structures will continue indefinitely, but maintenance of these structures will eventually be terminated. It is my opinion that we must make good decisions now in order to minimize future problems associated with today's wastes.

b. Do solid waste landfills exist in flood plains?

Response: Yes.

c. Can new solid waste landfills be constructed in floodplains?

Response: My understanding is that new solid waste landfills are required to be lined and have leachate collection systems, whether or not they are located on a floodplain. Closing an unlined CCR impoundment in place, as is being proposed at many CCR sites – which is essentially establishing a new landfill without a liner or leachate collection system – would not to be allowed.

d. Can CCR be disposed in solid waste landfills, even those located in floodplains?

Response: I know of no prohibition against disposing of CCR in solid waste landfills located in floodplains, but I support the suggestion.

4. For Section 845.630(a), you suggest a CCR surface impoundment elevation monitoring system. Please describe more fully what type of system you're envisioning to measure CCR surface impoundment water elevation?

Response: Measurement of the elevation standing water in an impoundment is readily accomplished by establishing a staff gauge in the facility. Measurement of the elevation of porewater within an impoundment need be nothing more that constructing a piezometer, or piezometers with waste to all for measuring subsurface water elevation.

5. For Section 845.630(a)(1), you suggest that Part 845 needs background not impacted by any site operations or CCR-related activity.

a. Does Section 22.59 of the Act require the Agency to propose, and the Board adopt, rules regulating CCR surface impoundments?

Response: Yes.

b. Does Part 845 as proposed regulate CCR surface impoundments?

Response: Yes, they are intended to regulate CCR surface impoundments once finalized.

c. Does Part 845 contain provisions for closure and corrective action at CCR surface impoundments?

Response: Yes.

6. For Section 845.640(g)(1), you suggest a specific prohibition for intra-well statistical methods except for new CCR surface impoundments. Does Part 845 include a provision which specifies intra-well statistical methods can be used for existing and inactive CCR surface impoundments?

Response: I do not believe that Part 845 specifies that intra-well statistical methods can or cannot be used at existing impoundments. Part 845 appears to use the same language as the federal coal ash rule with regard to statistical analysis of groundwater samples, and I am aware that facilities have used intra-well analysis for compliance with the federal rule. This is a concern because I have seen a number of instances where intra-well analysis was used improperly. There are only a few circumstances in which intra-well analysis should be used, as USEPA explains in the preamble to its Part A rule,[2] including where the groundwater gradient is unstable or unknown, but only in locations thought to be uncontaminated. I have seen intra-well analysis used outside of those circumstances. The improper use of intra-well analysis that I observe most often is use of this test on a monitoring well completed in impacted groundwater, and Part 845 should bar such uses.

7. For Section 845.600(a)(1), you suggest including Iron, Manganese and Vanadium in the list of GWPS.

a. Are you aware that USEPA included Iron, Manganese and Vanadium in their analysis of potential contaminants of concern for Part 257?

Response: Yes, I am aware of this, but am also aware that I commonly see elevated concentrations of iron and manganese, and occasionally see elevated vanadium, in laboratory analyses of CCR impoundment porewater and leachate.

b. Are you aware that USEPA did not include Iron, Manganese and Vanadium in either Appendix III or Appendix IV of Part 257?

Response: Yes, I am aware of this.

[2] 85 Fed. Reg. 53,516, 53,543 (Aug. 28, 2020) (attached hereto as Attachment 2).

c. Are you aware that Iron and Manganese are sensitive to oxidation and reduction conditions in groundwater?

Response: Yes, as are arsenic and selenium, which are included as Appendix IV contaminants.

d. Can a number of anthropogenic activities impact oxidation and reduction conditions in groundwater?

Response: Yes. I also believe that disposal of CCR in contact with groundwater would qualify as one of those anthropogenic activities.

e. Are you aware that Part 620 has GWQS for Iron, Manganese and Vanadium?

Response: Yes. I made my suggestion that these parameters are included in the list of groundwater protection standards in Section 845.600 because I sometimes see these parameters at elevated concentrations in CCR leachate and there are already existing GWQS values.

f. Are you aware that the Agency has testified that Part 620 is applicable to any constituent at CCR surface impoundments, which does not have a Part 845 GWPS, and that once all of the requirements of Part 845 have been met, all of the Part 620 GWQS will be applicable?

Response: No, I was not aware of this testimony, but support this position. I do, however, still suggest that the list of Groundwater Protection Standards presented in section 845.600 be expanded to include all of the parameters that are applicable, including those listed in Part 620. Addition of the Part 620 parameters to the list in section 845.600 will eliminate confusion about which parameters must be included on the list of analytes for monitoring at a CCR unit, as well as help clarify the corrective action requirements that apply for those analytes.

8. For Section 845.610, you suggest quarterly data—chemical and water level—be displayed and put into machine readable tables. How do you envision data security will be maintained with machine readable tables?

Response: When I say machine readable, I am envisioning something as basic as a downloadable Microsoft Excel file containing water elevation and results of chemical analyses. A system similar to the Virtual File Cabinet used by the Indiana Department of Environmental Management would be appropriate. I do not believe that elaborate security is necessary to enable downloading data files, but a computer security person should be consulted if this is a concern.

9. For Section 845.650(d)(1)(a), you suggest much greater detail.

a. Does 845.650(d)(1)(A) already require the installation of additional monitoring wells to define the contaminant plume?

Response: Yes, but it fails to explicitly specify that there must be wells located in front of the plume to identify the position of and detect passage of the leading edge of the plume in relation to any potential receptors such as surface waters.

b. Isn't it likely that characterizing the nature and extent of a release require the installation of multiple monitoring wells within and beyond the plume?

Response: Yes, but in practice, many facilities are not particularly interested in developing sufficient data to define the location, depth, or rate of movement of the leading edge of contaminant plumes, and do not take the measures necessary to do so.

10. For Section 845.650(d)(1)(a), you suggest specific requirements regarding plume movement.

a. Does Part 845.640(c) require owners and operators to determine the rate and direction of groundwater flow after each monitoring event?

Response: The rate and direction of groundwater flow is required to be estimated after each sampling event, but the location and extent of a contaminant plume is different than the direction and rate of flow. Sites located on floodplains are especially susceptible to wide variation in flow direction and rates that can spread contaminants in widely differing directions around the site. The direction and rate of groundwater flow during monitoring events may be completely different than what exists during other portions of the year. The calculated rate of groundwater flow would approximate the maximum expected rate of contaminant migration under normal flow conditions with no attenuation of contaminants and is not likely to represent actual field conditions.

b. To the best of your knowledge, do any of the constituents listed in Part 845.600(a)(1) typically migrate faster than the flow of groundwater?

Response: The calculated rate of groundwater flow would approximate the maximum expected rate of contaminant migration under normal flow conditions with no attenuation of contaminants. As described above, the rate and direction of flow can vary widely in response to changes in flow.

11. For Section 845.650(d)(4), you suggest that the alternative source demonstration to be part of a permit instead of an Agency review.

a. Have you given any consideration to the amount of time the permit process would take relative to the required Agency review?

Response: The point of my comment was to modify the process enough that the public is made aware and has the opportunity to comment on Alternative Source Demonstrations. See my response to Pollution Control Board Staff Comment #10.

b. Couldn't the permit process unnecessarily delay corrective action?

Response: I do not agree that a slight delay in order to facilitate input from the public should be characterized as unnecessary. Given the length of time that most CCR impoundments have been in use place, a short pause for the Agency to gather input from the public prior to accepting an alternative source determination, while other activities proceed seems inconsequential. See my response to Pollution Control Board Staff Comment #10.

12. **For Section 845.750(c)(1), you suggest that any alternative cover has to be protected from human and environmental damage and that it last as long as the standard cover.**

    a. **Section 845.750(c)(1) requires that an alternative cover use "…low permeability layer construction technique or material provides equivalent or superior performance…" Would you agree that one aspect of performance is the effective life-span of a technique or material?**

Response: The life-span of a technique or material used in capping a site is one aspect of cap performance.

    b. **Please describe and provide examples of the protection from environmental and human damage you are referring to in the proposed language for Part 845.750(c)(1).**

Response: As a young geologist, I spent two years working for IEPA doing inspections of open and closed waste disposal facilities, primarily landfills in Illinois. I then spent an additional two years working on a contract for USEPA performing site investigations at waste disposal sites scattered around USEPA Region V. During this period, I observed the impacts of human usage of long-closed facilities, including tracks and ruts in the cover produced by vehicles, and gullies eroded into the cover in areas used for vehicle access. I recall at least one site where the side of the covered landfill had been used as a backstop for target practice. Once sites are no longer active and cared for, they can be popular locations for dirt bike enthusiasts to ride. Any or all of these activities have the potential to shorten the effective lifespan of a cap and are difficult to avoid once a site is no longer staffed.

    c. **Would restricting access to the CCR impoundment provide the needed protection?**

Response: I believe that most of the sites that I describe above started out as controlled-access facilities. I would not expect any of these issues to occur until after the post-closure care period has lapsed.

13. **On page 20, you testify about monitored natural attenuation**.

    a. **Could you further describe and provide examples of the attenuation mechanisms that remove contaminants from groundwater?**

Response: USEPA's 1999 guidance[3] on use of Monitored Natural Attenuation (MNA) describes control of source materials as the most effective means of ensuring the timely attainment of remediation objectives. The guidance describes removal of inorganic contaminants from groundwater by attenuation mechanisms that potentially remove inorganic contaminants from groundwater through sorption reactions and oxidation-reduction (redox) reactions. Sorption reactions include processes such as precipitation, adsorption on soil particles, or partitioning into organic matter. Redox reactions can alter inorganic contaminants to be less soluble (and less mobile). These reactions may remove some CCR contaminants from groundwater, while other CCR contaminants such as boron, are essentially non-reactive in the subsurface. The most frequent attenuation mechanisms that I have seen called on to remediate CCR contaminant plumes are dilution and dispersion. While these mechanisms are listed as attenuation processes, USEPA's 2015 MNA guidance document[4] clearly states "However, dilution and dispersion generally are not appropriate as primary MNA mechanisms because they reduce concentration through dispersal of contaminant mass rather than destruction or immobilization of contaminant mass."

b. Could you further describe and provide examples of the types of demonstrations you suggest be required so that the rate of movement of the leading edge of any contaminant plumes are reliably identified?

Response: Documentation of the location and rate of movement of the leading edge of the contaminant plume is readily achieved by monitoring groundwater quality within and downgradient of the plume. Contour maps of the water quality data can then be compared over time to establish the location of the plume and that its location is stable. However, USEPA's 2015 MNA guidance document[5] states that "MNA is generally not appropriate for plumes that are considered stable, yet there is confirmed discharge to surface water bodies or potential human or ecological receptor exposure." Given the close proximity of many CCR impoundments to surface water bodies, there is often inadequate space between the impoundment and surface water discharge area for MNA to remove contaminants prior to discharge into river sediments or water.

14. For Section 845.220(c)(2), you suggest a requirement that the closure plan and corrective action plan require achievement applicable groundwater standards. Do Sections 845.220(c)(2) and 845.220(d)(3) require that groundwater modeling show that corrective action and closure, respectively, will achieve applicable groundwater standards?

Response: I apologize for the confusion, that comment should have read: "This rule should be altered to specify that the groundwater modeling and calculations must show how the corrective

[3] USEPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, Office of Solid Waste and Emergency Response, Directive 9200.4-17P, April, 1999 (attached here as Attachment 3, p.22.

[4] USEPA, 2015, Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites, Office of Solid Waste and Emergency Response, Directive 9283.1-36, August 2015 (attached hereto as Attachment 4), p. 14.

[5] USEPA, 2015, Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites, Office of Solid Waste and Emergency Response, Directive 9283.1-36, August 2015 (Attachment 4), p. 18.

action will achieve compliance with the applicable groundwater standards and estimate how **long it will take for** the closure plan to achieve the applicable groundwater standards."

15. On pages 20 and 21 of your testimony, you suggest that models used by owners and operators to model system performance include "evaluations of how declining closure system performance (such as estimated cap deterioration) will affect compliance" with the GWPS.

a. **Have you been involved at sites where modeling has been done to evaluate post-closure deterioration of the final cover into the future**?

Response: I have not yet seen this done. Because I have reviewed closure plans that specify a synthetic material cap material that would be exposed on the surface of the fill with no protective soil layer, I suggest modeling to evaluate post-closure deterioration. It is a suggested improvement for evaluating site closures in Illinois that would be particularly useful on sites where synthetic cap materials are likely to be exposed at or near the surface with little or no protective layer, potentially subjecting the cap to damage or deterioration.

i. If so, where? If there are multiple, please provide a list of the sites.

Response: I have not yet seen this done.

ii. If not, are you aware of sites where this has been done? What sites?

Response: I have not yet seen this done.

A. Are these for research or for implementation of choosing a closure or corrective action plan?

Response: I have not done a review of available literature to identify specific research being done on this topic.

B. What were the results of these studies?

Response: I have not done a review of available literature to identify specific research being done on this topic.

C. Were these sites maintained? If so, for how long?

Response: I have not done a review of available literature to identify specific research being done on this topic.

b. Are you aware for how long landfill final covers are to be maintained? If so, for how long?

Response: The post closure care period is typically thirty years past site closure.

c. Do landfills commonly have their final covers modeled post-closure? If so, for how long?

Response: Yes, the last time I worked on a modeling project in Illinois we were required to run the simulation out for 100 years. I assume that that requirement has not changed since that time.

d. Are landfill final covers modeled into the future with assumed deterioration?

Response: I have not yet seen this done. Because I have reviewed closure plans that specify a synthetic material cap material that would be exposed on the surface of the fill with no protective soil layer, I suggest modeling to evaluate post-closure deterioration. It is a suggested improvement for evaluating site closures in Illinois that would be particularly useful on sites where synthetic cap materials are likely to be exposed at or near the surface with little or no protective layer, potentially subjecting the cap to damage or deterioration.

16. On page 21 of your testimony, you criticize Part 845 for allowing additional CCR to be placed in a surface impoundment for the purposes of grading and contouring the final cover system.

a. If you consolidate multiple areas or impoundments at a site in proximity to one another, could the consolidation into one impoundment reduce the areal size of the plume?

Response: Depending on site-specific conditions, it could reduce the size of the plume for as long as waste components are segregated from water and contaminants are contained in the new location. The added contaminant mass in the new location could also have the effect of extending the duration over which leachable constituents could eventually be released once containment is breached.

b. If so, is reducing the areal size of a contaminant plume a desired outcome for a corrective action?

Response: The size of a contaminant plume is related to other factors than just the size of the impoundment footprint. In particular, releases from impoundments located on floodplains are subject to migrating in different directions depending on river stage. The effect can be that groundwater contaminants are spread in multiple directions from the facility making adequate and reliable groundwater monitoring a very difficult endeavor. This is yet another reason that I am suggesting that Illinois recognize river floodplains are inappropriate and unstable locations for establishing new permanent waste disposal sites.

Questions from Dynegy

1. **Groundwater corrective action under the federal CCR Rule is required only when there is an exceedance of a groundwater protection standard, right?**

Response: It is correct that the federal CCR rule requires corrective action when there is an exceedance of groundwater protection standards. My suggested additions to the proposed Illinois rules are intended to make exceedances of groundwater protection standards less frequent.

2. **Groundwater corrective action under IEPA's proposed Part 845 is required only when there is an exceedance of a groundwater protection standard, right?**

Response: It is correct that the proposed Part 845 requires corrective action when there is an exceedance of groundwater protection standards. My suggested additions to the proposed Illinois rules are intended to make exceedances of groundwater protection standards less frequent.

3. **The groundwater protection standards proposed in Part 845 provide a threshold to determine when degradation of groundwater from CCR surface impoundments is unacceptable, right?**

Response: My understanding is that Illinois EPA stated that the groundwater protection standards in Part 845 are based on the standards set by USEPA in the federal coal ash rule and existing Illinois groundwater quality standards.

4. **The groundwater protection standards proposed in Part 845 are intended to assure protection of human health and the environment, right?**

Response: It would be my assumption that the Part 845 groundwater protection standards are intended to protect human health and the environment, but Section 845.100 Scope and Purpose makes no mention, and I have no first-hand knowledge, of the intention.

5. **Is it your opinion that Part 845 should preclude any release to groundwater of CCR constituents, even if that release does not result in an exceedance of a groundwater protection standard?**

Response: In a perfect world, prevention of any releases to groundwater would be the goal of Part 845. If achieved, this goal would eliminate potential for accumulating elevated concentrations of CCR contaminants in receiving media. In the real world, my hope is that Part 845 will change current practices enough to make releases of CCR constituents at concentrations above groundwater protection standards less common.

6. **In general, are consideration of future risk and the assessment of risk important factors when selecting and designing remedial actions?**

Response: Risk assessment is a factor used in evaluating remedial actions that, if Part 845 is successful, would be less frequently utilized to justify contaminant releases.

7. **Do site-specific conditions and characteristics typically inform which remedial actions will be effective at a site?**

Response: Site-specific conditions are critical to successful remedial actions, especially if waste is proposed to be left buried in place below the water table.

8. **Is it important to evaluate current and potential future risks when evaluating and selecting closure alternatives at CCR surface impoundments?**

Response: Risk assessment is a factor used in evaluating remedial actions that, if Part 845 is successful, would be less frequently utilized to justify contaminant releases. It is unclear to me that risk assessment addresses potential risks of releases due to future deterioration or damage to cap systems, or changes in river channel location.

9. **Is it your opinion that closure by removal is the only closure alternative that is protective of human health and the environment at CCR surface impoundments that are not "isolated from water"?**

Response: There are remedial options other than closure by removal that can be evaluated against site-specific conditions that might be viable remedial options to control release of CCR contaminants. Techniques such as construction of slurry walls to restrict interaction between groundwater and waste, or installation of wells or drains to lower groundwater levels could be effective, depending on site-specific conditions. Many of these techniques, however, require regular monitoring and maintenance to continue proper function. Simply placing a cap over CCR, with groundwater continuing to flow through waste containing soluble constituents, should not be assumed to be protective of groundwater quality.

10. **Are there risks to workers and the community associated with closure by removal?**

Response: This is not my area of expertise, but in my experience, there is some level of risk associated with any construction or remediation project. As long as risks of a removal action are properly identified and mitigated, with adequate precautions taken to protect workers and the community, I expect that any risk to workers or the community would be no greater than from any other construction or remediation project.

11. **Do you believe there are scenarios where an unlined CCR surface impoundment that is not "isolated from water" can be capped in a way that is protective of human health and the environment?**

Response: I assume that one could think of some scenario where leaving CCR in an unlined impoundment and in contact with groundwater would be protective of groundwater quality. One scenario that comes to mind is a situation where the waste is such that it does not add significant contaminants to groundwater, for instance, where the volume of CCR is small or the CCR has

been in contact with water for long enough that all of the soluble constituents have already been leached from the waste, although leaching all of the soluble metals out of CCR will take many decades.

12. Are all floodplains "unstable" areas?

Response: I recommend that floodplains be included as unstable areas because over time, river channels are known to migrate and shift, potentially undercutting and endangering structures used to contain CCR. CCR units located on floodplains are potentially subject to a variety of natural events or forces capable of impairing the ability of a surface impoundment to prevent releases. The obvious potential impairment is that floodwaters have the potential to erode surface structures, including berms and cap systems. The not-so-obvious problem is that these are generally shallow groundwater locations under normal conditions and groundwater elevations increase along with rising surface water, sometimes to elevations above ground surface. The combination of normally high groundwater and episodically high groundwater and surface waters during flood events enhances the potential for rewetting of disposed CCR and stimulation of renewed leachate generation. Not all sites located on floodplains will be subject to all of these issues but, in my opinion, the issues associated with leaving waste buried on floodplains should make floodplains unacceptable locations for establishing permanent waste disposal facilities.

13. If a CCR surface impoundment is located within a floodplain, existing Illinois regulations require that it must be, at a minimum, kept "in good repair," correct? *See* 17 Ill. Adm. Code § 3702.30.

Response: I am not familiar with that particular provision. It appears to concern dams. However, even if an impoundment berm were required to be kept "in good repair," the risks that I highlighted in response to Dynegy question number 12 remain.

14. If a CCR surface impoundment is located within a floodplain, is the owner/operator required to demonstrate that a release of material will not occur if the unit becomes inundated? *See* Section 845.110(b)(1)(A); 17 Ill. Adm. Code § 3706.630 ("Storage of materials likely to cause water pollution, in the event of flooding, is prohibited unless adequate safeguards approved by the Illinois Environmental Protection Agency are provided.").

Response: According to the ilga.gov website,[6] the regulation cited states: "Materials that are buoyant, flammable, explosive, or could be injurious to human, animal or plant life shall be stored at or above the regulatory flood protection elevation, floodproofed, or protected by structural measures consistent with the standards set forth herein. Storage of materials likely to cause water pollution, in the event of flooding, is prohibited unless adequate safeguards approved by the Illinois Environmental Protection Agency are provided." I have never worked with these regulations and am not familiar with what safeguards Illinois EPA has approved, or not approved, under this provision.

[6] https://www.ilga.gov/commission/jcar/admincode/017/017037060F06300R.html.

15. Do you believe there are scenarios where an unlined CCR surface impoundment located within a floodplain can be capped in a way that is protective of human health and the environment?

Response: I assume that one could think of some scenario where leaving CCR in an unlined impoundment would be protective of groundwater quality. One scenario that comes to mind is a situation where the waste is such that it does not add significant contaminants to groundwater, for instance where the volume of CCR is small or the CCR has been in contact with water for long enough that all of the soluble constituents have already been leached from the waste, although leaching all of the soluble metals out of CCR will take many decades.

I recommend that floodplains be included as unstable areas because over time, river channels are known to migrate and shift, potentially undercutting and endangering structures used to contain CCR. However, migration of the channel is far from being the only hazard associated with disposal of wastes in unlined pits on a floodplain. CCR units located on floodplains are potentially subject to a variety of natural events or forces capable of impairing the ability of a surface impoundment to prevent releases. The obvious potential impairment is that floodwaters have the potential to erode surface structures, including berms and cap systems. The not-so-obvious problem is that these are generally shallow groundwater locations under normal conditions and groundwater elevations increase along with rising surface water, sometimes to elevations above ground surface. The combination of normally high groundwater and episodically high groundwater and surface waters during flood events enhances the potential for rewetting of disposed CCR and stimulation of renewed leachate generation. Not all sites located on floodplains will be subject to all of these issues but, in my opinion, the issues associated with leaving waste buried on floodplains should make floodplains unacceptable locations for establishing permanent waste disposal facilities.

16. Do you believe there are scenarios where an unlined CCR surface impoundment that has failed a location restriction can be capped in a way that is protective of human health and the environment?

Response: Based on my training and experience, it is my opinion that a failed location restriction indicates that the location is not suitable for establishing a permanent waste disposal facility.

17. Do you believe there are scenarios where an unlined CCR surface impoundment that has a bottom located within 5 feet of the uppermost aquifer can be capped in a way that is protective of human health and the environment?

Response: Based on my training and experience, it is my opinion that one could think of some scenario where leaving CCR in an unlined impoundment with bottom within five feet of the uppermost aquifer can be capped that would be protective of groundwater quality. Techniques such as construction of slurry walls to restrict interaction between groundwater and waste, or installation of wells or drains to lower groundwater levels could be effective, depending on site-specific conditions. Many of these techniques, however, require regular monitoring and maintenance to continue proper function. Simply placing a cap over CCR, with groundwater

continuing to flow through waste containing soluble constituents, should not be assumed to be protective of groundwater quality.

18. Do you believe there are scenarios where a CCR surface impoundment located in an "unstable area" can be capped in a way that is protective of human health and the environment?

Response: Based on my training and experience, it is my opinion that a failing a location restriction, such as location in an unstable area, indicates that the location is not suitable for establishing a permanent waste disposal facility.

19. Does proposed Section 845.710 present a structure for evaluating risks to human health and the environment when selecting a closure method for CCR surface impoundments?

Response: It appears that this section presents a list of items that must be examined when conducting a closure alternatives analysis. Whether this is a structure that would be used for evaluating risks, I cannot say.

20. Do proposed Section 845.710(b)(1)(B) and 845.710(b)(2) require owners/operators to assess the risk of future releases of CCR and constituents from CCR surface impoundments, including at sites with intersecting groundwater?

Response: It appears that these sections require evaluation of the likelihood of future releases and the effectiveness of the closure in controlling future releases. The resulting evaluations should make it clear that sites with intersecting groundwater would have a higher likelihood of future releases than does a site where the waste is contained above groundwater. This is the reason I am recommending that the Illinois rule prohibit ash from being left submerged in groundwater.

21. Do proposed Section 845.710(b)(1)(B) and 845.710(b)(2) require owners/operators to assess the risk of future releases of CCR, including at sites located within a floodplain?

Response: It appears that these sections require evaluation of the likelihood of future releases and the effectiveness of the closure in controlling future releases. The resulting evaluations should make clear that sites located on an active floodplain would have a higher likelihood of future releases than does a site located off of a floodplain, and sites with intersecting groundwater would have a higher likelihood or future releases than does a site where the waste is contained above groundwater. This is the reason I am recommending that the Illinois rules prohibit CCR disposal on floodplains.

22. Does proposed Section 845.710(b)(1)(E) require owners/operators to assess the time each proposed closure will take to achieve the groundwater protection standards, including at sites with intersecting groundwater?

Response: It appears to me that this section requires assessment of the time until closure and post-closure care or completion of groundwater monitoring is completed.

23. Does proposed Section 845.710(b)(1)(F) require owners/operators to assess whether long-term contact of CCRs with groundwater is of concern?

Response: This section appears to require assessment of potential threats to human or environmental receptors from direct contact with remaining waste. It is unclear to me whether this section requires assessment of long-term contact of CCRs with groundwater.

24. Does proposed Section 845.710(b)(1)(G) require owners/operators to assess structural hazards posed by floodwaters when a CCR surface impoundment is located within a floodplain?

Response: It appears that this section requires assessment of long-term reliability of engineering controls, presumably including hazards posed by floodwaters, but structural hazards from floodwaters are not specified.

25. Do proposed Section 845.710(b)(1)(G) and 845.710(b)(3)(B) require an owner/operator to assess whether overtopping floodwaters present a reliability risk to a particular site?

Response: It appears that section 845.710(b)(1)(G) requires assessment of long-term engineering controls, presumably including hazards posed by overtopping floodwaters, but floodwater hazards are not specified. It is not clear to me that section 845.710 (b)(3)(B) pertains to the hazards posed by overtopping floodwaters.

26. Were IEPA's prior approvals of closure plans for CCR surface impoundments in Illinois sufficient to protect the quality of groundwater and surface water?

Response: I am not aware of the site closure plans that have been approved by IEPA. I would have to review specifics on approved sites and the approved closure plans in order to adequately respond to this question.

27. Do you agree that techniques such as groundwater modeling, site characterization, and risk assessment are widely accepted tools to evaluate closure alternatives for CCR surface impoundments?

Response: Site characterization is needed to collect site-specific data that supports further evaluations, potentially including groundwater modeling and risk assessment.

a. Do you agree that these techniques are employed by a variety of companies and engineering consultants across the country?

Response: Yes.

b. Do you agree that these techniques are regularly requested and reviewed by state regulators?

Response: Site characterization data is almost universally requested. Use of groundwater modeling and risk assessment to evaluate closure alternatives varies between sites and regulatory agencies.

28. Do municipal solid waste landfills store materials containing metals that are also found in coal combustion residuals?

Response: Municipal solid wastes typically contain some of the same metals as are found in CCR.

29. Do the metals found in materials stored in municipal solid waste landfills biodegrade?

Response: Metals found in municipal solid wastes generally do not biodegrade, however, some metals in municipal solid wastes are immobilized in complex compounds with organic chemicals. Soluble metals contained in CCR are readily leached into water without significant retention in organic compounds.

a. If not, are those metals capable of leaching from solid waste landfills into Illinois' groundwater?

Response: If left in unlined pits and directly in contact with groundwater, metals from solid waste landfill leachate would definitely be capable of leaching into Illinois' groundwater. Fortunately, for many years solid waste landfills in Illinois have been required to be lined and have leachate drainage and collection systems designed to prevent such a release. The proposed Part 845 rules for CCR disposal sites should be no less stringent, especially considering the fact that most of these impoundments are in locations with shallow groundwater and/or near surface water discharge areas.

30. Do special and hazardous waste landfills store materials containing metals that are also found in coal combustion residuals?

Response: Special and hazardous wastes may contain some of the same metals as are found CCR.

31. Do the metals found in materials stored in special and hazardous waste landfills biodegrade?

Response: Special and hazardous wastes includes a broad spectrum of wastes with widely varying properties about which it is difficult to draw conclusions. Generally speaking, metals found in special and hazardous wastes would not biodegrade, however, some metals in special and hazardous wastes may be immobilized in chemical complexes with organic compounds.

Soluble metals contained in CCR are readily leached into water without significant retention in organic compounds.

b. [Note: no subpart "a." included]: If not, are those metals capable of leaching from solid waste landfills into Illinois' groundwater?

Response: If left in unlined pits and directly in contact with groundwater, metals from special and hazardous waste landfill leachate would likely be capable of leaching into Illinois' groundwater. Fortunately, special waste and hazardous waste landfills in Illinois have for many years been required to be lined (double lined in the case of hazardous wastes) and have leachate drainage and collection systems designed to prevent such a release. The proposed Part 845 rules for CCR disposal sites should be no less stringent, especially considering the fact that most CCR impoundments are in locations with shallow groundwater and/or near surface water discharge areas.

32. Is it your belief that coal ash in an unlined impoundment will always come in intermittent, recurring, or sustained contact with groundwater when the impoundment is located within a floodplain?

Response: Based on my training and experience, it is my opinion that when dealing with geologic and hydrogeologic materials and processes, there are few things that should be characterized as always occurring. I would therefore not say that coal ash in an unlined impoundment will always be in contact with groundwater within a floodplain. I recommend that floodplains be included as unstable areas because over time, many river channels are known to migrate and shift, potentially undercutting and endangering structures used to contain CCR. However, migration of the channel is far from being the only hazard associated with disposal of wastes in unlined pits on a floodplain. CCR units located on floodplains are potentially subject to a variety of natural events or forces capable of impairing the ability of a surface impoundment to prevent releases. The obvious potential impairment is that floodwaters have the potential to erode surface structures, including berms and cap systems. The not-so-obvious problem is that these are generally shallow groundwater locations under normal conditions and groundwater elevations increase along with rising surface water, sometimes to elevations above ground surface. The combination of normally high groundwater and episodically high groundwater and surface waters during flood events enhances the potential for rewetting of disposed CCR and stimulation of renewed leachate generation. Not all sites located on floodplains will be subject to all of these issues but, in my opinion, the issues associated with leaving waste buried on floodplains should make floodplains unacceptable locations for establishing permanent waste disposal facilities.

a. If not, what are some of the factors that determine whether coal ash within an unlined impoundment located within a floodplain will come in intermittent, recurring, or sustained contact with groundwater during a flood event?

Response: Potential factors controlling contact with groundwater would include items such as the vertical distance between the bottom of waste and groundwater, the stage and duration of flood events, and the hydraulic conductivity of underlying soils.

33. Is it your belief that coal ash in an unlined impoundment will always come in intermittent, recurring, or sustained contact with groundwater when the bottom of the unlined impoundment is located within five feet of the uppermost aquifer?

Response: Based on my training and experience, it is my opinion that when dealing with geologic and hydrogeologic materials and processes there are few things that should be characterized as always occurring. I would therefore not say that coal ash in an unlined impoundment will always be in contact with groundwater if located within five feet of the uppermost aquifer. The 5-foot separation between the waste and groundwater is the same amount required by Section 845.300 of the proposed CCR rules. My suggestion is simply that the rule be modified to require five feet of separation between the waste and any zone of saturation, irrespective of whether or not the saturated unit is classified as an aquifer.

a. If not, what are some of the factors that determine whether the coal ash is expected to come in intermittent, recurring, or sustained contact with groundwater?

Response: Potential factors controlling contact with groundwater would include items such as the vertical distance between the bottom of waste and groundwater, the effectiveness of the cap system, the hydraulic conductivity of underlying soils, the range of groundwater elevations and gradient beneath the impoundment, the effectiveness of any groundwater control features that may be in place around the impoundment, and whether the site is potentially subject to flooding.

34. **If the bottom of an unlined CCR surface impoundment is located within 5 feet of the seasonal high groundwater elevation, including any perched water zones, *irrespective of* whether the water-bearing unit is classified as an aquifer, will groundwater <u>always</u> come in intermittent, reoccurring or constant contact with ash?**

Response: Based on my training and experience, it is my opinion that when dealing with geologic and hydrogeologic materials and processes there are few things that should be characterized as always occurring. I would therefore not say that coal ash in an unlined impoundment will always be in contact with groundwater if located within five feet of the uppermost aquifer. The of 5-foot separation between the waste and groundwater is the same amount required by Section 845.300 of the proposed CCR rules. My suggestion is simply that the rule be modified to require five feet of separation between the waste and any zone of saturation, irrespective of whether or not the saturated unit is classified as an aquifer.

a. If not, what are some of the factors that determine whether the coal ash is expected to come in intermittent, recurring, or sustained contact with groundwater?

Response: Potential factors controlling contact with groundwater would include items such as the vertical distance between the bottom of waste and groundwater, the hydraulic conductivity of underlying soils, the range of groundwater elevations and gradient beneath the impoundment, the effectiveness of any groundwater control features that may be in place around the impoundment, and whether the site is potentially subject to flooding.

35. Is it your belief that coal ash in an unlined impoundment that is located within a floodplain will always result in an exceedance of the groundwater protection standards?

Response: Based on my training and experience, it is my opinion that when dealing with geologic and hydrogeologic materials and processes there are few things that should be characterized as always occurring. I would therefore not say that coal ash in an unlined impoundment in a floodplain will always result in an exceedance of a GWPS. I recommend that floodplains be included as unstable areas because over time, many river channels are known to migrate and shift, potentially undercutting and endangering structures used to contain CCR. However, migration of the channel is far from being the only hazard associated with disposal of wastes in unlined pits on a floodplain. CCR units located on floodplains are potentially subject to a variety of natural events or forces capable of impairing the ability of a surface impoundment to prevent releases. The obvious potential impairment is that floodwaters have the potential to erode surface structures, including berms and cap systems. The not-so-obvious problem is that these are generally shallow groundwater locations under normal conditions and groundwater elevations increase along with rising surface water, sometimes to elevations above ground surface. The combination of normally high groundwater and episodically high groundwater and surface waters during flood events enhances the potential for rewetting of disposed CCR and stimulation of renewed leachate generation. Not all sites located on floodplains will be subject to all of these issues but, in my opinion, the issues associated with leaving waste buried on floodplains should make floodplains unacceptable locations for establishing permanent waste disposal facilities.

36. Is it your belief that coal ash in an unlined impoundment that is in intermittent contact with groundwater will always result in an exceedance of the groundwater protection standards?

Response: Based on my training and experience, it is my opinion that when dealing with geologic and hydrogeologic materials and processes there are few things that should be characterized as always occurring. I would therefore not say that coal ash in intermittent contact with groundwater will always result in an exceedance of a groundwater protection standard (GWPS). I will say that disposing of waste containing soluble components in a location where that waste is in intermittent contact with groundwater would increase the probability of an exceedance of groundwater protection standards as compared with wastes stored without contact with water.

37. Is it your belief that coal ash in an unlined impoundment that is in reoccurring contact with groundwater will always result in an exceedance of the groundwater protection standards?

Response: Based on my training and experience, it is my opinion that when dealing with geologic and hydrogeologic materials and processes there are few things that should be characterized as always occurring. I would therefore not say that coal ash in recurring contact with groundwater will always result in an exceedance of a GWPS. I will say that disposing of waste containing soluble components in a location where that waste is in recurring contact with groundwater would increase the probability of an exceedance of groundwater protection standards as compared with wastes stored without contact with water.

38. Is it your belief that coal ash in an unlined impoundment that is in constant contact with groundwater will always result in an exceedance of the groundwater protection standards?

Response: Based on my training and experience, it is my opinion that when dealing with geologic and hydrogeologic materials and processes there are few things that should be characterized as always occurring. I would therefore not say that coal ash in constant contact with groundwater will always result in an exceedance of a GWPS. I will say that disposing of waste containing soluble components in a location where that waste is in constant contact with groundwater would increase the probability of an exceedance of groundwater protection standards as compared with wastes stored without contact with water.

39. What are some of the factors that determine the rate of groundwater flowing through an unlined impoundment where the bottom of the impoundment is located below the water table?

Response: Factors controlling the rate of groundwater flow through porous media include the hydraulic conductivity of the material, the hydraulic gradient of the water, and effective porosity of the material.

40. What are some of the factors that determine the rate of groundwater flowing through an unlined impoundment during flood events?

Response: Factors controlling the rate of groundwater flow through porous media include the hydraulic conductivity of the material, the hydraulic gradient of the water, and effective porosity of the material.

41. What are some of the factors that determine the contaminant loading to groundwater from coal ash when a CCR surface impoundment is unlined and coal is in intermittent contact with groundwater?

Response: Some of the factors controlling the rate of loading to groundwater include the solubility of the various soluble parameters, the water/waste contact time, and chemistry (such as pH and redox potential) of the groundwater and waste.

42. What are some of the factors that determine the contaminant loading to groundwater from coal ash when a CCR surface impoundment is unlined and coal is in reoccurring contact with groundwater?

Response: Some of the factors controlling the rate of loading to groundwater include the solubility of the various soluble parameters, the water/waste contact time, and chemistry (such as pH and redox potential) of the groundwater and waste.

43. What are some of the factors that determine the contaminant loading to groundwater from coal ash when a CCR surface impoundment is unlined and coal is in constant contact with groundwater?

Response: Some of the factors controlling the rate of loading to groundwater include the solubility of the various soluble parameters, the water/waste contact time, and chemistry (such as pH and redox potential) of the groundwater and waste.

44. On page 7 of your pre-filed testimony you state that "without a clear and specific prohibition on leaving CCR in contact with groundwater, owners/operators are free to propose CCR unit closures that fail to contain CCR constituents. . . ."

a. Does proposed Section 845.710 require owners/operators to evaluate the "effectiveness of the closure method in controlling future releases?"

Response: It appears that this section requires evaluation of the effectiveness of the closure in controlling future releases. The evaluation of closure methods should make it clear that sites with intersecting groundwater would have a higher likelihood or future releases than does a site where the waste is contained above groundwater.

b. Does proposed Section 845.710 require owners/operators to propose a closure method that will "achieve compliance with the groundwater protection standards in Section 845.600?"

Response: It appears that this section requires the owner/operator to select a closure method that will achieve compliance with the groundwater protection standards.

c. Does proposed Part 845 require IEPA to review and approve all closure plans?

Response: Draft Part 845 requires that closure plans be approved by IEPA. I see nothing in the rules that requires IEPA to approve all closure plans.

d. Under proposed Part 845, is an owner/operator free to implement any closure plan it chooses?

Response: Please note that my original comment reproduced in question #44 indicates that "owners/operators are free to *propose* CCR unit Closures that fail to contain constituents." In the

case of unlined CCR left in unlined pits and submerged in groundwater, that is often the result. The remedy finally implemented by an owner/operator will depend on what is actually approved by IEPA.

45. On page 10 of your pre-filed testimony you raise concerns with CCR surface impoundments located in floodplains along river channels. Do those same concerns exist when a CCR surface impoundment is not located along a river channel, but instead in a floodplain along a lake or pond?

Response: Areas near lakes could be of concern in locating a permanent waste disposal facility due to a shallow water table, potential flooding, or proximity to contaminant receptors, but they would not likely be subject to erosion from fast moving flood waters unless they are also located adjacent to a stream or river that is subject to flooding.

46. On page 10 of your pre-filed testimony you discuss rising floodwaters in Wilmington, North Carolina and allege they inundated coal ash storage and disposal units.

a. Are you aware of any such examples in Illinois of rising floodwaters inundating CCR surface impoundments?

Response: I am not aware of whether floodwaters have yet completely inundated a CCR impoundment in Illinois. There are, however, examples of sites that have had floodwaters rise well up the side of their containment berms, such as the Springfield CWLP Dallman impoundments, where flooding along Sugar Creek caused berm erosion and damage to monitoring wells.

b. The rising floodwaters that you allege inundated coal ash storage and disposal units in Wilmington, North Carolina in 2018 were associated with a hurricane, correct?

Response: If I recall correctly, a hurricane came ashore in South Carolina and became a tropical storm system that moved into upstream areas of CCR impoundments in North Carolina, and then stalled. In this case, I do not believe that the CCR impoundments were actually hit by a hurricane. High water caused by the slowly moving storm system caused significant flooding further downstream.

47. Was the photo included on page 11 of your pre-filed testimony obtained from a Washington Post article available at the following link: www.washingtonpost.com/energy-environment/2018/09/21/dam-breach-reported-formernc-coal-plant-raising-fears-that-toxic-coal-ash-may-pollute-cape-fear-river ?

Response: The picture in my testimony is from an article in the Washington Post. That is why I identified it as such in my testimony. I have not been able to get the hyperlink provided above to work, so I cannot verify that the photo is from the same article.

48. The article states that the photo "shows flooding . . . overtopping an earthen dike . . ." Do you have any information demonstrating that the photo included in your testimony depicts an ash pond breach or water flowing in/out of an ash pond?

Response: If you read the Washington Post article on flooding at CCR sites in North Carolina (included as an attachment to my testimony), you will notice that Mr. Pete Harrison from Earthjustice was in the area and on the water at the Sutton facility during the flooding. I was contacted by Earthjustice on the day that Mr. Harrison was at the site to inquire about CCR units that would be of concern during this event since I had previously done some review of that site for another client. I was able to provide Mr. Harrison with a map of the site showing the location of current and former CCR units so those in the field would know what locations were of concern. The people in the field were subsequently able to verify flooding of CCR units and releases of CCR into surface water. Samples of ash in floodwater collected during this event contained cenospheres and high arsenic concentrations in the water.

a. If so, identify the source and provide a description of the information.

Response: See my response to #48, above.

49. On page 12 of your testimony you state that certain elements of groundwater monitoring systems are "often ignored . . . by regulators." Is it your opinion that IEPA has ignored certain elements of groundwater monitoring systems associated with CCR surface impoundments?

Response: It is my opinion that IEPA is "off to a good start" with these proposed rules. My intention is to point out places that, based on training and experience, I believe the draft rules can be improved to better protect water quality.

a. If so, please provide examples.

Response: In my testimony I provide two specific items that I would like to see required of all CCR disposal facilities. The first item cited is collection of porewater elevation inside CCR disposal units. This data needs to be evaluated and potentially incorporated into water table maps in order to provide a better indication of local groundwater flow directions. The second identified item is characterization of porewater chemistry. Adequate characterization of porewater chemistry is needed to identify source concentrations for groundwater fate and transport modeling and is often needed to evaluate the validity of alternative source determinations.

50. Is it your opinion that current IEPA approved groundwater monitoring systems associated with CCR surface impoundments are "inadequate to identify impacts to water quality from CCR surface impoundments"?

Response: Not necessarily. Each monitoring system would be based on site-specific conditions. I am recommending additions to the monitoring program that could enhance understanding of conditions in the field.

51. Does the collection of porewater sampling inform the design and construction of a final cover system for CCR surface impoundments?

Response: If I understand the question correctly, to my knowledge, porewater chemistry data would not inform the design and construction of a final cover system, although regular measurement of porewater elevation data could prove useful in identifying increased leakage through the cap system should increased leakage occur at some point in the future.

52. Does the collection of porewater sampling support the development of an accurate approximation of the direction of groundwater flow?

Response: If I understand the question correctly, to my knowledge, porewater chemistry data does not support development of accurate flow directions. However, measurement of porewater elevations is useful in developing accurate groundwater flow directions.

53. Does the chemical composition of CCR influence how a CCR surface impoundment is closed?

Response: I assume that there could be questions about compatibility of disposed CCR with liner or cap materials, but this is not my area of expertise. The chemical composition of CCR is related to the contaminants that are or may be released from disposed CCR. The ability of a facility to contain soluble contaminants from disposed CCR should be the main influence how a CCR impoundment is closed.

a. If so, please describe.

Response: See above answer.

54. You propose adding iron, manganese, and vanadium to the list of groundwater protection standards. Are you aware that these three constituents were included in U.S. EPA's 2014 Risk Assessment?

Response: I am aware that these constituents were included in the EPA risk assessment. I am also aware that I frequently see these constituents in elevated concentration in and around some CCR disposal sites and that Illinois has previously established health-based groundwater protection standards for these common CCR constituents. The Illinois Part 620 are generally equivalent to the USEPA's Maximum Concentration Levels (MCLs). The MCL levels were specified as water quality standards under the principle that groundwaters that are naturally potable should be available for drinking water supply without treatment.[7]

a. Are you aware that U.S. EPA did not identify any risks to either human or ecological receptors for any of these constituents?

[7] Illinois Pollution Control Board (1991), Groundwater Quality Standards, 35 Ill. Adm. Code 620, R89-14(B) Rulemaking, November 7, 1991, P. 18. Available at: https://pcb.illinois.gov/documents/dsweb/Get/Document-21965.

Response: I am aware that the EPA risk assessment did not identify risks associated with these parameters. I am also aware that I frequently see these constituents in elevated concentration in and around some CCR disposal sites and that Illinois has previously established health-based groundwater protection standards for these common CCR constituents.

55. Is it your opinion that IEPA's current proposal is insufficient to allow IEPA to effectively review and evaluate the groundwater data collected?

Response: It is my opinion that collection of porewater head and chemistry data will be useful to IEPA in verifying the owner/operator's interpretation of groundwater flow directions and potential impacts to water quality from CCR facilities.

56. In forming your opinion, did you review any groundwater data collected from any sites in Illinois?

Response: I have reviewed many sets of groundwater data from sites in Illinois, but none specifically for the purpose of forming my opinion.

a. If so, were you able to understand and interpret the data?

Response: I have been reviewing groundwater quality data on a regular basis since 1978. I am confident that I am able to understand and interpret the data.

b. If so, were you able to gain an understanding of the impacts to groundwater associated with CCR surface impoundments in Illinois?

Response: This is a very broad, generalized question. Groundwater monitoring data is specific to individual sites. I have not attempted to come up with a general characterization of impacts to groundwater from CCR impoundments in Illinois.

57. Typically, in what portion of a sediment column does biological activity occur?

Response: I am not an aquatic biologist, but I would expect that it is dependent on the creatures that are present, the thickness of the sediments and the composition of the sediments.

a. What biological activity occurs in these sediments?

Response: I am not an aquatic biologist, but I would expect that it is dependent on the creatures that are present, the thickness of the sediments and the composition of the sediments.

58. Are you aware that US EPA's 2014 Risk Assessment did not identify any unacceptable risks to surface waters or sediments associated with groundwater contamination from CCR surface impoundments?

Response: Yes, I am aware of this, yet I have seen sediment data[8] from a river adjacent to a CCR site that showed that arsenic transported from the site in groundwater was detected in porewater and sediments at the bottom of the river at concentrations up to 452.2 ug/l and 8.2 mg/l, respectively.

59. Are sediment systems complex and dynamic?

Response: Sediment systems can be complex and dynamic in some locations and under some conditions. This is a very generalized question about a site-specific sediment system.

60. Generally speaking, are sediments in rivers constantly moving down stream?

Response: Actually, no. The buried sediments below the bottom of a river can be mobile or may be stationary for long periods between high water events. Again, these processes are site-specific and will vary depending on the size of a stream or river, the bed load composition, river stage, flood frequency, etc.

61. Does the Clean Water Act's point source discharge program allow dilution and dispersion to occur within "mixing zones" in receiving water bodies?

Response: Yes, it is my understanding that mixing zones are allowed for certain types of requirements under certain circumstances. But I do not typically work on Clean Water Act issues and this question is outside of my area of expertise.

62. Is it appropriate to apply groundwater standards to surface waters?

Response: There may be circumstances where a groundwater standard is relevant to evaluation of surface water quality, but again, I do not typically work on Clean Water Act issues and this question is outside my area of expertise.

63. On page 18 of your testimony you suggest that closure by removal should be required when there is less than 5-feet of vertical separation between the bottom of an impoundment and "the elevation of the seasonal high groundwater elevation, including any perched water zones, irrespective of whether the water-bearing unit is classified as an aquifer," correct?

Response: I do not believe that I actually indicate that the waste must be removed. The intention of my comments is to indicate that the waste should be segregated from groundwater. That could be by removal, lining the unit, lowering of the water table, construction of slurry walls around the unit, or some other method that might be appropriate given site-specific conditions. It is true that in my opinion, simply capping a CCR unit to reduce infiltration into the waste while allowing groundwater to flow through the waste will not control the source of contamination.

a. What is a "perched water zone"?

[8] AMEC Earth and Environment, 2010, Natural Attenuation of Arsenic Demonstration, Chesapeake Energy Center Ash Landfill, Chesapeake, Virginia, June 7, 2010 (attached hereto as Attachment 1).

Response: Perched groundwater is subsurface water that is supported on a low permeability layer below the surface and above the local or regional water table.

b. Generally speaking how close to the ground surface are perched water zones located along rivers in Illinois?

Response: Generally speaking, groundwater along rivers in Illinois, including perched groundwater, is shallow.

c. Have you identified the number of CCR surface impoundments in Illinois that would have to close by removal if the Board were to follow your recommendation regarding closure by removal for CCR surface impoundments located within 5 vertical feet of a perched water zone?

Response: I have not attempted to identify this information.

64. If the bottom of an unlined CCR surface impoundment is located within 5 feet of the seasonal high groundwater elevation, including any perched water zones, irrespective of whether the water-bearing unit is classified as an aquifer, will groundwater always come in intermittent, reoccurring or constant contact with ash?

Response: Based on my training and experience, it is my opinion that when dealing with geologic and hydrogeologic materials and processes, there are few things that should be characterized as always occurring. I would therefore not say that coal ash in an unlined impoundment will always be in contact with groundwater if located within five feet of the seasonal high groundwater elevation, including perched water zones. The 5-foot separation between the waste and groundwater is the same amount required by Section 845.300 of the proposed CCR rules. My suggestion is simply that the rule be modified to require five feet of separation between the waste and any zone of saturation, irrespective of whether the saturated unit is classified as an aquifer.

65. Is 30 years the standard post-closure care period for hazardous and solid waste management units under the Resource Conservation and Recovery Act ("RCRA")?

Response: Yes.

66. Dilution and dispersion can reduce concentrations of dissolved compounds to levels below applicable groundwater standards, correct?

Response: Dilution and dispersion are the most frequently invoked attenuation mechanisms that I see described referenced in relation to CCR contaminant plumes. These are processes that reduce the concentration of contaminants in water without actually removing contaminant mass. While these mechanisms are listed as attenuation processes, USEPA's 2015 MNA guidance

document[9] clearly states: "However, dilution and dispersion generally are not appropriate as primary MNA mechanisms because they reduce concentration through dispersal of contaminant mass rather than destruction or immobilization of contaminant mass."

67. U.S. EPA guidance has established the below definition for the term "monitored natural attenuation," as used at CERLCA, RCRA Corrective Action, and Underground Storage Tank Sites, correct?

"...[t]he reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; *dispersion; dilution*; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants." U.S. EPA, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites at 3 (Apr. 21, 1999) (emphasis added) (attached as Appendix B).

Response: While the mechanisms of dilution and dispersion are listed as attenuation processes, USEPA's 2015 MNA guidance document[10] clearly states "However, dilution and dispersion generally are not appropriate as primary MNA mechanisms because they reduce concentration through dispersal of contaminant mass rather than destruction or immobilization of contaminant mass." Dilution and dispersion are the most frequently invoked attenuation mechanisms that I see referenced in relation to CCR contaminant plumes. These are process that reduce the concentration of contaminants in water without actually removing contaminant mass.

The 2015 guidance from USEPA also clarifies that "MNA is generally not appropriate for plumes that are considered stable, yet there is confirmed discharge to surface water bodies or potential human or ecological receptor exposure."[11] If an owner/operator can identify and document another MNA mechanism other than dilution and dispersion that actually does remove contaminant mass from a CCR contaminant plume before contaminants are discharged to a surface water body, it may be appropriate for MNA to be part of a remedial action.

68. When placing additional coal ash for purposes of grading and contouring, does proposed Section 845.750(d) allow an owner/operator to place the additional coal ash in a manner that would allow the coal ash to be in contact with groundwater?

[9] USEPA, 2015, Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites, Office of Solid Waste and Emergency Response, Directive 9283.1-36, August 2015 (attachment 4), p. 14.
[10] USEPA, 2015, Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites, Office of Solid Waste and Emergency Response, Directive 9283.1-36, August 2015 (Attachment 4), p. 14.
[11] USEPA, 2015, Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites, Office of Solid Waste and Emergency Response, Directive 9283.1-36, August 2015 (Attachment 4), p. 18.

Response: Section 845.750(d) requires that CCR be placed entirely above the elevation of CCR in the surface impoundment, following dewatering. It is unclear to me if this provision requires the CCR in the impoundment is temporarily dewatered to allow for placement of new ash followed by re-wetting of the newly place ash as groundwater re-saturates waste, or if this provision is requiring that the newly placed waste be placed above the elevation of saturated waste in the impoundment. This proposed provision needs clarification.

69. Do you agree that the placement of CCR above the water table during closure in accordance with Section 845.750(d) will not increase the magnitude/size of groundwater impacts?

Response: I agree that as long as CCR is isolated from water, either groundwater or leakage through a cap, the size and concentrations of contaminants in groundwater should not be affected. I would expect this to be the case until such time as groundwater conditions change or the cap becomes damaged or deteriorates and infiltration into the waste increases.

70. Would consolidating coal ash from two impoundments into one reduce the coal ash footprint at a site?

Response: Presumably this would be the case.

a. Are there any potential benefits associated with this?

Response: It would reduce the land area involved in waste storage and consolidate monitoring activities onto a smaller footprint.

71. Have you determined what it would cost if removal is required for all CCR surface impoundments located within a floodplain, failing the aquifer separation location restriction, or in intermittent, reoccurring, or constant contact with groundwater?

Response: I have not.

a. If so, what are the costs?

Response: Costs would depend on the volume of waste to be removed, where the waste would be relocated, whether some or all of the waste could be recycled, how far waste would be transported, whether a new lined disposal cell could be constructed on-site, etc. These are all questions that I have no way to answer without far more detailed review and analysis for each site.

72. Have you determined whether there is sufficient existing operating landfill capacity to accommodate all of the ash that would have to be excavated if removal if required for all CCR surface impoundments located within a floodplain, failing the aquifer separation location restriction, or in is intermittent, reoccurring or constant contact with groundwater?

Response: I have not.

a. If so, please describe your methodology?

Response: The question assumes that all excavated waste would be transported off-site to existing operating landfill. In locations where I have seen ash excavated, some has been relocated to a new lined disposal cell on-site or nearby, some has been recycled, and some has been transported to off-site landfills (either new or existing). The landfill capacity needed would depend on the volume of waste to be removed, where the waste would be relocated, whether some or all of the waste could be recycled, how far waste would be transported, whether a new lined disposal cell could be constructed on-site, etc. These are all questions that I have no way to answer.

73. Have you determined the environmental and community impacts if removal is required when all CCR surface impoundments located within a floodplain, failing the aquifer separation location restriction, or in intermittent, reoccurring or constant contact with groundwater?

Response: I have not.

a. If so, please describe your methodology?

Response: This is not my area or expertise, but in my experience there is some level of risk associated with any construction or remediation project. As long as risks of a removal action are identified and mitigated, I expect that any risk to workers or the community would be no greater than from any other construction project.

Questions from Midwest Generation

1. Identify prior projects you have worked on for any federal or state environmental agency regarding the development of rules or regulations of general applicability that applied to coal combustion residuals ("CCR") as that term is defined Section 3.142 of the Illinois Environmental Protection Act ("Act").

Response: My previous work on development of rules applying to coal combustion residuals has been performed for outside parties, not as an employee or consultant for any federal or state environmental agency. My experience working directly for IEPA or as a contractor for USEPA included learning the applicable rules and applying those rules in the field. More recently, I assisted Southern Environmental Law Center in their work on establishing state CCR regulations in North Carolina. I have also provided input to USEPA on various aspects of CCR regulations on behalf of Earthjustice.

2. Identify any prior projects which you have worked on for an industrial facility in the past 10 years that involved CCR as that term is defined in the Act and describe the work conducted.

Response: My experience for industrial facilities that involved CCR includes:

1) Midwest Generation, Lincoln Stone Quarry, Groundwater Impact Assessment
2) Midwest Generation, Will County Generating Station, Groundwater Quality Stats

Although not specific to CCR, my past experience at industrial facilities includes at least twenty-five years of experience working on waste disposal problems at industrial facilities including nuclear materials plants, a chemical weapons manufacturing facility, refineries, and other manufacturing facilities with significant releases of organic and inorganic contaminants.

3. **Identify the scope of any work you have been requested to perform on behalf of the clients you are representing here today, including any work related to any coal-fired generating stations.**

Response:

i. Review and Prepare Comments; Sunflower Coal Ash Landfill Permit Application
ii. Review and Prepare Comments; Savage Mine Permit Application
iii. Review and Prepare Comments; USEPA Coal Combustion Waste Rules NODA
iv. Review and Comment on Documents; Colstrip Generating Station Coal Ash
v. Review and Prepare Comments; Iatan Generating Station Permit Application
vi. Review Documents, Expert Report, Deposition; Colstrip Generating Station Coal Ash
vii. Review Documents and Prepare Expert Report, Site Visit; Hatfield Ferry Generating Station CCR
viii. Review and Comment on Documents, Site Area Visit; Confidential matter.
ix. Review and Prepare Expert Opinions USEPA CCR Rules
x. Review and Prepare Comments; AES Puerto Rico CCR Groundwater Monitoring
xi. Review and Prepare Comments; USEPA CCR Rule Ash Piles
xii. Review and Comment; Shay Mine Proposed Wick Drains
xiii. Review, Site Visit and Prepare Expert Report, Springfield CWLP Dallman Ash Ponds
xiv. Review Documents and Prepare Comments; Colorado Springs Utilities Clear Springs Ranch CCR Monitoring Plan
xv. Review and Prepare Comments – USEPA Part A, Low Volume/Uniquely Associated CCR Wastes
xvi. Review and Prepare Comments – USEPA Part B, Proposed CCW Rule Changes
xvii. Review and Prepare Comments – Michigan City Generating Station CCR Closure Plan
xviii. Review Documents and Prepare Expert Report – Tanners Creek Generating Station Fly Ash Pond Closure
xix. Review, Comment, and Prepare Expert Testimony – Proposed Illinois Coal Ash Rules

4. **Have you reviewed the U.S.EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals"?**

Response: I reviewed and prepared comments on the draft Risk Assessment that were submitted to EPA in 2008, and reviewed the 2014 Risk Assessment at some time after it came out.

5. **You attached the U.S.EPA Criteria for Solid Waste Disposal Facilities, A Guide for Owners/Operators ("U.S.EPA Criteria) to your testimony. What is the purpose of the U.S.EPA criteria for Solid Waste Disposal Facilities, for your testimony on CCR surface impoundments?**

Response: I included a quotation from the document that addressed the need to protect groundwater quality, so I attached the document to my testimony.

   a. **Do you agree that the U.S.EPA Criteria states that if a landfill does not meet a location restriction, such as being located in a floodplain, that the landfill must be closed by placing a final cover over the waste?**

Response: The document actually states that "Owners/operators of landfills that stop receiving waste between October 9, 1991, and October 9, 1993 must install final covers that meet the federal criteria within six months of the last receipt of waste." Since this narrow time window in the 1990's is long past, I do not see how this is relevant to dealing with different wastes, in different types of facilities, almost twenty-seven years after the closure guidance was applicable.

6. **The preamble of the federal CCR rule, based on a detailed scientific study, states:**

   "EPA did not propose to require clean closure nor to establish restrictions on the situations in which clean closure would be appropriate. As EPA acknowledged in the proposal, most facilities will likely not clean close their CCR units given the expense and difficulty of such an operation. Because clean closure is generally preferable from the standpoint of land re-use and redevelopment, EPA has explicitly identified this as an acceptable means of closing a CCR unit. However, both methods of closure (i.e., clean closure and closure with waste in place) can be equally protective, provided they are conducted properly. Thus, consistent with the proposal, the final rule allows the owner or operator to determine whether clean closure or closure with the waste in place is appropriate for their particular unit." 80 F.R. 21412.

   What is the scientific and risk-based foundation that makes you suggest a more restrictive rule than the USEPA in regard to selection of clean closure or closure in place?

Response: It is my opinion that the preamble quoted above is consistent with my suggested changes to the rules. The preamble specifically states the clean closure and closure in place "**can** be equally protective, **provided they are conducted properly**." The preamble does not state that closure in place is always equally protective. It also does not state that closure in place consists only of placing a cap over the waste. Closure in place can be an effective closure method in locations where the waste can be isolated from water, with a cap alone in some locations, or with a cap and other remedies needed to segregate the waste from water in other

locations. In my opinion, an in-place closure that allows groundwater to flow through disposed waste is not equally protective with removal.

7. **On p. 9 of your testimony, you state that the point of CCR rules should be to keep waste out of water, whether or not it is capable of yielding usable quantities of groundwater to wells or springs.**

    a. **You agree that when a clay liner is compacted, it is often at or very near full saturation, resulting in a liner that has a much lower permeability, yet it is saturated with water. Please explain how saturated layers that have very low permeability, when exposed to CCR, are a hazard to human health and the environment.**

Response: Geotechnical engineering is not my area of expertise, but it is well known that water is added during compaction of clay materials. It is my understanding that soils are generally wetted to a few percentage points over optimum to achieve maximum compaction and low permeability. Water incorporated into a low permeability soil is incorporated into the matrix of the liner material. In my opinion, there is a significant difference between water added to and incorporated into clay soils to form a low permeability liner, and groundwater capable of flowing through soil and into or through wastes if it was allowed to do so.

8. **On p. 14 of your testimony you suggest that the performance standard for the groundwater monitoring systems be modified to represent the quality of background groundwater that has not been affected by any site operations.**

    a. **Are you aware of Illinois Pollution Control Board ("Board") Regulations, Part 620, Groundwater Quality"?**

Response: I have seen and used Part 620 water quality rules.

    b. **Do you agree that Part 620 regulates the groundwater quality in Illinois, including at power generating stations? If not, please explain why.**

Response: As I indicated on page 14 of my testimony, I am recommending that the Illinois CCR rules include iron, manganese, and vanadium in the list of monitoring parameters. These are parameters that I often see at elevated concentrations in porewater and groundwater at CCR impoundment sites. As to whether both Part 620 and the proposed CCR rules will apply, I assume so, but that would seem to be a more appropriate question for an attorney.

    c. **How is your proposed language consistent with Part 620 of the Board Regulations?**

Response: It is unclear to me what language is being questioned. This question also seems better addressed by an attorney.

d. Assuming power generating stations have underground storage tanks ("USTs"), how is your proposal consistent with Parts 731 through 734 of the Board regulations, which are regarding USTs?

Response: I am not familiar with the UST regulations. I have worked on a wide variety of sites but have not worked on an UST project in Illinois.

9. On p. 14 of your testimony you state that comparisons of downgradient water quality to "background" concentration using intra-well analysis are not effective in monitoring an existing facility since intra-well tests do not compare each well against "background."

a. What is your definition of "background"?

Response: Groundwater quality that is unimpacted by CCR storage or disposal.

b. Do you agree that intra-well statistics assist in establishing a contrast between past and present groundwater data?

Response: Intra-well statistics are one way to establish differences between past and present water quality. Whether this is a meaningful comparison depends on whether there has been a meaningful change in conditions between the two time periods being measured.

c. Do you agree that the contrast established between the past and present groundwater data can assist in evaluating the concentrations of constituents in the groundwater?

Response: The problem with using intra-well statistics related to its use at CCR sites is that these sites have been in operation for several decades in many cases. Monitoring of groundwater has only recently been required and implemented at most of these sites. This creates a situation where monitoring systems are put in place and sampling is initiated even though in many cases the contaminant plume being monitored has been present for a considerable period of time. Since intra-well statistics are designed to detect changes from past to present, and the initial (past) concentrations in the water were already impacted, intra-well testing will indicate that there is no statistically significant change in water quality. Use of intra-well testing to identify statistically significant changes in water quality after the groundwater has already been impacted is not a reliable testing protocol. Intra-well testing would be a fine data evaluation tool in newly established locations where changes in water quality have not already happened.

i. Can this tool also provide insight into results of groundwater monitoring at sites with complex issues?

Response: Use of intra-well testing to identify statistically significant changes in water quality after the groundwater has already been impacted is not a reliable testing protocol. Intra-well testing would be a fine data evaluation tool in newly established locations where changes in water quality have not already happened.

ii. Why do you propose or support removing this data evaluation tool from being able to be used to assist in data interpretations?

Response: The problem with using intra-well statistics related to its use at CCR sites is that these sites have been in operation for several decades in many cases. Monitoring of groundwater has only recently been required and implemented at most of these sites. This creates a situation where monitoring systems are put in place and sampling is initiated even though in many cases the contaminant plume being monitored has been present for a considerable period of time. Since intra-well statistics are designed to detect changes from past to present, and the initial (past) concentrations in the water were already impacted, intra-well testing will indicate that there is no statistically significant change in water quality.

10. Do you agree that each groundwater situation, because of varying conditions and circumstances, such as the historical use of the impoundment and the site's hydrogeology, are unique and may require flexibility in order to make an accurate assessment of the groundwater situation?

Response: I have no doubt that this can be the case, although I am also aware that many CCR impoundments were constructed using similar techniques and materials, contain similar wastes, and release similar constituents.

a. Do you agree that rules of general applicability should be flexible enough to allow the Agency to adapt them to a given situation? If not, please explain.

Response: I believe that the Agency needs and has the necessary flexibility. My purpose in making my proposed changes to the rules is to minimize potential problem sites that the Agency and the public have to deal with.

11. On p. 14 of your testimony you discuss reviewing CCR monitoring data from multiple CCR sites, were any of those sites in Illinois and if so, which ones?

Response: I did not review monitoring results from Illinois sites to specifically identify sites with elevated concentrations of iron, manganese, and vanadium, although these would be common constituents and a quick check of my records confirms that manganese is routinely detected in wells AP-2 and AP-3 at the CWLP Dallman Ash Ponds in concentrations above the Class I Standard. CCR impoundments at the Roxboro, Belews Creek, and Mayo Generating Stations in North Carolina immediately come to mind where all three of these contaminants are elevated in various media.

12. Are you aware that the U.S.EPA did not include iron, manganese, and vanadium in its list of groundwater protection standards because it did not identify any risks to human health or the environment based on the U.S.EPA's risk assessment?

Response: I am aware of that risks were not identified for these constituents in the EPA risk assessment. I am also aware that I frequently see these constituents in elevated concentration in

and around some CCR disposal sites and that Illinois has previously established health-based groundwater protection standards for these common CCR constituents. The Illinois Part 620 are generally equivalent to the USEPA's Maximum Concentration Levels (MCLs). The MCL levels were specified as water quality standards under the principle that groundwaters that are naturally potable should be available for drinking water supply without treatment.[12]

13. **On p. 16 of your testimony, you state that metals from a CCR release "can accumulate to elevated concentrations in stream-side and/or bottom sediments while contamination of surface water remains undetectable due to high dilution."**

Response: Yes.

a. Identify any scientific studies and/or data you relied on for this statement.

Response: I am attaching a report on sampling conducted at the Dominion Chesapeake Energy Center by AMEC[13] that concludes with the following statement: "Arsenic sequestration on iron-bearing geomedia is attenuating dissolved arsenic concentrations outside the landfill and peninsula boundaries." In fact, arsenic transported from the site in groundwater was detected in in porewater and sediments at the bottom of the river at concentrations up to 452.2 ug/l and 8.2 mg/l, respectively.

b. Is your statement on page 16 true only for CCR? If so, what is your basis.

Response: I expect that similar results could be found at other locations located near surface water bodies where contaminant plumes discharge into bottom sediments. This understanding is also consistent with my experience in performing site investigations and characterizations.

14. **On p. 16 of your testimony, you suggest that the language be modified so that a "sufficient number of wells" are installed to identify the leading edge of the contaminant plume. Do you agree that at least two sets of sampling data from a newly installed monitoring well will result in better information on the groundwater system and the potential plume? If not, please explain.**

Response: My opinion is that it is safe to say that more data is better than less, so yes, two sets of data would be preferable.

a. How long do you believe installing multiple additional wells will take?

Response: Without knowing many details, I am not sure that I can accurately answer this question. Variables such as how many wells, how deep the wells will be, what formation is

[12] Illinois Pollution Control Board (1991), Groundwater Quality Standards, 35 Ill. Adm. Code 620, R89-14(B) Rulemaking, November 7, 1991, p. 18. Available at: https://pcb.illinois.gov/documents/dsweb/Get/Document-21965.

[13] AMEC, 2010, Natural Attenuation of Arsenic Demonstration, Chesapeake Energy Center Ash Landfill, Chesapeake, VA, June 7. 2010, p. 6-1 (Attachment 1).

being drilled, whether there is ready drilling site access, whether staff and a driller are available etc. will all affect the answer. I would think that in general it might take two months to install "multiple additional wells."

b. If the contaminant plume is offsite, do you agree that installing additional wells on an adjacent property could possibly take longer than your estimate in your answer to Question 14.a?

Response: If there is a plume migrating off-site onto properties owned by other parties I expect that it is possible that obtaining access could take additional time. If the plume is migrating off-site, robust monitoring is even more necessary to establish how far the contamination has traveled, the depth, width, and contaminant concentrations within the plume, whether any public or private water wells are at risk, etc.

15. On p. 16 of your testimony, you state that the chemical composition of CCR disposed in impoundments is highly variable between locations and depths sampled. Identify any scientific studies and/or data you relied on for this statement.

Response: As an example of the type of information on porewater chemistry that I have seen that supports this statement, I am attaching a spreadsheet[14] of data developed by and for Duke Energy at the Roxboro generating station in North Carolina. The first bloc of data on the spreadsheet shows porewater chemistry data collected from four different locations in the Roxboro coal ash impoundment. The variation in chemistry between sampling locations is evident. Iron, manganese, and vanadium are all detected in these samples at concentrations above North Carolina standards.

16. On p. 16 of your testimony, you state that an alternate source demonstration relying upon one or two CCR samples ignores "the variability of the source material."

a. Identify any scientific studies and/or data you relied on for this statement.

Response: Please see response to question # 15, above.

b. Do you believe that if the source coal is from the same coal mine, and the coal is consistently burned in the power generating plant using the same combustion process the primary chemical composition of the resulting CCR is significantly different? If so, please explain why and identify the studies and/or data you rely upon.

Response: The assumptions of same coal mine, coal burned in the same plant, using the same process should tend to limit the range of CCR chemistry, however one example is Midwest Generation's own Lincoln Stone Quarry. If I recall correctly, there are some portions of the quarry that contain buried fly ash that was placed in the quarry prior to the time that it was used for bottom ash disposal. The presence of the buried fly ash in portions of the quarry created

[14] 2016 Analytical Results (January-March), Roxboro Steam Electric Plant, Duke Energy Progress, LLC (Attachment 5).

leachate with variably elevated boron, arsenic, and Total Dissolved Solids (TDS). Changes in operations such as this are common over the extended time periods that these facilities operated. Changes to how and where wastes were disposed over time are an important factor driving porewater chemistry variability.

17. On p. 17 of your testimony, you state "porewater within a CCR disposal unit is horizontally and vertically variable." Identify any scientific studies and/or data you relied on for this statement.

Response: Attachment 5 is a spreadsheet of data developed by and for Duke Energy at the Roxboro generating station in North Carolina. The first bloc of data on the spreadsheet shows porewater chemistry data collected from four different locations in the Roxboro coal ash impoundment. In my opinion, the variation in chemistry between sampling locations is evident. The Roxboro site was one of three sites that I am aware of that developed similar porewater chemistry data. Also see response to question #16b, above.

18. On p. 17 of your testimony, you state that issues related to insufficient analysis of porewater in a CCR surface impoundment have been identified in other states as well as in Illinois. Identify where in Illinois the issues been identified. Identify the other states and the power stations in those states.

Response: I provided one example of an alternative source demonstration in Illinois in my testimony that illustrated the point that I was making. I have not done a search of Illinois sites to identify other sites that have performed insufficient analysis of porewater samples and do not keep a listing of sites with that identified problem. An example from another state is Plant Scherer in Georgia.

19. On p. 18 of your testimony, you state that "leaving industrial waste in the form of CCR buried in unlined impoundments…"

a. What distinguishes CCR from other industrial waste to the point that it requires a separate treatment relative to regulatory considerations?

Response: Wastes generated by coal combustion have for decades been exempted from environmental regulations that other waste streams have long ago become accustomed to complying with. It is not the characteristics of CCR that has caused separate treatment relative to regulatory consideration. CCR has been treated differently than other industrial wastes because the industry was successful in separating fossil fuel combustion wastes from regulations that pertain to other wastes. In my opinion, these rules should have been imposed many years ago when other industries were regulated.

b. Do you believe CCR creates a higher risk to human health and the environment than all other industrial waste? If so, what is your basis and identify the scientific studies and/or data that support your basis.

Response: Generally, no. It is not the chemical composition of CCR in itself that creates concern for human health and the environment. In my opinion, concerns to human health and the environment from CCR are related to poor choices in handling and disposal of the large volume of CCR produced at generation stations over a long period of time, not necessarily due to the chemical composition of the waste.

20. Do you agree that, unlike municipal solid waste, CCR does not generate its own leachate from decomposition?

Response: In my opinion, CCR does not release liquid during decomposition. Leachate generated by CCR is the result of the interaction of waste with infiltrating or flowing water. That is the reason for my statements indicating that effective disposal of CCR must be keep CCR segregated from water, including flowing groundwater as well as infiltrating precipitation.

21. Do you agree that municipal solid waste also contains metals?

Response: Yes, that is one reason that municipal solid waste landfills are required to have liners and leachate collection systems.

22. Do you agree that risk-based closure considerations, including restrictive institutional controls, are an effective approach to remediate contaminated sites when there are no receptors? If not, explain your answer and identify the basis for your answer.

Response: A full answer to this question would depend on site-specific conditions. The question appears to be asking if, in my opinion, it is acceptable to let groundwater contamination go unaddressed as long as institutional controls are in place to prevent future exposures. It is an interesting question, but unfortunately we cannot see into the future and know how future land use might change. For instance, the direction of groundwater flow at the Lincoln Stone Quarry site was altered by off-site pumping of groundwater associated with development of a nearby quarry. In that circumstance, off-site development caused concern for potential receptors that needed to be addressed to prevent exposures. Institutional controls might prevent exposure to receptors under then-current conditions but be ineffective at controlling contaminants under new conditions. If that development had occurred thirty-five years following site closure including institutional controls, after groundwater monitoring had been discontinued, the result could have been much different.

23. Do you agree that much of the CCR that you suggest should be removed from a CCR surface impoundment will be placed in a landfill at different location?

Response: I have no way to predict how much of the CCR removed from CCR impoundments would go to landfills at different locations. I know that some portion of the waste generated by Springfield CWLP has been transported back to the coal mine that supplies the coal for use in mine land reclamation. I am unaware if other facilities in Illinois have similar agreements. In North Carolina, Duke Energy was investigating the feasibility of recycling their excavated CCR in addition to their existing commitments to provide CCR to drywall manufacturers who had

established a least one plant adjacent to the Roxboro generating station. Construction of new landfills, both on-site and off-site, was also being considered, as was disposing of waste at existing landfills. Waste excavated from the Wateree generating station was being disposed in a new landfill that had been constructed for this purpose on adjoining property.

a. If not, identify where you believe the CCR will be disposed, and provide your basis, including any studies, you rely upon.

Response: See response to Question #23, above.

i. Provide the estimated volume of CCR to be disposed in a landfill and the estimated volume for disposal at the location(s) you identify in answer to Question 23.a. and provide your basis, including any studies, you rely upon.

Response: I have no way to predict how much of the CCR removed from CCR impoundments would go to landfills at different locations.

b. Have you conducted an evaluation of the existing landfill capacity available in Illinois? If so, what were your results?

Response: No.

c. Have you conducted an evaluation of the existing landfill capacity available in states neighboring Illinois? If so, what states and what were your results?

Response: No.

d. Assuming there is insufficient existing landfill capacity, are you aware of the process and time required for siting and permitting a new location for a landfill?

Response: It has been decades since I was involved in characterizing a property and developing a permit application for a new landfill, so, no, I do not know the current time required for siting and permitting a landfill.

i. If you are aware, what is your understanding of the process?

Response: It has been decades since I was involved in characterizing a property and developing a permit application for a new landfill, so, no, I do not know the current time required for siting and permitting a landfill.

ii. And, what is your estimate of the time required for siting and permitting a new landfill?

Response: See response to the previous question #23d(i). It is my opinion that the time required to construct a proper permanent disposal facility for CCR wastes over the long term is more important than a rapid closure.

iii. What is your estimate of the time required for the construction of a landfill and approvals prior to getting an operational permit issued?

Response: See response to the previous question #23d(ii).

e. Are you aware that the post-closure care period for putrescible and chemical waste landfills in Illinois is 30 years?

Response: I am aware of this.

f. Are you aware that upon closure, landfills may be capped with a synthetic liner?

Response: I am aware that synthetic cap materials are allowed in Section 811.314 in conjunction with a Final Protective Layer.

24. If groundwater monitoring results around an unlined CCR surface impoundment show no elevated concentrations of constituents, do you agree that there is no risk to human health or the environment by leaving the CCR in place?

Response: As long as the monitoring system is capable of detecting release contaminants and that conditions at the site do not change over time, there would likely be little risk to human health or the environment. However, as I described in my response to question #22 above, conditions occasionally do change over time and have the potential to increase risk.

a. **If you do not, please explain**.

Response: See response to question #22.

b. Also, if you do not, explain how removing CCR that is not causing elevated concentrations of constituents in the groundwater using equipment and vehicles (rail or trucks) is more protective of the environment than capping the material in place.

Response: As long as the monitoring system is capable of detecting release contaminants and that conditions at the site do not change over time there would likely be little risk to human health or the environment. However, as I described in my response to the previous question, conditions occasionally do change over time and have the potential to increase risk.

25. Provide the groundwater monitoring results for the Grainer [sic] Generating Station you describe on pages 22 and 23 of your testimony.

Response: I am attaching a spreadsheet[15] containing groundwater monitoring data from the Grainger site.

26. On p. 23 of your testimony, you refer to four monitoring points at the Grainger Generating Station. How many monitoring points are there total at the Grainger Generating Station?

Response: The groundwater monitoring data that was available at the time that I originally reviewed the data included ten monitoring wells.

a. Did all of the monitoring points exhibit a decrease in arsenic?

Response: All four of the wells that originally reported elevated arsenic concentrations showed decreases in concentration. The remaining wells did not originally contain significant arsenic and concentrations remained low.

b. Did any monitoring points exhibit no change in arsenic water quality over the same period and if so, how many?

Response: Yes, the wells that originally showed little or no arsenic originally showed no change.

c. Did any exhibit an increase in arsenic concentrations and if so, how many and what was the magnitude of that increase?

Response: No.

27. On p. 23 of your testimony, you only discuss arsenic at the Grainger Generating Station. How many parameters are analyzed at the Grainger Generating Station?

Response: My data shows multiple sample results for arsenic, iron, sulfate, and TDS. I also have results for manganese from one sampling event. I do not recall what, if any, other parameters were analyzed.

a. Of the parameters analyzed, how many exhibited similar decreases in concentrations as arsenic?

Response: I have multiple sets of data on only four parameters. Of these, only arsenic showed the concentration decline.

b. Of the parameters analyzed, how many exhibited no change in concentrations?

Response: Three parameters showed no significant change in concentration.

c. Of the parameters analyzed, how many increased in concentration?

[15] Grainger Analytical Summary (2011 – 2017) (attached hereto as Attachment 6).

Response: One upgradient well showed increases in TDS, sulfate, and iron near the end of the period covered in my data.

28. The most recent Grainger Generating Station results you discuss on page 23 are from 2017, have you evaluated data from 2018 to present? If so, provide the data.

Response: No, I have not reviewed anything from the Grainger Station since 2017.

29. In your experience, is it unusual to see substantial decreases in concentrations of contaminants during the early stages of remediation?

Response: No, it is not unusual to see substantial decreases in contaminant concentrations followed by slowing declines in concentrations. I was, however, surprised to see arsenic concentrations declining at both the Grainger and Wateree Generating Stations while excavation and removal of the wastes was so early in the process.

a. Are you familiar with the concept of diminishing returns for remedial sites?

Response: I am familiar with this concept.

b. If you are familiar with the concept of diminishing returns for remedial sites, do you agree that at some point the concentrations of constituents in the groundwater will reach an asymptotic level? If you do not agree, please explain why.

Response: I agree that remediation of sites often shows slowing improvement in water quality over time. I am not, however, sure that describing the decline in concentrations as asymptotic is correct. The term asymptotic implies that contamination will decline but never be removed. In my opinion, there will come a time when the contaminants have been removed from the groundwater.

c. If in answer to Question 28 above, you reviewed more recent groundwater data from the Grainger Generating Station, what does the more recent data show?

Response: I have seen no further information on the Grainger Generating Station, although I am aware that excavation and removal of the waste has been completed.

30. **On p. 24 of your testimony, you state that damage to a cap can occur if people "in pick-up trucks or on dirt bikes decide to turn the 'big hill out where the old plant used to be' into a playground. What is your basis for this statement?**

Response: As a young geologist, I spent two years working for IEPA doing inspections of open and closed waste disposal facilities, primarily landfills in Illinois. I then spent an additional two years working on a contract for USEPA performing site investigations at waste disposal sites

scattered around USEPA Region V. During this period, I observed the impacts of human usage of long-closed facilities, including tracks and ruts in the cover produced by vehicles, and gullies eroded into the cover in areas used for vehicle access. Once sites are no longer active and cared for, they can be popular locations for dirt bike enthusiasts to ride.

31. Identify locations in Illinois in which people have trespassed on a capped landfill with their vehicles or bikes.

Response: I do not now recall the locations of these sites.

32. Confirm that the Groundwater Impact Assessment you conducted in Illinois and described on p. 3-4 of Attachment 4 of your testimony is the Lincoln Stone Quarry in Joliet, IL.

Response: That is correct.

a. Confirm that part of the project was preparing a large and detailed numerical groundwater flow and contaminant transport model for the Lincoln Stone Quarry.

Response: That is correct.

b. Confirm that the groundwater model, developed as part of the GIA, could be used to assist in the design of the closure of the Lincoln Stone Quarry.

Response: Groundwater models in general, and this model in particular, should be a useful tool in evaluating closure alternatives. I am, however, unaware of the various scenarios under consideration for closing the Lincoln Stone Quarry, and therefore cannot specifically confirm that the model would be helpful or appropriate for evaluating all potential scenarios.

Questions from Springfield City Water Light & Power

1. Do you agree that capped CCR impoundments are less subject to settling that Municipal Solid Waste ("MSW") landfills?

Response: It is my opinion that CCR waste would settle less than municipal solid wastes.

2. When capping in place is able to cut off interaction with groundwater, is it a more environmentally friendly method of closure than transporting of waste by truck to another location?

Response: I am not aware that capping waste in place is necessarily effective at cutting off interaction with groundwater. Capping waste will reduce infiltration of precipitation. In my opinion, removing the waste by truck, as I am aware that CWLP has done for several years with

some portion of their CCR, is an environmentally-friendly remedy as long as proper controls are implemented.

3. **Do you know of existing landfills able to accept CCR wastes in the quantities necessary to close all ash ponds in the State by removal within the proposed time frames?**

Response: No, I have not looked into the availability of existing landfill space. In other states where removal of CCR is being done, the waste is generally going to some combination of disposal in new on-site landfills, transport off-site for recycling, or transport to an off-site landfill.

   a. **If so, where are these landfills located?**

Response: I have not looked into the availability of existing landfill space.

   b. **Will new landfills need to be constructed for this purpose?**

Response: See response to question #3.

   c. **Have you had experience with existing MSW landfills accepting Coal Combustion Residual ("CCR") material?**

Response: I am not involved in arranging for off-site landfill disposal of CCR.

   d. **If so, do you know whether these facilities combine it with other waste or create separate cells for this material?**

Response: I am not involved in arranging for off-site landfill disposal of CCR.

4. **On page 23 of your testimony you referenced closures by removal in South Carolina that were projected to take 8 and 9 years to complete. Are those timeframes typical? Where did the ash go in these closures?**

Response: The time required to do closures by removal will vary with the volume of waste removed. I am unaware if these would be considered typical as these were the first closures of CCR impoundments by excavation and removal that I have seen completed. The CCR at the Wateree Generating Station was disposed in a new, lined landfill constructed on property near the original impoundment. I cannot now recall where CCR from the Grainger Generating Station was disposed.

5. **You testify on page 13 that Section 845.630(a) should be amended to add a "requirement that the owner or operator on [sic] a CCR impoundment install a monitoring system capable of characterizing the liquid within the unit as well as the chemistry of leachate collected from near the bottom of the CCR unit during each monitoring event."**

a. Explain what type of monitoring system for the chemistry of leachate near the bottom of the CCR unit you are referring to?

Response: Measurement of the chemistry of leachate in an impoundment is readily accomplished by constructing a piezometer or monitoring well in filled areas of the impoundment. Construction of monitoring wells in filled areas of CCR impoundments must be carefully planned, but can be done. A map showing monitoring locations, including wells installed in filled areas of the coal ash impoundment, at the Belews Creek Generating Station in North Carolina is provided as Attachment 7[16].

b. What type of monitoring system capable of characterizing the elevation of liquid within the impoundment do you want the Board to require?

Response: Measurement of the elevation of standing water in an impoundment is readily accomplished by establishing a staff gauge in the facility. Measurement of the elevation of porewater within an impoundment need be nothing more that constructing a piezometer, or piezometers within the waste for measuring subsurface water elevation.

c. What information will be derived from these monitoring systems and how it will it be used by the permittee or the Agency?

Response: Knowledge of the elevation of liquid within unlined impoundments is necessary in order to identify local groundwater gradients that might indicate mounding beneath an impoundment. Mounding can cause wells that would otherwise be located upgradient of an impoundment to actually be downgradient of the impoundment due to radial flow.

d. How much will your recommendation cost?

Response: I have no estimate of anticipated costs, but they should be similar to that of installing a typical monitoring well in your area.

6. Is it your opinion that floodplains need to be included in the definition of unstable area in Section 845.340(a) and 845.120? If so, what definition of floodplain are you relying on for this recommendation?

Response: See response to Board Question #8. I have made no specific recommendation for the definition of floodplain, but the 1% annual chance of recurrence flood, as identified by FEMA, would provide a good estimate of the floodplain.

7. What is the difference between the term "uppermost zone of saturation" you suggest for Section 845.700 and the term "highest seasonal zone of saturation" which you suggest for Section 845.220(b)(1)(A)?

[16] Duke Energy Carolinas, LLC, Sample Location Map: Belews Creek Generating Station, Stokes, N.C. (Aug. 2016).

Response: For the sake of simplicity, I suggest that I retract my use of the term "highest seasonal zone of saturation" and retain "uppermost zone of saturation." The elevation of water in the uppermost zone of saturation is the elevation of water in the highest saturated zone encountered in the subsurface.

8. **On page 9 you state "Floods with a probability of 1% in any year are becoming more common as the climate warms."**

    a. **Are you relying on particular sources when you make this statement or are you just speaking in general terms?**

Response: I was speaking in general terms but am aware of documents such as the one cited in comment c below, that summarizes its findings by stating that "the results of this study generally show increasing precipitation amounts at selected frequencies for most of the sections with some relatively smaller decreases in the southern and western sections of Illinois."[17] This study indicates that the total annual precipitation and observed number of precipitation events in Illinois is increasing over time.

    b. **Are you referring to the size of large storms or their frequency?**

Response: The frequency of extreme storm events has been shown to be increasing in Illinois.

    c. **Do you agree that the size of the 1 hour, 100-year flood in the southern half of Illinois has not grown in the last 30 years according to the current version of Bulletin 70? (See Exhibit 41 of Andrew Rehn testimony).**

Response: Review of Figure 13 of Bulletin 70 shows declines of a few hundredths of an inch for the 1-hour, 100-year storm frequency in southern Illinois as compared with increases of almost half an inch in northern Illinois. This document states that "the results of this study generally show increasing precipitation amounts at selected frequencies for most of the sections with some relatively smaller decreases in the southern and western sections of Illinois."[18] Cherry-picking data that happens to show minimal declines in rainfall in one part of the state for one particular storm frequency and duration simply verifies the common understanding that the effects of climate change are not occurring at the same rate in all locations.

Signed,

Date: September 24, 2020

[17] Illinois State Water Survey, 2019, Frequency Distributions of Heavy Precipitation in Illinois: Updated Bulletin 70, March 2019.
[18] Illinois State Water Survey, 2019, Frequency Distributions of Heavy Precipitation in Illinois: Updated Bulletin 70, March 2019.

LIST OF ATTACHMENTS FOR MARK HUTSON (via separate transmission)	
	Group 1
Attachment #	**Description**
1	AMEC Earth and Environment, 2010, Natural Attenuation of Arsenic Demonstration, Chesapeake Energy Center Ash Landfill, Chesapeake, Virginia, June 7, 2010
	Group 2
1	AMEC Earth and Environment, 2010, Natural Attenuation of Arsenic Demonstration, Chesapeake Energy Center Ash Landfill, Chesapeake, Virginia, June 7, 2010 (continued)
2	85 Fed. Reg. 53, 516 (Aug. 28, 2020)
3	USEPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, Office of Solid Waste and Emergency Response, Directive 9200.4-17P, April, 1999
4	USEPA, 2015, Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites, Office of Solid Waste and Emergency Response, Directive 9283.1-36, August 2015
5	2016 Analytical Results (January-March), Roxboro Steam Electric Plant, Duke Energy Progress, LLC
6	Grainger Analytical Summary (2011 – 2017)
7	Duke Energy Carolinas, LLC, Sample Location Map: Belews Creek Generating Station, Stokes, N.C. (Aug. 2016)

CERTIFICATE OF SERVICE

The undersigned, Jennifer Cassel, an attorney, certifies that I have served by email the Clerk and by email the individuals with email addresses named on the Service List provided on the Board's website, *available at* https://pcb.illinois.gov/Cases/GetCaseDetailsById?caseId=16858, a true and correct copy of the **PREFILED ANSWERS OF MARK HUTSON**, before 5 p.m. Central Time on September 24, 2020. The number of pages in the email transmission is 428 pages.

Dated: September 24, 2020

Respectfully Submitted,

/s/ Jennifer Cassel

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